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INCOME SHARES, SECULAR STAGNATION, AND THE LONG-RUN DISTRIBUTION OF WEALTH

Luke Petach[1], Daniele Tavani[2]

ABSTRACT

Four alarming stylized facts have characterized the recent economic history of the United States: (i) a fall in labor productivity; (ii) a fall in the labor share, (iii) an increase in the capital income ratio, and (iv) an increase in the wealth share owned by top income earners. In this paper, we offer a non-Neoclassical explanation for these facts that merges the Pasinetti (1962) approach to differential saving propensities among classes with the theory of induced technical change (ITC) by Kennedy (1964). First, we provide a simple microeconomic rationale for workers' saving propensity being lower than capitalists' based on the empirically-supported argument that consumption peer effects are more prevalent at lower brackets of the income distribution (Petach and Tavani, 2018). We then show that institutional changes that lower the labor share – a decline in unionization, an increase in monopsony power in the labor market, the so-called 'race to the bottom' fostered by a hyper-competitive global environment, or the exhaustion of path-breaking scientific discoveries as argued by Gordon (2015) – can explain the decline in labor productivity growth because of the reduced incentives to innovate to save on labor costs. Combined with ITC, differential savings delivers a direct relationship between the capitalist share of wealth and the capital-income ratio independent of the elasticity of substitution between capital and labor. Finally, we argue that these tendencies are not inevitable: tax policy can be used to implement any wealth distribution, similarly to Zamparelli (2016); while worker-crushing institutional arrangements can be reversed through counteracting policy changes. However, both policy changes appear unlikely given the current institutional and global climate.

[1] Email: Luke.Petach@Colostate.edu, Colorado State University.
[2] Preliminary Draft. Corresponding author: Daniele Tavani, 1771 Campus Delivery, Fort Collins, CO 80523-1771.
Email: Daniele.Tavani@Colostate.edu, Colorado State University.

Income Shares, Secular Stagnation, and the Long-Run Distribution of Wealth

Luke Petach,[*] Daniele Tavani[†]
Colorado State University.

May 23, 2018

Abstract

Four alarming stylized facts have characterized the recent economic history of the United States: (i) a fall in labor productivity; (ii) a fall in the labor share, (iii) an increase in the capital-income ratio, and (iv) an increase in the wealth share owned by top income earners. In this paper, we offer a non-Neoclassical explanation for these facts that merges the Pasinetti (1962) approach to differential saving propensities among classes with the theory of induced technical change (ITC) by Kennedy (1964). First, we provide a simple microeconomic rationale for workers' saving propensity being lower than capitalists' based on the empirically-supported argument that consumption peer effects are more prevalent at lower brackets of the income distribution (Petach and Tavani, 2018). We then show that institutional changes that lower the labor share—a decline in unionization, an increase in monopsony power in the labor market, the so-called 'race to the bottom' fostered by a hyper-competitive global environment, or the exhaustion of path-breaking scientific discoveries as argued by Gordon (2015)—can explain the decline in labor productivity growth because of the reduced incentives to innovate to save on labor costs. Combined with ITC, differential savings delivers a direct relationship between the capitalist share of wealth and the capital-income ratio *independent of the elasticity of substitution* between capital and labor. Finally, we argue that these tendencies are not inevitable: tax policy can be used to implement *any* wealth distribution, similarly to Zamparelli (2016); while worker-crushing institutional arrangements can be reversed through counteracting policy changes. However, both policy changes appear unlikely given the current institutional and global climate.

Keywords: Capital-Income Ratio, Secular Stagnation, Factor Shares, Wealth Inequality.
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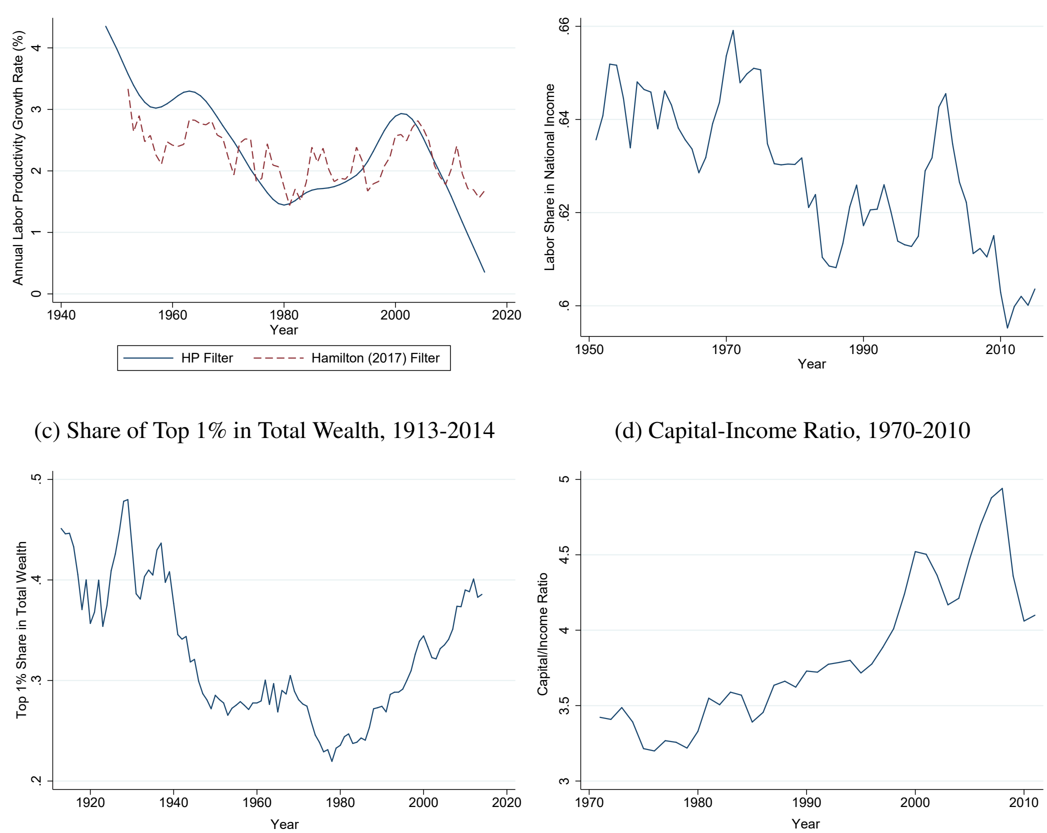
[*]Email: Luke.Petach@Colostate.edu

