Dynamic Status Effects, Savings, and Income Inequality[♣]

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Abstract

This paper advances the hypothesis that the intensity of status preferences negatively depends on the average wealth of society *(endogenous dynamic status effect*), in accordance with empirical evidence. Our behavioral driven theory is able to replicate the contradictory historical facts of an increasing savings rate along with declining returns on capital over time. Employing these results, we are also able to explain the observed historical dynamics of income inequality as an implication of our hypothesis. In particular, our theoretical model implies that, as an economy develops, the savings rate increases (for plausible parameter values) during transition. Convergence to a balanced growth path requires the *level* of the (increasing) savings rate to be lower compared to a standard growth model, thereby a lower rate of capital accumulation as well as –speed of convergence (SOC). This benefits the wealthy households relative to poor ones, as the rate of interest declines at a lower rate during transition. Therefore, the endogenous dynamic status effect contributes to a rise (to a lower decline) in wealth inequality. Along the same lines, we analyze the more recent behavior of inequality in response to changes in wealth (income) induced by productivity shocks. Under a positive productivity shock, in economies with a strong enough endogenous dynamic status effect, inequality increases – a fact that we experience in many countries around the globe nowadays.

JEL classification: *D11, D31, O11.*

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1. Introduction

It is well documented that individuals are concerned with social comparisons and status, particularly as it pertains to consumption. [1] This paper advances the hypothesis that the degree to which individuals in a society are concerned with status is determined by that society's stage of development, which we proxy by its average level of wealth. Social comparisons in terms of consumption seem to be more important during the early stages of development rather than in later stages, due to, among other factors, the evolution of institutions (education), culture, and social norms that are opposed to, or at least discourage, conspicuous consumption activities. To address this process we endogenize the degree of status concern, by relating it to average national wealth, and demonstrate that over time, as a country develops, this degree (with respect to consumption) declines. We refer to this mechanism as "*endogenous dynamic status preferences*."

The idea that individuals are often motivated in their behavior by a quest for social status is not new. It goes back to the earliest writings known to humanity. It has been a recurring theme in a diverse range of endeavors and was a central theme in Western political philosophy long before the birth of economics.[2] While economic theory has focused on the implication of status preferences on economic outcomes and policy, little work has been done on the bi-directional interaction of status preferences and economic development.[3]

Employing endogenous dynamic status preferences enables us to address and explain important phenomena that cannot be satisfactorily explained by the standard neoclassical growth model (at least for reasonable calibrations). These include: (i) the historical and contemporary evolution of the savings rate together with the evolution of the real return on capital; (ii) the historical dynamics and contemporary dynamics of wealth and income inequality;

In this paper, we consider the following stylized facts, pertaining to the transitional dynamics

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[1] Most of the "status" literature focuses on comparing consumption, although there is a substantial literature that evaluates status in terms of relative wealth.

[2] Nobel Laureate economist, John Harsanyi, has said that apart from economic payoffs, social status seems to be the most important incentive and motivating force of social behavior.

[3] Examples include early `modern' models and applications like Pigouvian taxation, Buchanan and Stubblebine's (1962) treatment of externalities, Becker's (1971) analysis of discrimination, Becker's (1974) theory of social interaction, and Frank's (1985a) model of positional goods.

of the savings rate and income inequality that a standard growth model augmented by endogenous dynamic status preferences can replicate for reasonable calibrations. (i) Historical data show that from the dawn of the modern world until 1970s, the savings rate increases (along with declining returns to capital), a fact that cannot be reproduced by the standard neoclassical growth model, for reasonable calibrations (Fact 1). (ii) From 1970s onwards, in many countries savings rates tend to decrease along with declining returns to capital (Fact 2). (iii) World income inequality decreases from the 1900s until the 1970s at a decreasing rate (Fact 3, illustrated in Figs. A1 and A2). (iv) After the 1970s, for one group of countries income inequality remains approximately constant, yielding an L-shaped pattern (Fact 4, illustrated in Fig. A.1). (v) In contrast, for another group of countries inequality increases sharply after the 1970s, yielding a U-shaped pattern (Fact 5, illustrated in Fig. A2). In addition, Saez and Zucman (2016) confirm a U-shaped behavior of wealth inequality using historical data for US from 1913 to 2013.

Our key mechanism enabling reconciliation with Facts 1 to 5 – endogenous dynamic status preferences – operates through the transitional dynamics of the savings rate, which in turn affect the development of income inequality, as discussed below. This mechanism relies on behavioral changes that occur during the development process. As already noted, it is well documented that people obtain utility not only from their own consumption but also from their social position with respect to others (Easterlin, 2001). Once consumption is a visible action (Heffetz, 2011, 2012), the social position of individuals can be largely determined from their own consumption relative to the average consumption of others.[4] On the one hand, by consuming more, people increase their own relative position and, in turn, their utility. On the other hand, the pursuit of one's own status initiates a race with other individuals, which results in excessively high equilibrium consumption that strains savings and intertemporal utility. We argue that during the development process, increases in average wealth lead to the formation of educational institutions, cultures and social norms that are opposed to such conspicuous consumption activities. As a result, the increase in average wealth induces behavioral changes that imply a lower degree of status concern, which, *ceteris paribus*,

[4] A commodity is visible if, in the cultural context in which it is consumed, society has direct means to correctly assess the expenditures involved (Heffez, 2011).

tends to raise the savings rate along transitional paths. By employing numerical simulations, we show that this effect dominates over long periods during (the stages of) development, so that the savings rate initially increases over a long period.

The hypothesis of a declining degree of status concern during development is supported by a number of empirical studies. Clark and Senik (2010), using a large European survey, demonstrate that comparisons are mostly in an upward direction. In this respect there is much more scope for upward comparisons for the poor (for poor countries) than exists for the rich (for rich countries). Moreover, poor tend to care more about status with respect to relative consumption.[5] Heffetz (2011) estimates income elasticities for the consumption of "status" goods, and confirms the negative relationship between the degree of status concern and income. Looking across countries, Moav and Neeman (2009) provide examples where the consumption basket of the poor countries includes many goods that do not appear to alleviate poverty. In their theoretical model, unobservable income is correlated with observable human capital. As a result, they conclude that in rich countries people signal status rather through professional titles and degrees and have less motivation to signal through conspicuous consumption.

Our explanation of the long-run development of income inequality is based on the interplay between the savings rate dynamics and the dynamics of the return to capital during the development process. While there is an extensive literature that examines the effect of capital returns on income inequality (among many others, Piketty 2013), we highlight how this interplay is impacted by the evolution of the dynamic status preferences. In a standard neoclassical world, as the capital stock increases, the rate of return to capital decreases. This "*return-to-capital effect*" benefits the poor, who hold less capital than do the rich (the "convergence" hypothesis).[6] Our model, however, emphasizes an additional mechanism. During development, as the economy's capital stock increases, people tend to increase their savings rate due to a reduction of the degree of status concerns. If this endogenous dynamic status effect is strong enough, then, in a society with a

[5] Importantly, literature in psychology states that individuals seem to care about their ranking and the esteem of others, even if they derive no clear economic benefits, and are willing to pay respect to others and to modify their behavior accordingly, without receiving any direct benefit (cf. Heffetz and Frank 2008).

[6] During transition, a decline in the return on capital lowers the capital income of the rich by more than that of the poor.

heterogeneous wealth distribution, the increase in the savings rate benefits the rich[7], reduces the speed of convergence, and induces a more unequal wealth- or income distribution. That is, the strength of the endogenous dynamic status effect relative to that of the standard return-to-capital effect governs the evolution of income inequality.

Our numerical simulations performed for a positive technology shock show how the evolution in the interplay between the return-to-capital and the endogenous dynamic status effects can play an important role in reconciling the implications of the augmented neoclassical growth model with the empirical evidence illustrated in Figs. A.1 and A.2. Starting in 1900, when all economies were relatively undeveloped, the return-to-capital is strong and clearly dominates the status-effect, and inequality declines upon a positive productivity shock. Over the period 1900-1970 as economies develop, the strength of the dynamic status effect increases relative to the return-to-capital effect and the rate of decline in income inequality increases. After around 1970, with the different rates of development characterizing different economies, for the slower developing countries cultural developments occur slowly, so that the two effects are roughly in balance and inequality remains roughly constant, yielding the L-shaped curve as in Fig. A.1. For other economies where the dynamic status effect is stronger and continues to increase, it begins to dominate the return-to-capital effect. Income inequality starts to increase, yielding the U-shaped curve illustrated in Fig. A.2.

The remainder of the paper is structured as follows. Section 2 relates our contribution to the relevant literature. Section 3 sets out the model and provides empirical evidence for status concerns to decline in average wealth over time. Section 4 solves the optimization problem of households and firms, and studies the properties of the decentralized economy. Section 5 analyzes the dynamics on wealth inequality. Finally, Section 6 concludes the paper and discusses further research directions. Technical details are relegated to the Appendix.

2. Related Literature

[7] A rise in the savings rate increases the wealth of rich more than that of poor individuals.

To our knowledge, this is the first paper that theoretically formalizes and analyzes the implications of the hypothesis asserting that the subjective evaluation of status preferences declines as a country develops. In this regard it contributes to three bodies of literature. These include: (i) implications of positional goods in utility; (ii) studies of the dynamics of the savings rate; (iii) the dynamics of wealth and income inequality.

2.1 Degree of Positionality

The proposition that people derive utility not only from their own consumption but also from their level of consumption relative to others can be traced back to Smith (1759) and Veblen (1889). Veblen's (1889) observation has been empirically justified by the Easterlin (1995) "paradox" who found that increases in income by all individuals had a negligible effect of their happiness. This finding was confirmed in empirical studies by Clark and Oswald (1996) and Frank (1997). The consequences of positional preferences has been extensively investigated in a number of areas. These include their effects on capital accumulation and growth: [Brekke and Howarth 2002, Carroll et al., 1997, Alvarez-Cuadrado et al., 2004, Liu and Turnovsky, 2005, Wendner, 2010], on asset pricing [Abel 1999, Campbell and Cochrane 1999, Dupor and Liu 2003)] on optimal tax policy over the business cycle (Ljungqvist and Uhlig 2000) and on public good provision [Micheletto 2011, Wendner and Goulder, 2008, Wendner, 2014]. But in all those applications the strength of positional preferences is exogenous and constant over time, making these models incapable of deriving the non-monotonic evolution of savings and the distribution of wealth we observe in the historical and contemporary empirical data.

