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The New Normal: Demand, Secular Stagnation and the Vanishing Middle-Class

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ABSTRACT

The U.S. economy is widely diagnosed with two ‘diseases’: a secular stagnation of potential U.S. growth, and rising income and job polarization. The two diseases have a common root in the demand shortfall, originating from the ‘unbalanced’ growth between technologically ‘dynamic’ and ‘stagnant’ sectors. To understand how the short-run demand shortfall carries over into the long run, this paper first deconstructs the notion of total-factor-productivity (TFP) growth, the main constituent of potential output growth and “the best available measure of the underlying pace of exogenous innovation and technological change”. The paper argues that there is no such thing as a Solow residual and demonstrates that TFP growth can only be meaningfully interpreted in terms of labor productivity growth. Because labor productivity growth, in turn, is influenced by demand factors, the causes of secular stagnation must lie in inadequate demand. Inadequate demand, in turn, is the result of a growing segmentation of the U.S. economy into a ‘dynamic’ sector which is shedding jobs, and a ‘stagnant’ and ‘survivalist’ sector which acts as an ‘employer of last resort’. The argument is illustrated with long-run growth-accounting data for the U.S. economy (1948-2015). The mechanics of dualistic growth are highlighted using a Baumol-inspired model of unbalanced growth. Using this model, it is shown that the ‘output gap’, the anchor of monetary policy, is itself a moving target. As long as this endogeneity of the policy target is not understood, monetary policymakers will continue to contribute to unbalanced growth and premature stagnation.

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1. Making America ‘great’ and ‘whole’ again

More than eight years after the Great Financial Crisis, U.S. growth remains anemic, even after interest rates hit the ‘zero lower bound’ and the unconventional monetary policy arsenal of the Federal Reserve has been all but exhausted. Output growth has not returned to its pre-recession trend and this has led some commentators, including Foster & Magdoff (2009), Palley (2012) and Summers (2013, 2015), to suggest that this insipid recovery reflects a “new normal”, characterized by ‘secular economic stagnation’ which set in *already well before* the global banking crisis of 2008 (Fernald 2014, 2016; IMF 2015). If true, it means that the extraordinary policy measures taken in response to the 2008 crisis merely stabilized an otherwise already comatose U.S. economy. This ‘new normal’ is characterized not just by this slowdown of *aggregate* economic growth, but also by a concurrent heightening of income and wealth inequalities and a growing polarization of employment and earnings into high-skill, high-wage and low-skill, low-wage jobs—at the expense of ‘middle-wage’ jobs (Autor and Dorn 2013; Weil 2014; Temin 2017). Clearly, the brunt of the slowdown of U.S. economic growth has been borne by the lower- and middle-income classes (Eberstadt 2017), who had to cope with fewer (job) opportunities, stagnant wages, higher inequality, and greater (job and economic) insecurity. The stagnation has devastated all that low-wage and middle-wage workers demand, as George Orwell (1943) insightfully wrote: “... the indispensable minimum without which human life cannot be lived at all. Enough to eat, freedom from the haunting terror of unemployment, the knowledge that your children will get a fair chance.” Big parts of the U.S.A. are hit by elevated rates of depression (Temin 2015, 2017), drug addiction and ‘deaths of despair’ (Case and Deaton 2017), as ‘good jobs’ (often in factories and including pension benefits and health care coverage), ones that could be turned into a career, were destroyed and replaced by insecure, often temporary on-call, freelance and precarious jobs—euphemistically called “alternative work arrangements’ or the “gig economy” (Weil 2014; Katz and Krueger 2016).²

² Weil (2014) called this the ‘fissuring of the workplace’ as large corporations from Google to Walmart outsourced functions and activities that used to be managed internally to small subcontracting companies that compete fiercely with one another. Often 20 to 50% of the workforce has been outsourced with companies like Bank of America, Procter & Gamble, FedEx Corporation, and Verizon using thousands of contractor firms each. Predictably, the result has been declining wage growth, inadequate health & safety conditions and widening inequality. See Lauren Weber, ‘The end of work’, *The Wall Street Journal*, February 2, 2017.

In line with all this, recent evidence suggests that the ‘American dream’ of inter-generational progress has begun to fade: children’s prospects of earning more than their parents has fallen from 95% for children born in 1940 to less than 50% for children born in the early 1980s (Chetty *et al.* 2016). America is no longer ‘great’, as its economic growth falters, nor ‘whole’, because, as part of the secular stagnation itself, it is becoming a *dual economy*—two countries, each with vastly different resources, expectations and potentials, as America’s middle class is vanishing (Temin 2017).

This paper argues that the secular stagnation of U.S. economic growth and the vanishing of the American middle class have common roots—in the deliberate creation after 1980, through economic policies, of a structurally low-wage-growth economy that not only polarized jobs, incomes and wealth, but also slowed down capital deepening, the division of labor, and labor-saving technical progress in the dynamic segment of the economy (Storm and Naastepad 2012). My ‘demand-side’ diagnosis of America’s current plight is fundamentally at odds with dominant ‘supply-side’ narratives on secular stagnation in the macroeconomics literature. Perhaps Summers’ account (2015) comes closest, as he originally pointed to sluggish demand as a main cause of secular stagnation—with the ‘under-consumption’ arising from over-indebtedness and heightened ‘political risk’, which (in his view) raised savings too much relative to investment. This, however, is a minority position, as most observers including Cowen (2011), Fernald (2014, 2016), Eichengreen (2015), Furman (2015) and Gordon (2012; 2014; 2015), hold that the slow growth is a purely supply-side problem of slow *potential growth* rather than of weak demand. Importantly, in such supply-side narratives, rising inequality, growing polarization and the vanishing middle class play no role whatsoever as drivers of slow potential growth. They simply drop out of the story.

‘Demand-deficiency’ explanations have been brushed aside based on evidence that the so-called ‘output gap’ between *actual* GDP and its *potential* is currently quite narrow for the U.S. economy (see Figure 1). Potential output has come down partly as a result of demographic stagnation, due to an ageing labor force (Aaronson *et al.* 2014). But the real problem, in this supply-side view, is the alarming faltering of total-factor-productivity (TFP) growth, which is considered the main constituent of potential output growth and “the best available measure of the underlying pace of innovation and technological change” (Gordon 2015, p. 54).