[†]Preliminary Draft. Corresponding author: Daniele Tavani, 1771 Campus Delivery, Fort Collins, CO 80523-1771. Email: Daniele.Tavani@Colostate.edu. We thank Anders Fremstad and Luca Zamparelli for helpful conversations about this topic, Steve Pressman for insightful comments and criticism, as well as participants to the Eastern Economic Association Meetings 2018. All errors are ours.

1 Introduction

Two spectres are haunting macroeconomics: the specter of secular stagnation, and the specter of inequality. The recent economic history of the United States has been characterized by simultaneous occurrence of: (i) a falling rate of labor productivity growth; (ii) a falling labor share; (iii) an increase in the share of wealth held by the top 1% of wealth owners, and (iv) a rising capital-income ratio. Figure (1) plots each of these series for the United States.

Figure 1: Secular Stagnation and Inequality in the United States: Stylized Facts



(a) Labor Productivity Growth, 1940-2016

(b) Share of Labor Compensation in GDP, 1950 - 2014

(c) Share of Top 1% in Total Wealth, 1913-2014

(d) Capital-Income Ratio, 1970-2010

Notes: Data on labor productivity, the labor share, the top 1% wealth share, and the capital-income ratio are from the Bureau of Labor Statistics, the Federal Reserve, the World Top Incomes Database, and Piketty (2014), respectively. Figure (1a) plots the trend component of labor productivity growth.

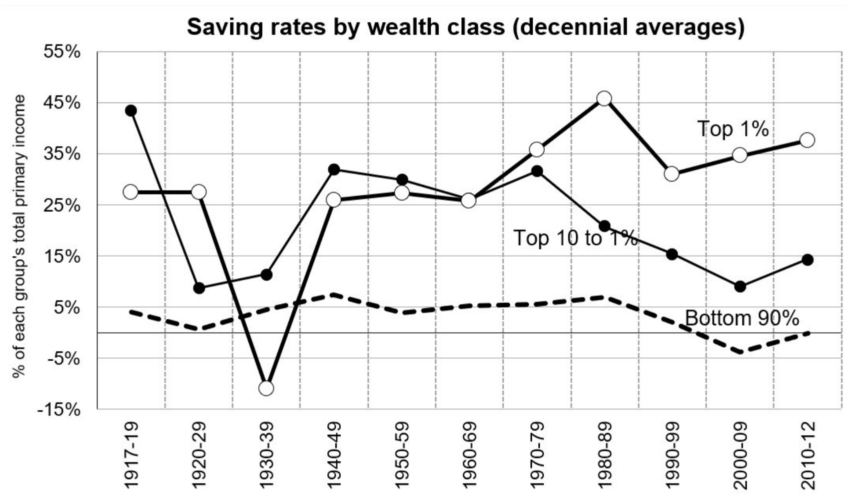
Despite the amount of attention that economists have paid to these trends, prominent theoretical explanations of inequality lack not only a clear link between a rising capital-income ratio, a falling labor share, and growing wealth inequality, but also a link from these distributional phenomena to changes in the rate of labor productivity growth. Piketty (2014), for example, argues that a differential between the rate of return on capital and the rate of growth (the famous $r > g$ inequality) is responsible for rising wealth inequality, but provides only a tangential link from an increasing capital-income ratio to rising wealth inequality, via changes in the capital share in national income.

Further strain is put on Piketty (2014)'s logic by the fact that within his theoretical framework (what amounts to a standard one-sector Neoclassical growth model) increases in the capital-income ratio only increase the capital share in national income if the elasticity of substitution between labor and capital is greater than one. As Jones (2016) points out, this is only likely to hold when the capital input to the production function includes land (thus stretching the notion of "capital"). Additionally, the empirical evidence is mixed with respect to whether the elasticity of substitution between capital and labor is higher or smaller than one: Karabarbounis and Neiman (2013) find an elasticity of substitution around 1.25 using a cross-section of countries, while Oberfield and Raval (2014) and Semieniuk (2017) find elasticities of substitution below one. Finally, the Piketty inequality only makes sense when the growth rate g is exogenous and the rate of return r is endogenous: in Classical and Kaleckian theories, for instance, the growth rate and the profit rate are related through the Cambridge equation $g = sr$ which establishes a causal link from the (exogenous) rate of return to the (endogenous) growth rate via the saving propensity. Since the latter is less than one, the Piketty inequality *always* holds, but is not useful in explaining the increase in the capital-income ratio.

Strict requirements on the degree of substitutability between factors of production as a means of explaining the simultaneous positive trends in wealth inequality and the capital share in national income are not unique to Piketty (2014). Recently, Zamparelli (2016) revisited the debate on the long-run distribution of wealth between classes initiated by Pasinetti (1962) and Samuelson and Modigliani (1966). In an a two-class, exogenously growing economy where "capitalists" save at higher rates than "workers" Pasinetti (1962) famously demonstrated the irrelevance of workers' saving for the determination of the rate of profit. The long-run of this economy is characterized by a distribution of wealth where both workers and capitalists own a positive share of total overall wealth. As a rejoinder, Samuelson and Modigliani (1966) established a "dual" result for the Pasinetti theorem: they showed that a second type of equilibrium exists where workers own all the wealth in the economy, and the capital-output ratio is exclusively determined by the workers' propensity to save. This equilibrium requires a savings rate on behalf of workers which exceeds the savings rate of capitalists. On the other hand, Zamparelli (2016) demonstrates the existence of an "anti-dual" Pasinetti result in a Neoclassical economy with factor substitution: a long-run equilibrium where capitalists own the entire stock of wealth is assured as long as the elasticity of substitution between capital and labor is high enough for the marginal product of capital to converge to a positive constant in the long-run.

