A General Equilibrium Analysis of Consumption Dynamics in Rural Economies*

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Abstract

I explore the role of a fixed factor of production in shaping consumption dynamics in a general equilibrium model with uninsurable income risk. A productive asset in fixed supply, like land, offers a particularly effective form of self-insurance through its effect on the share of safe to risky household income in general equilibrium. I apply the model to explain consumption dynamics in land-intensive rural developing economies. The theory rationalizes the puzzlingly low passthrough from income shocks to consumption as well as low intergenerational mobility found in developing economies, and explains low aggregate saving rates in rural economies.

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1 Introduction

Income and consumption dynamics of rural households in developing economies differ substantially from urban ones: First, rural households' consumption appears well insulated from income risk as indicated by a low measured passthrough from income shocks to consumption, see Townsend (1994). A corollary of this is that consumption inequality tends to be low relative to income inequality, changes little over the life cycle, and is relatively persistent. Second, intergenerational mobility is low in rural environments, see for instance Alesina et al. (2021), i.e., household consumption also persists across generations. In this paper, I argue that the role of land as a fixed factor of production represents a quantitatively important force that can explain much of the differences in consumption dynamics across rural and urban households.

The key insight in the paper is that the link between income and consumption volatility is sensitive to the share of land in a general equilibrium Aiyagari style model where households self-insure against idiosyncratic labor income shocks. Final output is produced combining land T, physical capital K, and labor H according to

$$Y = T^{\chi} K^{\nu} H^{1-\chi-\nu}, \tag{1}$$

where the labor share $1-\theta := 1-\chi-\nu$ is fixed throughout. The importance of land and reproducible capital varies depending on χ and ν. For concreteness, think of a rural economy as one with $\nu = 0$, and an urban economy as one with $\chi = 0$. To see why the land share matters, consider a stationary economy with idiosyncratic risk. As income risk increases, households' precautionary savings pick up, and demand for safe assets rises. In the rural economy, savings pressure ends up raising the equilibrium price of land, p_T, which is endogenous. This turns out to be convenient for rural households as more safe assets are created through land price appreciation. Contrast this with the urban sector, where savings have to be channeled into physical capital accumulation. Whenever physical capital depreciates at non-zero rate $\delta > 0$, saving in capital represents an inferior storage technology because additional savings reduce the share of safe to risky income in the economy, i.e., total asset income vis-a-vis total labor income. The reader can verify this claim by computing the ratio of safe to risky income in a competitive environment given by

$$\frac{(R-\delta)\,K + R_T T}{wH} = \frac{\theta}{1-\theta} - \frac{\nu}{1-\theta}\frac{\delta}{r+\delta}, \tag{2}$$

where R and R_T are return to capital and land, respectively. It is easy to see that in the land-only economy, the ratio is fixed at $\frac{\theta}{1-\theta}$, and strictly larger than the ratio in the urban economy as long as $\delta > 0$. What is more, a risk-induced fall in the interest rate in a capital-intensive economy further reduces the share of safe to risky income since expression (2) is increasing in the interest rate for $\nu > 0$. These aggregate aspects of the economy induce distinct household consumption dynamics: they shape the passthrough from labor income shocks to consumption, the evolution of consumption inequality within cohorts, and the intergenerational persistence of consumption across cohorts in a way that is consistent with the empirical literature reviewed below.

I develop this argument in four steps. First, I build an incomplete market model with infinitely-lived dynastic households that make consumption-saving choices in the presence of idiosyncratic labor income risk as in Aiyagari (1994). Relative to this canonical framework, I include land as a factor of production and allow for informal insurance schemes, which are potentially important for rural communities, see Rosenzweig and Stark (1989). I use a perpetual youth structure (Yaari, 1965; Blanchard, 1985) with accidental bequest to tractably embed a unit-root income process into an infinite horizon model,[1] and consider each sector in autarky.[2] Three aspects differentiate rural from urban: the role of land in production, the income process, and the degree of informal insurance. The rural sector is by definition the land-intensive sector, and the other two dimensions will be informed by household-level panel data on income and consumption from South Africa.

Before I quantify the model I prove formally that a more land-intensive production sector induces a higher equilibrium interest rate, all else equal, whenever physical capital depreciates. The reason is that depreciation renders the production sector's demand for productive assets relatively inelastic. In that case, income risk exerts strong pressure on the interest rate (prices) while the amount of productive assets is relatively fixed (quantities). A higher land share reduces the average rate of depreciation by construction since land is in fixed supply. This induces a more elastic asset demand schedule ultimately sustaining higher interest rates compared to a capital intensive economy. The argument does not require the capital share of the rural sector to be zero and instead hinges on the average depreciation rate being lower in rural than in urban.

This land-induced difference in interest rates has important feedback effects on consumption dynamics. Note that labor income is the volatile component of income and higher interest rates imply that future labor income is more heavily discounted rendering the volatile component of household wealth less important. In contrast, high interest rates elevate the role of household financial wealth in household consumption. This shift in household income reduces the passthrough from persistent labor income shocks to consumption, and ultimately risk exposure.[3]

A flip side of this is that financially wealthy rural households are more likely to remain wealthy in the future. This persistence of rural inequality is due to the larger role of financial wealth in shaping

[1] I drop the assumption of perfect annuity markets so that newborn cohorts enjoy accidental bequests, which is convenient for two reasons. First, the setup nests the neoclassical model exactly when shutting down income risk, which is not the case in the standard perpetual youth model. Second, the framework allows for a straightforward and empirically plausible link between parental and child life outcomes driven by the role of financial wealth.

[2] Financial markets must be at least partially segmented so that the rural and urban interest rates can differ. Intermediate cases of imperfect integration seem realistic, see Kleinman et al. (2023). If rural and urban sector are fully integrated, the basic logic of the paper still goes through, but the unit of observation would be the country level, i.e., the more land-intensive country would feature a higher interest rate, ceteris paribus. The interaction of rural-urban migration and income risk is addressed in a companion paper in Trouvain (2025b).

[3] Of course, on net, asset accumulation reduces household consumption volatility in urban, which is the point of self-insurance. In general equilibrium, however, asset accumulation in the capital-intensive sector leads to a decline in the interest rate undermining self-insurance motives.

life outcomes enabled by the relatively high and safe asset return. In contrast, human capital wealth plays a more important role in the urban sector, which evolves stochastically and induces greater income mobility within and across cohorts. Both the greater importance of financial wealth, which is partly inherited, and the smaller role assigned to human capital, which is the fickle component of income, induce higher intergenerational persistence in consumption in rural.

In the second step, I quantify the model. I calibrate the income process to match income dynamics for rural and urban households in South Africa. Differences in land-intensity, the income process, and informal insurance are all quantitatively important in shaping consumption risk, and I bring in consumption-level data to discipline these different margins building on Deaton and Paxson (1994)'s insight that the joint distribution of income and consumption contains information on the degree of insurance. This idea also underpins the popular passthrough coefficients of Townsend (1994) and Blundell, Pistaferri, and Preston (2008), henceforth BPP. Consistent with prior literature, I find that rural consumption appears surprisingly smooth. In contrast to the literature, I highlight how land-intensity in this general equilibrium setup impacts the structural interpretation of these commonly used methods.[4] The fact that a larger share of household income derives from asset income lowers the passthrough from labor income shocks to consumption substantially.

In the third step, I quantify how important differences in land-intensity and informal insurance are in explaining consumption dynamics across rural and urban sector in South Africa. I focus on the passthrough of persistent income shocks to consumption, which is directly related to the fanning out of inequality over the life cycle and a summary statistic for the degree of consumption insurance.[5] The model implied urban passthrough is about .75, i.e., a one percent increase in permanent income raises consumption by .75%. If the rural sector is as land-intensive as the urban one and in the absence of informal insurance, the passthrough in rural would be about .75 as well. The theoretical passthrough necessary to rationalize the low responsiveness of consumption in the data is about .5. Land-intensive production accounts for two-thirds of the gap, and one third is accounted for by informal insurance bringing the model implied passthrough all the way down to .5. Ignoring differences in the structure of production or the income process leads to a large overstatement of the role of informal insurance in rural economies.

The same forces that give rise to a low passthrough of persistent income shocks to consumption also lead to low intergenerational mobility in consumption in the rural sector. I measure intergenerational persistence in the model using a regression of simulated log parent consumption on simulated offspring consumption, and find that land-intensity induces high intergenerational persistence. The reason is again that high interest rates make asset bequests quantitatively important in determining offspring consumption, which is the only channel through which offspring and parent are connected.

[4] For recent applications of either BPP's or Townsend (1994)'s approach in developing economies see De Magalhaes and Santaeulalia-Llopis (2018), Santaeulalia-Llopis and Zheng (2018), Meghir et al. (2022), Attanasio et al. (2025), and De Magalhaes, Martorell, and Santaeulalia-Llopis (2024).

[5] Note that self-insurance is effective in insuring against transitory shocks, both in rural and urban.

I compare this to empirical estimates of intergenerational persistence in education in South Africa, which is the best proxy for consumption in the absence of direct measures of consumption across generations. Land-intensive production explains the lions' share of the higher degree of intergenerational persistence in rural South Africa.

Lastly, I consider the implications of the model for aggregate savings. In an influential paper, Laitner (2000) makes the qualitative argument that rising aggregate savings rates along the development spectrum could be explained by land-intensive production in poor countries. I apply my framework to revisit this question quantitatively and find that differences in the structure of production in a standard Aiyagari-style model can account for most of the relationship between GDP per capita and aggregate savings. I decompose the role of differences in the structure of production and income risk. The latter leads to additional precautionary savings that can raise the aggregate saving rate by about three percentage points in urban economies but has little impact on aggregate saving rates in land-intensive economies.

The role of land in the model entirely operates through its impact on aggregate equilibrium objects –such as the interest rate, the relative supply of safe assets, and the endogenous wealth distribution– and has nothing to do with any particularities of the market for land, of which of course there are many. I focus on the most parsimonious version of the benchmark Aiyagari model where land and physical capital are frictionlessly traded to highlight the impact of the structure of production on consumption dynamics neglected in the literature. To establish this basic point I mostly abstract away from frictions concerning the tradability of capital and land in the baseline model, but I consider a version of the model where land is imperfectly traded in a robustness exercise.

Note that despite limited access to financial markets rural environments time and again have been found to display high levels of consumption insurance, see Townsend (1994) and the large literature that followed. While the development literature often focuses on the fact that consumption insurance appears incomplete in poor rural communities, see for instance Kazianga and Udry (2006), the reader should keep in mind that consumption insurance appears even more incomplete in developed and urban environments as indicated by a larger passthrough from income shocks to consumption. The model developed here helps understand the relatively low passthrough of income shocks to consumption, high intergenerational persistence, and low overall aggregate savings in poor rural environments through one simple mechanism that captures a first-order feature of the economic environment: land-intensive production in a general equilibrium model with idiosyncratic risk.

Related Literature. The paper relates to the larger literature on the aggregate implications of idiosyncratic income risk in general equilibrium, building on Bewley (1986), Huggett (1993), and Aiyagari (1994).[6] Relative to these studies, I consider the role of land as a fixed factor of production, and explore the model's ability to account for differences in consumption dynamics across rural and urban sector. Note that modeling the rural sector as land-intensive has many antecedents in the literature.

[6] See also Imrohoroğlu (1989), Deaton (1991), and Carroll (1997).

Yet, land-intensive production is usually invoked in environments that either abstract away from idiosyncratic risk (Hansen and Prescott, 2002; Lucas, 2004) or are set in partial equilibrium (Lagakos, Mobarak, and Waugh, 2023), so that the link between land as a fixed factor of production and risk has been overlooked.

The special role of safe assets in the presence of idiosyncratic risk goes back to the seminal work of Bewley (1980). Woodford (1990) and Aiyagari and McGrattan (1998) study the optimal amount of government debt in this context, and Aguiar, Amador, and Arellano (2024) consider robust Pareto-improving fiscal policy in such environments. I highlight that land as a factor in fixed supply automatically generates more safe assets in the presence of idiosyncratic risk, which also means there is less scope for welfare-improving fiscal policy.

Empirically, I build on the seminal works of Deaton and Paxson (1994), Townsend (1994), and Blundell, Pistaferri, and Preston (2008) to measure income and consumption risk in the data. I compare these estimates with coefficients based on simulated data from the model to explore potential biases similar to Kaplan and Violante (2010).[7] Kaplan and Violante (2022) summarize and extend recent work that models carefully the response of consumption to income shocks (Kaplan and Violante, 2010; Kaplan and Violante, 2014). My general equilibrium focus is complementary to their work set in partial equilibrium,[8] and useful for understanding how the economy responds to changes in income risk or aggregate shocks, which are counterfactual questions that turn out to be sensitive to the share of land in production.

A growing literature has been documenting the micro-dynamics of income and consumption in developing economies, see De Magalhaes and Santaeulalia-Llopis (2018), Santaeulalia-Llopis and Zheng (2018), De Magalhaes, Martorell, and Santaeulalia-Llopis (2024), Lagakos, Mobarak, and Waugh (2023) and Attanasio et al. (2025). My findings are, on a high level, consistent with theirs. A related literature has studied risk in two-sector rural-urban economies, see Banerjee and Newman (1998) and Munshi and Rosenzweig (2016).[9] A key difference to these works is the role of land in the presence of

[7] An important difference to Kaplan and Violante (2010) is that I operate in an infinite horizon framework, which has a number of benefits. First, I reduce the computational burden by ridding the model of an explicit age structure with life-cycle consumption smoothing motive. Second, this also is a natural starting point since rural family units are closely knit, pension schemes are often non-existent, and elderly parents reside with children in the same households. A standard life-cycle model is not a good fit for such an environment.

