Transfer Progressivity and Development

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Abstract

With micro panel data from 32 countries including the poorest and the richest in the world we document (i) a negative relationship between the level of transfer progressivity and the stage of economic development and (ii) a negative relationship between the ability to insure consumption against income shocks and economic development. Importantly, our measure of transfer progressivity includes both *public* and *private* net transfers across households—e.g. food transfers. Using an overlapping generations model in which agents differ in permanent productivity, face income shocks and accumulate physical and human capital through learning-by-doing (a labor choice), we find that cross-country differences in transfer progressivity go a long way in explaining the larger ability to insure consumption in poor countries than in rich countries. Then, we use our model to assess the role of transfer progressivity in explaining income per capita differences across countries. We find that decreasing progressivity of poor countries to the levels of rich countries increases income per capita of poor countries by 62%. However, a reduction in progressivity is not necessarily welfare improving because although it increases the incentives to work and accumulate physical and human capital, at the same time, it reduces social insurance—and redistribution. Taking into account the trade-off between growth and insurance, we find that moving poor economies to their optimal transfer progressivity increases their GDP per capita by 56% and increases their welfare by 18% in consumption equivalent terms.

Keywords: Transfers, Progressivity, Redistribution, Risk, Insurance, Learning-by-Doing, Optimal, Income per capita, Cross-Country Differences
JEL Classification: C01, H00, E01, E22, E25

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1 Introduction

Poor countries are able to insure consumption against income shocks to a large extent, even if full insurance is not achieved (Townsend, 1994). The high levels of empirically observed consumption insurance can be sustained by transfers that potentially emerge from constrained-efficient arrangements (e.g. limited commitment or limited information) across households; see a recent discussion in Kinnan (2022). Importantly, the equilibrium transfers that emerge from constrained-efficient allocations are progressive. That is, the marginal transfer given (received) by an individual increases (decrease) with that individual's income. In this paper, we ask whether these progressive transfers support or hinder economic growth.

How does consumption insurance and transfer progressivity differ across countries?

We compile micro data from 32 countries including the poorest and richest economies in order to document how the ability to insure consumption against income shocks evolves across stages of economic development. Using complete markets tests on our consumption and income panel data and covariance tests on cross-sectional data, we find that the ability to insure consumption is higher at lower stages of development; see Figure 4. The result is clear once country-fixed effects are removed.

We document how in poor countries norms-based informal transfers arrangements provide insurance and, potentially, redistribution. Whereas, in richer countries, larger state capacity allows insurance and redistribution to be publicly provided through formal transfers (i.e. taxes and subsidies). Implicitly, the provision of insurance and redistribution—in both poor and rich countries—implies that transfers are, in some degree, progressive.

We put together private and public transfers to carefully document how the level of transfers differs across the income distribution separately for poor and rich countries. We find that poor countries show a degree of progressivity (an income-to-transfer elasticity) up to 0.40 (mostly driven by food transfers) which is twice as large as that of rich countries. That is, there is a negative relationship between the degree of transfer progressivity and the stage of development. Importantly, the computation of transfer progressivity includes both *private* and *public* transfers, which is particularly relevant for poor countries where private transfers are dominant.

What are the aggregate effects of transfer progressivity for cross-country income per capita differences? To answer this question propose a macroeconomy with idiosyncratic income shocks in which agents accumulate physical and human capital (through learning-by-doing) and face a progressive income tax function that depends on the stage of development. We solve our model (a sequence of steady states) from poor to rich, that is, across different degrees of tax progressivity.[1] Our calibration consists of country-specific elements such as aggregate productivity, human capital productivity and the degree of tax progressivity which depends on the stage of development. We find that our framework based on cross-country heterogeneity in tax progressivity is able to largely explain the higher ability to insure consumption in poor countries compared with rich countries. Then use this economy to assess the role of transfer progressivity in explaining income per capita and welfare differences across countries. We quantitatively assess the implications of informal and formal tax progressivity on income per capita differences by imposing the US progressivity on the rest of the world. Lower progressivity implies higher aggregate physical and human capital at the expense of social insurance. Our results imply a relevant role for transfer progressivity in explaining income per capita differences across countries. We find that decreasing progressivity of poor countries to the levels of rich countries increases income per capita of poor countries by 62%. The opposite experiment, using the progressivity of poor countries on rich countries, reduces income per capita of rich countries by 30%.

What is the optimal level of transfer progressivity across countries Since a decrease in transfer progressivity increases the incentives to work and accumulate (physical and human capital) while, at the same time, it reduces social insurance and redistribution, a reduction in progressivity is not necessarily welfare improving. For this reason, we also compute the optimal transfer progressivity for rich and poor countries separately. We find that optimal progressivity is actually similar (for different reasons) across stages of development which implies that the *status quo* transfer progressivity for poor (rich) countries is too high (low). Reducing the progressivity of poor countries to optimal levels increases the GDP per capita of the poor by 46% and increases their welfare by 14% in consumption equivalent terms.

Related literature. Our work is related to growing empirical evidence on the relationship between insurance and economic growth. In particular, our work relates to the experimental evidence on how individuals will forgo returns in order to avoid transferring resources to their peers Jakiela and Ozier (2016). It also related the literature on migration and its relationship (or trade-off) with insurance (Munshi and Rosenzweig, 2016; Morten, 2016; Meghir et al., 2019). We contribute by providing cross-country evidence of consumption insurance in which a negative pattern emerges between insurance and economic development. In this context, our work also relates to the micro-macro evidence on how insurance correlates negatively with economic growth (Santaeulàlia-Llopis and Zheng, 2018; De Magalhães and Santaeulàlia-Llopis, 2018). Clearly, our work also relates to the vast literature on contsrained-efficient contracts that give rise to transfers (Kehoe and Levine, 1993; Kocherlakota, 1996; Ligon et al., 2002; Krueger and Perri, 2006; Kinnan, 2022). In our context, we assess the optimality of these transfer arrangements

[1] The comparison across steady states resembles that in Conesa et al. (2009).

using an exogenously incomplete markets approach, which has the advantage that it allows us to study accumulation of different types and hence assess implications for aggregate development. The important role for progressivity in explaining income and welfare differences across countries which contributes to the literature on cross-country income per capita differences (Klenow and Rodríguez-Clare, 1997; Caselli, 2005; Lagakos et al., 2018). More generally, our work also relates to the growing literature that uses micro evidence to explore macro differences across countries (e.g. Hsieh and Klenow, 2009; Buera et al., 2011; Lagakos and Waugh, 2013; Lagakos et al., 2018). In our case, we show how insurance and, more generally redistribution—i.e. second order moments—can have a first order impact.

2 Empirical Evidence

For our empirical analysis on the ability to insure consumption, we use a data set currently comprising of 32 countries with at least 2 years of representative household surveys for consumption and income. Austria, Belgium, China, Cyprus, Estonia, Ethiopia, Croatia, Cyprus, Estonia, Ethiopia, Finland, France, Germany, Greece, Hungary, India, Indonesia, Ireland, Italy, Latvia, Luxembourg, Malawi, Mexico, Netherlands, Niger, Nigeria, Portugal, Russia, Slovakia, Slovenia, Spain, Tanzania, Uganda, United Kingdom, United States. For our empirical estimate of a progressivity parameter, we use a data set currently comprising of 12 countries for which there is availability of representative household surveys data on income with detailed entries for taxes and transfers. Australia, China, India, Indonesia, Italy, Malawi, Mexico, Poland, South Korea, Spain, United Kingdom, United States.

2.1 Transfer Progressivity across GDP per capita

None of the surveys has been designed to compare progressivity across countries or even years within country.

To study the degree of progressivity we use a class of tax policies traditional in public finance (Feldstein (1969)) defined by:

$$T(y, Y) = y\left(1 - \lambda(Y)y^{-\phi(Y)}\right), \tag{1}$$

where y is pre-tax and pre-transfer income, $T(y, Y)$ is the total tax ($\widetilde{y} = y - T(y, Y)$ is post-tax and post-transfer income). The parameters to be estimated are $\lambda(Y) \geq 0$, and $\phi(Y) \geq 0$. The parameter $\lambda(Y)$ determines the net revenue and $\phi(Y)$ the degree of progressivity. Importantly, notice that these parameters depend on the aggregate income per capita[2] That is, the degree of

[2] Two key restrictions are implicit in $T_y(y)$. First, it is either globally convex in income, if $\phi_y > 0$, or globally

progressivity can change with development. This implies that disposable income is:

$$y^d = (1 - \tau(y, Y))\, y$$

where $\tau(y,Y) = \frac{T(y,Y)}{y}$ is the average tax rate. This tax function has been recently used in quantitative macro with heterogeneous agents (Persson, 1983; Benabou, 2000, 2002). In the United States, Heathcote et al. (2017) estimate a degree of tax and transfers progressivity ϕ of 0.18.[3]

Various studies have used the above function to estimate the progressivity parameter ϕ, but their definition of *pre* and *post* income has varied. Some have focused solely on labor income to calculate an 'income-tax progressivity' (e.g., Holter et al. (2019), García-Miralles et al. (2019), Tran and Zakariyya (2021)). Whereas, Heathcote et al. (2017) and Fleck et al. (2021) estimate a 'tax and transfer progressivity', which includes other income sources (e.g., self-employment, capital income, pension income) and taxes (social security, medicare taxes) plus government transfers.

The above estimates have focused exclusively on high income countries, where the most common source of income is wages and the main source of tax revenue is the income tax. In low income countries, however, the vast majority of households do not pay income taxes (or most formal taxes).[4] Nevertheless, there are substantial levels of private transfers among households in Sub-Saharan Africa. For example, received food gifts represent 17% of the total income for households on the bottom quintile of the income distribution in rural Malawi, whereas government transfers are no more than 3% (De Magalhães and Santaeulàlia-Llopis (2015)).

Herein, we incorporate these private transfers across households as a norms-base tax-and-transfer systems that functions along side a formal taxation system. We will therefore define the pre-tax and pre-transfer level of income as labor, self-employment, business, agricultural, and capital income. The post-tax and post-trasfer income will add not only formal taxes and government transfers but also private transfers given and received. The unit of analysis is the

concave, if $\phi_y < 0$. As a result, marginal tax rates are monotonic in income. The same restriction applies to the average tax rate. Second, it does not allow for lump-sum transfers in cash, since $T_y(0) = 0$.

[3]We can write the Post-Tax/Pre-Tax Income Ratio as $\frac{\widetilde{y}}{y} = 1 - \tau((y, Y)) = \lambda(Y) y^{-\phi(Y)}$. Hence, with data on post- and pre-tax income we can estimate $\lambda(Y)$ and $\phi(Y)$. In particular, taking logs we have the equation we estimate:

$$\ln\left(\frac{\widetilde{y}}{y}\right) = \ln\lambda(Y) - \phi(Y)\ln y.$$

[4]Mayega et al. (2019) report that there are 1,218,316 individuals registered as potential tax payers in Uganda in 2017, approximately 10% of households, but less than half of those pay any income taxes.

household.

In order to gain some understanding on whether this high level of private transfers do indeed function as a norms-based tax and transfers system, we discuss evidence from Malawi in more detail before comparing estimates of transfer progressivity across countries. Malawi is one of the World's poorest countries, it has a functioning democracy since 1994, and government revenue is not based on commodity exports. Approximately 80% of the population lives in rural areas and to some extent cultivate maize for subsistence (De Magalhães and Santaeulàlia-Llopis (2018)).

We interviewed 60 village chiefs in Balaka, Southern Malawi, in 2017. We asked the chiefs to 'Explain the procedures people follow when they approach others to ask for aid'. These are a few answers out of the 60 chiefs who were interviewed that characterize their views on village transfers:

> 'Mostly it is not very common to approach the village head. But relatives.'[...] 'from the others, they go buy from them.'[...] We do not state the amount[...] just ask them to help'.

> 'They start to the village head.'[...] 'we just get in the house and get maize'.[...] 'piece work [ganyu] in farms to find the food.'

> '[ask family to help another] Yes'; [amount to share]'No'. '[refuse to help when they have food?] No, that can not happen here.'

These explanation by rural village chiefs make clear that food redistribution across household is common practice and based on strong norms. The remaining question is whether they are substantial in practice.

Therefore, in order to estimate the norms-based tax and transfers progressivity in Malawi we define pre-tax and pre-transfer (total gross income) as the sum of annualized labor income; business income; capital income including pensions, rental and sales of property, land, equipment, and livestock; fishery income net of costs; and agricultural income net of costs. Post-tax and post-transfer income (net income) includes private gifts given and received in cash or in kind; transfers received from government; transfers received from adult children living elsewhere; annualized value of weekly food consumption received as gift; food given as gift (available for 2016 only); and estimated income tax dues on wage and business income.[5]

[5]Household agricultural income is not taxed. Less than 5% of household in the 2016 IHS4 survey have income taxes dues according to our calculations. Brackets are calculated following the 2006 Taxation Act, PWC World Wide Tax summaries for 2010/11, and KPMG Malawi Fiscal Guide for 2015/16.

Using household survey data from the LSMS-ISA for the years 2004, 2010, 2013, and 2016, we find transfer progressivity parameters of 0.21 to 0.30 [6] These estimates of the progressivity parameter ϕ match the estimates we retrieve from a survey we conducted with all 242 households of one particular village in Malawi, Geradi, in the region of Balaka in June 2019, i.e., two months after the main maize harvest. The survey asked households to report their wealth, income, and consumption in similar lines to the LSMS-ISA surveys for Malawi. Within the consumption questionnaire we asked households about the consumption of food gifts received in the last week - as in the LSMS-ISA. In addition, we asked about food gifts given in the last week. We also asked about whether they were given or gave away fertilizer subsidy vouchers and other private or government transfers. We estimate a progressivity parameter ϕ equal to 0.60.

Some of the answers given by the chiefs in our qualitative survey, exemplified by the second quotation, suggests another way households provide help, by paying - mostly in kind - for informal odd jobs. This type of work has its own name in Malawi 'ganyu', and it so widespread and understood that the LSMS-ISA survey asks respondents specifically whether they engaged in any 'ganyu' and how much they received in return. Questions referring to other wage work deliberately exclude 'ganyu'.[7] This raises the issue whether 'ganyu' should be included in the tax and transfer estimates of progressivity. In some instances ganyu may function as payment for work done, but in some instances it could be a form of transfers that allows a household to ask and receive help without openly begging. Were we to move ganyu from the pre-tax and pre-transfers income into post income, our estimates for the progressivity parameter ϕ would increase to 0.41 in the village and be as high as 0.49 for the 2016 LSMS-ISA survey in Malawi. This highlights that our estimates used for cross-country comparisons (with ganyu treated as pre income) are a lower bound.

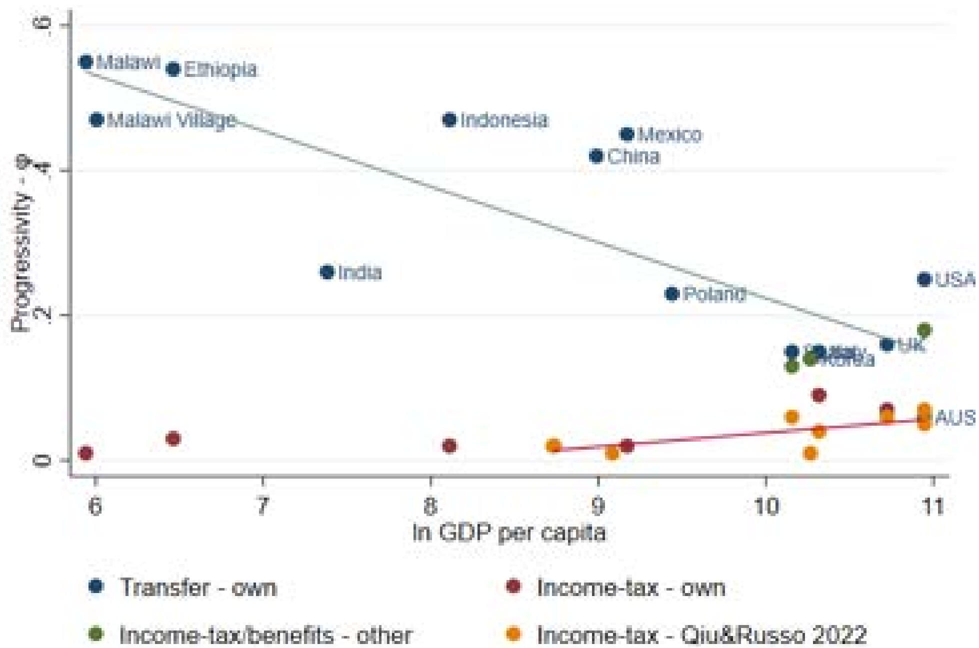
We expand our analysis to a series of countries for which household survey data allows pre-tax and pre-transfers income to be calculated: labor, business, self-employement, capital income and pensions. Ideally, both private and government transfers would be included in the post-tax post-transfer income. A clear pattern emerges in terms of progressivity across GDP per capita. In Figure 1 where we plot the country-year progressivity parameter 'ϕ' against income per capita. Low income countries have a a more progressive norms-based tax and transfers system than high income countries.

For comparison purposes we add estimates of the progressivity of each country's income tax on its own to Figure 1. The red dots are the progressivity estimates with gross income

[6] For more detail on data compilation see the section A in the appendix and De Magalhães and Santaeulàlia-Llopis (2018).