In this paper, we offer a non-Neoclassical way of organizing the stylized facts presented above that draws from a number of staples in alternative traditions of economic thought. First, we show that the simultaneous rise of the capital-income ratio and wealth inequality can occur even without a high degree of substitutability between factors of production. To make this point, and fully siding with the winning Cambridge of the capital controversy of the 1960s, we adopt a Leontief aggregate production technology for the economy under consideration, so that capital and labor are used in fixed proportions in producing output. Second, instead of allowing instantaneous substitution between capital and labor, we draw from the *induced innovation hypothesis* first formalized by Kennedy (1964) drawing from an idea by Hicks (1932) in allowing capitalist firms to change the available production technique by choosing from a menu of factor-augmenting technologies (the so-called *innovation possibility frontier*) in order to maximize the rate of unit cost reduction. As is well-known, the hypothesis of induced innovation delivers the result that changes in factor-augmenting technologies respond to factor shares. In particular, labor (capital) productivity growth will increase (decrease) following an increase in the share of labor in production.

Figure 2: Evolution of Savings in the United States by Wealth Class



Source: Saez and Zucman (2016)

The third distinctive element of our analysis is the recognition by classical and post-Keynesian economists that different classes save at different rates. Saez and Zucman (2016) show an important feature of rising wealth inequality is the existence of high savings inequality across wealth levels. Figure 2 reproduces Saez and Zucman (2016)'s depiction of savings rates by wealth class overtime. From 1970 onward the savings rate of the top 1% of wealth holders has increased relative to all other wealth classes. This result is not unique to Saez and Zucman (2016). Kumar (2016) finds that the relative saving rate of the top 1 percent of the income distribution in the United States has been roughly 300 percent of the aggregate saving rate since 1980. While Pasinetti (1962), Samuelson and Modigliani (1966), and Zamparelli (2016) all posited differential savings rates between capitalists and workers, none of them offered a behavioral explanation for the difference. Our model differs from these contributions by grounding differential savings rates in the prevalence of other-regarding preferences, which increase consumption and reduce savings and wealth accumulation, at the lower end of the income distribution. In line with the evidence we presented in Petach and Tavani (2018), workers' preferences are assumed to be negatively affected by the average consumption of other workers,[1] motivating increases in consumption through expenditure cascades, external habits or "keeping up with the Joneses" behavior. Conversely, and backed by the empirical evidence, top income earners' consumption appears not to be affected by peer consumption. A savings rate differential between capitalists and workers—as well as a simple relation between the accumulation rates of the two classes—emerges endogenously as a result, ensuring the savings rate of the latter is always lower, thereby ruling out the "dual" outcome in the steady-state.

Importantly for our analysis, the combination of induced bias in technology and class-based differential saving rates generates a downward-sloping, long-run relationship between wealth inequality and the income-capital ratio (or, a positive relationship between wealth inequality and the capital-income ratio) which we will refer to as the "Piketty schedule." This finding is important because, while *Capital in the XXI Century* is silent on the relationship between the capital-income ratio and wealth inequality, its very argument presupposes a direct link between the two: if wealth was equally distributed, there would be no room for the gloomy predictions about an increase in the capital-income ratio translating into class-stratified outcomes with respect to wealth ownership.

It remains to be seen how these distributional changes relate to changes in the growth rate of labor productivity. We capture this within our model via a catch-all shift parameter that affects the induced bias in innovation and directly affects the labor share in the long run. We argue that changes in this parameter can be interpreted in a consistent fashion as a variety of policy and/or institutional changes potentially related to secular stagnation, by which we mean the general slowdown in the rate of labor productivity growth. While one popular explanation for secular stagnation revolves around an excess supply of saving in the market for loanable funds (Summers, 2015), we find this explanation unsatisfactory in that: (i) it hinges on the questionable argument that there exists an interest rate that ensures full employment, and (ii) it ignores important long-run structural forces in the economy related to both income distribution and labor productivity. Such forces include: (a) a slowdown in the growth rate due to the exhaustion of path-breaking scientific discoveries à la Gordon (2015), (b) increasing monopsony power in the labor market (Krueger and Posner, 2018; Dube et al., 2018), (c) globalization and the "race to the bottom" in unit labor costs (Rada and Kiefer, 2015), (d) fiscal austerity (Wisman, 2013), and (e) financialization and growing financial fragility (Skott and Ryoo, 2008; Cynamon and Fazzari, 2016; Michl, 2017). In our model, an institutional shift that results from these forces causes a simultaneous fall in the labor share, a rise in the long-run capital-income ratio, and an increase in wealth inequality along the "Piketty schedule" via the differential savings of the two classes.

Thus, the present contribution provides a parsimonious organizing framework for thinking about both secular stagnation and rising wealth inequality in the United States. Over the past thirty years, political and institutional changes have put downward pressure on the labor share in income, resulting in a rising capital-income ratio and a slower rate of labor productivity growth via induced technical change. Empirically-supported differences in savings rates across households have translated the increased wealth accumulation for the top 1% of wealth holders—at the expenses of everyone

[1] See equation (1).

else— into an increase in the capital-income ratio.