The diminishing TFP growth is taken to reflect a structural technological stagnation which, by lowering the return on investment, has pushed desired investment spending down too far. While some commentators have suggested that the slowdown of TFP growth is in part illusory, because real productivity data have failed to capture the new and better, but increasingly lower-priced, high-tech products of the past decade, the empirical evidence suggests that any such mismeasurement cannot account for the actual extent of the productivity slowdown (Syverson 2016). The stagnation is real. The U.S. is ‘riding on a slow-moving turtle’, and ‘there is little politicians can do about it’, in Gordon’s (2015, p. 191) diagnosis.

In Table 1 appear recent accepted estimates for the U.S. (1950-2014), which suggest that TFP growth has been on a long-run downward trend ever since the early 1970s (although there is agreement that this decline was temporarily interrupted for a few years during the ‘New Economy’ bubble of 1995-2000). Recent (post-crisis) TFP growth is said to be less than a third of average annual TFP growth during the period 1950-1972/73, the so-called ‘golden age of capitalism’. The long-term downward trend in potential growth (represented by the fitted regression line) is clearly visible in Figure 1 as well. And it looks set to get worse: Fernald’s (2016) modal forecast for U.S. TFP growth during 2016-2023/26 is in the range of 0.41 – 0.55% per year. Secular stagnation, when interpreted as a crisis of waning TFP growth (Gordon 2015), implies a general *malaise* in innovation, a torpor of progress in general purpose technologies, and a lack of supply-side dynamism *tout court* (Fernald 2014; IMF 2015; Jones 2015).

TFP growth is the key diagnostic, as Jason Furman (2015, p. 2), the Chairman of President Obama’s *Council of Economic Advisors*, explains, because it “tells us how efficiently and intensely inputs are used” and “this is easily mapped to innovation of the technological and managerial sorts.” To Furman (2015, p. 11) TFP growth measures “pure innovation”; waning TFP growth must therefore mean that the cumulative growth effects of the latest innovations (in microprocessors & computer chips, materials and biotechnology) is weaker than those of past technologies—as has been argued by Kasparov and Thiel (2012). Likewise, based on his estimates of declining TFP growth, Gordon (2015) contends that the ‘Information and Communications Technology’ (ICT) revolution, after peaking in the late 1990s, must have already run its course, while there are no great inventions on the horizon—and Gordon goes on to attribute declining TFP growth and stalling business dynamism to the socioeconomic

decay of the U.S., as marriage (‘society’s cornerstone’) declines, traditional family structures are upended, and growing number of young men find themselves in prison. Technology-optimists Brynjolfsson and McAfee (2015) disagree with Gordon’s apocalyptic prognosis and argue instead that the ICT revolution will take decades to play out fully, as it requires parallel innovation in business models, new skills and institutional set-ups to work—in their meliorist account, the stagnation of TFP growth is only a temporary blip. Economic historian Mokyr (2014) concurs, venturing, without providing much evidence to support his claim, that emerging technologies such as robotics and 3D-printing will ‘revolutionize’ the economy, just as the steam engine and electronics did in earlier ages.

Until now, however, so the argument goes, existing labor and product-market rigidities have been limiting the ability of firms and markets to restructure and reorganize to benefit from ICT (see Furman 2015; Fernald 2016). However, while there is no agreement on what exactly is causing the secular decline of TFP growth or on how long it might last, most analysts are agreed that waning TFP growth reflects technological decline and is an exclusively supply-side problem. If so, remedying it will require a supply-side policy agenda—which could include, following Furman (2015), trade liberalization (supposedly to increase pressure on firms to innovate, while expanding their market access), further labor market deregulation, business tax reforms and more public investment in infrastructure, education and R&D (Eichengreen 2015; Glaeser 2014; Gordon 2015). It would not require sustained fiscal stimulus, higher real wages or a restructuring of the private debt overhang, however.

Table 1

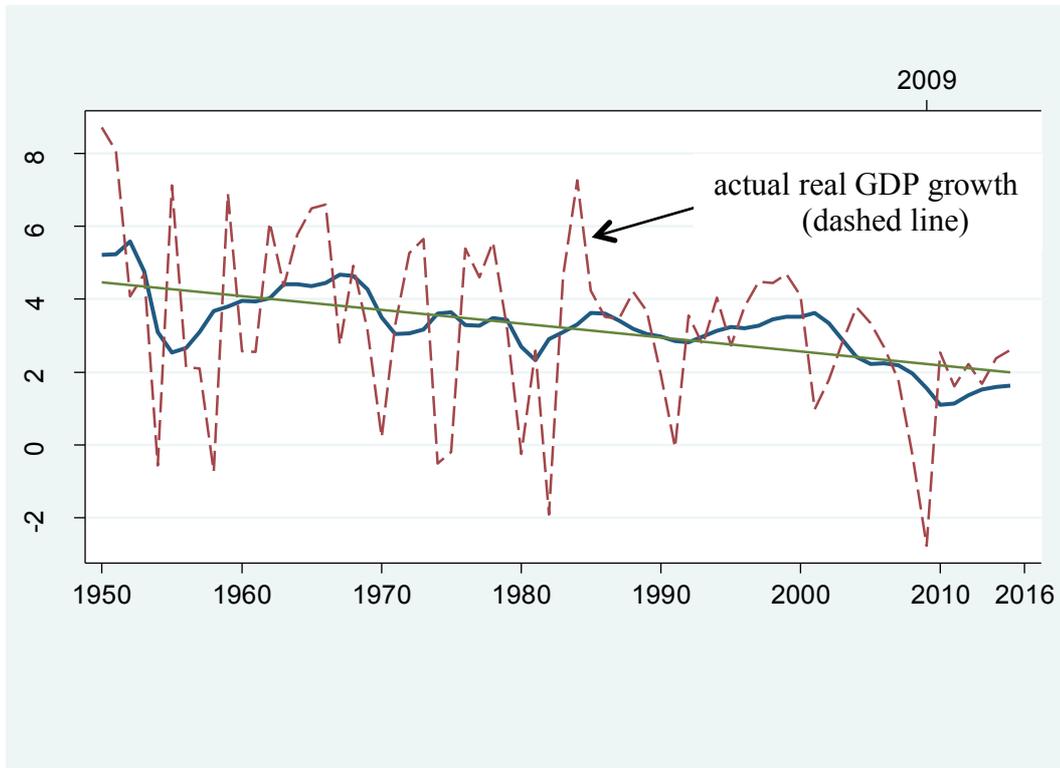
Evidence on the protracted slowdown of TFP growth in the U.S., *c.* 1950- *c.* 2014