[8] Kaplan and Violante (2022) explain that the link between income and consumption can be effectively studied in partial equilibrium, and incorporate portfolio adjustment frictions and asset return heterogeneity to match households' marginal propensity to consume. Measuring rural wealth distributions and interest rates is, of course, much harder than in advanced economies as data is more scant. Aguiar, Bils, and Boar (2024) highlight that even for a model with return heterogeneity and portfolio adjustment costs, it is difficult to match household consumption dynamics without preference heterogeneity.

[9] Ligon (1998) and Ligon, Thomas, and Worrall (2002) explore limits to full risk pooling in village economies based on limited commitment constraints, see Morten (2019) and Meghir et al. (2022) for related work in the context of rural-urban migration. Other central references in the development literature on risk in rural environments are Rosenzweig and Wolpin (1993), Fafchamps, Udry, and Czukas (1998), Fafchamps and Lund (2003), and Jayachandran (2006), Kinnan and Townsend (2012), Cole et al. (2013), Samphantharak and Townsend (2018), and Silva and Townsend (2023). Donovan (2021) studies the role of income risk in explaining low intermediate input shares in subsistence agriculture using a quantitative model, while Cole et al. (2013) and Karlan et al. (2014) considers the effect of formal insurance on agricultural outcomes based on experimental variation. Manysheva (2022) and Rodrigues (2022) explore the role of land reallocation frictions in developing countries in incomplete

idiosyncratic income risk. While I abstract away from rural-urban migration to focus on the role of land in general equilibrium, I consider how income risk shapes selection into rural-urban migration in related work (Trouvain, 2025b). Moreover, I explore the transition dynamics of the theory developed here in a more involved non-stationary two-sector model with long-run growth and endogenous migration to explain aggregate savings in fast-growing emerging markets (Trouvain, 2025a).

2 Model

2.1 Environment

Time is continuous, markets are competitive, and there is a constant mass of household L.[10] Infinitely-lived dynasties supply their labor inelastically and make consumption-saving choices.[11]

Income Risk. The logarithm of household labor income follows a stochastic process with persistent and transitory component

$$dp = \sigma_p dZ, \tag{3}$$

$$d\epsilon = dN\left(\epsilon' - \epsilon\right) \tag{4}$$

where dZ is a Wiener process. Transitory shocks arrive at rate λ_ϵ, and involve an iid draw from a mean zero normal distribution $G\left(\epsilon'\right)$ with variance σ_ϵ^2. Household labor income reads

$$W_i\left(p, \epsilon\right) = we^{p_i + \epsilon_i}. \tag{5}$$

To render the income distribution stationary, I assume that dynasties are hit with a death shock at rate ϕ.[12] Households are then replaced by new dynasties that draw their persistent type in logs from a normal distribution with mean $c_0 \leq 0$ and variance σ_0^2, their transitory type from $G\left(\epsilon'\right)$, and that take over the asset position from the dying dynasty. This setup is convenient because it nests the neoclassical model, which is not the case in the alternative setup of Yaari (1965) or Blanchard (1985) where annuity markets give rise to asset accumulation and consumption dynamics even in the absence of risk.[13]

market settings.

[10] Note that the urban economy is neoclassical so population growth would only changes the effective rate of depreciation. The rural sector features a fixed factor, land, so a constant population is a natural assumption that could be micro-founded using Malthusian forces.

[11] The infinitely-lived dynastic household assumption abstracts away from limits to risk sharing within families, see for instance Dercon (2002).

[12] See Gabaix et al. (2016) for a detailed discussion of how to stabilize stochastic processes that contain a random walk.

[13] Note that asset accumulation over the life cycle together with a changing time horizon as households age would induce an age-dependent passthrough of income shocks to consumption. Surprisingly, BPP do not find evidence in favor of an age-dependent passthrough.

I model informal insurance tractably by assuming that unobserved effective household labor income, W_i^*, reads

$$W_i^* = we^{(1-\kappa)(p_i+\epsilon_i)+d} \tag{6}$$

where $\kappa \in [0,1]$ represents an implicit insurance coefficient in the following sense. I assume income is redistributed across households within the same sector while leaving aggregate income unchanged so $\mathbb{E}[W_i^*] = \mathbb{E}[W_i]$, and redistribution takes the form of a percentage increase in effective disposable household income of size $d = \log\left(\frac{\mathbb{E}\left[e^{p_i+\epsilon_i}\right]}{\mathbb{E}\left[e^{(1-\kappa)(p_i+\epsilon_i)}\right]}\right)$.[14] A positive value of κ implies that income shocks pass through only partially to effective income, which serves as a simple way to capture informal insurance arrangements in rural village communities including, for example, implicit contracts amongst villagers (Townsend, 1994; Ligon, 1998) or marriage markets (Rosenzweig and Stark, 1989; Munshi and Rosenzweig, 2016).[15] The setting maps directly to the popular BPP estimator concerned with the passthrough from persistent income shocks to consumption.

Household problem. Dynastic households solve a consumption-saving problem

$$\begin{aligned} V(b,p,\epsilon) &= \max_{\{c,a\}} \mathbb{E}_t\left[\int_t^\infty e^{-(\rho+\phi)s}\frac{c^{1-\gamma}}{1-\gamma}ds\right] \\ &\text{s.t.} \\ \dot{b} &= rb + W^*(p,\epsilon) - c \\ b &\geq 0, \end{aligned} \tag{7}$$

with zero-borrowing constraint $b \geq 0$.[16]

Aggregates and Production. I build on Hansen and Prescott (2002) with constant-returns-to-scale neoclassical production that includes land T in fixed supply and normalized to one, labor $H = \int e^{p_i+\epsilon_i}di$, and reproducible capital K in a Cobb-Douglas fashion

$$Y = T^\chi K^\nu H^{1-\chi-\nu} \tag{8}$$

[14]This model of informal insurance is very similar to commonly used progressive tax functions, see Benabou (2000) and Heathcote, Storesletten, and Violante (2017). The subtle difference is that taxes are observed, and then subtracted to obtain net income, while informal insurance and redistribution is unobserved and thus driving a wedge between consumption and after tax income inequality. In a model with endogenous human capital investment, one can envision how informal insurance could induce underinvestment, see recent work of Carli et al. (2025) along these lines.

[15]The presumption that there is some form of informal insurance in rural economies seems uncontroversial, going back at least to Rosenzweig and Stark (1989). See Ligon, Thomas, and Worrall (2002) and Morduch (1995) for succinct summaries of the many possible ways in which rural farming communities insure against income shocks: plot diversification, planting low yield low risk crops, delaying investment in face of uncertainty, informal transfer and credit schemes, and inter-temporal labor substitution.

[16]The zero-borrowing constraint seems appropriate for the emerging market context as a first pass. The assumption does matter in that higher interest rates help build up bufferstock savings so a high interest rate environment is desirable when dealing with idiosyncratic income risk. The predictions would be more ambiguous with a natural borrowing limit as lower interest rates would expand the natural borrowing limit assuming it is proportional to $\frac{w}{r}$.

where χ and ν are land and capital share, respectively. Output can either be consumed, or turned one-for-one into reproducible capital. Together with a depreciation rate δ, the law of motion of capital is given by

$$\dot{K} = I - \delta K, \tag{9}$$

where $Y = C + I$. The rental rate of land, price of land, rental rate of capital, and wage rate per efficiency unit are denoted by R_T, p_T, R, and w, respectively. Differences between urban and rural economy comprise differences in land vs. capital intensity while holding the labor share fixed,[17] differences in the income process, and differences in informal insurance. All other aspects of the model are the same, and each sector is considered in autarky.

2.2 Equilibrium.

I focus on a stationary equilibrium defined as follows.

Definition 1. A stationary equilibrium consists of aggregate output, capital, factor prices, consumption, and savings policy functions such that

- households solve (7) subject to constraints and transversality condition;
- final goods firms maximize profits, taking factor prices as given;
- goods, factor, and asset markets clear with $\int b_i di = K + p_T$ within each sector;
- a stationary distribution $g(x)$ obtains, defined over idiosyncratic income and wealth states $x = (b, p, \epsilon)$, consistent with aggregation constraints.

In next discuss the equilibrium properties of the model, and highlight novel feature of the framework.
Wages and Asset Prices. Competitive production implies the following wage rates

$$w = (1 - \chi - \nu) \left(\frac{\nu}{r + \delta} \right)^{\frac{\nu}{1-\nu}} \left(L\tilde{h} \right)^{-\frac{\chi}{1-\nu}} \tag{10}$$

where $\tilde{h} = \int h(x) g(x) dx$ is the average amount of efficiency units of labor per household.

Turning attention to the demand for assets, note that households only hold one risk free bond, and a financial intermediary in the background ensures that an arbitrage condition between physical capital and land holds

$$\frac{R_T}{p_T} + \frac{\dot{p}_T}{p_T} = R - \delta, \tag{11}$$

[17] This is consistent with the evidence in Gollin (2002) documenting that the aggregate labor share is unrelated to income per capita.

where $\dot{p}_T = \frac{d}{dt}p_T$ represents gains from land price appreciation. In the steady state the price of land will be constant. In that case equation (11), together with profit maximization and land supply normalized to one, pins down the equilibrium price of land

$$p_T = \frac{\chi Y}{r}, \tag{12}$$

which implies a constant ratio of the value of land to the physical capital stock

$$\frac{p_T}{K} = \frac{\chi}{\nu}\frac{r+\delta_k}{r}. \tag{13}$$

Equation (13) is useful in deriving equilibrium demand for physical capital, which is a scaled-down version of total household demand for risk-free assets, $K = \frac{1}{1+\frac{\chi}{\nu}\frac{r+\delta}{r}} \int b(x)\, g(x)\, dx L$. Before I solve the model computationally using Achdou et al. (2022)'s finite difference scheme, I make several theoretical observations.

2.3 Analytical Results

A novel feature of the model is the special role of land as safe asset in the presence of idiosyncratic income risk. I emphasize that this effect is entirely driven by general equilibrium forces, and ultimately is based on the observation that land as a factor in fixed supply does not depreciate.[18]

I start by stating a neutrality results under the complete markets benchmark to set the stage for the role of land when markets are incomplete.

Proposition 1. *In the case of fixed household types, i.e., $\sigma_p^2 = \sigma_\epsilon^2 = 0$, the interest rate equals the discount rate adjusted for death shocks, $r = \rho + \phi$, and is independent of the share of land.*

The significance of proposition 1 is that in the absence of income risk the land share is irrelevant for the determination of equilibrium interest rates.[19] The model inherits this feature from the standard neoclassical model, which is nested, and explains why the role of land-intensity is inconsequential for representative agent frameworks as in Hansen and Prescott (2002). This is no longer true once households face idiosyncratic risk, at which point the share of land vis-a-vis capital becomes important in the determination of equilibrium interest rates and household consumption dynamics.

To make this point formally, I first introduce the notion of normalized asset demand $\tilde{b} := \frac{B}{wL}$ and assume for convenience that average efficiency units of labor per household, $\tilde{h}$, is fixed at unity, so increases in risk represent mean-preserving spreads.

[18] The reader should not that a non-reproducible factor in a stationary equilibrium does not depreciate by construction, otherwise the production factor would disappear in the long-run. My notion of land is thus one of "raw" land. Investment in land to make it amenable to agricultural production is captured by a positive reproducible capital share in rural.

[19] The proposition can be extended to one for insurance markets for idiosyncratic risk as long as there are no life cycle wage dynamics, see the appendix for details.

Lemma 1. *Denote aggregate asset demand B as a function of exogenous parameters Θ as well as interest rate, wage, and total measure of households, $B(\Theta, r, w, L) := \int b(x)\, dG(x)\, L$, and note that B is homogenous of degree one in both w and L, so $B(\Theta, r, w, L) = B(\Theta, r, 1, 1)\, wL := \tilde{b}(\Theta, r)\, wL$.*

Lemma 1[20] is useful in two ways. First, note that because household asset demand scales linearly in the wage rate I can ignore effects of land-intensity on the mean level of income,[21] which is fully captured in the scalar w, and focus on normalized household saving choices captured in the normalized aggregate asset supply function $\tilde{b}(\Theta, r)$. While it is difficult to characterize theoretically the shape of the normalized asset supply function,[22] in most applications aggregate asset supply is upward-sloping in the interest rate, which I assume to be the case. I will use the linearity of the asset supply function to simplify the asset market clearing condition, which also depends on firms' demand for productive assets. Firms' demand for capital and land in the convenient Cobb-Douglas case and normalized by the aggregate wage bill equals $\tilde{a} = \frac{K}{wL} + \frac{p_T}{wL}$. This normalized aggregate asset demand schedule is downward sloping in the interest rate, and depends on the share of land vs. capital and the extent to which physical capital depreciates. Crucially, the semi-elasticity w.r.t. the interest rate, $|\frac{\partial \log \tilde{a}(r)}{\partial r}|$, is increasing in the share of land in production as summarized in the following proposition.

Proposition 2. *Holding the labor share $1-\theta := 1-\chi-\nu$ fixed, the normalized asset demand schedule is a downward-sloping function of the interest rate and reads*

$$\tilde{a}(r) = \frac{1}{1-\theta}\left(\chi\frac{1}{r} + \nu\frac{1}{r+\delta}\right), \tag{14}$$

where the shares χ and ν sum up to the non-labor share, $\chi + \nu = \theta$. An increase in the land share, holding the non-labor share fixed, increases the semi-elasticity of firms' normalized asset with respect to the interest rate whenever $\delta > 0$, i.e., $\frac{\partial}{\partial \chi}|\frac{\partial \log \tilde{a}(r)}{\partial r}| > 0$ iff $\delta > 0$.