[7] Question E13 in the IHS4 is as follows 'How many hours in the last seven days did you do any work for a wage, salary, commission, or any payment in kind, excluding ganyu?'.

Figure 1: Transfer Progressivity Across GDP per Capita



Note: Transfer (blue) and income tax only (red) progressivity parameter ϕ estimate with most recent survey year. Ethiopia 2017; Malawi 2016; Indonesia 2014; India 2011; China 2009; Mexico 2009; Poland 2016; Italy 2016; UK 2009; USA 2006. Data compiled by the authors with sources described in the appendix. Income tax progressivity (orange) estimated by Qiu and Russo (2022): Spain, Italy, UK, AUS, USA, Korea, Brazil, Peru, and Colombia. Country specific estimates (green) for Australia (Tran and Zakariyya (2021)), Korea (Chang et al. (2015)), Spain (García-Miralles et al. (2019)), USA (Heathcote et al. (2017)), GDP per capita in 2015 dollars.

defined as before (wages, business, capital, and agricultural) and the post-tax income is the gross income after subtracting the income tax dues according to each country's income tax brackets. Our estimates are similar in magnitude to an independent exercise that estimates income tax progressivity in Qiu and Russo (2022) (orange dots). We report the values estimated in Qiu and Russo (2022) for the same countries in our data set with the addition of the three poorest countries in Qiu and Russo (2022): Brazil, Colombia, and Peru. Finally, we also report country specific studies that estimate a country's income tax progressivity taking into account deductions: Australia (Tran and Zakariyya (2021)), Korea (Chang et al. (2015)); and Spain (García-Miralles et al. (2019)). For the USA, Heathcote et al. (2017) add federal benefits in post-income and private transfers into gross-income. Our measure of transfer progressivity for the US (blue dot) uses a the same data and code as Heathcote et al. (2017), but moves private transfers from 'pre' to 'post' income.

The comparison between our measure of transfer progressivity and the income-tax progressivity is stark. Income-tax progressivity are near zero compared to the values we find for transfer progressivity. Malawi helps us understand why this is. Only approximately 10% of Malawian household pay any income tax. Pre and post income-tax in Malawi is identical for approximately 90% of households. Whereas, once all informal transfers, gifts, taxes are included, there are virtually no Malawian household with the same pre and post income. For the richest countries, since the income tax affects a majority of households and provides a large share of the government revenue, and because informal transfers do not play a major role, the gap between the income-tax progressivity and transfers progressivity is much smaller.

This comparison highlights even though formal taxation and redistribution are unable to eliminate poverty among low income countries (Ravallion (2010)), these countries have a very effective informal transfers system that has a large effect in providing insurance for income shock. [8]

2.2 Consumption Insurance across GDP per capita

We are interested in how the the transmission of unanticipated changes in income (i.e., income shocks) to consumption evolves across the development path. The larger is this transmission the lower is the ability to insure consumption. We focus on standard measures of this transmission à la Townsend (1994). To capture income shocks we use residual (within-group) measures of consumption and income that remove the between-group inequality generated by a set of deterministic observable variables. The idea is that the residual variation captures changes in income and consumption that are not anticipated (Krueger and Perri, 2006; Meghir and Pistaferri, 2010).

[8] See also Table 8 in the Appendix.

We remove between-group variation in sex, age, education of the household head, household composition (size and number of children), area of residency (rural/urban) and within-country regions separately by country c and year t.[9]

The formulation of full risk sharing implies that the ratio of the marginal utility of consumption is constant across individuals for any period or state of the world (Townsend, 1994; Kinnan, 2022), that is,

$$\frac{U_{c_i}(c_i(s^t))}{U_{c_{-i}}(c_{-i}(s^t))} = \frac{\omega_{-i}}{\omega_i}$$

where U_{c_i} is the marginal utility of consumption of a household i, $U_{c_{-1}}$ is the marginal utility of another not-i household in the economy, ω_i and ω_{-i} are the respective weights in the social planner problem, and s^t captures a history of exogenous events from time zero to t.[10]

Assuming a specific shape for preferences over consumption further allows for the development of full risk sharing tests. In particular, under constant relative risk aversion preferences (CRRA) with coefficient σ, full risk sharing implies that individual changes in consumption are only affected by aggregate (average) changes in consumption.

$$\ln c_i(s^t) = \frac{1}{\sigma}\left[\ln \omega_i - \overline{\ln \omega}\right] + \overline{\ln c(s^t)}.$$

Notice that we can develop this further defining the log-deviations from aggregate (average) consumption as $\ln \hat{c}_i(s^t) = \ln c_i(s^t) - \overline{\ln c(s^t)}$, and their growth rates between t and $t-1$ as $\Delta \ln \hat{c}_i(s^t) = \ln \hat{c}_i(s^t) - \ln \hat{c}_i(s^{t-1})$. This way, we can write the full risk sharing result more compactly as $\Delta \ln \hat{c}_i(s^t) = 0$. That is, under full insurance, individual consumption growth follows aggregate consumption growth and nothing else. In particular, unanticipated changes in income should not affect consumption growth. This gives rise to the following and standard testable full risk sharing hypothesis,

$$\Delta \ln(\hat{c}_{it}) = \beta \Delta \ln(\hat{y}_{it}) + \varepsilon_{it} \tag{2}$$

[9]Specifically, residuals, $\varepsilon_{x,t}$, are computed by year and country using the regression:

$$\ln x_t = cons. + f(age; \Theta) + \beta_g \mathbf{1}_{gender} + \beta_n hhsize + \beta_u \mathbf{1}_{urban} + \beta_r \mathbf{1}_{region} + \varepsilon_{x,t}$$

for any variable $x = c, y$. We use a quadratic for age. We control for other characteristics such as education and marital status.

[10]To be precise, at time zero, the social planner solves an economy with n agents maximizing $\max_{\{\{c_i(s^t)\}_{i=1}^n\}\}_{t=0}^\infty} \sum_i^n \omega_i \sum_{t=0}^\infty \beta^t \sum_{s^t} \pi(s^t) U\left(c_i(s^t)\right)$ subject to an aggregate endowment $\sum_i c_i(s^t) = \sum_i y_i(s^t)$ for a an exogenous history of events s^t that occurs with probability $\pi(s^t)$. Notice that there is one aggregate constraint per period. There is a set of individual weights ω_i, and a discount factor β.

where full insurance implies (the null hypothesis) that β is zero. We can test (2) using consumption and income panel data. Clearly, the farther the estimate β is from zero the lower is the ability of households to insure consumption against income shocks. If β is equal to one then consumption moves one-to-one with income shocks which could be explained with households living in autarky and without storage technology.

Before testing the full insurance hypothesis in (2), we use one straightforward variant of the full insurance result. The covariance of the left hand side of (2) with respect to its income counterpart should be zero with full insurance, that is, $Covar(\Delta \ln (\hat{c}_{ict}, \Delta \ln(\hat{y}_{ict}))) = 0$. Panel (a) in Figure 4 shows the covariance of residual consumption and income growth over the level of development. The covariance of residual logged consumption and income increases with the GDP per capita from a value close to zero for poor countries to a value slightly above 0.4 in rich countries. This implies a correlation between consumption and income shocks of 0.4 in poor countries and 0.65 in rich countries.

In panel (b) in Figure 4 we present the results of the Townsend full insurance test described in equation 2 separately by country and year. This implies an insurance parameter per country and year, ϕ_{ct}. Poor countries are closer to full insurance than rich countries. In poor countries we obtain a Townsend β of approximately 0.025 that is not significantly different from zero. In rich countries we obtain a Townsend β of approximately 0.30 that is significantly different from zero.

In a second stage we simply compute

$$\beta_{ct} = cons. + \beta \ln GDPpercapita_{ct} + u_{ct} \tag{3}$$

The results of this regression are in column (1) of Table 1. In column (2) we redo the previous estimation additionally controlling for fixed effects.[11]

An important aspect concerning consumption and income data is potential measurement error in either of these variable (Meghir et al., 2019; De Magalhães and Santaeulàlia-Llopis, 2018). It is unclear whether the under-reporting of income is related to levels of development (Kukk et al.,

[11] A recurring concern that arises with these measures is that part of the changes in income can be attributed to measurement error (Grosh and Deaton, 2000; De Magalhaes et al., 2019). In the Appendix, we also adopt an additional approach less prone to measurement error by focusing on observable income shocks (unemployment) as in Cochrane (1995). We find similar inisghts in this alternative approach. This relates to the recent work of Lagakos (2018) that documents an increase in unemployment across the level of development. Building on this result we document the effects that a rise in unemployment has on consumption insurance,

$$\Delta \ln (\hat{c}_{it}) = \phi \mathbf{1}_u + varepsilon_{it} \tag{4}$$

where $\mathbf{1}_u$ is a dummy equal to one if household i is unemployed in period t, and zero otherwise.

2020). A relevant aspect of our analysis is that the statistics that we are interested in—i.e. our measures of consumption insurance—are constructed from either cross-sec or panel household data at the country-year level. In this manner, since our unit of measurement are country-year observations, if we control for country fixed effects, then our analysis strictly uses the within-country variation of consumption insurance across GDP per capita which is less prone to be subject to measurement error. Since our results stand strong with country-year effects, we argue that our results are unlikely to be driven by measurement error.

Across both statistics presented, there is a clear deterioration of insurance across stages of development. In other words, a negative relationship between social insurance and development. This complements the experimental evidence in Jakiela and Ozier (2016). This is true whether we compare countries at different levels of development, or whether we control for fixed effects and focus on within country changes in income and consumption.

Table 1: Consumption Insurance Across GDP per capita

(a) By Country & Groups:	Poor	Middle	Rich	Ethiopia	Uganda	Tanzania	U.S.
Townsend Test	0.0992	0.1571	0.3323	0.0728	0.0493	0.0964	0.1762
	(0.0036)	(0.0022)	(0.0047)	(0.0088)	(0.0097)	(0.0094	(0.0067)

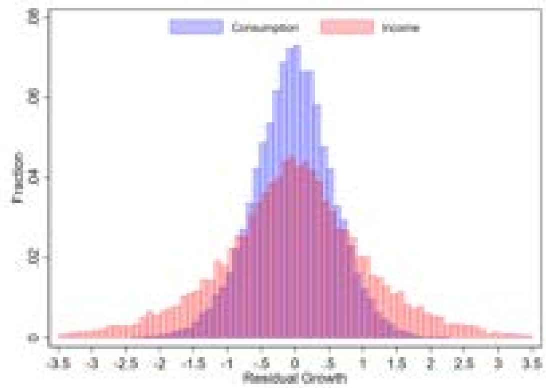
						Covariances:	
			Townsend β			$(\Delta \ln c, \Delta \ln y)$	$(\ln c, \ln y)$
(b) Full Sample:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\ln$ GDP p.c.	0.0176	0.0176	0.0172	0.0171	0.0167	0.0357	0.0418
	(0.004)	(0.026)	(0.029)	(0.021)	(0.098)	(0.000)	(0.000)
Country FE	No	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	No	No	Yes	Yes	Yes	Yes	Yes
Age FE	No	No	No	Yes	Yes	Yes	Yes
Household Controls	No	No	No	No	Yes	No	No
Sample: Country-Years:	66	66	66	66	63	66	81
Countries	22	22	22	22	21	22	32
Households	185,572	185,572	185,572	185,572	150,700	185,572	185,572

Notes: Panel (a) uses household-panel data to report the value of the Townsend β resulting form a full-risk sharing test as specified in (2). In column (1) the econometric specification controls for country and time fixed effects. In column (2), we additionally control for age effects using a quadratic. In column (3), we additionally control for household size, gender and education of the household head. In parenthesis we report $p-$values. Panel (b) uses household-panel data to report the covariance of the growth rate of consumption and income. Panel (c) uses cross-sectional data to report the covariance of consumption and income. In panel (d) we use the predicted value (net of country-fixed effects) of our benchmark specification (2) associated with Malawi 2013 (poor), Mexico 2005 (middle income) and United States 2006 (rich). We trim bottom and top 1% of consumption and income for each country-year observation.

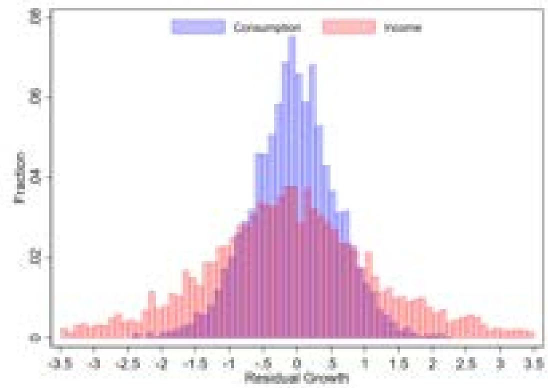
Figure 2: Consumption and Income Growth Across GDP per capita

(a) Poor Countries [Pooled] and Some Country Examples

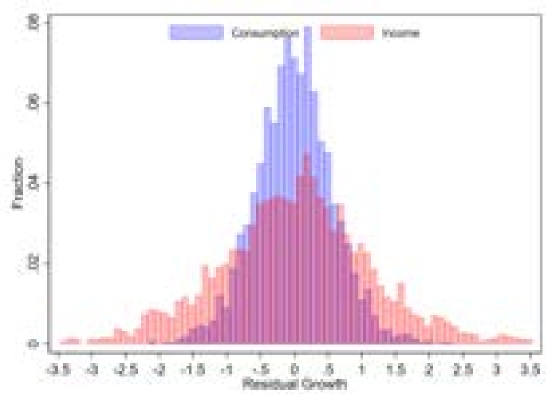
Poor Countries [Pooled]



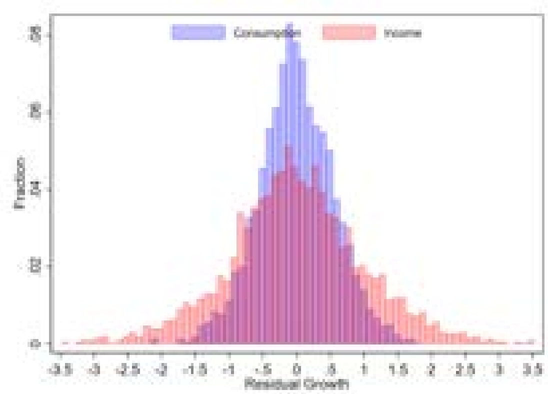
Poor-country example: Ethiopia



Poor-country example: Tanzania

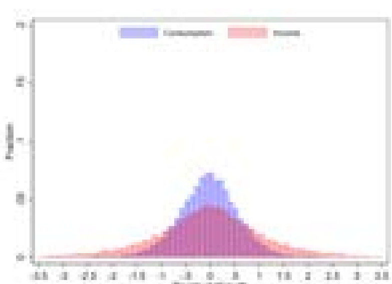


Poor-country example: Uganda

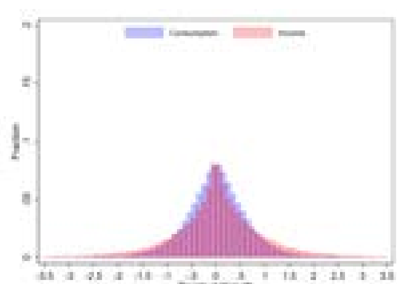


(b) Poor, Middle Income and Rich Countries [Pooled]:

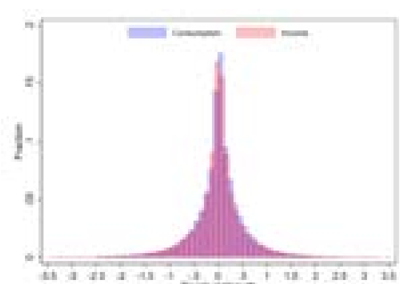
Poor Countries



Middle Income Countries



Rich Countries

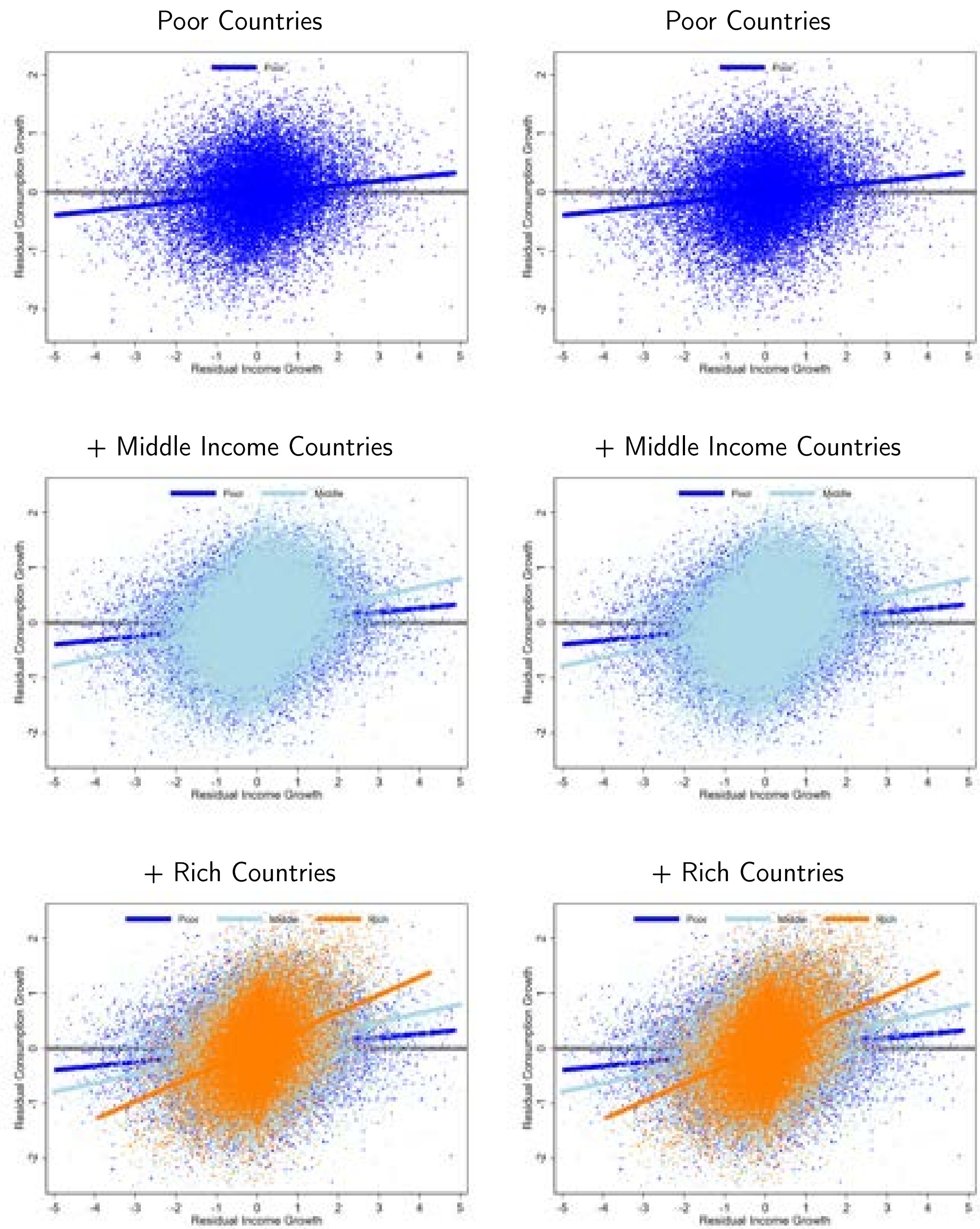


Notes: Country fixed-effects have been removed. Figure **??** includes the 32 countries detailed in Table **??**. Figure **??** includes the 22 countries for which we have a panel.