	Fernald (2014)	Furman (2015)	Gordon (2015)	Jones (2015)
<i>c.</i> 1950-1972/3	2.1	1.9	1.79	3.2
1972/3-1995	0.4	0.4	0.52	0.7
1995-2007/8	1.4	1.1	1.43	2.3
2007/8- <i>c.</i> 2014			0.54	1.1
Full period: <i>c.</i> 1948-2014	1.3	1.2		2.0

Notes: Estimates by Fernald (2014) are for 1947-73; 1973-95; and 1995-2007. Furman’s (2015) periods are: 1948-1973; 1973-1995; and 1995-2014. Gordon’s (2015) periodization is: 1950-72; 1972-96; 1996-2004; and 2004-14. Jones (2015) estimates labor-augmenting TFP-growth; his periods are: 1948-73; 1973-90; 1990-95; 1995-2000; 2000-07; and 2007-13.

Figure 1

Secular stagnation of real potential GDP growth in the U.S.A., 1950-2016



Source: Federal Reserve Economic Data (<https://fred.stlouis.org>).

Notes: The thick line is potential real GDP growth. The fitted linear regression line indicates that potential growth is on a downward long-term trend. The gap between potential and actual growth is the ‘output gap’—and post-2010 it is rather small. During 1950-1972/3, potential output growth did not exhibit a statistically significant (downward) trend. But during 1973–2016, potential output growth does exhibit a statistically significant (at less than 1%, indicated by ***) negative trend:

$$\begin{aligned} \text{potential real GDP growth} &= 3.29 & - 0.043 \text{ Time} & \bar{R}^2 = 0.52; n = 43 \\ & (37.81)^{***} & (6.91)^{***} & \end{aligned}$$

This downward trend is becoming stronger over time—as is suggested by the regression for the period 1995-2016:

$$\begin{aligned} \text{potential real GDP growth} &= 5.27 & - 0.129 \text{ Time} & \bar{R}^2 = 0.82; n = 21 \\ & (15.79)^{***} & (8.83)^{***} & \end{aligned}$$

2. “Modest doubt is call’d the beacon of the wise”

This is what William Shakespeare (1602) wrote in *Troilus and Cressida*. In similar vein, this paper calls for caution about interpreting declining TFP growth as a supply-side indicator of technological progress and innovation. It wishes to cast doubt on the view that the secular stagnation of U.S. growth must be attributed to supply-side factors that restrict new technologies from revolutionizing the economy, and argue instead that the slowdown in TFP growth reflects a demand (management) crisis, with the ‘under-consumption’ driven by stagnating real wages, rising inequality and greater job insecurity and polarization.

I argue that the secular stagnation of U.S. TFP growth and the vanishing of the American middle class have common roots—and must be diagnosed together as symptoms of one underlying ‘disease’. My ‘modest doubt’ concerns the unstated assumption, taken for granted in the supply-side explanations of secular stagnation, that ‘steady-inflation potential output growth’ as well as the ‘output gap’ are tangential to aggregate demand growth (Storm and Naastepad 2012; Costantini 2015). Steady-inflation potential output growth is assumed to fully and structurally depend on the supply-side factors ‘technological progress & innovation’ (operationalized as TFP growth) and ‘demographic change’ (or the growth of effective labor supply).

This paper argues, with a focus on the concept of TFP-growth, that this neat separation between ‘actual’ and ‘potential’ output growth is the Achilles’ heel of supply-side explanations of secular stagnation (Storm and Naastepad 2012). My ‘modest doubt’ stems from the mounting empirical evidence that potential output growth is *not* independent from actual—demand-determined—growth. Study after study show that the current (demand) recession is causing *permanent* damage to potential output growth in the OECD (*e.g.* Haltmaier 2012; Reifschneider *et al.* 2013; Ball 2014; Ollivaud & Turner 2014; Anderton *et al.* 2014). In what is perhaps the most comprehensive study of the issue to date, Blanchard, Cerutti and Summers (2015) find, analysing 122 recessions in 23 OECD countries during 1960-2010, that in one-third of all cases, the recession is followed by *permanently lower output growth* relative to the pre-recession output trend—an outcome they call ‘super-hysteresis’.

In terms of Figure 1, this means that the observable slowdown in *actual* economic growth has helped depress *potential* output growth—which is the exact claim made in this paper. However, I will not scrutinize this concept of ‘super-hysteresis’, but instead try to theoretically and empirically deconstruct the notion of ‘total-factor-productivity growth’, as it is the cornerstone on which the mentioned supply-side explanations of secular stagnation rest. The paper argues that TFP-growth is not a supply-side concept, unlike what is commonly believed to be the case. However, to make the argument, we need to do some growth accounting first, because, as John von Neumann once remarked, “there is no sense in being precise, when you don’t even know what you’re talking about.”

3. Some basic growth arithmetic

To uncover the determinants of (the slowdown of) TFP growth we need to do some detective work. Let me begin this task by defining the notion of ‘potential output’ x_p in terms of TFP growth. To do so, let us first define L_p is potential (or maximum) labor supply (defined in terms of hours of work) and $\lambda_p = x_p / L_p$ is potential labor productivity per hour of work. By definition,

$$(1) \quad x_p = L_p \times \lambda_p$$

If we logarithmically differentiate (1), we get the following expression in growth rates:

$$(2) \quad \hat{x}_p = \hat{L}_p + \hat{\lambda}_p$$

where a circumflex “^” indicates a growth rate. Potential output growth thus depends on the growth of potential labor supply (or ‘demography’) and potential labor productivity growth (or ‘technology’). I assume that $\hat{L}_p = 0$ to focus on hourly labor productivity growth $\hat{\lambda}_p$. Next, to explain $\hat{\lambda}_p$ and following standard growth-accounting practice, start with the neoclassical Cobb-Douglas (constant-returns-to-scale) production function³:

$$(3) \quad x = A L^\phi K^{1-\phi}$$

³ The analysis is, for reasons of exposition, restricted to two factors of production—but it can easily be extended to include human capital, ICT capital, or energy without affecting the main conclusions (in a qualitative sense).

