The Unproductive Wealth of Nations

The Case of Gold in India

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Soroush Sabet Jonas Gathen*

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Abstract

In advanced economies like the US, households allocate a large share of their savings to financial assets that fund productive investment. In contrast, household balance sheets in developing countries are dominated by non-financial and often unproductive assets such as gold. This paper quantifies the development costs of unproductive savings, focusing on the case of gold in India, where private gold holdings account for nearly one-fifth of aggregate assets. We develop a rich equilibrium model of households' portfolio choice and entrepreneurial investment in the presence of financial frictions. The model incorporates the main reasons for holding gold (preferences, returns and hedging, and liquidity) and matches key macro and micro moments of the Indian economy. We find that unproductive savings matter, but policies that narrowly focus on discouraging gold holdings will backfire. If idle gold could be utilized productively, output would increase by 13%. However, taxing gold leads to welfare losses and no output gains.

*Jonas Gathen: Tilburg University, j.gathen@tilburguniversity.edu. Soroush Sabet: London School of Economics, s.sabet@lse.ac.uk. We particularly thank Matthias Doepke & Ben Moll for their continued support and helpful feedback. We further thank in no particular order, Christian Hellwig, Rachel Ngai, Wouter Den Haan, Vedant Agarwal, and Mokul Gupta for great comments. We are also grateful for useful comments from participants of LSE's CfM workshop and Tilburg's internal Economics seminar. Dans Staermans provided fantastic research assistance and we acknowledge generous support from CEPR's STEG PhD grant. Last but not least, a special thanks to Vimal Balasubramaniam for generously sharing replication material.

1 Introduction

There are large differences in the types of assets that households save in. In rich countries like the US, a large share of household savings is held in financial assets such as deposits, bonds, and pension funds, which are channeled into productive investments. In contrast, in developing countries like India, financial assets are almost absent from household balance sheets. Instead, households often save in *unproductive* assets – assets that do not end up as capital in production – such as gold, foreign currency, idle real estate, and digital assets. At the same time, businesses in developing countries often lack capital and face severe credit constraints.

This paper asks whether it matters quantitatively that significant shares of household savings are in unproductive assets. We focus on the case of gold in India. Gold is the prototypical example of an unproductive asset; it mostly sits idle and the share of gold used in production is negligible. Importantly, gold can always be traded internationally for productive capital. Gold is also quantitatively important: its stock in India is around 60% of GDP, more than six times the size of aggregate bank deposits. Was Keynes (1913) right to believe that "India's love of the precious metals" has ruined "her development"?

To quantify the aggregate costs of (unproductive) gold savings, we build a rich equilibrium model of household business investment and portfolio choice. Households can save in gold and two productive assets: deposits and capital for their own business. Gold can thus directly crowd out productive investment; and aggregate savings are not equal to aggregate capital. The model incorporates three main motives for holding gold: (1) social norms, (2) hedging against aggregate income risk and financial returns, and (3) liquidity benefits. In line with the Indian data, there is only a small corporate sector and most output is produced by household businesses that face financial constraints. Finally, we calibrate the model using a combination of micro and macro moments and validate it using a rich set of untargeted moments, including household balance sheets across the wealth distribution, the firm size distribution and business-level returns to capital.

We establish two main results. First, unproductive savings matter. If idle gold could be utilized productively, output and welfare would increase by 13% and 10.7%, respectively. This is because bringing idle gold back into the financial system increases aggregate savings, relaxes borrowing constraints, and reduces existing misallocation. Second, discouraging gold demand backfires and policy should instead focus on addressing the root problem of financial frictions. Taxing gold leads to welfare losses and no output gains. Instead, gold demand would drop sharply if collateral constraints were relaxed.

A development accounting exercise.— To benchmark our main results and gain intuition, let us start with a naive thought experiment: how much would Indian output increase if India, as a small open economy, trades its existing stock of gold for capital goods from the rest of the world? Assuming a Cobb-Douglas aggregate production function as is standard in the development accounting literature, aggregate output gains can be written as:

$$Y = ZK^{\alpha}N^{1-\alpha} \implies \frac{Y^{cf}}{Y} = \left(\frac{\text{Gold} + K}{K}\right)^{\alpha} \tag{1}$$

where Y denotes baseline aggregate output, and Y^{cf} aggregate output if the gold stock were to be fully traded for capital. With a capital-output ratio of 2.7 [1], a capital elasticity of $\frac{1}{3}$, and a gold-output ratio of 0.6, the "aggregate costs of gold" $\frac{Y^{cf}-Y}{Y}$ would be 7%, a sizable cost.

Our model captures two important aspects that are crucial for the quantitative results, but which the development accounting exercise misses. First, we model the drivers of household saving decisions, including demand for gold. Aggregate capital and gold in an economy are the result of saving decisions by households. Mechanically trading aggregate gold for capital goods ignores how households' portfolio choice and saving behavior endogenously respond to changes in the economy. Second, output costs depend on how capital is distributed across (household) businesses. The development accounting exercise implicitly assumes away any misallocation across businesses by assuming a representative firm. However, misallocation across businesses in India is well-documented, and endogenously responds to changes in the economic environment.

We consider three main motives for holding gold. The first motive is social norms around gold, including the special role of gold in Indian weddings, the dowry system, and wealth signaling. We model it as "gold in the utility", so that households directly derive a flow utility from the stock of gold they hold, similar to a durable consumption good. The second motive is about gold as an investment good. Our model captures important aggregate risks to wage income and business profits, and gold can be used as a hedge against this risk since the gold price tends to depreciate in economic booms and appreciate in economic busts. Besides hedging, gold also has small positive conditionally expected returns in some states of the world, which makes it attractive to households with no access to lucrative investment opportunities. The third motive is liquidity: gold can be used to underwrite loans, capturing the quantitatively important role of "gold loans" in India.

[1] According to national accounts data and detailed capital data of the Penn World Table dataset.

Alongside gold, there are two productive assets available to households: bank deposits that pay a safe interest rate, and investment in households' own business whose risky returns depend on their idiosyncratic productivity as well as aggregate productivity in the economy. Returns to and investment in productive assets are directly affected by three important financial frictions that realistically capture India's underdeveloped financial system. First, returns on bank deposits are low, given large spreads between deposit and borrowing rates as observed in the data. Second, we model standard collateral-based borrowing constraints that capture important and well-documented financial frictions even for larger businesses in India (Banerjee & Duflo, 2014). Borrowing constraints drive misallocation across businesses and explain heterogeneous returns to capital that can be particularly large for productive firms that are constrained. Third, there is no equity market in line with its small role on household balance sheets. Less productive households are thus deprived of access to lucrative business investments: absent a mature equity or debt market that allows them to supply capital to the most productive yet constrained entrepreneurs, they park their savings in gold (along with deposits).

We calibrate our model mostly on aggregate data, as is typical in macroeconomics; this includes data from Indian financial and national accounts, aggregate moments from household-level micro data (AIDIS: All India Debt and Investment Survey) including information on household borrowing, collateral use, and asset holdings; and microdata on household businesses for example to discipline parameters of the stochastic process on entrepreneurial productivity with data from a large panel of small- and medium-sized enterprises (IHDS:. Indian Human Development Survey). Finally, for calibrating the aggregate risk, we rely on the gold price data from the central bank of India (RBI) while backing out the aggregate TFP from a well-known dataset on the Indian corporate sector, CMIE (Centre for Monitoring Indian Economy) *aka* "Indian Compustat". We then carefully validate the model using some untargeted distributional moments that are key for our investigation. This is to ensure that the model correctly captures the main features of household balance sheets across the wealth distribution, firm size distribution (from the Indian Economic Census). Finally, we also validate the (micro) returns to capital by replicating the RCT by De Mel et al. (2008) in our model.

With the calibrated model in hand, we start quantifying the drivers of saving in gold. We find that social norms account for 42.7%, financial returns and hedging account for 47.3%, and liquidity motives account for 10% of aggregate gold holdings. However, these contributions vary significantly across the wealth distribution. For poor households who – both in the data and our model – hold the highest shares of their assets in gold, the social norm channel dominates, explaining about 80% of gold holdings. The case of poor but productive entrepreneurs is of particular interest: they want to expand their business and accumulate capital to self-finance themselves out of poverty, while being motivated by social norms to allocate part of their savings in gold. Wealthy households, on the other hand, hold much lower shares of their assets in gold, and social norms also account for a smaller part of it, around 25%. For wealthy households, return and hedging motives dominate. Finally, we find that gold saving shares decline with business productivity because productivity increases the marginal product of capital, thus raises the opportunity costs of holding gold.

We then set out to establish our first main quantitative result on the aggregate costs of gold being unproductive. For this, we follow a thought experiment analogous to the development accounting exercise: what would happen if idle gold could instead be used productively? Suppose that banks could *monetize* a fraction of the gold that remains idle at any point in time and depositing it for households. In the limit case where all gold could be monetized, we find large aggregate output gains of 13%, much larger than the 7% predicted by the naive development accounting exercise. Incidentally, in this exercise aggregate capital increases by almost the same level as suggested by the development accounting. Output gains are much larger because most of the additional capital ends up in the hands of the most productive households. The monetization of gold allows the poor but most talented entrepreneurs to borrow more, expand their business more rapidly, and end up being much wealthier in equilibrium. However, beneficiaries of this exercise are not exclusively the most productive households: all households, particularly the poor, benefit from the more relaxed borrowing constraints, which also explains the large welfare gains. Although we conclude from this exercise that whether assets are unproductive matters for the aggregate economy, there are clearly practical limitations to making gold productive. In India, the *Gold Monetization Scheme* is one example policy that tried to utilize idle jewelry in the economy but ultimately failed to gain traction, potentially due to a lack of trust, but also for ignoring that gold in the form of jewelry is most tied to the social norm, and households did not like the requirement that their jewelry will get melted and reshaped in the process.

Our second main result is more policy-focused: Given the large aggregate costs of unproductive savings, it may be tempting to try to discourage gold holdings. We show that this backfires and that policy should instead focus on the underlying frictions that cause households to hold more unproductive savings. Specifically, we quantify the output and welfare effects of taxing gold and redistributing proceeds lump-sum. We find that output does not increase and welfare even decreases. Since gold enters utility, taxing gold hurts welfare similar to a consumption tax. Furthermore, it decreases the financial return to gold, thereby shrinking the investment opportunity set of households. This makes households poorer and decreases the overall level of aggregate savings. This negative wealth effect largely cancels out the policy's substitution effect from gold to productive capital. In contrast, if policy could directly relax financial frictions (i.e., collateral constraints) aggregate gold holdings would sharply decrease and output would increase.

Finally, we look closer into the societal norms that drive preferences for gold, and ask whether it matters that society values saving in unproductive rather than productive assets. For this, we first show strong empirical support in survey data that signaling wealth is a major driver for holding gold in India. We then consider a counterfactual in which society also appreciates holding productive capital, introducing "spirit of capitalism[2]" into the social norms. If 20% of norm-driven demand for gold is for status signaling, and there is a change in norms such that signaling is now associated with business assets, aggregate output would increase by more than 20%. Huge output gain comes from business investment becoming more attractive, particularly for the most productive households who now rely mostly on their business assets for signaling. Hence, saving rates increase significantly, leading to larger stock of capital in equilibrium, while capital misallocation reduces. This indicates how social norms can imply even larger aggregate costs of unproductive savings.

Related literature.— This paper contributes to three strands of literature. First and foremost, this paper contributes to the literature on Saving, Finance and Development. To the best of our knowledge, this is the first paper to quantitatively revisit an old question raised by Keynes (1913) a century ago, that has since resonated with policy makers in many of developing countries: to what extent are unproductive savings responsible for lower investment and output? What distinguishes our paper from earlier theoretical contributions such as (e.g. Acemoglu & Zilibotti, 1997; Greenwood & Jovanovic, 1990) is, in the first place, the quantitative nature of our investigation: we providing an actual estimate of the costs of unproductive savings in a model that can account for household balance sheets and distribution of business profits in developing countries. Moreover, the above papers do not contain an unproductive saving device properly speaking: they are

[2]"Spirit of capitalism" models, formalized by Bakshi and Chen (1996) and Carroll (1998) among others, introduces wealth into the utility function, either in the absolute or relative terms. Calvet and Sodini (2014) provide empirical support for its role in the context of portfolio choice. Here we use a variant of Model 1 in Bakshi and Chen (1996).

mostly limited to two productive technologies, one less and one more productive that are different only in terms of risk or fixed costs.

Second, this paper introduces household finance and portfolio choice into the Macro Development literature (e.g. Buera et al., 2011; 2021; 2023; Moll, 2014). We draw upon the theoretical Household Finance literature on asset allocation and portfolio choice with durables (e.g. Campbell & Viceira, 2002; Flavin & Yamashita, 2002; Piazzesi et al., 2007; Yogo, 2006) and comparative household finance (Badarinza et al., 2016), but contribute in three ways. First, we consider the aggregate implications for development when assets on household balance sheets differ not only in their risk-characteristics, but also in how productive they are. Second, we introduce gold as a new asset. Gold is quantitatively important in a development context and we realistically capture the main features that make it appealing to households: e.g. gold loans, financial returns and hedging, and the social norms around it. Third, the riskiest and most productive asset in our setup is entrepreneurial business with a decreasing-returns-to-scale technology, subject to both idiosyncratic and aggregate risk. Finally, our contribution to the Macro Development literature is to make the household portfolio choice center stage: the entrepreneur does not merely decide on the size of their business or how much to borrow, they also consider holding gold to hedge against shocks to their business, for its liquidity, or because of social norms. And their decisions differ in good or bad states of the world (low or high TFP), contributing to booms and bust.

Finally, we contribute to Micro Development literature on household savings and business investment in developing countries, including (e.g. Karlan et al., 2014; Schaner, 2018) on savings and (e.g. De Mel et al., 2008) on the returns to capital. While we do not model any behavioral frictions in savings, our model can account for observed micro returns to household business capital and savings responses of households. Hence, our model can offer insights on aggregate implications of savings and financial frictions.

The rest of the paper is structured as follows. Section 2 introduces the data and establishes main stylized facts on unproductive savings and gold in particular. Section 3 introduces the model and Section 4 discusses the calibration and validation exercises. In Section 5, we quantify the aggregate costs of unproductive savings and consider the role of policy. Section 6 concludes.

2 Empirical evidence

The aim of this section is to give an overview of the importance of unproductive forms of savings on household balance sheets. The focus is on India and we start by describing the data that we use throughout.

2.1 Data

The main data we draw on is the 2013 wave of the *All India Debt and Investment Survey* (AIDIS), which is a large-scale survey that provides representative information on household balance sheets across Indian households (NSSO, 2013). To compare India to a rich country, we also draw on the 2010 wave of the US *Survey of Consumer Finances*, SCF (2010) in short. To study how household balance sheets changed over time, we also draw on the 2019 AIDIS wave.

AIDIS is the oldest running survey on household wealth in developing countries, first conducted by the Reserve Bank of India (RBI) in 1951-52. Similar to the SCF, it contains detailed questions on all major categories of household wealth holdings. For the purposes of this paper, we group assets into six broad asset classes: (1) Residential real estate, (2) Vehicles, (3) Business assets, (4) Gold, (5) Deposits, and (6) Financials. Table 1 provides a detailed overview of what we include under each of the six asset classes for AIDIS and the SCF respectively. Importantly, we look at *net* assets, subtracting asset-specific debt when possible. One implication of focussing on these categories of net assets is that we ignore consumption-related debt such as credit card debt and student debt, which is important at the left tail in the US, but not sizable in India.

AIDIS has a large sample size with over 100k household observations for both the 2013 and 2019 waves, compared to the SCF with only roughly 6,500 households. The data quality of AIDIS is also generally considered to be high, but it does suffer from drawbacks. Most importantly and as for the SCF, AIDIS is only a repeated cross-section, not a panel dataset, preventing us from zooming closer into within-household changes in wealth. Second, AIDIS does not have good information on household income nor does it have good information on costs and revenues for household businesses. For these reasons, we complement our analysis with detailed information on household businesses and household income using the India Human Development Survey (IHDS), a nationally representative panel with waves from 2005 and 2012 (Desai & Vanneman, 2005; 2012). Third, as is common for wealth surveys, AIDIS struggles to correctly capture the far right tail of the

Common class	In AIDIS	In SCF
Residential real estate	Net equity in residential buildings; Residential urban and rural land	Net equity in primary residence of household and other residential real estate held by household
Vehicles	Transport equipment for household use	All (private) vehicles less corresponding debt
Business	Total of the following categories less all outstanding debt for business capital expenditure: Livestock and poultry; Agricultural machinery and implements; Non-farm business equipment; Transport equipment used mainly for farm or non-farm business; Non-residential buildings and land	Total value of business(es) in which the household has either an active or nonactive interest (net equity value of the household's interest); Net equity in nonresidential real estate
Gold	Bullion & ornaments	Other non-financial assets held by household (gold, silver, jewelry, antiques, art, etc.)
Deposits	Government deposits, NSC, KVP, saving bonds, post office deposits, other small savings schemes, etc.; Bank deposits; Deposits with non banking companies; Deposits with micro-finance institutions/self-help groups	All types of transactions accounts; Certificates of deposit
Financials	Shares & debentures; Annuity schemes; Fund shares; Insurance schemes; Receivables	Directly held stocks; Directly held pooled investment funds; All other financial assets

Table 1: Construction of common asset classes from AIDIS and SCF underlying data.

wealth distribution (Deaton, 2005).[3] As one data check, we compare the AIDIS-implied stock of aggregate bank deposits with the official RBI estimate based on bank-reporting; we find that AIDIS underestimates aggregate deposits by roughly 30%. While our model helps us to extrapolate for the far right tail, this only works well if the very wealthy do not behave systematically different.

We closely follow Badarinza et al. (2019) for cleaning the AIDIS data to ensure comparability with previous research. Specifically, we restrict observations where the household head is at least 24 years of age, remove observations with no assets, negative values of urban land or negative values for company shares held, as well as households that have reported residential real estate or transport of value higher than their total real estate and transport ownerships. For SCF, we also remove records with negative real estate values and business holdings. These restrictions ensure that net asset shares are always positive. Appendix D provides further details on the data cleaning. These data cleaning steps have small effects on the overall sample; we only remove 2.6% and 2.4% of observations for the 2013 and 2019 waves respectively, and 5.5% for the SCF.

[3]In contrast, the SCF is one of the few surveys that captures the far right tail by administering an additional list sample of wealthy households to deal with higher non-response rates among the wealthy Kennickell (n.d.).