Our fundamental hypothesis is based on two elements regarding the formation of households' preferences. First, the evolution of preferences for status is negatively related to the level of average wealth. This element has important consequences for the dynamics of savings, as discussed in this section and analyzed in the proceeding sections below. Second, the dependence of status preferences on average wealth varies across countries due to different cultural and institutional characteristics. This element helps explaining how cultural differences in the evolution of the concern for status can account for the divergence in wealth and income inequality.

Empirical support for both elements is provided by studies on the determinants of status preferences. In particular, Bloch et al. (2004), Chung and Fischer (2001), Banerjee and Duflo (2007), and Heffetz (2011) empirically support the ideas that people rely on relative consumption to raise their perceived status and that average income or wealth plays an important role in shaping the strength of status preferences. Charles et al. (2009), argues that since the marginal return to signaling through conspicuous consumption is decreasing in the average income of a person's reference group, less conspicuous consumption should be observed among individuals who have richer reference groups. This observation has also been empirically formalized by Heffetz and Frank (2011) as stated in the Introduction. Boppart (2014), looking at time series data for the US and other advanced countries, states as an empirical regularity the fact that poor households spend a larger fraction of their budget on goods (as opposed to services, which are considered less positional) than do rich households [although the relative price of goods falls over time].[8]

Across countries, Banerjee and Duflo (2007) show that in poor countries, people care more about status. Moav and Neeman (2009) argue that more developed countries possess, on average, more human capital than do less developed countries. If human capital is visible (e.g. an academic title), then in more developed countries, the signaling of status (unobservable income) is pursued more with human capital than with consumption. This is not possible in less developed countries, where status signaling is done primarily via conspicuous consumption.

2.2 Dynamics of the Savings rate and the Real Return to Capital

The first implication of our hypothesis relates to the determination of the savings rate. According to the standard neoclassical growth model, for reasonable parameter values (see Barro and Sala-i-Martin 2004, p.109), higher capital (wealth) leads to a lower rate of return on capital and, in turn, to a lower savings rate (see Barro and Sala-i-Martin 2004, pp.109f, pp.135ff). However, empirical evidence indicates that savings rates are higher for richer countries (Loayza,

[8] According to the Bureau of Economic Analysis (BEA), a 'good' is defined as "a tangible commodity that can be stored or inventoried," which, in turn, can be a status good (as opposed to services that are positional to a lesser degree). The main (sub)categories the BEA classifies as 'goods' are: "motor vehicles and parts," "furnishings and durable household equipment," "recreational goods and vehicles," "food and beverages purchased for off-premises consumption," "clothing and footwear,". The goods belonging to that category typically can be positional goods because they are observable and their value depends relatively strongly on how they compare with goods owned by others.

Schmidt-Hebbel, and Serven, 2000). Also, examining historical data for the US, Saez and Zucman (2016) find that the saving rates tend to rise with wealth. Furthermore, Weil (2005) documents that the savings rate is about 5 percent on average for countries in the lowest income decile (i.e. those most closely to subsistence and most similar to England and other European countries in the Middle Ages). The savings rate then gradually increases with income. It is about 10 percent in countries in the second decile, about 20 percent for the seventh decile and somewhat above 30 percent for the tenth decile.

The savings rate increases with wealth over time. To address this, the literature mainly considers technological factors that increase the return to capital over time and, in turn, the savings rate. However, by associating the increased savings rate with increasing returns to capital this explanation contradicts recent evidence provided by Boppart (2014) and Ledesma and Moro (2016), suggesting that the return to capital is decreasing over time.

On the preference side, Strulik (2014) shows that as wealth increases, the pure rate of time preference decreases. Therefore, in any given country, as capital accumulates over time, individuals become more patient, which tends to raise the savings rate. Likewise, at any given point in time, countries with patient individuals tend to experience higher saving rates. In this respect, we provide a new mechanism based on preferences as well. Following our main hypothesis, we formally argue that as a country develops people are less concerned with relative consumption. As a consequence, individuals reduce their consumption growth rate over time, that is, they tend to increase their savings rate over time. This mechanism is based on preferences, thus, it creates the possibility that, over time, the savings rate rises while the return on capital simultaneously declines.

2.3 Savings and Inequality

There is an emerging literature that attributes the contemporary increase in income- and wealth inequality to differences in the savings rates across individuals. De Nardi and Fella (2016) provides an extensive review of the literature where differentials in the savings rates and income levels between wealthy and less wealthy individuals are generated by various sources. These include: the transmission of bequests and human capital [De Nardi, 2004], by preference heterogeneity [Krusell and Smith, 1998], by rates of returns heterogeneity [Benhabib, Bisin and Luo, 2015], by entrepreneurship [Cagetti and De Nardi, 2006], by richer earnings processes [Castaneda, Diaz-Gimenez, and Rios-Rull, 2003, and De Nardi, Fella, and Paz Pardo, 2016], and by medical expenses [De Nardi, French, and Jones, 2010]. The main assumption of this literature is ex-post heterogeneity, and its theoretical underpinning is the Bewley (1977) model, which features an incomplete market environment, in which people save to self-insure against idiosyncratic earnings shocks

These models are compelling and useful to capture quantitatively the increase in wealth inequality in the US after 1970s. However, they do not explain: a) why those factors (the richer model structure) were less crucial during the *decline* in wealth and income inequality that we observe from the 1900s (Saez and Zucman, 2016); b) why the saving rate of rich individuals is higher but still declining in wealth (as capital accumulates) over time – something that we do not observe before the 1970s and in many countries even not after the 1970s; c) why wealth inequality develops differently in the US and similar developed countries (among others Sweden and Japan); d) the transitional dynamics of the wealth- or income distribution (but rather focus on contemporary data).

Our theory is consistent with the results of the previously discussed literature on savings and inequality. But in addition, it also provides explanations of the aforementioned points a) to d). To accomplish this, our model follows a different methodological approach. First, we depart from the incomplete markets assumption and from stochastic environments by assuming ex-ante rather than ex-post heterogeneity in individual wealth endowments or individual abilities. This enables us to rely on a deterministic mechanism that is able to explain the early decline in inequality. Second, we emphasize a behavioral mechanism according to which the saving rate is not only determined by the rate of return to capital, but also by a change in status preferences over time. This preference-based mechanism enables us to explain the contemporary differentials in wealth- and income inequality across developed countries when they are hit by the identical aggregate shock.

Our methodology follows, among others, Caselli and Ventura (2000) and Garcia-Penalosa and Turnovsky (2015) that assume ex-ante heterogeneity in wealth and/or abilities. In particular, Caselli and Ventura (2000) show that a technology bias (differences in the elasticity of substitution of factors of production) is able to capture the contemporary increase in inequality under a positive productivity shock. In particular, a positive productivity shock benefits the holders of capital, if capital is or becomes more important in the production function. This mechanism is also in line with Piketty's (2014) empirical observation of an increasing capital share in production as economies develop. However, these frameworks are less helpful in explaining the differentials in savings behavior of rich relative to poor countries, following recent evidence (Dynan, Skinner and Zeldes, 2004 and De Nardi, Frence and Jones, 2010). Moreover, as technologies in developed countries seem to converge (e.g. according to Caselli and Feyrer, 2007 the marginal product of capital is very similar across countries), technology-based mechanisms seem less capable of explaining why inequality evolves differently in countries with the same factor shares in production. To this end, our framework complements this literature by providing a preference-based mechanism that operates through the strength in status preferences (implying differential behavior of savings) whose development is captured by cultural characteristics (Acemoglu and Robinson, 2015).

Finally, while there is agreement that the share held by the richest few is high, the extent to which this share has changed over time (and why) is still subject to debate (Piketty (2014), Saez and Zucman (2014), Bricker et al. (2015), and Kopczuk (2014)). To this end, we study the transitional dynamics of the wealth distribution.

3. The model

We modify the standard neoclassical growth model with heterogeneous agents to allow for interdependence in consumption and *endogenous dynamic status* preferences, the strength of which declines as the country develops.

3.1 Households

The economy is populated by a continuum of individuals (households) of mass one. Each agent is endowed with one unit of labor that is supplied inelastically and they are identical in all respects except for their initial endowment of capital (wealth), K_{i0}.[9] At each instant $k_i(t) \equiv K_i(t)/K(t)$ is household i 's individual to total wealth ratio.[10] Heterogeneity in wealth ratios is summarized by the cumulative distribution function, $H_t\left(k_i(t)\right)$ with the standard deviation (coefficient of variation of $K_i(t)$) by $\sigma(t)$. The initial distribution $H_0(k_{i0})$ is exogenously given, with standard deviation

3.1.1 Endogenous dynamic status preferences

Individual utility depends both their own consumption level, $C_i(t)$, as well as their consumption, relative to some comparison group, $r_{it}(C_i(t),\overline{c}(t))$, where $\overline{c}(t)$ represents the consumption reference level. We consider average consumption to represent the consumption reference level: $\overline{c}(t) = \int_0^1 C_i(t)\,di$, where the bar indicates that individual households consider the consumption reference level as exogenously given.[11] A preference for relative consumption is frequently termed "positional or status preference". Our theory of endogenous dynamic status preferences mainly focuses on how strongly r_{it} is valued in a given country over (long periods of) time. We hypothesize that the valuation of r_{it} relative to own individual consumption C_{it} evolves over time, as a country develops – as measured by the *average* capital stock $k(t) \equiv K(t)$.[12]

We have already cited empirical data to suggest that the valuation of r_{it} relative to $C_i(t)$ declines over time, as a country develops. Before considering this claim more analytically, we provide a graphical intuition, as suggested by Clark et al. (2008). They argue that over time, as a country becomes wealthier, a higher-than-average income (wealth) contributes less and less to happiness.

[9] We discuss the case with endogenous labor supply in an extension to this base model. By having labor supply fixed in our base model, we sharpen the discussion (and intuition) of the impact of *endogenous dynamic status* preferences.
[10] We consider a closed economy in which capital is the only asset. That is, total wealth in the economy corresponds to the aggregate capital stock $K(t)$.
[11] Clearly, the consumption reference level might differ from $\overline{c}_t$. In this paper, however, we focus on the *endogeneity of status preferences* and would otherwise like to keep the setup as simple as possible.
[12] By normalizing the population to one, averages and aggregates coincide.