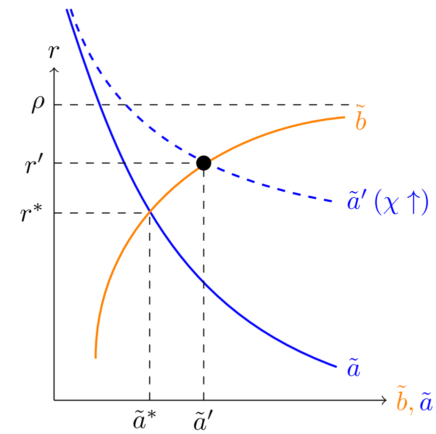
The significance of proposition 2 is that a higher land share in production makes asset demand more elastic in the interest rate. This is quantitatively important for households' ability to self-insure as a more elastic demand for productive assets from the firm side sustains a higher interest rate, all else equal. The easiest way to illustrate this is to trace out the implications of land-intensity using Aiyagari (1994)'s canonical asset market clearing diagram in figure 1. The diagram depicts the long-run effect on an increase in the land share on the interest rate in general equilibrium. As the land

[20] Lemma 1 exploits the well-known homogeneity property of the households' consumption-saving problem, which holds true as long as preferences are homothetic, labor income shocks are multiplicative, the borrowing constraint is proportional to the wage rate, and there is no capital income risk, all of which hold in my setup.

[21] That is to say, I do not consider the negative effect of high land shares on the link between precautionary savings and wages. In the welfare analysis in Davila et al. (2012), low income households earn most of their income in labor income, and thus would like precautionary savings for the economy as a whole to be higher as higher savings raise the real wage. If there is a fixed factor of production, this link is much weaker since capital accumulation runs into diminishing returns faster.

[22] See Achdou et al. (2022) for a proof that the asset supply function is upward-sloping in the interest rate when the coefficient of relative risk-aversion is below one.

Figure 1. Normalized Asset Market Equilibrium



share increases, demand for productive assets from the firm side becomes more elastic, and the $\tilde{a}\,(r)$ schedule flattens. This induces, ceteris paribus, a higher interest rate, and increases the relative share of assets to labor income in the economy. Why do we care that a higher land share induces a higher equilibrium interest rate? The reason is that the ability of households to self-insure improves in the interest rate, i.e., a higher interest rate environment allows for more consumption smoothing.[23]

Three remarks are noteworthy. First, the increase in normalized assets in this comparative static exercise coincides with a reduction in normalized physical capital, $\frac{K}{wL}$. The obvious reason is that the capital share is smaller by construction. Only slightly less obvious is that a higher equilibrium interest rate leads to less demand for capital through its impact on the rental rate, $R = r + \delta$. I shall return to this observation when exploring the implications of land-intensity for the aggregate saving rate in the economy later on.

Second, the result is robust to a number of extensions that I explore in the appendix. Of particular interest is to allow for differences in the relative price of investment vis-a-vis consumption, which differs along the development spectrum, see Hsieh and Klenow (2007). This extension has no bearing on any of the results. Another extension considers a more general CES production structure with $Y = \left(\left(\psi_{\chi}^{\frac{1}{\sigma}} T^{\frac{\sigma-1}{\sigma}} + \psi_{\nu}^{\frac{1}{\sigma}} K^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}\right)^{\theta} L^{1-\theta}$ where I maintain the Cobb-Douglas assumption between labor and non-labor factors of production in line with the findings of constant factor shares in Gollin (2002). When the elasticity of substitution between land and labor is non-unitary, the relative share

[23]This is the key benefit of government debt in Aiyagari and McGrattan (1998), which is traded off against a crowding out of capital. Aguiar, Amador, and Arellano (2024) highlight the scope for Pareto improving fiscal policy when the economy is dynamically inefficient with $r < 0$. Incorporating land as a factor of production rules out welfare-improving fiscal policy along the lines of Aguiar, Amador, and Arellano (2024) simply because the real rate cannot fall below zero. Tirole (1985) made this observation in the context of OLG models, see the overview in Hirano and Stiglitz (2025) for recent work along these lines.

$\frac{\chi(R_T,R)}{\nu(R_T,R)}$ is no longer constant and depends on the rental rates, yet the demand for productive assets from the production sector otherwise takes the same form as in (14). A sufficient condition for the main result to go through is that capital and land are complements. Similarly, if non-labor and labor inputs were characterized by an elasticity of substitution below unity then the main mechanism would be amplified.[24] Moreover, the qualitative result is likely robust to details of the household problem like portfolio adjustment frictions.[25] This conjecture is based on the convenient separation between production side in (14) and households' supply of assets $\tilde{b}$. Since the proposition centers on the link between the structure of production and the equilibrium interest rate, and only imposes mild assumptions on the aggregate normalized asset supply schedule, namely that it is upward-sloping in the interest rate, $\frac{\partial \tilde{b}}{\partial r} > 0$, and increases in income risk, $\frac{\partial \tilde{b}}{\partial \sigma_p^2} > 0$, it is robust to extensions on the household side that generate a more complicated aggregate asset supply function.

Third, note that proposition 2 does not use the fact that land is in fixed supply, and the result would remain the same for a model with two types of capital where only one type depreciates. Consequently, the key feature that turns land into a superior safe asset, and physical capital into an inferior one, are their different depreciation rates. The insight that depreciating assets are inferior assets goes back at least to Samuelson (1958) in the context of overlapping generations models. The setup here is quite different and leverages a convenient normalization to focus on income and consumption dynamics in a stochastic environment, which turn out to be quite sensitive to the share of fixed assets in production, and find a direct empirical counterpart in the data.

Safe to risky income shares. The general result that self-insurance improves as interest rates rise, while well-known, is somewhat opaque. A simple complementary intuition can be gained from computing the share of safe income to risky income in the economy

$$\frac{rB}{wL} = \frac{\theta}{1-\theta} - \frac{\nu}{1-\theta}\frac{\delta}{r+\delta}. \tag{15}$$

It is easy to see that (15) is falling in the capital share ν, and increasing in the interest rate r. In the absence of uninsurable income risk, this ratio is inconsequential. Yet, once households face idiosyncratic shocks, the asset income to labor income ratio begins to matter. Intuitively, the higher this ratio, the smaller is the share of volatile income in the economy. Consequently, for the same amount of income risk and otherwise identical calibration, the capital-intensive urban economy will feature a lower ratio of safe income to risky income, which will make it harder for households to maintain a smooth consumption profile.

The idea that aggregate safe to risky income matters for households' ability to smooth consump-

[24] Boppart et al. (2023) find that the agricultural sector becomes more capital-intensive as countries get richer, suggesting a higher elasticity of substitution across land, labor, and capital. Their findings reflect a long-run cross-country relationship and have little to do with the elasticity of substitution across factors within country at a point in time. More relevant in this context are studies like Oberfield and Raval (2021), which tend to find elasticities of substitution across factors of production below unity.

[25] See Kaboski and Townsend (2011) and Kaplan and Violante (2014) for models with non-convex adjustment costs.

tion, while intuitive, is incomplete since individual and not aggregate safe to risky income ratios determine consumption dynamics, which in turn depend on the entire endogenous wealth distribution. I next use both an approximate solution and a fully simulated model to show that household consumption dynamics are indeed sensitive to the share of land in the economy, and that self-insurance is more effective in land-intensive economies.

2.4 Consumption Volatility and Consumption Inequality

Foreshadowing the quantitative analysis, I first focus on the passthrough from labor income shocks to consumption building on BPP. The structural passthrough coefficient from permanent income shocks to consumption is defined as

$$\mathbb{E}_i\left[\frac{\Delta \log c_i}{\Delta p_i}\right] = \beta_{c\_p}, \tag{16}$$

where Δc and Δp is the change in log consumption or log permanent income measured over a discrete time interval.

This passthrough of permanent shocks on consumption depends crucially on the interest rate, which is not a new result. BPP and Kaplan and Violante (2010) discuss how the ratio of financial to human wealth matters for the passthrough. Note, however, that the more appropriate and slightly different concept I focus on is based on the income generated by financial assets vis-a-vis labor, which is also well defined when the interest rate is below zero. To see why the interest rate income matters, let's focus on the case of a financially wealthy households so the consumption policy function is well approximated by a linear solution of the form[26]

$$c_t = \frac{\tilde{\rho} + r(\gamma - 1)}{\gamma}\left(a_t + W_t\right), \tag{17}$$

with $W_t = \mathbb{E}_t\left[\int_t^\infty e^{-rs} w h_s ds\right]$ representing the expected present discounted value of human wealth. If h_s follows a random walk in levels, the expression would simplify to $c_t = \frac{\tilde{\rho}+r(\gamma-1)}{\gamma}\left(a_t + \frac{wh_t}{r}\right)$. The passthrough from permanent income shocks to consumption growth in (16) can be expressed in discrete increments $\frac{\Delta c}{c}$ using (17)

$$\frac{\Delta c_t}{c_t} = \underbrace{\frac{r}{ra_t + wh_t}}_{\text{trans. passthrough}} \Delta a_t + \underbrace{\frac{wh_t}{ra_t + wh_t}}_{\text{perm. passthrough}} \frac{\Delta wh_t}{wh_t}, \tag{18}$$

where the change in the asset position proxies for a transitory shock,[27] and Δwh_t is a permanent

[26] See Benhabib, Bisin, and Zhu (2015) for a proof.

[27] In the continuous time setup this transitory shock is somewhat ill-defined, and the reader can think of it as the case where the passing shock has a high arrival rate λ_ϵ. The discrete time version is more natural here, see Kaplan and Violante (2022) for

shock given the random walk in household labor income. Equation (18) shows what would correspond to the BPP passthrough coefficients for transitory and permanent shocks using $\frac{\Delta c_t}{c_t} \approx \Delta \log c$ and $\frac{\Delta wh_t}{wh_t} \approx \Delta p$.[28]

Clearly, this passthrough depends on the ratio of financial income to labor income, which in turn will be a function of both the interest rate and the endogenous asset distribution. And while the passthrough coefficient for transitory shocks is increasing in the interest rate, the reverse is true for permanent shocks. It is now easy to see why rural households in a high interest rate environment with relatively higher financial income share will appear more insulated against persistent shocks and feature an overall lower persistent passthrough coefficients, even if households in each sector were exposed to identical stochastic processes and enjoyed the same degree of informal insurance.

The flip side of high insurance from persistent labor income shocks is low income mobility. High interest rates ensure that financial income takes a larger share of total household income. Since financial income offers a safe return, while human capital is volatile, the rise and fall of dynasties driven by persistent income shocks will be slower in the high interest rate environment as initial endowment of financial wealth are a more important determinant of household resources. This translates into relatively high consumption inequality for young cohorts, while the fanning out of consumption inequality as cohorts age is suppressed. Social mobility is lower in rural.

The previous statement is not sharp as there are no analytical results to characterize consumption inequality in general incomplete market models. I thus solve a version of the baseline model to show how much bite a changing land share can have through its impact on equilibrium interest rate and safe to risky income ratios. I provide a more careful quantification in the next section, here I simply want to point out that for a reasonable calibration, a varying land share can have striking consequences for consumption volatility, inequality, and passthrough of income shock. To do so, I set informal insurance to zero ($\kappa = 0$), hold the volatility of the income process and the labor share fixed, and only vary the land share from 0.0 to 0.38.

Figure ?? plots the results, and before inspecting the implied household consumption dynamics, take account of the upper left panel depicting the aggregate share of safe to risky income in the economy, which is falling in the share of physical capital. Note that this share is bounded by $\frac{\theta}{1-\theta}$ when land is the only asset in the economy, and can in principal turn negative when capital is below the gold rule level defined by $\frac{\partial F}{\partial K} = \delta$. The falling share of safe to risky income finds its mirror image in the equilibrium interest rate depicted in the upper right panel. The interest rate is clearly sensitive to the land share and ranges from 3.5% to 4.1%, which is the quantitative equivalent of proposition 2. The interest rate is bounded by the neoclassical interest rate of $\rho + \phi = .045$.[29] Moreover, I verify

a discussion. The numerical implications in either case are similar.

[28] In the presence of borrowing constraints, advance information, or a misspecified income process, the BPP estimates do not generally coincide with this structural parameter, see Kaplan and Violante (2010).