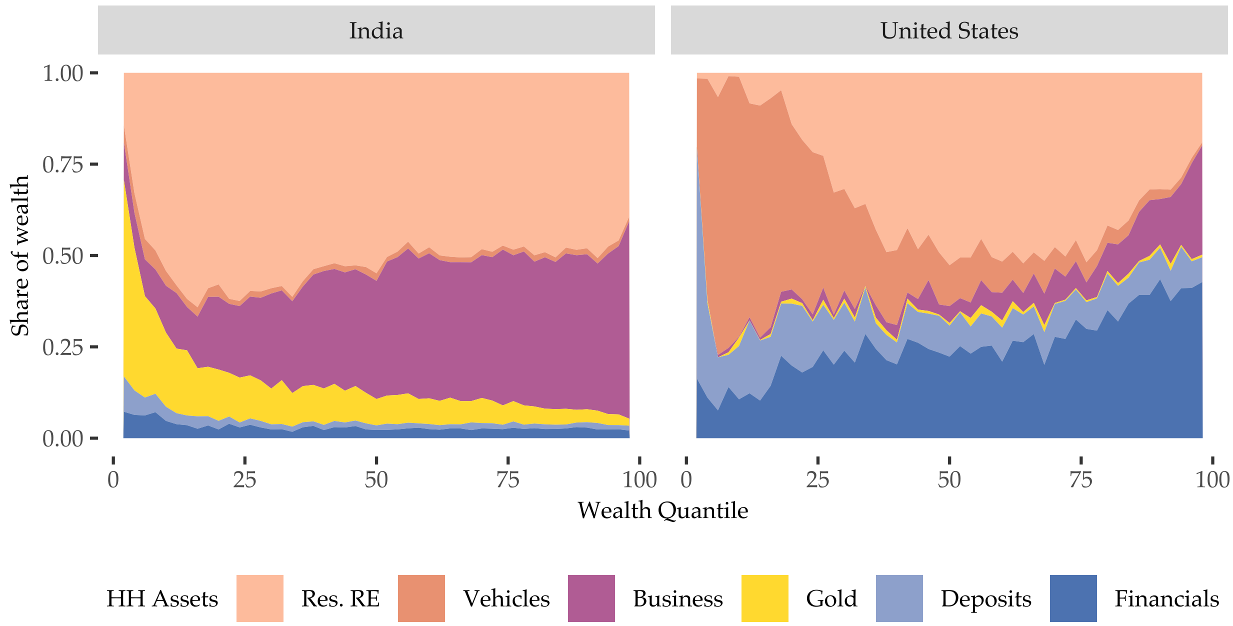
2.2 Main stylized facts

We start with a general overview of the household balance sheet distribution in Figure 1, comparing India to the US. Household balance sheets look remarkably different in India and the US in at least three important ways. First, deposits and financial assets play a small role in India, while they account for about 38% of total household assets in the US, with a split of 25% and 13% respectively. This difference is even stronger at the right tail; the wealthiest 10% in India hold less than 4% of their wealth in deposits and financial assets, while wealthy households in the US hold about half their wealth in them. Second, while the importance of residential real estate (i.e. housing) is broadly comparable in the two countries, business wealth differs completely. Due to the importance of agriculture and much higher shares of self-employment, business wealth accounts for more than 30% of the aggregate household wealth in India. In contrast, business wealth in the US is mostly a feature of the right tail, in line with Bricker et al. (2014) and Smith et al. (2022). Third, and most importantly for this paper, gold plays a central role on household balance sheets in India, while it is almost entirely absent from household balance sheets in the US (<1%). The aggregate household wealth share in gold is 11% in India, making up around 40% of wealth at the left tail and then slowly decreasing over the wealth distribution.

In the Appendix, we provide further evidence. Figure A1 compares India and the US in terms of the level of wealth instead of the distribution, allowing us to compare similarly wealthy households in India and the US. The three main results above also hold conditional on the level of wealth; at every single level of wealth that can be compared, US households hold much less gold and business assets and much more financial assets. Of course, in this exercise we cannot compare the richest households in the US since they have no counterpart in India, and we cannot compare the poorest households in India because they have no counterpart in the US. Figure A3 looks at changes in the wealth distribution in India between 2013 and 2019. Patterns are very similar, but the biggest change between 2013 and 2019 has been an increasing importance of deposits at the left tail, and an overall bigger role for financial assets at the right tail. Throughout the paper, we use the 2013 AIDIS wave as main target for our model economy, but return to the change between 2013 and 2019 for when we discuss policy counterfactuals.

While Figure 1 gave an overview of the entire balance sheet of Indian households, our subsequent model abstracts from some features of the balance sheet which we think are either not key to our story or difficult to incorporate. Specifically, we abstract from residential real estate and vehicles, focusing only on the remaining four categories of household assets. Vehicles are small in India and given that they are durable consumption

Figure 1: Average household asset allocation by wealth quantile

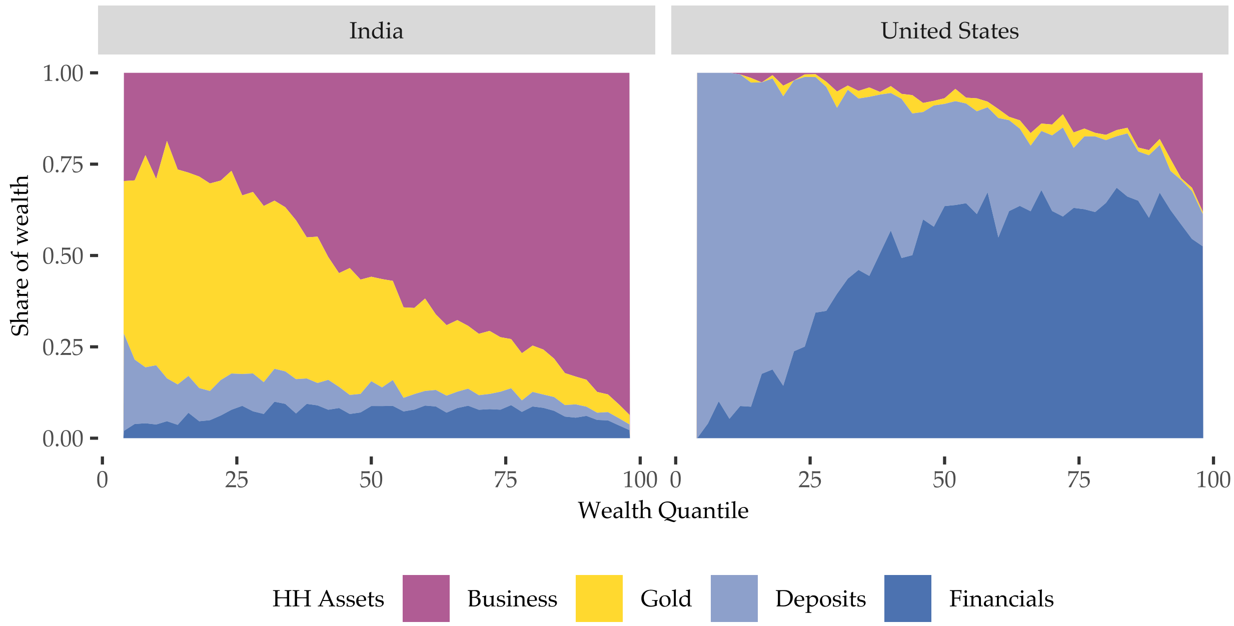


Note: Data is based on the 2013 wave of AIDIS for India and the 2010 wave of the SCF for the US. Total wealth is the sum of net assets across the six asset classes (details in Table 1). "Res. RE" refers to residential real estate. Quantiles are computed independently for each country and the figure is smoothed by showing average shares within 50 equal-sized wealth bins. The figure restricts to (weakly) positive net assets and drops households with zero overall wealth, which affects less than 2% of observations in India and the US respectively. Since consumption is not part of assets, we do not include consumption loans in our measure of wealth.

goods, we implicitly incorporate them as consumption goods in the model. Residential real estate, on the other hand, is large, but given the difficulty of disentangling productive and unproductive forms of real estate and the additional complications of modeling a housing and land market, we abstract from it in this paper. As for vehicles, we implicitly capture housing as a durable consumption good as part of consumption in the model, but we fully acknowledge its limitations. In the conclusion, we return to the issue of abstracting from housing and discuss how this might bias our main results.

Figure 2 shows the main household balance sheet when abstracting from residential real estate and vehicles. The three stylized facts are now even clearer: (1) Deposits and financial assets are minor in India, while they are dominant in the US, (2) household business assets are dominant and increasing with wealth in India, and (3) gold makes up a sizable share of household wealth but is declining with wealth. For the remainder of the paper, Figure 2 serves as the main reference for the wealth distribution in India.

Figure 2: Average household asset allocation by wealth quantile



Note: Data is based on the 2013 wave of AIDIS for India and the 2010 wave of the SCF for the US. Total wealth is the sum of net assets across four asset classes: Business assets, Gold, Deposits and Financials. This figure drops net residential real estate vehicles. Quantiles are computed independently for each country and the figure is smoothed by showing average shares within 50 equal-sized wealth bins. The figure restricts to (weakly) positive net assets and drops households with zero overall wealth, which affects less than 2% of observations in India and the US respectively. Since consumption is not part of assets, we do not include consumption loans in our measure of wealth.

3 The Model

We proceed by quantifying the aggregate costs of unproductive savings within a model of household saving and investment behavior. Households can save in productive and unproductive assets. For productive assets, we consider physical capital in household's own business, and deposits. We focus on gold as the unproductive asset given its importance in the Indian context.[4]

To accurately capture why households invest in gold rather than in more productive assets, the model incorporates three main motives: (1) households obtain direct utility from holding gold, in line with the cultural value of gold and the importance of gold in the dowry system; (2) households earn returns on gold in the form of capital gains from changes in the (global) gold price and the fact that gold depreciates little; and (3) house-

[4] As previously noted, we abstract from residential real estate and vehicles in this model, but capture durable consumption goods implicitly via consumption. What to add on land here?

holds can use gold as a hedge against other risk they face, given that the (global) gold price is allowed to covary with other aggregate risk. We model aggregate risk in terms of an exogenous global gold price and (exogenous) aggregate TFP that captures in a reduced form way different sources of aggregate risk such as changes in aggregate demand or exchange rate shocks. We model India as a small open economy that trades with the world and also accesses international financial markets for borrowing and lending. Importantly, in line with the data, India does not directly produce gold itself, so that it relies on imports of gold to satisfy excess demand. We believe that this realistically captures the first-order policy concern of Indian policy makers that large imports of gold crowd out capital imports.

Demand for gold is also driven by the returns to alternative investment opportunities, namely capital and deposits. To accurately capture returns on capital, we consider a rich household production side similar to Moll (2014) & Buera et al. (2021) and in line with the importance of household businesses across the entire wealth distribution in India. Households differ in the productivity with which they run their business and they face risk over their future productivity. Household businesses use both labor and capital. For labor, they can draw on family labor or, if they are productive enough, hire outside labor. For business capital, households can invest their own savings and also borrow capital from the financial market. However, in line with the ubiquity of collateral constraints in India, household businesses face standard financing constraints that limit their borrowing. One key novelty is that we do not only model collateral constraints in own capital but also allow households to collateralize (parts of) their gold, in line with the importance of gold loans in India. This introduces a potentially positive impact of gold, as it makes it easier for household businesses to borrow capital.[5] Finally, households can also choose to deposit parts of their wealth to diversify risk and to earn (safe) financial returns. A domestic financial intermediary collects all deposits and lends these to household businesses or the corporate sector. We model a separate corporate sector that demands both capital and labor to realistically account for the part of the Indian economy that is not captured by household businesses.

Model setup.— Our economy features three main actors: a corporate sector, a financial intermediary and a continuum of households of measure 1. There exist two goods in this

[5]This introduces a trade-off between the direct crowding-out of productive savings and the crowding-in from productive investments via the collateral channel. A similar trade-off is also key in Tirole & Farhi (2008), who consider it in a "short-run" setting of financial bubbles. The main difference is that we do not endogenize the price of gold and do not allow for a bubble, since we are interested in the long-run effects of holding unproductive assets.

economy: a consumption good (which can be freely converted to capital), and gold. The consumption good serves as numéraire and time is discrete. We denote the (exogenous) aggregate state of the economy by $\mathbf{\Omega} = \{P^g, Z, r^*\}$ where P^g denotes the global gold price, Z denotes aggregate TFP, and r^* the global interest rate. The endogenous domestic wage is denoted w. We start by describing households.

3.1 Households

Preferences.— Households seek to maximise lifetime expected utility:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U(c_t, g_{t+1})$$

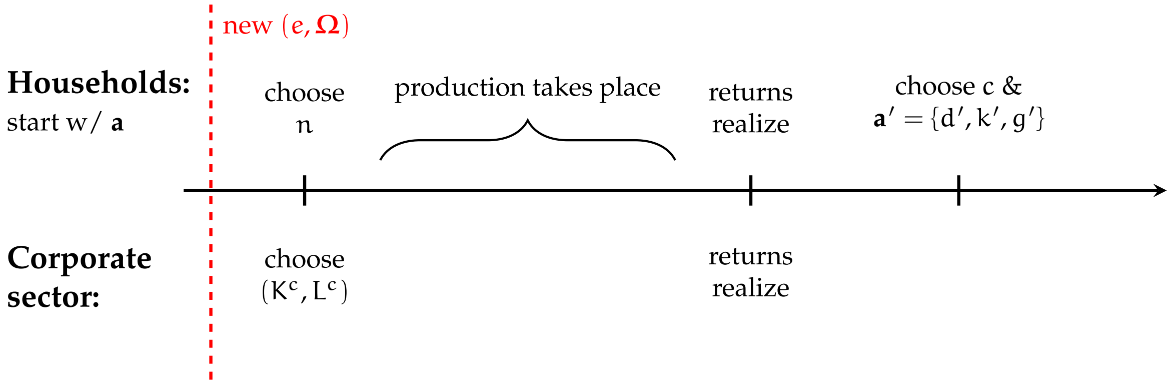
where preferences for consumption c and gold g are described by:

$$U(c, g) = \frac{1}{1-\gamma} \left[\left((1-\theta_g)^{\frac{1}{\varepsilon}} c^{\frac{\varepsilon-1}{\varepsilon}} + \theta_g^{\frac{1}{\varepsilon}} g^{\frac{\varepsilon-1}{\varepsilon}} \right)^{\frac{\varepsilon}{\varepsilon-1}} \right]^{1-\gamma} \tag{2}$$

This utility function combines standard inter-temporal CRRA preferences with standard intra-temporal CES preferences. We denote the coefficient of relative risk aversion by γ and the elasticity of substitution between gold and the consumption good by ε. For $\varepsilon \in (0, 1)$, gold and the consumption good are complements, which will be the empirically relevant case. Complementarity pushes households towards balancing gold and consumption, and marginal utility of gold is increasing in consumption. We include the stock of gold g in the utility function and assume households derive a flow utility from holding gold, similar to a durable consumption good. This flow utility is proportional to θ_g, which also denotes the utility weight of gold, capturing the cultural importance of gold beyond its return properties as an asset. The same intra-temporal CES aggregator is used in the literature to model preferences over (other) consumption and houses Piazzesi and Schneider (2016) or non-durable and durable consumption Yogo (2006).

Timing.— Figure 3 gives an overview of the main model timeline. Households enter a period with the wealth position $\mathbf{a}$. Wealth is composed of three different assets that have been chosen in the previous period: physical capital k, deposits (or debt) d, and previous gold holdings g. After both the (exogenous) idiosyncratic business productivity e and the aggregate state of the economy $\mathbf{\Omega}$ are revealed at the start of the period, households choose how much labor n to hire for their business. After production, households earn labor income, and returns on all components of their wealth–including their business–

Figure 3: Main timeline of model



are realized. They then make choices on consumption c and new asset position $\mathbf{a}' = (d', k', g')$ that they carry forward to the next period.

The budget constraint.— Conditional on labor hiring n at the start of the period, households face the following budget constraint (in recursive notation):

$$c + \underbrace{d' + k' + P^g g'}_{\equiv \text{ savings } a} \leqslant w + \overbrace{R^f d + \underbrace{y(k, n, e, Z) - wn}_{\equiv \text{ HH business returns}} + (1-\delta)k + P^g g}^{\equiv \text{ ex-post HH net worth } \tilde{a}} \tag{3}$$

Household's income consists of labor earnings and total sum of returns on previous savings choices, that is, the ex-post net worth $\tilde{a}$. Since each household is endowed with one unit of labor which they supply inelastically each period, labor earnings are w.[6] Ex-post net worth $\tilde{a}$ is composed of total return to investment in physical capital k (which includes household business returns in addition to undepreciated capital $(1-\delta)k$), financial returns on gold holdings which depend on the price of gold P^g (capital gains), and risk-free return on deposits.

Household can also borrow, in which case $d' < 0$, but due to the imperfect nature of credit markets, their borrowing is constrained by the size and composition of their wealth. In particular, they need collateral to borrow, which can be in the form of physical capital – as is standard in the macro-development literature Moll (2014) – or gold. We also consider gold as a collateral because of the importance of *gold loans* in India, where they constitute

[6] In terms of accounting, any payment of wages by household business to labor of its own members is accounted for as labor earning, separated from net business income (the gross operating surplus). For example, if $n^*_{it} = 1$ and the household's business only employs the labor of its own members, the wage payment w_t is referred to as labor earning of the household, netted out from their business income. The advantage is more clear notation when analyzing the optimal asset allocation between own capital, gold and deposits.

a significant portion of the secured loan market. Specifically, we assume that:

$$d' \geqslant -\phi_k k' - \phi_g (P^g g'), \qquad \phi_g, \phi_k \geqslant 0 \tag{4}$$

where (ϕ_k, ϕ_g) reflect the strength of financial markets, with lower ϕ corresponding to less developed financial markets. In particular, $\phi_k = \phi_g = 0$ implies no external borrowing is possible, and $\phi_g = \phi_k = 1$ corresponds to the case of perfect credit markets. Following Buera et al. (2011), Buera and Shin (2013) and Buera et al. (2015), the term "perfect credit" applies to frictionless borrowing only for funding trading of assets and does not extend to consumption insurance. .

Households make deposits or borrow money from financial intermediaries, both at the same risk-free rate $R^f = (1+r^f)$. While deposits offer a risk-free saving vehicle, investment in both capital and gold is risky. Financial returns to gold are driven by changes in the global gold price, whereas return to household business are subject to both aggregate risk (aggregate TFP Z) and idiosyncratic risk (household's productivity e). In particular, conditional on the hiring choice n, household business return that we define as sum of the household's profit and factor payment to capital, in other words, total revenue of household's business less compensation of employees, is given by

$$y(k, n, e, Z) - wn = eZ(k^\alpha n^{1-\alpha})^\eta - wn, \qquad \eta \in (0, 1) \tag{5}$$

with η denoting the span-of-control parameter. Since the productivity of the household business is given by product of the idiosyncratic and the aggregate productivity, attractiveness of investment in physical capital is subject to both idiosyncratic and aggregate productivity uncertainties.

Idiosyncratic productivity process.— At the beginning of a period, households draw their new realization of productivity e. Productivity of individual households evolve independently from each other and from any aggregate risk. It follows a standard AR(1) process:

$$\log(e') = \mu_e + \rho_e \log(e) + u_e{}' \tag{6}$$

where $\rho_e \in (0, 1)$ denotes the persistence of productivity, and innovations u_e are distributed iid over time according to $u_e \sim \mathcal{N}(0, \sigma_e^2)$.

Aggregate risks process.— Our economy features aggregate risk in terms of the (global) gold price P_t^g and aggregate TFP Z_t. Indian households take the price of gold as given.[7] $\log(Z)$

[7] Add discussion whether this is a reasonable assumption!

and $\log(P^g)$ jointly evolve according to a VAR(1) process. Specifically, $\mathbf{X} \equiv [\log(Z), \log(P^g)]^\top$ evolves according to

$$\mathbf{X}' = \begin{pmatrix} \rho_z & 0 \\ 0 & \rho_g \end{pmatrix} \mathbf{X} + \mathbf{U}'_{\mathbf{zg}} \qquad \text{with:} \qquad \mathbf{U}'_{\mathbf{zg}} = \begin{pmatrix} u'_z \\ u'_g \end{pmatrix} \sim \mathcal{N}\left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_z^2 & \sigma_{zg} \\ \sigma_{zg} & \sigma_g^2 \end{pmatrix} \right) \tag{7}$$

where ρ_z and ρ_g denote the auto-correlation (persistence) parameters, and σ_z^2 and σ_g^2 are the variances of the innovation terms of the stochastic processes for $\log(Z)$ and $\log(P^g)$ respectively. σ_{zg} denotes the correlation between the two processes and is an important determinant of the hedging properties of gold against the aggregate fluctuations in return to capital and national income (a point we will further discuss in Section 3.2).