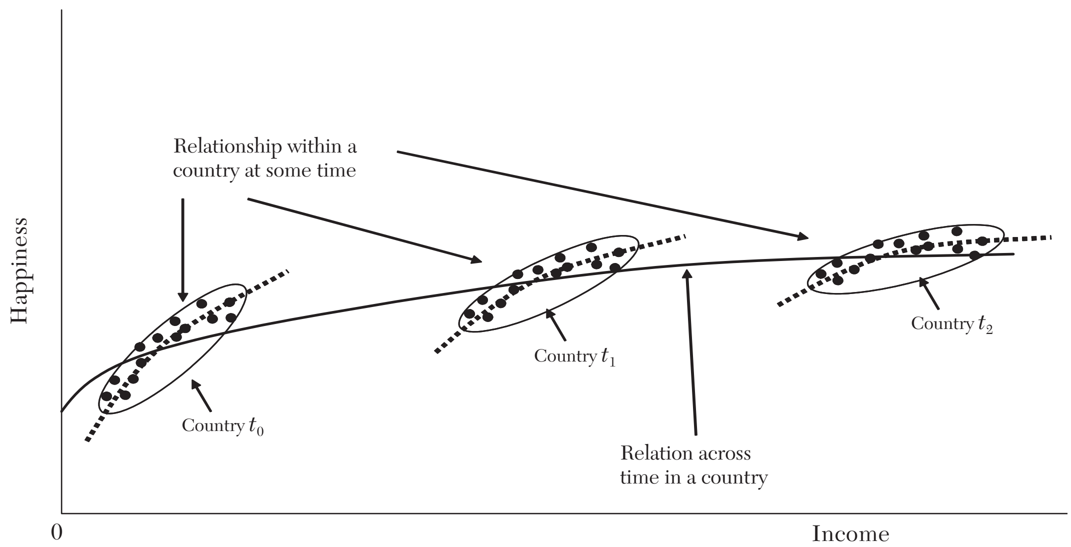

Figure 1: Income (wealth) and happiness as a country develops over time. *Source.* Clark, Frijters and Shields (2008, p.101)

Consider the dotted lines in Figure 1. These specify the relationship between *individual* incomes and happiness. The ellipse corresponding to date t_0 shows that a given increase in own income relative to the average raises happiness as given by the dotted line. Considering the other ellipses corresponding to later time when the country is more developed, the same given increase in own income relative to the average raises happiness, but by less (i.e. the dotted curves become the flatter over time/with increasing wealth).

The key elements of our theory of endogenous dynamic status preferences are individual consumption, $C_i(t)$, relative consumption, $r_{it} \equiv C_i(t)/\bar{c}(t)$, and a development-dependent ($k(t)$ -dependent) variable, $\varepsilon(k(t))$, which measures the relative strength of status preferences and the properties of which are discussed below.[13] Thus, omitting time subscripts the instantaneous individual utility is given by

$$U = U\left(C_i, \left(\frac{C_i}{\bar{c}}\right), \varepsilon(k)\right) = U\left(C_i, r_i, \varepsilon(k)\right), \tag{1}$$

Instantaneous utility increases in both individual and both relative consumption ($U_{C_i} > 0, U_{r_i} > 0$).

[13] This specification of status preferences in relative terms is prevalent throughout the literature; see. e.g Gali (1994). A *subtractive* formulation $r_{it} = C_i(t) - \bar{c}(t)$, is also possible and yields results equivalent to those presented in this paper.

The impact of the relative strength of status on utility is also important, but is less clear-cut. We shall assume that $U_\varepsilon \varepsilon / U > 0$. As we shall see from the example to be presented in Section 4.2, the direction of this effect depends crucially upon the magnitude of the consumption reference level, $\overline{c}$.

To capture the weight that is being applied to the absolute and relative consumption levels, we introduce the notion of the *degree of positionality* (DOP). The DOP, as defined by Johansson-Stenman et al. (2002), reflects the proportion of the total marginal utility of individual consumption that can be attributed to its impact on the increase in relative consumption. Formally, we specify this by

$$DOP_i = \frac{(\partial U / \partial r_i)(\partial r_i / \partial C_i)}{(\partial U / \partial r_i)(\partial r_i / \partial C_i) + (\partial U / \partial C_i)} \quad . \tag{2}$$

Thus, if $DOP_i = 0.4$, then 40% of marginal utility of consumption arise from an increase in relative consumption, and 60% of marginal utility of consumption arise from an increase in own *absolute* consumption (holding fixed r_i).[14]

To make our analysis tractable, we assume

Assumption 1. The instantaneous utility function $U\left(C_i, r_i, \varepsilon(k)\right)$ is homogeneous of degree R in C_i. Specifically, $U\left(C_i, r_i, \varepsilon(k)\right) = R^{-1} C_i^R V(\overline{c}, \varepsilon(k))$, where $V_{\overline{c}} < 0$.

Adopting Assumption 1, the degree of positionality, as shown in the Appendix, becomes

$$DOP(c,k) = -\frac{V_{\overline{c}}(\overline{c}, \varepsilon(k))\overline{c}}{RV(\overline{c}, \varepsilon(k))} . \tag{3}$$

The homogeneity imposed in Assumption 1 implies that the DOP is the same for all individuals. We capture the fact that the DOP declines in average wealth by endogenizing $\varepsilon(k(t))$. As seen in (3), the degree of positionality is a function of both consumption and the stock of capital.

Assumption 2. The properties of $\varepsilon(t) \equiv \varepsilon(k(t))$ are:

(i) $\varepsilon(t) > 0$ is strictly positive and continuous;

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[14] As a canonical example consider the utility function $U\left(C_i, r_i, \varepsilon(k)\right) = \gamma^{-1}(C_i^{1-\varepsilon(k)} r_i^{\varepsilon(k)})^\gamma$. Applying (2), one can immediately establish that $DOP_i = DOP = \varepsilon(k)$.

(ii) $\varepsilon'(t) \equiv \frac{\partial \varepsilon(t)}{\partial k(t)} < 0$;

(iii) $\lim_{k(t)\to 0} \varepsilon(t) = \varepsilon_0 > 0$ and $\lim_{k(t)\to\infty} \varepsilon(t) = \varepsilon_\infty < 1$, with $\varepsilon_0 > \varepsilon_\infty$.

Assumptions (2.i) and (2.iii) characterize the concern for status (positional preferences).[15] Households do not choose their individual DOP to display status. Rather the strength of the status preference is socially determined by the society's wealth (proxied by average wealth), which the individual households take as given, and therefore treat $\varepsilon(t)$, as given, as well. Assumption (2.ii) asserts that the strength of status concerns declines in wealth (income), as suggested by Fig. 1, and the empirical evidence presented in Section 2. That is, agents are more concerned with status in a status-oriented society (low wealth) than in a less status-oriented society (high wealth).

3.1.2 Household optimization

The individual household's optimization problem is to choose a consumption stream, C_{it}, and to accumulate capital, $K_i(t)$, so as to maximize intertemporal utility

$$\int_0^\infty U(C_i(t), r_{it}, \varepsilon(k(t)))e^{-\beta t}dt, \quad \beta > 0 \tag{4}$$

subject to the flow budget constraint:

$$\dot{K}_i(t) = \upsilon(t)K_i(t) + w(t) - C_i(t). \tag{5}$$

the initial asset endowment, $K_{i0} > 0$, the transversality condition, and taking $\bar{c}(t)$ and $k(t)$ as given. In (4) and (5), β is the constant pure rate of time preference, $\upsilon(t)$ is the real return on asset (capital) and $w(t)$ is the wage rate.

Solving the intertemporal maximization problem, the individual's equilibrium consumption growth rate is given by (see the Appendix):

$$\frac{\dot{C}_i}{C_i} = \frac{1}{1 - R(1 - DOP)}\left[\upsilon - \beta + \left(\frac{V_\varepsilon \varepsilon'(k)}{V}\right)\dot{k}\right]. \tag{6}$$

Equation (6) represents the usual Euler equation, augmented by our status effect. Consumption

[15] In the canonical example in footnote 14, if $\gamma\varepsilon < 0$, our specification implies that households keep up with the Joneses (cf., e.g., Garcia-Peñalosa and Turnovsky, 2008).

growth depends positively on the return on assets (return-to-capital effect). In the absence of positional preferences ($DOP = 0 = \varepsilon'(k)$), the optimal consumption growth rate (6) corresponds to the expression corresponding to the standard neoclassical growth model.

In the standard neoclassical growth model, $1/(1-R)$ corresponds to the intertemporal elasticity of substitution (IES). Here IES is given by[16]

$$IES(c,k) = \frac{1}{1 - R(1 - DOP(c,k))} > 0\,. \tag{7}$$

Positional preferences modify the optimal consumption growth rate in two ways. First, they impact the IES. If $R < 0$, as the empirical evidence overwhelmingly suggests, positionality raises the IES.[17] For a given rate of interest, individual households raise the optimal consumption growth rate, as documented, among others, by Liu and Turnovsky (2005). Second, positional preferences introduce a dynamic status effect. If $\dot{k} > 0$, under Assumption 2(ii), the status effect causes the optimal consumption growth rate to decline as a country develops. The intertemporal consumption decision is affected by the degree with which people evaluate their social status over time. The more the agents evaluate their *relative* position, the more they consume in order to raise their respective relative position. However, as the economy accumulates capital, the degree of positionality declines. As the society becomes wealthier, people develop norms towards investment in assets rather than current consumption. As a consequence, agents tend to increase the savings rate and to reduce the consumption growth rate (during transition). It is this second effect of positional preferences that we emphasize and focus on in this paper.

3.2 Production

There is a single representative firm, which produces aggregate output Y in accordance with the Cobb-Douglas production function

$$Y(t) = AK(t)^{\alpha} L(t)^{1-\alpha}\,, \;\; 0 < \alpha < 1, \tag{8}$$

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[16] By taking account of the impact of the consumption externality on the agent's intertermporal substitution, (7) can be interpreted as measuring the "social intertemporal elasticity of substitution".

[17] See e.g. Guvenen (2006).

where K, L denote capital and labor inputs, and A represents total factor productivity (TFP). Labor endowment is normalized to unity, and we assume no population growth. The representative firm maximizes profit $\pi(t) = Y(t) - w(t)L(t) - (\upsilon(t)+\delta)K(t)$, where δ is the depreciation rate of physical capital, yielding the standard first-order conditions optimality conditions:

$$\begin{aligned} \upsilon(t) &= \alpha A L(t)^{1-\alpha}\left(K(t)\right)^{\alpha-1} - \delta, \\ w(t) &= (1-\alpha) A L(t)^{-\alpha}\left(K(t)\right)^{\alpha}. \end{aligned} \tag{9}$$

4. Equilibrium and the Dynamics of Savings and Wealth

4.1 Equilibrium Dynamics of Savings and Wealth and Long-run Equilibrium

In this section we solve for a competitive equilibrium and analyze its properties. Notice that $c(t) \equiv C(t)/L(t)$; $k_i(t) \equiv K_i(\mathrm{t})/K(t)$.

