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Path Dependence and Stagnation in a Classical Growth Model

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Abstract

This paper embeds a technical progress function in a classical growth model and studies the effects of permanent changes in parameters and temporary shocks such as pandemics. Technical change is driven by dynamic economies of scale and responds to distributional forces: the wage share regulates labor-saving technical change and employment regulates its capital-using bias. The model features path dependence in the employment-population rate and the output-capital ratio. Population growth and distribution can respond to the employment rate. Interpreted through the model, secular stagnation under neoliberal capitalism has been driven by a combination of diminished investment and reduced worker bargaining power more than by slower technical change and population growth. A temporary unfavorable shock to the output-capital ratio will permanently reduce the employment rate. In the fully endogenous model, this will increase the profit share and reduce the rates of technical change, capital accumulation, and population growth.

JEL Codes: E12, E24, I14
Keywords: Kaldor-Verdoorn Law, hysteresis, technical progress function, wage-led growth, COVID-19, pandemics

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1 Introduction

The COVID-19 pandemic and recession of 2020 will undoubtedly cast a long shadow in a global economy already suffering from secular stagnation, even after the public health systems of the world eventually learn to manage the virus and the economic policy authorities have contained the most immediate instabilities. This paper addresses what kind of long-term effects we might expect after an event that defies classification as either a pure demand or supply shock. We offer a novel structuralist growth model that features endogenous technical change, population growth, and distribution by combining elements of classical (in the sense of the classical political economists) and Keynesian theory. To be sure, the paper is not meant to predict the effects of the pandemic with precision but rather to use this opportunity to advance some potentially useful ideas about the long-term effects of aggregate shocks in structuralist macroeconomic models.

The key feature of the model is path dependence: even in the best-case scenario in which the COVID-19 recession is a temporary negative shock, it can inflict permanent damage through the supply-side effects that the model emphasizes. The model does not directly address the demand-side aspects of the COVID-19 shock as it is intended to provide a baseline for the long-run supply impact under a business-as-usual policy regime which may lock in an inferior outcome because it fails to appreciate the inherent path dependence of capitalist economies. Indeed, a robust response that addresses both the demand shortfall and provides positive support for productivity growth, for example through the pursuit of a high-pressure labor market and strong infrastructure program, could lead to a more positive outcome. Even though our focus is on the longer term response to the crisis and we think the model shows merit on its own terms, we submit that this is the right time to sound the alarm about the inadequacy of conventional policy frameworks.

Our growth model is constructed around the technical progress function proposed by Taylor et al. (2019) (TFR hereafter), which builds on two staples in structuralist Keynesian thinking on economic growth. On the one hand, it features endogenous technical change through a Kaldor-Verdoorn Law based on dynamic increasing returns to scale; on the other hand, it emphasizes the notion that labor-saving technical change is distribution-led, either because of induced bias in technical change as in Foley (2003); Julius (2005); Zamparelli (2015) or endogenous technical progress in models of class-conflict as in Tavani and Zamparelli (2021).[1] One of the innovative features of TFR's technical progress hypothesis, its use of the capital-population ratio as a scale factor, lends itself to the development of a transparent growth model with path dependence in the employment rate, i.e. the employment-population ratio. We then embed the technical progress function in a familiar classical growth environment. The rate of capital accumulation obeys the usual Cambridge Equation, so that it depends on profitability and the capitalization rate—the propensity to invest and save out of capitalist wealth. The direction or bias of technical change, as captured by changes in the output-capital ratio, responds to changes in the employment-population ratio, supplying a homeostatic mechanism that pins down the output-capital ratio in a steady state.

We study the comparative dynamics of this model in detail. Because both population growth and technical change are endogenous, changes in the capitalization rate, the bargaining power of workers, and the rates of autonomous population growth or technical change all have long-run growth effects. They also have level effects through path dependence. Significantly, the results lie somewhere in between the limiting cases of a labor-constrained system like a Goodwin (1967) model and a capital-constrained system with exogenously determined distribution.

We also study the effects of one-time shocks in order to cast light on the likely effects of the COVID-19 recession. These can be modeled in a variety of ways, including pure technical regress

[1] Sylos Labini (1984) introduced a similar technical progress function much earlier.

or premature obsolescence of capital stocks: either way, the output-capital ratio is expected to fall following such a shock. In brief, assuming a negative shock and absent a strong policy response we should anticipate a post-recovery period with lower employment rates, a more unequal distribution of income, less vigorous capital accumulation, and slower productivity growth due to the "wage-led" nature of labor-augmenting technical change in the long run. These predictions are in sharp contrast to Jordà et al. (2020) who offer empirical evidence that pandemics (including the 1918 Influenza and the Black Death) have historically been followed by periods of rising real wages. We believe that their findings are not applicable to a stagnant capitalist economy. One source of confidence in our model's predictions is that it captures many of the stylized facts of the last major shock event, the Global Financial Crisis of 2008, whose legacy has been an era of secular stagnation. Indeed, it is precisely because the COVID-19 shock has perturbed an already-vulnerable form of capitalism that the need for new thinking about the policy challenge has grown so critical.

2 Basic Elements of the Model

Our analysis amounts to building a compact growth model around the technical progress function introduced by Taylor et al. (2019). Rather than closing the model with the Keynesian assumption of independent investment and saving functions, we study the technical progress function in a suite of classical models to project the effects of both permanent and temporary macroeconomic shocks toward the medium-to-long run. We first take the wage share to be parametric and adopt a *conventional wage share* closure (Foley et al., 2019). We then consider endogenous distribution based on a reserve army effect. Since population growth plays a role in the TFR model of technical progress, we progressively complicate the framework by endogenizing the rate of population growth; we finally study a fully endogenous growth model where both distribution and population evolve endogenously. All of these models abstract from *very* short-run dynamics where suppressing the investment function is inappropriate: any reference to "short-run" in what follows means "away from a steady state."

We consider a one-sector capitalist economy in continuous time. As is standard in the heterodox literature, the economy is populated by two classes, workers and capitalists. Workers earn wage income that they consume entirely. Capitalists earn profit income out of which they consume and save in order to accumulate more capital. Let ρ denote the net output-capital ratio (capital productivity), and x be net output per worker (labor productivity): with capital stock K, labor demand N in the economy is $\rho K/x$. Further, let π denote the net profit share, and let γ, χ denote the rates of labor- and capital-saving technical progress, both endogenous in what follows. We use net output in order to economize on notation and omit explicit reference to depreciation.

The TFR technical progress function uses the profit rate to capture the notion of induced technical change. A more direct and intuitive choice is the profit share (Kennedy, 1964; Foley, 2003; Julius, 2005; Zamparelli, 2015) since its complement to one (the wage share) correlates with unit labor costs, providing a precise measure of a firm's savings from any productivity improvements. Then the technical progress function is

$$\gamma = \gamma_0 + \gamma_1 \hat{\kappa} - \gamma_2 \pi \qquad 0 < \gamma_1 < 1 \tag{1}$$

where κ is the capital-population ratio, K/POP, and the hat notation denotes a growth rate. This equation represents a reduced-form approach that combines two theories of technical change that have been widely used in the heterodox literature: dynamic economies of scale following a Kaldor-Verdoorn law (Verdoorn, 1949; Kaldor, 1957) and distribution-induced research and development (Kennedy, 1964). The intercept term captures any autonomous technical change. The disadvantage of a reduced-form approach, of course, is that it leaves open some deeper questions about microeconomic and behavioral mechanisms. But an advantage is that it can help interrogate the statistical record, as we do below in Section 7 focusing on neoliberal capitalism and stagnation. With the profit share given, the steady state will be defined by

$$\gamma^* = \hat{\kappa} = \tilde{\gamma_0} - \tilde{\gamma_2}\pi.$$

where $\tilde{\gamma_0} = \gamma_0/(1-\gamma_1)$ and $\tilde{\gamma_2} = \gamma_2/(1-\gamma_1)$.