The household's problem.— Taking market prices as given, the optimal labor hiring, consumption, and asset allocation problem of a household who enters the period with the asset position $\mathbf{a} = (k, d, g)$, idiosyncratic productivity e, and aggregate state $\mathbf{\Omega} = (P^g, Z, r^*)$ can be stated as:

$$V(\mathbf{a}, e; \mathbf{\Omega}) = \max_{n,c,g',k',d'} U(c, g') + \beta\, \mathbb{E}\left\{ V(\mathbf{a}', e'; \mathbf{\Omega}') \,|\, e, \mathbf{\Omega} \right\} \tag{8}$$

subject to the budget constraint (3), borrowing constraint (4), and laws of motion of household productivity and aggregate states (6), (7), and where $\mathbf{a}' = (d', k', g')$. Let's denote the corresponding policy functions by q^n, q^c, q^g, q^k, q^d, all defined over the same domain as the value function V, such that, for example, optimal consumption is given by $c = q^c(\mathbf{a}, e; \mathbf{\Omega})$.

3.2 Optimal Labor Hiring and Asset Allocation

Return on physical capital.— Let's start by clarifying few interrelated terms to avoid any further confusion. By "household business return," we mean revenue of the household business, less factor payment to labor (*aka* compensation of employees) yet inclusive of payment to physical capital. "Household business profit," is its revenue less factor payments to both labor and capital. Finally, realized return on physical capital includes the profit, the factor payment to capital, and the value of undepreciated capital. Therefore, a natural place to start investigating the return on capital is the hiring policy $n(\mathbf{a}, e; \mathbf{\Omega})$ of the household whose value function is represented by Equation (8). Optimal hiring is one that maximizes household's profit, ex-post realization of idiosyncratic and aggregate productivity (e, Z):

$$\pi(k|\mathbf{a}, e; \boldsymbol{\Omega}) = \max_{n} \left\{ eZ \left(k^{\alpha} n^{1-\alpha}\right)^{\eta} - wn - (r^f + \delta)k \right\} \tag{9}$$

where $(r^f + \delta)$ denotes the user-cost of capital. Hiring policy, and ex-post profit function are then given by

$$n^* = n(\mathbf{a}, e; \boldsymbol{\Omega}) = \left(\eta\,(1-\alpha)\, Z\, e\, k^{\alpha\eta}\ w^{-1}\right)^{\frac{1}{1-\eta(1-\alpha)}}, \tag{10}$$

and

$$\pi(\mathbf{a}, e; \boldsymbol{\Omega}) = \kappa\ (e\,Z)^{\frac{1}{1-\eta\,(1-\alpha)}}\ \ w^{\frac{-\eta\,(1-\alpha)}{1-\eta\,(1-\alpha)}}\ k^{\frac{\alpha\,\eta}{1-\eta\,(1-\alpha)}} - (r^f + \delta)\, k, \tag{11}$$

where $\kappa = \kappa(\eta, \alpha) = (1 - \eta\,(1-\alpha))\,[\eta\,(1-\alpha)]^{\frac{\eta\,(1-\alpha)}{1-\eta(1-\alpha)}} > 0$ is a positive constant.

As return on physical capital k is given by

$$y(k, n(\mathbf{a}, e; \boldsymbol{\Omega}), e, Z) - w\, n(\mathbf{a}, e; \boldsymbol{\Omega}) + (1-\delta)k = \pi(\mathbf{a}, e; \boldsymbol{\Omega}) + (1 + r^f)k,$$

the business profit amounts to the excess return on capital investment, i.e., return in excess of the risk-free rate.

In particular, the marginal rate of return on capital of size k, denoted by $R^k(k)$ is given by

$$\begin{aligned} R^k\,(k|e, \boldsymbol{\Omega}) &= R^f + \frac{\partial}{\partial k}\pi(k|\mathbf{a}, e; \boldsymbol{\Omega}) \\ &= \alpha\eta\, \left(\frac{\eta\,(1-\alpha)}{w}\right)^{\frac{\eta\,(1-\alpha)}{1-\eta(1-\alpha)}}\ (e\,Z)^{\frac{1}{1-\eta\,(1-\alpha)}}\ k^{\frac{-(1-\eta)}{1-\eta\,(1-\alpha)}} + (1-\delta) \end{aligned} \tag{12}$$

so that the excess marginal return to capital is equal to the marginal profit of capital investment.

3.2.1 Optimal Asset Allocation and Demand for Gold

Denoting the stochastic discount factor (SDF) by

$$m'(\mathbf{a}', e'; \boldsymbol{\Omega}') = \beta \frac{\partial_c U(c', g')}{\partial_c\, U(c, g)},$$

where $c' = q^c(\mathbf{a}', e'; \boldsymbol{\Omega}'), g' = q^g(\mathbf{a}', e'; \boldsymbol{\Omega}')$, the optimal investment in capital for the unconstrained household can be represented by the equation:

$$\begin{aligned}\mathbb{E}\left[m'(\mathbf{a}', e'; \boldsymbol{\Omega}')\ \left(R^k\left(k'|e', \boldsymbol{\Omega}'\right) - R^f\right) \mid (e, \boldsymbol{\Omega})\right] &= \\ \mathbb{E}\left[m'(\mathbf{a}', e'; \boldsymbol{\Omega}')\,\frac{\partial}{\partial k}\pi(\mathbf{a}', e'; \boldsymbol{\Omega}') \mid (e, \boldsymbol{\Omega})\right] &= 0.\end{aligned} \tag{13}$$

That is, the household invests in physical capital, to the point where the expected marginal profit of investment discounted by the SDF (or, expectation of marginal profit with respect to the equivalent martingale measure) is zero. Equivalently, in terms of the equation on top, they invest in physical capital to the point where the expected discounted marginal return to capital is equal to that of the risk-free rate. For the constrained households, the above expressions on the left-hand-side are positive, that is, while the expected marginal profit is strictly positive, the household is inhibited from larger investment in business as they are hitting their collateral constraint (Equation (4)).

Moreover, note that by the Equation (12), conditional on the idiosyncratic and aggregate productivity, marginal profit of investment is decreasing in capital, due to the decreasing-returns-to-scale technology. This implies that higher correlation between wealth and productivity (for example due to high persistence), would imply lower share of investment in capital. .

Optimal gold investment.— Defining the financial rate of return on gold simply as the capital gain (or loss)

$$\widetilde{R^g_t} = \frac{P^g_t}{P^g_{t-1}}$$

the optimal gold investment (for the unconstrained) households is given by

$$\mathbb{E}\left[m'(\mathbf{a}', e'; \boldsymbol{\Omega}')\ \left(\widetilde{R^g}' - R^f\right) \mid (e, \boldsymbol{\Omega})\right] = -\underbrace{\frac{1}{P^g}\mathrm{MRS}_{g,c}}_{\text{gold MU premium}} = -\frac{1}{P^g}\left(\frac{\theta_g}{1-\theta_g}\,\frac{c}{g}\right)^{\frac{1}{\varepsilon}}. \tag{14}$$

Notice the difference with typical equations for excess returns on securities, where the right-hand-side is zero. Households are willing to invest in gold, even if expected financial returns to gold is lower than the risk-free rate with the wedge given by the marginal utility of gold (in units of marginal utility of consumption or marginal value of assets).

Written differently, Equation (14) implies:

$$\mathbb{E}\left\{ m'(\mathbf{a}', e'; \boldsymbol{\Omega}') \left(\left[\widetilde{R^g}' + \underbrace{\frac{1}{P^g} \frac{U_g(c,g)}{\beta U_c(c',g')}}_{\text{utility dividend}} \right] - R^f \right) \mid (e, \boldsymbol{\Omega}) \right\} = 0, \tag{15}$$

that is, the *total return* on gold exceeds its *financial return* due to the flow of *utility dividends* from holding gold, that is the marginal utility of 1 Rupee in gold, measured in terms of the discounted marginal utility of wealth tomorrow (that is when returns to other assets get realized).

Demand for gold, consumption and household business investment opportunities.— Finally, note that the Euler equations imply the following relation between (non-gold) consumption expenditure, return on capital investment, and value of gold holdings:

$$\frac{P^g g}{c} = \frac{\theta_g}{1-\theta_g} P^{g\,1-\varepsilon} \left(\underbrace{\mathbb{E}\left(R^k(k') - \widetilde{R^g}\right)/R^f}_{\text{opportunity cost}} + \underbrace{\mathrm{Cov}\left(R^k(k') - \widetilde{R^g}, m'\right)}_{\text{hedging}} \right)^{-\varepsilon} \tag{16}$$

The first part of the equation is the standard CES function expenditure shares on gold and non-gold consumption based on preferences, relative prices, and substitutability of gold with consumption. However, the big brackets introduce an interesting additional factor, which is the financial properties of gold. These financial properties depend on the opportunity cost in terms of forgone returns on business investment, and potentially hedging properties. Few remarks on the interaction between the financial and preference motives of gold holding is in order. First, higher investment opportunities, i.e., higher $R^k(k)$ implies lower demand for gold. In particular, all other things remaining equal, more productive constrained households are expected to have lower demand for gold. However, according to Equation (12) and Equation (13), due to DRS technology, this effect becomes weaker the wealthier the household with given business productivity is. Finally, note that according to Equation (12) again, relative demand for gold is higher, the stronger the hedging properties of gold are; in particular, strong negative correlation between aggregate productivity Z, and world gold price P^g, as resulted from $\sigma_{gz} < 0$ in the law of motion of aggregate state of the economy (Equation (7)).

3.3 The Corporate Sector

We model the corporate sector as a representative firm that produces consumption goods with a constant-returns-to-scale production function:

$$Y^c(\mathbf{\Omega}) = Z\,(K^c)^{\alpha}\,(N^c)^{1-\alpha} \tag{17}$$

where K^c and N^c are, respectively, labor and capital used in the corporate sector, and α denotes the output elasticity with respect to capital. We assume that the corporate sector rents capital from the financial intermediaries at rate $(r^f + \delta)$. The corporate sector also hires labor at wage rate w such that the corporate sector's full problem is:

$$\max_{\{K^c,N^c\}} Z\,(K^c)^{\alpha}\,(N^c)^{1-\alpha} - (r^f + \delta)K^c - wN^c \tag{18}$$

3.4 (Domestic) Financial Intermediaries

The intermediary can borrow or lend funds on the international funds market at the global (fixed) rate r^*, and offers deposit and loan contracts to households at the rate r^f_t. They also accumulate and rent capital to the corporate sector, having access to the one-to-one technology to convert capital goods to consumption goods, and vice versa. Each period, the intermediaries offer debt and deposit contracts to households. After receiving the demand for capital by the corporate sector, and based on the the aggregate supply of funds and demand for physical capital across the whole distribution, they collect deposits, make loans, borrow money from or lend money to global markets, hand in capital goods to households and lend capital to the corporate sector.

Assets of the financial intermediary can hence consist of loans to households, foreign bonds, and capital lent to the corporate sector. Liabilities consist of deposits by domestic households, and borrowing from the rest of the world. Hence, denoting the distribution of households over $(\mathbf{a}, e)$ this period by $\Gamma(\mathbf{a}, e)$, their marginal distribution over $\mathbf{a}$ by $\Gamma(\mathbf{a})$, and the (predetermined) aggregate net deposit of households entering the period with D, balance sheet of the financial intermediary can be expressed as

$$D = \int_{(\mathbf{a},e)} d(\mathbf{a})\ d\Gamma(\mathbf{a}) = B + K^c, \tag{19}$$

where B denotes the net foreign assets position (NFA) of the economy this period. Also, recalling that $\mathbf{a} = (k, d, g_{-1})$, $d(\mathbf{a})$ simply refers to the second component of $\mathbf{a}$. Note that D denotes the net supply of funds by the households entering this period. When the aggregate demand by capital from the corporate sector exceeds the net domestic supply of funds $D < K^c$, financial intermediaries borrow from the global markets to make for excess domestic demand for funds. And when $D > K^c$, they invest the excess supply of funds in foreign bonds.

The budget constraint for the financial intermediary is then written as:

$$(1 + r^f)D \leqslant (1 - \delta)K^c + (r^f + \delta)K^c + (1 + r^*)B \tag{20}$$

3.5 Equilibrium

Our model features a standard open-economy version of a *Recursive Competitive Equilibrium with Aggregate Risk*. Define the distribution of households over $(\mathbf{a}, e)$ by Γ, the exogenous aggregate states by $\mathbf{\Omega} = \{P^g, Z, r^*\}$ and the law of motion of the distribution by: $\Gamma' = \mathcal{H}(\Gamma, \mathbf{\Omega}, \mathbf{\Omega}')$.

Then an equilibrium is given by $\mathcal{H}$, value function and optimal policies of households $\{V, q^n, q^c, q^g, q^k, q^d\}$, capital and labor demand functions of the corporate sector $\{K^c(\Gamma, \mathbf{\Omega})$ and $N^c(\Gamma, \mathbf{\Omega})\}$, net foreign asset position $B(\Gamma, \mathbf{\Omega})$ and price functions $r^f(\mathbf{\Omega}), w(\mathbf{\Omega})$, such that

1. Policy functions $\{q^n, q^c, q^g, q^k, q^d\}$ solve the household problem 8, taking prices and laws of motions as given,

2. Free entry for the financial intermediary ensures zero profit such that $r^f(\mathbf{\Omega}) = r^*$ (with $(r^* + \delta)$ giving the user-cost of capital.)

3. The labor market clears such that

$$\int_{(\mathbf{a},e)} q^n(\mathbf{a}, e; \mathbf{\Omega})\; d\Gamma(\mathbf{a}, e) \;+\; N^c(\Gamma, \mathbf{\Omega}) = 1. \tag{21}$$

   And as long as $N^c > 0$ (add sufficient conditions!)the equilibrium wage in the competitive labor market is pinned down by the marginal product of labor in the corporate sector such that:

$$w(\mathbf{\Omega}) = (1 - \alpha)\left(\frac{\alpha}{r^* + \delta}\right)^{\frac{\alpha}{1-\alpha}} Z^{\frac{1}{1-\alpha}} \tag{22}$$

4. The (international?) capital market clears such that:

$$\int_{(\mathbf{a},e)} d(\mathbf{a})\ d\Gamma(\mathbf{a}) = B(\Gamma, \boldsymbol{\Omega}) + K^c(\Gamma, \boldsymbol{\Omega}), \tag{23}$$

where $d(\mathbf{a})$ simply refers to the second component of asset position vector $\mathbf{a}$. This means that capital flows out of India in case domestic supply of funds exceeds demand, and capital flows into India if domestic demand exceeds domestic supply.

5. $\{K^c(\Gamma, \boldsymbol{\Omega}), N^c(\Gamma, \boldsymbol{\Omega})\}$ solve the corporate sector problem 18. Note that while the distribution Γ does not enter directly into the corporate problem, the scale of corporate sector is pinned down by the labor market clearing, so they implicitly depend on the Γ.

6. $\mathcal{H}$ is generated by the policy functions $\{q^g, q^k, q^d\}$, in the sense that given Γ over the current asset position and policies of households, their combined asset allocation policies corresponds to Γ' as given by the mapping $\mathcal{H}$.

7. The net foreign asset position evolves taking into account the net export and the net factor income of the economy. To define the evolution of net foreign asset position in this economy, let's first specify the key aggregate variables. First, let's denote by C, the aggregate consumption of households, given by

$$C(\Gamma, \boldsymbol{\Omega}) = \int_{(\mathbf{a},e)} q^c(\mathbf{a}, e; \boldsymbol{\Omega})\ d\Gamma(\mathbf{a}, e).$$

Denote also by $\mathcal{G}_{-1}(\Gamma)$ and $\mathcal{G}(\Gamma, \boldsymbol{\Omega})$, respectively, the aggregate stock of gold that households bring in the period, and choose to invest in for the next period. Similarly, $K^h(\Gamma)$ and $K^{h\prime}(\Gamma, \boldsymbol{\Omega})$ denote the stock of capital with which households enter into the period, and their optimal investment in capital, which allows us to define the investment in the household sector at this period as $I^h = K^{h\prime} - (1-\delta)K^h$:

$$I^h(\Gamma, \boldsymbol{\Omega}) = \int_{(\mathbf{a},e)} \left(q^k(\mathbf{a}, e; \boldsymbol{\Omega}) - (1-\delta)k(\mathbf{a})\right)\ d\Gamma(\mathbf{a}, e).$$

Finally, denote the investment for the corporate sector by $I^c(\Gamma', \boldsymbol{\Omega}')$ and aggregate output of the economy by $Y(\Gamma, \boldsymbol{\Omega})$, then the net export is given by:

$$NX = Y - C - (I^h + I^c) - P^g(\mathcal{G} - \mathcal{G}_{-1})$$

and the evolution of the net foreign asset by:

$$B'(\Gamma', \boldsymbol{\Omega}') = B'(\mathcal{H}(\Gamma, \boldsymbol{\Omega}, \boldsymbol{\Omega}'), \boldsymbol{\Omega}') = NX + (1 + r^*)B(\Gamma, \boldsymbol{\Omega}) \tag{24}$$

3.6 Remark on the Solution Method

The key to tractably combining aggregate risk with heterogeneous agents in our economy is that the combination of the open-economy and constant-returns-to-scale production in the corporate sector ensure that prices are not endogenous functions of the entire distribution, as in Krusell and Smith (1998). This allows us to use global solution methods instead of local approximations that would miss part of the risk and hedging motives of households that arises from aggregate risk. The downside of not having prices depend on the entire distribution of households is that we have to abstract from the interesting feedback loop of how household behavior affects prices. For example, we have to abstract from the general equilibrium mechanism whereby increases in Indian gold demand could additionally crowd out productive capital by either making imports or the cost of capital more expensive. However, note that the equilibrium market clearing in our setup still depends on the entire distribution of households; for example, both the employment share of the corporate sector and the net foreign asset position are functions of the aggregate state and the entire (time-varying) distribution of households.

4 Calibration & Validation

To quantify the aggregate costs of unproductive savings, we calibrate our model using a combination of micro data and aggregate moments. We then carefully validate our model using untargeted moments, including the entire distribution of household balance sheets shown in Figure 2.

4.1 Calibration

There are 16 structural parameters in total. We start out by setting a few parameters based either on standard values in the literature or because they are policy parameters that can be directly observed. We calibrate the remaining parameters internally in two steps. In the first internal calibration step, which we denote "direct calibration", we show how to directly back out a set of parameters from observed data. Specifically, this relates to parameters of the production function, the micro-level productivity process, the parameters that govern aggregate risk and the collateral constraint parameters; all of which can be directly pinned down in the data without solving the model. In the second and last calibration step, which we call "indirect calibration", we find the remaining model parameters by minimizing the distance between a set of targeted empirical moments and their model counterparts, which requires solving the model. Table 2 provides an overview of all parameters and how we calibrate them.

4.1.1 Parameterization / External calibration

For a set of parameters we pick standard values, these include the intertemporal elasticity of subsitution γ (which we set to 2.0), the world real interest rate r^* (which we set to 4%), the depreciation rate δ (which we set to 7.5%) and the capital share of the household business α (which we set to 1/3). We currently also fix the elasticity of substitution between gold and consumption ε at a value of 0.5, but plan to internally calibrate this better in future versions of the paper.

4.1.2 Direct calibration

Production function & firm productivity process.— We can directly back out the remaining parameters of the production function and productivity process by drawing on micro data for household businesses from the IHDS. Specifically, household's optimal labor decisions imply that:

$$(1-\alpha)\eta = \frac{w_t \cdot n_{it}}{Rev_{it}}$$

which relates the remaining returns-to-scale parameter η to the observed labor share of household businesses (given a known value for α). Based on the IHDS data using detailed information on household labor costs and revenue (net of intermediates), we use the median observed labor share to ensure results are not driven by outliers, which is 54%.[8] Together with $\alpha = 1/3$ we find that $\eta = 0.81$.

