Explaining World Savings*

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July 31, 2017

Abstract

Data on the world saving distribution reveals that saving rates are significantly different across countries and remain different for long periods of time. This paper provides an explanation for these sustained differences in observed savings. We formalize a model of the world economy comprised of open economies inhabited by heterogeneous agents endowed with recursive preferences. Our assumed preferences imply increasing marginal impatience of agents as their consumption rises relative to average world consumption. Using measured productivity and fiscal shocks as exogenous drivers, we show that the model can not only reproduce the sustained long run differences in average saving rates across countries, but also provides a good fit of the time series behavior of saving observed in the data between 1970 and 2010.

JEL Classification: E2, F3, F4

Keywords: World savings, recursive preferences

*We would like to thank Igor Livshits, seminar participants at UBC, and conference participants at the SED, Midwest Macro, North American Econometric Society, and Asian Econometric Society meetings for helpful comments and discussions. Thanks also to Roger Farmer whose previous work with Lahiri provided the basis for this paper.

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§The views in this paper are solely the responsibility of the authors and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System or of any other person associated with the Federal Reserve System.

1 Introduction

Data on the world saving distribution reveals that cross-country differences in saving rates are significant and persistent. This is problematic for the standard model with time-additive preferences. Without equal rates of time preference, the asymptotic distribution of world wealth is typically degenerate under additively separable preferences. While models with equal rates of time preference but cross-country differences in demographics and productivity have had some success in accounting for part of the cross-country dispersion in saving rates, a substantial amount of variation still remains unexplained in these models.

This paper provides an alternative explanation for the observed saving patterns. We formalize a model of the world economy that is comprised of open economies inhabited by infinitely-lived agents. Our main point of departure from the standard exogenous growth neoclassical model is that we endow agents with recursive preferences.[1] Specifically, we follow Farmer and Lahiri (2005) and use a modified version of recursive preferences. The key implication of the Farmer-Lahiri specification is that it generates a determinate steady state wealth distribution within a growing world economy, a feature that typical models with recursive preferences cannot generate.[2]

One might of course consider the issue of balanced growth to be irrelevant to understanding savings behavior. We however believe that the inconsistency of standard recursive preferences with balanced growth is problematic if one's goal is to explain saving rates. In particular, given the constancy of both long run average growth rates and saving rates for most groups of countries (regions or continents), understanding long run patterns of savings would appear to be intrinsically linked to long run steady state dynamics. As is well known, the Kaldor growth facts are quite stark

[1]The dynamic properties of models with recursive preferences and multiple agents were analyzed in a celebrated paper by Lucas and Stokey (1984). Assuming bounded utility, Lucas-Stokey studied an endowment economy. Consequently, the results of Lucas-Stokey cannot be directly applied to growing economies. There is a small literature on recursive preferences with unbounded aggregators. Boyd (1990) has developed a version of the contraction mapping theorem that can be used to generalize Lucas-Stokey's proof of existence of a utility function to the unbounded case. If preferences are time-separable, King, Plosser, and Rebelo (1988) showed that the period utility function must be homogenous in consumption and Dolmas (1996) has generalized their result to the case of recursive utility. Farmer and Lahiri (2005) have applied the Dolmas result to a multi-agent economy and have established that homogeneity rules out the assumption of increasing marginal impatience. Hence, the existence of an endogenous stationary wealth distribution is inconsistent with balanced growth.

[2]The problem with the standard recursive preference specification is that it is inconsistent with balanced growth. The existence of balanced growth requires homothetic preferences. However, under homothetic preferences, the asymptotic wealth distribution in multi-agent environments is either degenerate or reflects the initial wealth distribution. Farmer and Lahiri (2005) provided a reformulation of the standard recursive preference specification that avoids this problem.

in suggesting balanced growth to be a robust feature of long run growth. Hence, we feel that any model attempting an explanation of dispersions in long run saving rates across countries should be consistent with balanced growth.

We follow Farmer and Lahiri (2005) and construct a model of recursive utility in which agents care about *relative* consumption. We assume that preferences are described by an aggregator that contains current consumption, future utility, and a time-varying factor that is external to the agent but grows at the common growth rate in a balanced growth equilibrium. This time dependence allows for preferences to exhibit increasing marginal impatience, which is a necessary condition for a non-degenerate asymptotic wealth distribution. A positive productivity shock in our model induces a rise in saving which ultimately reverts back to its prior level due to the increasing marginal impatience of agents as their wealth rises relative to world wealth, thereby preserving a determinate asymptotic wealth distribution. Equally importantly, this specification implies that different preferences induce different steady state consumption-to-wealth ratios of different agents. This implies that countries operating in the same world bond market and facing a common world interest rate have different steady state saving rates.

Can the modified recursive preferences of Farmer and Lahiri (2005) account for the observed differences in average long run saving rates between regions for the period 1970-2010? Can they also explain the time series behavior of region-specific saving rates in an open economy environment? In the context of a four-region, heterogenous agent world economy where the external factor in preferences is indexed to the common world per capita consumption level, we demonstrate that our model with recursive preferences can achieve both these goals.

The paper first calibrates the baseline open economy, four-region model to match the 1970 average regional saving rates and the capital shares in the G7, the Newly Industrialized economies (NIE), the Latin American & Caribbean economies (LAC), and sub-Saharan African countries (SSA). This list comprises 86 countries of the world. We are able to match these average saving rates and capital by allowing one preference parameter and the capital depreciation rate to vary across regions. This strategy implies that matching the level difference in saving rates across regions cannot be used as a test of the model since it is calibrated to match that variation. Instead, we test the model by examining its time series behavior and compare that with the data.

We examine the time series properties of the model by first estimating a region specific productivity and government spending process for each of our four regions using data between 1970 and 2010. The model is simulated by taking 100,000 correlated draws from the estimated processes for each region. The model's time series fit is examined by comparing the simulated moments on regional savings from the model with their data counterparts. In order to establish a frame of reference for our results, we also compute the model-induced saving rates under the more traditional CRRA preferences. Our focus is on two moments of the time series behavior of regional saving rates: volatility of savings and the correlation of the model-induced saving rates with the data.

The recursive preference specification outperforms CRRA preferences. In terms of savings volatility, the CRRA specification generates saving rates that are an order of magnitude greater than the data with the excess volatility ranging between 7 and 1000 times the data. The corresponding excess volatility of regional saving rates under recursive preferences ranges between 1 and 5 times that in the data. We also find that the saving rates generated by the model in response to the actual in-sample productivity and fiscal shocks between 1970 and 2010 correlate more strongly with the actual regional saving data for almost all regions. We view these results as suggesting that the recursive preference specification provides a better description of saving behavior relative to the traditional CRRA specification since it better matches the time series behavior of savings while also being able to match the long-run differences in saving rates between the regions. Recall that the additively-separable CRRA preferences cannot generate steady state differences in saving rates between countries operating in an integrated world economy with free cross-country flow of goods and capital.