We conclude our analysis with a few questions with policy relevance: to what extent are these trends irreversible? First, can taxation be used to counter the observed rise in wealth inequality? And second, are these labor-crushing institutions inevitable? Piketty (2014) delineated an ambitious list of policy proposals to combat growing inequality, none more provocative than his suggestion of a global tax on wealth; demonstrating the economic feasibility of using tax policy to alter the distribution of wealth is a necessary first step if such a policy is to enter the realm of possibility. Pace Zamparelli (2016), we show that a tax on capital income can be used to implement *any* given distribution of wealth between the two classes. In a way, a similar answer applies to the institutional shifts affecting labor: because of their very institutional nature, these shifts are not inevitable. However, addressing their causes—with the possible exception of the Gordon (2015) argument—requires a degree of international cooperation on labor conditions that is simply not currently in the cards.

The rest of our paper is organized as follows. Section 2 describes the economic environment of the baseline version of our model. Section 3 details the dynamics of the model. Section 4 characterizes the steady-state, presents results from simulations, and examines the policy implications of the model. Section 5 concludes. Most of the mathematical arguments behind our results are presented in the Appendix.

2 The Economic Environment

2.1 Economic Classes and Preferences

A one-sector closed economy is populated by two classes, "workers" and "capitalists." Time is continuous, and the total labor force is assumed to be constant and normalized to one for simplicity. Workers supply their labor services inelastically in exchange for a real wage w, consume, and save in order to accumulate capital stock. Denote by k^w the capital stock owned by workers in per-capita terms. Capitalists own capital stock (again, per-capita) k^c, earn profit incomes, consume and save. For the sake of simplicity, assume that neither type of capital depreciates. Let r be the uniform rate of return on capital, endogenous to the model but given to each economic agent. Both capitalists and workers discount the future at the same rate $\rho > 0$. The difference between the two classes is in their respective instantaneous preferences. Empirical evidence using Consumer Expenditure Survey data from the United States suggests that consumption peer effects are large—over 30% in magnitude—for the bottom quintiles of the income distribution, but vanish as top income earners are considered (Petach and Tavani, 2018). Thus, we assume that, while capitalists derive (logarithmic, for simplicity) utility from their own consumption c^c, workers have (logarithmic, again) preferences that reflect so-called "external habits", or their intent to "keep up with the Joneses" (Ljunqvist and Uhlig, 2000; Turnovsky *et al.*, 2004; Dynan and Ravina, 2007; Alvarez-Cuadrado and Van Long, 2011):

$$u^w(c^w; \bar{c}) = \ln(c^w - \theta\bar{c}) \tag{1}$$

where c^w denotes the worker household consumption, $\bar{c}$ stands for average consumption of the reference group of workers, and $\theta \in (0,1)$ denotes the extent to which working households' preferences are other-regarding. Each working household takes $\bar{c}$ as a given *at all times* in their decision-making. As such, average consumption across working households has the nature of a pure externality: workers neither take into account the fact that their decisions affect average consumption within their class, nor consider the effect of changes in average consumption on the (shadow-) value of their wealth.

In order to avoid unnecessary complications, we assume that neither class holds debt at any moment in time. Thus, the accumulation constraints for capitalists and workers are given respectively by

$$\dot{k}^c = rk^c - c^c \tag{2}$$

$$\dot{k}^w = w + rk^w - c^w \tag{3}$$

Appendix A shows that simple dynamic optimization problems deliver the following Euler equations for the "representative capitalist" and the "representative worker" respectively:[2]

$$\frac{\dot{c}^c}{c^c} = r - \rho \tag{4}$$

$$\frac{\dot{c}^w}{c^w} = \frac{c^w - \theta\bar{c}}{c^w}(r - \rho) \tag{5}$$

2.2 Production Technology and Income Distribution

Final output per worker $y \equiv Y/L$, homogeneous with capital stock, is produced using fixed proportions of capital per-worker $k \equiv k^c + k^w$ and labor: $y = \min\{A, Bk\}$ where B denotes the output-capital ratio, and A is the stock of labor-augmenting technology. Since the profit rate is the same for the two types of capital stock, for both classes of wealth-owners we have the typical wage-profit relation

$$r = B(1 - \omega) \tag{6}$$

where $\omega \equiv w/A$ is the labor share. The growth rates of factor-augmenting technologies are endogenous to the model, and determined below.

2.3 Wealth Accumulation

For both classes of agents, we look at a balanced growth path where their respective consumption and their capital stock grow at the same rate—that may be different between classes, however—$g^i, i = \{c, w\}$. A balanced growth path for capitalist households is straightforward: it is a textbook

[2]The literature has downplayed the effect of consumption externalities in dynamic optimization models. In Petach and Tavani (2018), we argued that a proper account of such externalities requires to consider their dynamic effects also, and that CEX data supports this hypothesis. Such considerations are crucial in order to obtain equation (5).

result that consuming a constant fraction of their wealth $c^c = \rho k^c$ ensures that

$$g^c = B(1-\omega) - \rho \tag{7}$$

On the other hand, imposing balanced growth for worker households is slightly more involved. First, observe that the workers' accumulation equation can be written as:

$$\begin{aligned} \frac{\dot{k}^w}{k^w} &= \frac{w}{k^w} + r - \frac{c^w}{k^w} \\ &= \frac{w}{Y}\frac{Y}{K^w} + r - \frac{c^w}{k^w} \\ &= \omega B + (1-\omega)B - \frac{c^w}{k^w} \\ &= B - \frac{c^w}{k^w}. \end{aligned}$$