Kaldor's (1957) original formulation of the technical progress function featured growth in the capital-labor ratio, rather than growth in the capital-population ratio, as a determinant of technical change. This created a potential stabilizing role for the direction or bias of technical change. Rapid accumulation per worker, for example, creates capital-using (Marx-biased) technical change that could reduce profitability and contain growth. The TFR formulation, on the other hand, leaves the bias of technical change unspecified except at the steady state where the output-capital ratio will stabilize. Rapid accumulation per person (relative to the steady state value) only requires that the growth rate of the employment-population ratio, $e = N/POP$, exceed the growth rate of the output-capital ratio χ. This puts no restriction on χ, and indeed could be achieved with Harrod-neutral technical change, $\chi = 0$.

Therefore, and in the interests of incorporating the TFR function into a classical growth model, we propose an auxiliary assumption that restores Kaldor's idea that the direction of technical change can provide a homeostatic mechanism. A functional relationship like

$$\chi = f(\hat{e}) + \varepsilon; \qquad f(0) = 0, \qquad f' < 0 \tag{2}$$

achieves that objective. Here the ε term has a mean zero (consistent with steady state growth) and represents shocks to capital productivity that can have any sign. Like the TFR function itself, this is a reduced form intended to capture economically meaningful behavior. Importantly, it plays a central role in generating the path dependence that characterizes our model, as explained in further detail in the Appendix.

The economic motivation for this functional relationship is that increases in the employment rate create labor shortages that induce more mechanization and automation, as argued in Robinson (1962). In a sense, this motivation relies on the intuition behind models of induced technical change such as the one in Foley et al. (2019, Ch.7). In this case, during boom periods when accumulation per person is rising and the employment rate is driven up, the system will tend to stabilize through Marx-biased technical change. In the converse case, capital-saving technical change will restore profitability.[2]

To summarize, our approach to technical change brings together the three main mechanisms that have often been studied separately by structuralist economists. By combining dynamic returns to scale, distribution-led labor productivity growth, and Marx-biased technical change, we aspire to apply our approach empirically, as well as contribute to a fuller understanding of the relationships between growth and distribution.

Accumulation follows the continuous-time Cambridge equation in Michl and Foley (2007), where β represents the capitalist *consumption* propensity out of wealth (capital). The accumulation rate g is then:

[2]Dutt (2006, 2010) has used a specification in which the employment rate affects directly the growth rate of labor productivity. His assumption is not incompatible with ours: the so-called Marx-biased pattern of technical change features simultaneously rising labor productivity and falling capital productivity, and is observed over long periods of time in several economies (Tavani and Zamparelli, 2017).

$$g = \pi\rho - \beta. \tag{3}$$

where $\pi\rho$ is the net rate of profit, r, in the economy.

The Cambridge equation has been motivated as the consumption plan of a class of capitalist agents who are optimizing the discounted sum of the log of consumption (Foley et al., 2019, Ch.5) over an extended intergenerational horizon. It can also be motivated as the bequest plan of capitalists with a pure legacy motive who optimize over their own natural lifetimes but who value their own end-of-life accumulation with the same log utility function (Michl, 2008). In either case, we can think of profit income not consumed as a form of saving, although we could just as easily apply the term investment to this act since in our model there is no other wealth asset to accumulate. In order to avoid the impression that we have privileged saving over investment, let us use the term "capitalization rate" to refer to the propensity to accumulate out of wealth, $(1-\beta)$.[3] The classical approach in this paper describes accumulation at a high level of abstraction with no distinction made between saving by households and investment by firms with the intention of capturing a limited set of low frequency (say generational periods of 15-20 years) dynamics. In models that do make that distinction (Michl, 2016), the observed capitalization rate can reflect the interaction of intertemporal preferences (saving) and managerial animal spirits (investment). We think of the two approaches as complements rather than competitors, with the choice between them often depending on judgments about which is fit for purpose.

The capitalization rate is defined as a flow-stock ratio but it will also be useful to consider the flow-flow ratio of net investment to profits, s, which shows up in a familiar growth equation, $g = sr$. From the Cambridge equation above we can see that the capitalization rate is $(1-\beta) = 1-r(1-s)$. We use this accounting relationship in the empirical applications in Section 7.

Since we are implicitly including employment, this model will produce a steady state employment-population ratio. To deal with the fact that the employment-population ratio is bounded above by one, we propose a set of regimes based on how the employment rate affects population growth and distribution.

Increases in the employment rate can potentially raise the rate of population growth through immigration or pronatal policy. Endogenizing population growth makes sense in a global economy characterized by uneven development. Advanced countries have global reserves of labor at their disposal. At some point, the world economy may itself make a transition to "maturity" so that this method of endogenizing population growth no longer makes sense.

We model the growth rate of population as a simple affine function of the employment rate up to its upper bound,

$$n = \bar{n} + \eta \min\{e, 1\}, \tag{4}$$

which captures the fact that, since the employment rate is bounded by one, this model is only relevant in the interval bounded from above by a maximum rate of population growth equal to $\bar{n} + \eta$.

Similarly, higher employment rates are associated with stronger worker bargaining power and a higher wage share. This is the central premise of Goodwinian growth cycle models.[4] In order

[3] Michl and Foley (2007) show that capitalist consumption in a dynastic model with log utility is equal to a constant fraction of end-of-period wealth.

[4] The empirical evidence in support of the Goodwin cycle has mounted (Grasselli and Maheshwari, 2017) since the seminal paper by Goodwin (1967). Mohun and Veneziani (2008) have shown that the evidence is stronger when allowance is made for secular drift in the employment rate and wage share.

to capture distributional conflict at low frequency, we model the distribution of income through another simple function of the employment rate,

$$\pi = \bar{\pi} - \mu e. \tag{5}$$

Along with basic accounting relations, Equations (1-5) comprise a fully specified growth model. In order to build some intuition that can help explain its comparative equilibrium properties, we ascend through a series of increasingly complex cases to the general model. While each of the four cases we examine can potentially capture or approximate features of real historical episodes, they also facilitate the exposition of the economic mechanisms under study, and in particular the sometimes counterintuitive effects of distributional shocks. Moreover, they contextualize the model in the existing literature. The results are summarized below in Table 1 that shows the comparative equilibrium properties of the general model described in Section 6: some readers may prefer to skip ahead to the corresponding section.

In the basic model we assume that the rate of population growth and distribution are independently given. The system is stabilized by the dynamics of biased technical change. In the endogenous population growth model, increases in employment create pressure to raise the rate of population growth through immigration or pro-natal policy, with no effect on distribution. In the endogenous distribution model, increases in employment create a reserve army effect on distribution, with no effect on population growth. Finally, in the complete model, both population growth and distribution are endogenous.

The following sections present the models and the comparative statics arising from the various closures in turn. The stability analysis corresponding to each alternative closure is left to Appendix A which shows that in each case the model displays path dependence.

3 Exogenous population growth and distribution

In the most basic version of the model, the employment rate is free to increase and the rate of population growth is constant. Thus we can close the growth model with an exogenous population growth rate

$$n = \bar{n} \tag{4'}$$

and the conventional wage share closure:

$$\pi = \bar{\pi}. \tag{5'}$$

In this case, the steady state solutions (indicated by an *) are

$$\begin{aligned} \gamma^* &= \tilde{\gamma}_0 - \tilde{\gamma}_2 \bar{\pi} \\ g^* &= \gamma^* + \bar{n} \\ \rho^* &= \frac{\beta + g^*}{\bar{\pi}}. \end{aligned}$$

To maintain clarity we will only consider increases in the key parameters ($\bar{n}$, γ_0, $\bar{\pi}$, $(1-\beta)$, and ε) despite the fact that in applications we are often interested in negative shocks.