Figure 3: Transmission from Income to Consumption Across GDP per capita

(a) With Growth Data
$\Delta \ln c = \beta \Delta \ln y$

(b) With Residual Growth Data
$\Delta \ln \varepsilon_c = \beta \Delta \ln \varepsilon_y$



Notes: Country fixed-effects have been removed. Figure **??** includes the 32 countries detailed in Table **??**. Figure **??** includes the 22 countries for which we have a panel.

Figure 4: Transmission from Income to Consumption: Robustness to Measurement Error

(a) Recollection Error, Adjusted

x

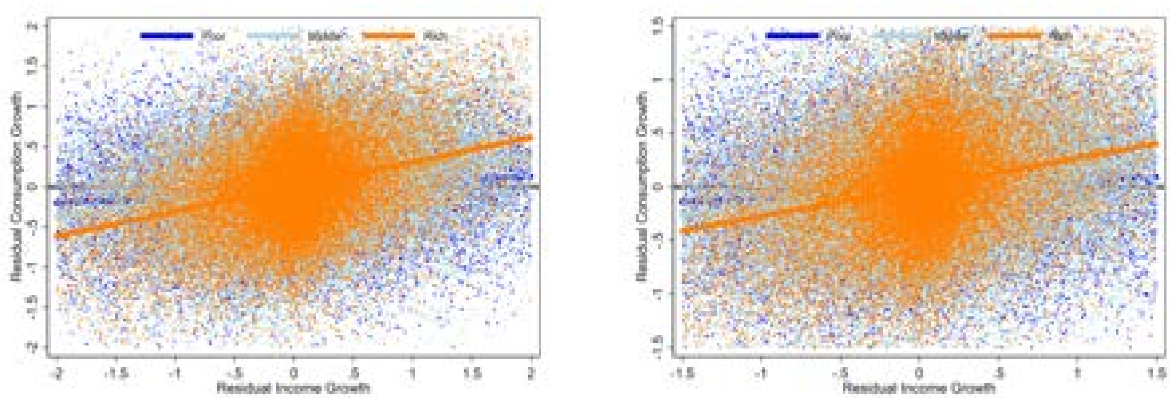
(b) Underreporting of Income, Adjusted

x

(c) Further Trimming: U.S. Administrative Data Window for $\Delta \ln \varepsilon_y$ in Guvenen et al. (2021)

$\{\Delta \ln \varepsilon_y, \Delta \ln \varepsilon_c\} \in [-2, 2]$

$\{\Delta \ln \varepsilon_y, \Delta \ln \varepsilon_c\} \in [-1.5, 1.5]$



Notes: In the Appendix, we conduct two additional robustness checks: (i) instrument income shocks with weather shocks (e.g. deviations from historical rain averages) and (ii) use unemployment shocks to proxy for income shocks.

3 An Illustrative Two-Age OLG Model

3.1 The Effects of Transfer Progressivity

At every period, n individuals are born with an initial endowment ω_{0t} distributed according to an initial endowment distribution $\Psi(\omega_{0t})$, and an initial level of human capital s_{0t} which is the same across all agents in the economy. Agents live for two periods which makes the total population alive in each period equal to $L = 2n$. Agents also differ in labor income shocks in the second period that can take two values ε_{1t+1} and $-\varepsilon_{1t+1}$, with .5 probability.

3.1.1 Household Problem

Each price-taker households solve this two-age model.

First age ($a = 0$). For given (k_{0t}, s_{0t}), agents solve:

$$\max_{\{c_{0t}\geq 0, 0\leq h_{0t}\leq 1, k_{1t}, s_{1t}\}} \left(\log\left(c_{0t} - \overline{c}\right) - \kappa \frac{h_{0t}^{1+\frac{1}{\nu}}}{1+\frac{1}{\nu}} \right) + \beta \sum_{\varepsilon_{1t+1}} \pi(\varepsilon_{1t+1}) \left(\log\left(c_{1t+1} - \overline{c}\right) - \kappa \frac{h_{1t+1}^{1+\frac{1}{\nu}}}{1+\frac{1}{\nu}} \right) \tag{5}$$

subject to a set of first-period constraints,

$$\begin{aligned} c_{0t} + k_{1t} &= w_t s_{0t} h_{0t} + \omega_{0t} \\ s_{1t} &= z h_{0t}^{\alpha} + (1 - \delta_s) s_{0t} \end{aligned}$$

Second age ($a = 1$). For given $(k_{1t}, s_{1t}, \varepsilon_{1t+1})$ agents solve

$$\max_{\{c_{1t+1}\geq 0, 0\leq h_{1t+1}\leq 1\}} \left(\log\left(c_{1t+1} - \overline{c}\right) - \kappa \frac{h_{1t+1}^{1+\frac{1}{\nu}}}{1+\frac{1}{\nu}} \right) \tag{6}$$

subject to a second-period constraint,

$$c_{1t+1} = y_{1t+1}^{d} + (1 - \delta_k) k_{1t} \tag{7}$$

where y_d^1 is disposable income,

$$y_{1t+1}^{d} = (1 - \tau(y_{1t+1})) y_{1t+1} \tag{8}$$

with pre-tax income,

$$y_{1t+1} = w_{t+1} s_{1t} h_{1t+1} \varepsilon_{1t+1} + r_{t+1} k_{1t} \tag{9}$$

The tax-subsidy scheme implies that above a given income threshold $\overline{y}$ individuals pay a tax that depends on their income y_1 and below that income threshold individuals receive a transfer. Notice that there is labor income risk only in the second period. Initial ω_0 and s_0 are given.

The tax code allows for tax progressivity as in HSV with:[12]

$$\tau(y) = 1 - \lambda y^{-\phi} \tag{10}$$

where the parameter ϕ determines the degree of progressivity. This implies that the threshold of income above which individuals pay a tax, i.e., $\tau(y) \geq 0$, is $\overline{y} = \lambda^{\frac{1}{\phi}}$.

This means that we can write disposable income (8) as,

$$y_1^d = \lambda y_1^{1-\phi} \tag{11}$$

Firms. A representative firm produces a consumption good with a CRS technology,

$$Y_t = B K_t^{1-\theta} N_t^{\theta}$$

with

$$K_t = \sum_a \sum_{i=1}^n k_{iat} = \sum_i^n k_{i1t} \text{ and } N_t = \sum_a \sum_{i=1}^n x_{iat}$$

where note that k_{i1t} is chosen in the previous period, and $x_{iat} = s_{iat} h_{iat} \varepsilon_{iat}$. This firm demands capital and labor in competitive markets $r_t = (1-\theta)\frac{Y_t}{K_t}$ and $w_t = \theta \frac{Y_t}{N_t}$.

[12] Recall that disposabie income as

$$y^d = y - T(y)$$

where y is pre-tax income and $T(y)$ is the total tax. We use Feldstein 1969 or HSV: $T(y) = y(1 - \lambda y^{-\phi})$ with $\lambda \geq 0$ and $\phi \geq 0$. Note than that we can write disposable income as

$$y^d = y - T(y) = (1 - \tau(y))y = \lambda y^{1-\phi}$$

where we have used the fact that $\tau(y) = \frac{T(y)}{y} = 1 - \lambda y^{-\phi}$.

Aggregate Transfer Budget. The economy satisfies an aggregate transfer budget constraint in the second period:

$$\sum_{i=1}^{n} \mathbf{1}_{y_1 \geq \overline{y}} \tau(y_1) y_1 = \sum_{i=1}^{n} \mathbf{1}_{y_1 < \overline{y}} \tau(y_1) y_1 + \mathcal{G} \tag{12}$$

with $\mathcal{G} = G + \mathcal{W}$. The amount G can be interpreted as the provision of a public good (or rent-seeking resources and corruption). We start by setting G its minimum, $G = 0$. In addition, part of the tax revenues are randomly allocated to the youngest individuals with $\omega_0 \sim N(0, \sigma_\omega^2)$ subject to the constraint that $\sum_i^n \omega_{i0} = \mathcal{W}$.

Parameters. We need to choose three preference parameters ($\overline{c}$, κ, $\nu = 1$), two production parameters (B, $\theta = .64$), the labor income shock ε, two human capital parameters (z, α, s_0), and the distribution of initial endowment $\Psi(\omega_0)$ and initial human capital $\Psi(h_0)$. We also need to choose the degree of tax progressivity ϕ and the size of the government budget through λ.[13]

3.1.2 Stationary OLG Equilibrium

Given a tax system $\tau(y)$ (i.e., λ and ϕ), government expenditure $(G, \mathcal{W})$, a joint initial distribution of initial wealth and schooling $\Phi(\omega_0, s_0)$, and a probability distribution $\pi(\varepsilon_1)$, a GE is a sextuplet $\{c_0^*, c_1^*, h_0^*, h_1^*, k_1^*, s_1^*\}$ of optimal choices, market wages (w^*) and interest rate (r^*) such that:

1. Given factor prices, households solve their maximization problem, that is, the sextuplet $\{c_0^*, c_1^*, h_0^*, h_1^*, k_1^*, s_1^*\}$ is the solution to the lifecycle problem (5)-(20).

2. Firms solve their optimization problem equating factor prices to marginal productivies.

[13] To see how λ determines the size of public expenditure we use the budget constraint (12),

$$\sum_{i=0}^{n} \mathbf{1}_{y_1 \geq \overline{y}} \tau(y) y = \sum_{i=0}^{n} \mathbf{1}_{y_1 \geq \overline{y}} y - \lambda \sum_{i=0}^{n} \mathbf{1}_{y_1 \geq \overline{y}} y^{1-\phi} = \mathcal{G}.$$

Therefore, for a given distribution of income $\Phi(y)$, the higher is λ, the lower is aggregate amount of taxes collected, $\sum_{i=0}^{n} \mathbf{1}_{y_1 \geq \overline{y}} \tau(y) y$, and hence the lower is public expenditure, $\mathcal{G}$. First, an increase in λ increases the income threshold ($\overline{y} = \lambda^{\frac{1}{\phi}}$) above which population gets taxed which reduces the aggregate tax revenue. Second, because the aggregate amount of tax revenue is reduced, so is the aggregate amount of transfers. In paricular, an increase in λ increases the number of individuals that get transfers while at the same time reducing public expenditure $\mathcal{G}$. Nevertheless, the distribution of income, $\Phi(y)$, potentially changes in equilibrium in response to λ and this makes the effects of λ on the size of the aggregate tax revenue (and aggregate transfers) ambiguous.

3. Markets clear,

$$K^* = \sum_{i=1}^{n} k_1^*, \;\; N^* = \sum_{a} \sum_{i=1}^{n} x_a^*,$$

where $x^* = sh^*\varepsilon$.

4. Government budget balances:

$$\sum_{i=1}^{n} \mathbf{1}_{y_1^* \geq \overline{y}} \tau(y_1^*) y_1^* = \sum_{i=1}^{n} \mathbf{1}_{y_1^* < \overline{y}} \tau(y_1^*) y_1^* + \mathcal{G}$$

where $\mathcal{G} = G + \mathcal{W}$ with $\sum_{i=1}^{n} \omega_0 = \mathcal{W}$.

3.1.3 Solution Algorithm

We solve the problem with the following algorithm:

STEP 1. Guess the stationary interest rates (r_m^*) (hence, (w_m^*)).

STEP 2. Given factor prices, solve the household problem (where m stands for the iteration number). (See Appendix B).

STEP 3. Compute the excess of demand of aggregate capital and labor per period,

$$K^* - \sum_{i}^{n} k_1^* = 0, \;\;\; N^* - \sum_{a} \sum_{i=1}^{n} x_a^* = 0,$$

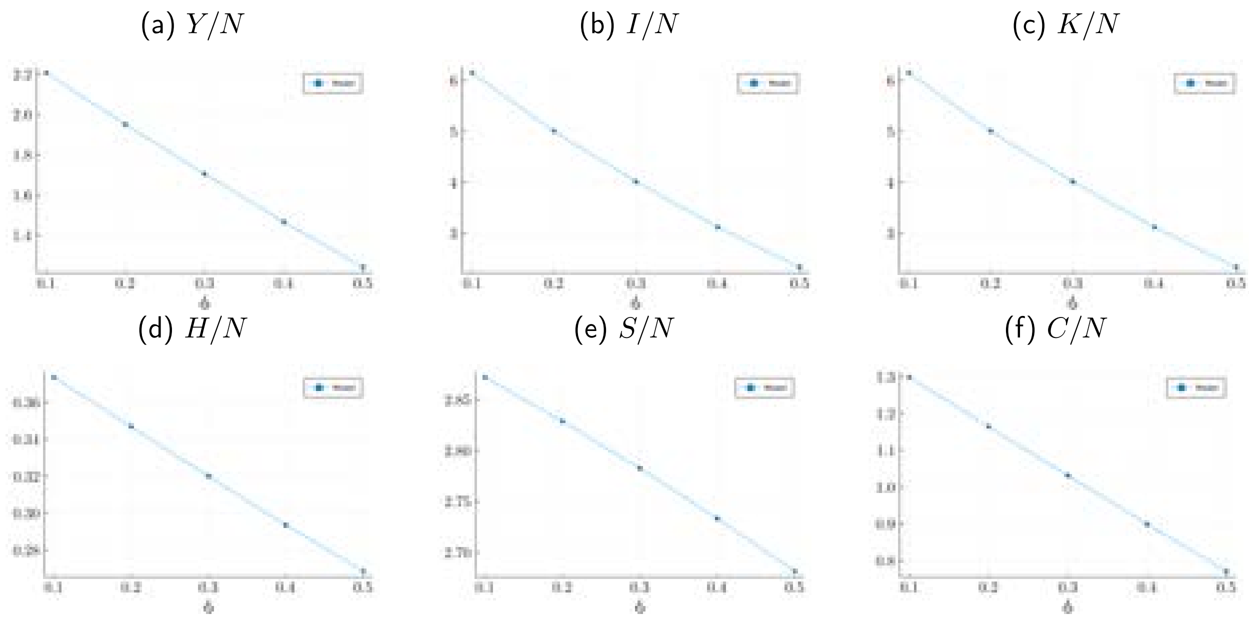
STEP 4. Check for the aggregate transfer budget balance,

$$\sum_{i=1}^{n} \mathbf{1}_{y_1^* \geq \overline{y}} \tau(y_1^*) y_1^* = \sum_{i=1}^{n} \mathbf{1}_{y_1^* < \overline{y}} \tau(y_1^*) y_1^* + \mathcal{G}$$

Notice that for the budget balance to clear we need to choose the adequate λ (that is we need to also iterate over λ together with the r_m^* loop or outside)

STEP 5. If factor markets clear and government budget balances, then STOP. Otherwise guess a new interest rate and transfers.