Another striking feature of the cross-country saving data is the sudden increase in saving rates (or saving miracles) that are often observed in specific regions. Can our model generate saving miracles? In order to generate sudden switches in saving rates, we propose a new mechanism. Specifically, we allow the external factor in preferences to be different in *levels* for the three groups even though we continue to constrain it to have the same *growth rate*. The basic idea behind this is that all societies have role models/peer groups that they want to keep up with or imitate. This approach to explaining miracles amounts to a hypothesis that these sudden transformations of economies occur due to changes in their aspirations. Under our formalization, steady state saving rates are functions of the external factor in preferences which describes the benchmark relative to whom the country evaluates itself. Changes in this reference level can cause an immediate and sharp change in desired long run consumption which can only be brought about through sustained changes in savng rates.

As an example, we divide the world into three regions: the G7, the Asian tigers, and Emerging countries and show that our model can, both qualitatively and quantitatively, generate the observed saving miracle of the Asian Tigers if their benchmark external factor is switched in 1970 from the average consumption level of the world to the G7 average consumption level instead. The model predicts that saving rates rise towards the observed levels in the data as the economy starts building its consumption towards its new aspiration level. As consumption rises however, increasing marginal impatience starts to become stronger over time which eventually induces the saving rates to come back down. We show that these predictions match the facts quantitatively as well as qualitatively for the Asian Tigers. We believe this aspirations based explanation for sudden increases in saving rates is novel and is worth investigating further in future work.

Our work is related to two different strands of literature. The first is the relatively large body of research focused on explaining the dispersion of saving rates across countries. Explanations for the observed variation in cross-country savings have typically focused on variations in per capita incomes, productivity growth, fertility rates or the age distribution of the population. Contributions along these lines can be found in Mankiw, Romer, and Weil (1992), Christiano (1989), Chen, Imrohoroglu, and Imrohoroglu (2006), Horioka and Terada-Hagiwara (2012), Loayza, Schmidt-Hebbel, and Serven (2000) and Tobing (2012). These papers typically find significant explanatory power for demographics and some explanatory power for per capita income (though the direction of causality there is somewhat unclear). However, a significant part of the saving variability in the data continues to remain unaccounted for.

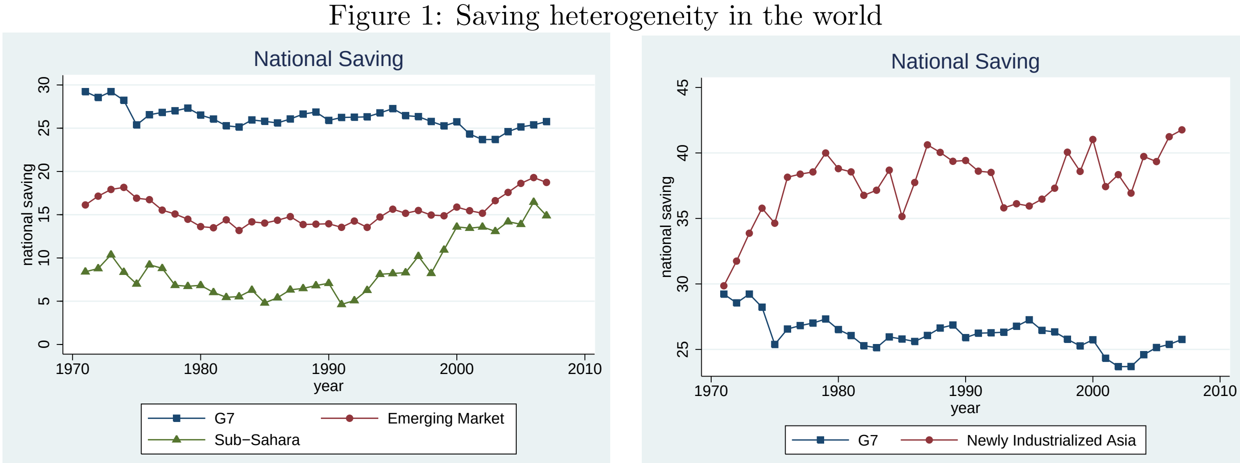
This paper is also related to the work on recursive preferences and stationary wealth distributions that goes back in its modern form to Lucas and Stokey (1984) and Epstein and Hynes (1983). Of particular relevance to our work are the contributions of Boyd (1990), Dolmas (1996) and Ben-Gad (1998) who focused on characterizing the stationary wealth distribution in growing economies. A second line of research has examined the implications of recursive preferences for stationary wealth distrbitution in growing economies. Also relevant to our work are the papers by Uzawa (1969), Mendoza (1991) and others who examined the effects of endogenously varying discount rates on the equilibrium dynamics of the neoclassical growth model.

In the next section we describe some of the key data features that motivate our study. Section 3 quickly reviews the key issues associated with recursive preferences under balanced growth as well as the “fix” to the problem suggested by Farmer and Lahiri (2005). Section 4 presents and develops the model. In section 5 we calibrate the model and examine its quantitative fit to average saving rates in a two-region economy. Section 6 discusses miracles while the last section concludes.

2 Two Facts on Cross-Country Saving

There are two features of the data that we want to draw attention to. First, we highlight the sustained differences in saving rates across groups of countries. To do this we collect countries into three groups: the G7, the Emerging Market, and Sub-Saharan Africa.[3] Panel (a) of Figure 1 plots the savings rates of these three groups of countries between 1970 and 2010. The figure illustrates that savings rates are different for different countries for long periods of time. Further, they show little or no evidence of convergence.

Figure 1: Saving heterogeneity in the world



(a) Differences in saving rates across regions

(b) Saving miracles

Note: The graph depicts the saving rates in different regions of the world between 1970 and 2010. Panel (a) plots the saving rates in the G7, Emerging economies and sub-Saharan Africa. Panel (b) plots the saving rates in the G7 and Newly Industrialized Asia (or the Asian Tigers).

While the overall pattern suggests that saving rates are persistent, the data has another important feature: in some countries saving rates show sudden and sharp swings over relatively short periods of time. Panel (b) of Figure 1 highlights this by plotting the saving rates in the Asian

[3]The list of countries in each group is in the Appendix.

Tigers between 1970 and 2008. Clearly, saving rates in the Asian economies increased very sharply from 1970 onward. In a short time period of 20 years, their saving rates rose by over 10 percentage points. Since the mid-1980s, the average saving rate in the Asian tigers has routinely exceeded the average saving rate in the G7 countries by over 10 percentage points.

We believe this data can be explained by allowing the rate of time-preference to vary across countries using a modified version of recursive preferences. In the standard model of recursive preferences studied by Lucas and Stokey (1984) and Epstein and Hynes (1983), agents become less patient as they become richer in an absolute sense. We adapt this idea to the case of a growing economy with the assumption that agents become less patient as they become richer in a *relative* sense.

3 Recursive preferences and balanced growth

As discussed in Section 1, a key goal of the paper is to examine the ability of a modified version of recursive preferences to rationalize the cross-country saving facts. Before presenting the model it is worthwhile to review why a modification is needed at all. In a nutshell, the need to modify the standard recursive specification arises because we are interested in analyzing environments with steady state balanced growth. Balanced growth is not only one of the celebrated Kaldor facts but also happens to characterize the modern data.