Definition 1. *A competitive equilibrium is a (factor) price vector $(\upsilon(t), w(t))$ and an attainable allocation for $t \geq 0$ such that:*

(i) Individuals solve their intertemporal utility maximization problem by choosing $K(t)$ and $K_i(t)$, given factor prices, initial wealth endowments, and the consumption reference level.

(ii) Firms choose $K(t)$ and $L(t)$ in order to maximize profits, given the factor prices.

(iii) All markets clear. Capital market clearing implies $k(t) = K(t)$ (total assets held by agents equal the firms capital stock). Labor market clearing implies $L(t) = 1$.

(iv) Aggregation: $K(t) = \int_0^1 K_i(t)di = k(t)$; $\int_0^1 k_i(t)di = 1$; and $C(t) = \int_0^1 C_i(t)di = c(t)$.

(v) Consumption reference level: $\overline{c}(t) = c(t)$.

Considering (iii), observe that the mean individual to total wealth ratio equals unity: $\int_0^1 k_i(t)di = \int_0^1 (K_i(t)/K_t)di = 1$. While individual households take the consumption reference level, $\overline{c}(t)$, as given *(i)*, in equilibrium we assume that the consumption reference level is given by the economy-wide average consumption level (c).

Combining (5) – (9), and using market clearing (and aggregation) conditions, we obtain the equilibrium dynamics of the average variables in the economy:

$$\dot{k} = Ak^{\alpha} - c - \delta k$$
$$\dot{c} = \frac{c}{1 - R(1 - DOP)}\left[\alpha A k^{\alpha-1} - (\delta + \beta) + \left(\frac{V_{\varepsilon}\varepsilon'(k)}{V}\right)\dot{k}\right] \tag{10}$$

where DOP is defined by (3). Defining the elasticity of utility with respect to k by $E(c,k) \equiv V_k k / V = V_{\varepsilon}\varepsilon'(k)k / V \leq 0$, we can conveniently rewrite the dynamic system as

$$\dot{k} = Ak^{\alpha} - c - \delta k$$
$$\dot{c} = c\, IES(c,k)\left[\alpha A k^{\alpha-1} - (\delta + \beta) + \left(E(c,k)/k\right)\dot{k}\right] \tag{10'}$$

Clearly, in the absence of the endogenous dynamic status effect $\varepsilon'(k) = 0 = E(c,k)$, while in its presence $\varepsilon'(k) < 0 \Rightarrow E(c,k) < 0$. Finally, we define the savings rate by

$$s = 1 - \frac{c}{Ak^{a}} \quad . \tag{11}$$

Setting $\dot{c} = \dot{k} = 0$, the steady state per capita capital and consumption, (k^*, c^*) are given by

$$k^* = \left(\frac{A\alpha}{\beta + \delta}\right)^{\frac{1}{1-\alpha}} > 0, \quad c^* = \beta\left(\frac{A\alpha}{\beta + \delta}\right)^{\frac{1}{1-\alpha}} + A(1-\alpha)\left(\frac{A\alpha}{\beta + \delta}\right)^{\frac{\alpha}{1-\alpha}} > 0$$

which further yield the long-run capital-output ratio and savings rate

$$\frac{k^*}{y^*} = \frac{\alpha}{\beta + \delta}, \; s^* = \frac{\alpha\delta}{\beta + \delta}$$

Thus these steady state quantities are all unique and positive with the savings rate lying in the range $0 < s^* < 1$. Furthermore, linearizing the dynamic system (10') around the steady state one can easily show that the determinant of the matrix of coefficients of the linearized system is negative implying that the unique steady state is a saddle point and is saddle-point stable.

Thus we see that the long-run equilibrium is identical to that of the standard neoclassical growth model and is independent of the degree of status preferences. This is because, with inelastic labor supply status does not affect the production process in the economy, which is the driving force behind the long-run equilibrium. However, it does affect the transitional dynamics and the distribution of income and wealth, as the change in the intensity of status matters for the intertemporal decision of agents.[18] The impact of the changing status on savings behavior is summarized by the following proposition:

Proposition 1. *Consider Assumption 2, specifically the endogenous dynamic status effect* $\varepsilon'(t) < 0$ *. During transition, the dynamics of the savings rate may be non-monotonic while the dynamics of the real interest rate is always monotonic. In particular:*

(i) As long as the endogenous dynamic status effect is sufficiently strong, there exist plausible parameter values such that at low levels of k*, the savings rate increases, as capital increases. Specifically, the savings rate increases as long as*

$$\dot{s} \gtrless 0 \Leftrightarrow s^* \gtrless \frac{IES(c,k)}{\xi(c,k)}, \;\; \xi(c,k) \equiv 1 - IES(c,k)\, E(c,k)/\alpha \geq 1. \tag{12}$$

Once k *reaches a threshold level, the savings rate declines, and levels out to its steady state value, as capital increases further.*

(ii) The interest rate is always declining as the capital stock increases.

Proof. See the Appendix.

Proposition 1 shows that the transitional dynamics of the savings rate may not possess the standard neoclassical properties. According to the neoclassical growth model an increase in the capital stock increases the supply of capital and reduces its return. As the return to capital falls, individuals have a lower incentive to save and the savings rate falls (return-to-capital effect). In turn, the consumption growth rate falls (see (10)). However, in our model, a rise in the capital stock also has a positive effect on savings through its effect on status preferences. When the capital stock increases agents choose a lower rate of consumption growth together with an initially higher level of consumption, as is evident from (10') due to the fact that $E(c,k) < 0$. If the dynamic status effect is sufficiently strong, that is, the absolute value $\left|E(c,k)\right|$ is large enough, then the consumption

[18] This characteristic is identical to the conventional model where status preferences are exogenously fixed; see Liu and Turnovsky (2005). As in that model, status preferences will have long-run effects if labor supply is elastic.

growth rate is lower than the output growth rate, and the savings rate increases.[19]

Proposition 1 states that $\dot{s} \gtreqless 0 \Leftrightarrow s^* \gtreqless \dfrac{IES(c,k)}{\xi(c,k)}$. In the absence of status preferences, this condition is well known. Barro and Sala-i-Martin (2004, p.136) show that $\dot{s} \gtreqless 0 \Leftrightarrow s^* \gtreqless IES(c,k)$. Without status preferences (i.e. $E(c,k)=0$) $\xi(c,k)=1$, and our condition reduces to Barro and Sala-i-Martin's (2004) condition. However, in the presence of the endogenous status effect, $\xi(c,k)>1$, and is unconstrained by any upper limit. For this reason, as long as $\xi(c,k)$ is large enough, $\dot{s}>0$ during transition, even when $s^* < IES(c,k)$ for reasonable calibrations. In this latter case, though, for large *k*, $E(c,k)$ becomes close to zero, thus $\xi(c,k)\approx 1$, and the savings rate declines.

To summarize: on the one hand, the increase in capital reduces the return to capital. This lowers the rate of interest and tends to lower the savings rate. On the other hand, the increase in capital reduces the consumption growth rate via the endogenous dynamic status effect $(\varepsilon'(k)<0)$. The lowering of the consumption growth rate tends to raise the savings rate. As long as the dynamic status effect dominates the return-to-capital effect, the savings rate increases during transition.

4.2 An example of endogenous dynamic status preferences

We specify the instantaneous utility function to be:

$$U = \frac{1}{\gamma}\left(\left[1-\varepsilon(k)\right]C_i^{\rho} + \varepsilon(k)\left(\frac{C_i}{\overline{c}}\right)^{\rho}\right)^{\frac{\gamma}{\rho}} = \frac{C_i^{\gamma}}{\gamma}\left(\left[1-\varepsilon(k)\right]+\varepsilon(k)\overline{c}^{-\rho}\right)^{\frac{\gamma}{\rho}}, \qquad (13)$$

in which the degree of homogeneity corresponds to $R=\gamma$. The degree of positionality becomes

$$DOP = \frac{\varepsilon(k)\overline{c}^{-\rho}}{1-\varepsilon(k)+\varepsilon(k)\overline{c}^{-\rho}}.$$

Letting $\rho \to 0$ yields the Cobb-Douglas case, and $DOP=\varepsilon(k)$. The first-order condition becomes $C_i^{\gamma-1}\left(\left[1-\varepsilon(k)\right]+\varepsilon(k)(\overline{c})^{-\rho}\right)^{\frac{\gamma}{\rho}}=\mu$. Taking the time derivative,

$$-(1-\gamma)\frac{\dot{C}_i}{C_i} - \left[\frac{\gamma\varepsilon(k)\overline{c}^{-\rho}}{1-\varepsilon(k)+\varepsilon(k)\overline{c}^{-\rho}}\right]\frac{\dot{\overline{c}}}{\overline{c}} + \frac{\gamma}{\rho}\left[\frac{\varepsilon'(k)(\overline{c}^{-\rho}-1)\dot{k}}{1-\varepsilon(k)+\varepsilon(k)\overline{c}^{-\rho}}\right] = -(r-\beta),$$

[19] Notice that $s = 1-c/f(k)$.

i.e.,

$$\left[1-\frac{\gamma(1-\varepsilon(k))}{1-\varepsilon(k)+\varepsilon(k)\bar{c}^{-\rho}}\right]\frac{\dot{c}}{c}=r-\beta+\frac{\gamma}{\rho}\left[\frac{\varepsilon'(k)(\bar{c}^{-\rho}-1)\dot{k}}{1-\varepsilon(k)+\varepsilon(k)\bar{c}^{-\rho}}\right],$$

where the left-hand side term in square brackets corresponds to $[1-\gamma(1-DOP)]$. Consider $\gamma<0$, $\rho<0$ (the elasticity of substitution is less than unity), and $\bar{c}>1$. Then, as a country develops, the dynamic status effect ($\varepsilon'<0$) reduces the consumption growth rate during transition.