Then, setting $\dot{c}^w/c^w = \dot{k}^w/k^w$ requires also to impose that the typical working household's consumption equals average consumption: $c^w = \bar{c}$. This is justified observing that the saving rule captured by (5) is a best-response function to average consumption. Imposing $c^w = \bar{c}$ at all times is therefore equivalent to imposing a symmetric Nash equilibrium in a "keeping up with the Joneses" game between the representative working household and the average working household. By so doing, we obtain the growth rate of workers' capital stock as

$$g^w = (1-\theta)\left[B(1-\omega) - \rho\right] = (1-\theta)g^c \tag{8}$$

The resulting accumulation rates for workers and capitalists can be used in order to assess the relation between the two classes' saving rates. Noting that, for class $i = \{c, w\}$, the saving rate is defined as $s^i = g^i k^i/(c^i + g^i k^i)$, after simple algebra one obtains:

$$\frac{s^w}{s^c} = (1-\theta)(1-\omega) \tag{9}$$

Incidentally, this expression makes it clear why the result obtained in Samuelson and Modigliani (1966), where a dual equilibrium exists provided that workers save at higher rates than capitalists, is little more than a theoretical *curiosum*. Even with no difference in social preferences between classes ($\theta = 0$), the workers' saving rate is *always* smaller than the capitalists' saving rate. And yet, the extent of social preferences matters: absent consumption peer effects, the accumulation rate is the same across the two classes, and the distribution of wealth is of no relevance to the model. This conclusion requires some clarification. In principle, one would assume that the class with a lower saving rate would accumulate less capital stock, which bears the question of why is it necessary to assume an asymmetry in social preferences at all. The answer is found by noting that, with both classes owning and accumulating capital stock in the forward-looking fashion described here, the respective Euler equations only depend on the return to the accumulated factor—capital—and not on the income from the non-accumulated factor—labor (Bertola, 1993). Hence, even though the overall saving rate of workers is always smaller than that of capitalists—because they have two sources of income instead of just one—absent social preferences both classes would save at the same rate from capital income, which is the only source of income that matters for the accumulation rate.

Using (7) and (8), the accumulation rate in this economy will be a weighted average of the accumulation rates of the two classes, the weight being the fraction of wealth owned by each class. Denoting the capitalist share of wealth by $\phi \equiv k^c/(k^c + k^w)$, we have:

$$g = \phi g^c + (1-\phi)g^w = [1-\theta(1-\phi)][B(1-\omega)-\rho] \tag{10}$$

The only difference between the two classes is the extent of consumption peer effects: accordingly, if $\theta = 0$ in equation (10), the class-distinction with respect to accumulation behavior vanishes, and both workers and capitalists accumulate at the same rate. In this case, the wealth distribution is irrelevant for long-run growth. As soon as θ becomes positive, however, the accumulation rate is directly related to the capitalist share of wealth.

2.4 Technical Change: the Induced Innovation Hypothesis

Following Kennedy (1964); Drandakis and Phelps (1965); Julius (2005), we suppose that firms have access to a menu of technological improvements that potentially can increase both the output-capital ratio (at a rate χ) and labor productivity (at a rate γ). However, there are trade-offs between improving along one technological dimension versus the other. Such trade-offs are summarized by a twice-continuously differentiable, strictly decreasing, strictly concave *innovation possibility frontier* (Kennedy, 1964, IPF henceforth) which can be written in explicit form as

$$\gamma = f(\chi),\ \ f' < 0, f'' < 0 \tag{11}$$

Firms choose a profile of technological improvements to maximize the rate of reduction in unit costs, or equivalently the rate of change in the profit rate (see Tavani, 2012, for a duality result):

$$\begin{array}{lll} \text{Choose} \quad \chi & \text{to maximize} & \omega\gamma + (1-\omega)\chi \\ & \text{subject to} & \gamma = f(\chi) \end{array} \tag{12}$$

The solution to the problem yields a dependence on growth rates of factor-augmenting technologies on factor shares through the first-order condition $-f'(\chi) = (1-\omega)/\omega$. Inverting this condition yields a positive (negative) relation between labor (capital) productivity growth and the labor share. We also assume an exogenous intercept of the IPF, denoted by z, which could be interpreted in standard fashion as either as the exogenous 'natural' growth rate or —and this would be our preferred interpretation—as any institutional variable positively affecting the labor share in the long run. Thus, the growth rates of capital- and labor-augmenting technologies that solve (12) can be written

$$\chi = \chi(\omega; z); \quad \gamma = f(\chi(\omega; z)) \tag{13}$$

with $\chi_\omega < 0$—and correspondingly $\gamma_\omega > 0$. In what follows, we assume $\chi_z > 0$.

3 Dynamics of Wealth, Income Shares, and the Output-Capital Ratio

Consider first the share of wealth owned by the capitalist class. Its law of motion over time obeys the replicator-style equation (see Appendix B.1 for a derivation):

$$\dot{\phi} = \phi(1-\phi)(g^c - g^w) \tag{14}$$

which, using (7) and (8), gives simply

$$\dot{\phi} = \phi(1-\phi)\theta\left[B(1-\omega) - \rho\right] \tag{15}$$

As for the dynamics of the labor share, we assume that its rate of change increases with capital accumulation, and it decreases with labor productivity growth. As investment takes place, the labor market tightens and the resulting pressure on wages relative to labor productivity determines an increase in the wage share. Conversely, for a given state of the labor market, an increase in labor productivity growth reduces labor requirements thus putting downward pressure on the labor share. With speed of adjustment $\lambda > 0$, we have that:

$$\begin{aligned} \dot{\omega} &= \lambda(g-\gamma)\omega \\ &= \lambda\left\{[B(1-\omega)-\rho][1-\theta(1-\phi)] - \gamma(\omega)\right\}\omega \end{aligned} \tag{16}$$

Finally, the evolution of the capital/output ratio is governed by induced innovation, and satisfies:

$$\dot{B} = \chi(\omega; z)B \tag{17}$$

Equations (15), (16), and (17) form a dynamical system describing the economy under consideration. We turn to characterizing its steady state and implications.