With η & α pinned down and with data on the revenue of household businesses including their capital and labor inputs, we can back out their model-implied productivity $x_{it} \equiv Z_t \cdot e_{it}$. We then estimate the AR(1) process directly on observed productivity by running:

$$\tilde{x}_{it} = \mu_e + \rho_e \tilde{x}_{it-1} + u_{it} \tag{25}$$

where $\tilde{x}$ gives log productivity x after residualizing on time fixed effects that purge the

[8]In Appendix C.1.1 we provide further details on measurement, including how we impute costs of household labor using local wages.

Table 2: Overview of parameter identification and estimation

Object	Description	Identification idea	Value	Details
Preferences:				
β	HH discount rate	SMM	0.87	Section 4.1.3
γ	IES	Parameterized	2.0	Standard
ε	Elasticity of substitution g vs. c	Parameterized	0.5	Yogo (2006)
θ_g	Preference share for gold	SMM	0.11	Section 4.1.3
Production:				
r^*	World interest rate	Parameterized	0.038	Standard
δ	Depreciation rate	Parameterized	0.075	RBI
α	Capital share HH business	Parameterized	0.387	Standard
α_C	Capital share corporate sector	Direct calibration	1/3	Section 4.1.2
η	Returns to scale	Direct calibration	0.868	Section 4.1.2
ρ_e	Autocorrelation e	Direct calibration	0.9	Section 4.1.2
σ_e^2	Variance of e innovation	Direct calibration	0.3	Section 4.1.2
μ_e	Level of e	SMM	0.1178	Section 4.1.3
Financing constraints & frictions:				
ϕ_k	Collateral constraint k	Direct calibration	0.69×0.40	Section 4.1.2
ϕ_g	Collateral constraint g	Direct calibration	0.75	Section 4.1.2
Aggregate risk:				
ρ_z	Persistence of log Z_t	VAR direct estimate	0.63	Section 4.1.2
ρ_g	Persistence of log P_t^g	VAR direct estimate	0.81	Section 4.1.2
σ_z^2	Variance of u_t^z	VAR direct estimate	0.00046	Section 4.1.2
σ_{zg}	Covariance of u_t^z and u_t^g	VAR direct estimate	-0.00018	Section 4.1.2
σ_g^2	Variance of u_t^g	VAR direct estimate	0.0088	Section 4.1.2

Details: Add notes here.

log-additive effect of Z. Given that we are also interested in the variance of shocks σ_e^2, we further control for individual fixed effects that ensure that all residual variation in u_{it} is driven by household-level shocks rather than other fixed differences between households from which our model abstracts. We find a value of $\rho_e = 0.9$, which is solely identified from within-household changes in (revenue) productivity. We further find a value for $\sigma_e^2 = 0.3$.

Aggregate risk process & corporate sector production function.— Next, we estimate the parameters of the joint process for (Z_t, P_t^g) using standard VAR estimation tools. To measure the time series for Z_t, we draw on the CMIE Prowess database, which has information on all publicly listed firms in India, which we treat as a representative picture of the corporate sector in our model.[9] Specifically, we back out Z_t from Equation 17, using aggregate (real)

[9]While the number of firms in CMIE Prowess changed strongly over time, all we require for constructing Z is having a representative sample of the corporate sector at any point in time.

value-added output, capital and labor payments together with a value for α_C, the capital output elasticity in the corporate sector. We compute α_C drawing on the model-based first-order condition of the corporate sector:

$$1 - \alpha_C = \frac{wL}{PY} \tag{26}$$

using the observed median labor share across all firm-year observations. We find that $\alpha_C = 0.62$, a relatively high value that reflects the low labor share in India's corporate sector. In Appendix (add!), we provide further details on the cleaning and estimation steps and show that our estimated Z-series is robust to different values of α_C. As a measure for P_t^g, we use the annual gold prices from the Reserve Bank of India database. With the series for (Z_t, P_t^g) in hand, we proceed to estimate the parameters of the aggregate risk process Equation (7).

We estimate a VAR(1) process with trend and levels for $\mathbf{X}_t \equiv [\log(Z_t), \log(P_t^g)]^\top$, that is:

$$\mathbf{X}_{t+1} = \begin{pmatrix} \nu^z \\ \nu^g \end{pmatrix} + \begin{pmatrix} \mu_z \\ \mu_g \end{pmatrix} t + \begin{pmatrix} \rho_z & \rho_{zg} \\ \rho_{gz} & \rho_g \end{pmatrix} \mathbf{X}_t + \mathbf{U}_{t+1}^{zg}, \quad \mathbf{U}_t^{zg} = \begin{pmatrix} u_t^z \\ u_t^g \end{pmatrix} \sim \mathcal{N}\left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_z^2 & \sigma_{zg} \\ \sigma_{zg} & \sigma_g^2 \end{pmatrix} \right) \quad \forall t$$

The trend estimates (μ_z, μ_g) are different, which makes a case against a balanced growth model. Hence, in line with our assumption of a stationary economy, we drop the trend parameters as well as the intercepts (ν^z, ν^g). Moreover, the estimates of ρ_{zg} and ρ_{gz} are not (statistically) significantly different from zero, so it is not necessary to orthogonalize the series. Estimates for the main parameters of the process can be found in the bottom panel of Table 2.

Collateral constraints.— To pin down the collateral constraint parameters (ϕ_k, ϕ_g) we draw on micro loan-level information in AIDIS. Intuitively, (ϕ_k, ϕ_g) are identified from the ratio of household's loan size to collateral for the subset of households for whom the collateral constraint binds, which are households that are at the limit of their allowed loan size to collateral ratio. In practice, we need to adapt this approach to our setting with two types of collateral: gold *and* capital. In the AIDIS data, households can have multiple loans at the same time but each loan is at most collateralized with either capital *or* gold, which allows us to look at both separately.[10] Another feature of the micro data that is

[10] Among secured loans, roughly 75% of loans and loan volume are collateralized with either capital (57%) or gold (18%), with cash-flow based constraints being rare. Discuss narrower definition here?. Importantly, only about 45% of loans in India are collateralized, with the remainder capturing a larger informal loan market. While we abstract from this, we note that unsecured loans are fine for our model as long as collateral constraints would not bind for them.

important to capture is that most households that take out loans – even households that seem to be constrained – do not freely combine gold and capital loans. To capture this additional friction, we rewrite the collateral constraints ϕ_i for $i \in \{k, g\}$ as the product of $\mathbb{P}(i - \mathrm{loan}|\text{any loan})$, the probability that a constrained household can take out any loan collateralized with i, and $\tilde{\phi}_i$, the collateral constraint conditional on having taken out a loan on i.

We pin down $\mathbb{P}(i-\mathrm{loan}|\text{any loan})$ by the share of constrained households that hold a loan collateralized by i conditional on having any collateralized loan. We classify households as being constrained if they are above the 80th percentiles for either the distribution of capital-backed loans over capital holdings or gold-backed loans over gold holdings. We find that $\mathbb{P}(k - \mathrm{loan}|\text{any loan}) = 69\%$ and $\mathbb{P}(g - \mathrm{loan}|\text{any loan}) = 35\%$.[11] That is, constrained households are twice as likely to hold capital-backed loans. Importantly, these probabilities do not sum up to one precisely because we allow households to take out multiple loans; however, the probabilities indicate that having both loans is uncommon even for constrained households for whom this should be most beneficial.

Next, we identify the collateral constraints $\tilde{\phi}_i$ by looking at borrowing limits in the data. Any constrained household would borrow $|d|$ up to what their capital and gold collaterals $\tilde{\phi}_k$ and $\tilde{\phi}_g$ allow. In AIDIS, we observe both total asset values and loan sizes, which is critical for estimating de-facto collateral constraints. While standard loan-level micro data would have total collateral value, it would not generally include total household assets. However, not all capital and gold held by households is collateralizable, for example because some parts are hard to appraise, or because they lack proper documentation such as land titles. Taking total household assets as reported in AIDIS rather than only collateral values allow us to credibly capture these broader borrowing frictions in the Indian context.

$\tilde{\phi}_k$ is then identified from the maximally observed ratio of loan size $|d|$ to capital assets k among loans collateralized by capital: $\max_{i \in \text{k-loans}}\{(|d|/k')_i\}$. By loan size we mean the total size of all such loans held by a household. Similarly, $\tilde{\phi}_g$ is identified from: $\max_{i \in \text{g-loans}}\{(|d|/P^g g)_i\}$. In practice, the maximum value is particularly susceptible to outliers, so we use the 95th percentile instead. Using this approach, we find that $\tilde{\phi}_k = 0.40$ and $\tilde{\phi}_g = 2.92$.[12] Our estimated value for $\tilde{\phi}_k$ implies that a loan taken out purely for

[11] As reported in Appendix (add!), probabilities are very similar when using the 90th percentile as cutoff instead. See subsection C.3 of the Appendix for more details on the estimation steps.

[12] Values are relatively flat over most of the distribution but sharply increase at the right tail. At the 90th percentile, values are 0.27 and 1.68, respectively. The 95th percentile is thus a conservative choice as it leads to less binding collateral constraints.

investment purposes would need to be underwritten by at least 50% more own capital. Compared to the previous literature, we find a slightly higher, less binding collateral constraint; for example Buera et al. (2021) find $\phi = 0.15$ targeting aggregate data for India. We find a substantially higher value for gold, which is in line with gold being easier to collateralize, to seize and to liquidate in case of default. However, it is important to note that the magnitudes of $\tilde{\phi}_k$ and $\tilde{\phi}_g$ cannot be directly compared; in the case of investment loans, $\tilde{\phi}_k$ will be mechanically lower because the denominator includes the new capital investment itself. For gold, on the other hand, it is uncommon to take out a loan to buy more gold.

4.1.3 Indirect calibration: Simulated Method of Moments (SMM)

In the last step of the model calibration, we set the remaining model parameters to best match a set of empirical target moments. Table 3 gives an overview of the relevant parameters, the empirical target moments and how our model captures them.

4.2 Validation

In this subsection, we carefully validate our model on a rich set of untargeted moments related to household savings and the production side, given that both dimensions are crucial for the main counterfactuals.

4.2.1 Validating household savings behavior

We start by validating our model on the household balance sheet over the entire wealth distribution. Figure 4 compares our model-implied household balance sheet with the data. We capture well the main savings patterns over the entire wealth distribution. Deposits/financials are small throughout, business assets are dominant and increase in wealth, and gold is sizable but declines in wealth. Currently, the model fails to correctly capture the extreme right tail in business assets and thus also erroneously predicts an increase in deposits at the right tail. As we shall see in the next subsection, this results from the fact that households in the top quantile, particularly the less productive ones, are still substantially investing in gold.

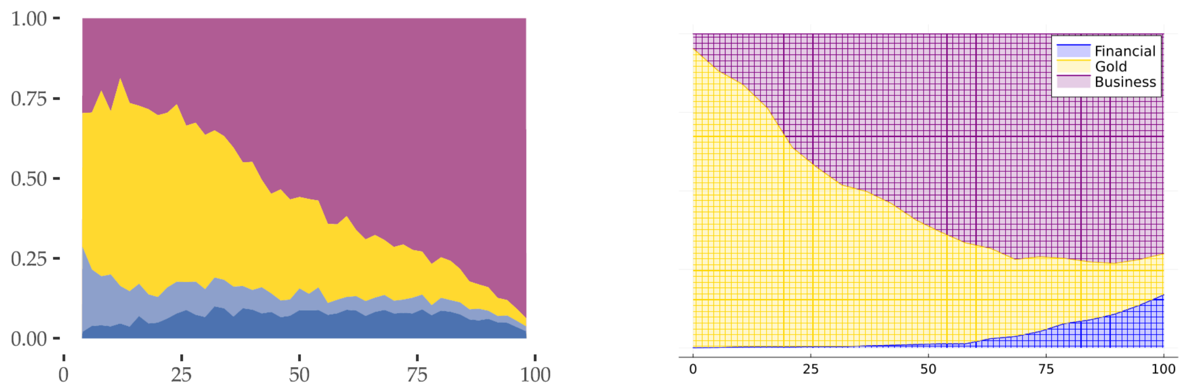
4.2.2 Validating the production side: Firm size distribution and returns to capital

To validate the production side of our economy, we consider two key validation exercises. First, we verify that our model can correctly capture the (household) firm size distribu-

Table 3: Internally calibrated parameters: Model vs. Data

Parameter	Description	Value	Target moment	Data	Model
β	HH discount factor	0.88	K/Y	1.7	1.71
θ_g	Preference share for gold	0.089	Aggregate share of gold	28.1	28.5
μ_e	Mean entrepreneurial talent	0.1178	GDP share of HH sector	85%	85.2%

Figure 4: Model Fit: Household Balance Sheet.

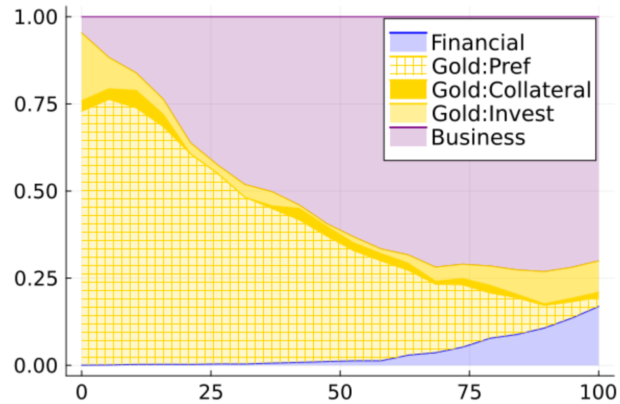


Note: Left: household balance sheet by wealth quantiles in the data. Right: household balance sheet by wealth quantiles in the model.

tion. Empirically, we draw on the firm size distribution based on the IHDS data for 2005, which gives a representative picture of household businesses in India.

Second, we look at the returns to capital as implied by our model. Given that the marginal returns to capital (MPKs) are crucial to our quantification exercise, we want to ensure that our model is in the right ballpark for empirical estimates of MPKs. For this, we draw on the influential RCT by De Mel et al. (2008), which gave out capital grants to micro-enterprises. We replicate the RCT within our model, forming a treatment and control group that are similarly selected as in De Mel et al. (2008). In line with the small scale of the program, we replicate the RCT in "partial equilibrium" in the sense that the share of households that receive the program is small, so that the program does not affect equilibrium allocations and prices. While the original RCT was conducted on micro-entrepreneurs in Sri Lanka, not in India, we believe that the context of South Asia with a shared cultural history and a similar level of development makes this still comparable. We provide further details on the RCT and our implementation of the RCT, including the careful selection of the relevant treatment group in Appendix C.4. Here, we focus on the main results. [Will be added soon.]

Figure 5: Gold Demand Motives by Wealth



5 Main Quantitative Results

In this section, we use our calibrated model to better understand the drivers of gold savings in India, answer our main research question, and study the role of policy. We proceed in turn.

5.1 Who holds how much gold and why?

We start our investigation by decomposing the demand for gold savings into different motives and discuss how the demand composition changes with wealth and productivity. This exercise not only sheds light on the relative importance of culture versus financial reasons for holding gold, but also sets the stage for better understanding our main quantitative results.

We decompose the demand drivers of gold using model counterfactuals in which we shut down one demand mechanism at a time and compare the resulting equilibrium to the baseline calibrated model. Specifically, we isolate the role of *culture* by shutting off preferences for gold, setting $\theta_g = 0$ in Equation (2). For the liquidity value of gold, we shut down the collateral value of gold, setting $\phi_g = 0$ in Equation (4). Finally, we quantify the investment motive as the residual motive, shutting down both the cultural and the liquidity motives of holding gold.

Figure 5 shows results of this decomposition exercise over the entire wealth distribution. By construction, Figure 5 keeps the relative savings share for business capital and financial assets fixed and only decomposes the gold share into its three motives, each denoted by a different gold-colored shading. In terms of the aggregate level of gold holdings, we find that culture accounts for 41.2%, the liquidity motive for 8.8% and the investment motive for the remaining 50%. However, the relative importance of these motives varies considerably over the wealth distribution: the cultural motive is dominant across most of the distribution, except for the wealthiest households. For the top decile (where most of the aggregate wealth is concentrated), the investment motive clearly dominates the cultural motive, driving its higher contribution to aggregate gold holdings. Finally, the liquidity motive is more or less evenly distributed throughout the wealth distribution.

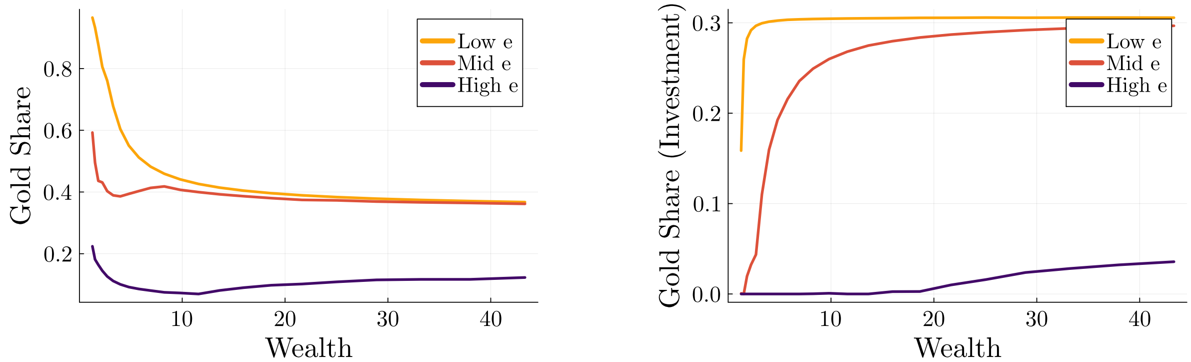
Next, we ask how the gold share of wealth differs with entrepreneurial productivity. Figure 6a plots optimal gold shares as a function of household wealth for different levels of productivity. The plot clearly shows that gold shares are decreasing in productivity, especially for low wealth households. The reason is that lower productivity means lower opportunity costs of saving in gold rather than in productive capital, and returns to business capital are particularly high for low wealth households with high productivity. This is simply a function of the decreasing-returns-to-scale technology. As summarized in Duflo and Banerjee (2011), returns to capital can be very high for very small businesses. Figure 6b further decomposes the gold share, looking only at the investment motive. For any given level of productivity, investment demand for gold increases in wealth but is asymptotically constant. The reason is again tied to opportunity costs; as households grow wealthier, their returns to capital in their own business diminish and they search for alternative investments; given generally poor alternative investment opportunities in India, wealthy Indian households choose to invest sizably in gold.

These distributional effects are crucial to understand our subsequent quantitative results. Through the lens of the model, most of the investment demand for gold comes from the wealthy households with low marginal returns to productive capital. In contrast, a larger fraction of households with high returns to capital are credit constrained, in line with empirically observed returns to capital. It is thus important to ask how costly the investment demand for gold is for the aggregate economy, and whether there can be efficiency or output gains from taxing gold and subsidizing productive investment?