Figure 5: Progressivity Effects on Development



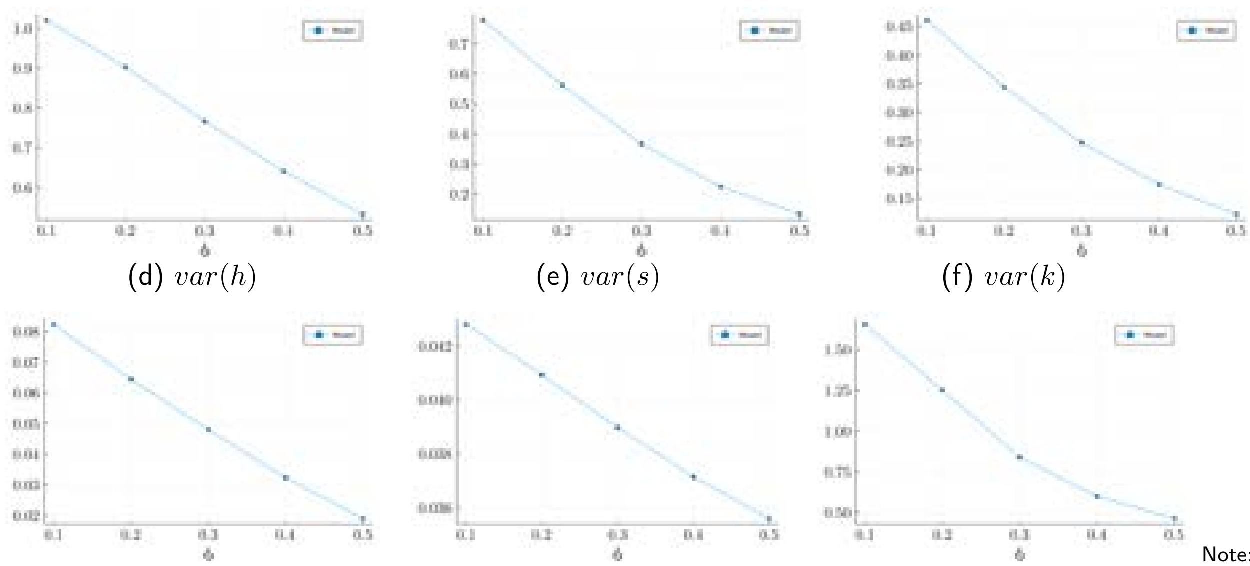
3.1.4 Illustrative Numerical Results

We now illustrate the implications of tax progressivity in aggregate variables and distributions. To do so we choose some model parameters, $A = 5.0$, $\theta = .66$, $z = 1.0$, $\alpha = 0.33$, $\delta_s = 0.001$, $\kappa = 5.0$, $\nu = 1.0$, $\bar{c} = 0.5$. We also assume that all individuals are born with the same initial human capital $s_0 = 1.0$. In this manner, individuals differ in the amount of initial wealth they are born with k_0 which is drawn from a log normal distribution with mean 0.0 and variance 0.1.

We now show the effects of changing tax progressivity from $\phi = 0.1$ to $\phi = 0.3$. This implies changing λ to satisfy tax reveneu neutrality across scenarios. In particular, the aggregate transfer scheme implies that 5% of all tax revenue is devoted is transferred as initial wealth to the youngest individuals with an evenly distributed lump sum.

The effects of tax progressivity on development are in Figure 5. Focusing on the effects from moving progressivity from 0.1 to 0.3, we find clear effects. The higher the progressivity lowers income per capita by 17.3% (see panel (a)). This is due to the drop in investment and aggregate capital (32.5%) and a smaller drop in efficient labor supply (-0.8%). Because there are no taxes for young individuals, a higher progressivity makes households work more in the first period and accumulate human capital which explains the rise in human capital (though small, 0.6%). The overall effects on hours is a decrease of 1.5% in response to increases in progressivity. This decline in aggregate hours is driven by the old adults that reduce hours supplied in response to increases in progressivity. The decline in consumption per capita is similar to that of output. Wages follow labor productivity that goes down with progressivity due to the larger decline of

Figure 6: Progressivity Effects on Inequality



(a) $var(y)$ (b) $var(y^d)$ (c) $var(c)$ (d) $var(h)$ (e) $var(s)$ (f) $var(k)$

Note: Computed by the authors

output than hours. The opposite occurs to the interest rate which increases due to the larger decline of capital than output.

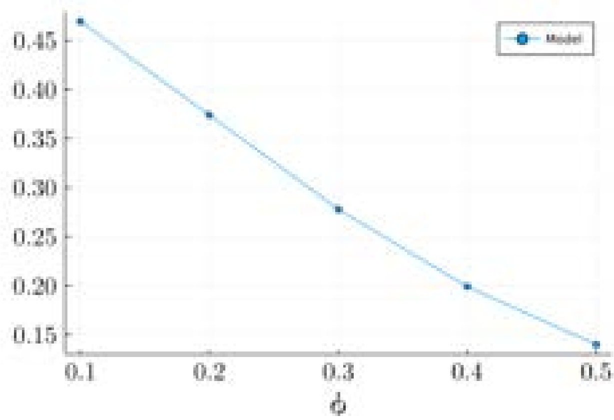
The effects of progressivity show up in the average tax rate (ATR) across the income distribution. Higher progressivity from 0.1 to 0.3 increases the income subsidies received by the bottom 1% by 349.9% (from an ATR of -0.11% to -52.6%). On the other side of the income distribution the top 1% income earners see their ATR increase by 74.7% (from 0.08% to 14.2%). The increase in progressivity in turn implies that the fraction of tax payers goes down. Looking at the implications of increases in progressivity for the behavior of household y, x, k, h, s and c is also important.

Inequality in income and consumption is reduced with progressivity, see Figure 6. Increasing ϕ from 0.1 to 0.3, he variance of logged income goes down by 6.5% and that of consumption by 20%. This implies a reduction in the inequality ratio between consumption and income of 14.4%, which is our first evidence of consumption insurance improvement due to increases in progressivity. This is directly related to the decrease in the variance of disposable income with respect to pre-tax income by 37.1% (from 0.81 with $\phi = 0.1$ to 0.51 with $\phi = 0.3$). Part of the reduction in consumption inequality is related to the increase in the inequality of the labor supply that is also used as insurance mechanism.

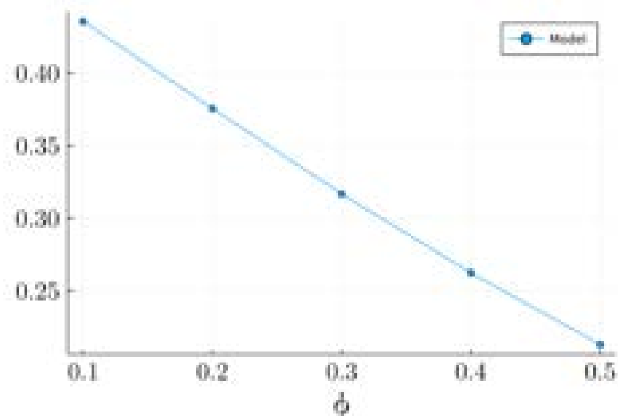
An alternative measure of consumption insurance is the co-movement of consumption and income. Clearly, higher progressivity implies lower covariance between consumption and income

Figure 7: Progressivity Effects on Consumption Insurance

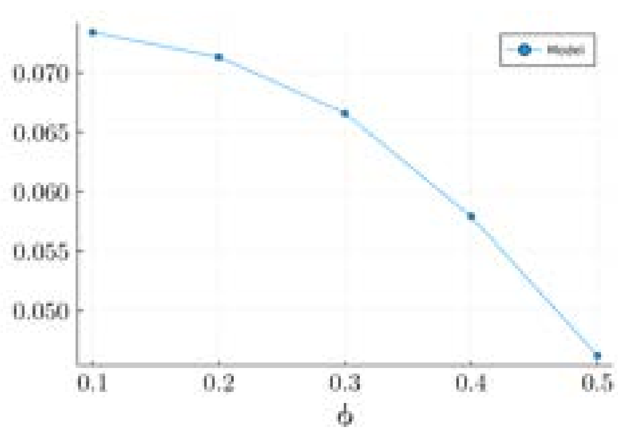
(a) $cov(\ln c, \ln y)$



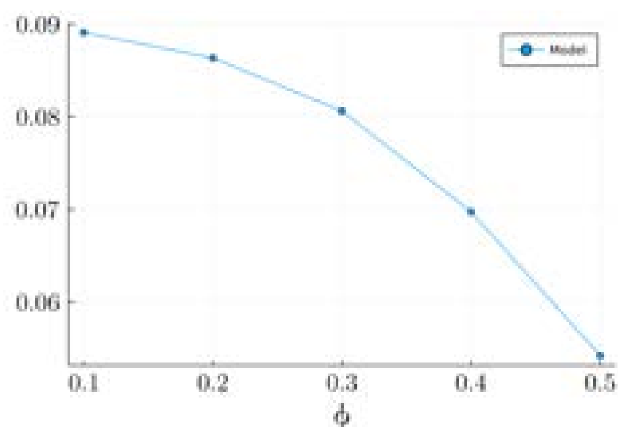
(b) $cov(\ln c, \ln \varepsilon)$



(c) $cov(\ln s\varepsilon, \ln h)$



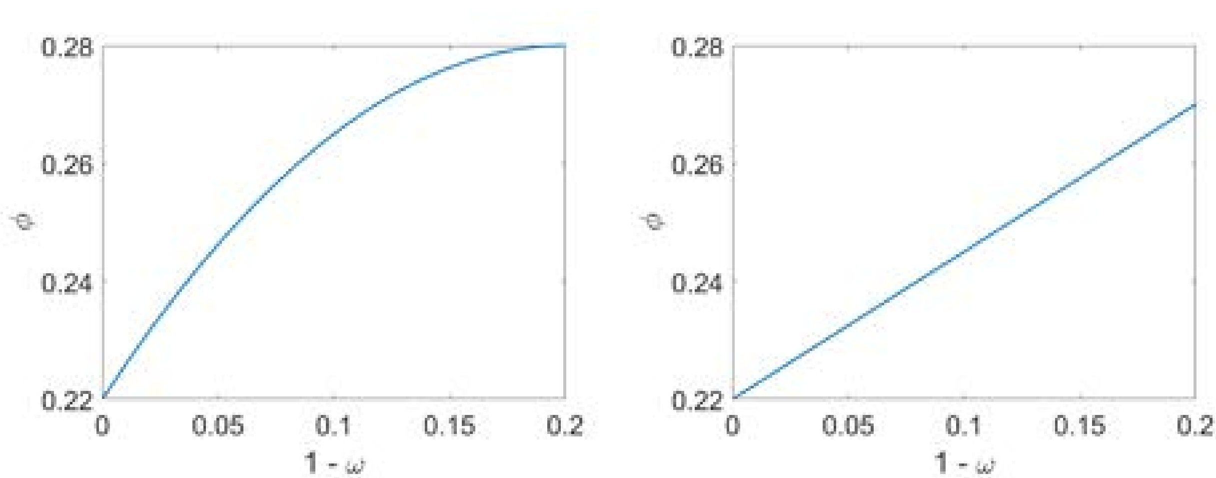
(d) $cov(\ln h, \ln \varepsilon)$



Note: Computed by the authors

which is reduced by 25.4% (from 0.460 with $\phi = 0.1$ and 0.343 with $\phi = 0.3$), see panel (a) in Figure 7. A perhaps more direct measure of consumption insurance is the covariance between the income shock ε and consumption. Again, the results are clear. Higher progressivity implies lower covariance between consumption and income shocks which is reduced by 21.1% (from 0.057 with $\phi = 0.1$ and 0.045 with $\phi = 0.3$), see panel (a) in Figure 7. Analogously, the higher is the progressivity the lower is the co-movement between wages (or wage income shocks) and hours.

3.2 A Social Norm Interpretation: Microfounding Transfer Progressivity



(a) Interim Participation (b) Incentive Compatibility

4 The Model

4.1 Households

This is an OLG economy with J generations. That is, at every period there is a continuum of ex-ante identical households being born that lives for J periods. Let us cast the problem of these households recursively and then explain it. At any given age $j \in (J_0, J)$, agents with physical capital $k \in \mathcal{K}$, human capital $s \in \mathcal{S}$, labor productivity shock $\varepsilon \in \mathcal{E}$ solve the following problem. Let $\mathbf{x} = (k, s, \varepsilon, j)$ define the set of individual state variables.

$$V(\mathbf{x}, \Phi) = \max_{\{c,h,k',s'\}} \left(\frac{(c - \overline{c})^{1-\sigma}}{1-\sigma} - \kappa^j \frac{h^{1+\frac{1}{\nu}}}{1+\frac{1}{\nu}} \right) + \delta^j \beta \sum_{\varepsilon'} \pi(\varepsilon'|\varepsilon) V(\mathbf{x}', \Phi') \tag{13}$$

subject to individual constraints,

$$c = (1 - \tau(y))(w(\Phi)sh\varepsilon + r(\Phi)a) \tag{14}$$

$$s' = zh^\alpha + (1 - \delta_s)s \tag{15}$$

$$c \geq 0 \tag{16}$$

$$h \geq 0 \tag{17}$$

$$k' \geq \underline{k} \tag{18}$$

and to the aggregate law of motion,

$$\Phi' = H(\Phi) \tag{19}$$

where the joint distribution of individual states $\Phi(\mathbf{x})$ is the aggregate state of the economy which evolves following a law of motion H defined below.

Households derive utility from consumption c and dislike working hours h. We assume a subsistence level in consumption $\bar{c}$. Labor is supplied elastically with an elasticity with respect to effective wages determined through ν. The degree of disutility of labor, relative to the joy of consumption, is guarded by κ and it is allowed to be age dependent. The future is discounted with a factor β. Agents survive with probability δ

The flow of worker household resources consists of labor income and capital income ,$y = wsh\varepsilon + ra$, which are taxed at an endogenous rate $\tau(y)$ defined as,

$$\tau(y) = 1 - \lambda y^{-\phi} \tag{20}$$

where the parameter ϕ determines the degree of progressivity. This implies that the threshold of income above which individuals pay a tax, i.e., $\tau(y) \geq 0$, is $\overline{y} = \lambda^{\frac{1}{\phi}}$. At a fixed $j = J^{RET}$ households retire and they start earning a tax free proportion ξ of their accumulated human capital as a pension.

Households differ in labor income through three different components: the level of human capital, labor supply, and a labor productivity shock. Each individual faces the same stochastic labor productivity process $\varepsilon \in \{\varepsilon_1, ..., \varepsilon_N\}$ that follows a stationary Markov process with conditional transition probabilities denoted by $\pi(\varepsilon'|\varepsilon)$.[14]

Human capital is accumulated through learning-by-doing that depends on the amount of labor supplied according to (15). The ability to accumulate human capital is defined by the parameter z and its curvature by α. Human capital depreciates at some rate δ_s.

There is investment in physical capital which will be rent out to firms in exchange of a common capital return.

There are four individual states: $\{k, s, \varepsilon, j\} \in \mathcal{K} \times \mathcal{S} \times \mathcal{E} \times \mathcal{J}$. The set $\mathcal{K} = [\underline{k}, \overline{k}]$ contains the possible asset holdings, $\mathcal{S} = [\underline{s}, \overline{s}]$ is the possible values of human capital, $\mathcal{E}$ contains the possible realizations of the labor productivity shock, $\mathcal{J} = \{J_0, J\}$. Define by $\mathcal{M}$ the set of all probability measures on the measurable space $M = (Z, \mathcal{B}(Z))$ where $Z = \mathcal{K} \times \mathcal{S} \times \mathcal{E} \times \mathcal{J}$ and $\mathcal{B}(Z) = \mathcal{B}(\mathcal{K}) \times \mathcal{B}(\mathcal{S}) \times \mathcal{P}(\mathcal{E}) \times \mathcal{P}(\mathcal{J})$.[15] This is relevant because our measures Φ are required to be elements of $\mathcal{M}$.

The aggregate law of motion $H : \mathcal{M} \to \mathcal{M}$ maps distributions onto distributions. It basically summarizes how agents move within the distribution of physical assets, k, human capital, s, income shocks, ε, and age, j, from one period to the next.[16] Then, the evolution of the physical asset-human capital-productivity-age distribution is,

$$\Phi'(\mathcal{K}, \mathcal{S}, \mathcal{E}, \mathcal{J}) = H(\Phi)(\mathcal{K}, \mathcal{S}, \mathcal{E}, \mathcal{J}) = \int_{k,s,\varepsilon,j} Q((k, s, \varepsilon, j)(\mathcal{K}, \mathcal{S}, \mathcal{E}, \mathcal{J}))d\Phi$$

[14]We assume a law of large numbers to hold. This means that $\pi(\varepsilon'|\varepsilon)$ is also the deterministic fraction of the population that goes through this particular transition (from ε to ε').

[15]Notice that $\mathcal{B}(\mathcal{K})$ is the Borel σ-algebra of $\mathcal{K}$, $\mathcal{B}(\mathcal{S})$ is the Borel σ-algebra of $\mathcal{S}$, $\mathcal{P}(\mathcal{E})$ is the power set of $\mathcal{E}$ (i.e., the set of all subsets of $\mathcal{E}$), and $\mathcal{P}(\mathcal{J})$ is the power set of $\mathcal{J}$.