Note that as $\rho\to 0$, $(\bar{c}^{-\rho}-1)/\rho\to -\ln\bar{c}$, and hence the above converges to

$$\frac{\dot{c}}{c}=\frac{1}{1-\gamma(1-\varepsilon(k))}\left[r-\beta-\left(\gamma\,\varepsilon'(k)\ln\bar{c}\right)\dot{k}\right].$$

In the following, we resort to numerical simulations to test the performance of our model with respect to historical data. Preferences are given by the CES utility function (13), and technology by the Cobb-Douglas function, (8). For the evolution of the dynamic status preferences, we use an explicit function that satisfies Assumption 1:

$$\varepsilon(k(t))=\varepsilon_\infty+(\varepsilon_0-\varepsilon_\infty)\exp(-\kappa k(t)),\ \kappa\geq 0,\ \varepsilon_0\geq\varepsilon_\infty>0\ . \tag{14}$$

Parameter κ captures the sensitivity of $\varepsilon(t)$ with respect to a change in k. If $\kappa=0$, $\varepsilon(t)$ is constant over time, and our dynamic (endogenous) status mechanism is absent. Equivalently, if $\varepsilon_\infty=\varepsilon_0$, $\varepsilon(t)$ is constant, and there is no dynamic status effect.

The parameterization follows standard growth literature and is largely uncontroversial. The technology parameters are assigned the following values: $\alpha=0.4$, $A=2$, $\delta=0.03$.[20] The preference parameters assume the following values: $\beta=0.03$, $\gamma=-3$, implying an elasticity of intertemporal substitution equal to 0.25, and $\rho=0$ (unless otherwise stated). Finally, the status parameters are given by $\kappa=0.1$, $\varepsilon_0=2$, $\varepsilon_\infty=0.2$.[21] We consider the transitional dynamics of both the savings rate and the rate of interest when our economy starts with a capital level, k_0, that is low relative to the steady state level.

[20] A scales the productivity, and we choose a value that guarantees $\ln c(t)>0$.

[21] Notice that in our simulations the initial capital stock equal $k(t_0)>0$, implying an associated $\varepsilon(t_0)<1$ as consistent with our restrictions.

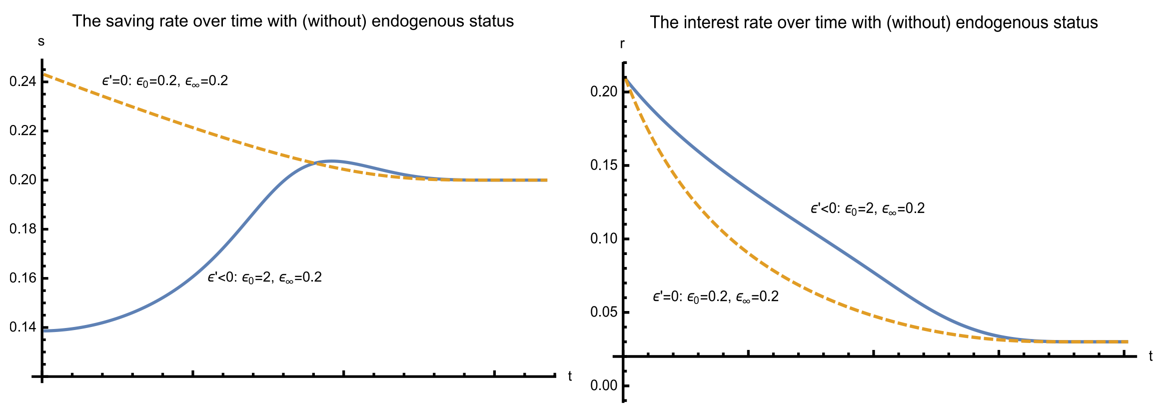

Figure 2. The Dynamics of Savings and Return on Capital.

The solid lines in Fig. 2 display the transitional dynamics of the savings rate and the return to capital in the presence of the endogenous dynamic status effect (when $\varepsilon' < 0$). As analyzed above (as well as in the Appendix), in early stages of development savings increase, and after a threshold level of the capital stock is reached, savings decline slightly, before leveling out. Thus, our model augmented to include dynamic status is able to capture both the joint historical dynamics of the savings and real interest rates (when they diverged), as well as their contemporary co-movement. Initially the dynamic status effect dominates and, although capital returns decrease, the savings rate increases. After some threshold level of capital stock is reached, the fall in the return to capital dominates the dynamic status effect, and savings declines

The dashed lines in Figure 2 display the transitional dynamics of the savings rate in the absence of the dynamic status effect (when $\varepsilon(t) = \varepsilon = 0.2$ is constant). Without the dynamic status effect, the savings rate always decreases (due to the return-to-capital effect). Thus, the model without dynamic status effect represents the contemporary empirical facts, well but fails to explain the historical evolution of the savings rate.

Four remarks merit comment. First, *in contrast to the prediction of the standard neoclassical growth model*, the positive correlation between the savings rate and the level of development helps us explain the cross country evidence where rich countries save more (see, among others, Dynan et al. 2004, Weil 2005). While the rate of return on capital historically falls, poor countries never seem to catch up. In this discussion our behavioral mechanism provides an additional explanation.

Second, a non-monotonic savings rate across time plays a crucial role with respect to the speed of convergence to the long-run equilibrium. This becomes even more important in a heterogeneous agents world where people differ in their initial wealth endowments. Below, we show how the interplay of the endogenous dynamic status- and return-to-capital effects, by affecting the speed of convergence, helps to explain the behavior of income inequality quantitatively and qualitatively.

Third, our model provides a *preference-driven mechanism* to explain non-monotonic behavior (especially a rise followed by a decline) of the savings rate over time. Caselli and Ventura (2000) provide a technology-driven mechanism in order to explain non-monotonic behavior of the savings rate over time. They show that the elasticity of substitution between capital and labor is a key ingredient for explaining non-monotonic behavior of the savings rate (Caselli and Ventura 2000, p. 920). In contrast, we exclude a technology-driven explanation by setting the elasticity of substitution between capital and labor equal to one, according to (8). In this sense, our model provides a genuinely new foundation for the historically observed non-monotonic development of the savings rate.

Fourth, we allow the elasticity of substitution between absolute and relative consumption, $1/(1-\rho)$, to vary. A variation in ρ is seen to affect the transitional path of the savings rate quantitatively but not qualitatively. Figure 2A shows that the non-monotone pattern (increase followed by decrease) of the transitional path of the savings rate prevails for $\rho = -1$ (solid line); $\rho = 0$ (dashed line); $\rho = 0.2$ (dotted line).

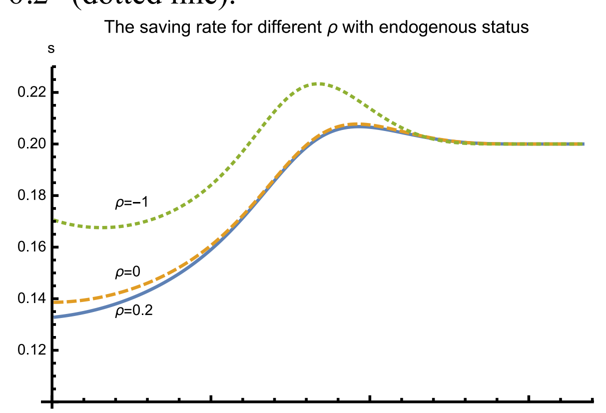

Figure 2A. The Dynamics of Savings for different values of ρ.

5. Wealth Distribution

We first analyze the main mechanism underlying the transitional behavior of income inequality.[22] We then examine the comparative dynamics in income inequality across countries that face the same productivity shock but differ in terms of how strongly their intensity of status preferences responds to the productivity shock-induced change in k. Specifically, in the numerical simulations below, we compare the comparative dynamics in income inequality for both cases: presence of the endogenous dynamic status effect ($\varepsilon'(t) < 0$); absence of the endogenous dynamic status effect $(\varepsilon'(t) = 0)$. While in the former case income inequality is increased, consistent with empirical evidence, in the latter case, the shock reduces income inequality.

5.1 The historical dynamics of income inequality

We begin by determining the equilibrium dynamics of individual-to-total capital ratios, $k_i(t) \equiv K_i(t)/K(t)$. To do so, we consider the individual wealth accumulation equation (5) together with the corresponding aggregate accumulation relationship $\dot{K}(t) = \upsilon(t)K(t) + w(t) - C(t)$ to yield:

$$\dot{k}_i(t) = \frac{w(t)}{k(t)}(1 - k_i(t)) + \frac{c(t)}{k(t)}(-\theta_i(t) + k_i(t)) \,, \tag{15}$$

where $\theta_i(t) \equiv C_i(t)/C(t)$. Following the procedure described by García-Peñalosa and Turnovsky (2008, p. 463ff) the bounded solution for $k_i(t)$ is

$$k_i(t) = k_i + h(k)(1 - k_i)\frac{k(t) - k}{k}\frac{1}{\mu - \beta} \,, \tag{16}$$

where variables without a time subscript are *final* steady state values, $h(k) \equiv -f''(k)k - (\xi_1 w)/c$, μ is the negative eigenvalue associated with the dynamic system (16) evaluated at the final steady state, and $\xi_1 = \beta - \mu > 0$ is the normalized part of the eigenvector associated with μ. As the sign of $h(k)$ plays a key role for the shock-induced development of income inequality, we need to investigate this term further.

[22] As we use a framework with exogenous labor supply, the development of wealth inequality, as measured by the standard deviation of the wealth distribution, is proportional to the development of income inequality.

First, $h(k)$ depends on only average characteristics. Second, under Assumption 1, the sign of $h(k)$ is ambiguous. If status preferences are exogenous $(\varepsilon'(k)=0)$ and the technology is Cobb-Douglas, $h(k)<0$.[23] However, in the present case, the sign of $h(k)$ also depends on the change of the intensity of status concerns, $\varepsilon'(t)$, via its impact on the negative eigenvalue. If $\varepsilon'(t)<0$ and large enough (in absolute terms), then $h(k)$ becomes positive, governing the transitional dynamics of inequality induced by shocks.

Integrating (16) across all agents García-Peñalosa and Turnovsky (2008), show that the (dynamics of the) standard deviation of wealth is given by

$$\sigma_k(t) = \frac{\zeta(t)}{\zeta_0}\sigma_{k0}, \tag{17}$$

where $\zeta(t) \equiv 1 + \frac{h(k)}{\beta-\mu}\frac{k(t)-k}{k}$ and $\zeta_0 \equiv 1 + \frac{h(k)}{\beta-\mu}\frac{k_0-k}{k}$. We employ equation (17) to measure the transitional development of inequality *close to a steady state*. Being a function of $h(k)$ it is a function of average wealth only.