5.2 The aggregate costs of unproductive savings

In this section, we address our main research question: quantifying the aggregate costs of unproductive savings. For this, we study counterfactuals in which households are incentivized to shift their savings away from gold, looking specifically at the simple case of taxing gold. Without yet thinking about the feasibility of taxing gold, we want to understand whether there is any welfare or efficiency rationale for taxing gold, which is our measure of the aggregate welfare and efficiency costs of gold. Specifically, we

Figure 6: Asset Share of Gold by Productivity



(a) All motives

(b) Investment motive

Note: The left panel shows the asset share of gold demanded for any motive, across the wealth and productivity. The right panel shows the asset share of gold demanded exclusively for investment motive. Different colours correspond to (a selection of) different entrepreneurial ability levels (e): lighter shades correspond to lower productivity, darker shades to higher productivity. Specifically, the deep violet, the red-orange, and yellow represent the highest, the medium and the lowest productivity levels, respectively.

study two different counterfactual exercises. In the first exercise, we assume that the proceeds from gold taxation are used to subsidize the purchase of business capital. In the second exercise, the gold tax revenue is simply rebated back to households as lump-sum transfers.

5.2.1 Utilizing the idle gold

5.3 Policy questions

The model also incorporates the main policy instruments that Indian policy makers have considered to either make unutilized gold more productive (the Gold Monetization Scheme), let households capitalize on their gold holdings (gold loans) or discourage the use of gold (e.g. via taxing gold). While the main counterfactual looked at extreme cases, these policy levers describe feasible real world policies that policy makers can use.

5.3.1 The setup for the counterfactual exercises

The counterfactual exercises can be formalized in terms of their effects on the budget constraints of households and the government. Assuming a constant tax rate of τ_g on gold, the household budget constraint for the case with a capital subsidy is given by:

$$c + d' + (\mathbf{1} - \boldsymbol{\tau}_{\mathbf{k}})k' + (\mathbf{1} + \boldsymbol{\tau}_{\mathbf{g}})P^g g' \leqslant w + R^f d + y(k, n, e, Z) - wn + (1 - \delta)k + P^g g \quad (27)$$

Similarly, for the case of lump-sum transfers T, the budget constraint is given by:

$$c + d' + k' + (\mathbf{1} + \boldsymbol{\tau}_{\mathbf{g}})P^g g' \leqslant w + R^f d + y(k, n, e, Z) - wn + (1 - \delta)k + P^g g + \mathbf{T} \quad (28)$$

Note that the tax rate on gold, the subsidy rate on capital, and the lump-sum transfer are all assumed to be constant and not contingent upon the aggregate state. Hence, the government budget is also assumed to balance intertemporally, meaning, in the stationary distribution of the economy,

$$\mathbb{E}\left[\sum_{t=0}^{\infty}\left(\prod_{s=0}^{t}\frac{1}{1+r_s^f}\right)\tau_g P_t^g G_{t+1}\right] = \mathbb{E}\left[\sum_{t=0}^{\infty}\left(\prod_{s=0}^{t}\frac{1}{1+r_s^f}\right)\tau_k K_{t+1}\right]$$

for the case of the capital subsidy, and

$$\mathbb{E}\left[\sum_{t=0}^{\infty}\left(\prod_{s=0}^{t}\frac{1}{1+r_s^f}\right)\tau_g P_t^g G_{t+1}\right] = \mathbb{E}\left[\sum_{t=0}^{\infty}\left(\prod_{s=0}^{t}\frac{1}{1+r_s^f}\right)T\right]$$

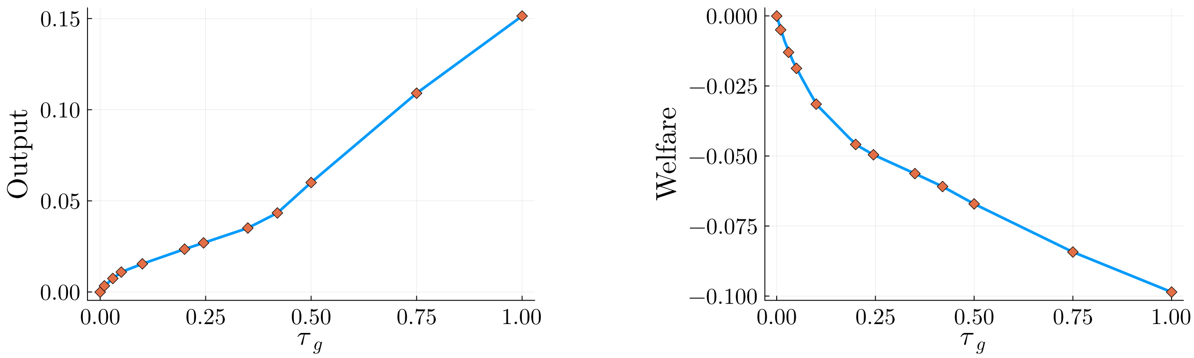
for the case of lump-sum transfers.

For each of the counterfactuals, we use the above equations and solve for the value and policy functions of the counterfactual economies. For each counterfactual exercise, we consider a range for τ_g, and for each τ_g we solve for the capital subsidy τ_k or the lump-sum transfer rate T that balance the government budgets according to Equation (27) and Equation (28). We then quantify how aggregate output and welfare change relative to the baseline economy, and use the changes in policy functions and the stationary distribution to explain the results.

5.3.2 Taxing gold to subsidize capital

Figures 7a and 7b show, respectively, the output and welfare effects of taxing gold and subsidizing capital. Perhaps surprisingly, we find significant output gains in tandem with positive welfare gains, implying large aggregate costs of gold. To explain the results, let us focus on the highest gold tax rate in the bracket, $\tau_g = 0.5$, which leads to output gains of 15%. Why do we find such a large increase in output? The reason is that the counterfactual economy not only reduces misallocation and shifts savings towards productive

Figure 7: Output and Welfare Effects of Taxing Gold and Subsidizing Capital

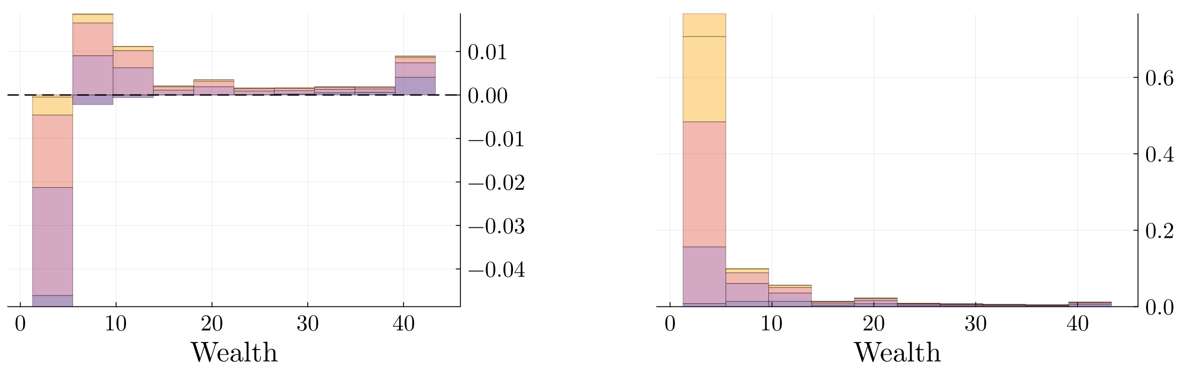


(a) Relative Change in Output

(b) Relative Change in Welfare

Note: The left panel shows the relative change in aggregate output in the tax-gold-subsidize-capital counterfactual, relative to the stationary equilibrium of the baseline. The right panel shows the relative change in welfare. For each τ_g, the output and welfare gains are computed after solving for the equilibrium capital subsidy rate τ_k that makes the government budget intertemporally balanced.

Figure 8: Distributional Effects of Taxing Gold and Subsidizing Capital



(a) Change in Distribution

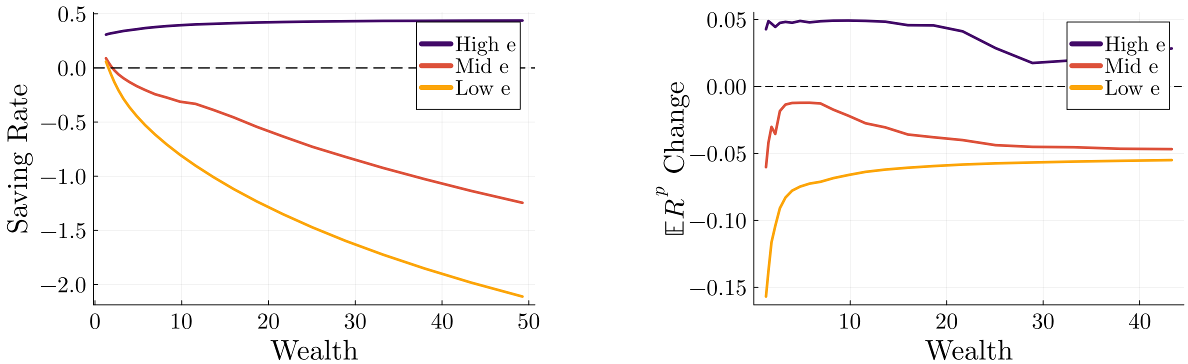
(b) Baseline Distribution (Histogram)

Note: The left panel shows the change in the stationary equilibrium distribution of assets, in the tax-gold and subsidize-capital counterfactual. The right panel shows the average wealth distribution (by productivity) in the baseline economy. Different colours correspond to different entrepreneurial ability levels (e): lighter shades correspond to lower productivity, darker shades to higher productivity. Specifically, the deep violet, the red-orange and yellow, respectively represent the highest, the medium and the lowest productivity levels.

capital and away from gold (as gold now performs worse as an investment device), but also leads to a higher average level of assets. In other words, the distribution of assets in the stationary equilibrium shifts to the right.

The corresponding change in the distribution is depicted in Figure 8a, while Figure 8b

Figure 9: Saving Rates and Return Gains of Taxing Gold and Subsidizing Capital



(a) Saving Rates in Baseline

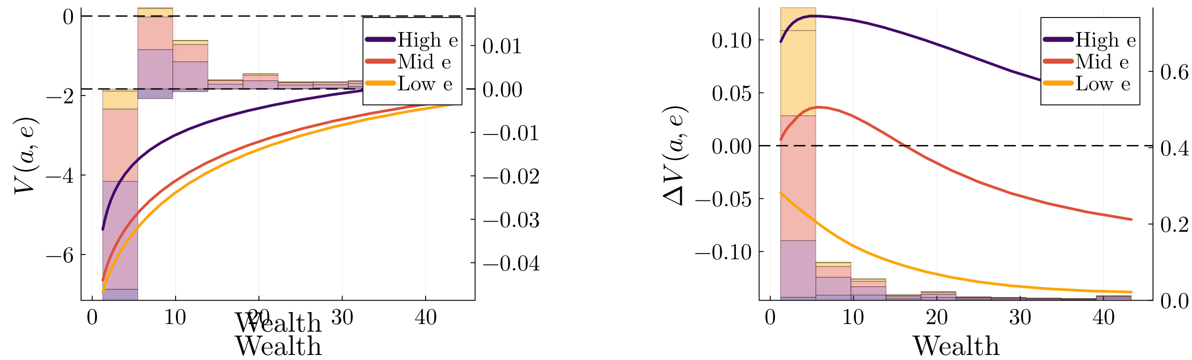
(b) Change to Return to Wealth (pp)

Note: The left panel shows the saving rates in the stationary equilibrium of the baseline economy. The right panel shows the change in return to wealth, by productivity and assets. Different colours correspond to different entrepreneurial ability levels (e): lighter shades correspond to lower productivity, darker shades to higher productivity. Specifically, the deep violet, the red-orange and yellow, respectively represent the highest, the medium and the lowest productivity levels.

shows the baseline wealth distribution (averaged over the aggregate states in the stationary equilibrium). Although there is a significant reduction in the number of households in the lowest asset bracket, the main driver of the increase in aggregate wealth are asset gains by the rich and productive households. The reason is that in the counterfactual economy the return to capital increases strongly for highly productive households who already have the highest saving rates. Highly productive households are thus the main winners of this policy and their wealth holdings increase strongly. This can be seen in Figures 9a and 9b, that show the average saving rates of households at the baseline equilibrium (left), and change (measured in percentage point) in the return to wealth of households at different levels of wealth and productivity, in the counterfactual economy relative to the baseline.

Note that changes in returns to wealth in Figure 9b are a combination of asset compositions and changes in the relative return to assets for households at different levels of productivity and wealth. For example, for most of the households to the very left of the distribution, there is a larger reduction in returns to wealth; this results from the fact that those households are the ones who tended to have a higher share of gold in their assets through the preference channel, and high taxes on gold means that the financial return to gold decreases significantly in the counterfactual economy. On the other hand, return to capital would increase more for households with higher idiosyncratic productivity and

Figure 10: Decomposition of Welfare Gains of Taxing Gold and Subsidizing Capital



(a) Baseline VF's and Distributional Change

(b) Baseline Distribution and VF Change

Note: The left panel shows the saving rates in the stationary equilibrium of the baseline economy. The right panel shows the change in return to wealth, by productivity and assets. Different colours correspond to different entrepreneurial ability levels (e): lighter shades correspond to lower productivity, darker shades to higher productivity. Specifically, the deep violet, the red-orange and yellow, respectively represent the highest, the medium and the lowest productivity levels.

households with lower levels of capital. The latter results from the span of control forces: with decreasing returns to scale, when the entrepreneur's ability is spanned over a larger firm, each additional unit of (subsidised) capital receives a lower portion of it, and its marginal product will increase by less. This is formalized in the following proposition:

Proposition 1. *With a subsidy on capital goods as in Equation (27), the increase in the marginal rate of return on capital (Equation (12)) is larger for entrepreneurs with*

1. *higher productivity;*
2. *or lower capital, provided that the technology has decreasing returns to scale ($\eta < 1$).*

Importantly, we find that not only output increases in the counterfactual that taxes gold, but welfare increases on average as well. We define welfare in a utilitarian manner:

$$\text{Welfare}(\Gamma, \boldsymbol{\Omega}) = \int_{(\mathbf{a},e)} V(\mathbf{a}, e; \boldsymbol{\Omega})\ d\Gamma(\mathbf{a}, e),$$

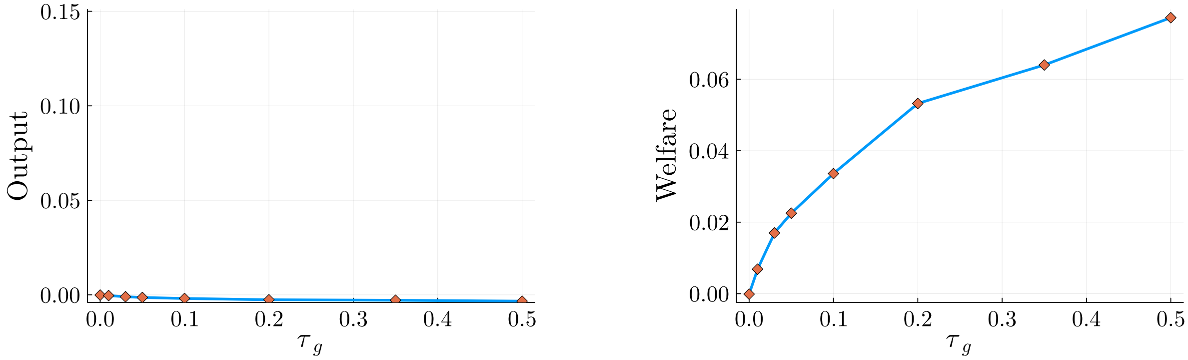
which implies that any change in average welfare between the two economies can be decomposed to the first order, into changes in the distribution, and changes in the value function. Quantitatively, we find that most of the welfare gains come from changes in the distribution, particularly the increases in wealth at the left tail as depicted in Figure 8a. As is apparent from the productivity-level composition of changes in different brackets of the histogram, households with high- and medium-level business productivity are the main winners in terms of welfare, while households with low business productivity lose. These distributional effects are visualized in Figures 10a and 10b. Figure 10a shows the main driver of welfare gains that we discussed above. Figure 10b shows the change in the value function across the distribution: the value function increases for households with high entrepreneurial productivity, as well as medium-productivity households that hold lower wealth.

To summarise, there are two channels through which the policy of taxing gold and subsidizing capital leads to twin gains in productivity and welfare: First, gold is more strongly held by households with lower business productivity; a tax on gold thus manages to redistribute from households with a low marginal product of capital towards households with higher marginal products. Baseline misallocation is key for the output and welfare results; taxing gold and subsidizing capital only improves output and welfare because it undoes part of the equilibrium misallocation of capital. Second, subsidising capital is also progressive in the sense that it benefits the majority of poor households except those with lowest productivity levels. While the decreased return to gold is costly to poor households who have relatively high demand for gold through the preference channel, these households still experience a larger increase in returns to their productive capital due to decreasing returns to scale. In equilibrium, this incentivizes these households to save more; they thus end up owning a higher average level of capital in the new stationary equilibrium. The combination of these two channels explains sizable output losses and moderate welfare losses from availability of gold, the unproductive asset, in this economy.

Taxing gold to transfer lump sum

There will be no output gains if the gold tax revenue is rebated lump-sum rather than being used to subsidise capital; but welfare gains are more than twice as large as the case of capital subsidy. Not surprisingly, here the main driver of welfare gains are the change in the utility of the households to the left, thanks to the lump-sum transfers. Indeed, the stationary distribution (on average) shifts slightly to the left. But there are large welfare gains thanks to the redistributive policy of lump-sum transfers.

Figure 11: Output and Welfare Effects of Taxing Gold and Transferring Lump-Sum

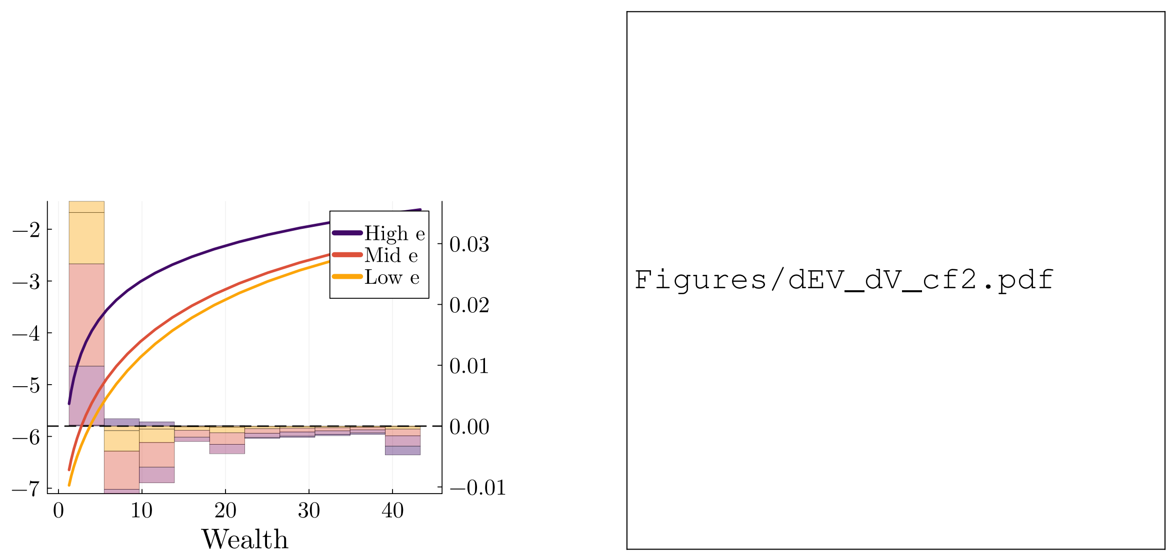


(a) Relative Change in Output

(b) Relative Change in Welfare

Note: The left panel shows the relative change in aggregate output in the tax-gold-transfer-lump-sum counterfactual, relative to the stationary equilibrium of the baseline. The right panel shows the relative change in welfare. For each τ_g, the output and welfare gains are computed after solving for the equilibrium capital subsidy rate τ_k that makes the government budget intertemporally balanced.