[16]That is exactly what a transition function tells us. Define the transition function $Q : Z \times \mathcal{B}(Z) \to [0, 1]$ by

$$Q((k, s, \varepsilon, j)(\mathcal{K}, \mathcal{S}, \mathcal{E}, \mathcal{J})) = \begin{cases} \pi(\varepsilon'|\varepsilon) & \text{if} \quad g_k(k, s, \varepsilon, j; \Phi) \in \mathcal{K},\ g_s(k, s, \varepsilon, j; \Phi) \in \mathcal{S} \text{ and } \varepsilon' \in \mathcal{E} \\ 0 & \text{else} \end{cases}$$

for all $(k, s, \varepsilon, j) \in Z$ and $(\mathcal{K}, \mathcal{S}, \mathcal{E}, \mathcal{J}) \in \mathcal{B}(Z)$. That is, $Q((k, s, \varepsilon, j)(\mathcal{K}, \mathcal{S}, \mathcal{E}, \mathcal{J}))$ is the probability that an agent with current physical assets k, current human capital s, and current shock ε and current age j ends up with assets k' in $\mathcal{K}$ tomorrow, human capital s' in $\mathcal{S}$ tomorrow, income shocks $\varepsilon \in \mathcal{E}$ tomorrow, and age j' in $\mathcal{J}$ tomorrow.

The fraction of people with assets in $\mathcal{K}$, human capital in $\mathcal{S}$, productivity shock in $\mathcal{E}$, and age $\mathcal{J}$, as measured by Φ, that transit to $(\mathcal{K}, \mathcal{S}, \mathcal{E}, \mathcal{J})$ as measured by Q.

The evolution of the aggregate state is important because it provides a forecast of the evolution of the future rate of return on aggregate capital which is identical across households. Capital and labor demand are determined competitively by a representative firm that maximizes profits producing consumption goods using a constant returns to scale technology,

$$Y = BK_t^{\theta} N_t^{1-\theta} \tag{21}$$

The competitive capital and labor market factor prices are $r(\Phi) = (1-\theta)\frac{Y}{K}$ and $w(\Phi) = \theta\frac{Y}{N}$, respectively.

The economy satisfies an aggregate transfer budget constraint in every period:

$$\int_{k,s,\varepsilon,j} \mathbf{1}_{y \geq \overline{y}} \tau(y) y d\Phi = \int_{k,s,\varepsilon,j} \mathbf{1}_{y < \overline{y}} \tau(y) y d\Phi + \mathcal{G} \tag{22}$$

with $\mathcal{G} = G + \mathcal{W}$. The amount G can be interpreted as the provision of a public good (or rent-seeking resources and corruption). We start by setting G its minimum, $G = 0$. In addition, part of the tax revenues are randomly allocated to the youngest individuals with $\omega \sim N(0, \sigma_\omega^2)$ subject to the constraint that the youngest individual wealth is: $\int_{k=0,s,\varepsilon,j=1} \omega d\Phi(k=0, s, \varepsilon, j=1) = \mathcal{W}$.

4.2 Stationary Recursive OLG Competitive Equilibrium

Definition. A stationary recursive OLG competitive equilibrium is a value function $V : Z \to R$, policy functions for the household $c : Z \to R$, $h : Z \to R$, $k' : Z \to R$ and $s' : Z \to R$, policies for the firm K, L, prices r, w and a measure $\Phi \in \mathcal{M}$ such that,

1. V, c, h, k' and s' are measurable with respect to $\mathcal{B}(Z)$, V satisfies the household's Bellman equation and c, h, k', s' are the associated policy functions, given r and w.

2. K and L satisfy, given r and w,

$$r = F_K(K, L)$$
$$w = F_L(K, L)$$

3. Markets clear,

$$
\begin{aligned}
K &= \int_{k,s,\varepsilon,j} k'(k,s,\varepsilon,j)d\Phi \\
N &= \int_{k,s,\varepsilon,j} s'(k,s,\varepsilon,j)h(k,s,\varepsilon,j)\varepsilon d\Phi
\end{aligned}
$$

and

$$
\int_{k,s,\varepsilon,j} c(k,s,\varepsilon,j)d\Phi + \int_{k,s,\varepsilon,j} k'(k,s,\varepsilon,j)d\Phi = F(K,N) + (1-\delta)K
$$

4. The economy satisfies the aggregate transfer budget:

$$
\int_{k,s,\varepsilon,j} \mathbf{1}_{y \geq \overline{y}} \tau(y) y d\Phi = \int_{k,s,\varepsilon,j} \mathbf{1}_{y < \overline{y}} \tau(y) y d\Phi + \mathcal{G} \tag{23}
$$

with $\mathcal{G} = G + \mathcal{W}$, and $\int_{k=0,s,\varepsilon,j=1} \omega d\Phi(k=0,s,\varepsilon,j=1) = \mathcal{W}$.

Note that value functions (decision rules) and prices are not any longer indexed by measures Φ, all conditions have to be satisfied only for the equilibrium measure Φ. The last requirement states that the measure Φ reproduces itself: starting with measure physical capital, human capital, productivity, and ages today generates the same measure tomorrow.

5 Calibration Strategy

Our calibration is country specific. The goal is to use our model to match a set of aggregate and cross-sectional variables as well as age profiles for consumption, income and wages. This section is summarized in Table 2.

The discount factor is set to, $\beta = 0.96$. We use the total factor productivity B to normalize income per capita. The depreciation rate, δ, pins down the capital-income ratio. More details can be found in Appendix D. The capital share in the production function is set to, $\theta = 0.33$ as standard in the literature. We set the level of risk aversion $\sigma = 1.0$ and the Frisch elasticity of labor supply $\nu = 1.0$ as standard in the literature.

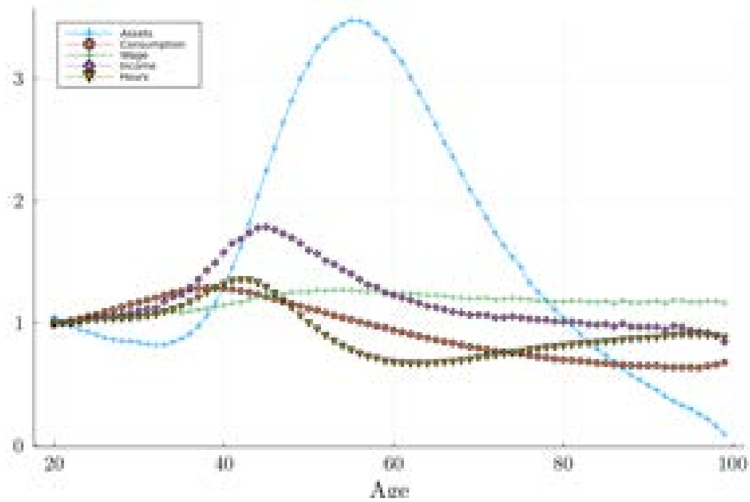
A set of parameters comes from the data used in Section 2 and further detailed in Appendix A. Those are the degree of progressivity ϕ, the persistence ρ and the variance σ_ε of the income process. This means that when we refer to a type of country we refer to the tuple $\{\phi, \rho, \sigma_\epsilon\}$. We are going to allow for these parameters to be calibrated within the confidence interval of our estimation from the data.

We are left with the learning productivity z, learning curvature parameter α, human capital depreciation δ_s. Also, we fit two third order polynomial: (i) the age profile of κ^j and (ii) the age profile of the family size.

Table 2: Calibration

	Moment	Description	Source
Country-specific parameters:			
ϕ	0.4	Tax Progressivity	Micro Data
B	0.69	Productivity	SMM
δ_k	0.064	Depreciation of Capital	SMM
z	0.13	Learning Productivity	SMM
α	1.90	Learning Curvature	SMM
δ_s	0.01	Depreciation of Human Capital	SMM
ρ	0.6	Persistence of income shocks	Micro Data
σ_ε	0.65	Variance of income shocks	Micro Data
λ	0.98	Budget Balancing	Model
r	0.045	Market Clearing	Model
w	0.66	Market Clearing	Model
$\{\kappa_0, \kappa_1, \kappa_2, \kappa_3\}$	{3.2, 0.5, 1.8, 1.8}	Disutility of hours	SMM
$\{n_0, n_1, n_2, n_3\}$	{1.0, 0.9, 1.5, 1.5}	Family size/Preferences	SMM
Common parameters:			
β	0.96	Discount factor	-
ν	1.00	Elasticity of Labor Supply	-
θ	0.66	Labor Share	-
σ	1.0	Risk aversion	-

Figure 9: Age Profile



5.1 Model fit

Table 3: Model Fit

Moment	Moments	
	Data	Model
Y/N	1.9	1.0
K/Y	2.9	2.9
H/N	0.39	0.39
$var(\ln c)$	0.26	0.21
$var(\ln y)$	1.12	1.14
$\{c_m, c_o\}$	$\{1.20, 0.90\}$	$\{1.23, 0.88\}$
$\{y_m, y_o\}$	$\{1.75, 1.11\}$	$\{1.78, 1.14\}$
$\{w_m, w_o\}$	$\{1.22, 1.22\}$	$\{1.21, 1.23\}$

6 Quantitative Experiment: The Effects of Progressivity

We compute through counterfactuals the effects of progressivity on income per capita differences across countries and on welfare differences across countries.

6.1 Income per capita differences across countries

We conduct our first counterfactual of changing ϕ in poor countries to ϕ in rich countries. Our preliminary results are depicted in Figure **??**. We find that moving poor countries to the tax progressivity of rich countries implies an increase in income per capita of approximately 5.1/4.2-1=25%, which explains roughly 8% of the total income per capita differences between rich and poor countries. The gain in income per capita generated by reducing income tax progressivity

Table 4: Welfare decomposition

		Poor
Total Change		0.144
Consumption	Total	0.165
	Level	0.193
	Distribution	-0.028
Labor	Total	-0.021
	Level	-0.010
	Distribution	-0.011

Table 5: Conterfactual 1

	Benchmark $\phi = 0.4$	Experiment 1 $\phi = 0.1$	
Moments	Poor	Poor	% Δ
Y/N	1.0	1.56	56
K/N	4.59	9.16	99
H/N	0.38	0.46	21
S/N	2.00	2.86	43
w_m	1.21	1.24	2.4
w_o	1.19	1.27	6.7
$Var(\ln c)$	0.21	0.48	128.6
Townsend β	0.14	0.20	42

comes at the cost of loosing insurance, see Figure **??**. Moving poor countries to the US tax progressivity increases the covariance between income and consumption substantially explaining approximately 1- (0.475-0.455)/(0.475–.325)=85% of the difference between in consumption insurance between rich and poor countries.

6.2 Welfare differences across countries

Table 4 shows the welfare gains for both countries of moving from its status quo to their optimal levels of progressivity as depicted in Figure 10. As shown in Figure 6 the implied increase in income (and consumption) per capita rises welfare, , while the loss of consumption insurance reduces welfare. We find that the first two effects dominate the loss in insurance.

Figure 10: Optimal Progressivity

Table 6: Conterfactual 2: Optimal Progressivity

	Benchmark		Optimal for Poor	
	$\phi = 0.4$	$\phi = 0.1$	$\phi = 0.10$	
Moments	Poor	Rich	Poor	% Δ
Y/N	1.0	71.0	1.56	56
K/N	4.59	219.6	9.16	99
H/N	0.38	0.28	0.46	21
S/N	2.00	4.40	2.86	43
w_m	1.21	1.86	1.24	2.4
w_o	1.19	1.89	1.27	6.7
$Var(\ln c)$	0.21	0.34	0.48	128.6
Townsend β	0.14	0.51	0.20	42

7 Conclusion

After carefully documenting the evolution of consumption insurance and transfer progressivity across stages of development, we find that the decline in progressivity along the development path goes a long way in explaining the loss of consumption insurance that we see in the data. Second, we show that this progressivity has first order implications on the cross-country differences in income per capita. Decreasing progressivity of poor countries to the levels of rich countries increases income per capita of poor countries by 62%. The opposite experiment, using the progressivity of poor countries on rich countries, reduces income per capita of rich countries by 30%. Finally, optimal progressivity is actually similar across stages of development which implies that the *status quo* transfer progressivity for poor (rich) countries is too high (low). In particular, reducing the progressivity of poor countries to optimal levels increases the GDP per capita of the poor by 46% and increases their welfare by 14% in consumption equivalent terms.

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A Data description

A.1 Consumption and Income

We use nationally representative panel survey data for 32 countries and 81 country-year observations. We construct a measure of annualized nondurable expenditures and income in the same fashion as in De Magalhães and Santaeulàlia-Llopis (2018).

Table 7: Country List

Country	Wave	Panel	Obs.	Percent	Cumulative	Source
Austria	AUT09	Yes	2,380	0.53	0.53	HFCN-ECB
	AUT13	Yes	2,996	0.66	1.19	HFCN-ECB
Belgium	BEL09	No	2,327	0.52	1.71	HFCN-ECB
	BEL13	No	2,231	0.5	2.2	HFCN-ECB
China	CHN00	Yes	2,186	0.49	2.69	CHNS
	CHN04	Yes	2,340	0.52	3.21	CHNS
	CHN06	Yes	2,364	0.52	3.73	CHNS
	CHN09	Yes	2,665	0.59	4.33	CHNS
	CHN89	Yes	2,198	0.49	4.81	CHNS
	CHN91	Yes	2,404	0.53	5.35	CHNS
	CHN93	Yes	1,429	0.32	5.66	CHNS
	CHN97	Yes	1,636	0.36	6.03	CHNS
Cyprus	CYP09	Yes	1,237	0.27	6.3	HFCN-ECB
	CYP13	Yes	1,289	0.29	6.59	HFCN-ECB
Germany	DEU09	Yes	3,565	0.79	7.38	HFCN-ECB
	DEU13	Yes	4,279	0.95	8.33	HFCN-ECB
Spain	ESP07	Yes	6,197	1.38	9.7	HFCN-ECB
	ESP10	Yes	6,103	1.35	11.06	HFCN-ECB
Estonia	EST13	No	2,220	0.49	11.55	HFCN-ECB
Ethiopia	ETH11	Yes	3,090	0.69	12.24	LSMS-ISA
	ETH13	Yes	3,179	0.71	12.94	LSMS-ISA
	ETH15	Yes	3,956	0.88	13.82	LSMS-ISA
Finland	FIN13	No	11,029	2.45	16.27	HFCN-ECB
France	FRA09	Yes	4,914	1.09	17.36	HFCN-ECB
	FRA14	Yes	10,708	2.38	19.74	HFCN-ECB
Great Britain	GBR00	Yes	9,652	2.14	21.88	BHPS
	GBR01	Yes	8,321	1.85	23.72	BHPS
	GBR02	Yes	8,168	1.81	25.54	BHPS
	GBR03	Yes	7,835	1.74	27.28	BHPS
	GBR04	Yes	7,693	1.71	28.98	BHPS
	GBR05	Yes	7,543	1.67	30.66	BHPS
Greece	GRC09	Yes	2,951	0.65	31.31	HFCN-ECB
	GRC13	Yes	2,991	0.66	31.98	HFCN-ECB
Hungary	HUN13	No	5,670	1.26	33.23	HFCN-ECB
Indonesia	IDN00	Yes	10,183	2.26	35.49	IFLS
	IDN07	Yes	12,890	2.86	38.36	IFLS
	IDN14	Yes	14,999	3.33	41.68	IFLS
India	IND04	Yes	39,575	8.78	50.47	IHDS
	IND11	Yes	32,378	7.19	57.65	IHDS
Ireland	IRL13	No	3,989	0.89	58.54	HFCN-ECB
Italy	ITA09	Yes	7,951	1.76	60.3	HFCN-ECB
	ITA14	Yes	8,156	1.81	62.11	HFCN-ECB
Luxemburg	LUX09	Yes	950	0.21	62.32	HFCN-ECB
	LUX13	Yes	1,601	0.36	62.68	HFCN-ECB
Latvia	LVA13	No	1,201	0.27	62.95	HFCN-ECB
Mexico	MEX02	Yes	7,783	1.73	64.67	MXFLS
	MEX05	Yes	7,880	1.75	66.42	MXFLS
	MEX09	Yes	8,680	1.93	68.35	MXFLS
Malta	MLT13	No	874	0.19	68.54	HFCN-ECB
Malawi	MWI04	Yes	10,565	2.34	70.89	LSMS-ISA
	MWI10	Yes	11,873	2.64	73.52	LSMS-ISA
	MWI13	Yes	2,945	0.65	74.18	LSMS-ISA
Niger	NER11	Yes	2,933	0.65	74.83	LSMS-ISA
	NER14	Yes	2,542	0.56	75.39	LSMS-ISA
Nigeria	NGA10	Yes	4,309	0.96	76.35	LSMS-ISA
	NGA12	Yes	4,228	0.94	77.29	LSMS-ISA
Netherlands	NLD09	Yes	1,299	0.29	77.57	HFCN-ECB
	NLD13	Yes	1,211	0.27	77.84	HFCN-ECB
Portugal	PRT09	Yes	4,404	0.98	78.82	HFCN-ECB
	PRT13	Yes	6,159	1.37	80.19	HFCN-ECB
Russia	RUS10	Yes	4,864	1.08	81.27	RLMS
	RUS11	Yes	5,239	1.16	82.43	RLMS
	RUS12	Yes	5,358	1.19	83.62	RLMS
	RUS13	Yes	4,664	1.04	84.65	RLMS
	RUS14	Yes	4,278	0.95	85.6	RLMS
	RUS15	Yes	4,320	0.96	86.56	RLMS
	RUS16	Yes	4,384	0.97	87.54	RLMS
	RUS17	Yes	4,381	0.97	88.51	RLMS
Slovakia	SVK09	Yes	2,057	0.46	88.96	HFCN-ECB
	SVK13	Yes	1,992	0.44	89.41	HFCN-ECB
Slovenia	SVN09	Yes	343	0.08	89.48	HFCN-ECB
	SVN13	Yes	2,547	0.57	90.05	HFCN-ECB
Tanzania	TZA09	Yes	2,933	0.65	90.7	LSMS-ISA
	TZA11	Yes	2,929	0.65	91.35	LSMS-ISA
Uganda	UGA09	Yes	1,605	0.36	91.71	LSMS-ISA
	UGA10	Yes	1,890	0.42	92.12	LSMS-ISA
	UGA11	Yes	1,596	0.35	92.48	LSMS-ISA
United States	USA04	Yes	8,002	1.78	94.25	PSID
	USA06	Yes	8,289	1.84	96.09	PSID
	USA08	Yes	8,690	1.93	98.02	PSID
	USA10	Yes	8,907	1.98	100	PSID
Total			450,572	100		

A.2 Transfer Data

For each country we use nationally representative surveys. We construct a measure of pre-transfers income and a measure of post-transfer income. Transfers can be either given or received, and our measure of net transfers that we use for estimation can be positive or negative. We include all available transfers that are given or received, private (informally or formally) or public is included when available.