The baseline recursive preference structure however is not consistent with balanced growth.[4] To see this, consider the following recursive aggregator of preferences

$$u_t = W\left(c_t, u_{t+1}\right)$$

With heterogenous agents, there exists a stationary asymptotic wealth distribution if along a steady state balanced growth path all agents equate

$$W_u^i\left(c^i, u^i\right) = W_u^j\left(c^j, u^j\right) = 1/R \text{ for all } i, j \tag{3.1}$$

[4]We should note that the celebrated Lucas and Stokey (1984) paper that studied recursive preferences in a heterogenous agent economy did not examine an environment with long run growth. Hence, this inconsistency was not germane to their work.

where c is consumption, u is utility and R is the steady state interest factor common to all agents. Dolmas (1996) showed that this can only occur if the aggregator W is homogenous of the form

$$W(\lambda x, \lambda^{\gamma} y) = \lambda^{\gamma} W(x, y) \tag{3.2}$$

When this homogeneity condition is satisfied W_u becomes a constant along a balanced growth path thereby making it possible for the endogenous rate of time preference to remain constant and equal to the constant interest rate along a balanced growth path. More fundamentally, the asymptotic value of W_u is independent of the values of c and u along the balanced growth path.

While the condition above is intuitively obvious, Farmer and Lahiri (2005) showed that this homogeneity condition also implies that the stationary wealth distribution in a heterogenous agent economy is generically degenerate. It admits a non-degenerate steady state wealth distribution only in the knife-edged case of $W_u^i = W_u^j$. In this case, however, the independence of W_u^i from c and u in the long run implies that any distribution of wealth/savings across agents will satisfy the asymptotic equilibrium conditions and so the wealth distribution alng the balanced growth path will be indeterminate. These are exactly the implications inthe case of additively separable preferences. In other words, the key Farmer-Lahiri result is that recursive preferences do not add anything to our understanding of stationary wealth distributions beyond what we already know from additively separable preferences.

In the context of recursive preferences in environments without steady state growth, Lucas and Stokey (1984) proved the existence of a stationary wealth distribution as long as preferences exhibited increasing marginal impatience, i.e., agents became more impatient as they grew wealthier. Intuitively, rising impatience bounds the desire to accumulate assets by raising the desire to consume. The problem of the specification in equation (3.2) is that there is no force akin to the increasing marginal impatience of Lucas-Stokey that can endogenously equate it across agents. Consequently, the equilibrium has a knife-edge property to it.

Farmer and Lahiri (2005) showed however that the introduction of an externality into preferences could fix this problem. In particular, they considered preferences of the form

$$u^i = W^i\left(c_t^i, u_{t+1}^i, a_t\right)$$

where a_t is a factor that is external to the individual. This could stand in for habits, the average consumption level of the economy, or any other factor provided it grows at the rate of steady state growth and, as formalized here, is external to the individual household. Farmer-Lahiri showed that as long as the aggregator W was homogenous in all three arguments so that $W(\lambda x, \lambda^\gamma y, \lambda z) = \lambda^\gamma W$, an economy with heterogenous agents would give rise to an endogenously determined stationary wealth distribution with different agents choosing different saving levels in order to equate $W_u^i\left(\tilde{c}^i, g^{\gamma_i}\tilde{u}^i, 1\right) = W_u^j\left(\tilde{c}^j, g^{\gamma_j}\tilde{u}^j, 1\right)$ where $\tilde{x} = \frac{x}{a}$ and g denotes the steady state growth. Moreover, the homogeneity property also ensures that W_u would be constant in steady state. Hence, this specification can generate steady state differences in saving rates across agents facing a common vector of prices. In the rest of the paper we shall examine the potential of these preferences to account for the disparity in saving rates across the world.

4 The Model

We consider a world economy consisting of N small economies. Each country i is populated by l_i agents and this measure remains constant over time. Introducing population growth into the model is a straightforward extension that does not change any fundamental result. With no loss of generality we normalize the world population to unity so that $\sum_i l_i = 1$. We assume that the world economy has an integrated bond market. Hence, there are no impediments to savings flows throughout the world. This assumption is in stark contrast to closed economy literature on savings which forces saving to equal investment. Consequently, those models are equally well described as explaining investment behavior rather than saving behavior.

Agents globally are endowed with one unit of labor time which they supply inelastically to the market. We assume that all agents within a country have identical preferences but preferences of agents across countries maybe different. The preference of the representative agent in country i are described by the recursive representation

$$u_{it} = \frac{c_{it}^{\theta_i}\bar{\zeta}_{it}^{1-\theta_i}}{\theta_i} + \mathbb{E}_t\left[\frac{\beta_i u_{it+1}^{\delta_i}\bar{\zeta}_{it}^{1-\delta_i}}{\delta_i}\right] \tag{4.3}$$

where c denotes consumption and u denotes utility. This recursive preference specification is standard except for the argument $\bar{\zeta}_{it}$ which stands for an externality in preferences. It is external to the individual but is indexed by i since we allow this externality parameter to vary across countries. This externality could represent a number of different things including external habits, relative consumption ("keeping up with the Jones's"), etc... Allowing it to vary across agents implies, for example, that the relative consumption targets could vary across countries. Note that these preferences reduce to the standard additively separable across time specification in the special case where when $\delta = 1$. *Ceteris paribus*, a higher δ makes agents more patient by raising the discount factor. It is easy to check that this aggregator is linearly homogenous, thereby satisfying the homogeneity and regularity conditions needed for the existence of a Balanced Growth Path (BGP) as shown in Farmer and Lahiri (2005).

Agents have four sources of income: wage income from working, capital income earned by renting out their capital to firms, government transfers, and interest earned on risk-free one-period bonds. Households save by accumulating capital or by purchasing bonds. Income can be used for either consumption or saving. The budget constraint for households is thus given by

$$c_{it} + \iota_{it} + b_{it} = r_{it}k_{it} + w_{it} + R_{t-1}b_{it-1} + T_{it} \tag{4.4}$$

where k is the capital stock of household i at the beginning of period t, ι denotes investment in capital, b denotes bond holdings, and T are government transfers. The rental rate on capital for country i is denoted by r_i, while w_i is the wage rate of labor for country i, and R is the risk-free rate on bonds. The capital stock of the household evolves according to the accumulation equation

$$k_{it+1} = (1 - d_i)\, k_{it} + \iota_{it} - k_{it-1}\phi\left(\frac{i_{it}}{k_{it}}\right) \ , k_{i0} \text{ given for } i = 1, ..., N \tag{4.5}$$

where d is the depreciation rate and the function ϕ represents capital adjustment costs which is increasing and convex. In the following we shall assume that ϕ is given by

$$\phi\left(\frac{i}{k}\right) = \frac{b}{2}\left(\frac{i}{k} + 1 - d - g\right)^2 \tag{4.6}$$

where g is the gross rate of trend growth in aggregate productivity. This specification implies that in a non-stochastic steady state of the model, the adjustment costs would be zero.