where x is output (or real value added at factor cost); L is the actual number of hours worked; K is the value of the capital stock (expressed in constant dollars); and A is a scale factor. Exponent ϕ is typically assumed to correspond to the observed labor share in income. If one divides both sides of equation (3) by x^ϕ and then solves for (x/L) , or productivity per hour of work, one obtains (Jones 2015):

$$(4) \quad \lambda = A^\phi \kappa^{1-\phi}$$

where $\lambda = x/L$ is actual labor productivity per hour of work and $\kappa = x/K$ is capital productivity. Differentiation of (4) yields this expression for labor productivity growth:

$$(5) \quad \hat{\lambda} = \frac{1}{\phi} \hat{A} + \frac{1-\phi}{\phi} \hat{\kappa}$$

where \hat{A} stands for TFP growth. What (5) tells us is that labor productivity growth has two separate sources: capital productivity growth and ‘this thing’ called TFP growth. However, in the steady state of a neoclassical growth model, the capital-output ratio must be constant, which means capital productivity is constant ($\hat{\kappa} = 0$). Equation (5) must then be read as follows:

$$(5\#) \quad \hat{\lambda}_p = (1/\phi) \hat{A}$$

When we substitute (5#) into (2), we find that potential output growth depends on TFP growth, or $\hat{x} = (1/\phi) \hat{A}$ (while assuming $\hat{L}_p = 0$). This means (when true) that the observed slowdown of potential output growth must have been due to the secular fading of TFP growth—as is the consensus view. What then is TFP growth and how is it determined?

At this point we are stepping into murkier water. Ever since Solow (1957) began cranking the numbers six decades ago, TFP growth has been treated as a non-observable variable that can only be quantified, under certain assumptions, as an ‘unexplained residual’ in a growth-accounting scheme. Specifically, if we logarithmically differentiate production function (3), we get:

$$(6) \quad \hat{x} = \hat{A} + \phi \hat{L} + (1-\phi) \hat{K},$$

from which \hat{A} can be determined as a residual:

$$(6\#) \quad \hat{A} = \hat{x} - \phi \hat{L} - (1 - \phi) \hat{K}.$$

Eq. (6#) defines TFP growth as the unexplained ‘Solow residual’, an often used approach as is attested by a Google search giving more than 129,000 hits for this term. Textbook convention interprets \hat{A} as an indicator of Hicks-neutral disembodied technological progress. But as has been widely noted, equation (6#) lacks any deeper analytical insight into its structural determinants. Abramovitz (1956), fittingly, called the Solow residual a “measure of our ignorance”, and while the search for dependable and robust determinants of TFP growth has consumed the research efforts of at least two generations of (growth-accounting) economists, Abramovitz’s conclusion still rings true: “a rigorous conceptual understanding of that gap continues to elude economists even today”, concludes Furman (2015, p. 2). Hence, unlike the Brout-Englert-Higgs boson, an elementary building block of modern physics, which was first conceptualized in 1964, while its existence could be experimentally confirmed only in 2013, understanding the Solow residual has not so far progressed a lot. This is problematic, because the residual is large: according to Solow (1957), during 1909-1949, only 13% of output growth in the U.S. was due to working more hours and using more machines, with TFP growth accounting for the remaining 87%. More recently, Jones (2015, p. 10) finds that TFP growth accounts for about 80% of economic growth in the U.S. during 1948-2013.

Fortunately, TFP growth may be less of a mystery than Furman and others presume, because there are two ways in which it can be unambiguously measured—using real observable data. The first approach to direct measurement of TFP growth is as follows (Rada and Taylor 2006). Using definitions $\hat{\lambda} = \hat{x} - \hat{L}$ and $\hat{\kappa} = \hat{x} - \hat{K}$, TFP growth in (6#) can be rewritten as:

$$(7) \quad \hat{A} = \phi \hat{\lambda} + (1 - \phi) \hat{\kappa}$$

Equation (7) is rather unsurprising, as it defines \hat{A} as the weighted average of the growth rates of average labor and capital productivities (which is exactly what it should be). If we accept Kaldor’s (1961) stylized fact that the capital-output ratio does not show a systematic trend in the long run—which means $\hat{\kappa} = 0$ —then (7) becomes: $\hat{A} = \phi \hat{\lambda}$. Note that the causality in equation (7) runs from labor productivity growth to TFP growth, and not *vice*

versa as in equation (5#). Labor productivity growth is the only structural determinant of TFP growth in the long run, and it follows not just that $\hat{x}_p = \hat{\lambda}_p = (1/\phi) \times \hat{A} = \hat{\lambda}$, but also that TFP growth adds no additional analytical insight and can be dropped from the economist's growth-accounting toolkit without consequence.

The second approach is the 'dual approach' (Simon and Levy 1963; Jorgenson and Griliches 1967; Shaikh 1974; Barro 1999; Rada and Taylor 2006; Felipe and McCombie 2012). It starts off from the NIPA accounting identity that real GDP at factor cost is the sum of wage income and capital income:

$$(8) \quad x = wL + rK$$

where w is the real wage rate per hour of work and r is the real profit rate on the capital stock. This condition must hold if all the GDP is attributed to one of the factors. Dividing (8) by x , we get: $1 = (wL/x) + (rK/x) = \phi + (1 - \phi)$, where ϕ is the observed labor share in income at any time and $(1 - \phi)$ is the observed capital share. Eq. (8) can be written in terms of growth rates as follows:

$$(9) \quad \hat{x} = [\phi \hat{w} + (1 - \phi)\hat{r}] + \phi\hat{L} + (1 - \phi)\hat{K}$$

It should be recognized that growth equation (9) remains an accounting identity, that its derivation uses only the NIPA condition $x = wL + rK$, and that (9) holds true even if the aggregate production does not exist (Felipe and McCombie 2012). Eq. (9) is functionally equivalent to (6)—but the latter must be read as a wrongly specified representation of the former (for reasons explained by Felipe and McCombie 2012). This isomorphism between production function (6) and NIPA value-added accounting identity (9) does not permit us to make any direct inference about 'aggregate technological progress'. Empirically, the only valid interpretation of TFP growth is in terms of 'total-factor-payment growth':

$$(10) \quad \hat{A} = \phi \hat{w} + (1 - \phi)\hat{r}$$

"Solow's measure of technical change," as Shaikh (1974, p. 118) noted early on, "is merely a weighted average of the growth rates of the wage w and rate of profit r ." The aggregate production function, concluded Shaikh, is based on 'a law of algebra, not a law of

production'. Given this isomorphism, statistically estimating (3) means that one is estimating an identity and this explains why the empirical fit is generally exceptionally good for production functions, with \bar{R}^2 often close to unity (Felipe and McCombie 2012).