A permanent increase in population growth increases accumulation. The mechanism is capital-saving technical change triggered by the decrease in the employment rate from the shock. Ultimately, capital-saving technical change increases the profit rate sufficiently to accommodate higher growth. Thus, the employment rate will permanently decrease and capital productivity will increase.

A permanent increase in autonomous technical change has similar effects. In this case, the employment rate falls due to the more rapid displacement of workers through technical change. Again, the employment rate decreases and capital productivity increases in the long run.

Figure 1

A permanent increase in the conventional profit share reduces accumulation, perhaps counterintuitively, as is illustrated in Figure 1 that shows the technical progress function before and after the shock. The induced effect on the rate of labor-saving technical change depresses growth in the long run. Like all classical models, this one is profit-led in the short run (point B in the figure) but over time the reduced wage share relaxes the incentive to economize on labor and sustains a lower rate of accumulation, given the balanced growth condition $g^* = \gamma^* + \bar{n}$ above (point C). The mechanism that reduces accumulation is capital-using (Marx-biased) technical change that lowers capital productivity as the bias of technical change responds in the short run to the profit-led increase in accumulation and employment. The increase in employment will remain in place in the long run, as will the decline in capital productivity. A numerical evaluation of such a scenario is presented in Figure 2: following a 5% increase in the conventional profit share at time zero, capital productivity falls monotonically to its new steady state; the employment rate rises monotonically; while labor productivity growth initially spikes up but then converges to a lower long-run value. The plot of the capital-population ratio in logarithmic scale shows that, compared to the pre-shock trend (the dashed line), κ initially grows faster until it settles onto a slower growth path. This trajectory mirrors the evolution of $\hat{\kappa}$ in Figure 1.

Figure 2

A permanent increase in the capitalization rate (i.e., a reduction in β, capitalist consumption normalized by capital stock) has no long-run effect on the growth rate. There is no paradox of thrift in the short run, as in all classical models, but over time the effects of Marx-biased technical change would bring the rates of profit and growth back to original levels. As in the previous scenario, the immediate increase in the employment rate provides the impetus for capital-using technical change; the employment rate rises and capital productivity falls in the new steady state.

The employment-population ratio is path dependent in this model since any steady state has the growth of labor demand equal to population growth, $(g^* - \gamma^*) = n$, and any point along the line $n = \bar{n}$ represents a possible solution. In formal terms, the system has a zero root,[5] the hallmark of path dependence (Dutt, 1997, 2006, 2010). Temporary shocks to capital productivity will have permanent effects on the employment rate, but no long-run effect on any other endogenous variable. We will present a numerical evaluation of this point, which pertains to the predicted effects of the COVID-19 pandemic in the exogenous model as opposed to the endogenous model, in Section 8.

This property of the model resonates with theories of hysteresis (Rowthorn, 1999) that emphasize the role of capital and investment in propagating shocks so that they permanently alter the apparent "natural" rate of employment. One of the implications of our analysis is that a complete assessment of the "natural rate hypothesis" needs to take into account theories that can account for permanent hysteresis effects.[6]

[5]For further discussion, refer to Appendix A. Discrete time models in the form of difference equations that are path dependent display a unit root.

[6]The recent survey by Blanchard (2018) focuses on insider-outsider and skills obsolescence effects that arguably do deteriorate over time, generating persistence rather than hysteresis.

4 Endogenous population growth

We retain the conventional wage share assumption but assume that (perhaps beyond some critical level) increases in the employment rate trigger increases in population growth, for example because of in-migration outpacing out-migration. We can model that by replacing equation (4') with equation (4).

Within the space bounded from above by the maximum rate of population growth, the model shares the property of having path dependence, which now involves both the employment rate *and* capital productivity. Since $g^* = \gamma^* + n^* = \tilde{\gamma_0} - \tilde{\gamma_2}\bar{\pi} + \bar{n} + \eta e^*$, we now have

$$\rho^* = \frac{\bar{n} + \beta + \tilde{\gamma_0} - \tilde{\gamma_2}\bar{\pi} + \eta e^*}{\bar{\pi}}.$$

The steady state (ρ^*, e^*), will lie on this curve, with any particular position selected by history or initial conditions since the model continues to display a zero root.

A permanent increase in autonomous population growth ($\bar{n}$) will increase accumulation as before: the mechanism is again capital-saving technical change that increases the profit rate. This shock is likely to reduce the employment rate; this, in turn, will drag down population growth, somewhat attenuating the initial increase in autonomous population growth. Since there has been no change in distribution, the rate of labor-saving technical change will eventually return to its original value.

A permanent increase in autonomous technical change has similar effects. Now, however, its impact on the employment rate will induce slower population growth so that it will not translate one-for-one into long-run growth. As before, both these increases in the growth of the *effective* labor force (i.e, measured in efficiency units) reduce the employment rate and increase capital productivity in the long run.

A permanent increase in the profit share may (again, counterintuitively) lower the steady state rate of accumulation as before, because it eventually reduces the rate of labor-saving technical change. Again, Marx-biased technical change will bring the rate of accumulation down. But the adjustment will also involve an induced increase in population growth if the employment rate rises during the transitional period. This should attenuate the decline in accumulation. In fact, if the response of population growth to the employment rate is large, it can actually overcompensate for the decline in labor-saving technical change so that accumulation has to increase.

As the sensitivity of population growth to employment increases, the model becomes less constrained by population growth. The conventional wage share model in Foley et al. (2019, Ch.6) can be seen as a limiting case as $\eta \to \infty$ and population growth adapts to capital accumulation to keep the employment rate stable.[7]

A permanent increase in the capitalization rate (a reduction in β) will have no effect on the steady state rate of labor-saving technical change, but it will create a boom that raises the employment rate and rate of population growth. As a result, it will increase the rate of capital accumulation in the long run. Marx-biased technical change offsets some of the resulting increased accumulation, but not all of it because population growth has risen and must be accommodated.

Temporary shocks that increase capital productivity will increase the employment rate as before, but in this case they will also have a permanent positive effect on capital productivity. The temporary boom in accumulation and employment will generate Marx-biased technical change as in the

[7]In other words, in this case the population growth model becomes simply $e = 1$ or perhaps some constant, and there is no effective ceiling on population growth. Even though the employment rate can be defined, it can no longer be interpreted as a measure of labor market tightness since any incipient increase in the demand for labor is immediately accommodated by supply.

previous case, but these will fade out without returning capital productivity to its original level in order to sustain the new higher rate of population growth.

5 Endogenous distribution

If distribution plays the role of accommodating increases in the employment rate, we can return to Equation (4') and replace Equation (5') with Equation (5). This model also displays path dependence. Since $g^* = \tilde{\gamma_0} - \tilde{\gamma_2}(\bar{\pi} + \mu e^*) + \bar{n}$ we find that as in the previous regime, the steady state (ρ^*, e^*) lies on a curve:

$$\rho^* = \frac{\beta + \bar{n} + \tilde{\gamma_0} - \tilde{\gamma_2}\bar{\pi} + \tilde{\gamma_2}\mu e^*}{\bar{\pi} - \mu e^*}.$$

As before, a permanent increase in autonomous population growth creates capital-saving technical change, which tends to accommodate the need for more growth by raising the profit rate. However, to the extent that it tends to lower the employment rate and enlarge the reserve army, it raises the profit share, which in turn will attenuate any increase in accumulation by reducing the rate of labor-saving technical change.