[29] Changing the land share does impact the real wage. Note that this changing real wage does not show up in any of the distributional statistics as it is differenced out in passthrough and log variance estimates. When setting $\delta = 0$ every plot in

Land Share, Interest Rates, and Consumption Dynamics

Figure 2. Interest rate

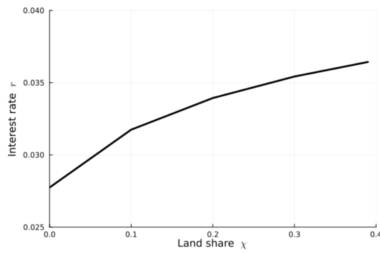


Figure 3. Safe to risky income

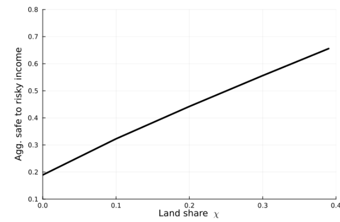


Figure 4. Cons. Inequality

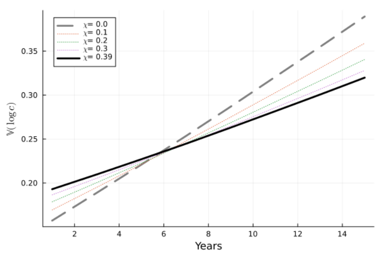
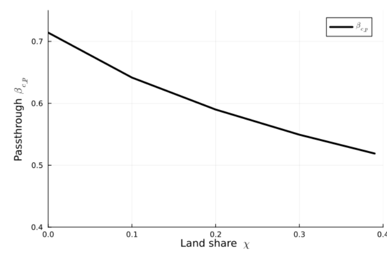


Figure 5. Passthrough perm. shock



The calibration is based on $\sigma_p^2 = .015$, $\lambda_\epsilon = 2$, $\sigma_\epsilon^2 = .2$, $\delta = .07$, $1 - \chi - \nu = .6$ and there is no informal insurance, $\kappa = 0$.

in a separate exercise that the difference between the interest rate for the no-land economy ($\chi = 0$) vs. the most land-intensive economy is increasing in the degree of income risk, i.e., $\frac{\partial^2 r}{\partial \chi \partial \sigma^2} > 0$. This is intuitive since for low levels of income risk the behavior of the model is close to the neoclassical benchmark with complete markets. For high levels of income risk, land intensity makes a substantial difference to the equilibrium interest rate.[30]

I next compute the implied consumption dynamics using the entire cross-section of simulated households. The bottom left panel plots the evolution of the log variance of consumption for a newborn cohort. Inequality of newborn cohorts is higher in the case with high land share. This reflects that inequality early in life is partly driven by asset endowments, which are more important when the interest rate is high. Conversely, the rise in consumption inequality over the life cycle is suppressed since high returns to safe financial wealth reduce social mobility. For a capital intensive economy with low interest rates, human capital is a much more important determinant of lifetime income, and since human capital is fickle and features persistent shocks, income and consumption fan out more strongly over the life cycle generating a steeper slope of the log variance of consumption as a

figure ?? turns into a horizontal line consistent with the role of depreciation in proposition 2.

[30] In the limit for where risk is so large that households want to hold nearly unlimited amounts of savings, the only-land economy will feature an interest rate of zero while the only-capital economy will feature an interest rate of $-\delta$.

function of time.[31]

The bottom right panel plots the structural passthrough coefficient from permanent income shocks to consumption, log on log. The higher the land share, the lower is the passthrough and the higher is the degree of consumption insurance with respect to persistent shocks. This effect is entirely driven by the changing equilibrium interest rate. Inspecting the scales of the y-axis of the left and the right plot, the reader can verify that the land share has a quantitatively large effect on this structural passthrough coefficient where structural means that the moment is simulated from the model where I observe transitory and permanent type and can run a simple regression that uncovers (16).

I next quantify a version of the model to explore how important differences in land intensity, income risk, and informal insurance are in shaping consumption dynamics in South Africa.

3 Quantification

3.1 Parameterization of the Model

I now describe the parameterization of the model.

Production, Preferences, Death Shock. Urban production follows the standard neoclassical model with a reproducible capital share of 40% and a labor share of 60%. I follow Hansen and Prescott (2002) and set the land share in rural to 30%, while labor and capital share are 60% and 10%, respectively. Measured labor vs. non-labor shares (including returns to capital and land) across the development spectrum are roughly stable after correcting for measurement problems due to self-employment, see Gollin (2002).[32] I use a depreciation rate of 7%. The discount factor is 2.5%, and the coefficient of relative risk aversion is set to 2, consistent with recent evidence in Choukhmane and Silva (2022). The arrival rate of the death shock equals $\phi = .025$, which ensure an average working life of 40 years.

Income Process. I pick the parameters governing the income process to be largely consistent with the results in Trouvain (2025b), which estimates the stochastic process in (3) separately for rural and urban households in South Africa. The theoretical moments implied by the postulated income process are

$$\mathbb{E}\left[\hat{y}_t \hat{y}_{t+k}\right] = \sigma^2_{\text{int}^*} + \sigma^2_p \cdot t + e^{-\lambda_\epsilon k}\sigma^2_\epsilon + \mathbb{1}_{\{k=0\}}\sigma^2_{x,t} \tag{19}$$

[31] Whether a newborn has a high or a low asset position is orthogonal to their initial human capital. I simply transfer the wealth from a dying dynasty to a newborn dynasty. If this capital was destroyed, instead of reshuffled, I would not be able to nests the neoclassical model the way I do in proposition 1.

[32] The land share is broadly consistent with estimates for the UK at the eve of the industrial revolution from Allen (2009) or Clark (2010), albeit the land share is a little bit higher in my rural economy. Note that the agricultural employment share in the UK around 1800 was already substantially below 40%. See for instance the long-run agricultural employment series of the Our World In Data webpage. Take into account that the aggregate land share already is a weighted average between rural and urban, so the rural land share ought to be even higher.

where $\mathbb{1}$ is an indicator function accounting for classical measurement error that appears only on diagonal entries of the covariance matrix and varies by year. The moments are fully determined by the set of parameters $\theta = \{\sigma^2_{\text{int}^*}, \sigma^2_p, \lambda_\epsilon, \sigma^2_\epsilon, \{\sigma^2_{x,t}\}\}$. The parameter $\sigma^2_{\text{int}^*}$ captures initial dispersion and depends on inequality in labor income at birth (σ^2_0) as well as the average age of a cohort since persistent shocks accumulate over time, which I take into account when I simulate the data. To keep the model focused on the role of land as a factor of production, I set the volatility of persistent shocks to be identical across rural and urban and equal to .01, i.e., $\sigma^2_p = .01$. In the data the persistent volatility is not estimated very precisely so setting them equal to isolate the role of land in production is helpful. I also set average destruction of human capital at birth, c_0, and initial inequality σ^2_0 equal across sectors so none of my findings are driven by these differences that are not precisely identified in the data but roughly consistent with the overall income distribution.

In contrast, the arrival rate and variance of imperfectly transitory shocks, $\lambda_\epsilon, \sigma^2_\epsilon$, turn out to be quite different across sectors. Imperfectly transitory shocks are larger and more persistent in rural South Africa. Taking account of this is important as it leads to a misspecification of the popular BPP estimator derived in detail in Trouvain (2025b). Intuitively, arrival rates are high in urban which renders the income process indistinguishable from the standard transitory-persistent process used in Blundell, Pistaferri, and Preston (2008). In rural, however, part of the imperfectly transitory shock is attributed to persistent shocks. The consumption response to an imperfectly transitory shock is substantially weaker leading to very low empirical estimates. When I quantify the role of land-intensity and informal insurance I take into account this source of misspecification that is explored in more depth in Trouvain (2025b).

Informal Insurance. Lastly, I pin down the degree of informal insurance κ in the rural sector while assuming $\kappa = 0$ in urban. In the baseline model I assume that this parameter is zero as well in the rural sector and I treat κ as a residual that is needed to match the data as in don't propose a deeper theory how informal insurance comes about. I ultimately estimate this parameter by matching the low empirical passthrough estimated in rural South Africa of around .25. To do so, I simulate the model and compute the BPP passthrough coefficient and increase the value of κ up until model and empirical estimate agree. The implied value of κ ends up being .18.

Table 1 summarizes the calibration.

I have chosen a conservative calibration in terms of preferences, income process, and technology. Regarding preferences, I could have relied on Epstein and Zin (1989) preferences to separate out inter-temporal elasticity of substitution, and risk-aversion. This would allow me to entertain a higher degree of risk aversion, and thus raise precautionary savings motives, see for example the calibration in Aguiar, Amador, and Arellano (2024). The more risk-averse households are, the more important is the role of land in sustaining high interest rates.[33] Similarly, regarding the income process,

[33]To gain intuition for this result, consider an economy that only uses land and labor for production. The interest rate can

Table 1. Summary Baseline Parameters

Parameter	Description	Rural	Urban	Target/Source
ρ	Discount factor	0.02	0.02	Standard value
ϕ	Death shock	0.025	0.025	Avg. work life
γ	Risk aversion	2.0	2.0	Standard value
δ	Capital depreciation	0.07	0.07	Standard value
ν	Capital share	0.1	0.4	Hansen/Prescott (2002)
χ	Land share	0.3	0	Hansen/Prescott (2002)
κ	Informal insurance	0.0	0	See text
σ_p^2	Variance perm. shock	0.01	0.01	Trouvain (2025)
λ_ϵ	Arrival trans. shock	0.6	3.0	Trouvain (2025)
σ_ϵ^2	Variance trans. shock	0.25	0.2	Trouvain (2025)
σ_0^2	Variance init. p	0.13	0.13	Trouvain (2025)
c_0	Avg. init. p	-0.4	-0.4	Trouvain (2025)
$\sigma_{y,error}^2$	Income meas. error	0.1	0.1	Trouvain (2025)
$\sigma_{c,error}^2$	Cons. meas. error	0.15	0.15	Trouvain (2025)

much of the empirical literature estimates a larger volatility of persistent income shocks in developing economies,[34] which again would elevate the role of land in keeping interest rates high in the presence of idiosyncratic risk. Regarding technology, note that I use the land share calibration from Hansen and Prescott (2002), which is likely a lower bound.[35] Lastly, and again compared to Aguiar, Amador, and Arellano (2024), I have chosen a relatively low depreciation rate of 7%. Increasing the rate of depreciation amplifies the results since the depreciation rate is what induces a low safe to risky income share.

Simulation. To simulate model-based moments I proceed as follows. I simulate N=50000 households from their time of birth, here normalized to zero corresponding to 27 years of age when "work life" begins, and simulate their income process using the stochastic process described earlier but absent death shocks.[36] Households' initial asset income is drawn from the stationary distribution, consistent with the Poisson death shock. I then obtain consumption and the evolution of household wealth using the solution to the household problem together with the simulated income process. I then take the log and and tack on mean-zero normally distributed measurement error. I do this for five biennial waves so that the simulated data mimics the South African household level data, and I approximate the continuous time process using small discrete time steps of $dt = .1$.[37]

never fall below zero no matter how high income risk is. Contrast that with a capital-intensive economy where the interest rate converges to $-\delta$ as capital accumulation becomes arbitrarily large.

34 See for instance Santaeulalia-Llopis and Zheng (2018) and other works cited in in the introduction. The discrepancy is explained by imperfectly transitory shocks, which I find to be important in the rural sector, see Trouvain (2025b).

35 Weil and Wilde (2009) summarize estimates for land's share in agricultural output in developing economies, which can exceed 50% in Sub-Saharan Africa. This contrasts with the much lower factor shares of land hovering around 20% in US agriculture, see Valentinyi and Herrendorf (2008), which is unsurprising given the high capital intensity of the agricultural sector in the US.

36 That is to say, in the simulated data death shocks don't materialize even though households use the effective discount factor $\rho + \phi$ to make saving-consumption choices.

37 Since the survey reports income and consumption on a monthly basis, time aggregation can be ignored. The solution

When computing simulated passthrough coefficients or autocovariance matrices, I match the average age of households to the age of households in the data, which is important since the distribution is fanning out as cohorts get older. The variable age_min represents the average age of households in the first wave normalized by the sample cutoff 27. This number is significant because the value σ^{2*}_{int} consist of a piece that represents initial dispersion in the human capital type of newborn households, and persistent shocks that have accumulated before the household appeared in the sample, i.e., $\sigma^2_{p,\text{int}^*} = \sigma^2_{\text{int}} + age \times \sigma^2_p$. An implication of this is that differences in average household age across rural and urban need to take into account when matching model to data since, for example, the same amount of volatility will create more inequality amongst an older cohort. Table 2 summarizes the details, and contains information underlying the computational routine to solve the model.[38]

Table 2. Details Simulation

	Simulation
N	50000
Waves	5
dt	0.1
Rural min. age	11.2
Urban min. age	10.5
Age child	12

The finite difference scheme, using the method from Achdou et al. 2022, operates on the following grid space. Log income consists of two linearly spaced grids, p_grid = LinRange(-2.5 ,2.5 ,15), ϵ_grid = LinRange(-1.5 ,1.5 ,7). The asset grid is initially log-linearly spaced and turns into a linearly-spaced grid for more wealthy households using 100 grid points with a lower bound of zero and an upper bound sufficiently large that high-asset households want to dissave. Note that household consumption choices and the evolution of assets is based on the budget constraint implied by W^*, while raw income is measured in terms of W, and the gap between the two is accounted for by informal insurance when $\kappa > 0$.

Simulated Moments. I compute a number of moments, most important the passthrough from permanent shocks to consumption as well as the fanning out of inequality over the life cycle and consumption covariance matrices. I also compute the popular $\beta^{\text{BPP}}_{c\_p}$ estimator, which may be downward biased compared to β_{c_p} due to the misspecified income process

$$\beta^{\text{BPP}}_{c\_p} = \frac{cov\left(\Delta c_t, \Delta y_{-2} + \Delta y_t + \Delta y_{+2}\right)}{cov\left(\Delta y_t, \Delta y_{-2} + \Delta y_t + \Delta y_{+2}\right)}, \tag{20}$$

where subscripts -2 and +2 refer to lagged and leading growth rates relative to the growth rate in t here

routine is set up more generally and can be applied to annually measured income and consumption where I explicitly model time aggregation of continuous time stochastic processes.