As a matter of accounting, the 'primal' estimate of TFP growth in (7) must equal the 'dual' estimate based on the share-weighted growth of factor prices in (10). The neoclassical intuition for the dual (10) is, as Barro (1999) explains, that rising factor prices can be sustained only if factor productivities in (7) are increasing in tandem. In the neoclassical steady state and assuming 'perfect competition' in product and factor markets, real wage (profit) growth *must* converge to labor (capital) productivity growth, or $\hat{w} = \hat{\lambda}$ and $\hat{r} = \hat{k}$; in this hypothetical case of a 'perfectly competitive' economy, the primal and dual estimates fully coincide. However, there is nothing in the NIPA accounting to ensure that these conditions do actually hold—in historical time $\hat{w} \neq \hat{\lambda}$ and $\hat{r} \neq \hat{k}$, and hence (7) and (10) do not coincide. The most we can infer from the above is this. Subtracting (7) from (10), we get:

$$(11) \quad \phi(\hat{w} - \hat{\lambda}) + (1 - \phi)(\hat{r} - \hat{k}) = 0$$

which is, as pointed out by Rada and Taylor (2006, p. 488), "a cost-side restriction on observed growth rates of average productivities and factor payments." Eq. (11) states that, for any given rate of TFP growth, the weighted sum of wage share growth ($\hat{w} - \hat{\lambda}$) and profit share growth ($\hat{r} - \hat{k}$) must be zero—which underscores the zero-sum distributive conflict between workers and profit-recipients underlying TFP growth.

There is one additional interpretation of TFP growth that will prove useful. If we assume that ψ is the constant capital-to-potential-output ratio, then potential output becomes $x^* = K / \psi$ and capacity utilization is: $u = x / x^*$. It follows that actual output $x = uK / \psi$. Logarithmically differentiating this expression gives:

$$(12) \quad \hat{x} = \hat{u} + \hat{K}$$

Actual output growth in (12) depends on the growth of the capital stock (which reflects structural or potential growth) and the growth of capacity utilization which mirrors cyclical demand factors which may cause actual growth to deviate from potential growth. Combining (12) and (6) and rearranging, TFP growth becomes:

$$(13) \quad \hat{A} = \hat{u} + \phi(\hat{K} - \hat{L})$$

TFP growth thus directly depends on capital deepening and on the growth of utilization. Equation (13) could be read as a variant of the AK-model of endogenous growth, as TFP growth rises with capital stock growth, but with a twist, because—unlike in new growth theory—I do not need to invoke microeconomic (knowledge) externalities to justify it, but only to assume that ψ exists. If I next define $i = \Delta K / x$ as the investment-GDP ratio, then it

follows that $i = \frac{\Delta K}{K} \times \frac{K}{x^*} \times \frac{x^*}{x} = \psi \hat{K} u^{-1}$. This gives me the following result for capital stock growth:

$$(14) \quad \hat{K} = (u \times i) / \psi$$

A higher investment-to-GDP ratio leads to faster capital stock growth—at constant capacity utilization. Since empirically investment is usually dominated by ‘accelerator effects’ operating through aggregate demand, it follows from (13) and (14) that a structural decline in demand growth depresses TFP growth—through dithering business investment, a decline in capital deepening and/or a decline in capacity utilization. As a result, potential output growth must decline as well. Hence, as Kaldor (1957, p. 595) wrote, “A society where technical change and adaptation proceeds slowly, where producers are reluctant to abandon traditional methods and to adopt new techniques is necessarily one where the rate of capital accumulation is small.” As a result, the growth rate of potential output of that particular society must be low—which in turn suggests a low “speed limit” for actual growth, as inflation-adverse monetary policymakers, convinced that low TFP growth is due to a technological *malaise*, will keep actual growth down to sluggish potential growth (in order to keep inflation low and stable). Stagnation, while avoidable because *potential* growth can be raised by higher investment, becomes a self-fulfilling process.

4. Secular stagnation of TFP in the U.S. economy: 1948-2015

Table 2 presents empirical estimates for the U.S. economy (1948-2015) of TFP growth, defined as (a) the ‘Solow residual’ as per equation (6#), (b) ‘weighted factor productivities’ growth as in (7), and (c) total factor payments growth as defined in equation (10). The

analysis is based on a growth-accounting database constructed using *Bureau of Economic Analysis* (BEA) data on GDP at factor cost (in current and constant 2009 prices), hours worked by full-time and part-time employees, compensation of employees, and the net stock of fixed assets (in constant 2009) prices; details on the database are given in the appendix. Since the NIPA accounting condition $x = wL + rK$ holds by construction, estimates (a), (b) and (c) are similar (neglecting small errors due to rounding). But estimates (b) and (c) are preferable to the Solow residual, if only because these are direct measurements.