In the limiting case as $\mu \to \infty$ the distribution model becomes $e = 1$ to accommodate any feasible profit share, and this model approaches the full employment closure of Foley et al. (2019, Ch. 6). Distributional dynamics alone stabilize the system.

A permanent autonomous increase in the profit share (a rise in $\bar{\pi}$), reflecting a shift in the balance of class forces, should increase the employment rate, attenuating the ultimate increase in the profit share. The net increase in the profit share will reduce the rate of labor-saving technical change so that capital accumulation ultimately declines. The mechanism is "overaccumulation" resulting in Marx-biased technical change that reduces the rate of profit sufficiently to accommodate slower labor productivity growth.

A permanent increase in the capitalization rate will raise the employment rate, putting upward pressure on the wage share and consequently on the rate of induced labor-saving technical change. Marx-biased technical change will contribute to a decline in the profit rate, but the increased propensity to invest will prevail and accumulation will increase as a result of faster technical change.

In each case of a permanent shock, the effects on the steady-state employment rate and capital productivity will mirror those in the previous section.

Finally, a temporary positive capital productivity shock will increase the employment rate and capital productivity as in the previous section. However, the mechanism which prevents Marx-biased technical change from returning capital productivity to its starting value now involves distribution and technical change. A higher employment rate improves the workers' bargaining power and the wage share, incentivizing higher labor productivity growth and raising the long-run rates of profit and accumulation. With a lower profit share, this necessarily requires that capital productivity increases in the new steady state.

6 Endogenous population growth and distribution

Finally, we can combine the two previous cases into a general case with endogenous population growth and distribution by closing the model with Equations (4) and (5). Once again, capital productivity and the employment rate will be path dependent with

$$\rho^* = \frac{\beta + \bar{n} + \tilde{\gamma_0} - \tilde{\gamma_2}\bar{\pi} + (\eta + \tilde{\gamma_2}\mu)e^*}{\bar{\pi} - \mu e^*}$$

describing the solution sets. Temporary shocks to capital productivity will result in a positive association between capital productivity and employment as before.

The comparative dynamics of this hybrid case will combine elements of the previous two cases, depending on parameter values. In particular, the effect of an autonomous increase in the profit share on growth continues to depend on the sensitivity of population growth to the employment rate, since its effects on labor productivity growth, operating through distribution, go in the opposite direction.

A complete account of the comparative dynamics of the general model is provided in Table 1 which shows the sign of the relevant derivatives. In many cases, it depends on the value of key parameters such as the sensitivity of distribution or population growth to the employment ratio (μ and η respectively). We use these comparative equilibrium properties to interrogate the statistical record in the next section.

Table 1: **Comparative equilibria**

	de	$d\rho$	dn	$d\gamma$	dg	$d\pi$
$d\bar{n}$	$-$	$+$	$+$	$-/0$	$+$	$+/0$
$d\gamma_0$	$-$	$+$	$-/0$	$+$	$+$	$+/0$
$d\bar{\pi}$	$+$	$-$	$+/0$	$-$	$+/-$	$+$
$d(1-\beta)$	$+$	$-$	$+/0$	$+/0$	$+/0$	$-/0$
$d\epsilon$	$+$	$+/0$	$+/0$	$+/0$	$+/0$	$-/0$

The table shows the signs of dc/dr where r is the row entry and c is the column entry. A slash indicates that results depend on parameter values. Recall that $(1-\beta)$ is the capitalization rate. The bottom row identifies a temporary shock to capital productivity; all other entries refer to permanent changes in parameters.

As we observed above, one particular entry in Table 1 stands out: the effect of a change in distribution on capital accumulation (g). While all the other entries are either unambiguous in sign or zero, the sign of this entry is ambiguous, indicating that accumulation can be either wage- or profit-led. Table 2 presents the comparative equilibrium results for distributive shocks in the four cases we have examined, depending on whether distribution or labor supply are exogenous or endogenous. This two-way table makes clear that there is an important connection between productivity-driven wage-led growth and labor supply constraints. The right column of the table shows that an endogenous labor supply—such as in the limiting case of the conventional wage share growth model—is a necessary condition for profit-led growth, given the possibility of a positive response of the long-run growth rate to the profit share. Conversely, the left column shows that exogenous labor supply—such as in the limiting case of the classical full employment growth model—is a sufficient condition for wage-led growth, given the unambiguously negative response of the long-run growth rate to the profit share. To put it differently, the possibility for the labor force to expand in response to rising employment strengthens the classical role of profitability in driving capital accumulation, so that long-run growth *can* become profit-led, while an exogenous growth rate of the labor force, coupled with induced technical change, strengthens the role of labor-saving innovation to counter wage increases in driving productivity growth, so that long-run growth is unambiguously wage-led.

Table 2: **Distribution-led growth and alternative closures: the sign of $dg/d\bar{\pi}$.**

	exogenous n	endogenous n
exogenous π	$-$	$+/-$
endogenous π	$-$	$+/-$

The table shows the signs of $dg/d\bar{\pi}$ in each of the four cases. A slash indicates that results depend on parameter values. The four cells correspond to sections 3–6, beginning in the top-left entry and proceeding in a Z-pattern around the table.

7 Secular stagnation under neoliberalism

While the comparative dynamics exercise reviewed in the previous section gives precise analytical answers to well-defined questions, real economies rarely if ever offer such controlled experiments. Structural change ordinarily involves some combination of underlying parameters, just as human illness is typically multifactoral. At best, we can attempt to put together a narrative account that interprets the statistical record through the model. Indeed, this is one test of a model's practical value.

We consider two broad narratives about the neoliberal capitalist social structure that has risen and predominated over the last four decades. The first, which figures prominently in the orthodox views of secular stagnation, emphasizes supply factors, and in particular following Alvin Hansen's (1939) classic work, slower population growth and an exhaustion of technical change (a similar argument appears in Gordon, 2015). In this approach, demand problems are ultimately a consequence of the difficulty of transitioning to a lower natural rate of growth. The second, which is rooted in structuralist approaches in macroeconomics, emphasizes the political and institutional contradictions of neoliberalism itself. While a complete assessment is beyond the scope of this paper because it would require extensive discussion of the relationship between aggregate demand and accumulation, we can certainly benefit from consideration of these competing narratives within the model. Let us refer to these approaches as the supply-side story and the structuralist hypothesis.

The supply-side story works through slower autonomous population growth and a lower rate of autonomous technical change. For the most part, these changes have similar effects as they are analytically equivalent to a reduced rate of growth of the *effective* work force (i.e. measured in efficiency units). A lower autonomous natural rate of growth raises the employment rate and puts workers in a stronger bargaining position, lowering the profit share. The profit rate must decline to synchronize accumulation with a lower natural rate, partly through lower profits and partly through reduced capital productivity driven by Marx-biased technical change induced by the transitional dynamics of employment. Depending on the relative strength of the autonomous reductions and the parameters governing distribution and technical change, the effect on n or γ could go either way, but the sum of the two, which governs accumulation, will be negative. Some accounts (Summers, 2014) of secular stagnation add a decline in worker bargaining power into the mix in the interests of consistency with the well-known increase in income inequality over the neoliberal era.[8] In this case, they often emphasize some sort of savings glut since high income and capitalist households have higher propensities to save.

[8] In addition, Piketty (2014) argues that a rising profit share will accompany capital deepening because the putative elasticity of substitution exceeds one. An important cross-section analysis by Karabarbounis and Neiman (2014) finds support for the Piketty hypothesis. However, a meta-analysis of over 100 studies by Gechert et al. (2019) finds an elasticity of substitution, corrected for publication bias, of about 0.3.