Figure 12: Decomposition of Welfare Gains of Taxing Gold and Transferring Lump-Sum



(a) Baseline VF's and Distributional Change

(b) Baseline Distribution and VF Change

Note: The left panel shows the saving rates in the stationary equilibrium of the baseline economy. The right panel shows the change in return to wealth, by productivity and assets. Different colours correspond to different entrepreneurial ability levels (e): lighter shades correspond to lower productivity, darker shades to higher productivity. Specifically, the deep violet, the red-orange and yellow, respectively represent the highest, the medium and the lowest productivity levels.

5.3.3 Remedying financial frictions

5.4 Signaling through gold versus the spirit of capitalism

In this counterfactual exercise, we are going to leverage the anecdotal evidence that one reason for holding gold in India, is to signal wealth, either by wearing jewelry oneself or having one's daughter dowry awash in gold.

6 Conclusion

Saving in locally unproductive assets is rampant in developing countries. Using the example of gold, this article shows that a rich model that matches key moments of the Indian economy implies that the resulting output costs can be quantitatively significant. Moreover, to the extent that unproductive assets are disproportionately attractive to wealthy households with low business productivity, they can exacerbate existing financial frictions. Therefore, policies that aim to encourage productive investment by discouraging saving in unproductive devices can, at the same time, lead to gains in aggregate output and welfare.

Although the quantitative model of this paper offers a rather general framework for studying such questions in relation to other similarly unproductive saving devices and in different national contexts, there exist several directions for furthering and expanding upon the current framework. One is related to increasing interest worldwide in the so-called "non-sovereign" saving devices and stores of value, which are not the most productive assets, particularly as a result of rising geopolitical tensions and political uncertainties. This can be seen not only in the expanding demand for the so-called digital assets, even by the governments and prominent financial institutions, but also in the renewed global interest in gold investment beyond the traditional Asian hotbeds of gold demand, and particularly in the countries that are subject to severe political unrest and risk to sovereignty; a fact that is also reflected in the recent hyperbolic rise of gold price. What are the global aggregate costs of these nonsovereign investments? Another, related avenue for further research on this topic is the question of unproductive assets that are in fixed supply; for example, the phenomenon of investing in "unutilized" land and real estate, which can be observed in many Asian countries. Would they still be costly in terms of output (and welfare)? And how would those economies and effects compare to the ones presented in this paper?

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A Further details on data & empirics

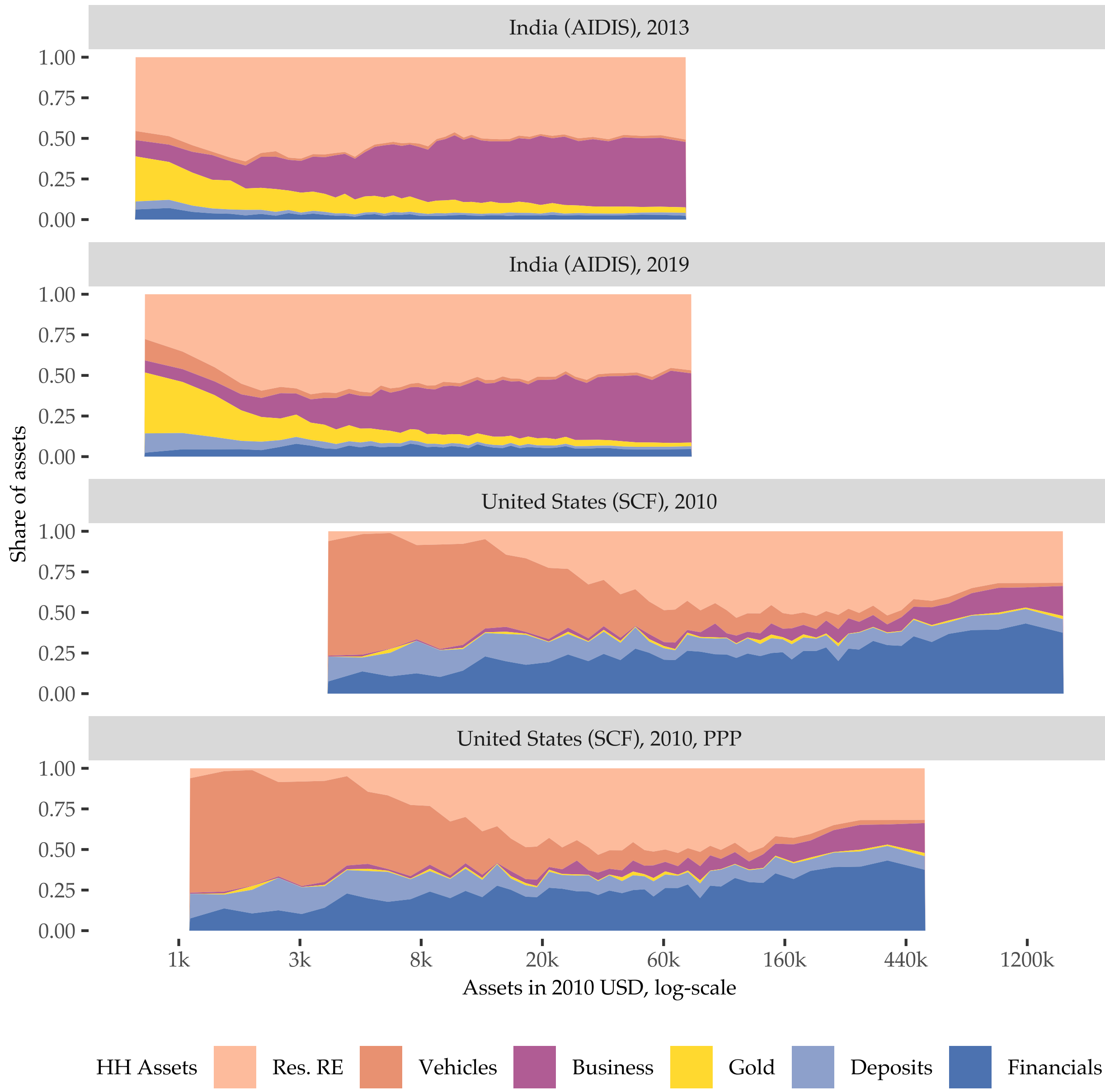

Figure A1: Average household asset allocation by wealth percentile in India and the US.

Note: This figure is based on 2013 and 2019 waves of AIDIS and 2010 wave of SCF. The definition of wealth is as in Figure 1. Additionally, we exclude the poorest and richest households by removing the bottom and the top 6 percentiles, i.e., 3+3 bins out of 50 bins (see the note for Figure 1).

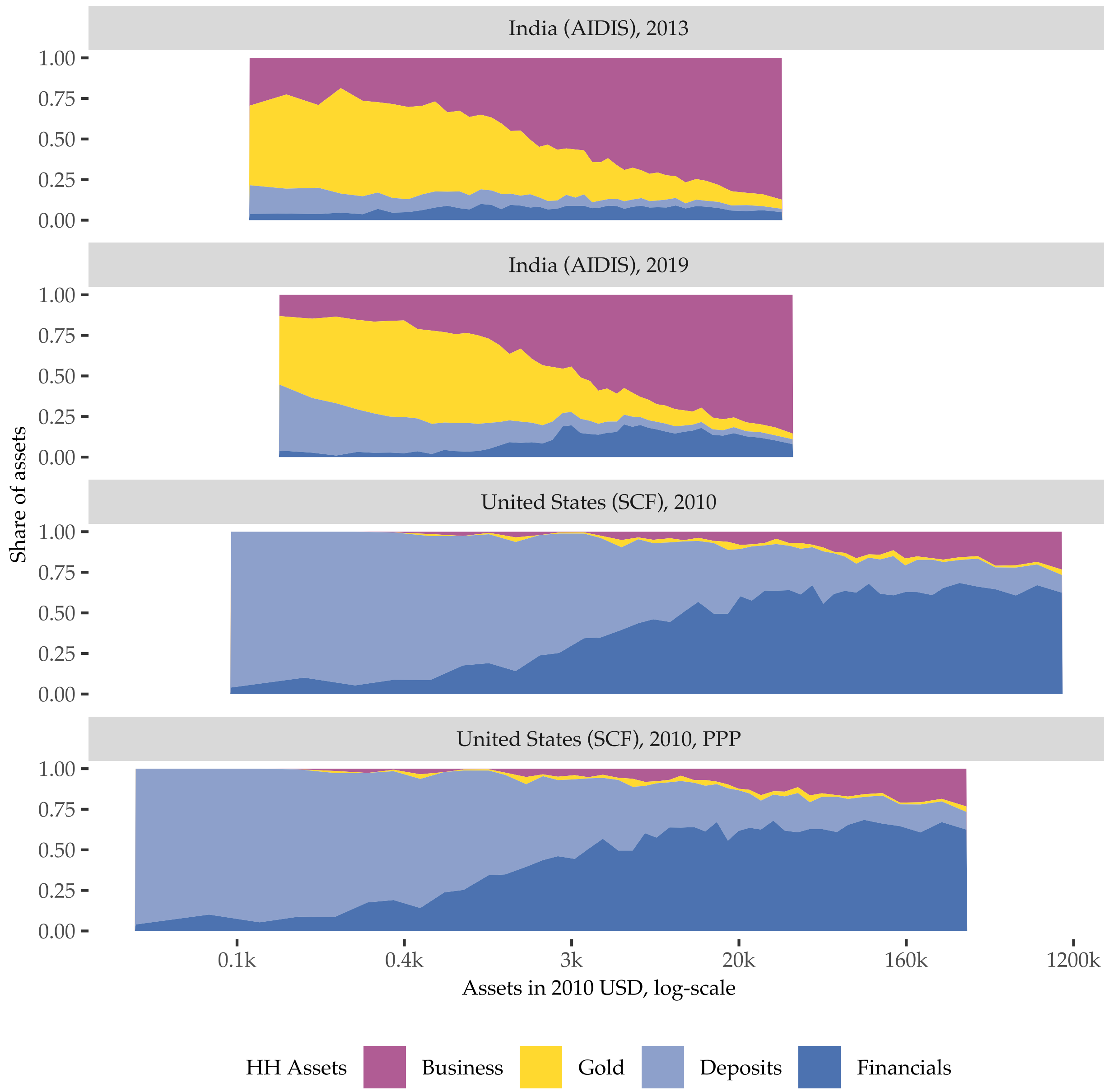

Figure A2: Average household asset allocation by wealth percentile in India and the US.

Note: This figure is based on 2013 and 2019 waves of AIDIS and 2010 wave of SCF. The definition of wealth is as in Figure 2. Additionally, we exclude the poorest and richest households by removing the bottom and the top 6 percentiles, i.e., 3+3 bins out of 50 bins (see the note for Figure 1).

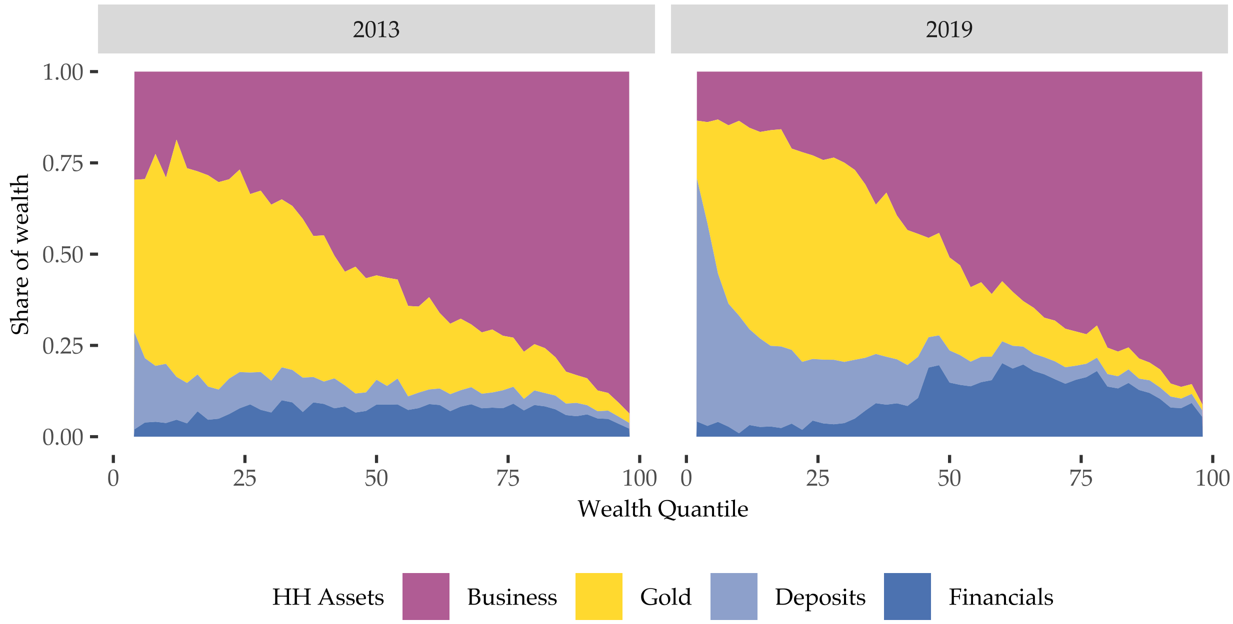

Figure A3: Average household asset allocation by wealth percentile in India: 2013 and 2019

Note: This figure is based on 2013 and 2019 waves of AIDIS. The definition of wealth is as in Figure 2.

B Further model details

B.1 Algorithm

Taking r^*, the safe interest rate on the financial markets as given, the equilibrium wage rate is pinned down by the Equation (22):

$$w(\boldsymbol{\Omega}) = (1-\alpha)\left(\frac{\alpha}{r^*+\delta}\right)^{\frac{\alpha}{1-\alpha}} Z(\boldsymbol{\Omega})^{\frac{1}{1-\alpha}}$$

- For the household entering the period with the asset position $\mathbf{a}(d,k,g)$ and idiosyncratic and aggregate states being revealed as $(e,\boldsymbol{\Omega})$ let's denote the ex-post net-worth as:

$$\begin{aligned}\widetilde{a}(\mathbf{a},e,\boldsymbol{\Omega}) &= (1+r^f)d + y\left(k,n,e,Z(\boldsymbol{\Omega})\right) - wn + (1-\delta)k + P^g(\boldsymbol{\Omega})g \\ &= (1+r^f)(d+k) + \pi(\mathbf{a},e;\boldsymbol{\Omega}) + P^g(\boldsymbol{\Omega})g\end{aligned}$$

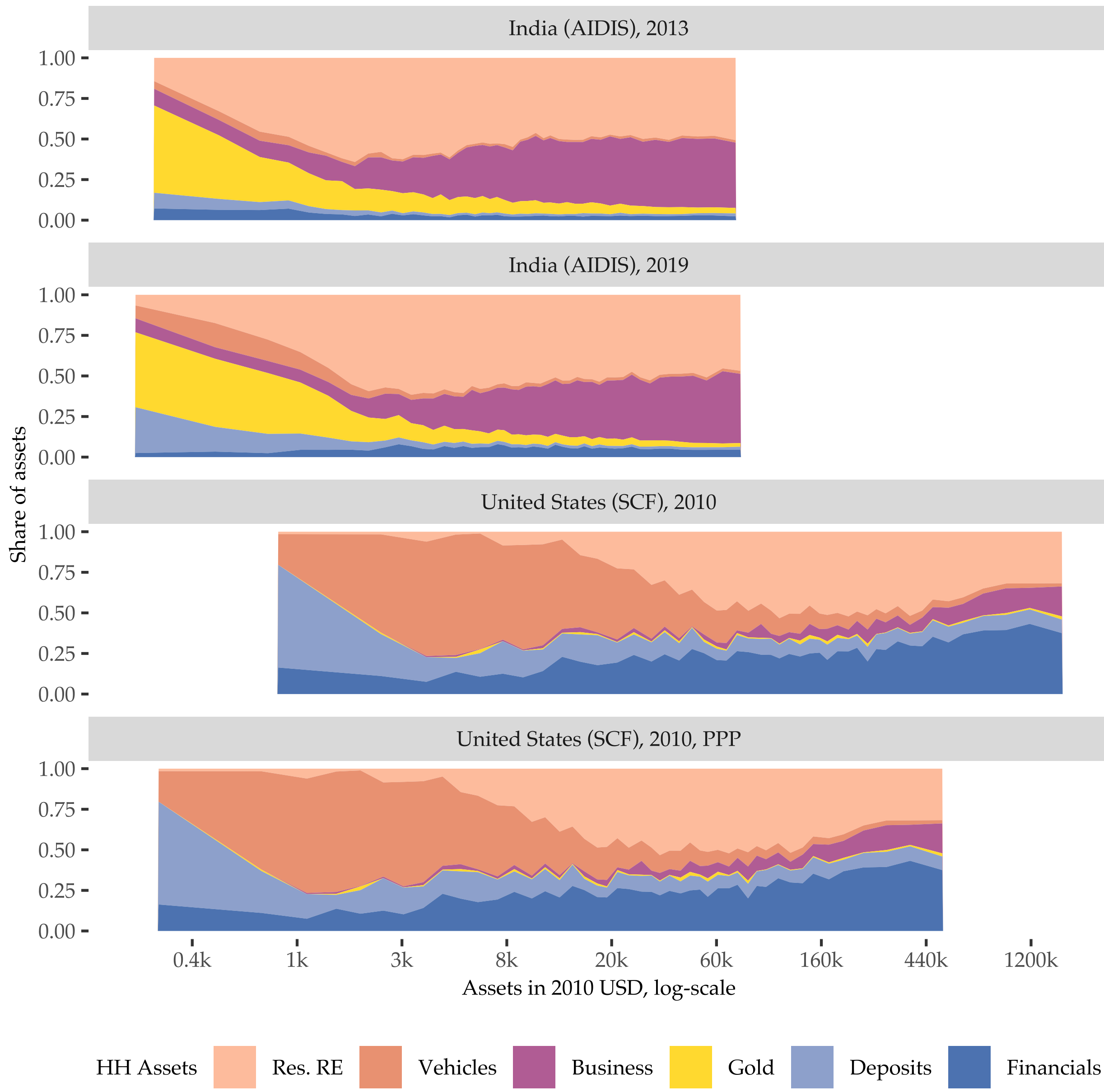

Figure A4: Average household asset allocation by wealth percentile in India and the US.