From Table 2, it is clear that both share-weighted factor productivity and factor prices started declining in the 1970s, but the process was interrupted in the second half of the 1990s as both measures exhibited significantly higher growth during the ‘New Economy’ boom of the late 1990s as well as the debt-led and misunderstood ‘Great Moderation’ of the early 2000s. The revival was remarkably short lived, however, and post 2008 share-weighted productivities’ and share-weighted factor prices’ growth reverted back to their earlier declining trend. These estimates are broadly similar to those appearing in Table 1. Column (b) of Table 2 presents the percentage share of weighted factor productivity growth explained by only labor productivity growth as in equation (7). It can be seen that labor productivity growth is of overwhelming importance to TFP growth, explaining around 84% of weighted factor-productivities growth during 1948-2015; the remaining 16% is due to capital productivity growth $\hat{\kappa}$. Going by equation (7), the secular decline in TFP growth, highlighted in Figure 1, has been driven by a (statistically significant) long-term downward drift in labor productivity growth—as illustrated in Figure 2. One further conclusion follows from the accounting and equation (10) in particular: the steady decline in labor productivity growth has been accompanied by a secular fall in the growth of factor payments, and especially of real wage growth (which has a greater weight in factor payment growth than profit rate growth). The dashed line in Figure 2 represents declining hourly real wage growth over the period 1948-2015—which is closely (but not one-to-one) correlated with labor productivity growth ($R^2 = 0.59$, significant at 1%).

Table 3 presents the stylized facts on the cost-side restriction on growth rates of average productivities and factor payments, defined by (11). It can be seen that the labor income share increased during 1948-1972, *i.e.* when labor productivity growth was highest, but declined more or less continuously during 1972-2015, in conjunction with the secular decline in labor

productivity growth and the recovery of the profit share. Importantly, the temporary ‘New Economy’ impulse to productivity growth during 1995-2008 coincided with a revival of real wage growth and a non-declining labor income share.

Table 2

Alternative measures of aggregate TFP growth in the U.S., 1948-2015

	‘Solow residual’ <i>eq. (6#)</i>	weighted factor productivity growth <i>eq. (7)</i>	total factor payment growth <i>eq. (10)</i>
	(a)	(b)	(c)
1948-1972	1.60	1.57 (88%)	1.57
1972-1995	1.06	1.04 (80%)	1.04
1995-2008	1.35	1.34 (85%)	1.34
1948-2008	1.34	1.32 (85%)	1.32
2008-2015	0.73	0.72 (73%)	0.73
1948-2015	1.27	1.25 (84%)	1.26

Source: Author’s estimates based on *Bureau of Economic Analysis* data; see data appendix.

Notes: The numbers in parentheses in column (b) give the percentages of weighted factor-productivity growth explained by labor productivity growth as *per* equation (7).

Table 3

Distributional shifts associated with aggregate U.S. TFP growth, 1948-2015

	ϕ	\hat{w}	$\hat{\lambda}$	$\phi(\hat{w} - \hat{\lambda})$	$1 - \phi$	\hat{r}	$\hat{\kappa}$	$(1 - \phi)(\hat{r} - \hat{\kappa})$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1948-1972	0.60	2.68	2.32	0.21	0.40	-0.06	0.46	-0.21
1972-1995	0.60	1.15	1.38	-0.14	0.40	0.88	0.52	0.14
1995-2008	0.59	1.92	1.92	0.00	0.41	0.49	0.49	0.00
1948-2008	0.60	1.94	1.88	0.03	0.40	0.41	0.49	-0.03
1972-2008	0.60	1.43	1.57	-0.09	0.40	0.73	0.51	0.09
2008-2015	0.57	0.58	0.91	-0.20	0.43	0.93	0.46	0.20
1948-2015	0.60	1.80	1.78	0.01	0.40	0.46	0.49	-0.01

Source: Author’s estimates based on *BEA* data; see data appendix.

Notes: ϕ = the period-average labor income share; \hat{w} = average annual real wage growth (per hour); $\hat{\lambda}$ = average annual hourly labor productivity growth; \hat{r} = average annual real profit rate growth; $\hat{\kappa}$ = average annual capital productivity growth; $(\hat{w} - \hat{\lambda})$ = average annual (real) wage share growth; and $(\hat{r} - \hat{\kappa})$ = average annual (real) profit share growth.

We therefore have two separate accounts of the secular stagnation of potential output growth—one centered on the slowdown of labor productivity growth and the other focusing on stagnating real wage growth. How can these two explanations be aligned? A first view, firmly grounded in standard neoclassical microeconomics, is that (exogenous) labor productivity growth ‘causes’ real wage growth in the longer run. That is, in line with the marginal productivity theory of income distribution, neoclassical ‘intuition’ holds that real wage growth follows exogenous productivity growth, because profit-maximizing firms will hire workers up until the point at which the marginal productivity of the final worker hired is equal to the real wage rate (Jorgenson and Griliches 1967; Barro 1999; Jones 2015). There is therefore nothing surprising about the co-occurrence of declining labor productivity growth and decreasing real wage growth, as the technological stagnation forces profit-maximizing firms to lower their real wage growth offer.