Agents maximize utility subject to equations (4.4) and (4.5). The first order condition describing the optimal consumption-saving plan is

$$\left(\frac{c_{it}}{\bar{\zeta}_{it}}\right)^{\theta_i-1} = \beta_i \mathbb{E}_t\left[\left(\frac{c_{it+1}}{\bar{\zeta}_{it+1}}\right)^{\theta_i-1}\left(\frac{u_{it+1}}{\bar{\zeta}_{it+1}}\right)^{\delta_i-1} R^I_{it+1}\right]$$

where

$$R^I_{it+1} \equiv \left(1-\phi'_t\right)\left(r_{it+1} + \frac{1-d_i-\phi_t+\phi'_t\cdot\left(\frac{i_{it}}{k_{it}}\right)}{1-\phi'_t}\right) \quad ; \quad \phi_t \equiv \phi\left(\frac{i_{it}}{k_{it}}\right)$$

is the effective gross return on capital investment. Lastly, the optimal portfolio allocation between capital and risk-free international bonds is

$$\mathbb{E}_t\left[\left(\frac{c_{it+1}}{\bar{\zeta}_{it+1}}\right)^{\theta_i-1}\left(\frac{u_{it+1}}{\bar{\zeta}_{it+1}}\right)^{\delta_i-1} R^I_{it+1}\right] = R_t\mathbb{E}_t\left[\left(\frac{c_{it+1}}{\bar{\zeta}_{it+1}}\right)^{\theta_i-1}\left(\frac{u_{it+1}}{\bar{\zeta}_{it+1}}\right)^{\delta_i-1}\right]$$

The production technology of each country is given by

$$Y_{it} = A_{it}k_{it}^{\alpha_i}l_i^{1-\alpha_i}$$

A_{it} is the productivity of the technology that is given by

$$A_{it} = e^{z_{it}}a_{it}^{1-\alpha}$$

where a and z are productivity processes described by

$$a_{it} = ga_{it-1} \tag{4.7}$$

$$z_{it} = \bar{z}_i + \rho_i^z z_{it-1} + \sigma_i^z \varepsilon_{it}^z \tag{4.8}$$

Thus, a_{it} is the long run trend in TFP with g being the trend growth of productivity (which is common across regions) while z_{it} represents TFP fluctuations around the trend.

Firms produce output by renting capital and labor in competitive factor markets. We assume that firms in country i at date t also face a per unit output tax τ_{it}. Consequently, optimality in factor markets dictates that factor prices are given by:

$$r_{it} = (1 - \tau_{it})\alpha_i \frac{y_{it}}{k_{it}} \tag{4.9}$$

$$w_{it} = (1 - \tau_{it})(1 - \alpha_i) y_{it} \tag{4.10}$$

where y and k denote per capita output and capital, respectively. The output tax is assumed to be exogenous and follows the process

$$\tau_{it} = \rho_i^\tau \tau_{it-1} + \sigma_i^\tau \varepsilon_{it}^\tau \tag{4.11}$$

We also maintain the assumption that governments in all regions have a balanced budget at all dates. Hence,

$$\tau_{it} y_{it} = T_{it} \tag{4.12}$$

Any world equilibrium must clear aggregate world goods and factor markets:

$$\sum_{i=1}^{N} l_i (c_{it} + \iota_{it}) = y_t \tag{4.13}$$

$$\sum_{i=1}^{N} l_i b_{it} = 0 \tag{4.14}$$

$$\sum_{i=1}^{N} l_i = 1 \tag{4.15}$$

Equation (4.13) is the goods market clearing condition which dictates that the total demand for consumption and investment by the world must equal the world GDP. Equation (4.14) is implied by clearing in the international bond market. Equation (4.15) is the corresponding world labor market clearing condition, while equation (4.12) is the government budget constraint.

Definition 4.1 *A world equilibrium is a set of allocations* $\{c_{it}, k_{it}, \iota_{it}, b_{it}, y_{it}\}$ *and prices* $\{w_{it}, r_{it}, R_t\}$ *such that at each* t *(a) all households in all* i *solve their optimization problem given prices; (b) firms maximize profits given prices; and (c) the allocations clear all markets.*

Before proceeding further it is worth sketching out a brief description of how the recursive preference specification works in steady state. Let $\tilde{x} = \frac{x}{a}$. In steady state, the rate of time preference for agent i is given by

$$W_u^i = \beta_i \left(g\tilde{u}^i\right)^{\delta_i - 1}$$

while steady state normalized utility is

$$\tilde{u}^i = \frac{(R\beta_i)^{\frac{1}{1-\delta_i}}}{g}$$

where $R = 1 + r - d$. Using the definition of the aggregator, we also get a steady state expression for normalized consumption:

$$\tilde{c}^i = \left[\theta_i \tilde{u}^i - \frac{\theta_i \beta_i}{\delta_i} \left(\tilde{u}^i g\right)^{\delta_i}\right]^{\frac{1}{\theta_i}}$$

Hence, each $\tilde{u}$ maps into a different $\tilde{c}$. In this set-up, different $\delta' s$ and $\beta' s$ imply different steady state $\tilde{u}' s$. The rate of time preference W_u is equated across agents by different steady state $\tilde{c}' s$ and $\tilde{u}' s$. Hence, different $\delta' s$ and $\beta' s$ across agents induce a dispersion in steady state saving rates across agents. In our calibration strategy below, we will set the β to be identical across countries and calibrate δ_i to match the initial saving rate in 1970 of each region i in our sample. We will then test the model by examining the closeness of fit of the model generated time series of regional saving rates in response to measured shocks with the corresponding time series data on regional saving for the period 1970-2010.

For a growing economy characterized by agents with such heterogenous preferences, Farmer and Lahiri (2005) used the results of Lucas and Stokey (1984) to prove that there exists a unique convergent path to a unique steady state with a stationary distribution of saving rates provided c and u are both "non-inferior"[5], and preferences display increasing marginal impatience, i.e., W_u is decreasing in c. Our specification satisfies all the conditions of Farmer and Lahiri (2005). Hence, their results apply to our model as well.

[5] c and u are non-inferior if $c < c'$ and $u > u' \Longrightarrow \frac{\tilde{W}_c^i(c,u)}{\tilde{W}_u^i(c,u)} > \frac{\tilde{W}_c^i\left(c',u'\right)}{\tilde{W}_u^i(c',u')},\ i = 1, 2.$

5 Quantifying the model

The model is calibrated using data from the Penn World Tables (PWT 9.0). Unless otherwise stated our sample period is 1970-2010. We divide the world into four groups: G7, Newly Industrialized economies (NIE), Latin American and Caribbean economies (LAC) and sub-Saharan Africa (SSA). Details regarding the countries in each region, the data and the series construction are contained in the Data Appendix.

The savings rate for each region i in the model is given by

$$\frac{S_i}{Y_i} = 1 - \frac{C_i}{Y_i} - \frac{T_i}{Y_i}$$

A data analogue of this series is constructed in the data from household and government consumption shares of GDP. In what follows we will consider a world composed of regional groupings of countries. For each region we compute their aggregate output, consumption, capital stock, workers and investment by summing across country level data in the PWT.