4 Steady State and Policy

In order to simplify the analysis in what follows, we will utilize a linearized version for both growth rates of factor-augmenting technologies: $\chi(\omega; z) = z - \beta\omega, \beta > z > 0$, and $\gamma = \eta\omega$. Setting $\dot{B} = 0$ in equation (17) solves for the long-run share of labor as

$$\omega_{ss} = \frac{z}{\beta} \tag{18}$$

which, in turn, gives the long-run growth rate of labor productivity as $\gamma(\omega_{ss}) = \eta(z/\beta)$. Notice that, as pointed out by Julius (2005), the labor share evolves so as to ensure a Harrod-neutral profile of technical change in the long run. Then, setting $\dot{\omega} = 0$ in equation (16) and using (18) gives the following nullcline in the "Piketty plane" (B, ϕ):

$$B(\phi) = \frac{\eta z + \rho\beta[1 - \theta(1 - \phi)]}{(\beta - z)[1 - \theta(1 - \phi)]} \tag{19}$$

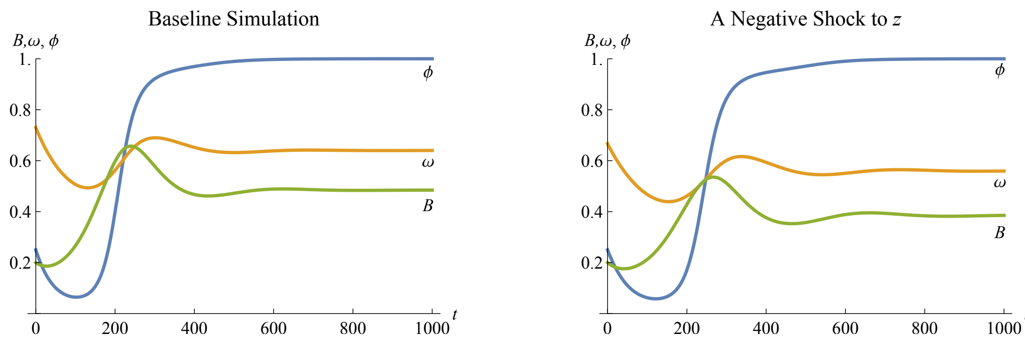
which is *downward sloping*: an increase in the capitalist share of wealth determines a decrease in the income-capital ratio (or equivalently an increase in the capital-income ratio, as highlighted by Piketty, 2014). Finally, as shown in the Appendix, the evolution of the capitalist share of wealth only has the extreme solutions $\phi_{ss} = 0$ and $\phi_{ss} = 1$, and there is no intermediate steady state where wealth is split among the two classes. This result holds because of the absence of factor substitution due to the fixed-proportion technology: induced bias is not sufficient for a distribution featuring both classes owning wealth to emerge. In the Appendix, we also show that the only (conditionally) stable distribution involves all the wealth accruing to the capitalist class. In this respect, induced innovation reinforces the distributive conflict, contrary to factor substitution *à la* Samuelson and Modigliani (1966) which dampens it so as to make it possible that a stable "dual" distribution is achieved where workers own all the wealth in the economy. At $\phi_{ss} = 1$, the steady state output-capital ratio reduces to $B_{ss} = (\eta z + \rho\beta)/(\beta - z)$.

Note also the stark difference between the implications of this model and the well-known Piketty argument according to which an increase in the capital-income ratio affects the distribution of income through the production technology via the elasticity of substitution. Here, income distribution is independent of the production technology, but the relationship goes from the capitalist share of wealth to the capital-income ratio, and not vice versa.

4.1 Parameter Calibration

Figure 1 shows that the upward trends in both the top wealth share and the capital-income ratio begin roughly in the 1980s. While labor productivity growth and the labor share have been subject to more fluctuations over the whole period displayed in the Figure, for the purpose of this analysis we can parameterize the model so as to to match the average values of the various endogenous variables of the model between 1950 and 1980. In so doing, we proceed as follows. First, we set the ratio z/β equal to .64, which is roughly the mean value for the labor share over that period. Fixing $z = .04$, this implies $\beta = .0625$. Second, we parameterize $\eta = .0625$ so as to obtain a labor productivity growth rate of 2.5%—about the average labor productivity growth rate up to 1980. Third, we use the estimates presented in Petach and Tavani (2018) to parameterize the extent of consumption externalities θ at .32. Fourth, noting that the average top wealth share between 1950 and 1980 was about 25% and that the capital-income ratio up to 1980 was roughly 3, we can use the above values in the "Piketty schedule" to calibrate the discount rate at about .134. Finally, we fix the adjustment speed in the labor share equation λ, which is inconsequential in determining the steady state of our model, at .05. Higher (lower) values for the adjustment speed would accelerate (slow down) the convergence to the steady state. The left panel of Figure 3 plots the corresponding baseline dynamic trajectories for the three endogenous variables in the model. The trajectory for labor productivity growth is omitted from the plot since it mirrors that of the labor share given the linear specification of induced bias.

Figure 3: Simulated trajectories for the labor share, the income-capital ratio, and the capitalist share of wealth. Parameter values: $\theta = .32, \rho = .134, z = .04$ (left panel), $z = .035$ (right panel), $\beta = .0625 = \eta, \lambda = .05$.



4.2 Institutional Change and Secular Stagnation

Consider the effect on labor productivity growth of a reduction in the policy parameter z, which is a catch-all parameter that could capture alternatively: (i) a fall in unionization, (ii) a downward push on real wages arising from globalization, (iii) increased monopsony power in the labor market, (iv) a decline in workers' bargaining power due to financialization, or (v) a reduction in the growth rate of labor productivity growth due to the exhaustion of path-breaking scientific discoveries in the spirit of Gordon (2015). The labor share falls, and labor productivity growth follows as a result of the lessened incentive to bias technological change toward labor. Further, the decline in the labor share has a level effect on the output-capital ratio in (19) which falls as a result. The reason is that the income-capital ratio is inversely related to the overall saving rate in the economy.[3] Everything else equal, a reduction in the labor share increases both the workers' saving rate and the capitalist saving rate, and the income-capital ratio falls (the capital-income ratio rises). The right panel of Figure 3 displays the dynamic trajectories corresponding to a shock to the institutional parameter z.