Note: This is an alternative to Figure A1. Here, instead of cutting bottom 6 percentiles, we require at least 100 USD in wealth as described by the corresponding wealth measure. For the right tail, we still drop top 6 percentiles.

and the cash-on-hand by

$$x(\mathbf{a}, e, \mathbf{\Omega}) = w(\mathbf{\Omega}) + (1 + r^f)(d + k) + \pi(\mathbf{a}, e; \mathbf{\Omega}) + P^g(\mathbf{\Omega})g$$

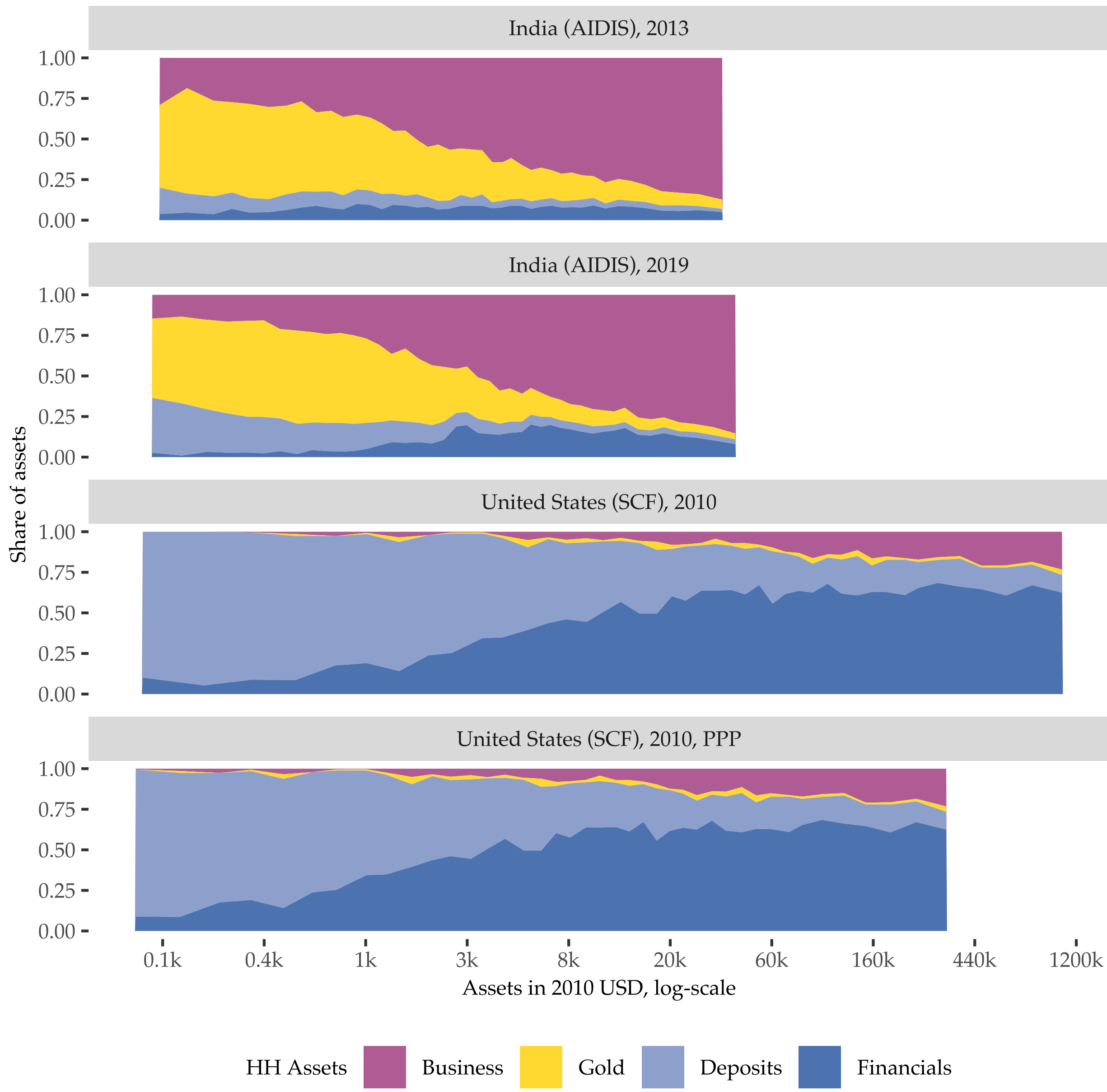

Figure A5: Average household asset allocation by wealth percentile in India and the US.

Note: This is an alternative to Figure A2. Here, instead of cutting bottom 6 percentiles, we require at least 100 USD in wealth as described by the corresponding wealth measure. For the right tail, we still drop top 6 percentiles.

where the household business profit is given by the Equation (11):

$$\pi(\mathbf{a}, e; \mathbf{\Omega}) = \kappa \, (e\,Z)^{\frac{1}{1-\eta\,(1-\alpha)}} \; w^{\frac{-\eta\,(1-\alpha)}{1-\eta\,(1-\alpha)}} \; k^{\frac{\alpha\,\eta}{1-\eta\,(1-\alpha)}} - (r^f + \delta)\, k,$$

and $\kappa = \kappa(\eta, \alpha) = (1 - \eta\,(1-\alpha))\,[\eta\,(1-\alpha)]^{\frac{\eta\,(1-\alpha)}{1-\eta(1-\alpha)}}$ is a constant. Note that this expression for profit, already assumes the optimal labor choice, so we will drop the hiring policy n as an explicit choice variable of households in the rest of this section.

- For solving the model, one can reduce dimensionality of the problem by rewriting the value function in terms of the cash-on-hand variable:

$$V(x, e, \boldsymbol{\Omega}) = \max_{c, g', k', d'} U(c, g') + \beta\, \mathbb{E}\left\{V(x'(g', k', d', e'; \boldsymbol{\Omega}'), e';\, \boldsymbol{\Omega}') \,|\, e, \boldsymbol{\Omega}\right\} \tag{29}$$

subject to

$$\begin{aligned} c + P^g(\boldsymbol{\Omega})g' + d' + k' &\leqslant x, \\ g' \geqslant 0, \quad k' &\geqslant 0, \\ d' &\geqslant -\phi_k\, k' - \phi_g\, (P^g\, g')\,. \end{aligned}$$

C Further estimation & validation details

C.1 Details on production function and productivity process estimation

C.1.1 Data details

To estimate the household production function parameters (α_h, η) and the productivity process for household businesses, we draw on the IHDS data.

The IHDS data separately reports input costs and revenues for farm and non-farm businesses. For farm businesses, the IHDS separately captures information on livestock-related and crop-related businesses, which we aggregate. For non-farm businesses, the IHDS asks separately for up to three different businesses a household may run simultaneously, which we also aggregate whenever possible. Throughout, we closely follow the data cleaning procedure for the IHDS in Bolhuis et al. (forthcoming).

Measuring labor input & labor costs.— The IHDS separately reports labor input and labor costs for farm and non-farm businesses. For both farm and non-farm businesses, we measure labor costs as the sum of salary expenses and imputed household labor costs. We start with non-farm businesses. For non-farm businesses, salary expenses capture reported costs of any hired workers for up to three household non-farm businesses, which we sum together. The reported data only asks about total labor costs, not hours or workdays. In contrast, for the labor input of household members, the IHDS reports average work days and average hours per work day on the non-farm business for each household member. We first compute total hours worked for each household member and then aggregate across household members using adult-equivalence scales (0.5 for a child, 0.8 for women) following the Indian Cost of Cultivation Surveys.

For farm businesses, the data reports salary expenses and hours worked for hired workers, giving us a measure of total quantity and costs for hired farm labor. For family labor, we proceed as for non-farm businesses, aggregating up all hours worked by each household member and weighing their relative efficiency using adult equivalence scales. To derive total costs of household labor for farm and non-farm businesses, we use the own-farm price of hired labor when available and otherwise use median state-level hourly farm wages.

Our final labor input and labor cost measures have two drawbacks. First, we use farm-level wages to impute non-farm wages, since we cannot directly compute an hourly non-farm wage from the IHDS household data. This may underestimate imputed household-level wages for non-farm work if non-farm wages are higher than farm wages. Second, the data unfortunately does not measure household labor hours on animal husbandry, which means we also likely underestimate total household hours.

Measuring revenue.— Through the lens of the model, we need to construct total (value-added) revenue across all household businesses y. IHDS separately reports revenue for farm and non-farm businesses. For non-farm businesses, the questionnaire reports *net income* after subtracting intermediate expenditures ("other expenditures") and labor costs. We thus construct (value-added) non-farm business revenue as *net income* plus adding back labor costs. For farm business revenue we proceed analogously: we draw on *net income* which takes out spending on a comprehensive list of intermediate inputs such as seeds, manure, pesticides, irrigation and other costs. Since *net income* for farm businesses also subtracts labor costs as well as different capital expenditures, we make sure to add them back. Note that we do not add back imputed household labor costs for revenues as they are also not subtracted in *net income*.

Measuring capital & land.— Our measure of the total capital stock includes both capital and land. Importantly and as stated in the main text, the IHDS only asked about capital and land for farm businesses and unfortunately not for non-farm businesses. We closely follow Bolhuis et al. (forthcoming) in constructing the stock for both. We start with land.

We measure total land cultivated as the sum of own land cultivated and land rented-in in wave I. In wave II, we calculate total land cultivated (own land + rented-in - rented-out) by season and then take the maximum value of the three. Similarly, total land rented-in and rented-out are taken as the maximum over all three seasons reported. To compute the total *value* of land, which we need to aggregate capital and land, we first compute the median rental value for an acre of land reported in the IHDS in wave 1. We then divide this by our model-implied interest rate r^* to get to the total value of land, assuming that there is no depreciation of land. We enforce the same value across both waves to ensure that we measure quantities of "capital + land" and do not factor in price appreciation.

For capital, we again follow Bolhuis et al. (forthcoming) to aggregate (net) capital rentals and different capital items that farm businesses own. The stock of capital items is calculated as the value of electric pumps, diesel pumps, bullock carts, tractors, threshers, and draft animals owned by the farm. We impute the value of machinery using 1997-98 prices reported in table 24 of Singh (2006). Electric and diesel pumps are priced at Rs. 18,000, bullock carts at Rs. 10,000, tractors at Rs. 250,000, and threshers at Rs. 25,000. For draft animals, we first take the average value of the minimum and maximum reported price for draft animals in the village database of the respective wave of IHDS, and then use the median of this value. A measure of capital items owned is then constructed as the total value of all machinery and draft animals owned by the farm.

IHDS also reports expenditure on renting capital as well as income made from renting out capital from the farm. We convert these rental values to capital stock values using our model implied (world) interest rate and capital depreciation. That is, we assume the data reports the rental costs for renting capital K^R as $R \times K^R$ where $R = r^* + \delta$. Bolhuis et al. (forthcoming) instead use the median nominal interest rate paid by households on loans from banks. We deviate from this because we believe bank loans do not correctly capture the depreciation costs priced into capital rentals. Correspondingly, our measure of R (11.5%) is higher than what Bolhuis et al. (forthcoming) use (8.5%).

Total capital stock employed on the farm is calculated as capital owned plus capital rented in minus any capital rented out. To this value we follow Bolhuis et al. (forthcoming) by adding a minimum amount of capital to every household equal to 10 percent of the median capital-to-land ratio multiplied by HH-specific operated land to account for basic tools used on the farm not usually reported in the data.

C.2 Details on Z-estimation in corporate sector

In this subsection, we provide further details on how we estimate the Z-process using the CMIE's Prowess database on publicly listed firms and other large firms – the Indian equivalent to Compustat. Drawing on the CRS production function in the corporate sector, we need to construct measures of (real) value added output Y, capital K and labor L, together with an estimate of α_C, the capital output elasticity in the corporate sector to back out Z:

$$Z = \frac{Y}{K^{\alpha_C} L^{1-\alpha_C}}$$

We start out with labor, or more precisely of the wage bill wL, for which we draw on a measure of the total costs of labor that include direct labor compensation (i.e. wages) but also bonuses and other forms of employee compensation. Since CMIE Prowess reports different measures of the labor wage bill, we make sure to always use the maximum reported wage bill within a firm-year observation. Specifically, we take the maximum among the following three measures of payroll expenses: "Compensation to employees", "Salaries and bonuses", and "Salaries".

Next, we compute value added output Y as total sales minus total intermediates. Since we do not have a direct measure of the costs of goods sold (COGS), which is commonly used as a measure of total intermediates, we indirectly infer total intermediates using the accounting identity whereby costs of intermediates are given by the difference between sales (we use "net sales"), PBDITA (profits before capital costs) and wL. At last, we use the measure of "capital employed" to measure capital K. To ensure that all variables are in real terms ($P = 1$), we deflate all three variables by the aggregate CPI.

We are then still left with a measure of the wage bill wL rather than a direct measure of labor L. To separate the two, we look at the wage bill per worker at the firm-year level. To allow for firms to use a different composition of worker skills (and thus different average wages per worker), we infer changes in wages from within-firm changes in the wage bill per worker. Specifically:

$$\Delta w = \Delta_i \frac{wL}{N} \tag{30}$$

as long as the ratio $\frac{L}{N}$ is constant in expectation at the firm-level. We then estimate wage changes over time by taking the median-observed change in the wage bill per worker at the firm level. We normalize the initial level of the wage w to one, without loss of generality. The corresponding wage series is plotted in Figure **??**. Wages per worker almost triple over the 30 year window that we look at, with a particularly rapid rise in the late 1990s, coinciding with the Indian growth miracle.

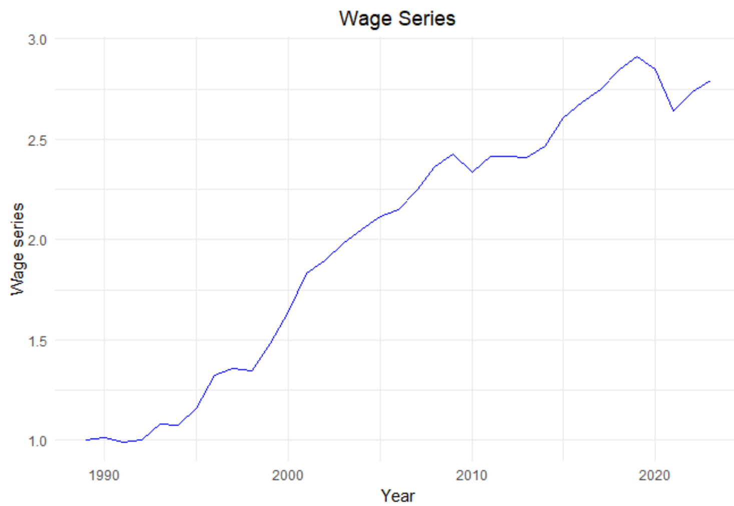

Figure C1: Wage series over time in the corporate sector.

At last, we infer α_C using the first-order condition of the corporate sector, specifically:

$$1 - \alpha_C = \frac{wL}{Y}$$

We draw on the median observed labor share across firms which gives $\alpha_C = 0.62$.

The corresponding Z-series is shown in Figure **??**. After an initial blip around 1990, productivity growth in the corporate sector was strong between 1994 and 2005, again coinciding with the Indian growth miracle. Since then, productivity declined in the wake of the Global Financial Crisis, but has been recovering more recently since 2013.

C.3 Details on calibration of collateral constraints

In this subsection, we outline the exact procedure used to obtain collateral constraints $\tilde{\phi}_k$ and $\tilde{\phi}_g$, as well as probabilities $\mathbb{P}(k - \mathrm{loan}|\text{any loan})$ and $\mathbb{P}(g - \mathrm{loan}|\text{any loan})$. The steps are as follows:

1. Create a sub-sample of the cleaned sample (see Appendix D) in which there are only such households that have at least one loan and whose oldest loan is issued in 2010 or later. The purpose of the issuance year restriction is that, ideally, we want to measure constraints at the moment of borrowing. Using 2010 is a compromise choice: it is arguably not too far from 2013 when they survey is conducted, and at the same time allows to consider most of households with debt. Around 16% of debtors have a loan originated prior to 2010, and are not considered further.

Figure C2: Z series in corporate sector inferred from CMIE Prowess database

2. In the sub-sample, calculate collateral to debt ratios: 1) total debt backed with business assets by business assets, 2) total gold backed loans by gold holdings. For 1), we consider loans to be backed by business assets if they have one of the following collateral types (called "type of security" in the survey schedule): first charge on immovable property, mortgage of immovable property, agricultural commodities, movable property other than bullion, ornaments, shares, agricultural commodities etc. Since such debt also includes mortgage debt, we subtract from this sum any debt that falls under these types and at the same time has "purpose of loan" specified as "for housing". For business assets, the definition is as in Table 1 but without subtracting debt.

3. To deal with cases of very small denominator, which inflates the right tail of the distribution of ratios, we use a filter that requires debt-holding households to have respective collateral assets larger than the 15th percentile in the distribution of all households holding any such assets (but not necessarily indebted). For example, for business assets, we take the cleaned dataset, select observations with strictly positive business assets, and in this distribution of business assets, take the 15th percentile. We record these two thresholds, which, coincidentally, are both equal to 5k Indian rupees.

4. Further split the sub-sample obtained in step 1 to two sub-samples. First is obtained by requiring business assets strictly above the threshold obtained in the previous step and strictly positive business-backed debt. Second is obtained by requiring gold assets strictly above the threshold obtained in the previous step and strictly

positive stock of gold loans. For the sub-sample of business debtors, we further introduce the following condition: value of non-residential buildings and land are at least half of for-business mortgages, calculated as the stock of mortgages of the household less any mortgages taken out for housing. This filter is motivated by the data themselves. There are cases when mortgage is recorded on the balance sheet with a purpose other than "for housing", yet non-residential real estate assets are very small or zero. This may be partially driven by cases when the value of non-residential real estate is for some reason lost or strongly diminished some time after taking a loan; we allow for up to 50% loss of value and consider other cases to be driven instead by incorrect specification of the purpose of the loan, i.e., that these loans are in fact for housing but are not recorded as such in the survey.

5. Determine the values of the ratios that are close to constraining. For this, in the two-sub-samples, we take 80th percentile of the respective ratios.

6. Construct a combined sub-sample of constrained borrowers by taking a union of the observations in the two sub-samples satisfying (independently) the condition described in the previous step.

7. In this combined sub-sample, determine $\mathbb{P}(k\mathrm{-loan}|\text{any loan})$ and $\mathbb{P}(g\mathrm{-loan}|\text{any loan})$ by looking at the shares of the sample with positive stock of the respective debt types.

8. Finally, obtain collateral constraints $\tilde{\phi}_k$ and $\tilde{\phi}_g$ as 95th percentile values of the respective ratios in the respective sub-samples. These are the same sub-samples from which 80th percentiles are drawn three steps before. The distributions up to 95th percentile are plotted in Figure C3.

C.4 Details on replicating capital-grant RCT in model

In this part of the Appendix, we provide further details on the capital-grant RCT by De Mel et al. (2008) and how we implement it within our model. We divide this discussion into four crucial parts: Selection, Experiment, Measurement, and Results.

Selection

De Mel et al. (2008) randomly select microenterprises based on the following two main criteria: (1) less than $1,000 USD in capital (excluding land and buildings), and (2) no paid employees. We try to implement the same selection rule within our model. Since

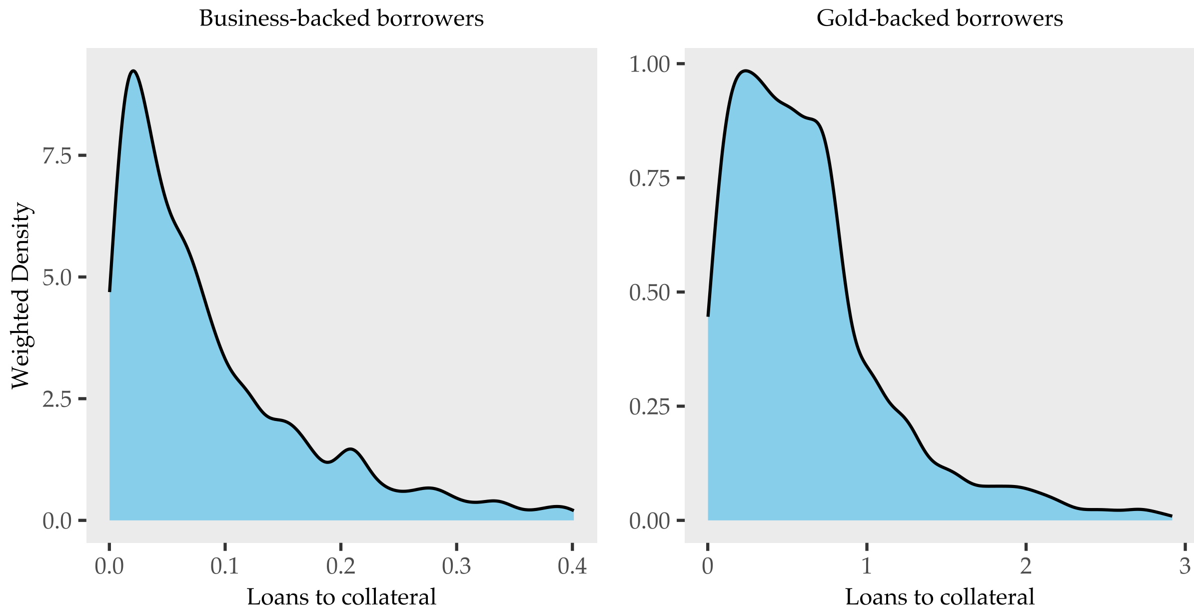

Figure C3: Probability distribution: ratio of the total value of business- and gold-backed loans to reported stock of collateral

Note: This figure is based on 2013 wave of AIDIS. The distributions are those from which the collateral constraints are estimated (see subsection C.3). The maximum value of the ratio in the plots is the 95th percentile, i.e., the collateral constraint. The unit of observation is still the household. Hence, to measure debt we sum up all the loans secured with the respective asset. As described in subsection C.3, only households with at least one loan and all debt issued no earlier than 2010 are considered for the construction of the collateral constraints.

our model does not distinguish different types of physical capital within a firm, we first check in the data the implied cutoff when including land and buildings. For this, we draw on the AIDIS data, restrict to the $1,000 threshold without land and buildings and measure average capital in land and buildings for this subset of firms, which we add on top of the $1,000 threshold. (Add numbers) To only capture micro-enterprises without paid employees, we restrict to firms with $n^* \in [0.5, 1.0]$. The upper bound rules out employer firms that hire workers from outside the own household. The lower bound, instead, ensures that we focus on micro-enterprises rather than households who only run a household business as a minor side project. The lower bound of 0.5 implies that for a two-worker household, one worker is full-time working in the household business.