The model has two sources of stochastic disturbances – productivity shocks and tax shocks. Productivity in each region is constructed using the model assumption about technology. Using regional GDP and capital stock we construct

$$Productivity_{it} = \frac{y_{it}}{k_{it}^{\alpha}}$$

We detrend this series using a linear trend and set the linear trend equal to $a_{it}^{1-\alpha}$. We set the detrended series equal to z and use the derived series for z to estimate

$$z_{it} = \hat{\bar{z}}_i + \hat{\rho}_i^z z_{it-1} + \hat{\sigma}_i^z \hat{\varepsilon}_{it}^z$$

We use the computed residuals $\hat{\varepsilon}_{it}$ as shocks to the model. There are thus four parameters to be estimated per region: z_i, ρ_i^z and σ_i^z. The estimated parameters are reported in Table 1 below:

For the fiscal shocks, note that from the government budget constraint we have $\tau_{it} = \frac{T_{it}}{y_{it}}$. The right hand side of this expression is the government consumption share of GDP. Hence, we use

Table 1: Estimated productivity parameters

	productivity parameters		
	$\hat{z}_i$	$\hat{\rho}_i^z$	$\hat{\sigma}_i^z$
G7	0.0007	0.945	0.023
NIE	0.0024	0.937	0.049
LAC	0.0023	0.804	0.047
SSA	0.0077	0.960	0.082

This table reports the estimated productivity parameters for the four regions. G7 denotes the G7 countries, NIE the newly industrialized economies, LAC the Latin American and Caribbean economies while SSA denotes sub-Saharan African economies.

PWT data on the government consumption share of GDP to estimate

$$\tau_{it} = \hat{\rho}_i^{\tau} \tau_{it-1} + \hat{\sigma}_i^{\tau} \hat{\varepsilon}_{it}^{\tau}$$

The estimated parameters[6] are reported in Table 2 below:

Table 2: Estimated tax process

	tax parameters	
	$\hat{\rho}_i^{\tau}$	$\hat{\sigma}_i^{\tau}$
G7	0.972	0.004
NIE	0.773	0.005
LAC	0.932	0.010
SSA	0.964	0.018

This table reports the estimated tax process parameters for the four regions. G7 denotes the G7 countries, NIE the newly industrialized economies, LAC the Latin American and Caribbean economies while SSA denotes sub-Saharan African economies.

A key variable in the model is the externality process. For our baseline case we set

$$\bar{\zeta}_{it} = \bar{c}_t \text{ for all } i \text{ and } t$$

where $\bar{c}_t$ denotes the average per capita world consumption level. This is the most neutral starting

[6] Note that the estimation includes a constant term, however we simulate the model under the assumption of a mean zero process for τ_{it}.

point where there is a common reference consumption target for all countries. Later we shall relax this assumption to explore its potential in explaining saving miracles. We also set the capital share parameter α to 1/3 for all the regions.[7] Another important parameter is b which controls size of the adjustment costs of capital. We calibrate b such that the model reproduces the standard deviation of world investment per worker. This gives $b = 2.85$. Lastly, we set the world trend growth of productivity to $g = 1.025$ or a 2.5 percent trend growth rate. This is the estimated world trend growth during the period 1970-2010.

Our calibration strategy is to first set $\beta = 0.97$ and $\theta = 0.85$ exogenously. These parameters are set to be identical across countries so as to retain the focus of the analysis on recursive preferences and the key aspect of heterogeneity in preferences emanating from the non-additively separable component of preferences.

The vector $(\delta_{G7}, \delta_{NIE}, \delta_{LAC}, \delta_{SSA})$ is then set so that the steady state values of the regional saving rates are equal to those observed in 1970. Note that our procedure targets the regional saving rates, hence we choose four parameters. We choose the regional $l_i'^s$ to match the relative labour shares of the regions in 1970. These parameter choices are summarized in Table 3 below:

Table 3: Parameterization of baseline model

	Parameters		
	labor share l_i	preference parameter δ_i	depreciation rate d_i
G7	0.590	0.989	0.047
NIE	0.038	0.993	0.058
LAC	0.171	0.995	0.044
SSA	0.200	0.996	0.042
$(\beta, \theta, \alpha, b, g) =$		$(0.97, 0.85, 0.33, 2.85, 1.025)$	

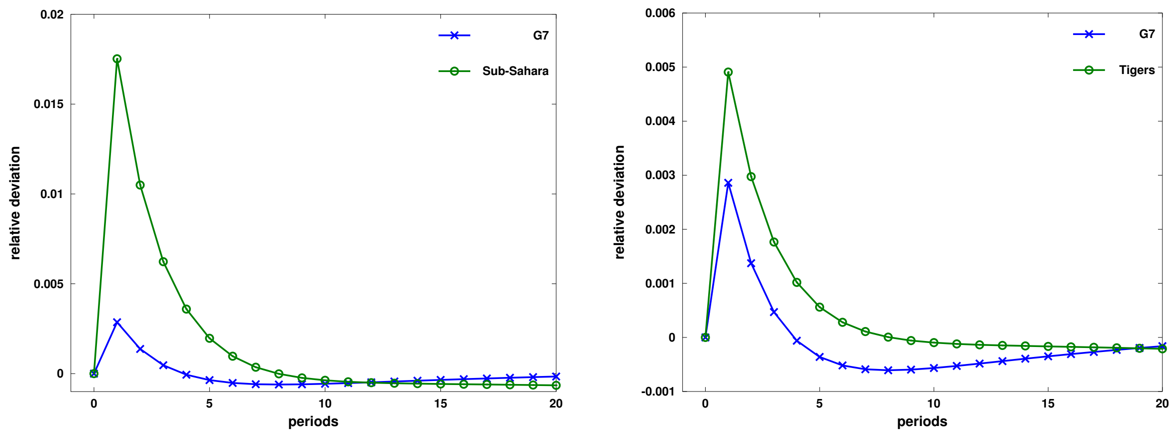
This table summarizes the regional parameter choices to enable the baseline model to match the calibration targets for regional saving rates and regional shares of world capital in 1970. G7 denotes the G7 countries, NIE the newly industrialized economies, LAC the Latin American and Caribbean economies while SSA denotes sub-Saharan African economies.

To illustrate the mechanics of the model we start by plotting the response of the saving rates in the G7, SSA and NIE regions to a one standard deviation positive shock to the common productivity

[7] For the capital share numbers we tried a number of alternative approaches ranging from a constant 1/3 share of capital for all countries to the numbers computed by Caselli and Feyrer (2007) as well as those from Bernanke and Grkaynak (2002). The results are robust to these alternative approaches, hence in the following we shall set the capital share to a common 1/3 for all countries.

process z. Figure 2 shows that the regions respond differently to the same productivity shock. Specifically, the saving rate in the G7 rises less and declines faster than in the SSA and the NIE regions. The reason for this is the *increasing marginal impatience* that is built into these preferences. The high consumption region (the G7) is also more impatient and hence responds less and and adjusts downwards faster in response to the same increase in the real interest rate relative to the emerging economies. The stationary world wealth distribution is non-degenerate precisely due to this feature of preferences.