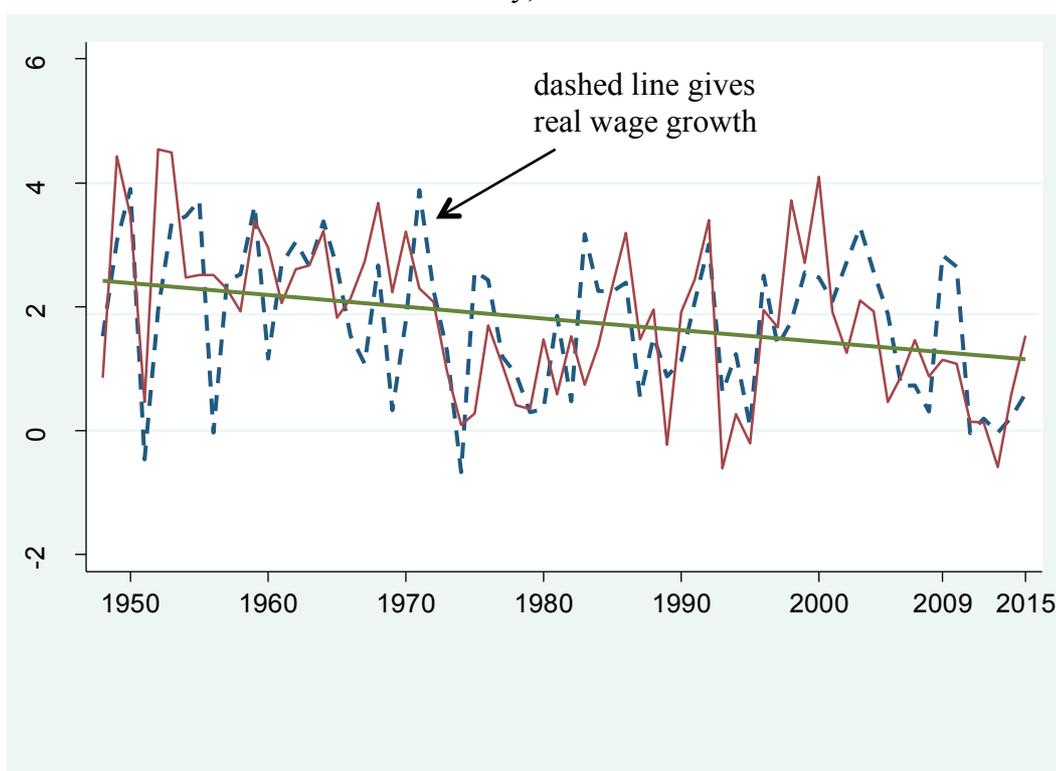
The simple ‘neoclassical intuition’ does not allow for any influence of wage-setting on productivity growth and treats exogenous technological progress as the driver of real wage growth as well as potential output growth. However, the problem with this simple ‘intuition’ is that it is wrong, because it fails to recognize that the relationship between wage growth and productivity growth must go both ways. “The *negative* response of labor hours to an increase in the real wage implies a *positive* response of output per hour to the same increase,” writes Gordon (1987, p. 154), pointing out that “substitution away from labor in response to an inexorable rise in the real wage has been at the heart of the economic growth process for centuries.” Gordon’s inference is corroborated by my growth accounting data. The general picture for hours worked and wages is shown in Figure 3, which indicates both variables are on a downward trend. The (statistically significant at 1%) response of growth of hours worked to an increase in real wage growth takes a value of -0.53. The corresponding *positive* elasticity of output per hour to higher real wages turns out to be +0.56 (as shown below Figure 2).

Hence, faster productivity growth may permit higher wage growth, but more importantly higher real wages will raise productivity growth by giving firms a reason to invest in labor-saving technology. Empirical research finds that real wage growth is a major determinant of productivity growth (Gordon 1987, 2015; Foley and Michl 1999; Marquetti 2004; Basu 2010; Storm and Naastepad 2012). Theoretically, the influence of wage growth on productivity growth has been alternatively explained in terms of ‘induced technical change’ (Hicks 1932;

Funk 2002; Brugger and Gehrke 2017), ‘Marx-biased technical change’ (Foley and Michl 1999; Basu 2009), or ‘directed technical change’ (Acemoglu 2002)—but the key mechanism is this: rising real wages, as during the period 1948-1972, provide an incentive for firms to invest in labor-saving machinery and productivity growth will surge as a result; but when labor is cheap, as during most of the period 1972-2015, businesses have little incentive to invest in the modernization of their capital stock and productivity growth will falter in consequence (Storm and Naastepad 2012).

Figure 2

Secular stagnation of U.S. hourly labor productivity and hourly real wage growth: total economy, 1948-2015



Notes: The fitted regression line for the total economy (1948-2015) is based on the following OLS regression (***) is statistically significant at 1%; ** is statistically significant at 5%):

$$\text{Labor productivity growth} = 1.76 - 0.02 \text{ Time} \quad \bar{R}^2 = 0.10; n = 68$$

$$(12.94)^{***} \quad (2.54)^{**}$$

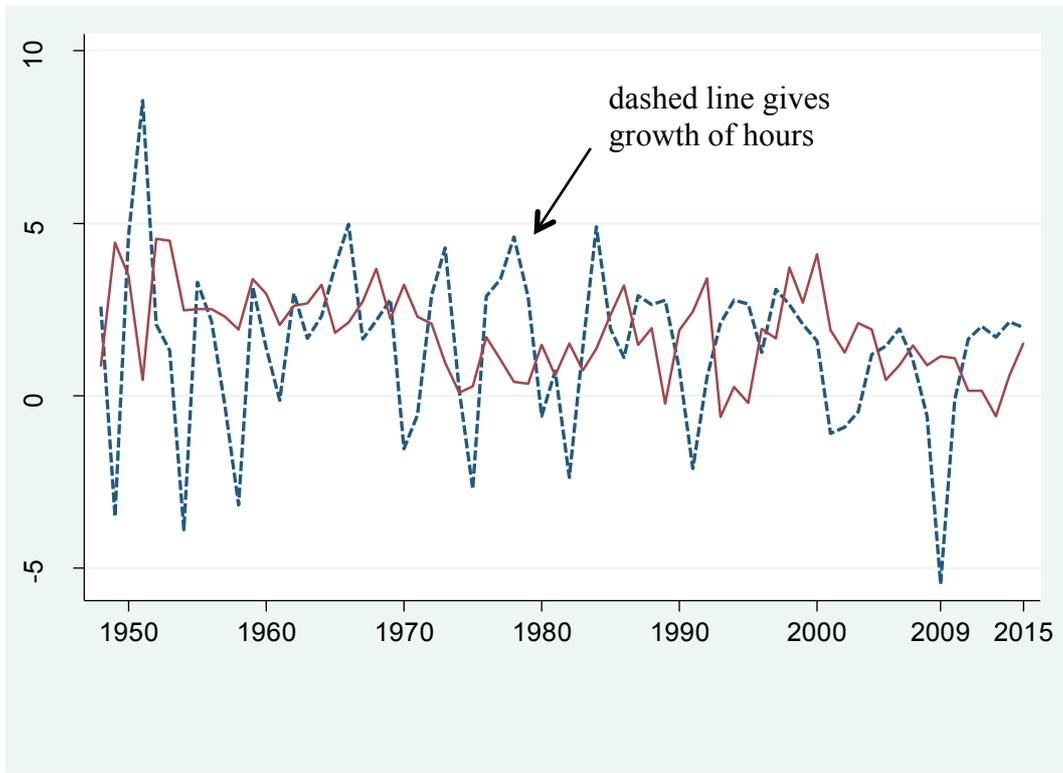
The OLS regression of productivity growth and real wage growth is as follows:

$$\text{growth of labor productivity} = 0.78 + 0.56 \text{ real wage growth} \quad \bar{R}^2 = 0.35; n = 68$$

$$(4.08)^{***} \quad (6.66)^{***}$$

Average annual real wage growth declined from 2.72% during 1948-1958 to 0.58% during 2009-2015. Average annual labor productivity growth declined from 2.31% during 1948-1958 to 0.92% during 2009-2015. Using the regression coefficient (0.56), the decline in real wage growth has been responsible for more than four-fifths of the decline in labor productivity growth by 1.4 percentage points between the 1950s and the period 2009-2015.