Structuralist economists would probably want to start with the historic shift in class power, or at least make it a central object of analysis.[9] Our model incorporates wage-led growth through the technical progress function, but aside from that channel it considers accumulation to be profit-led, and as a result predicts an increase in the employment rate. The net effect on growth of an increased autonomous profit share is therefore indeterminate, depending on the relative importance of demographic versus technological responses. However, structuralist research on the effects of financialization has found it to have disincentivized investment, reducing the capitalization rate in our model.[10] This factor weighs in on the side of reduced growth in labor-saving technical change and/or population as the consequence of a lower capitalization rate and the resulting slower accumulation. Our main proposal then is that a complete structuralist hypothesis would combine rising capitalist class power and the reduced propensity to invest out of profits as characteristic features of neoliberal capitalism.

Table 3: **Selected Data for the U.S. 1980-2018**

Variable	(1) 1980-1999	(2) 1980-1989	(3) 1990-1999	(4) 2000-2018	(5) 2000-2007	(6) 2008-2018	(4)-(1) Change
e	0.7058	0.6877	0.7239	0.7001	0.7211	0.6849	-0.0057
ρ	0.3459	0.3019	0.3899	0.3642	0.3587	0.3682	+0.0183
n	0.0111	0.0109	0.0113	0.0074	0.0117	0.0043	-0.0037
γ	0.0192	0.0164	0.0220	0.0183	0.0245	0.0138	-0.0009
g	0.0204	0.0194	0.0214	0.0154	0.0181	0.0135	-0.0050
π	0.2490	0.2475	0.2506	0.2806	0.2640	0.2928	+0.0316
$1-\beta$	0.9341	0.9445	0.9237	0.9132	0.9236	0.9056	-0.0209
s	0.2388	0.2613	0.2162	0.1539	0.1926	0.1258	-0.0848

Sources: Bureau of Economic Analysis/Federal Reserve Board, Integrated Macroeconomic Accounts (ρ, g, π, β); FRED (e, n); Bureau of Labor Statistics (γ). For details, see text and Appendix.

The panel of data assembled mainly from primary sources in Table 3 sheds some light on the relative merits of these two narratives. While complete details are provided in an Appendix, some salient features of the methodology follow. The employment data refer to the working age population, 15-64, so that the employment rate corresponds to the headline employment-population rate most often discussed by economists. With the exception of labor productivity growth, all the remaining variables describe a nonfinancial business sector that consolidates corporate and noncorporate sectors in the Integrated Macroeconomic Accounts of the U.S.[11] We chose to omit the financial sector due to questions about accounting conventions. The labor productivity measure is the non-farm private business sector index published by the Bureau of Labor Statistics. The output-capital ratio and profit share are measured net of depreciation, and the profit share is net of corporate taxes. The capitalization rate is measured using the Cambridge equation as (one minus) the difference between

[9]See Mendieta-Muñoz et al. (2019) for evidence of structural shifts in the time series properties of the labor share that are consistent with a major shift in the balance of class forces during the neoliberal era.

[10]For structuralist research, see Davis (2018), Orhangazi (2008), or Kotz and Basu (2018). Conventional researchers who have also found a significant decline in investment include Gruber and Kamin (2015) and Gutiérrez and Philippon (2019).

[11]One motivation for consolidation is that since the 1980s the share of value added in the nonfinancial business sector has shifted back towards unincorporated business quite sharply, from a high of around 80 percent to a little over 70 percent.

the profit rate and the rate of accumulation. To measure the accumulation rate, we used the ratio of net investment to capital stock. Because the national accounts in the U.S. have adopted the convention of including intellectual property in the capital stocks and investment flows—a questionable practice from a structuralist perspective—we have removed it from both.

We have divided the neoliberal era into two periods and four sub-periods, more or less reflecting a structuralist consensus that the first two decades represent the rise of the neoliberal system, and the last two decades represent its descent into secular stagnation, with the Global Financial Crisis of 2008 standing as a temporal fault line as in Kotz and Basu (2018).

The increased profit share observed in this data set calls into question the view that secular stagnation reflects a shortage of effective workers resulting from demographic and technological trends. This pattern, together with the decline in the employment rate, is at odds with the predictions of the supply story.[12] The decline in the employment rate suggests that at least some of the class polarization has been induced by labor market slack. The table also includes the flow version of the capitalization rate, s, to get a more complete view of the declining investment rate.[13] It is striking that by either the stock or flow measure, the capitalization rate has consistently fallen during the neoliberal era. Indeed the characteristic pattern in Table 3 could well be completely accounted for by the decline in the capitalization rate evident on the bottom rows: lower employment, population growth, productivity growth, and accumulation combined with a higher profit share. While there is no denying that population growth has a strong autonomous component, it is striking that the big declines there occur after the GFC. Similarly, labor productivity also collapses after the GFC, probably as a combination of attenuated distributional pressures and the Kaldor-Verdoorn effects of slower growth. Up to this point, we are inclined to score this for the structuralist hypothesis.

To complete the picture, however, we do need to address the differing predictions about capital productivity. While a broad comparison of the early and late stages of neoliberalism supports the stagnationist prediction that a lower capitalization rate will elevate capital productivity through capital-saving technical change, a more granular view leads to more nuanced conclusions. It is clear that this pattern reflects the difference between the earliest subperiod (column 2), and the latest subperiod (column 6). We do not have confidence that a *mechanical* implementation of such a simple model makes good sense in this area because the process driving the bias in technical change is in practice inherently stochastic. We should expect the data on capital productivity to be noisy. The supply-side story in its purest form predicts that slower growth of the effective labor force (from either of its components) will induce "capital deepening" along a pre-existing neoclassical production function or, translated into our model, Marx-biased technical change driving down capital productivity. Given the uncertainty of the theory and the volatility in the data,[14] we are inclined to reach a Scotch verdict of not proven.

In sum, we believe that this excursion through the statistical record gives us some confidence in the structuralist account of neoliberalism as interpreted through the model. Secular stagnation does not appear to be the result of unfavorable demographic or technological trends, and indeed we would argue that these trends are as much a consequence of stagnation as they are a cause. This is significant because a global economic shock is very likely to play out quite differently if the structuralist view is correct, with serious consequences for the fates of the working classes who are

[12]To be sure, this exercise should not be seen as a substitute for a proper comparison between our structuralist approach and the conventional supply story since it has been conducted entirely within our own framework.

[13]Note that since $(1-\beta) = 1 - r(1-s)$, changes in the capitalization rate are only a fraction of changes in the ratio of investment to profits, moving them over one decimal place.

[14]The absence of a reliable correction for the degree of capacity utilization is another possible source of measurement error for capital productivity. We also can report that capital productivity for the nonfinancial corporate sector alone declines slightly between the two long periods.

already vulnerable.

Two numerical plots below show the effect of a permanent reduction in the capitalization rate—i.e. an increase in the capitalist consumption propensity—in the exogenous vs. fully endogenous model. In the exogenous model, there are permanent long-run effects on the employment rate and capital productivity, while the effects on the (long-run trend of) capital/population ratio and labor productivity growth are only temporary. This scenario is depicted in Figure 3, which plots impulse-response functions corresponding to a 5% decrease in the capitalization rate at time zero.

Figure 3

In the endogenous model, a decline in the capitalization rate permanently shifts the capital/population ratio onto a slower growth trajectory. The employment rate, labor productivity growth, and the population growth rate converge to a lower steady state value, while long run capital productivity and the profit share both increase in the long run. Figure 4 provides an illustration.