[38]The finite difference scheme is defined on a grid. Note that log income consists of two linearly spaced grids, p_grid = LinRange(-2.5 ,2.5 ,15), ϵ_grid = LinRange(-1.5 ,1.5 ,7). The asset grid is initially log-linearly spaced and turns into a linearly-spaced grid for more wealthy households using 100 grid points with a lower bound of zero and an upper bound sufficiently large that high-asset households want to dissave. Note that household consumption choices and the evolution of assets is based on the budget constraint implied by W^*, while raw income is measured in terms of W, and the gap between the two is accounted for by informal insurance for the case of $\kappa > 0$.

adjusted to the biennial nature of the South African data.[39] Further, note that informal insurance reduces the passthrough of persistent income shocks to consumption. When interest rates are low, preferences are quadratic, households are sufficiently far away from their borrowing constraint, and transitory shocks are fully transitory, then the popular passthrough coefficient from BPP would equal $\beta_{c\_p}^{\text{BPP}} = 1 - \kappa$. The structural coefficient displays the same dependence on informal insurance.

Lastly, I compute intergenerational elasticities of consumption across dynasties using the simple log-linear regression

$$\beta_c^{\text{IGE}} = \frac{Cov\left(\log c_{\text{child,}} \log c_{\text{parent}}\right)}{\mathbb{V}\left(\log c_{\text{parent}}\right)}, \tag{21}$$

where log child consumption is measured per year, and 12 years after birth, while parent consumption is measured at death.[40] The parent-child connection here consists of a new cohort taking over the assets of the old cohort, and bequests are accidental. Incorporating bequest motives would amplify the main findings as it would raise savings pressure in the economy. I assume consumption of parents is measured without error to focus on the implications of differences in land intensity for properly measured intergenerational elasticities. While classical measurement error would push the estimated intergenerational elasticity towards zero, in practice, intergenerational elasticities are usually computed based on educational attainment or a proxy for lifetime income based on several years of panel data, which reduces the role of measurement error.

3.2 Results

I first analyze how the model based passthrough compares to empirical estimates and use this moment to pin down the degree of informal insurance. I then decompose the contribution of land intensity and informal insurance in generating low passthroughs, and compute other important moments relating to consumption inequality and the fanning out of inequality over the life cycle across sectors. Lastly, I explore the implications of land intensity on intergenerational mobility and compare it to empirical estimates.

Passthrough Persistent Shocks. The empirical estimates for the persistent BPP passthrough coefficient are reported in table 3. The estimated passthrough is overall low, and lower for rural households than for urban ones consistent with both informal insurance and GE forces and in line with the pre-

[39] In practice, BPP use all income and consumption moments to efficiently estimate this passthrough using a GMM routine. Moreover, The expression works for annual and biennial data when the transitory shock is fully transitory. In many applications the transitory shock is modeled as an MA(1) process in discrete time, in which case (20) remains appropriate for the case of biennial data but not for annual data.

[40] The simple log-linear regression used here is consistent with the commonly used regression of children on parental schooling (Hertz et al., 2008) given the log-linear relationship between years of schooling and earnings. Alternative measures of intergenerational mobility involve rank-rank correlation coefficients, see for instance Chetty et al. (2014), which are more susceptible to measurement error, see Mogstad et al. (2024).

vious literature.[41]

Table 3. BPP Passthrough Persistent Shocks in South Africa

	Rural	Urban
Estimate	.26	.43
SE	0.281	0.206

Results are based on Trouvain (2025b).

I next simulate income and consumption dynamics in the model in each sector to run the same regression as I run in the data and report the estimated model-based coefficients. I do this for different versions of the model to highlight the separate role of land intensity, informal insurance, and misspecified income process in generating a low rural passthrough of persistent income shocks on rural consumption.

Column one in table 3 reports the passthrough of persistent shocks on consumption for urban households. Row one reports the structural coefficient β_{c_p}, and row two reports the BPP passthrough coefficient $\beta_{c\_p}^{BPP}$ using the moment condition in (20). Note that both the structural coefficient and the BPP estimator agree on a passthrough of .74, which is in roughly in line and slightly below the simulated estimates from Kaplan and Violante (2010). The fact that households enter with some assets explains the discrepancy, and the estimate is not statistically different from the empirical estimate found in Blundell, Pistaferri, and Preston (2008) with point estimate .65 and standard error of .1. Given the large standard errors in my empirical passthrough estimate for urban households in South Africa, one would not be able to reject the hypothesis that the passthrough of persistent shocks for urban South African households is .74.

Table 4. Model-Implied Passthroughs

	Urban	Rural $(\chi = 0, \kappa = 0)$	Rural $(\chi = 0.3, \kappa = 0)$	Rural $(\chi = 0.3, \kappa = 0.18)$
β_{c_p}	0.74	0.72	0.57	0.49
$\beta_{c\_p}^{BPP}$	0.74	0.4	0.31	0.26

Column two is based on an economy that features imperfectly transitory shocks as the baseline rural economy but is otherwise capital intensive and without informal insurance. The structural passthrough coefficient very much coincides at .72 and the minimal discrepancy is explained by the larger precautionary motive induced by imperfectly transitory shocks. Crucially, the BPP estimator in row two is substantially below the structural passthrough β_{c_p}. The reason is that imperfectly

[41] See De Magalhaes and Santaeulalia-Llopis (2018), Santaeulalia-Llopis and Zheng (2018) or Attanasio et al. (2025) for recent work finding very high degrees of insurance in rural environments. The literature relies on both the original Townsend (1994) method, the BPP method, as well as simple consumption-income passthrough regressions. I have explored the implications of the model for this simple passthrough regression of log consumption on log income. Large measurement error trivially brings this passthrough measure close to zero and reveals little about the degree of insurance. This problem also applies to the specification with village level effects a la Townsend (1994).

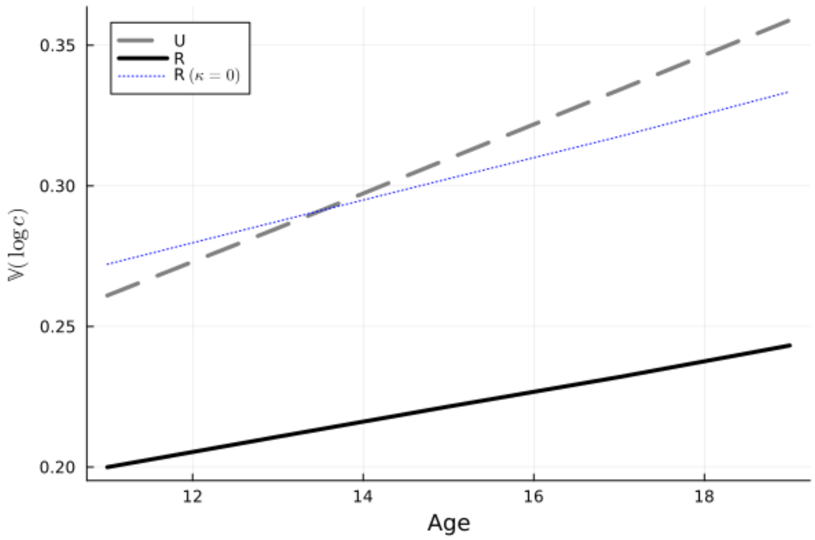
transitory shocks are falsely attributed to persistent shocks. Since the consumption response to an imperfectly transitory shocks is muted, the measured passthrough is low, see Trouvain (2025b) for a formal derivation of this bias. I emphasize, however, that the actual passthrough of persistent shocks is virtually identical in row one across column one and two. In column three I now consider a realistic degree of land intensity of .3 whilst maintaining zero informal insurance. The structural passthrough coefficient falls substantially by about 15 percentage points. Column four then allows for some informal insurance by setting $\kappa = .18$. This reduces the structural passthrough coefficient by an additional 8 percentage points. Note that the implied BPP passthrough coefficient is now exactly at .26 and in line with the empirical estimate.

One way to quantify the role of land vs. informal insurance is to simply split the fall of the passthrough coefficient from .72 to .49 into land and informal insurance margin based on the results in table 4. About two-thirds of the lower passthrough can be accounted for by the role of land in a general equilibrium model. For this exercise the order in which informal insurance or land-intensity is added to the model matters. Note that land-intensity is more important when income risk is high because this is precisely when households demand more safe assets, and the endogenous price of land adjusts accordingly. However, no matter in which order land-intensity and informal insurance is added to the model, it is clear that naively interpreting the low BPP passthrough estimate as structural insurance coefficient vastly overstates the role of informal insurance in rural environments. Both the misspecified income process and the role of land through its impact on asset income generate a passthrough as low as .31 without any informal insurance whatsoever.

Consumption Inequality over the Life Cycle. I next turn attention to life cycle consumption dynamics in the spirit of Deaton and Paxson (1994) by simulating the log variance of consumption as cohorts age. Table 6 computes the evolution of life cycle inequality implied by the baseline model for urban and rural households with and without informal insurance for rural households. Note that since persistent income shocks are the same across rural and urban sector, a naive guess would have been that inequality fans out at the same rate over time. The fact that the net asset return is higher in rural, however, already induces a markedly different slope as seen by the different gradient of the grey dashed lined and the blue dotted line. Moreover, note that initial inequality is actually higher in the rural economy without informal insurance since the blue dotted line lies below the dashed line for cohorts that have been in the labor market for less then 13 years. The reason is that asset endowments are determined at birth, and since assets pay a relatively higher return in rural, consumption responds more strongly to differences in initial asset endowments. This ultimately translates into higher consumption inequality at birth. Over time, asset income is much more stable than labor income because of the unit root in the income process, which explains why inequality is growing at a higher rate in the urban economy as cohorts age.

In the data, rural consumption inequality is not higher than consumption inequality in urban, and

Figure 6. Consumption Inequality



This plot is based on simulated data and compares the fanning out of consumption inequality over the life cycle as a function of households' working age. The gap between the dotted line and the thick black line is due to the role of informal insurance in rural. Simulated consumption is measured without error for this plot.

the model replicates that feature of the data due to the role of informal insurance with $\kappa = .18$, which gives rise to the thick black line. This line is not only below any other line, but also features a flatter profile.

Intergenerational Persistence. I next study the implications of the theory for intergenerational persistence, and in particular consider the implied the regression coefficient of log child consumption on log parent consumption. Table 5 reports the results and again decomposes differences based on imperfectly transitory shock, land intensity, and informal insurance. I also report the equilibrium interest rate in row two which is key to understanding the differences in intergenerational persistence.

Table 5. Model-Implied Intergenerational Persistence in Consumption

	Urban	Rural ($\chi = 0, \kappa = 0$)	Rural ($\chi = 0.3, \kappa = 0$)	Rural ($\chi = 0.3, \kappa = 0.18$)
β_c^{IGE}	0.2	0.24	0.43	0.43
r	0.03	0.03	0.04	0.04

The baseline model implies a fairly low intergenerational elasticity of .2 in the urban sector in column one. Column two produces a slightly higher intergenerational elasticity in the rural sector. In contrast, column three and four, which feature land intensive production as well as informal insurance, generate intergenerational elasticities in consumption that are twice as high. Note that I do not allow for any direct dependence of a child's labor income type on parents' labor income type so the persistence is entirely accounted for by the more important role of wealth in rural. Both the greater importance of financial wealth, which is partly inherited and a more powerful determinant of consumption as asset returns are higher, and the smaller role assigned to human capital, which is the fickle component of income, lead to a high intergenerational persistence in consumption in the rural sector. Low risk exposure and low social mobility are two sides of the same coin. Perhaps surprisingly, informal insurance matters little for intergenerational persistence. The reason is that two forces cancel each other out. On the one hand, lower overall inequality reduces the covariance between parent and child consumption. On the other hand, overall inequality falls, which reduces the variance in the denominator of (21).

The findings from this parsimonious model line up well with a growing literature documenting intergenerational elasticities, usually focused on schooling, across the development spectrum, see Weide et al. (2021) and Alesina et al. (2021). In the absence of parental consumption measures I use more readily available education measures to compute intergenerational persistence. Note that schooling is a strong predictor of household consumption in the data. Table 6 reports estimates for intergenerational persistence in years of schooling for South Africa based on the NIDS data. The rural-urban gap in intergenerational persistence is .2 and lines up exactly with the implied gap in the model.

Table 6. Regression of years of schooling – Parent vs. Child

	Rural	Urban
Estimate	.33	.53
SE	0.281	0.206

Estimate is based on a regression of child years of schooling on parent years of schooling in South Africa including cohort, year, sex, and province fixed effects. The rural-urban gap is statistically significant (p<0.01) and details are deferred to the appendix. I also offer an income-based estimate using the method of Björklund and Jäntti (1997). Additional estimates of intergenerational mobility can be found in Piraino (2015), Sinha (2016), Fan, Yi, and Zhang (2021), Syrichas (2022) consistent both with the model-implied estimates and the empirical estimates offered here.

The role of wealth in producing higher intergenerational persistence in consumption is distinct from and complementary to the much-studied link between borrowing constraints and (lack of) human capital investments.[42] Since I do not model human capital investment, the borrowing constraint plays no role for intergenerational persistence. The only mechanism at play is that the annuity value of wealth is higher in a high interest rate environment, which means wealth has a stronger influence on household consumption.