Figure 2: Impulse response of savings to productivity



(a) G7 and sub-Sahara (b) G7 and NIE

Note: The graph depicts the response of saving rates in the four regions to a common positive one standard deviation shock to the productivity process z_t.

5.1 Baseline results

So, how well does the model explain world saving behavior? We examine this by simulating from the model the response of saving to the measured productivity and fiscal shocks shocks in the data between 1970 and 2010. In particular, we compute moments from the model from data that is generated by taking 100,000 random draws from the estimated productivity and tax processes for the four regions. Recall that the model was parameterized to mimic data in 1970, not to explain actual saving movements between 1970 and 2010. We keep all those parameters fixed across time for these simulations.

Before presenting the results it is important to note that we need a frame of reference in order to assess the value-added by our model with recursive preferences. The most obvious reference point for this purpose is the standard model with time additive, constant relative risk aversion (CRRA) preferences since it is the typical workhorse macro model that is used widely for both quantitative and qualitative work. We consider standard CRRA preferences of the form

$$u(c) = \frac{c^{1-\sigma}}{1-\sigma}, \qquad \sigma > 0$$

where σ is the coefficient of relative risk aversion. For our baseline calibration of the CRRA model we assume that σ is the same across all regions. The common value of σ is set so that, as in the case with the model under recursive preferences, the 1970 regional saving rates we see in the data are consistent with steady state values[8]. The calibrated value of σ is 1.11, which is a relatively conservative estimate in the range of values that are typically used for this parameter in quantitative work. As before, the adjustment cost parameter b is set to match world per capital investment volatility to its value in the data. The rest of the model parameterization is exactly as before. As in the main exercise reported above, we feed in 100,000 random draws from the estimated TFP and tax processes for each of the regions into the model and generate the model implied saving rates for the four regions.

Table 4 presents a comparative analysis of the two models. The results emphatically indicate the better performance of the recursive preference model in explaining saving behavior. The CRRA model generates saving volatility that is an order of magnitude higher than the data for all four regions. The corresponding volatility in the recursive model, while generally higher than in the data, is much closer to the data with the excess volatility ranging from almost zero for the G7 to about five-fold for the other three regions. In addition, the recursive model on average outperforms the CRRA model in terms of the correlation between the model and data saving rates for all the regions except for the G7 where it marginally underperforms.

The results in Table 4 detail the relative success of the recursive specification formalized here in reproducing the time series behavior of regional saving rates. These results become all the more striking once one recalls that the recursive specification can also reproduce the long run differences in saving rates across regions, a feature that the baseline CRRA model cannot reproduce. Put

[8] As discussed in section 3 there are a continuum of saving rate distributions consistent with steady state under a given calibration of the CRRA preferences. However, the assumption that σ is common across regions, together with the assumption that steady state saving rates equal a given set of data values $\{\hat{s_i}\}$, implies a unique value of σ.

Table 4: Comparing the recursive and CRRA models

	Data	Model	
		Recursive Perferences	CRRA Preferences
coeff var(S_{G7})	0.108	0.099	5.625
coeff var(S_{NIE})	0.118	0.237	133.0
coeff var(S_{LAC})	0.073	0.365	1.641
coeff var(S_{SSA})	0.236	1.085	1.690
coeff var($\bar{S}$)	0.062	0.125	1.477
$corr$(data, model)			
G7	·	0.555	0.785
NIE	·	0.165	0.140
LAC	·	0.398	0.266
SSA	·	0.641	0.498

Notes: The table reports moments of national saving rates in the data for the period 1970-2010 and simulated from the model using 100 000 random draws from the measured TFP and tax shock distribution. G7 denotes the G7 countries, NIE the newly industrialized economies, LAC the Latin American and Caribbean economies while SSA denotes sub-Saharan African economies. Results are shown for the model both with recursive preferences under the baseline calibration and for the model with CRRA preferences (coefficient of relative risk aversion calibrated to a value of 1.11). $\bar{S}$ denotes the population-weighted mean saving rate across the regions of the model. $corr$(data, model) denotes the correlation between the 1970-2010 data and the model simulated using measured shocks from 1970-2010 data.

differently, under an open economy specification, the CRRA preference model can neither reproduce the observed dispersion in the levels of saving rates across the world, nor can it generate the observed time series behavior of those savings. We view these results as a strong confirmation of the success of our recursive preference specification in explaining the observed world saving heterogeneity.

5.2 Robustness

How sensitive are the simulation results to the assumed parameter values for θ, a parameter for which we do not have direct estimates? Comparing the last two columns of Table 5 suggests that the results of the baseline model are reasonably robust to changing θ to 0.6 from the baseline value of 0.85. While the volatility of saving rates rises marginally when θ is reduced, the correlation statistics change very little in response to changing the baseline specification for θ.

Table 5 also shows the sensitivity of the results to changing the capital adjustment cost parameter b. Comparing the first two columns under "Model" shows that eliminating all adjustment costs from the baseline model by setting $b = 0$ has the predictable effect of raising volatility of the simulated regional saving rates. Removing adjustment costs also, in general, tends to reduce the correlation between the simulated saving series with the data counterpart.

Table 5: Robustness of moments to parameter values

	Data	Model		
		(θ, b)	(θ, b)	(θ, b)
		$(0.85, 5)$	$(0.85, 0)$	$(0.6, 0)$
coeff var(S_{G7})	0.108	0.094	0.207	0.273
coeff var(S_{NIE})	0.118	0.220	0.420	0.632
coeff var(S_{LAC})	0.073	0.346	0.621	0.724
coeff var(S_{SSA})	0.236	1.005	1.582	2.331
coeff var($\bar{S}$)	0.062	0.112	0.289	0.296
$corr$(data, model)				
G7	·	0.481	0.622	0.677
NIE	·	0.166	0.113	0.160
LAC	·	0.389	0.262	0.187
SSA	·	0.655	0.381	0.361

Notes: The table reports moments of regional saving rates in the data for the period 1970-2010 and in the model for a simulation using 100 000 random draws from the measured TFP and tax shock distribution. Results are shown for different values of the preference parameter θ and adjustment cost parameter b. Reported (θ_i, b_i) values are common across regions in the model. G7 denotes the G7 countries, NIE the newly industrialized economies, LAC the Latin American and Caribbean economies while SSA denotes sub-Saharan African economies. $\bar{S}$ denotes the population-weighted mean saving rate across the regions of the model. $corr$(data, model) denotes the correlation between the 1970-2010 data and the model simulated using measured shocks from 1970-2010 data.

The model presented above aggregated the world economy into four regions – the G7, NIE, LAC and SSA economies. However, this list omits China and India which are currently two of the major developing countries in the world. Can the model capture the world saving heterogeneity when we include China and India? We have checked this by expanding the four-region model to a five-region economy by including China and India as an additional region. The results of that exercise, which we do not report here in the interests of space, are very similar to the results reported above and are available from the authors upon request.

Overall, our results suggest that the quantitative results are quite robust to varying the two key parameters that were held constant across time and regions in our model calibration.