With these selection criteria in hand, we draw a large number of micro-entrepreneurs which we randomly allocate into treatment and control group, as in the main paper. The large number ensures that sampling uncertainty is not an issue for us. Importantly, we also shut down uncertainty from variation in aggregate states by running the RCT many different times from different aggregate starting points.

Experiment

The experiment gave out four different treatment types, which we mimic in our model-based replication. Treatment arms 1 and 2 gave out capital grants of $100 and $200 dollars each, while Treatment arms 3 & 4 respectively gave out the same amounts in cash instead.

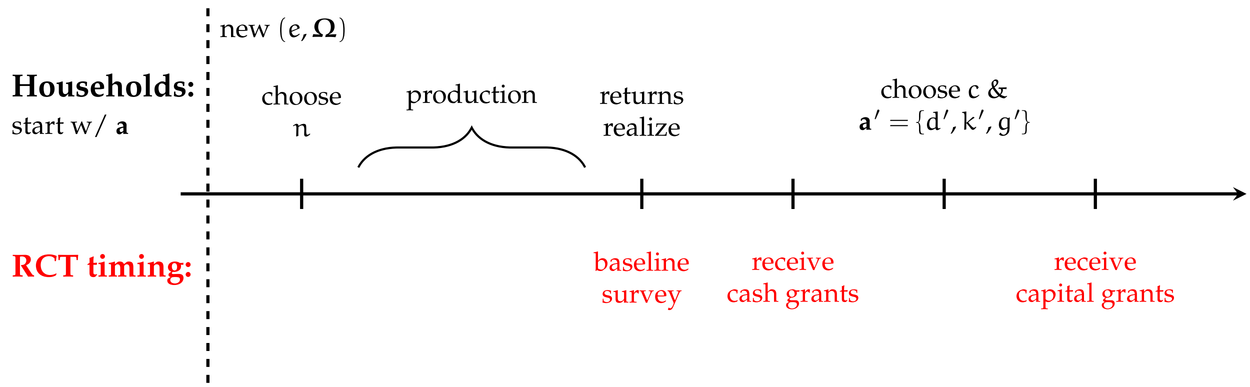

Figure C4: Timeline of RCT within the model

Figure C4 shows how we think about the timing of the experiment within our model. Cash grants in our model are treated as additional cash-in-hand at the end of a period before making future consumption and savings choices. Capital grants are instead handed out *after* households made their savings choices for tomorrow and simply add to the households' choice of capital. This is to replicate that capital grants were unanticipated and micro-entrepreneurs had to directly buy the capital. An alternative modeling choice would have been to allow households to still choose capital, deposits, and gold while already knowing they would receive an additional capital bonus after.

In De Mel et al. (2008), for funding reasons, half the grants were given out immediately after the baseline survey, while the other half were randomly given out only after the third survey wave (approximately 6 months later). Since our model period is 1 year, we cannot implement this staggered roll-out and simply assume everyone received the treatment after the baseline survey. Since we can more flexibly control for the state of the aggregate economy and there are no general equilibrium effects of the program, we do not see how this would bias our results.

Measurement

De Mel et al. (2008) follow the treatment and control group of selected micro-entrepreneurs for 2 years, or 8 waves after the baseline survey at the quarter frequency. Given that our model time period is annual, we aggregate the data in De Mel et al. (2008) at the yearly level and show results at this frequency, in line with our model. The main outcome variable in De Mel et al. (2008) is the *monthly* profits of the firm measured as total business income after paying out all expenses including wages to employees, but not including income paid to the household. Our corresponding measure of profits is:

$$12 \times \hat{\pi}^{RCT} \equiv \begin{cases} y(e, \Omega, k, n^*) & \text{if } n^* \leqslant 1 \\ y(e, \Omega, k, n^*) - w(n^* - 1) & \text{if } n^* > 1 \end{cases}$$

Importantly, we follow De Mel et al. (2008) in not subtracting capital depreciation. Note that this definition still incorporates paid employees, because selected firms may over time hire workers even if they did not have any paid employees at baseline.

Pseudo-code

Consider a large set of initial (aggregate) states $(\Omega_0, \Gamma_0)_\tau$ with $\tau \in \mathcal{T}$.

For each state $\tau \in \mathcal{T}$:

1. **Selection at t=0**, start from $(\Omega_0, \Gamma_0)_\tau$ and randomly draw $2 \times N$ firms (indexed by i) among firms with:
    - $k_0 <= \bar{k}$
    - $n_0^* \in [0.5, 1.0]$
2. **Roll-out**:
    (a) Measure baseline profits $\hat{\pi}_{i,0}^{RCT}$, capital $k_{i,0}$, revenues $y_{i,0}$ and save in dataframe

    (b) Randomly divide N firms in control group (C), N firms in treatment group (T)

    (c) Among treated firms, divide into 4 groups $g \in \{K1, K2, C1, C2\}$:
    - Capital grant \$100: K1
    - Capital grant \$200: K2
    - Cash grant \$100: C1

- Cash grant \$200: C2

(d) Hand out cash grant after returns at $t = 0$ but before decisions (c_0, k_1, g_1, d_1) are made; hand out capital grant after decisions are made, but before (e_1, Ω_1) are revealed.

3. **Tracking:** Follow simulated firms in T & C over 2 years, save their decisions:

$$(\hat{\pi}_1^{RCT}, \hat{\pi}_2^{RCT}, k_1, k_2, y_1, y_2)$$

4. **Results:** Following De Mel et al. (2008), run three types of regressions

   - Basic treatment effects:

$$Y_{i,t} = \alpha + \sum_g \beta_g T_{g,i,t} + \lambda_t + \lambda_i + \varepsilon_{i,t}$$

   where Y is the outcome of interest and (λ_t, λ_i) are fixed effects for time and individual firms. Following De Mel et al. (2008), also trim the top 0.5% of both the absolute and percentage changes in profits measured from one period to the next. Results are reported for the two main outcomes in levels and logs:

$$(k, \log(k), \hat{\pi}^{RCT}, \log())$$

   - Pooled treatment effects:

$$\hat{\pi}_{i,t}^{RCT} = \alpha + \beta \text{Treatment amount (in \$)}_{i,t} + \lambda_t + \lambda_i + \varepsilon_{i,t}$$

   - Returns to capital regression (IV):

$$\hat{\pi}_{i,t}^{RCT} = \alpha + \beta k_{i,t} + \lambda_t + \lambda_i + \varepsilon_{i,t}$$

   where $k_{i,t}$ is instrumented using the treatment amount T_i.

For each $\tau \in \mathcal{T}$, we obtain a set of treatment parameters β_τ. Do derive our final model-implied parameters, we average across τ to obtain:

$$\hat{\beta}^M = \frac{1}{|\mathcal{T}|} \sum_\tau \beta_\tau$$

Results

D Data cleaning

This section covers data cleaning procedure for household balance sheet data. The filters are developed such that the parts of assets are all positive and sum up to one. We also follow Badarinza et al. (2019) in limiting the sample to household heads that are at least 24 years old. We apply the same set of filters to both waves of AIDIS (Tables D.1 an D.3) and, where applicable, extend them to SCF (Table D.2).

Table D.1: AIDIS 2013 cleaning procedure

No	Cleaning step	Obs.	Share	Removed	Notes
Sample before any filters		110,800	100.00%		
1	Household head at least 24 years of age	2,269	2.05%	−2,269	Foll. BBR
2	Transport for HH needs not larger than total transport	10	0.01%	−10	Our filter
3	Residential buildings no larger than total buildings	4	0.00%	−4	Our filter
4	Residential urban land no larger than total land	14	0.01%	−14	Our filter
5	Residential rural land no larger than total land	14	0.01%	−14	Our filter
6	Urban land value not negative	1	0.00%	−1	Our filter
7	Value of stockholdings not negative	11	0.01%	−11	Our filter
8	Total assets strictly positive	1,096	0.99%	−584	Our filter
Sample after cleaning		107,893	97.38%	−2,907	

Details: "Obs." are counts of observations that do not satisfy the filter in the sample before any filters, and "Share" are corresponding fractions. For summary rows (before and after cleaning), this column contains observations present and their share of the original sample. "Removed" is the number of observations removed at each step; as some filters overlap, this number may be smaller than "Obs." BBR is Badarinza et al. (2019).

To avoid negative denominator when calculating asset shares for constructing asset decompositions, e.g. for Figures 1 and 2, we require that those asset classes from which debt is subtracted are non-negative. In particular, for AIDIS, we require that net equity in residential real estate and business is at least zero, affecting 1931 and 1543 negative records, i.e., around 1.8% and 1.4% of the clean sample, respectively. For SCF, 275 observations with negative residential real estate equity (4.4%), 54 observations with negative vehicles equity (<1%) and zero observations with negative business equity are likewise replaced with zeroes. Once the replacements are made, total wealth measures are recalculated to ensure that the parts of assets sum up to one.

Table D.2: SCF 2010 cleaning procedure

No	Cleaning step	Obs.	Share	Removed	Notes
Sample before any filters		6,482	100.00%		
1	Household head at least 24 years of age	188	0.16%	−188	Foll. AIDIS procedure
2	Total value of primary residence not negative	3	0.00%	−3	Our filter
3	Net equity in non-residential RE not negative	15	0.01%	−15	Our filter
4	Business equity not negative	4	0.00%	−4	Our filter
5	Total assets strictly positive	160	0.14%	−144	Our filter
Sample after cleaning		6,128	94.54%	−354	

Details: See the notes for Table D.1.

Table D.3: AIDIS 2019 cleaning procedure

No	Cleaning step	Obs.	Share	Removed	Notes
Sample before any filters		116,461	100.00%		
1	Household head at least 24 years of age	2,591	2.22%	−2,591	Foll. BBR
2	Transport for HH needs not larger than total transport	0	0.00%	0	Our filter
3	Residential buildings no larger than total buildings	0	0.00%	0	Our filter
4	Residential urban land no larger than total land	0	0.00%	0	Our filter
5	Residential rural land no larger than total land	0	0.00%	0	Our filter
6	Urban land value not negative	0	0.00%	0	Our filter
7	Value of stockholdings not negative	4	0.00%	−4	Our filter
8	Total assets strictly positive	492	0.42%	−251	Our filter
Sample after cleaning		113,615	97.56%	−2,846	

Details: See the notes for Table D.1.

E Further results details

E.0.1 Other counterfactual exercises

E.1 Other counterfactual exercises

The first counterfactual exercise is in the spirit of the back-of-the-envelope development accounting exercise of the introduction, Equation (1): Gold getting traded for capital goods. More specifically, for the household who starts the period with the stock of gold g and capital k, the production function would now be given by:

$$y^{cf_1}(k, g, n, e, Z) = y(k + \lambda_g g, n, e, z) = eZ((k + \lambda_g g)^{\alpha} n^{1-\alpha})^{\eta} \tag{31}$$

and the ex-post net worth by

$$\widetilde{a} = R^f d + y^{cf_1}(k, g, n, e, Z) - wn + (1-\delta)k + P^g(1-\lambda_g)g.$$

Figures/cf1_GNI.png

Figure E1: Counterfactual exercise 1: gold getting traded for capital goods

In other words, a fraction λ_g of the gold stock at the beginning of the period is automatically converted to capital. Figure E1 shows result of the counterfactual exercise with λ_g indexing the strength of the gold conversion. Note that here gold retains its cultural values in the sense that the household who invests in gold today enjoys the cultural service of gold in this period, before their gold gets traded for capital good at the beginning of the next period.

If the first counterfactual can be roughly described as "making gold productive," the second counterfactual can be interpreted as "making capital culturally valuable." Formally, rather than having gold enter the production function, we now assume that part of the cultural value of gold is attained by productive investment, modeled by replacing the gold in the utility function by a convex combination of gold and capital, i.e., Equation (2) turns into:

$$U^{cf_2}(c, g, k) = \frac{1}{1-\gamma}\left[\left((1-\theta_g)^{\frac{1}{\varepsilon}} c^{\frac{\varepsilon-1}{\varepsilon}} + \theta_g^{\frac{1}{\varepsilon}}(\psi k + (1-\psi)g)^{\frac{\varepsilon-1}{\varepsilon}}\right)^{\frac{\varepsilon}{\varepsilon-1}}\right]^{1-\gamma} \tag{32}$$

and the recursive problem of the household in Equation (8) turns into

$$V(\mathbf{a}, e; \boldsymbol{\Omega}) = \max_{n,c,g',k',d'} U^{cf_2}(c, g', k') + \beta\, \mathbb{E}\left\{V(\mathbf{a}', e'; \boldsymbol{\Omega}') \,|\, e, \boldsymbol{\Omega}\right\}.$$

Figures/cf2_GNI.png

Figure E2: Counterfactual exercise 2: productive business becomes culturally valuable

Figure E2 presents the results of this counterfactual, indexed by ψ. Interestingly, the gain peaks at $\psi = 0.3$. The reason is that, to the extent that gold saving is driven by financial (including investment and collateral) motives, having the cultural value attributed to a convex combination of gold and productive investment allows the households to take advantage of favourable financial properties of gold in some states of the world (e.g. when expected returns to productive investment are lower, while not losing the marginal cultural value of their investments.

F Gold policies in India

Since the 1960s, India's gold policy has undergone shifts, though its overarching objective has remained consistent: to reduce pressure on current account stemming from gold imports and mobilize idle stock held by households and temples. The Gold Control Act of 1968 marked the beginning of a restrictive era, banning production and sale of jewelry above 14 carats, ownership of bars and coins, and imposing a ban on gold imports that lasted until the 1990s Reddy (2002) and Reserve Bank of India (2012). The 1990s brought liberalization, but quantitative restrictions remained important in the government's toolkit (Soundararajan et al., 2014).

There have been several forms of quantitative restrictions. These include outright bans, such as the 1962–1990 import ban, elevated import duties, and more recent measures like the 80:20 rule introduced in 2013, which required importers to set aside 20% of imports for re-exports (Chilkoti, 2014). Such interventions have been able to affect official flow of gold into India, but have had a side affect of activating unofficial channels. For example, following a series of import duty hikes, smuggling activity surged in 2013 with seizures nearly doubling compared to the previous year (2013b). The demand for gold in India is widely considered price inelastic due to strong traditions, and it persisted through any "stick" measures. As one analyst put it, "whatever the methodology, the impact will be the same" (Singh & Bang, 2013).

To mobilize existing gold, the government introduced two types of schemes: deposit-based schemes and return-mimicking schemes. The former allowed households to deposit physical gold with banks, which was then melted down and reused. Households would get tax-free interest in return, and the principal at maturity. Particularly, the most recent Gold Monetization Scheme (GMS), introduced in 2015, aimed at bringing the mobilized gold to jewelers, who account for a sizable fraction of gold imports (International Monetary Fund. Asia and Pacific Dept [IMF], 2016; Kaminska & Keohane, 2015). Uptake was minimal due to limited awareness, logistical difficulties, and cultural attachment to jewelry (Parkin, 2019), which can be worn and used as a status symbol in addition to its financial value. The scheme was mostly discontinued in 2025 (Ministry of Finance, Government of India, 2025).

The most notable return-mimicking scheme is the 2015's Sovereign Gold Bonds (SGB), introduced together with the GMS. For SGBs, the government issues gold-denominated bonds, effectively borrowing at the gold price (International Monetary Fund. Asia and Pacific Dept [IMF], 2016). As the policy did not require the government to back up all holdings, import demand was reduced. At the same time, it exposed the government to excessive increases in gold price, which materialized during the post-Covid years and led the government to stop offering new SGBs (Mittal, 2025).

Deposit policies are estimated to have mobilized around 100t of gold since the 1960s (Reddy, 2002; World Gold Council [WGC], 2023), and the SGB scheme around 146t since

2015 (Reserve Bank of India [RBI], n.d.). The latter policy has been relatively more successful, yet both make up only a small fraction of the total gold stock in India, estimated by various sources at more than 20kt in recent years (Parkin, 2019; Sanderson & Parkin, 2020).

In contrast, lending against gold has become the most widespread gold-related financial activity in India. Small operations by pawnbrokers and moneylenders have been present for centuries, particularly in rural areas of southern Indian states (Chilkoti, 2013a; Reserve Bank of India, 2012). In these regions, access to banking has been limited and gold has been used as a liquid store of wealth. In the last decades, there has been a trend toward formalization of the sector, with specialized non-banking financial companies (NBFC) rapidly gaining market shares alongside traditional banks (2012; Venugopal, 2025).

Conventionally, households have pledged gold when facing bad financial conditions, e.g. due to crop failures and medical emergencies. As of 2013, average loan size of gold loans is around Rs50-80k ($900-1400) at banks and less at NBFCs, with interest rates ranging between 12% to 30% and gold loans have had minimal default rates historically (Chilkoti, 2013a; Reserve Bank of India, 2012). In very recent years, elevated gold prices and economic slowdown have further boosted demand (Venugopal, 2025), leading to higher default rates and tighter regulations by the RBI (Reserve Bank of India [RBI], 2025). World Gold Council (WGC, 2023) reports 2.9-3.4kt of golden jewelry (bars are not accepted) being used as collateral in India. The sector has attracted interest beyond India, as evidenced by Bain Capital's acquisition of a significant stake in Manappuram Finance, one of the largest NBFC lenders (Reuters, 2025).

Newer instruments like gold ETFs and digital gold apps have also emerged. ETFs, first launched in 2007, gained traction during Covid-19 and saw record inflows in 2025 (Schipani & Alim, 2025; WGC, 2023). Digital apps backed by major tech firms offer small-scale investment options, but holdings per user are generally under $100 (Sanderson & Parkin, 2020). Overall adoption of digital holding solutions remains modest, with ETFs and other digital formats comprising less than 1% of India's total gold stock (WGC, 2023).

In sum, gold lending stands out as the most impactful gold-related financial product. Monetization schemes have faltered, and while digital products are growing quickly, their scale remains limited. Still, their expansion offers a modestly hopeful path toward integrating India's deep gold tradition into a more productive financial system.

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