In the previous section, we have argued that the endogenous dynamic status effect influences the transitional dynamics of the interest rate (see Fig. 2). Due to the dynamic status effect, the rate of interest declines at a slower pace. This, in turn, impacts on the development of inequality – both during transition and in steady state – and leads us to

> **Result 1.** *Under Assumption 2, the endogenous dynamic status effect impacts on the development of wealth inequality. Specifically, the endogenous dynamic status effect tends to raise- or delay the reduction of wealth inequality over time. Moreover, the historical development of inequality becomes inversely-S-shaped, in accordance with empirical data.*

The return-to-capital effect tends to lower wealth inequality directly, as lower rates of interest disadvantage wealthy households more than the less affluent households. Clearly, the faster the speed of convergence (SOC), the faster the rate of interest declines, and the faster is the decline in

[23] See Garcia-Penalosa and Turnovsky (2008, p. 455)

wealth inequality. The SOC is directly linked to the dynamic status effect. In its presence ($\varepsilon'(t) < 0$), the savings rate – while increasing – is lower than in its absence (see Figure 2).[24] The lower savings rate in that case implies a lower rate of capital accumulation during transition, thereby a lower SOC. As a consequence, the rate of return on capital declines at a lower rate (see Figure 2), which benefits wealthy households more than households without wealth. That is, due to a lower savings rate, the dynamic status effect tends to raise- or delay the reduction in wealth inequality. Hence, Result 1 is an immediate consequence of the fact that the dynamic status effect reduces the speed of decline in the rate of interest during transition.

For low levels of development, the endogenous dynamic status effect (tending to raise wealth inequality via its impact on the SOC) is strong. Therefore, working against the return-to-capital effect (which tends to lower wealth inequality), it slows down the decline in wealth inequality *initially, while strong*. For more advanced levels of development (as measured by a higher level of *k*), the endogenous dynamic status effect is weak, and our model behaves according to the standard neoclassical growth model. Consequently, the historical development of inequality becomes inversely-S-shaped, in accordance with empirical data.

To illustrate Result 1, we resort to numerical simulations. Our parameterization is identical to that of the previous section. Fig. 3 displays the transitional dynamics of wealth inequality for both cases: presence- and absence of the endogenous dynamic status effect. Due to the exogeneity of labor supply, the developments of wealth- and income inequality coincide. The vertical axis of the figure shows the growth factor of the standard deviation of wealth inequality, as given by (17), with $\sigma_{k0} \equiv 1$ normalized to unity.

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[24] In both specifications – with and without the dynamic status effect – the savings rate converges to the *same* steady state value. When $\varepsilon' < 0$, as the savings rate is increasing, it initially starts at a lower level compared with $\varepsilon' = 0$ (in which case the savings rate declines throughout).

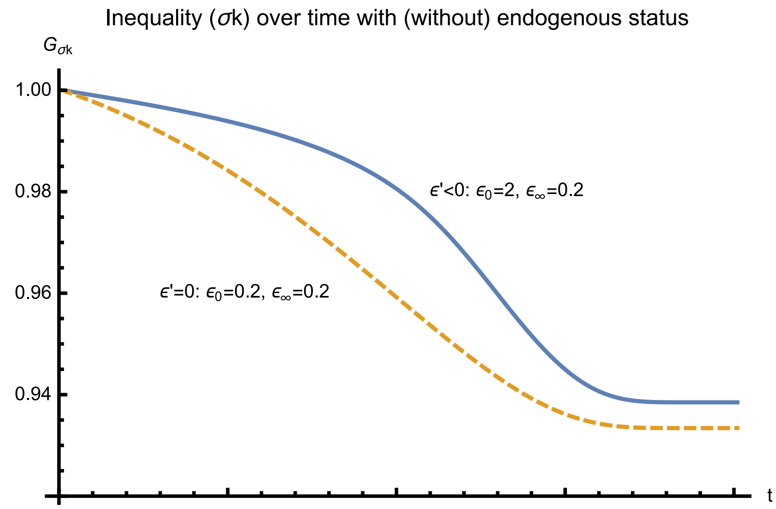

Figure 3. The Historical Dynamics of Income Inequality

The solid line in Fig. 3 displays the evolution of wealth- or income inequality in the presence of the endogenous dynamic status effect ($\varepsilon' < 0$). Inequality falls over time. The decline, though, follows a non-convex pattern (inverse-S-shaped dynamics) in accordance with empirical data. In fact, the dynamics of income inequality resembles that shown in Figures A-1 and A-2 in the Appendix below, for the period from 1900 until the 1970s.

Intuitively, initially, the endogenous dynamic status effect is strong. As a consequence, the savings rate (while increasing) is low, which lowers the SOC. The lower SOC leads to a slower decline in the rate of interest. Consequently, inequality does not fall as fast as in the absence of the endogenous dynamic status effect. At later stages of development, the endogenous dynamic status effect becomes small and is dominated by the return-on-capital effect. This is the reason for why the change in inequality is initially flat, as shown in Fig. 3, while later on the standard return-on-capital effect dominates. Hence, the interplay of both effects makes the transitional dynamics of inequality, as measured by σ_k, inversely-S-shaped, as supported by data.

In contrast, in a standard growth model with exogenous status preferences (dashed line in Fig. 3), the rate of decrease in inequality follows a steeper (and more convex) pattern – a pattern that is less supported by empirical evidence.

Two remarks are in order. First, the dynamic status effect on the aggregate economy are only transitory, in that while it affects the transitional dynamics of aggregate wealth, it does not impact the aggregate steady-state level of wealth. In contrast, the dynamic status effect impacts the wealth distribution both during the transition *and* in the steady state. In fact, steady-state inequality is higher in the presence of the dynamic status effect than in its absence (see Fig. 3). The higher inequality during the transition carries over to the steady state, making it path dependent. This enables us to capture the empirical evidence according to which countries even at the same level of economic development (steady-state) have noticeable differences in the wealth distribution. In turn, cultural differences on the responsiveness of status preferences to the development of aggregate wealth can account for differences in the wealth distribution.

Second, this result is consistent with García-Peñalosa and Turnovsky (2008) who show that the presence of exogenous status preferences $(\varepsilon > 0, \varepsilon' = 0)$ increases the decline in wealth inequality. Specifically, they show that exogenous status preferences contribute to a *lower* steady-state wealth inequality. While we compare a model with endogenous dynamic status $(\varepsilon > 0, \varepsilon' < 0)$ to one with exogenous status $(\varepsilon > 0, \varepsilon' = 0)$, García-Peñalosa and Turnovsky (2008) compare a model with exogenous status to one without status ($\varepsilon = 0$). They show that the presence of status raises the intertemporal elasticity of substitution (in (10) DOP becomes positive, for $R < 0$). As a consequence, households desire, for any given *k*, a higher consumption growth rate. A higher consumption growth rate is compatible only with an initially lower consumption level, or, equivalently, a higher savings rate initially. The higher savings rate raises the SOC, thus, it lowers wealth inequality relative to a model without status. In contrast, in our model with endogenous dynamic status, as the savings rate initially increases, s is initially lower compared to a model without status. Thus, the SOC is lower, which benefits the rich more than the poor. As a consequence, the wealth distribution becomes more unequal in the presence of the dynamic status effect than in its absence.

5.2 Contemporary Evolution of Inequality under Universal Shocks

In this section, we show how differences in status preferences among countries – in the presence of the dynamic status effect – can account for the differential dynamics of income inequality followed by shocks, as observed in contemporary data. Our method is to analyze the responsiveness of income inequality to a common productivity shock, where differences in status preferences are captured by different values of $E(c,k) \le 0$. Different values of $E(c,k)$ proxy *cultural differences* between countries. In particular, the smaller (the more negative) the value of $E(c,k)$ the more sensitively a country responds to changes in aggregate wealth, i.e. the more responsive are a country's status concerns with respect to a rise in its aggregate capital, *k.*

In the following, we first discuss the impact of a positive technology shock on the development of inequality. In light of Result 1, we find that whether the shock leads to rising or declining wealth inequality depends critically on the strength of the dynamic status effect. Second, we show that the necessary and sufficient condition for the shock to generate rising or declining wealth inequality equals the one we state in Proposition 2. The way the dynamic status effect impacts on the savings rate behavior is key to the differential impact of a positive technology shock on inequality.

Proposition 2. *A (positive) productivity shock impacts both the transitional dynamics and the steady state of income and wealth inequality. The strength of the dynamic status effect is key in determining whether inequality rises or falls following a productivity shock. In countries with a strong (small) dynamic status effect, inequality rises (falls). Specifically, in a neighborhood of the steady state, inequality rises (falls) following a positive productivity shock, if* $h(k) > 0$ *(if* $h(k) < 0$*):*

$$h(k) \gtrless 0 \Leftrightarrow -\frac{E(c,k)}{\alpha} \gtrless \left[\frac{1}{s^*} - \frac{1}{IES(c,k)} \right] . \tag{18}$$

Proof. See the Appendix.

Proposition 2 shows that a positive productivity shock *raises* inequality in countries with a "strong" dynamic status effect, and it *lowers* inequality in countries with a "weak" dynamic status effect. Result 1, as given above, helps to provide intuition. In the absence of a dynamic status effect $E(c,k) = 0$. As for reasonable parameterizations $s^* < IES(c,k)$, cf. Barro and Sala-i-Martin (2004, p.109), condition (18) implies $h(k) < 0$. In words, inequality declines in response to the positive technology shock. The shock raises the steady state level of capital. As $s^* < IES(c,k)$, the dynamic status effect weak. According to Result 1, the savings rate initially jumps to a higher level and declines towards its steady state level during transition (see Figure A-3 in the Appendix). Due to the initially higher savings rate the SOC increases. Consequently, the rate of interest decreases at a higher pace, which disadvantages the wealthy households more than the poor ones. As a result, the wealth distribution becomes more equal – inequality declines along the transition path (see also Fig. 4 below).

This argument however changes once the dynamic status effect becomes strong enough: $E(c,k)<0$ and $h(k)>0$ in (18). In this case, households wish to lower their consumption growth rate, ceteris paribus, due to the dynamic status effect. The savings rate initially declines and rises towards its steady state level (see Figure A-3 in the Appendix). Consequently, the SOC declines, and the rate of interest becomes smaller at a lower pace, which benefits the wealthy households more than the poor ones. As a result, wealth inequality increases both along transition and in the steady state.

To shed additional light on Proposition 2, we consider three corollaries as well as a numerical simulation.