Interest Rates. A key implication of the theory is that asset returns are relatively high in land-intensive rural economies. This observation is consistent with a vast literature in development economics that finds high returns to capital in rural settings, see for instance Udry and Anagol (2006), and persistent

[42] See Atkinson (1983), Becker and Tomes (1986), Loury (1981), Galor and Zeira (1993), and Lochner and Monge-Naranjo (2011).

effects of temporary cash transfers on household outcomes, see also Haushofer and Shapiro (2016). Of particular interest is a recent meta study of Crosta et al. (2024), which finds that assets increase more strongly for rural households after a windfall cash inflow in comparison to urban households. The fact that the RCT literature reports persistent positive effects with relatively larger increases of asset positions of rural households compared to urban ones for the same intervention suggests that the average rural household can channel their income into productive assets that enable a persistent increase in consumption. This effect would be larger in rural than in urban through the lens of the simple model developed here precisely because interest rates are high representing favorable intertemporal terms of trade. I interpret these positive effects consistent with the simple incomplete market model developed here that elevates the role of land as a factor of production when income is risky. This in no way contradicts that borrowing rates may be prohibitively high. In fact, in my baseline model the cost of debt is infinite. This is important as it suggests that rural households have access to productive assets allowing for effective smoothing of windfall income gains over time consistent with the model.[43] Consistent with this is also recent work of Guzman et al. (2024) highlighting high interest rates in remote rural environments.

4 Non-Tradable Land

In this section, I generalize the model to include non-traded land, which seems particularly relevant for subsistence farmers operating in environments with ill-defined property rights. To be clear, land tenure systems in developing economies are extremely complex, and differ greatly even within the same country.[44] Even so, effective land ownership changes frequently, see for instance Arteaga et al. (2025). The model here is not designed to capture this richness but allows for an important and straightforward extension where some land may not be traded at all.

There are two crucial implications of incorporating non-tradable land. First, if some land is non-tradable, one needs to adjust the total supply of traded land accordingly. Because I have chosen a relatively low land-share in rural areas to begin with, this concern is largely addressed in the baseline model. Second, once a specific plot of land is non-traded, one begins to worry about idiosyncratic capital risk that does not wash out since a law of large numbers is unlikely to hold for small plots

[43] The findings from the development literature contrast with models of entrepreneurial risk and financial frictions, see Song, Storesletten, and Zilibotti (2011) or Buera and Shin (2013). In such models, a gap between the relatively low asset returns households can obtain on their safe assets and the high marginal product of capital of a subset of entrepreneurial households largely cutoff from financial markets.

[44] See Pande and Udry (2005) and Deininger and Binswanger (2001) for insightful reviews.

of land.[45][46] Fortunately, my measure of household labor income already incorporates this sort of risk since own-consumption of agricultural goods and business profits are included. Consequently, the household side of the model hardly needs any changing to incorporate non-traded land since idiosyncratic risk associated with non-tradable land is already captured by the stochastic labor income process. What is crucial for the main point to go through is that there is a market for some assets, and the average rate of depreciation of such assets is relatively lower than in the urban sector. Land clearly satisfies this criterion, but there are other assets in rural areas, think of the role of livestock (Rosenzweig and Wolpin, 1993) in Subsaharan Africa, or the role of gold in rural India, that could play this role.[47]

Non-Tradable Land. Formally, suppose that households are endowed with $x_i \geq 0$ units of non-tradable land. The aggregate share of non-tradable land equals $\zeta < 1$, and I otherwise maintain a similar setup as before with informal insurance set to zero, $\kappa = 0$. In this scenario, non-tradable land x_i becomes an idiosyncratic state variable, and appears in the budget constraint

$$\dot{b} = rb + R_T x + wh - c. \tag{22}$$

Moreover, the aggregate asset market clearing condition changes to

$$K + p_T (1 - \zeta) = B$$

to account for the fact that only some land is traded. Since capital and labor are mobile, the return to land is equalized everywhere including non-traded land so $R_T = \chi Y$ still holds. In addition, the aggregate asset supply function B is still homogenous of degree one in w and L. To see this, it is convenient to rewrite the budget constraint using $w\widehat{h} = w\left(\frac{R_T}{w}x + h\right)$. After noting that $\frac{R_T}{w} = \frac{\chi}{1-\theta}L\tilde{h} = \frac{\chi}{1-\theta}$ for $\tilde{h}$ normalized to one, it is easy to see that the new stochastic process, $\widehat{h}$, is similar to the previous one, h, but shifted to the right by a constant household-specific term $\frac{\chi}{1-\theta}x$. At this point, proving that the aggregate asset supply function is homogenous of degree one is identical to proving lemma 1. I

[45] This plot-level risk is still distinct from aggregate risk, which is beyond the scope of the paper. The methods developed in Deaton and Paxson (1994), Townsend (1994), or Blundell, Pistaferri, and Preston (2008) have nothing to say about the role of aggregate risk since aggregate time effects are partialled out. Abstracting from aggregate risk remains a popular modeling choice because idiosyncratic risk appears an order of magnitude larger than aggregate risk, which is true even in developing economies.

[46] The role of aggregate risk also relates to a classic argument in Newbery and Stiglitz (1984) positing that the value of agricultural production in autarkic economies is implicitly insured through a market clearing mechanism whereby a negative shock to agricultural output raises the price of agricultural goods, which in turn reduces volatility of farm income, see Allen and Atkin (2022) for a quantification of this idea in the context of India. Arguments along these lines, while relevant, pertain to aggregate shocks since individual idiosyncratic shocks are unlikely to shift aggregate supply sufficiently much to move equilibrium prices.

[47] I abstract away from access to banking, which is severely restricted for poor rural communities, see for instance Dupas and Robinson (2013) or Dupas et al. (2018). It is unclear, however, whether the lack of a formal large-scale banking sector deprives rural communities of the ability to save. The fact that consumption is relatively smooth suggests that the lack of professional financialization cannot be the only key feature distinguishing rural and urban communities.

can then proceed as before and derive the normalized aggregate asset market clearing condition

$$\frac{1}{r}\left(\frac{\theta}{1-\theta}-\zeta-\frac{\nu}{1-\theta}\left(\frac{\delta}{r+\delta}-\zeta\right)\right)=\tilde{b}, \tag{23}$$

where it is understood that normalized asset demand $\tilde{b}\left(\Theta,r\right)$ now also depends on the distribution of non-tradable land. For the case of $\zeta=0$, I am back to the standard model. For the case of $\zeta>0$, households have an additional stream of safe income from their fixed land endowment possibly reducing the demand for precautionary savings. At the same time, the left hand side of (23) is smaller as fewer tradable units of land are supplied. Whether the interest rate is lower or higher relative to the frictionless benchmark depends on whether the left hand side of (23) falls more than the right hand side. Moreover, note that as long as $\frac{\delta}{r+\delta}>\zeta$, which seems a mild restriction given that the ratio of depreciation relative to rental rate easily exceeds 50% for any reasonable calibration, it is still true that a relatively more land-intensive economy will feature a lower passthrough from income risk to equilibrium real rate, i.e., proposition 2 goes through.

Idiosyncratic Land Risk. While idiosyncratic land risk washes out in the aggregate by a law of large numbers argument, such a logic would not necessarily apply to the case of small non-traded plots of land common in subsistence farming. To extend the previous analysis along those lines, assume that the returns to non-traded land are stochastic and equal

$$R_i x_i = R_T A_i x_i,$$

where A_i is a stationary stochastic process orthogonal to x_i and normalized to unity, i.e., $x\perp A$ and $\mathbb{E}\left[A_i\right]=1$.[48] Note that the budget constraint in (22) is unchanged but the randomness now depends on both labor, h_i, and non-traded land x_i. Crucially, the way income risk is measured in the data is consistent with (22) since I have incorporated own-consumption and agricultural sales into household income. The only adjustment left to be made is the reduced supply of traded land on the left hand side of (23).[49]

Table 7 reports the results where I compare the baseline rural scenario with one where 10% of land is non-tradable, which is a crude compromise for most land being imperfectly traded, and I also consider an extreme version where half of land is not traded. To benchmark the results against the urban sector and distill the importance of land, I assume that the income process follows the baseline urban income process and informal insurance is zero.

[48]The orthogonality assumption can be relaxed by simply redefining the problem, i.e., A_i and x_i could be correlated, in which case one could think of effective land $\widehat{x}=x\mathbb{E}\left[A|x\right]$, and the stochastic component would involve the normalized term $\frac{A}{\mathbb{E}[A|x]}$.

[49]When computing average efficiency units of labor per household, note that one is confounding the role of non-tradable land and actual labor income. I show in the appendix how to compute average efficiency units correctly in this scenario.

Table 7. Robustness exercise with non-traded land

	$\zeta = 0$	$\zeta = .1$	$\zeta = .3$
β_{c_p}	0.57	0.59	0.64
β_c^{IGE}	0.43	0.4	0.33

Column one is the baseline without insurance, $\kappa = 0$, which is maintained throughout. Column two and three consider a scenario where 10% and 30% of land are non-tradable.

When only 10% of land is non-traded, the results change very little, and the passthrough of around .58 is substantially below the passthrough of income shocks of .75 in the urban sector, whilst the intergenerational elasticity of consumption remains substantially higher in rural.[50] I emphasize that what matters for the robustness of the results is whether there is a relative abundance of low-depreciating assets in rural, not so much what exactly gives rise to the household income dynamics measured in the data.

5 Aggregate Savings and Interest Rates

I conclude the paper by highlighting an important macro implication that is generated by the simple model, namely the positive correlation between value added of the rural sector and aggregate savings, and I cite additional evidence from the development economics literature that highlights that the key implication, namely high asset returns in rural environments, is borne out in the data.

5.1 Aggregate Savings

In an influential paper Laitner (2000) argues that rising aggregate savings rates along the development spectrum are explained by land-intensive production in poor countries. The reason is the differential treatment of valuation gains, which are ignored when agg. savings are computed, compared to physical capital investment, which are counted towards savings in the national accounts. I revisit this question quantitatively using my model.

I first compute aggregate sectoral saving rates implied by my model and compare rural vs. urban aggregate saving rates. I further decompose differences in aggregate saving rates into two margins. The first margin represents the pure effect of differences in the structure of production assuming markets are complete so $r_{\text{U}} = r_{\text{R}} = \rho + \phi$, while the second margin takes into account that in the presence of idiosyncratic income risk, land-intensity matters for effective household insurance, which further increases the gap in urban vs. rural savings due to uneven precautionary savings pressure. Table 8 shows that these effects are large, and the urban saving rate is roughly 20% larger than the rural one.

[50] For values of $\zeta \approx \frac{1}{2}$ when half of all land is non-tradable, rural consumption dynamics appear similar to the urban sector in terms of the passthrough of permanent income shocks to consumption. The main point of the paper is, of course, to explain the differences in consumption dynamics. Financial frictions and non-tradability of assets only make it harder to confront the empirical facts so it is not my inclination to elevate these points.

Table 8. Agg. Savings: Rural vs. Urban

	Urban	Rural ($\chi = .3, \kappa = 0$)	Rural ($\chi = .3, \kappa = .18$)
$s_{\text{agg}}^{\text{complete}}$	24.35	6.09	6.09
$s_{\text{agg}}^{\text{Aiyagari}}$	27.32	6.63	6.46

The results are based on the baseline calibration, see table 1.

Note that this in no way implies that net household saving rates differ across sectors – in the stationary environment these have to add up to zero by construction. Note, however, that higher depreciation in urban necessitates higher investment, and thus higher aggregate saving. In fact, it is easy to see that aggregate sectoral saving rates in a stationary closed economy by construction have to equal $s_{\text{agg},j} = \frac{K_j \delta}{Y_j}, j \in \{\text{R}, \text{U}\}$. Note that idiosyncratic risk increases the aggregate saving rate in the urban sector by about 12%, or three percentage points, surprisingly close to the original findings of Aiyagari (1994). Relative to Aiyagari (1994), the results here highlight that the structure of production, and depreciation rates are of first order importance for this finding. Income risk in rural only raises the aggregate saving rate by 9%, and only .55 percentage points.

Next, I explore the cross-country implications of the theory and highlight how the simple insight offers an intuitive explanation for the large differences in saving rates across countries. To take the model to the data in the most straightforward way I think of each country as consisting of a rural and an urban sector existing in autarky.[51] To proxy for the size of the rural economy I simply use the nominal value added share of agriculture $\omega_{\text{R}} := \frac{Y_{\text{R}}}{Y_{\text{R}} + Y_{\text{U}}}$, which allows me to compute the aggregate saving rates in the stationary environment using $s_{\text{agg}} := \frac{Y - C}{Y} = \frac{\delta(K_{\text{U}} + K_{\text{R}})}{Y_{\text{U}} + Y_{\text{R}}}$. With Cobb-Douglas production, the aggregate saving rates is a simple function of the relative size of each sector, sector specific capital intensity, depreciation, and interest rates ν_j, δ, r_j for $j \in \{\text{R}, \text{U}\}$,

$$s_{\text{agg}} = \frac{\delta}{r_{\text{U}} + \delta} \nu_{\text{U}} - \omega_{\text{R}} \left(\frac{\delta}{r_{\text{U}} + \delta} \nu_{\text{U}} - \frac{\delta}{r_{\text{R}} + \delta} \nu_{\text{R}} \right). \tag{24}$$

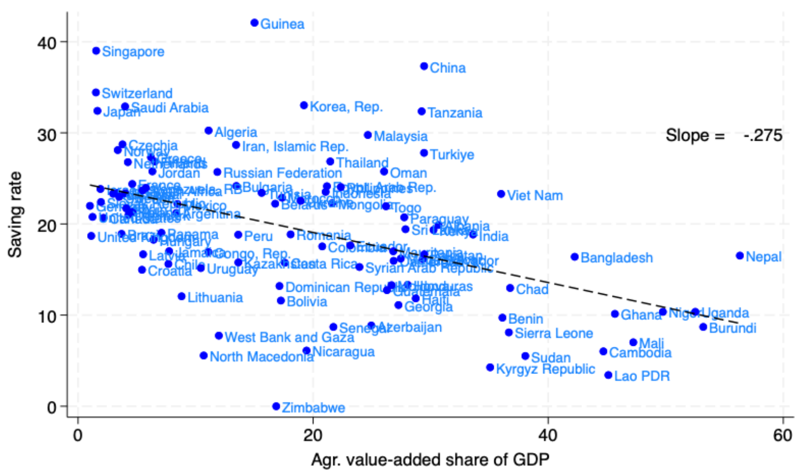
I abstract away from differences in depreciation rates or income risk across countries and maintain my baseline calibration to explore how far this very parsimonious model can go in accounting for differences in aggregate saving rates across the development spectrum. Equation (24) predicts a negative relationship between aggregate savings and the size of the rural economy as long as $\frac{\delta}{r_{\text{U}} + \delta} \nu_{\text{U}} > \frac{\delta}{r_{\text{R}} + \delta} \nu_{\text{R}}$. Note that for equal amounts of income risk in each sector, this inequality is satisfied since the urban sector is more capital intensive, and interest rates are lower due to precautionary savings and relatively high depreciation. Using parameters from the baseline calibration, equation (24) implies that the slope coefficient of a simple bivariate regression with country-level savings on

[51] Differences in the relative price of capital goods, which are large across countries (Hsieh and Klenow, 2007), can be incorporated without any consequences for consumption and income dynamics as well as aggregate saving rates as shown in the appendix.

the left hand side and the share of agricultural value added on the right hand side should be about $-.21 = \frac{\delta}{r_U+\delta}\nu_U - \frac{\delta}{r_R+\delta}\nu_R = \frac{.07}{.0325+.07}.4 - \frac{.07}{.0383+.07}.1$. While this simple link omits many important factors that differ across countries and no narrow causal interpretation is presumed, it turns out that the basic implication lines up very nicely with the cross-country data.