6 Saving miracles

The second motivation of this paper was the observation that some countries have shown sudden and dramatic increases in their average saving rates. We showed an example of this in Figure 1 which depicted the sharp pickup in the average saving rate of the Asian Tigers. We now turn to demonstrating how our model can accommodate these dramatic saving miracles. Our principal idea is that saving behavior is dictated by aspirations which, in turn, is often determined by one's position relative to a comparison group. If a society begins to aspire to have the wealth levels of a much richer comparison group then its saving levels have to respond to achieve that new goal. A key feature of the recursive preference structure we have formalized here is the presence of relative consumption. In the model presented in the previous section the relative consumption level in preferences was just the world average per capita consumption. In this section we shall examine the consequences of a country changing its relative comparison group from the average world level to a richer cohort. Could such a change generate an increase in saving rates similar in magnitude to the rise in Asian savings we saw in Figure 1? We should clarify at the outset that we are not building a theory of aspirations in this paper. Rather, we are quantitatively exploring the dynamic general equilibrium consequences of a change in aspirations.

Consider a world economy comprising three regions. Let the three regions now be the G7, Emerging economies, and the Asian Tigers. The list of countries in each of these groupings is given in table 8 in the Appendix. This list of 118 countries is much larger than the list of countries that were included in the previous sections since now we also include a number of emerging Asian economies in either the Asian Tigers group or in the Emerging economies group.

Recall that at each date t the externality in preferences for each i is denoted by ζ_i. Let average per capita world consumption be

$$C = l_{G7}c_{G7} + l_{Emg}c_{Emg} + l_{Tigers}c_{Tigers}$$

where c_i is the per capita consumption of region i. Consider two regimes:

$$\text{Regime 1: } \zeta_{G7} = \zeta_{Emg} = \zeta_{Tigers}$$

$$\text{Regime 2: } \zeta_{G7} = \zeta_{Emg} = C \ ; \ \zeta_{Tigers} = \zeta_{G7}$$

Under Regime 1 all three regions value their own consumption relative to the world per capita consumption level. Under Regime 2 however, the Asian Tigers switch their comparison group to the G7 while the other two regions continue to use the world average as the relevant consumption comparison group. We consider an environment where at some date t^*, the regime switches from Regime 1 to Regime 2. Given that per capita consumption is higher in the G7, such a regime switch represents a switch to a higher aspiration level for the Asian Tigers.

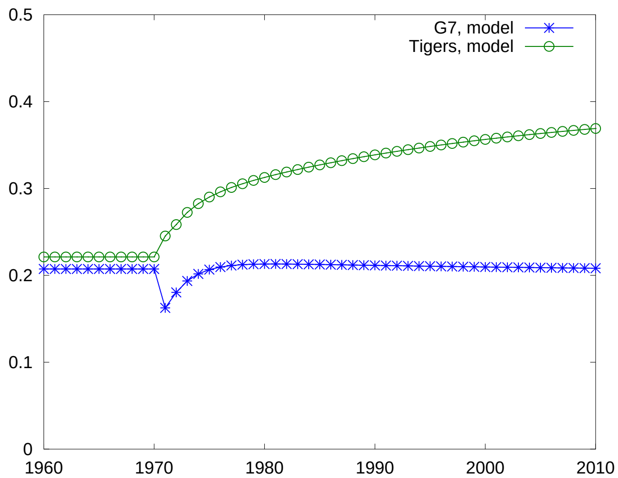
In the context of our model, could such a regime switch account for the almost 15 percentage point increase in the saving rate of the Asian Tigers since 1970? To answer this question we calibrate the model by choosing parameter values such that the model reproduces the steady state saving rates, world capital shares and world labor shares of the three regions in 1960 under the maintained assumption of the world being in Regime 1. Keeping the parameters underlying the initial calibration unchanged, we then feed the estimated productivity process from 1960 to 2010 into the model and simulate the equilibrium paths for the three economies under two scenarios: (a) a regime switch to Regime 2 in 1970 where the reference consumption level for the Tigers increases to the per capita consumption of the G7 economies; and (b) the regime stays in Regime 1 with identical and unchanged reference consumption levels in all regions. We then compare the model generated saving rates with their data counterparts under both scenarios.

To clarify the role of the regime switch in generating the saving increase, we start with Figure 3 which shows the saving rates of the G7 and the Tigers when we shut down all productivity movements and only allow for a regime switch in 1970. Since the world economy is in steady state in 1960, saving rates are constant until 1970 when the regime switch occurs. From that date onward savings of the Tigers rises while the G7 saving rate initially declines before recovering towards its original level.[9]

What are the predicted saving rates of the model when we incorporate measured productivity shocks from the data? Panel (a) of Figure 4 shows the simulated path of savings between 1960 and 2010 with a regime switch from Regime 1 to Regime 2 in 1970. To make matters stark we

[9] The decline in the G7 saving on impact occurs due to the fall in the interest rate that is induced by the rise in the desired savings of the Tigers. Note that we do not plot the saving rate of the Emerging economies here in order to keep the graph uncluttered.

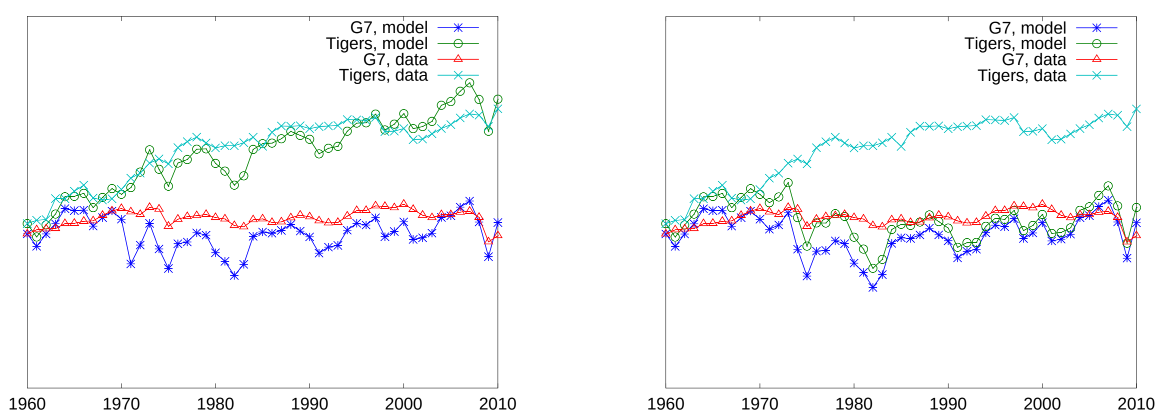
Figure 3: Response of savings to regime switch



Note: The graph depicts the response of saving rates in the two regions when the *only* shock is a change in the reference consumption level of the Asian Tigers to per capita consumption of the G7 in 1970.

assume the same production function for all regions with a common world productivity process estimated as in section 5. As a point of contrast, panel (b) of Figure 4 plots the saving rates under the assumption of no change in regime. We find the fit in Panel (a) quite remarkable in terms of how well the model-generated saving rates track the actual saving rates.

Figure 4: Saving miracles: data and the model



(a) saving rates under regime switch (b) saving rates without regime switch

Notes: Panel (a) shows the saving rates in the G7 and the Asian Tiger economies in the model under a switch in the comparison group for the Tigers with the data between 1970 and 2010. Panel (b) shows the saving rates of the G7 and the Asian Tigers in the model without any switch in regime.