4.3 Redistribution and Labor Market Institutions

Zamparelli (2016) has shown that in an "anti-dual" Pasinetti economy, tax policy can be used in order to implement any wealth distribution among the two classes. Following his contribution, suppose that capitalist incomes are taxed proportionally at a rate τ, while the tax proceedings are rebated to workers in the form of subsidies. The Euler equation for the capitalist households becomes

$$g^c = B(1-\omega)(1-\tau) - \rho \tag{20}$$

[3]This is true in pretty much any growth model that meets the Kaldor facts. See Tavani and Zamparelli (2017) for a survey of the non-Neoclassical literature.

while, since the workers' accumulation constraint is $\dot{k}^w = w + rk^w + \tau r k^c - c$, the corresponding Euler equation remains (8). Accordingly, the wealth distribution evolves over time following

$$\dot{\phi} = \phi(1-\phi)[B(1-\omega)(\tau-\theta) - \theta\rho] \tag{21}$$

Suppose that the wealth distribution starts at $\bar{\phi}$. Making use of equation (19), it is easy to show that setting a tax rate equal to

$$\tau^* = \theta \left\{ 1 + \frac{\rho\beta\left[1-\theta(1-\bar{\phi})\right]}{\eta z + \rho\beta\left[1-\theta(1-\bar{\phi})\right]} \right\}$$

is sufficient to keep the wealth distribution constant no matter its composition. Thus, tax policy can be used in order to crystalize the wealth distribution the economy starts off with, preventing it from evolving toward the class-stratified equilibrium.

Consider next the question regarding whether the institutional changes that constitute the first link of the chain reaction described in this paper are irreversible. Clearly, the answer is negative—with the possible exception of the Gordon (2015) argument. During the period between the 1950s and the 1970s, characterized by the so-called "capital-labor accord," the US economy saw high labor productivity growth coexisting with strong labor market institutions. The accord has faltered under the pressures of globalization on real US wages, the decline in unionization, and the overall retreat of the labor movement that have characterized the neoliberal era. In principle, there is no reason to see these developments as inevitable. Institutional changes are not a mechanistic process. The main issue, then, becomes the creation of a broad enough consensus about a reversal of these developments, and a coordinated solution to the tendency to suppress labor in the "race to the bottom" highlighted by Rada and Kiefer (2015).

5 Conclusion

In this paper, we drew from a number of established alternative traditions in economic theory to present a simple model that can be useful in framing the recent stylized facts on the increase in wealth inequality, the increase in the capital-income ratio, the decline in the labor share of income, and the decline in labor productivity growth in the United States.

The main mechanisms at work can be summarized as follows. Either the erosion of labor market institutions or the rise of globalization is responsible for the fall in the labor share of income. The induced innovation mechanism implies that the growth rate of labor productivity will fall as a result, because firms' incentives to innovate in order to save on unit labor costs are lessened by this process. Differential saving rates among workers and capitalists, which respond to class-specific degrees of emulation in consumption that are supported by empirical evidence, determine the progressive concentration of wealth in the hands of the latter. As wealth concentrates, the capital-income ratio increases: the pace of accumulation speeds up because of the increasing share of wealth in the hands of high-saving households, but the anchor to long-run growth is the growth rate of labor productivity, which has declined. Restoring balanced growth requires an increase in the capital-income ratio.

Our intuition for the ongoing transformations in the US economy is diametrically opposed to the technological explanation put forward by Piketty (2014) where the degree of substitutability between capital and labor is responsible for the fall in the labor share given the increase in the capital-income ratio. Conversely, our view is that institutions matter: declines in labor protection are the first—not the last—link of the chain reaction that set in motion the global economic conjuncture.

We also argued that these outcomes are not inevitable: on the one hand, tax policy can be used in order to stop the otherwise natural process of wealth accumulation in the hands of high-saving households whose incomes come mostly from profits. On the other hand, worker-crushing policies or global arrangements can be reversed provided that there is the political will to do so.

However, there is not much to be optimistic about the reversal of this process. First, and as is well-known after the recent literature on the 'race to the bottom' (Rada and Kiefer, 2015), individual countries do have incentives to suppress labor in order to increase (or at least not to decrease) their export share in the global economy. Therefore, labor-friendly policies require international coordination: but there are no global agreements or mechanisms in place to enforce a coordinated effort toward this aim. Second, even if the US were to act unilaterally to address anti-worker institutional arrangements (such as the recent growth of monopsony power in the labor market documented by Dube et al., 2018), capital moves quite easily around the globe. Thus, as long as there is policy competition between countries geared toward attracting wealth by redistributing away from wages, there is little room to hope for the kind of policy solutions discussed in this paper to take place.

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A Optimization

The current-value Hamiltonian functionals for the capitalist agent and the worker agent are, respectively:

$$\mathcal{H}^c = \ln c^c + \mu^c[rk^c - c^c] \tag{22}$$

$$\mathcal{H}^w = \ln(c^w - \theta\bar{c}) + \mu^w[w + rk^w - c^w] \tag{23}$$

and the battery of first-order conditions is:

$$\frac{1}{c^c} = \mu_c \tag{24}$$

$$\rho - \frac{\dot{\mu}_c}{\mu_c} = r \tag{25}$$

$$\frac{1}{c^w - \theta\bar{c}} = \mu_w \tag{26}$$

$$\rho - \frac{\dot{\mu}_w}{\mu_w} = r \tag{27}$$

plus the usual transversality conditions on both types of capital stocks. Differentiating (24) with respect to time and making use of (25) gives (4). Differentiating (26) and using (27), while keeping $\bar{c}$ as an externality throughout—so that agents do not consider the effect of its rate of change on the (shadow-) value of their own wealth—gives (5).