Figure 7 plots simple average agg. saving rates across countries against avg. value added shares of agricultural activity from the period 1960 to 2000. The time horizon is chose to avoid the confounding impact of financial globalization and large development aid flows, which drive a wedge between savings and investment in the more recent period that is beyond the scope of the paper.

Figure 7. Agg. Saving Rate and Rural GDP Share



The scatter plot is based on data from the WDI and averages saving rates and agricultural value added shares across countries from 1960 – 2000. The time horizon is due to data limitations, and the confounding role of financial globalization that allows for gaps between between savings and invest, which are beyond the closed-economy model that is the focus of the paper at hand. Averaging helps to deal with short-run fluctuations and measurement error. I drop observations with a population below 2 mio. and I drop observations with saving rates that are more negative than minus 10%.

A simple bivariate regression delivers an intercept of around 25.5% and a slope coefficient of -.275, i.e., the most urban country has an avg. aggregate saving rate of 25.5%, and the average saving rate is steeply falling in the size of the rural sector, hovering just above 10% for a country like Ghana where about 50% of value added is rural, i.e., in agriculture. It comes as no surprise that low income countries are the ones with high agricultural shares so that figure 7 effectively reproduces the negative link between savings and GDP per capita featuring prominently in the cross-country growth literature, see for instance Levine and Renelt (1992). Comparing this to the baseline model that predicted a slope of around -.2, one way to quantify the role of differences in the structure of production is to simply compute the ratio $.21/.275 = .76$, which leads to the conclusion that the simple model explains about 76% of differences in saving rates across the development spectrum. Going back to the previous decomposition in table 8, the negative slope of the saving rate in agricultural value added share is .18 in the complete markets benchmark, which means the interaction of income risk and capital-intensity raises the absolute value of the slope by about 17%, i.e., $.03/.18 \approx .17$. This suggests that the most important driver of differences in the aggregate saving rates are differences in the structure of production.

6 Conclusion

This paper studies the impact of land as a fixed factor of production in an otherwise standard Aiyagari-style general equilibrium model with idiosyncratic income risk. Land as a factor in fixed supply gives rise to a novel general equilibrium channel operating through the equilibrium interest rate and raising the safe-to-risky income ratio compared to a more capital intensive economy. The mechanism generates relatively smooth rural consumption and high intergenerational persistence, and explains much of the large variation in aggregate savings across countries we see in the data.

There are several caveats and avenues for future work. First, the simulations pertain to stationary environments at odds with the declining rural share in most countries. In ongoing work I explore the transitional dynamics of the theory developed here. These dynamics are non-trivial and helpful in reconciling the relationship between aggregate savings and economic growth in fast-growing economies, see Trouvain (2025a). Second, differences in income risk and insurance ought to matter for selection into migration and rural-urban wage gaps, an issue I take up in Trouvain (2025b). Third, I abstract away from aggregate risk, which may be particularly relevant in weather-dependent rural environments. Such a setting would also require one to take a stance of how different kinds of assets fare in the presence of aggregate shocks in poor rural economies which I view as a fruitful avenue of future research.

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A Theory Appendix

A.1 Setup baseline model

Production Side. I derive the production side equilibrium in the rural economy, which nests the case for the urban economy with the share of land being zero ($\chi = 0$). The competitive final goods firms takes land and capital rental rates as well as wages as given, to maximize

$$\max_{T,K,H} T^{\chi} K^{\nu} (AH)^{1-\chi-\nu} - R_T T - RK - wH.$$

First order conditions imply

$$\begin{aligned} \chi Y &= R_T T \\ \nu Y &= RK \\ (1-\chi-\alpha) Y &= wH \end{aligned}$$

which follows from the convenient Cobb-Douglas production function.

The capital rental rate reads $R = r + \delta$, where r is the equilibrium interest rate coming from the household side after imposing asset market clearing. An arbitrage argument implies that

$$\frac{R_T}{p_T} + \frac{\dot{p}_T}{p_T} = R - \delta,$$

i.e., the real return on a unit of land equals the real return on a unit of capital where p_T is the price of a unit of land. In steady state, this equation simplifies to

$$R_T = r \cdot p_T,$$

where $r = R - \delta_k$ is the risk-free rate. Since land is in fixed supply and normalized to unity, land market clearing implies $\chi Y = R_T$. Combining this with the first order condition for capital implies

$$\frac{\chi}{\nu} \frac{r+\delta}{r} K = p_T,$$

i.e., the equilibrium price of land is proportional to the share of land in production, and the overall capital stock. The equilibrium stock of capital follows from inverting the first order conditions and substituting out land

$$K = \left(\tfrac{\nu}{r+\delta}\right)^{\frac{1}{1-\nu}} (AH)^{\frac{1-\chi-\nu}{1-\nu}}$$

where A is a labor augmenting TFP term. The equilibrium wage rate reads

$$w = (1-\chi-\nu)\,(K)^{\alpha}\,\frac{(AH)^{1-\chi-\nu}}{H}$$
$$w = (1-\chi-\nu)\left(\frac{\nu}{r+\delta}\right)^{\frac{\nu}{1-\nu}}(AH)^{-\frac{\chi}{1-\nu}}A,$$

where the second line follows after substituting out capital. The fixed factor land leads to a negative link between labor supply and labor productivity.

Turning to asset market clearing, note that in steady state

$$K + p_T = \int b_i di$$
$$K + \frac{\chi}{\nu}\frac{r+\delta}{r}K = \int b_i di \Rightarrow$$
$$K = \frac{1}{1+\frac{\chi}{\nu}\frac{r+\delta}{r}}\int b_i di,$$

which means that the demand for capital can be directly inverted without solving for the price of land, which makes the algorithm simpler.

A.2 Extension with risky non-tradable land

To extend the model, consider that each household is endowed with a non-tradable amount of land x_i such that the total amount (and share since land is normalized to one) equals $\int x_i di = \zeta < 1$. This changes the budget constraint as follows

$$\dot{b} = rb + wh + R_T x - c$$

which can be rewritten as

$$\dot{b} = rb + \underbrace{w\widehat{h}}_{:=w\left(\frac{R_T x}{w}+h\right)} - c.$$

Next, note that I now allow for land to provide an uncertain return. One way to model this is to simply add stochastic productivity shifters such that the households' return on a unit of land is $R_{T,i} = R_T A_i$ with $A_i \perp x_i$ and $\mathbb{E}[A_i] = 1$. This is convenient because the solution routine applies largely unchanged. Specifically, the HJB equation still solves the household problem, and instead of applying Ito's lemma to h, I now apply it to $\widehat{h}$, which is just a relabeling. Moreover, the income process on which all exercises are based implicitly used the (potentially stochastic) returns to land in the form of own assumption and agricultural sales that I explicitly included.

I next turn to the aggregation constraints, which is the aspect of the model that changes. First, note that total asset supply in the economy is changed since a fraction ζ of land is not traded. Consequently, total asset demand equals

$$B^D = K^D + (1-\zeta)\, P_T$$

where demand of capital and demand for land comes from the production side, and is falling in the interest rate. The supply of assets comes from the household side and takes the same form as before, and again scales linearly in w. This linearity property survives because the ratio $\frac{R_T}{w}$ is constant and independent of the level of wages, which is ultimately an implication of the constant expenditure shares due to Cobb-Douglas production. I emphasize this because I exploit this property in my computational algorithm. Moreover, note that the price of land is again computed using $P_T = \frac{\chi Y}{r}$. I can thus again use $\frac{K^D}{P_T} = \frac{\nu}{\chi}\frac{r}{r+\delta}$,which implies

$$\begin{aligned} \int a_i di &= K^D + (1-\zeta)\, P_T \Rightarrow \\ K^D &= \frac{1}{1+(1-\zeta)\,\frac{\chi}{\nu}\frac{r+\delta}{r}} \int a_i di, \end{aligned}$$

which is identical to the expression in the previous section other than the factor $1-\zeta$.

What changes relative to the previous section, however, is the interpretation of $\tilde{h} = \mathbb{E}\,[h]$ because in the model we are no longer computing $\tilde{h}$ but instead $\tilde{\widehat{h}} = \mathbb{E}\left[\widehat{h}\right]$. Note that $\tilde{\widehat{h}}L = \tilde{h} + \frac{R_T\zeta}{w}$ assuming $L=1$. Using $\frac{R_T\zeta}{w} = \frac{\chi Y \tilde{h}}{(1-\theta)Y}$, and inverting yields

$$\tilde{h} = \frac{\tilde{\widehat{h}}}{1+\frac{\zeta\chi}{1-\theta}}.$$

To compute the real wage, we can now use

$$\begin{aligned} K &= \left(\frac{\nu}{r+\delta_k}\right)^{\frac{1}{1-\nu}} \left(A_{\text{tfp}}\tilde{h}\right)^{\frac{1-\chi-\nu}{1-\nu}} \\ w &= (1-\chi-\nu)\, K^{\nu}\, \frac{\left(A_{\text{tfp}}\tilde{h}\right)^{1-\chi-\nu}}{\tilde{h}}. \end{aligned}$$

This concludes the description of the extended model, and the key quantitative question is how the interest rate changes as we increase the share of non-traded land. If the interest rate does not re-sponds strongly, the results are robust to this extension. Again, all consumption dynamics measured in logs will only depend on the income process, which I am not changing, and the interest rate and asset distribution. If the interest rate is the same, so will be the asset distribution.

A.3 Generalized Model

A.3.1 CES Setup with Differences in Price of Investment

I generalize the baseline model along two extensions. First, I assume that the aggregate production function reads

$$\left(\left(\psi_\chi^{\frac{1}{\sigma}} T^{\frac{\sigma-1}{\sigma}} + \psi_\nu^{\frac{1}{\sigma}} K^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}\right)^\theta L^{1-\theta}.$$

Second, I assume that it takes $\tau \geq 1$ units of output to create one unit of investment good, which leads to a price of investment and capital $P_I = P_K = \tau$ that is potentially varying across countries if τ varies across countries as argued in Hsieh and Klenow (2007). If so, this requires an important adjustment when computing price-adjusted capital returns, see Caselli and Feyrer (2007), that needs to be taken into account when taking the model to the data. When the elasticity of substitution between land and labor is non-unitary, the relative share $\frac{\chi(R_T,R)}{\nu(R_T,R)}$ is no longer constant. I will show that the main result in the paper, namely that land-intensive production raises the effectiveness of self-insurance, becomes stronger when capital and land are imperfect substitutes in the sense that the elasticity of substitution between the two factors of production is below unity.

The standard first-order conditions based on competitive production imply

$$\frac{T}{K} = \frac{\psi_\chi}{\psi_\nu}\left(\frac{R_T}{R}\right)^{-\sigma}$$

and the cost shares spend on land and physical capital read

$$R_T T = \frac{\psi_\chi R_T^{1-\sigma}}{\psi_\chi R_T^{1-\sigma} + \psi_\nu R^{1-\sigma}} \theta Y$$
$$RK = \frac{\psi_\nu R^{1-\sigma}}{\psi_\chi R_T^{1-\sigma} + \psi_\nu R^{1-\sigma}} \theta Y.$$

Given the return to land, I can compute the value of land and capital as before using the standard arbitrage condition in the steady state, $\frac{R_j}{P_j} = r + \delta_j$, $j \in \{T, K\}$, which in the case of land implies

$$\begin{aligned} P_T &= \frac{R_T}{r} \\ &= \frac{1}{r}\frac{\psi_\chi R_T^{1-\sigma}}{\psi_\chi R_T^{1-\sigma} + \psi_\nu R^{1-\sigma}} \theta Y \end{aligned}$$

Since it takes τ units of output to produce one unit of investment, the price of investment equals τ at all times. Together with the arbitrage condition, the rental rate of capital thus equals $R_K = \tau(r + \delta)$.