Corollary 1. *A sufficient condition for an increase in inequality, due to a positive productivity shock, is given by:*

$$s^* > IES(c,k) \Rightarrow h(k) > 0 . \tag{19}$$

Proof. Consider the right hand side of the implication in (19). The left hand side of the inequality is greater than or equal to zero, as $E(c,k) \leq 0$. Then, $h(k)>0$ when the right hand side of the inequality is strictly less than zero, that is, when $K(t)$., or equivalently, $s^* > IES(c,k)$. ■

Corollary 1 builds on the well-known result of Barro and Sala-i-Martin (2004, p.136) according to which the savings rate rises along transition towards its steady state level. Under the sufficient condition given in Corollary 1, the level of the savings rate is initially low. Thereby, the SOC is low as well and the rate of interest also declines slowly, benefitting the wealthy households relative to the poor ones. Consequently, inequality rises during transition. The condition

$s^* > IES(c,k)$ is not likely to be satisfied empirically. However, notice that this is a sufficient, not a necessary condition.

Corollary 2. *In a neighborhood of the steady state, conditions (18) in Proposition 2 and (12) in Proposition 1 are equivalent.*

Proof. Considering $\xi(c,k) \equiv 1 - IES(c,k)E(c,k)/\alpha$ in (12) and rearranging terms immediately yields the right hand side of the equivalence in (18). As the right hand sides of the equivalences in (12) and (18) are identical, the left hand sides are identical as well. Thus, $h(k) > 0 \Leftrightarrow \dot{s} > 0$. ■

Corollary 2 states that whether or not a positive productivity shock gives rise to an increase in inequality during transition depends on the response of the saving rate to the shock. The savings rate behavior and the development of inequality are closely tied to each other. In the presence of a (strong) dynamic status effect, the savings rate initially jumps downward and increases to its steady state level. The downward jump lowers the SOC, which – via the development of the rate of interest – benefits the wealthy households disproportionally more than the poor ones. The opposite happens in the absence of the dynamic status effect, when the savings rate initially jumps upward in response to the positive productivity shock.[25]

In the following, we provide a specific example to illustrate the theoretical result given by Proposition 2. We employ the same functional forms as for the simulations above. However, here, differences in status preferences are captured by a single parameter, ε_∞. Parameter ε_∞ defines the range of values the status function, $\varepsilon(t)$, can assume. Different values of ε_∞ proxy cultural differences among countries. In particular, the lower the value of ε_∞ the more sensitively a country responds to changes in aggregate wealth.[26]

Corollary 3. *Consider our functionally specified economy* (13), (8), and (14), *with*

[25] Notice, however, that condition (18), regarding inequality, applies locally, around the post-shock steady state, while condition (12), regarding savings rate behavior, applies along the complete transitional path.

[26] Notice that the decline in $\varepsilon(t)$ is governed by the term $\kappa(\varepsilon_0 - \varepsilon_\infty)$. That is, instead of specifying parameter ε_∞ as county-specific, we could have specified parameter κ as country-specific. The two specifications are equivalent, though, and yield the same results. Absence of the dynamic status effect, in our approach, is captured by $\varepsilon_\infty = \varepsilon_0$.

$\rho = 0$ in utility function (13). Assume that in the steady state $\varepsilon'(k) \approx 0$. Then, following a positive productivity shock, inequality develops according to:

$$\sigma_k \gtrless 0 \Leftrightarrow \varepsilon_\infty \gtrless \frac{\beta + \delta\big(1 - \alpha(1-\gamma)\big)}{\alpha\delta\gamma} \quad . \tag{20}$$

Proof. If $\rho = 0$, then $DOP(c,k) = \varepsilon(k)$. Applying the definitions for $E(c,k)$ and $EIS(c,k)$ to (18) and setting $\varepsilon'(k)$ equal to zero yields (20). ■

Based on Corollary 3, we construct a simple numerical example. Consider two countries, A and B with the same technology and initial income distribution but with different cultural parameters in status preferences. Country A has a relatively stronger response in status concerns to the development of wealth ($\varepsilon_\infty = 0.02$) than has country B ($\varepsilon_\infty = 0.25$). For both countries, consistent with Proposition 3, we consider $\kappa = 0.2$, $\delta = 0.08$, $\varepsilon_0 = 0.3$. All other parameter values are identical to those employed in the previous section. Figure 4 shows the dynamics of income inequality following a positive productivity shock where we raise the productivity parameter A from a value of $A = 2$ to a value of $A = 3$.

The figure shows that in the economy where status preferences are more responsive to changes in wealth (Country A, dashed line in Figure 4), inequality increases while, for the economy where status is less responsive to a rise in wealth (Country B, solid line in Figure 4), inequality falls in response to the same positive technology shock.

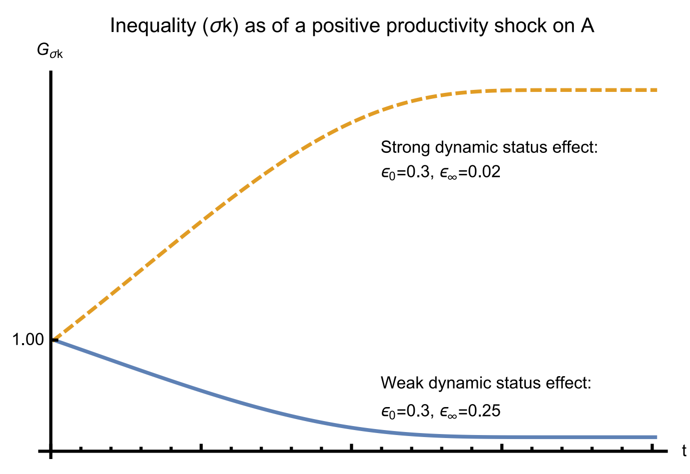

Figure 4. Contemporary Dynamics of Income Inequality

The intuition follows closely the mechanism involving the SOC described above. In the economy with a weak dynamic status effect the return-on-capital effect dominates, and while interest and savings initially increase due to higher productivity (see Fig. 4A in the Appendix), along the transition to the steady-state, the savings rates fall following the declining return on capital as people do not adjust their behavior rate toward lower status evaluation. Consequently, the SOC rises (due to the higher savings rate), and inequality declines because the interest rate declines at a faster rate. In contrast, in the economy with a strong dynamic status effect, initially, savings rate declines because agents, due to higher income from the productivity increase, consume more so as to display their status (see Figure 4A in the Appendix). However, in this case people have cultures to changes their preference for status at a high rate, and, during the transition to the steady-state, as capital increases savings increase at a higher rate than the fall in the return on capital. The SOC becomes low due to a lower savings rate initially, and inequality rises (or declines at a lower pace).

For the simulation displayed in Fig. 4, parameters were chosen to produce opposite effects regarding the impact of the productivity shock on the transitional dynamics of inequality. More generally, whether inequality rises or declines upon a positive productivity shock depends on the respective strengths of the return-on-capital- and dynamic status effects. In any case, the dynamic status effect always contributes to more inequality.

Two remarks merit comment. First, and more important, the sign of the inequality change, due to productivity shocks, depends on the sensitivity of status concerns with respect to wealth. According to Caselli and Ventura (2000) the differential dynamics of income inequality under a productivity shock operate through differences in the substitutability of capital and labor in the production function. The productivity shock has a positive effect on income inequality when there is a positive technological bias towards capital returns relative to labor wages. In our framework, we isolate such a technology bias, as our production technology is Cobb-Douglas. That is, in our framework, the differential dynamics of income inequality under a productivity shock operates through the dynamic change in agents' behavior. Thus, we complement the literature as we provide an explanation for why countries that share the same production technology (no any technology bias in factors of production) and have the same income in the long-run (the case of many advanced countries) can end up, with a very different distribution of income after a technology- or policy shock.

Second, following Proposition 1, cultural differences in status concerns (as proxied by differences in ε_{∞}) do not affect production and, in turn, do not have any long-run impact on income. This is important because the differentials in income inequality come through the dynamics of the economy rather than the level of economic development. This way we provide a framework to analyze the behavior of income distribution under a productivity shock in countries at the same stage of economic development (see for example the case of advances Countries in Figs. A1 and A2).

6. Conclusion and Open Research Directions [to be completed]

We believe that our mechanism opens many directions for empirical and policy research.

Appendix

A.1 Degree of positionality

Under Assumption 1, $U(C_i, r_i, \varepsilon(k)) = R^{-1} C_i^R V(\overline{c}, \varepsilon(k))$ so that

$$\frac{1}{R}\frac{\partial[C_i^R V(\overline{c},\varepsilon(k))]}{\partial C_i} = C_i^{R-1} V(\overline{c},\varepsilon(k)) = (\partial U / \partial r_i)(\partial r_i / \partial C_i) + (\partial U / \partial C_i),$$

which corresponds to the denominator of the definition of the DOP in (2). Next,

$$\frac{1}{R}\frac{\partial[C_i^R V(\overline{c},\varepsilon(k))]}{\partial \overline{c}} = R^{-1} C_i^R V_{\overline{c}}(\overline{c},\varepsilon(k)) = (\partial U / \partial r_i)(\partial r_i / \partial \overline{c})$$

$$\Rightarrow (\partial U / \partial r_i)(\partial r_i / \partial C_i) = R^{-1} C_i^R V_{\overline{c}}(\overline{c},\varepsilon(k)) \frac{\partial r_i / \partial C_i}{\partial r_i / \partial \overline{c}} = -R^{-1} C_i^R V_{\overline{c}}(\overline{c},\varepsilon(k)) \frac{\overline{c}}{C_i},$$

which represents the numerator of (2). Combining the numerator and the denominator yields (3).

A.2 Derivation of (6)

Optimizing (4) subject to (5) with respect to C_i yields the first order optimality condition $C_i^{R-1} V(\overline{c},\varepsilon(k)) = \mu_i$, where μ_i is the individual's shadow value of wealth. Taking the time derivative of this condition yields

$$(R-1)\frac{\dot{C}_i}{C_i} + \underbrace{\left(\frac{V_{\overline{c}}\overline{c}}{V}\right)}_{=-R\,DOP}\frac{\dot{\overline{c}}}{\overline{c}} + \left(\frac{V_{\varepsilon}\varepsilon'(k)}{V}\right)\dot{k} = \frac{\dot{\mu}_i}{\mu_i}.$$

As all agents face the same rate of return, $\dot{\mu}_i / \mu_i = -(\upsilon - \beta)$, individual consumption growth rates are independent of household characteristics, i.e., they are identical across households. Consequently, individual and average consumption growth rates coincide. Considering $\overline{c} = c$ in equilibrium, yields

$$-(1-R)\frac{\dot{c}}{c} - R\,DOP\frac{\dot{c}}{c} + \left(\frac{V_{\varepsilon}\varepsilon'(k)}{V}\right)\dot{k} = -(r-\beta).$$

Rearranging terms yields (6).