A.2.1 Malawi

We use the Living Standards Measurement Study - Integrated Agricultural Survey (LSMS-ISA) for Malawi in 2004, 2010, 2013, and 2016. We use variables from the 2016 to describe income. Household total gross income is the sum of gross annualized labor income (`hh_e25 hh_e27 hh_e39 hh_e59`); business income (`hh_n32 hh_n25 hh_n41 hh_n14`); capital income including pensions, rental and sales of property, land, equipment, and livestock (`hh_p02 ag_b217a ag_b217b fs_e16 fs_i16`); fishery income net of costs (`fs_e06a fs_d06 fs_d12 fs_d13 fs_d14 fs_d24`); agricultural income net of costs of rain (`ag_i02a ag_i03 ag_b209a ag_b209b ag_f09 ag_f10 ag_f40 ag_e04 ag_e14 ag_e15 ag_d46a ag_d47a ag_` dry season, permanent crops, and livestock.

Net income includes private gifts received in cash or in kind (`hh_p03a hh_p03b hh_p03c`); gifts given in cash or in kind (`hh_q02a hh_q02b hh_q02c`); transfers received from government (`hh_r02a hh_r02b hh_r02c`); transfers received from adult children living elsewhere (`hh_o11 hh_o15`); annualized value of weekly food consumption received as gift (`hh_g07a`).

Income tax dues are calculated based on wage and business income, but not on agricultural income as most household agricultural income is not taxed. Slightly over 10% of household have income tax dues. Brackets are calculated the 2006 Taxation Act, PWC World Wide Tax summaries for 2010/11, and KPMG Malawi Fiscal Guide for 2015/16.

In an alternative definition of gross income, ganyu (`hh_e59`) is coded as a transfer and therefore appears in post-income and not in pre-tax-transfer income.

For more details on the data construction for Malawi, see De Magalhães and Santaeulàlia-Llopis (2018).

A.2.2 United Kingdom

We use the British Household Panel Survey (BHPS) waves 1-18 (1991-2008); a set of derived variables described in Levy and Jenkins (2012). Household total gross income is the sum of gross labour income (hhyrlg), investment income (hhyri), state pensions (hhyrb), and pension income (hhyrp). Total tax is the sum total income taxes paid net of tax credits (yrtaxnt), national insurance (yrni) and pension contributions (yrcontr). Net income is the difference plus income from private transfers (hhyrt). Main missing variable: private transfers given. XXXXX Enric: Has Y been defined as such for the Covariance and Townsed test? Household consumption is XXXXX.

A.2.3 Poland

We use the 2016 Household Finance and Consumption Survey (HFCS) by the European Central Bank. Household total gross income is the sum yearly values rental income (hg0310), financial investment (hg0410), business investment (hg0510), lump sum sales/prizes/insurance payout (hg0610), labor income (pg0110), self-employed income (pg0210), state pension (pg0310), and private pension (pg0410).

Household net income is the sum of the following net variables: social transfers (hng0110), rental income (hng0310), financial investment (hng0410), business investment (hng0510), lump sum sales/prizes/insurance payout (hng0610), labor income (png0110), self-employed income (png0210), state pension (png0310), private pension (png0410), unemployment benefit (png0510), regular private tranfers/child support received (hng0210), and private transfers given per month (hi0310).

A.2.4 Italy

We use the 2016 Household Finance and Consumption Survey (HFCS) by the European Central Bank. Household total gross income is the sum yearly values of rental income (hg0310), financial investment (hg0410), business investment (hg0510), lump sum sales/prizes/insurance payout (hg0610), labor income (pg0110), self-employed income (pg0210), state pension (pg0310), and private pension (pg0410).

Household net income is the sum of the following net variables: social transfers (hng0110), rental income (hng0310), financial investment (hng0410), business investment (hng0510), lump sum sales/prizes/insurance payout (hng0610), labor income (png0110), self-employed income (png0210), state pension (png0310), private pension (png0410), unemployment benefit (png0510), regular private tranfers/child support receivved (hng0210), and private transfers given per month (hi0310). A separate measure of income taxes with health, pension, and social insurance contribution included is available (hng0710). So net income can be calculated also as the gross income estimated above net of taxes and social contributions. Both yield the same estimate.

A.2.5 Finland

We use the 2016 Household Finance and Consumption Survey (HFCS) by the European Central Bank. Household total gross income is the sum yearly values of social transfers (hg0110), rental income (hg0310), financial investment (hg0410), business investment (hg0510), lump sum sales/prizes/insurance payout (hg0610), labor income (pg0110), self-employed income (pg0210), state pension (pg0310), private pension (pg0410).

Net income is unavailable but data on income taxes with health, pension, and social insurance contribution included is available (hng0710). We estimate net income as gross income net of taxes and social contributions.

A.2.6 India

We use the India Human Development Survey - I/II (IHDS) 2004-05/2011-12. Household total gross income is the sum yearly values of wage income (INCSALARY), farm income (INCFARM), business income (INCBUS), agricultural wage (INCAGWAGE), non-agricultural wage (INCNONAG), other income (INCOTHER and INCNONNREGA). For net income we impose income tax dues on INCSALARY and add the following sources: remittances (INCREMIT), government transfers (INCGOVT) and National Rural Employment Guarantee Act income (INCNREGA). We use the site caclubindia (https://www.caclubindia.com/forum/income-tax-rates-slabs-from-a-y-2001-02-to-a-y-2013-14-132138.asp) to identify income brackets and estimate income taxes dues per household. We restrict the estimate to the 60% of households for whom pre and post income differ. In all other countries pre and post income differ for almost entirety of the sample.

A.2.7 Indonesia

We use the Household Survey Questionnaire for the Indonesia Family Life Survey, Wave 4 (2007) and 5 (2014). Household total gross income is the sum of yearly values of wage income (tk25), other labor income (tk26), net agricultural income (ut08 ut07), net business income (nt07 nt08), and pension income, lottery, scholarship, and insurance payout (hi14). For net income we add food transfers given (ks04), regular cash transfer given (ks06), gifts given (ks08 G), government transfers received (ksr21), food subsidy (ksr31 ksr32 ksr29 ksr26), fuel subsisdy (ksr40 ksr45 ksr43), tranfers received from NGO/church (ksr50), disaster relief (nd05y), credit rotation given/received (pm01 pm04 pm05), transfers given/received to/from parents (ba20 ba22), transfers given/received to/from siblings (ba55 ba57), transfers given/received to/from children (ba88 ba90), and transfers given/received to/from other households (tf04 tf06). We use PWC 'Indonesia Pocket Tax Book' to identify income brackets and estimate income taxes dues per household.

A.2.8 China

We use the XXXXXXXXXXX. Household total gross income is the sum of yearly values of agricultural income (ai), business income (bi), capital income (ci), labor income (lmi), and pension income (pi).

A.2.9 Mexico

We use the Mexican Family Survey (MXFLS) for 2002, 2005, and 2009. Variable names follow 2009. Household total gross income is the sum of yearly values of labor income (`ls13_2 tb36a_2 tb36aa_2 tb36ab_2 tb36ac` business income (`nna22_12`), sales of assets (`in01h_2 in01i_2 in01j_2 in01k_21`), renting out assets(`ah06a_2 ah06` pension/inheritance (`in01e_2 in01f_2 in01g_2`), and agricultural income: sales of products (`inr03a inr03b inr03c` plus value of non sold produced using from sales priced (`su141_21 su142_21 su143_21`), minus cost (`su231 su232 su233 su234 su235 su236 su238 su239 su2311_1`).

For net income we add annualized values of private transfers received: transport (`cs04e_22`),

Table 8: Progressivity and GDP per capita

Country	Progressivity $\phi(Y)$ per year of survey
Malawi	0.27, 0.21, 0.24, 0.30
India	0.22, 0.23
Indonesia	0.17, 0.27
Mexico	0.30, 0.20, 0.22
China	0.26, 0.41, 0.26
Poland	0.13
Spain	0.12**, 0.15**
Italy	0.11
Korea	0.14*
UK	0.13*, 0.13*, 0.13*, 0.14*, 0.15*, 0.17*, 0.17*, 0.15*
Australia	0.06**
USA	0.19*,

Note: Norms-based transfer progressivity is estimated using pre-tax and pre-transfers as gross income and post-tax and post-transfers as net income. Government and private transfers are included. * indicates that private transfers are missing; ** indicate measures of tax-only progressivity. Malawi village 2019; Malawi 2004, 2010, 2013, 2016; Indonesia 2007, 2014; India 2004, 2011; China 2004-2009; Mexico 2002-2009; Poland 2016; Korea 2006-2014; Spain 2013-2015; Italy 2016; UK 2001-2009; Australia 2001-2016, USA 2000-2006. Data compiled by the authors with sources described in the appendix, except for the estimates for Australia (Tran and Zakariyya (2021)), Korea (Chang et al. (2015)), Spain (García-Miralles et al. (2019)), USA modified estimate of (Heathcote et al. (2017)) to remove private transfers received, as there is no data on transfers given in HSV's original estimate: 0.18.

food(`cs04b_12 cs04b_22 cs04b_52 cs04c_32 cs04c_42  cs04d_22 cs04d_32 cs04d_42 cs04e_32 cs04e_42 c` gifts (`cs18_2`), other family gifts including remittances (`in01d_2 in01g_2`), firm transfers (`in01c_2`), received from parents (tp26), siblings (th20d), children (thi24d), others (to04); private transfers given: food (`cs06_2`), gifts(`cs20_2 cs26_2 cs29_2 cs31_2`), given to parents (tp24), siblings (th20b), children (thi24b), others (to02); government transfers received: Progressa and others (`in01a2_2 in01a3_2  in01a5_2 in0` income taxes dues calculated using brackets as described in Vázquez and Martínez (2016).

B 2-Period Model: Solution Algorithm for Households (Backwards)

This is a OLG model with uncertainty. We solve the problem backwards from last (second) period to the initial (first) period. In addition, to solve the problem we choose to plug c_0, c_1 and s_1 into the per-period objective functions. Our households take factor prices w and r as given.

Second Period. In the second period, for given $(k_1, s_1, \varepsilon_1)$, agents solve

$$\max_{\{0 \leq h_1 \leq 1\}} \left(\log \left(\underbrace{y_1^d + (1-\delta_k)k_1}_{c_1 \geq 0} - \bar{c} \right) - \kappa \frac{h_1^{1+\frac{1}{\nu}}}{1+\frac{1}{\nu}} \right) \tag{24}$$

where disposable income is,

$$y_1^d = \lambda y_1^{1-\phi},$$

with pre-tax income,

$$y_1 = w_1 (\underbrace{z h_0^\alpha - (1-\delta_s) s_0}_{s_1}) h_1 \varepsilon_1 + r_1 k_1.$$

This implies the following FOC(h_1) for the second period:

$$FOC(h_1): \quad \left(\underbrace{\frac{1}{c_1 - \bar{c}}}_{MU(c_1)} \underbrace{1}_{\frac{\partial c_1}{\partial y_1^d}} \underbrace{(1-\phi)\lambda y_1^{-\phi}}_{\frac{\partial y_1^d}{\partial y_1}} \underbrace{w_1 s_1 \varepsilon_1}_{\frac{\partial y_1}{\partial h_1}} - \underbrace{\kappa h_1^{\frac{1}{\nu}}}_{-MU(\ell_1)} \right) = 0 \tag{25}$$

with $c_1 = \lambda y_1^{1-\phi} + (1-\delta_k)k_1$ and $y_1 = w_1(\underbrace{z h_0^\alpha - (1-\delta_s)s_0}_{s_1}) h_1 \varepsilon_1 + r_1 k_1$. Notice that we solve this FOC for each triplet and all triplets $(k_1, s_1, \varepsilon_1)$.

Remark. Notice that the choice of h_1 depends on the values of k_1, s_1 and ε_1. Clearly, at this point we do not know the optimal (k_1, s_1) because these will be chosen in the previous period. For this reason, when solving for h_1 we do it for all feasible pairs (k_1, s_1). In terms of timing we assume that the shock ε_1 is realized after the choices k_1 and s_1 are done, and before h_1 is chosen. This implies that we solve for h_1 in (25) for each and all triplets $(k_1, s_1, \varepsilon_1)$.

First Period. In the first period, for given (k_0, s_0), agents solve

$$\max_{\{0\leq h_0\leq 1, k_1\}} \left(\log\left(\underbrace{w_0 s_0 h_0 + r_0 k_0 - k_1}_{c_0\geq 0} - \bar{c} \right) - \kappa \frac{h_0^{1+\frac{1}{\nu}}}{1+\frac{1}{\nu}} \right.$$
$$\left. + \beta \sum_{\varepsilon_1} \pi(\varepsilon_1) \left(\log\left(\underbrace{y_1^d + (1-\delta_k)k_1}_{c_1\geq 0} - \bar{c} \right) - \kappa \frac{h_1^{1+\frac{1}{\nu}}}{1+\frac{1}{\nu}} \right) \right)$$

where disposable income is,

$$y_1^d = \lambda y_1^{1-\phi},$$

with pre-tax income,

$$y_1 = w_1(\underbrace{z h_0^\alpha - (1-\delta_s)s_0}_{s_1})h_1\varepsilon_1 + r_1 k_1.$$

This implies that households face these two first order conditions with two unkowns h_0 and k_1:

$$FOC(h_0): \quad \underbrace{\frac{1}{c_0 - \bar{c}}}_{MU(c_0)} \underbrace{w_0 s_0}_{\frac{\partial c_0}{\partial h_0}} - \underbrace{\kappa h_0^{\frac{1}{\nu}}}_{-MU(\ell_0)} + \beta \sum_{\varepsilon_1} \pi(\varepsilon_1) \left(\underbrace{\frac{1}{c_1 - \bar{c}}}_{MU(c_1)} \underbrace{1}_{\frac{\partial c_1}{\partial y_1^d}} \underbrace{(1-\phi)\lambda y_1^{-\phi}}_{\frac{\partial y_1^d}{\partial y_1}} \underbrace{w_1 h_1 \varepsilon_1}_{\frac{\partial y_1}{\partial s_1}} \underbrace{\alpha z h_0^{\alpha-1}}_{\frac{\partial s_1}{\partial h_0}} \right) = 0 \tag{26}$$

$$FOC(k_1): \quad \underbrace{\frac{1}{c_0 - \bar{c}}}_{MU(c_0)} \underbrace{(-1)}_{\frac{\partial c_0}{\partial k_1}} + \beta \sum_{\varepsilon_1} \pi(\varepsilon_1) \left(\underbrace{\frac{1}{c_1 - \bar{c}}}_{MU(c_1)} \underbrace{\left(\underbrace{1}_{\frac{\partial c_1}{\partial y_1^d}} \underbrace{(1-\phi)\lambda y_1^{-\phi}}_{\frac{\partial y_1^d}{\partial y_1}} \underbrace{r_1}_{\frac{\partial y_1}{\partial k_1}} + (1-\delta_k) \right)}_{\frac{\partial c_1}{\partial k_1}} \right) = 0 \tag{27}$$

with $c_0 = w_0 s_0 h_0 + r_0 k_0 - k_1$, $c_1 = \lambda y_1^{1-\phi} + (1-\delta_k)k_1$ and $y_1 = w_1(\underbrace{z h_0^\alpha - (1-\delta_s)s_0}_{s_1})h_1\varepsilon_1 + r_1 k_1$.

Remark. Notice that the system (26)-(27) needs to be solved as many times as the number of initial conditions (i,e., pairs (k_0, s_0)). Also, notice that to solve for the system (26)-(27) we make use of the optimal allocation, h_1, obtained earlier for the next period from (25) defined for each triplet $(k_1, s_1, \varepsilon_1)$.

C Full Model: Solution Algorithm

C.1 State Space

The state space is $\mathbf{x} = (k, s, \varepsilon, j)$. The endogenous states are physical capital k, human capital s. The exogenous states are the productivity shock ε and age j.