Figure 4

8 Temporary shocks: pandemics and path-dependence

We can model the economic shock from a pandemic like COVID-19 in several ways. It is clear that it may have negative level effects on the productivity of capital and labor—a form of technical regress. As businesses restart with staffing restrictions imposed by the need for social distancing and health monitoring, fewer productive workers will operate the existing capital stock, producing a lower flow of output. The shock could also reduce the flow of output per worker so that it is closer to being Hicks-neutral in character. We have chosen to emphasize its Solow-neutral effect on the level of capital productivity in order to produce the stylized simulations presented in the impulse response functions below. We model the pandemic as a temporary reduction in the output-capital ratio due to the interplay of demand and supply forces that are a consequence of the various lockdown measures adopted around the world.

In the exogenous model, labor productivity growth initially falls but then returns to its steady state value, and the same is true for capital productivity. The effect on the trend of the capital-population ratio is also temporary. Given path dependence, however, the shock results in a permanent decline in the employment rate. Such a scenario is displayed in Figure 5.

Figure 5

The fully endogenous model of Section 6 paints a much bleaker picture. Since both population and income distribution respond to the employment rate—which falls permanently following the shock—the ultimate long-run effect of the pandemic is a combination of lower labor productivity growth, a higher profit share, a lower employment rate, lower capital productivity, lower population growth, and a slower growth of the capital-population ratio. Figure 6 provides a visual illustration.

Figure 6

9 Concluding Comments

It is interesting that the model presented here resolves Harrod's existence problem by a synthesis of Solow (capital productivity adjusts), Marx (population growth or labor-saving technical change adjusts) and Kaldor (distribution adjusts). But the Solow mechanism does not depend on the existence of some kind of well-behaved production function since it operates through technical change.

It is also interesting that the model can display wage-led growth, despite its classical foundations. This is one consequence of the TFR technical progress function, which has two main implications in the steady state that are apparent in the exogenous model. First, its Kaldor-Verdoorn component delivers something akin to a *semi-endogenous* growth rate $\tilde{\gamma}_0$, related to dynamic economies of scale, that is determined within the model but policy-invariant (see the discussion in Tavani and Zamparelli, 2017).[15] Second, it is therefore the distribution-led component that is ultimately responsible for the endogeneity of technical progress in the long run. In fact, both models with induced bias in technical change (such as Julius, 2005) and models with an endogenous rate of labor productivity growth arising from capital-labor conflict (such as Tavani and Zamparelli, 2021) deliver some form of "wage-led" results in the long run.[16]

Another consequence facilitated by TFR's innovative use of the capital-population ratio is that the model is path dependent in the employment rate and capital productivity. Finally, the fully endogenous model with both population growth and income shares responding to employment adds a role to the capitalization rate in determining long-run growth: such an effect is absent in the exogenous model, but it seems to be borne out by the historical record presented in Table 3 and visually illustrated in Figure 4, where a lower capitalization rate increases the long-run profit share but at the same time reduces long-run productivity growth and the employment rate.

We think this model sheds some light on the nature of secular stagnation under neoliberal capitalism. It suggests that the underlying structural changes leading to the rather poor performance of the last decade in particular involve a lower propensity to invest out of profits combined with the weakened bargaining power of workers as reflected in a reduced wage share. This contrasts with an alternative account that emphasizes demographic and technological exhaustion as the root causes (Gordon, 2015). In our model, these factors do not explain the stylized facts at all well. We think slower productivity and population growth are as much a consequence as a cause of secular stagnation.

Path dependence means that even temporary shocks, in particular to the output-capital ratio, can leave a permanent impression on employment, distribution, technical change, and accumulation. A major shock like the novel coronavirus pandemic could have a discrete negative effect on capital productivity. In our model, such a shock will lower employment rates permanently, and this will create a chain of causation that could reduce the (already low) wage share, depress the (already low) rate of labor-saving technical change, restrain the growth of population because of reduced inward migration to advanced countries, and lower the rate of capital accumulation. The model has been kept compact intentionally and does not include fiscal or monetary policy mechanisms that might be

[15]Even though the underlying Kaldor-Verdoorn parameter γ_1 features in the composite parameter $\tilde{\gamma}_2$ that captures the long-run response of the growth rate to income shares, and therefore this portion of the growth rate is not *exactly* semi-endogenous, it is in practice: the growth rate of capital stock per capita $\hat{\kappa}$ affects the transitional dynamics but not the long-run growth rate of the model. This point can be appreciated by a combined look at the simulations displayed in Figures 2 and 3. In the latter, a shock to the capitalization rate—which affects capital accumulation independent of the profit share—has no long-run effect on the long-run growth rate; in the former, a shock to income shares delivers permanent long-run effects on growth.

[16]Classical models with induced bias of technical change are characterized by an upward-sloping relation in *levels* between the employment rate and the wage share (Foley, 2003; Julius, 2005), whereas Tavani and Zamparelli (2021) as well as Foley et al. (2019, Ch. 9) provide microeconomic foundations for a wage-led *growth rate* in the long run.

used to repair some of these collateral damages, but it does call attention to their importance beyond short-run stabilization.

Figures

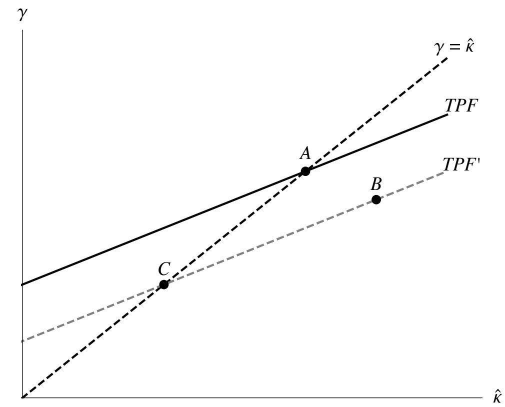

Figure 1: An increase in the profit share shifts the technical progress function (TPF) downward in the basic model. In the short run (B), accumulation and employment are profit-led. In the long run (C), growth is wage-led in the basic model.

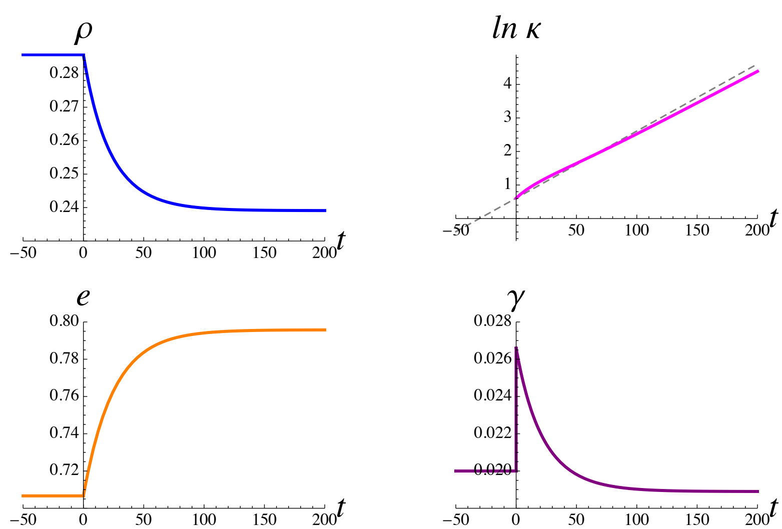

Figure 2: The effect of a 5% increase in the conventional profit share in the exogenous model. See Appendix C for a description of parameter values.