A.3 Proposition 1: Derivation of the savings rate dynamics

As shown in Section 4.1, the steady-state savings rate is given by $s^* = \alpha\delta(\beta+\delta)^{-1}$. To analyze the evolution of the savings rate $s = 1 - cA^{-1}k^{-\alpha}$, we analyze the behavior of $z \equiv cA^{-1}k^{-\alpha}$. Specifically, $g_z \equiv \frac{\dot{z}}{z} = \frac{\dot{c}}{c} - \alpha\frac{\dot{k}}{k}$, and we note that the savings rate increases (decreases) when $g_z < 0$ (when $g_z > 0$). Substituting the growth rates of c and k, and employing the elasticities $IES(c,k) = 1/(1 - R(1 - DOP))$ as well as $E(c,k) \equiv V_k k / V = V_\varepsilon \varepsilon' k / V \leq 0$, we obtain

$$g_z = IES(c,k)(\upsilon - \beta) + IES(c,k)\,E(c,k)\left(\dot{k}/k\right) - \alpha\left(\dot{k}/k\right). \qquad (21)$$

Let $\xi(c,k) \equiv \left[\alpha - IES(c,k)\,E(c,k)\right]/\alpha \geq 1$. Without the dynamic status effect, $\varepsilon' = 0 = E(c,k)$, and $\xi(c,k) = 1$. In the presence of the dynamic status effect, $\varepsilon' < 0$, that is $E(c,k) < 0$, and $\xi(c,k) > 1$. Theoretically, there is no limit for the value of ε', so that $\xi(c,k)$ can become arbitrarily large.

Considering $\xi(c,k)$, we can re-write (21) as $g_z = IES(c,k)(f'(k) - \delta - \beta) - \xi(c,k)\alpha\left(\dot{k}/k\right)$. For the Cobb Douglas production technology, $f(k)/k = (1/\alpha)f'(k)$, and $c/k = c/f(k)\,f(k)/k$ $= z\,f(k)/k = z(1/\alpha)f'(k)$. Therefore, $\alpha(\dot{k}/k) = f'(k)(1-z) - \alpha\delta$ $= f'(k)(1-z) - s^*(\beta+\delta)$. Re-arranging terms yields

$$g_z = f'(k)\left[IES(c,k) - \xi(c,k)(1-z)\right] + (\beta+\delta)\left[\xi(c,k)s^* - IES(c,k)\right] \quad . \qquad (22)$$

Note that without the dynamic status effect – $\varepsilon' = 0$, $\xi(c,k) = 1$ – growth rate (22) corresponds to the standard case, as given by Barro and Sala-i-Martin (p.136, 2004).

As demonstrated by Barro and Sala-i-Martin (p.109 as well as p.135ff, 2004), for the case without the dynamic status effect, $g_z > 0$, implying $\dot{s} < 0$ for reasonable calibrations. The presence of the dynamic status effect changes this conclusion. Following the arguments by Barro and Sala-i-Martin (p.135ff, 2004), during transition the savings rate increases as long as

$$s^* > \frac{IES(c,k)}{\xi(c,k)} \quad . \qquad (23$$

The dynamic status effect implies $\xi(c,k) > 1$, with no upper limit to $\xi(c,k)$ on grounds of theory. For this reason, (23) can be satisfied for reasonable calibrations. In particular, for *every* value of the elasticity of intertemporal substitution there exists a $\xi(c,k)>1$ for which (23) is satisfied, and consequently $\dot{s}>0$. ■

A.4 Proof of Proposition 2.

Following García-Peñalosa and Turnovsky (2008), equation (17) shows that inequality rises over time ($\sigma_k(t)>\sigma_k(0)$) if $h(k)>0$ and falls over time if $h(k)<0$. From our Cobb-Douglas technology, it follows that $f''(k)k=-(1-\alpha)f'(k)$. Moreover, in steady state, $c=f(k)-\delta k$. Thus, $h(k)=-f''(k)k-\upsilon_1 w/c=$ $(1-\alpha)f'(k)-(\beta-\mu)\left[f(k)-kf'(k)\right]/\left[f(k)-\delta k\right]$ $=(1-\alpha)f'(k)\left[1-(\beta-\mu)/(f'(k)-\alpha\delta)\right]$. Using the steady state condition $f'(k)=\beta+\delta$, we have

$$h(k)=\frac{(1-\alpha)(\beta+\delta)}{\beta+\delta(1-\alpha)}\left[(1-\alpha)\delta+\mu\right].$$

Therefore, $\operatorname{sgn} h(k)=\operatorname{sgn}((1-\alpha)\delta+\mu)$.

Next, we consider the Jacobian to the dynamic system (10'), evaluated at steady state. which we can write as

$$J\equiv\begin{bmatrix}\partial\dot{k}/\partial k & \partial\dot{k}/\partial c\\ \partial\dot{c}/\partial k & \partial\dot{c}/\partial c\end{bmatrix}=\begin{bmatrix}\beta & -1\\ j_{21} & j_{22}\end{bmatrix},$$

where $j_{21}\equiv IES(c,k)c\,f''(k)-\beta\,j_{22}<0$, $j_{22}=-IES(c,k)c\,E(c,k)/k\geq 0$, and $j_{22}>0$ if and only if $\varepsilon'(k)<0$. As the smaller eigenvalue equals $\mu=2^{-1}\left\{\beta+j_{22}-\sqrt{(\beta+j_{22})^2-4(\beta j_{22}+j_{21})}\right\}$, we know that $h(k)>0$ is equivalent to $2\delta(1-\alpha)+(\beta+j_{22})>\sqrt{(\beta+j_{22})^2-4(\beta j_{22}+j_{21})}$. Squaring both sides of the inequality and rearranging terms yields:

$$(1-\alpha)\delta\left[(1-\alpha)\delta+\beta+j_{22}\right]>-(\beta\,j_{22}+j_{21}). \tag{24}$$

From the definitions of j_{21},j_{22} we find $\beta\,j_{22}+j_{21}=IES(c,k)c\,f''(k)$. Next, we take into account that $c\,f''(k)=(c/k)k\,f''(k)=-(c/k)(1-\alpha)f'(k)=-\left[(\beta+\delta)/\alpha-\delta\right](1-\alpha)(\beta+\delta)$. Considering this result in inequality (24) and solving for j_{22} implies:

$$j_{22}>\left[IES(c,k)(\beta+\delta)/(\alpha\delta)-1\right]\left[\beta+\delta(1-\alpha)\right]. \tag{25}$$

Finally, we note that $j_{22}=-(c/k)IES(c,k)E(c,k)$. Taking into account that, in a steady state,

$(c/k) = \left[(\beta+\delta)/\alpha - \delta\right]$ and $s^* = \alpha\delta/(\beta+\delta)$, (25) can be (after simplifying) written as

$$h(k) > 0 \Rightarrow -\frac{E(c,k)}{\alpha} > \left[\frac{1}{s^*} - \frac{1}{IES(c,k)}\right]. \tag{26}$$

All above steps can likewise be done for the reversed inequality

$$h(k) < 0 \Rightarrow -\frac{E(c,k)}{\alpha} < \left[\frac{1}{s^*} - \frac{1}{IES(c,k)}\right]. \tag{27}$$

(26) and (27) imply (18). ■

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A.5 Figures

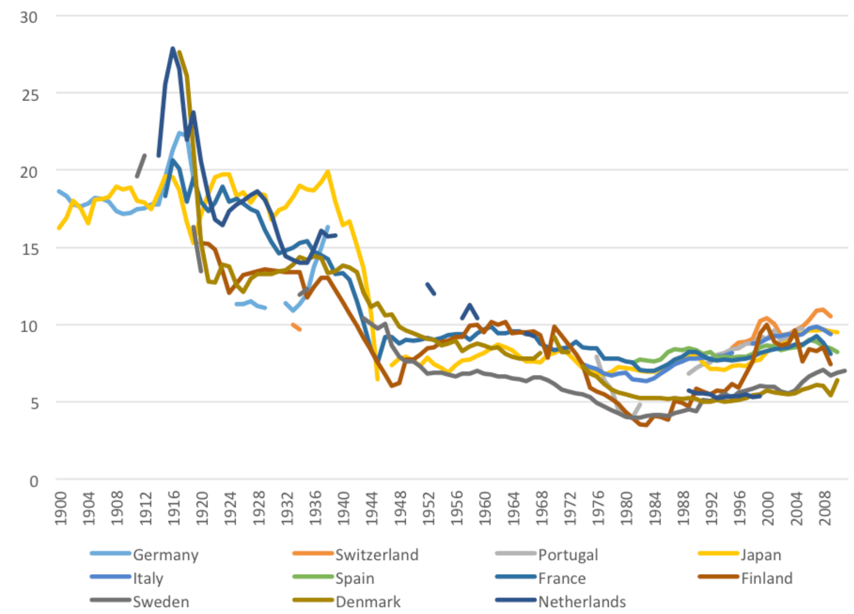

Figure A-1. Top 1% share of total income – Europe and Japan, 1900–2011

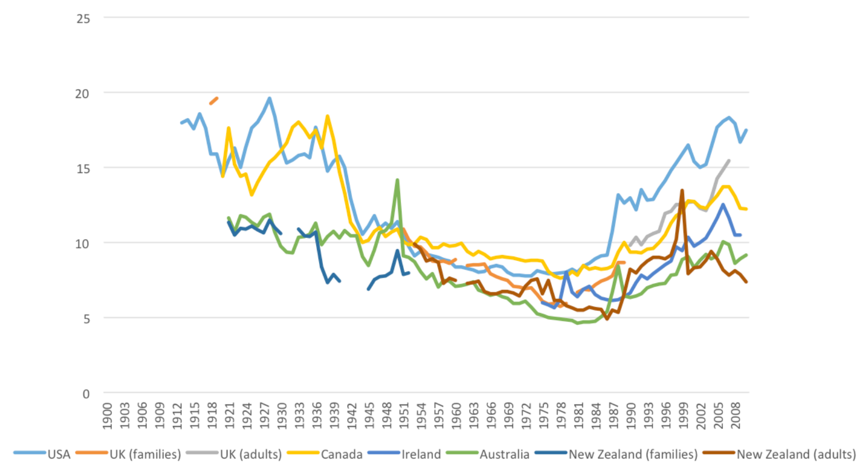

Figure A-2. Top 1% share of total income – English speaking countries (U-shaped), 1900–2011

Figure A-3. Response of *s* to a positive productivity shock