Both the realization set for the productivity shock and the transition probabilities come from the discretization of an AR(1) process done using Tauchen's method. We set the number of possible realizations $n_\varepsilon = 10$. Age transition depends on survival probabilities cite source. We set $J = 60$.

For the first endogenous state, k we set $\underline{k} = 0$, which implies no borrowing from the households. For $\overline{k}$ we use as a reference the capital in the deterministic steady state of the economy $k^{SS} = B((r^{SS} + \delta)/\theta)^{\frac{1}{\theta-1}}$, where $r^{SS} = 1/\beta - 1$. Then we set $\overline{k} = \psi k^{SS}$. ψ allows to adjust the maximum level of capital with respect to the capital in the deterministic steady state. We find that $\psi = 10$ is sufficient for none of the simulated households to hit the upper bound of the asset grid. Since most of the non linearities in this type of models are close to the borrowing limit we use a non-evenly spaced grid that has more grid points close to the lower bound. We set $n_k = 50$.

For the second endogenous state, s we normalize $\underline{s} = 1$ and given the low of motion for human capital accumulation we check that none of the simulated households hits the upper bound. We find $\overline{s} = 2.0$ to be suitable. We set $n_s = 10$

C.2 Household Problem

This is a life-cycle model with uncertainty. We solve the problem backwards from last period to the initial period. Our households take factor prices w and r as given.

Working Age. In the working periods $j = \{0, ..., J^{RET} - 1\}$, for given (k, s, ε), agents solve

$$V(k, s, \varepsilon, j) = \max_{\{c,h,k'\}} \frac{(c - \overline{c})^{1-\sigma}}{1-\sigma} - \kappa^j \frac{h^{1+\frac{1}{\nu}}}{1+\frac{1}{\nu}} + \delta^j \beta \sum_{\varepsilon'} \pi(\varepsilon'|\varepsilon) V(k', s', \varepsilon', j+1)$$

where consumption is,

$$c = y_d + k - k' - d(k', k)$$

where the capital adaptation cost,

$$d(k', k) = \frac{\chi_k}{2}(k' - k)^2$$

and disposable income is,

$$y_d = \lambda y^{1-\phi},$$

with total income,

$$y = wsh\varepsilon + rk$$

This implies that households face these two first order conditions with two unknowns h and k':

$$FOC(h): \quad \underbrace{\left(\frac{c}{n^j} - \bar{c}\right)^{-\sigma}}_{MU(c)} \underbrace{(1-\phi)\lambda y^{-\phi}}_{\frac{\partial y_d}{\partial y}} \underbrace{ws\epsilon}_{\frac{\partial y}{\partial h}} - \underbrace{\kappa^j h^{\frac{1}{\nu}}}_{-MU(h)}$$
$$+ \beta \sum_{\varepsilon'} \pi(\varepsilon'|\varepsilon) \left(\underbrace{\left(\frac{g_c(\mathbf{x}')}{n^{j'}} - \bar{c}\right)^{-\sigma}}_{MU(c')} \underbrace{1}_{\frac{\partial c'}{\partial y'_d}} \underbrace{(1-\phi)\lambda(y')^{-\phi}}_{\frac{\partial y'_d}{\partial y'}} \underbrace{wg_h(\mathbf{x}')\varepsilon'}_{\frac{\partial y'}{\partial s'}} \underbrace{\alpha z h^{\alpha-1}}_{\frac{\partial s'}{\partial h}} \right) = 0 \tag{28}$$

$$FOC(k'): \quad \underbrace{\left(\frac{c}{n^j} - \bar{c}\right)^{-\sigma}}_{MU(c)} \underbrace{[-1 - \underbrace{\chi_k^2(k'-k)}_{\frac{\partial d(k',k)}{\partial k'}}]}_{\frac{\partial c}{\partial k'}}$$
$$+ \beta \sum_{\varepsilon'} \pi(\varepsilon'|\varepsilon) \left(\underbrace{\left(\frac{g_c(\mathbf{x}')}{n^{j'}} - \bar{c}\right)^{-\sigma}}_{MU(c')} \underbrace{\left(1 + \underbrace{(1-\phi)\lambda(y')^{-\phi}}_{\frac{\partial y'_d}{\partial y'}} \underbrace{r}_{\frac{\partial y'}{\partial k'}} + \underbrace{\chi_k^2(g_k(\mathbf{x}') - k')}_{\frac{\partial d(k',k)}{\partial k'}}\right)}_{\frac{\partial c'}{\partial k'}} \right) = 0 \tag{29}$$

with $c = \lambda y^{1-\phi} + k - k' - d(k',k)$, $c' = \lambda(y')^{1-\phi} + k' - g_k(\mathbf{x}')$, $y' = wg_h(\mathbf{x}')s'\varepsilon' + rk' + \mathbf{1}\{j+1 = J^{RET} - 1\}\xi s'$ and $s' = zh^\alpha - (1-\delta_s)s$

Remark. Notice that the system (28)-(29) needs to be solved as many times as the number of possible states at that age (i,e., triplets (k,s,ε)). Also, notice that to solve for the system (28)-(29) we make use of the optimal allocation, $g_h(\mathbf{x}')$ and $g_k(\mathbf{x}')$, obtained earlier for $\mathbf{x}' = (k', s', \varepsilon', j')$.

Retirement. When retired $j = \{J^{RET}, ..., J-1\}$, for given (k,s,ε), agents solve

$$V(k,s,j) = \max_{0 \le k' \le} \frac{(c-\bar{c})^{1-\sigma}}{1-\sigma} + \beta V(k', s, j+1) \tag{30}$$

where consumption is,

$$c = y_d + k + \xi s - k' \tag{31}$$

where disposable income is,

$$y_d = \lambda y^{1-\phi} + \xi s,$$

with taxable income,

$$y = rk$$

where we assume that the experience based pension income is not taxable.

This implies the following FOC(k_{t+1}) for the retirement periods:

$$FOC(k') : \qquad \underbrace{(c-\overline{c})^{-\sigma}}_{MU(c)} \underbrace{(-1)}_{\frac{\partial c}{\partial k'}} + \beta \underbrace{(c'-\overline{c})^{-\sigma}}_{MU(c')} \underbrace{\left(1 + \underbrace{(1-\phi)\lambda(y')^{-\phi}}_{\frac{\partial y'_d}{\partial y'}} \underbrace{r}_{\frac{\partial y'}{\partial k'}} \right)}_{\frac{\partial c'}{\partial k'}} = 0 \tag{32}$$

with $c = y_d + k - k'$ and $c' = \lambda(y')^{1-\phi} + k' - g_k(k', s, e, j+1)$ and $y' = rk'$. Notice that we solve this FOC for each (k).

Last Period. At $j = J$, a retired household consumes all its assets.

$$V(k, s, J) = \frac{(c-\overline{c})^{1-\sigma}}{1-\sigma} \tag{33}$$

with optimal choices:

$$k' = 0 \tag{34}$$

$$c = \lambda(rk)^{1-\phi} + k + \xi s \tag{35}$$

The solution algorithm for the household problem follows:

1. For each triplet $(k_t, s_t, \varepsilon_t)$, in period $j = J$ set $g_c(k, s, e, J) = \lambda(rk)^{1-\phi} + (1-\delta)k + \xi s$ and

$g_a(k,s,e,J)=0$, $g_h(k,s,e,J)=0$.

2. Solve backwards for $j=\{J-1,...,J^{RET}\}$ using (32) to obtain $g_c(k,s,e,j)$ and $g_k(k,s,e,j)$. Set $g_h(k,s,e,J)=0$. This entails solving a total of $n_A \times n_S \times n_\varepsilon \times (J-J^{RET})$ non linear equations.

3. Solve backwards for $j=\{J^{RET}-1,...,J_0\}$ using (29) and (28) to obtain $g_c(k,s,e,j)$, $g_k(k,s,e,j)$ and $g_h(k,s,e,j)$. This entails solving a total of $n_A \times n_S \times n_\varepsilon \times J^{RET}$ non linear systems of 2 equations and 2 unknowns.

When solving backwards we use bi-linear interpolation of the previous period consumption, g_c, and hours, g_h policy functions. This allows us to use standard non-linear equation routines to solve for the system of equations at each point of the state space.

C.3 Stationary distribution

We compute the ergodic distribution of (k,s,ε,j) by iterating to convergence on the law of motion of the conditional transition probabilities from (k,s,ε,j) (denoted $\mathcal{M}_j(k,s,\varepsilon,j)$) to (k',s',ε',j') (denoted $\mathcal{M}_{j+1}(k',s',\varepsilon',j')$) $\forall(k,s,\varepsilon,j),(k',s',\varepsilon',j') \in \mathcal{K}\otimes\mathcal{S}\otimes\mathcal{E}\otimes\mathcal{J}$. The initial guess is a uniform distribution. The law of motion is formed using the decision rules for assets and human capital, the exogenous Markov process of the shocks and the exogenous age transition process. Since we have solved for approximately continuous decision rules using bi-linear interpolation, we use a standard modification of this law of motion adjusted for the fact that decision rules do not yield values on the nodes of the assets and human capital grids in general. For every (k,s,ε,j) we find $k_L \leq k'(k,s,\varepsilon,j) \leq k_U$ and $s_L \leq s'(k,s,\varepsilon,j) \leq s_U$, where k_L,k_U,s_L,s_U are the grid points closest to $k'(\cdot)$ and $s'(\cdot)$.

Let $\Pi(\varepsilon,j)=\sum_\varepsilon \Pr[\varepsilon' \mid \varepsilon] \times \sum_j \Pr[j' \mid j]$. Then we iterate on the conditional distributions as follows:

$$\mathcal{M}_{j+1}\left(k_L,s_L,\varepsilon',j'\right)=\Pi(\varepsilon,j)\mathcal{M}_j(k,s,\varepsilon,j)\left(\frac{k_U-k'(k,s,\varepsilon)}{k_U-k_L}\right)\left(\frac{s_U-s'(k,s,\varepsilon)}{s_U-s_L}\right) \tag{36}$$

$$\mathcal{M}_{j+1}\left(k_L,s_U,\varepsilon',j'\right)=\Pi(\varepsilon,j)\mathcal{M}_j(k,s,\varepsilon,j)\left(\frac{k_U-k'(k,s,\varepsilon)}{k_U-k_L}\right)\left(\frac{s'(k,s,\varepsilon)-s_L}{s_U-s_L}\right) \tag{37}$$

$$\mathcal{M}_{j+1}\left(k_U,s_L,\varepsilon',j'\right)=\Pi(\varepsilon,j)\mathcal{M}_j(k,s,\varepsilon,j)\left(\frac{k'(k,s,\varepsilon)-k_L}{k_U-k_L}\right)\left(\frac{s_U-s'(k,s,\varepsilon)}{s_U-s_L}\right) \tag{38}$$

$$\mathcal{M}_{j+1}\left(k_L,s_U,\varepsilon',j'\right)=\Pi(\varepsilon,j)\mathcal{M}_j(k,s,\varepsilon,j)\left(\frac{k'(k,s,\varepsilon)-k_L}{k_U-k_L}\right)\left(\frac{s'(k,s,\varepsilon)-s_L}{s_U-s_L}\right) \tag{39}$$

The convergence criterion is $\max|\mathcal{M}_{j+1}(k,s,\varepsilon,j)-\mathcal{M}_j(k,s,\varepsilon,j)| < \epsilon_{\text{Dist}} \quad \forall(k,s,\varepsilon,j) \in \mathcal{K}\otimes\mathcal{S}\otimes\mathcal{E}\otimes\mathcal{J}$, with the value of ϵ_{Dist} set to $1e-10$.

C.4 Simulation

Once we have found the ergodic distribution of (k, s, ε, j) we can easily simulate a cross-section of households by drawing from the ergodic distribution. We do this in order to generate some cross-sectional moments of interest. We set $N = 2,000,000$ after checking that beyond this sample size, the cross-sectional moments do not affected anymore.

C.5 Other Notes

D Calibration

D.1 Aggregates

Let $y = \frac{Y}{N}$, $k = \frac{K}{N}$ and $\chi = \frac{K}{Y}$. Using (21) we have:

$$\chi = \frac{K}{BK^{\theta}N^{1-\theta}} = \frac{1}{B}\left(k\right)^{1-\theta} \tag{40}$$

and,

$$k = (\chi B)^{\frac{1}{1-\theta}} \tag{41}$$

Using (21) and (41):

$$y = Bk^{\theta} = B(\chi B)^{\frac{\theta}{1-\theta}} = B^{\frac{1}{1-\theta}}\chi^{\frac{\theta}{1-\theta}} \tag{42}$$

or

$$B = y^{1-\theta}\chi^{-\theta} \tag{43}$$

The firm's maximization problem is:

$$\max_{K,N} BK^{\theta}N^{1-\theta} - (r+\delta)K - wN \tag{44}$$

with FOC:

$$r = B\theta(k^{-1})^{1-\theta} - \delta \tag{45}$$

$$w = B(1-\theta)k^{\theta} \tag{46}$$

Plugging (41) into (45) we obtain:

$$r = \frac{\theta}{\chi} - \delta \tag{47}$$

Equation (47) gives us a depreciation rate for a given interest rate and capital-to-income ratio. This allows us to use δ to pin down a given level of capital-to-income ratio observed in the data.

Alternatively, plugging (41) into (46) we obtain:

$$w = B(1-\theta)\left(\chi B\right)^{\frac{\theta}{1-\theta}} \tag{48}$$

and,

$$B = w^{1-\theta}(1-\theta)^{(\theta-1)}\chi^{-\theta} \tag{49}$$

D.2 Disutility of hours

We allow the level of disutility of hours, κ^j to be age dependent. We construct an age grid by:

1. Linearly interpolate the pairs $\kappa(j = 25) = \kappa_0$, $\kappa(j = 45) = \kappa_1\kappa_0$, $\kappa(j = 65) = \kappa_2/\kappa_0$ and evaluate it over the age space, $\mathcal{J} = \{J_0, ..., J\}$ to obtain a grid of size J.
2. Fit an nth order polynomial to the previous grid and evaluate it again over the age space to obtain an smoother approximation.

Table 9: Parameters

Cell	Simulation	Cell	Simulation
r	0.044	J_0	20
w	1.0	J	80
δ	0.065	J_r	81
K_Y	3.0	B	0.91
β	0.96	θ	0.33
σ	1.0	χ_k	0.0
ν	1.0	$\overline{A}$	0.0
κ_1	3.6	ψ	10.0
κ_2	0.55	μ_e	0.0
κ_3	1.85	ρ	0.2
κ_4	1.85	σ_e	0.55
n_2	0.9	z	0.15
n_3	1.6	α	1.9
n_4	1.7	δ_s	0.01
$\underline{c}$	0.0	$\bar{\mathrm{S}}$	5.0
η_0	0.0	μ_s	3.0
η_1	0.0	σ_s	2.0
η_2	0.0	λ	1.26
		ϕ	0.3
		G	0.3
		ξ	0.0
		na	10
		ns	5
		ne	5

E Quantitative Exercises

E.1 Changes in Progressivity for the poor

ϕ	0.04	0.06	0.08	0.09	0.10	0.11	0.12	0.15	0.20	0.25	0.30	0.40
y	3.39	3.28	3.17	3.11	3.06	3.00	2.95	2.79	2.52	2.26	2.01	1.53
k	10.16	9.82	9.49	9.33	9.17	9.00	8.84	8.35	7.56	6.78	6.04	4.59
h	0.47	0.47	0.47	0.47	0.46	0.46	0.46	0.45	0.44	0.43	0.42	0.38
s	2.99	2.95	2.90	2.88	2.86	2.84	2.81	2.74	2.62	2.48	2.33	2.00
c	1.57	1.54	1.52	1.50	1.49	1.47	1.46	1.41	1.32	1.22	1.11	0.89
$\frac{T}{Y}$	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
w	3.10	3.06	3.01	2.99	2.96	2.94	2.91	2.84	2.71	2.56	2.40	2.06
w_{45}	1.26	1.26	1.25	1.24	1.24	1.24	1.23	1.24	1.24	1.23	1.23	1.21
w_{65}	1.29	1.28	1.27	1.27	1.27	1.27	1.27	1.26	1.25	1.25	1.23	1.19
$\text{var}(\ln(y))$	1.48	1.47	1.45	1.44	1.44	1.43	1.42	1.39	1.34	1.28	1.21	1.05
$\text{var}(\ln(yh))$	2.68	2.62	2.56	2.54	2.51	2.48	2.46	2.39	2.29	2.20	2.14	2.09
$\text{var}(\ln(yd))$	1.37	1.30	1.23	1.20	1.16	1.13	1.10	1.01	0.86	0.72	0.59	0.38
$\text{var}(\ln(c))$	0.53	0.51	0.50	0.49	0.48	0.47	0.46	0.43	0.39	0.34	0.29	0.21
$\text{var}(\ln(h))$	0.57	0.55	0.52	0.51	0.50	0.49	0.48	0.45	0.41	0.38	0.36	0.34
$\text{var}(\ln(s))$	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.21	0.21	0.20	0.19	0.17
$\text{var}(\ln(k))$	1.62	1.61	1.60	1.60	1.59	1.59	1.58	1.56	1.51	1.43	1.34	1.09
$\text{cov}(\ln(c), \ln(y))$	0.63	0.62	0.60	0.59	0.59	0.58	0.57	0.55	0.51	0.47	0.43	0.33
$\text{cov}(\ln(c), \ln(\varepsilon))$	0.32	0.32	0.31	0.31	0.30	0.30	0.30	0.29	0.27	0.25	0.23	0.19
$\text{cov}(\ln(s), \ln(\varepsilon))$	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
$\text{cov}(\ln(h\varepsilon), \ln(\varepsilon))$	1.36	1.34	1.33	1.32	1.31	1.31	1.30	1.28	1.25	1.23	1.21	1.19
V	−0.46	−0.46	−0.46	−0.45	−0.45	−0.45	−0.46	−0.46	−0.48	−0.51	−0.55	−0.67
TFP	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70