This implies that the share of land wealth to physical capital wealth reads

$$
\begin{aligned}
\frac{P_T T}{P_K K} &= \frac{\frac{1}{r}\frac{\psi_\chi R_T^{1-\sigma}}{\psi_\chi R_T^{1-\sigma}+\psi_\nu R^{1-\sigma}}\theta Y}{\frac{1}{r+\delta}\frac{\psi_\nu R^{1-\sigma}}{\psi_\chi R_T^{1-\sigma}+\psi_\nu R^{1-\sigma}}\theta Y} \\
&= \frac{r+\delta}{r}\frac{\psi_\chi R_T^{1-\sigma}}{\psi_\nu R^{1-\sigma}} \\
&= \frac{r+\delta}{r}\frac{\psi_\chi \left(rP_T\right)^{1-\sigma}}{\psi_\nu \left(\tau\left(r+\delta\right)\right)^{1-\sigma}} \\
&= \left(\frac{r+\delta}{r}\right)^{\sigma}\frac{\psi_\chi \left(P_T\right)^{1-\sigma}}{\psi_\nu \left(\tau\right)^{1-\sigma}}.
\end{aligned}
$$

Next, using the normalization $T=1$ and the fact that $P_K=\tau$,

$$
\begin{aligned}
P_T &= \tau K\left(\frac{r+\delta}{r}\right)^{\sigma}\frac{\psi_\chi \left(P_T\right)^{1-\sigma}}{\psi_\nu \left(\tau\right)^{1-\sigma}} \Rightarrow \\
P_T &= \tau\left(\frac{r+\delta}{r}\right)\left(\frac{\psi_\chi}{\psi_\nu}\right)^{\frac{1}{\sigma}} K^{\frac{1}{\sigma}}.
\end{aligned}
$$

It is now easy to see that the aggregate asset ratio of land vs. physical capital equals

$$
\frac{P_T T}{P_K K} = \left(\frac{r+\delta}{r}\right)\left(\frac{\psi_\chi}{\psi_\nu}\right)^{\frac{1}{\sigma}} K^{\frac{1-\sigma}{\sigma}}, \tag{25}
$$

and this ratio is increasing in the physical capital stock for the relevant parameter of $\sigma<1$. It is now easy to see that land intensity will be even more powerful in generating low passthrough from income shocks to consumption in the presence of idiosyncratic labor income risk for the following reason. Income risk leads to downward pressure on the interest rate, which implies an increase in K. Note that because land is a fixed factor and the physical capital stock increases, the share of net income from land relative to income from physical capital increases, as can be seen in (25). Consequently, the now endogenous relative share $\frac{\chi(R_T,R)}{\nu(R_T,R)}=\left(\frac{\psi_\chi}{\psi_\nu}\right)^{\frac{1}{\sigma}}K^{\frac{1-\sigma}{\sigma}}$ is increasing in K. That means if there is income risk, and households build up bufferstock savings, the share of land further increases, which is desirable from a self-insurance point of view as the average rate of depreciation falls. This lowers the overall passthrough of income shocks to consumption as the share of safe income relative to labor income rises in the economy.

In a further extension one could could also break the Cobb-Douglas assumption across labor and non-labor inputs, see Auclert et al. (2021) for an application that pursues this formulation. In that case, the result of the paper become stronger when non-labor and labor inputs feature an elasticity of substitution below unity. The reason is that precautionary savings drive up physical capital. Because labor is fixed and labor and non-labor are strongly complementary, the share of output accruing to labor income goes up. This means that the share of income accruing to risky income increases, which in turn elevates the role of a factor in fixed supply to cope with income risk.

A.3.2 Long-Run Growth

The model can accommodate long-run growth just as any standard Aiyagari model. Care must be taken to apply appropriate TFP growth rates in each sector as the presence of a fixed factor in rural requires an overall faster TFP growth rate to obtain the same wage growth as a more urban economy. Let g_A be the labor-augmenting TFP growth rate of an urban economy with land share of zero. The growth rate of the rural economy then must equal $g_{A_R} = \frac{1-\nu}{1-\theta} g_A > g_A$. In that case, both sectors grow at the same long-run per capita rate and a consistent balanced growth path can be defined.

The more interesting case is one with endogenous migration where productivity growth in urban leads to an ever-declining rural sector, which is the focus of Trouvain (2025a).

A.4 Proofs

Proposition 1 in the main text claims that in the absence of idiosyncratic income risk, the equilibrium interest rate equals the effective discount factor. To prove this claim, note that in the absence of idiosyncratic income risk, the usual Euler equation obtains

$$\frac{\dot{c}}{c} = \frac{r - (\rho + \phi)}{\gamma}, \tag{26}$$

where I focus on an environments with stationary aggregates. The difference to the setup in Blanchard (1985) is that there are no annuity markets, which is why the death rate shows up in (26). Moreover, the resulting accidental bequests mean that newborn cohorts enter the economy with inherited assets.

Households use the inter-temporal budget constraint, $\dot{a} = ra + wh - c$, together with an omitted transversality condition, to compute the present discounted value of their human and nonhuman wealth, W, which reads

$$\begin{aligned} W_t &= a_t + \int_t^\infty e^{-rs} hwds \\ &= a_t + \frac{hw}{r}. \end{aligned}$$

Using the inter-temporal budget constraint, the usual linear consumption policy function obtains

$$c_t = \frac{\rho + \phi + r(\gamma - 1)}{\gamma} \left(a_t + \frac{wh}{r} \right). \tag{27}$$

If the interest rate is $r = \rho + \phi$, then consumption growth is optimally zero, and household consumption is given by (27). To see that this respects the economy wide resource constraint, aggregate up consumption and impose market clearing

$$\begin{aligned} C &= Y - \delta_k K \\ \int_i \frac{\rho + \phi + r(\gamma - 1)}{\gamma} \left(a_t^i + \frac{wh^i}{r} \right) di &= wH + rK \\ r \left(A_t + \frac{wH}{r} \right) &= wH + rK \\ rA_t + wH &= wH + rK, \end{aligned}$$

i.e., markets clear and $A = K$.

The previous derivation can be trivially used for the land-intensive economy as well simply by noting that the equilibrium interest rate is independent of the depreciation rate.

The result extends to the case of insurance markets for idiosyncratic income risk such that within a cohort, surviving households insure each other by trading a set of state-contingent assets as long as there are no life cycle wage dynamics. To see how such an equilibrium could come about, conjecture an equilibrium where each household obtains a constant amount of labor income consistent with their initial type at time zero. If labor income follows a martingale without drift, then households would prefer taking this constant income stream over the stochastic income process. Market clearing would be guaranteed by a law of large number such that negative shocks to households within a cohort cancel with positive shocks. A constant consumption stream just as in (27) would follow, where the interest rate would equal $r = \rho + \phi$. One can show that markets would clear within each cohort at such an interest rate, and thus would clear for the economy as a whole as well.

If there are life cycle wage dynamics, there is an additional savings motive related to consumption smoothing over the life cycle. The standard case considered in Blanchard (1985) is where labor income is declining so that younger households want to save for old age. If that is the case, the equilibrium interest rate will be sensitive to these wage dynamics and generically $r < \rho + \phi$. Markets won't clear within cohort, and young households' savings would put additional downward pressure on the interest rate.

B Computational Appendix

To be completed.

C Empirical Appendix

C.1 Intergenerational Persistence

In this section I provide empirical evidence on differences in intergenerational persistence across rural and urban sector in South Africa. I consider that standard statistical model of intergenerational persistence in Becker and Tomes (1986), where children's outcome is regressed on parent's outcome

$$y_i^{\text{child}} = \alpha + \beta_{\text{IGE}} y_i^{\text{parent}} + \boldsymbol{\gamma}' \boldsymbol{X}_i + u_i \tag{28}$$

where the regression coefficient β is known as intergenerational elasticity, $\boldsymbol{X}$ is a set of control variables and u is an error term. All results are based on versions of (28) with different outcome variables and control variables.

Three remarks are in order before I report the results. First, all methods employed avoid the so-called cohabitation bias, which I view as particularly troubling in my context. This bias arises when parent-child pairs are observed only when children and parents live in the same households. This is true for most survey data, and leads to selection bias. One would think, for instance, that adult children who continue to live at home are less successful than the ones that moved out, which could bias the mobility estimates.[52] In addition, cohabitation is more common in the rural sector, which makes it impossible to tell apart genuine differences from differences in selection across the two sectors. To avoid this, I only use information on parent outcomes that are reported irrespective of whether the parent is in the baseline sample or not. For example, every household member has to report their father's education and occupation, so using this information avoids any cohabitation bias.

This approach works well for schooling outcomes, but runs into difficulties when estimating intergenerational income mobility, as income is simply not observed for parents that are not interviewed. To deal with this, I follow Björklund and Jäntti (1997)'s two stage procedure and first impute parents' income, based on reported characteristics in combination with survey data for the respective cohorts, before I estimate the IGE. Given the measurement error induced in the first stage, these estimates represent a lower bound of intergenerational persistence. Second, instead of applying this exercise to individuals, I estimate this on the household level. This is consistent with the theoretical model proposed, but more importantly, it is difficult to tell apart the earnings of different household members in rural agricultural production. The household level focus circumvents this issue.

Lastly, the dataset is based on the NIDS dataset used in Trouvain (2025b) where I offer a detailed description of the dataset and explore how it compares to aggregate and administrative statistics.

[52] In the South African survey it is difficult to measure household splits since there is no well-defined household identifier. See details in the appendix of how to identify a household head. The Chinese survey data allows for household splits, but the survey is too short to produce sufficiently many families that started out together where the children eventually moved out.

IGE Schooling. I begin by documenting differences in mobility in educational attainment where I regress years of schooling across generations. The benefit of focusing on schooling is that measurement is relatively straightforward and educational attainment is a good predictor of lifetime income, even though the ultimate parameter of interest remains the IGE.

Table 9 reports the results. The interaction term represents the coefficient $\beta_{\text{IGE,school}}$, which is between .5-.6 for rural households, and between .3-.4 for urban households. That is to say, intergenerational mobility in educational attainment is substantially higher for urban households. While the

Table 9. Intergenerational Persistence in Education in South Africa

	Years of schooling	Years of schooling	Years of schooling	Years of schooling
Years of schooling (parents)	0.680***	0.586***	0.554***	0.526***
	(0.0125)	(0.0134)	(0.0138)	(0.0155)
Urban X years of schooling (parents)	-0.213***	-0.224***	-0.214***	-0.195***
	(0.0154)	(0.0159)	(0.0162)	(0.0186)
Urban fe	Yes	Yes	Yes	Yes
Year fe	No	Yes	Yes	Yes
Race, sex, province fe	No	Yes	Yes	Yes
Urban X child cohort fe	No	No	Yes	Yes
Urban X parent cohort fe	No	No	No	Yes
N	11592	11075	11072	8178
R^2	0.329	0.386	0.417	0.411

I restrict individuals to be weakly older than 25 years to make sure that the individual's education is complete. I do not impose any additional restrictions. Note that this regression is run on the individual, cross-sectional level so every person shows up once. I pick an individual when it first appears in the sample given that it has non-missing educational information. Cohort effects are computed within 5-year age bins. Parents' education is the average between mother's and father's education, results with only one parent are similar. Standard errors are clustered on the individual level.

results for South Africa need to be interpreted with caution due to the issue of unobserved parental urban-rural status, they are in line with recent work in Alesina et al. (2021) which documents the urban-rural divide in intergenerational mobility in literacy.[53]

IGE Income. Income persistence is difficult to estimate because we usually do not have access to the household income of the parents of a household head when they were prime earners because the household panels in emerging markets are too short. To overcome this issue, I employ a two-stage procedure using independent samples of household income of fathers and household income

[53] A related but distinct measure is intergenerational occupational mobility. I refer the reader to Sinha (2016) and Syrichas (2022), which offer evidence on occupational mobility broadly consistent with the idea that mobility is higher in the urban sector although their focus rests on high vs. low income countries. Another relevant study is Weide et al. (2021) which finds intergenerational mobility to be higher for high-income countries relative to low income countries. The finding that households with zero years of schooling drive high persistence in schooling in rural communities seems new relative to the previous literature.

of adult children. Using parent characteristics reported by the children, I first estimate the predicted household income of the father's household using separate cross-sectional data roughly two decades older than my main sample. I then use the imputed father household income measures to estimate the IGE. Estimating household income as opposed to individual income is important because individual income is often not well-defined in small-scale rural farming and could induce selection bias. Additional details are provided in the appendix. Table 10 reports the results.

Table 10. Intergenerational Income Persistence in South Africa

	log hh income	log hh income
log hh income (father)	0.528***	0.626***
	(0.0611)	(0.108)
Urban X log hh income (father)	0	-0.147
	(0)	(0.124)
Age (child)	Yes	Yes
Urban, Province, Race, Gender fe	Yes	Yes
N	1057	1057
R^2	0.269	0.270

Standard errors are bootstrapped to account for the first stage estimation procedure.

Intergenerational mobility is higher in urban areas. The estimated difference of roughly .2 is consistent with the previous differences in years of schooling. The results are not as precisely estimated with marginal significance close to the 10% level. Given the limited sample size and the two-stage estimation procedure that effectively relies only on three covariates, education, occupation, and household composition, I interpret the findings in table 10 as supportive of the main hypothesis.[54]

C.2 Consumption

[54] The overall elasticities is consistent with the findings in Piraino (2015) for South Africa, and broadly in line with other estimates, see for instance Solon (1992).