In summary, the switch to a higher aspiration is key for the model to reproduce the sharp increase in the saving rates of the Asian Tigers. We find this result indicative of the power of the aspiration mechanism to explain the rapid growth of savings in Asia.

7 Conclusion

The variation in saving behavior across countries has long been a puzzle and a challenge to explain for standard neoclassical models. In this paper we have explored the explanatory potential of recursive preferences and preference heterogeneity in jointly accounting for the cross-country saving data. We have used a utility specification that displays a form of relative consumption preference. Specifically, agents in a country derive utility from consumption relative to the consumption of a reference group. Our specification implies that when countries are poor they display high patience and high saving rates. As their consumption gets closer to the levels of their reference group however they become more impatient, a property that Lucas and Stokey (1984) called "increasing marginal impatience". This feature of the preferences keeps the wealth distribution from becoming degenerate even when preferences are heterogenous across countries.

We apply these preferences to a multi-country world economy model. We collect our baseline sample of 86 countries into four regions and calibrate the model to a four-region world economy in order to match the long-run differences in saving rates across regions. We then test the model by examining its time series predictions. A key component of this test is the performance of the recursive preference structure relative to the standard workhorse model with time separable CRRA preferences. Using only region-specific productivity and fiscal shocks as exogenous drivers, we show that the calibrated model routinely outperforms the CRRA model in matching the time series behavior in saving rates of the different regions in terms of both the volatility of saving rates as well as their correlation with the actual data saving rates. Given that our recursive preference structure can also account for the long run differences in saving rates across regions, a feature that CRRA preferences cannot match under the our environment, we view this as being strongly supportive evidence in favour of the recursive preference specification for understanding world saving behavior.

In addition, we have also shown that a change in the aspirations of societies, as captured by a change in the reference consumption basket they use to value their own utility, can account for sudden and sharp changes in saving rates. Thus, our model can account for the rapid increase in Asian saving rates and its overall behavior between 1960 and 2010 by allowing for a change in the reference basket being used by the Asian economies from the average world consumption level to the G7 consumption level in 1970. Intuitively, a higher reference consumption level induces greater saving as accumulating greater wealth is the only way to achieve a higher steady state consumption.

We believe this class of models has great potential in also helping us understand changes in the wealth distribution within countries over time. Wealth evolves as a function of saving. Accounting for differential saving rates is thus key to explaining wealth distributions and changes therein. We hope to address this issue in future work.

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A Data Appendix

A.1 Countries

Table 6: List of Countries in Figure 1

Region	Countries
G7	Canada, France, Germany, Italy, Japan, United Kingdom, United States
Emerging Market	Afghanistan, Albania, Algeria, Antigua & Barbuda, Argentina, Armenia, Azerbaijan, Bahamas, Bahrain, Bangladesh, Barbados, Belarus, Belize, Bhutan, Bolivia, Bosna & Herzegovina, Brazil, Brunei, Bulgaria, Cambodia, Chad, Chile, Colombia, Costa Rica, Croatia, Djibouti, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Fiji, Georgia, Grenada, Guatemala, Guyana, Haiti, Honduras, Hungary, Kiribati, Kosovo, Kuwait, Iran, Iraq, Jamaica, Kazakhstan, Kyrgystan, Laos, Latvia, Lebanon, Liberia, Libya, Lithuania, Macedonia, Maldives, Mauritania, Mexico, Moldova, Mongolia, Montenegro, Morocco, Myanmar, Nepal, Nicaragua, Oman, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Poland, Qatar, Romania, Russia, Samoa, Saudi Arabia, Serbia, Solomon Islands, Sri Lanka, St. Kitts & Nevis, St. Lucia, St. Vincent & the Grenadines, Suriname, Syria, Tajikistan, Timor-Leste, Tonga, Trinidad & Tobago, Tunisia, Turkey, Turkmenistan, Tuvalu, Ukraine, United Arab Emirates, Uruguay, Uzbekistan, Vanuatu, Venezuela, Yemen,
Sub Sahara	Angola, Benin, Botswana, Burkina Faso, Cameroon, Cape Verde Central Africa Republic, Comoros, Democratic Republic of Congo, Republic of Congo, Cote d'Ivoire, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya Lesotho, Liberia, Madagascar, Malawi, Mali, Maritius, Mozambique Namibia, Niger, Nigeria, Rwanda, Sao Tome Principe, Senegal, Seychelles, Sierra Leone, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Zambia, Zimbabwe

Table 7: List of Countries in 4-Region Model

Region	Countries
G7	Canada, France, Germany, Italy, Japan, United Kingdom, United States
Newly Industrialized Asia	Hong Kong, Korea, Singapore, Taiwan,
Latin America & Caribbean	Antigua & Barbuda, Argentina, Bahamas, Barbados, Belize, Bolivia Brazil, Chile, Colombia, Costa Rica, Dominica, Dominican Republic Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haitia, Honduras Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru St. Kitts & Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname Trinidad & Tobago, Uruguay, Venezuala
Sub Sahara	Angola, Benin, Botswana, Burkina Faso, Cameroon, Cape Verde Central Africa Republic, Comoros, Democratic Republic of Congo, Republic of Congo, Cote d'Ivoire, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya Lesotho, Liberia, Madagascar, Malawi, Mali, Maritius, Mozambique Namibia, Niger, Nigeria, Rwanda, Sao Tome Principe, Senegal, Seychelles, Sierra Leone, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Zambia, Zimbabwe

Table 8: List of Countries in 3-Region Aspirations Model

Region	Countries
Asian Tigers	Hong Kong, Indonesia, Korea, Malaysia, Philippines, Singapore, Taiwan, Thailand, Vietnam
Emerging Market + Sub Sahara	Afghanistan, Angola, Albania, Algeria, Argentina, Armenia, Bahamas, Bahrain, Bangladesh, Barbados, Belize, Benin, Bhutan, Bolivia, Botswana, Brazil, Brunei, Bulgaria, Burkina Faso, Burundi, Cambodia, Cameroon, Cape Verde, Central African Republic, Chad, Chile, China, Colombia, Comoros, Democratic Republic of Congo, Republic of Congo, Costa Rica, Cote d'Ivoire, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, Ethiopia, Fiji, Gabon, Gambia, Ghana, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Hungary, India, Iran, Iraq, Jamaica, Kenya, Laos, Lebanon, Lesotho, Liberia, Madagascar, Malawi, Maldives, Mali, Maritius, Mauritania, Mexico, Mongolia, Morocco, Mozambique, Namibia, Nepal, Nicaragua, Niger, Nigeria, Oman, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Poland, Romania, Rwanda, Senegal, Sierra Leone, Solomon Islands, South Africa, Sri Lanka, Sudan, Suriname, Swaziland, Syria, Tanzania, Trinidad Tobago, Togo, Tunisia, Turkey, Uganda, Uruguay, Venezuela, Zambia Zimbabwe
G7	Canada, France, Germany, Italy, Japan, United Kingdom, United States