B On the Evolution of the Capitalist Share of Wealth

B.1 Deriving Equation 15

Start from the definition of $\phi \equiv k^c/(k^c + k^w)$, and differentiate with respect to time to obtain:

$$\begin{aligned}
\dot{\phi} &= \frac{\dot{k}^c(k^c + k^w)}{(k^c + k^w)^2} - \frac{k^c}{k^c + k^w}\left(\frac{\dot{k}^w + \dot{k}^c}{k^c + k^w}\right) \\
&= \frac{\dot{k}^c}{k^c}\left(\frac{k^c}{k^c + k^w}\right) - \frac{k^c}{k^c + k^w}\left[\left(\frac{k^c}{k^c + k^w}\right)\frac{\dot{k}^c}{k^c} + \left(\frac{k^w}{k^c + k^w}\right)\frac{\dot{k}^w}{k^w}\right] \\
&= \phi g^c - \phi\left[\phi g^c + (1 - \phi)g^w\right] \\
&= \phi(1 - \phi)(g^c - g^w)
\end{aligned}$$

B.2 Long-Run Equilibria

Consider equation (15): clearly, it has steady states at both $\phi = 0$ and $\phi = 1$. The question is whether there is an intermediate steady state $\phi \in (0, 1)$, and the purpose of this subsection is to show that the answer is negative. To see this, consider the Piketty equation (19), and plug the corresponding value $B(\phi)$ into the right-hand side of (15). After simple algebra, we find:

$$\dot{\phi} = \phi(1-\phi)\left\{\frac{\eta z + \rho\beta[1-\theta(1-\phi)]}{\beta[1-\theta(1-\phi)]} - \rho\right\}$$

which further simplifies to

$$\dot{\phi} = \phi(1-\phi)\left[\frac{\eta z}{\beta[1-\theta(1-\phi)]}\right]$$

Since no value of $\phi \in [0,1]$ can void the term in square brackets, we conclude that the only long-run equilibria for equation (15) are the two extreme values $\phi = 0$ and $\phi = 1$.

C Stability Analysis

We start with linearizing the dynamical system around the steady state where all wealth is the hands of the capitalist class ($\phi_{ss} = 1$). This yields a Jacobian matrix with the following sign structure:

$$J(\omega_{ss}, 1, B_{ss}) = \begin{bmatrix} - & + & + \\ 0 & - & 0 \\ - & 0 & 0 \end{bmatrix}$$

given that

$$\begin{array}{lclcl} J_{11} & = & -\lambda[(B_{ss}+\eta]\omega_{ss} & < & 0; \\ J_{12} & = & \lambda\theta(B_{ss}(1-\omega_{ss})-\rho) & > & 0; \\ J_{13} & = & \lambda(1-\omega_{ss})\omega_{ss} & > & 0; \\ J_{21} & = & J_{23} & = & 0; \\ J_{22} & = & -\theta(B_{ss}(1-\omega_{ss})-\rho) & < & 0; \\ J_{31} & = & -\beta B_{ss} & < & 0; \\ J_{32} & = & J_{33} & = & 0. \end{array}$$

The Routh-Hurwitz conditions for local stability are as follows:

1. $TrJ < 0$, which is clearly satisfied.

2. $DetJ < 0$. We have $DetJ = -J_{31}J_{13}J_{22} < 0$ as required.

3. $PmJ > 0$, that is a positive value for the sum of the principal minors —the determinants of the sub-matrices obtained removing the first, second, and third row and column respectively. We have that $PmJ = -J_{13}J_{31} + J_{11}J_{22} > 0$ as required.

4. The final condition requires that $-TrJPmJ + DetJ < 0$. After some algebra, this boils down to checking whether $J_{11}(J_{31}J_{13} - J_{11}J_{22} - J_{22}^2) < 0$. This condition is not satisfied. In fact, we know that $J_{11} < 0$, that $J_{13}J_{31} - J_{11}J_{22} < 0$ because of condition 3 above, and that $-J_{22}^2 < 0$ always, so that we end up with a positive value for that product.

Thus, the equilibrium is in principle unstable. However, the forward-looking nature of consumption allows the corresponding initial value to be picked freely: consumption can function as a jump variable in this case to bring the dynamics onto the stable manifold converging to the steady state. If the number of unstable roots in the Jacobian is equal to the number of jump variables, then the system satisfies the well-known Blanchard and Kahn (1980) requirements for *conditional* (or saddle-path) stability.

We can then turn to a numerical evaluation of whether the condition holds. Under the baseline parameterization, the Jacobian matrix evaluated at $\phi_{ss} = 1$ has two negative (stable) eigenvalues $\varepsilon_1 = -.0302, \varepsilon_2 = -.0128$ and one positive (unstable) eigenvalue $\varepsilon_3 = .0115$. We conclude that the equilibrium with $\phi_{ss} = 1$ is conditionally stable.

At $\phi_{ss} = 0$, the J_{22} entry turns positive—it is equal to $\theta[B_{ss}(1 - \omega_{ss}) - \rho] > 0$—thus making it more difficult to check the various conditions analytically given, for instance, the ambiguity in the sign of the trace of the Jacobian matrix. Thus, we resort to evaluating the eigenvalues numerically at the baseline parameterization. We find two unstable roots $\varepsilon_2 = .0188, \varepsilon_3 = .0078$ and one stable root $\varepsilon_1 = -.0335$, while the number of jump variables is again one—consumption. Therefore, in this case the corresponding equilibrium is fully unstable, as confirmed by a quick glance at Figure 3, where the dynamics clearly pulls away from the $\phi_{ss} = 0$ steady state.

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