E.2 Changes in Progressivity for the rich

ϕ	0.05	0.10	0.15	0.20	0.25	0.30	0.40
y	274.47	264.88	254.63	244.49	234.14	223.66	201.73
k	906.07	873.99	840.25	807.31	772.49	738.28	666.51
h	0.30	0.29	0.28	0.27	0.26	0.25	0.23
s	9.50	9.49	9.48	9.48	9.47	9.45	9.43
c	60.46	59.43	58.59	57.61	56.51	55.31	52.47
$\frac{T}{Y}$	0.15	0.15	0.15	0.15	0.15	0.15	0.15
w	541.60	541.37	540.82	540.40	539.87	539.12	537.78
w_{45}	1.86	1.86	1.86	1.86	1.86	1.88	1.88
w_{65}	1.89	1.89	1.90	1.89	1.89	1.91	1.91
$\mathrm{var}(\ln(y))$	0.75	0.75	0.74	0.74	0.73	0.73	0.71
$\mathrm{var}(\ln(yh))$	0.93	0.92	0.91	0.90	0.90	0.90	0.90
$\mathrm{var}(\ln(yd))$	0.68	0.60	0.53	0.47	0.41	0.36	0.25
$\mathrm{var}(\ln(c))$	0.37	0.33	0.30	0.27	0.24	0.22	0.17
$\mathrm{var}(\ln(h))$	0.19	0.18	0.18	0.18	0.18	0.18	0.19
$\mathrm{var}(\ln(s))$	0.11	0.11	0.11	0.11	0.11	0.12	0.12
$\mathrm{var}(\ln(k))$	6.32	6.04	5.85	5.59	5.30	5.01	4.19
$\mathrm{cov}(\ln(c), \ln(y))$	0.41	0.38	0.36	0.33	0.30	0.28	0.23
$\mathrm{cov}(\ln(c), \ln(\varepsilon))$	0.23	0.21	0.20	0.18	0.17	0.16	0.13
$\mathrm{cov}(\ln(s), \ln(\varepsilon))$	0.36	0.36	0.36	0.36	0.36	0.36	0.36
$\mathrm{cov}(\ln(h\varepsilon), \ln(\varepsilon))$	0.48	0.48	0.47	0.47	0.46	0.46	0.46
V	1.50	1.59	1.66	1.74	1.80	1.87	2.00
TFP	11.73	11.73	11.73	11.73	11.73	11.73	11.73

F Income Risk

Adjustment for Unbalanced Panels We consider the following logged labor income process net of year effects and individual characteristics,

$$\widetilde{y}_{it} = g(w)\alpha_i + \beta_t \mathbf{1}_t + \beta x_{it} + y_{it} \tag{50}$$

where α_i is a permanent component and y_{it} follows,

$$y_{it} = \rho y_{t-1} + u_{it} \quad \text{with} \quad u_{it} \sim N(0, var(u)) \tag{51}$$

We estimate (50) by pooling all available waves m of data by country. Here, we need at least three waves (i.e. $m \geq 3$) so that ρ in (51) has a chance of being nonzero (i.e note that if $m < 3$ then $\rho = 0$ by construction). Note that the permanent component α_i is weighted by the number of observations across consecutive waves: $g(w) = \frac{t_w - t_{w-1}}{t_{w_m} - t_{w_1}}$ where t_w is the year of the wave of data w; t_{w-1} is the year of the immediately previous wave of data, $w-1$; t_{w_m} is the year of the last available wave of data; and

t_{w_1} is the year of the first available wave of data.

We conduct our estimation using information across two consecutive waves per country. In this context, we note that some of our country samples show unbalanced (and non-annual panels). To make our estimates comparable across countries and across time, we annualize our estimates. For example, if a country with two observations displays a three-year difference across two observations then the estimated income process actually takes the form:

$$
\begin{aligned}
y_t &= \rho y_{t-1} + u_t \\
y_t &= \rho(\rho y_{t-2} + u_{t-1}) + u_t \\
y_t &= \rho(\rho(\rho y_{t-3} + u_{t-2}) + u_{t-1}) + u_t \\
&= \underbrace{\rho^3}_{\gamma} y_{t-3} + \underbrace{\rho^2 u_{t-2} + \rho u_{t-1} + u_t}_{\epsilon}
\end{aligned}
$$

More generally, for any $n-$year difference across two waves:

$$
y_t = \underbrace{\rho^n}_{\gamma} y_{t-n} + \underbrace{\sum_{i=0}^{n-1} \rho^i u_{t-i}}_{\epsilon_t}
$$

Then, in order to recover the annual ρ from the estimated γ, we compute the annual persistence parameter as $\rho = \gamma^{\frac{1}{n}}$.

Analogously, since u_{it} are $i.i.d$ with constant variance across time, for the case with $n = 3$ we find,

$$
\begin{aligned}
var(\epsilon) &= var(\rho^2 u_{t-2} + \rho u_{t-1} + u_t) \\
&= \rho^4 var(u_{t-2}) + \rho^2 var(u_{t-1}) + var(u_t) \\
&= (\rho^4 + \rho^2 + 1) var(u_t)
\end{aligned}
$$

That is, with $n = 3$ we obtain the annual $var(u)$ from the estimated $var(\epsilon)$ as $var(u) = \frac{var(\epsilon)}{(\rho^4+\rho^2+1)}$.

More generally, for any $n-$year difference:

$$
\begin{aligned}
var(\epsilon) &= var\left(\sum_{i=0}^{n-1} \rho^i u_{t-i}\right) \\
&= \left(\rho^{n-1}\right)^2 var(u) + \left(\rho^{n-2}\right)^2 var(u) + ... + \rho^2 var(u) + var(u) \\
&= \left(\rho^{2(n-1)} + \rho^{2(n-2)} + ... + \rho^2 + 1\right) var(u)
\end{aligned}
$$

and hence $var(u) = \frac{var(\epsilon)}{\left(\rho^{2(n-1)}+\rho^{2(n-2)}+...+\rho^2+1\right)}$.

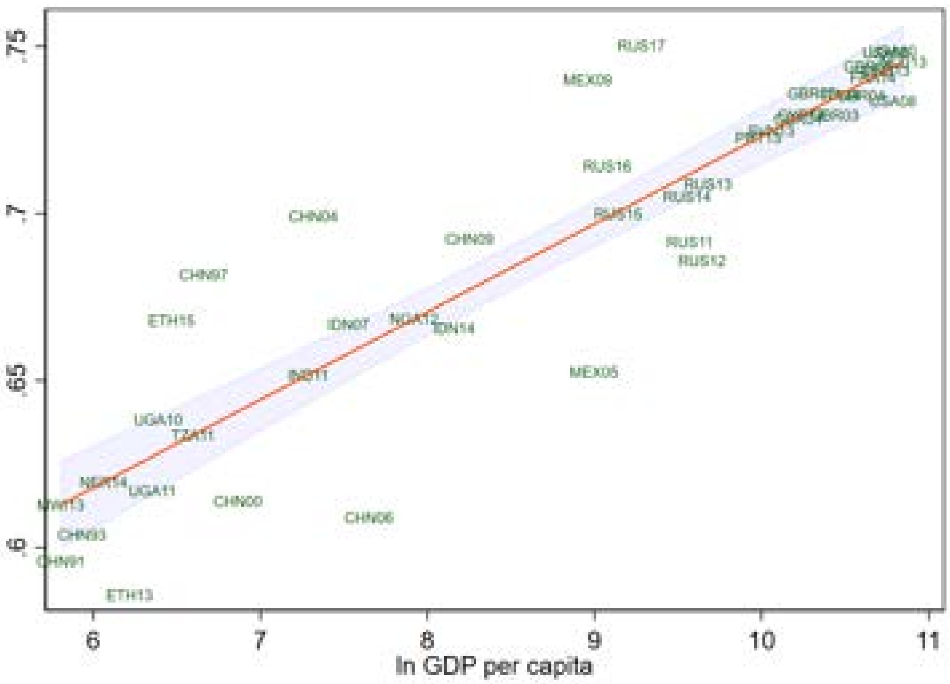
Table 10: Persistence and Risk Across Time and Space

	5% Trimming		1% Trimming		No Trimming	
	ρ	$var(u)$	ρ	$var(u)$	ρ	$var(u)$
Time fixed effects:						
$lnGDP$	0.0262	.0889				
	(0.056)	(0.000)				
+ Controls:						
ρ						
$var(u)$						

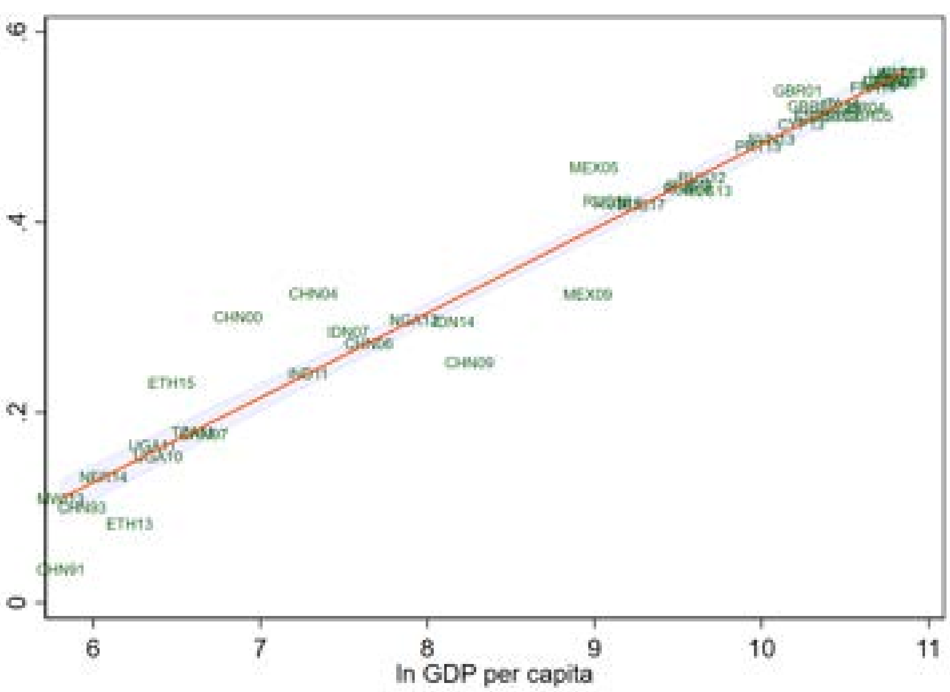
Notes: We provide estimates of the parameters in the process $y_{it} = \rho y_{t-1} + u_{it}$ with $u_{it} \sim N(0, var(u))$. Our sample consists of panel surveys for 22 countries with at least 2 waves for which we find 66 available country-year observations.

Figure 11: Persistence and Risk Across Time and Space

(a) ρ against GDP

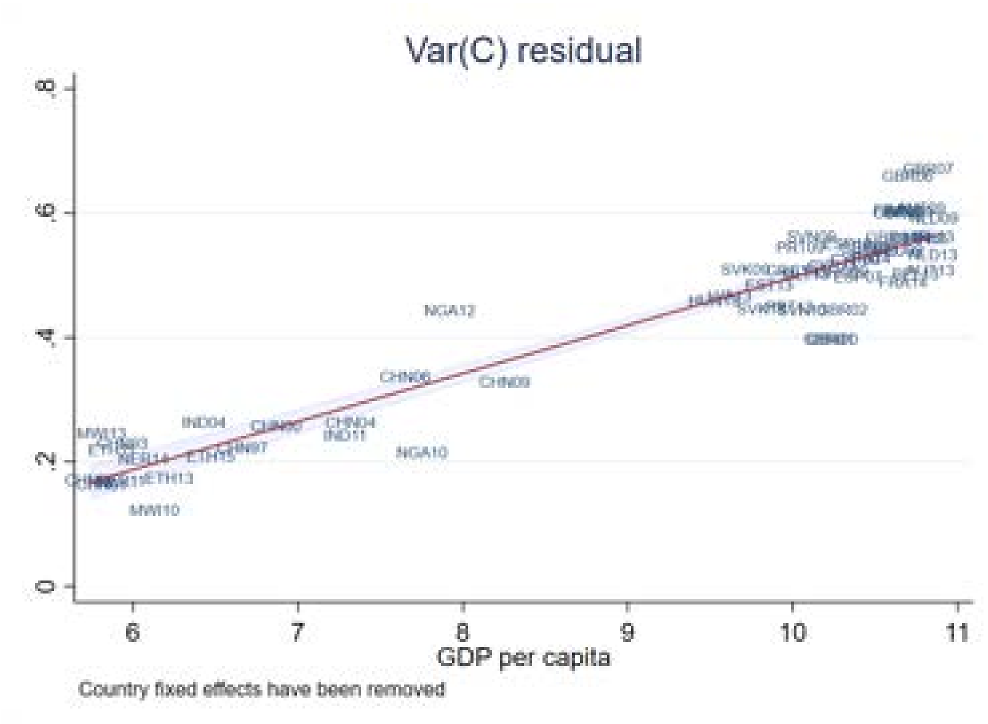


(b) σ against GDP

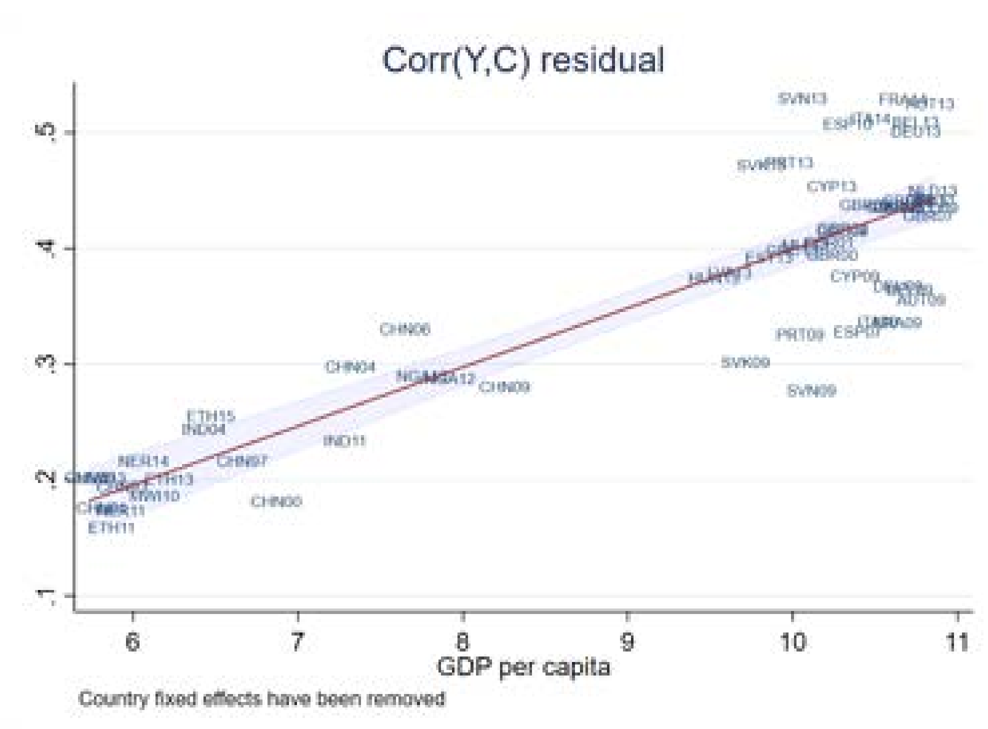


Notes: We provide estimates of the parameters in the process $y_{it} = \rho y_{t-1} + u_{it}$ with $u_{it} \sim N(0, var(u))$. Our sample consists of panel surveys for 22 countries with at least 2 waves for which we find 66 available country-year observations.

G Transmission of Income Inequality to Consumption Inequality: Alternative Measures



(a) Variance of C



(b) Correlation of C and Y

H Income Vs. Employment Shocks

A recurring concern that arises with these measures is that part of the changes in income can be attributed to measurement error (Grosh and Deaton, 2000; **?**). In the Appendix, we also adopt an additional approach less prone to measurement error by focusing on observable income shocks (unemployment) as in Cochrane (1995). We find similar inisghts in this alternative approach. This relates to the recent work of Lagakos (2018) that documents an increase in unemployment across the level of development. Building on this result we document the effects that a rise in unemployment has on consumption insurance.

$$\Delta \ln (\hat{c}_{it}) = \phi \mathbf{1}_u + \varepsilon_{it} \tag{52}$$

where $\mathbf{1}_u$ is a dummy equal to one if household i is unemployed in period t, and zero otherwise.