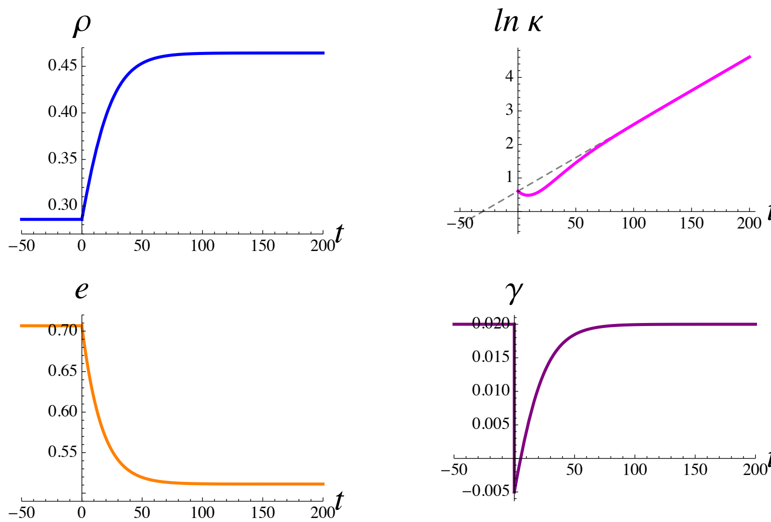

Figure 3: The effect of a 5% decrease in the capitalization rate $1 - \beta$ in the exogenous model. See Appendix C for a description of parameter values.

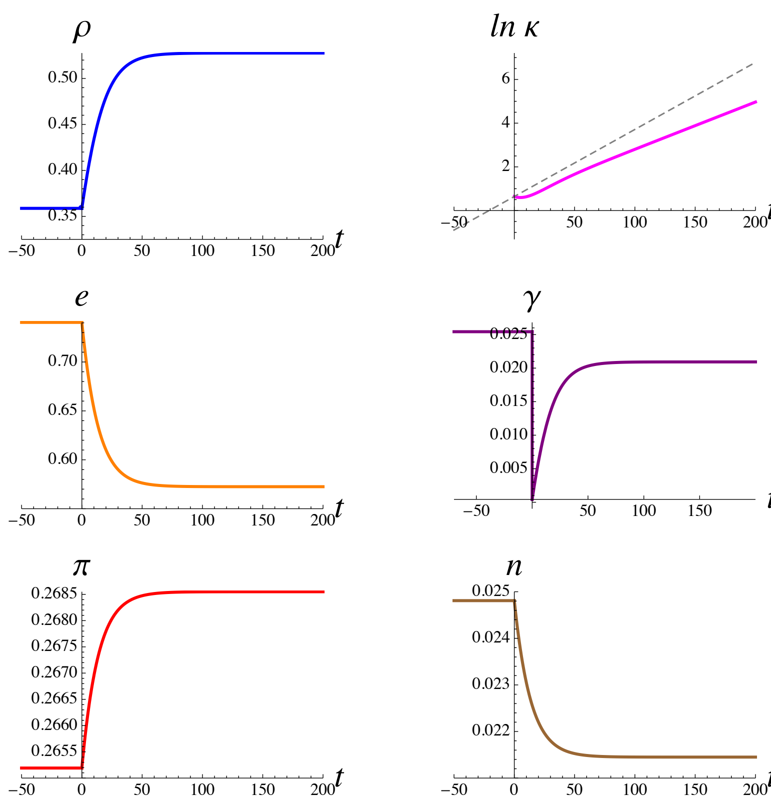

Figure 4: The effect of a 5% decrease in the capitalization rate $1 - \beta$ in the endogenous model. See Appendix C for a description of parameter values.

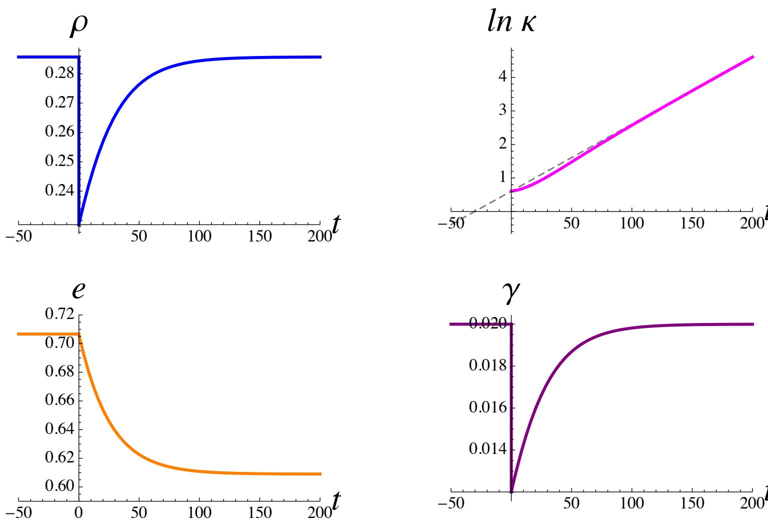

Figure 5: The effect of a 20% temporary decline in capital productivity in the exogenous model. See Appendix C for a description of parameter values.

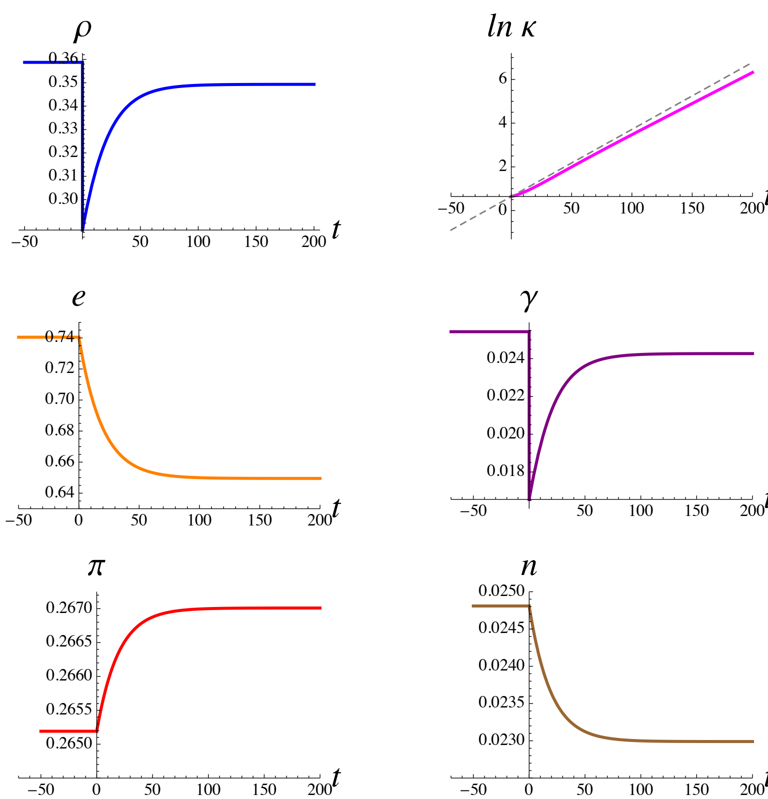

Figure 6: The effect of a 20% temporary decline in capital productivity in the endogenous model. See Appendix C for a description of parameter values.

A Stability Analysis

A.1 Exogenous Population Growth and Distribution

For analytical convenience, assume $f(\hat{e}) = -\chi_0\hat{e}, \chi_0 \in (0,1)$ throughout. Further, let $\phi \equiv (1-\gamma_1)/(1+\chi_0)$ throughout to economize on notation. We have the following two-dimensional system in the employment/population ratio and the output/capital ratio:

$$\begin{aligned}
\dot{e} &= \phi\left[\bar{\pi}\rho - (\beta + n + \tilde{\gamma}_0 - \tilde{\gamma}_2\bar{\pi})\right] e && (6)\\
\dot{\rho} &= \varepsilon - \chi_0\hat{e}\rho \\
&= \varepsilon - \chi_0\phi\left[\bar{\pi}\rho - (\beta + n + \tilde{\gamma}_0 - \tilde{\gamma}_2\bar{\pi})\right]\rho && (7)
\end{aligned}$$

where the term in square brackets in equation (6) is of course equal to $g-(\gamma+n)$ and with $E[\varepsilon] = 0$ as explained above. These equations highlight the path dependence, or equilibrium indeterminacy of the system. Given that the ε terms vanishes in expectations in the steady state, and that the growth rate of the output/capital ratio is proportional to the growth rate of the employment/population ratio, *any value of the employment-population ratio between zero and one is compatible with balanced growth*. Consequently, the model is only capable of pinning down the long-run output capital ratio ρ^* as in equation (6), but not the long-run employment/population ratio. As such, path dependence will arise in the sense that different initial conditions on our dynamic variable e will lead to different long-run values for the same variable. As far as the transitional dynamics is concerned, the Jacobian of the linearized system around the steady state (remember again $E[\varepsilon] = 0$) has the following structure:

$$J(e^*, \rho^*) = \begin{bmatrix} 0 & \phi\bar{\pi}e^* \\ 0 & -\chi_0\phi\bar{\pi}\rho^* \end{bmatrix}$$

where e^* is free between zero and one, and ρ^* is as in equation (6). The negative trace indicates local stability, while the zero determinant indicates path dependence.

A.2 Endogenous Population Growth

The evolution of the employment/population ratio —as long as it remains below one— now obeys:

$$\dot{e} = \phi\left\{\bar{\pi}\rho - \left[\beta + (\bar{n} + \eta e) + \tilde{\gamma}_0 - \tilde{\gamma}_2\bar{\pi}\right]\right\} e \qquad (8)$$

while the output/capital ratio once again evolves according to (7) which now of course takes into account that the labor force grows endogenously. The Jacobian has again zero determinant, highlighting the linear dependence between the two differential equations and steady-state indeterminacy, and a negative trace, indicating local stability. It is:

$$J(e^*, \rho^*) = \begin{bmatrix} -\eta\phi e^* & \phi\bar{\pi}e^* \\ \chi_0\eta\phi\rho^* & -\chi_0\phi\bar{\pi}\rho^* \end{bmatrix}$$

where e^* is free between zero and one, and ρ^* is as in the text. If the employment/population ratio reaches its upper limit, we are back to the previous case of exogenous population growth and its corresponding dynamics.

A.3 Endogenous Distribution

The employment/population ratio now evolves according to:

$$\dot{e} = \phi\left\{(\bar{\pi} - \mu e)\rho - \left[\beta + n + \tilde{\gamma}_0 - \tilde{\gamma}_2(\bar{\pi} - \mu e)\right]\right\} e \qquad (9)$$

while the output-capital ratio follows (7) taking into account that distribution is now endogenous. As before, the Jacobian matrix has zero determinant, given that the two differential equations are linearly dependent on each other: the steady state features once again path dependence. Given that

$$\frac{\partial \dot{e}}{\partial e}|_{e^*,\rho^*} = -\phi\mu(\rho^* + \tilde{\gamma}_2)e^* < 0$$

the Jacobian has a negative trace and the steady state is again locally stable.

A.4 Fully Endogenous Model

In the fully endogenous model, the evolution of the employment-population ratio follows:

$$\dot{e} = \phi\left\{(\bar{\pi} - \mu e)\rho - [(\beta + \bar{n} + \eta e) + \tilde{\gamma}_0 - \tilde{\gamma}_2(\bar{\pi} - \mu e)]\right\} e \tag{10}$$

while the output-capital ratio follows (7) taking into account that both population and distribution are now endogenous. Given the linear dependence of the two equations, the equilibrium is again indeterminate. The own-partial derivative evaluated at the steady state is

$$\frac{\partial \dot{e}}{\partial e}|_{e^*,\rho^*} = -\phi\left[\mu(\rho^* - \tilde{\gamma}_2) + \eta\right] e^* < 0$$

which guarantees a negative trace and is therefore sufficient for local stability.

B Data

The employment rate is from the St. Louis Federal Reserve Economic Data base (FRED): Employment Rate, Aged 15-64, All Persons for the United States, Seasonally Adjusted, Annual. Population from FRED is Working Aged Population, Aged 15-64, All persons for the United States, Seasonally Adjusted, Annual. The rate of labor productivity growth is calculated from Bureau of Labor Statistics, Major Sector Productivity and Costs, Nonfarm Private Business, Index=100, Base Year 2012, Annual. All data were downloaded from the respective website in April 2020. Growth rates of population and labor productivity are calculated using log differences divided by the number of years in the time interval. Ratios are simple averages over the time interval.

All other data are constructed from the Bureau of Economic Analysis-Federal Reserve Board joint project, Integrated Macroeconomic Accounts of the U.S. downloaded from the BEA website and dated March 27, 2020. We used Tables S4.a (Nonfinancial Noncorporate Business) and S5.a (Nonfinancial Corporate Business) to construct series for the consolidated nonfinancial business sector. The output-capital ratio is Net Value Added for the consolidated nonfinancial business sector divided by the adjusted capital stock. The adjusted stock is Nonfinancial Assets minus Intellectual Property Products for both sectors combined. The growth rate of capital, g, is the ratio of adjusted net investment to the adjusted capital stock. Adjusted net investment is Net Investment of the noncorporate business plus Net Investment of corporate business minus Acquisition of Nonproduced Nonfinancial Assets (intellectual property). The profit share is corporate Net Operating Surplus minus Current Taxes on Wealth, Income, Etc. (paid) plus noncorporate Net Operating Surplus, all divided by combined Net Value Added. To calculate the capitalization rate we first compute the net rate of profit, r which is the output-capital ratio times the profit share as described above. The capitalization rate is computed as $1 - r + g$.

Alternative versions of Table 3 were constructed using (i) the Extended Penn World Tables 6.0 downloaded from the *Growth and Distribution, Second Edition* website, and (ii) the IMA for the

Nonfinancial Corporate Sector separately. These calculations, which were broadly similar to the text except as noted, are available on request. The EPWT is less granular (for example, total population rather than working age) and ends in 2014.

C Parameter Calibration

To run the simulations, we have set the main parameters of the model in order to calibrate the steady state of the exogenous model to US data, and then imposed some arbitrary but small values for the two additional parameters in the endogenous model. From Table 3, the average after-tax profit share for the United States after 2000 is roughly 28%, which we used to fix $\bar{\pi}$ in the exogenous model. The average population growth rate for the same period is roughly 1%/year, which we used to fix $\bar{n}$. In order to calibrate the parameters determining the growth rate of labor productivity, we reasoned as follows. First, the available empirical estimates on γ_1 pin it down at roughly .5 (Foley et al., 2019, Ch.9). Second, De Souza (2017) provides estimates for $\tilde{\gamma}_2$ of about .022 for a panel of manufacturing industries, which translates into $\gamma_2 = .011$. We then internally calibrated γ_0 to obtain a steady state value for labor productivity growth of 2%/year, which is roughly the average value in Table 3. In order to initialize the system, we first chose an initial value for capital productivity corresponding to the average output-capital ratio in Table 3, around 36%. Given path dependence, we chose an initial condition on the employment rate to obtain a steady state value of 70%, which is about the average found in Table 3. Further, we set $\kappa(0)$ in the exogenous model equal to the average real capital/population ratio in the US between 1967 and 2014 from the Extended Penn World Tables 6.0, i.e. just below 1.85×10^3 per person. Finally, we set $\eta = \mu = .02$ to run the simulations following shocks in the endogenous model. The *Mathematica* notebook used for these simulation rounds is available at http://www.danieletavani.com under "Code."

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