Figure 3
 Hourly real wage growth and growth of hours worked:
 total U.S. economy, 1948-2015



Notes: The regression line is based on the OLS regression result (** is significant at 5%; *** is significant at 1%):

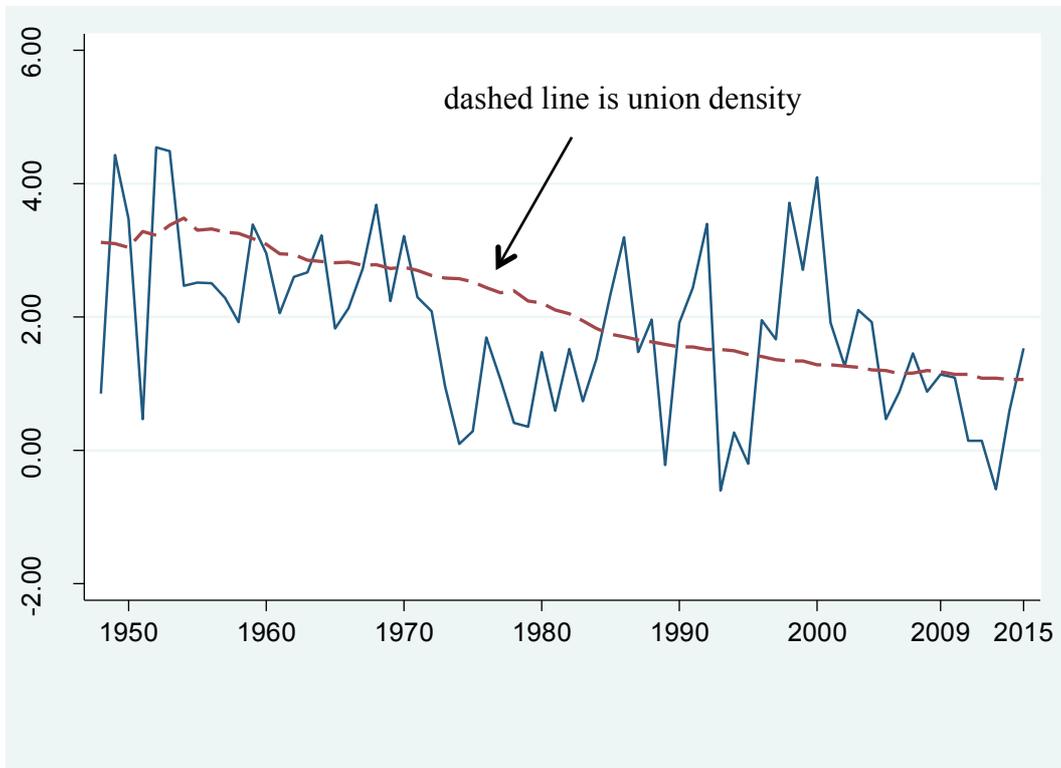
$$\text{growth of hours worked} = -0.54 \quad - \quad 0.53 \text{ real wage growth} + 0.91 \text{ real GDP growth}$$

$$(2.10)** \quad (6.31)*** \quad (15.29)***$$

$$\bar{R}^2 = 0.84; n = 68$$

These results are similar to findings by Gordon (1987) for the period 1964-84.

Figure 4
Stagnating hourly real wage growth and declining union density:
Total U.S. economy, 1948-2015



Notes: The dashed line represents national union density (which is defined in terms of ten percentage points), which declines from 3 (or about 30%) in the early 1950s to 1.1 (or 11%) in 2015. Hourly real wage growth and union density are very strongly correlated; the Prais-Winsten AR(1) regression result is (***) is statistically significant at 1%):

$$\text{hourly real wage growth} = 0.08 \text{ union density} \quad \bar{R}^2 = 0.60; n = 68$$

$$(9.62)^{***}$$

Average annual real wage growth declined from 2.72% during 1948-1958 to 0.58% during 2009-2015. Union density declined from 32.5% of the labor force during 1948-1958 to 11.1% during 2009-2015. Using the regression coefficient (0.08), declining union density has been responsible for four-fifths of the decline in real wage growth by 2.1 percentage points between the 1950s and the period 2009-2015.

The recognition that real wage growth is a major driver of labor productivity growth also holds an important insight for macroeconomic policy, as Gordon (1987, pp. 154-155) explains: "... a stimulus to aggregate demand provides not only the direct benefit of raising output and employment, but also the indirect benefit of raising the real wage and creating substitution away from labor that boosts productivity [...] With this dual benefit obtainable from demand expansion, the case against demand stimulation must rest on convincing evidence that such policies would create an unacceptable acceleration of inflation." There may be less inflation than expected, in other words, because the rate of *potential* growth would go up.

All this leads me to three conclusions. First, it is time to stop the reification of the 'Solow residual', because there is no and has never been a residual to begin with (Shaikh 1974; Rada and Taylor 2006; Felipe and McCombie 2012). It makes for good practice to follow common sense and define TFP growth as the weighted average of the growth rates of average labor and capital productivities (as in equation (7)). Second, doing so, we find that TFP growth is determined overwhelmingly by labor productivity growth. This means we are back to equation (2), according to which potential growth depends on labor productivity growth—and applying Occam's razor, we can forget about TFP growth altogether. Thirdly, labor productivity growth is endogenous and at least partly determined by real wage growth. This implies that the secular stagnation of productivity growth must be attributed at least partly to the long-term steady decline in the growth rate of U.S. hourly real wages. The decline in real wage growth in turn is widely argued to be associated with the post-1980 reorientation in macroeconomic policy, away from full employment and towards low and stable inflation, which paved the way for labor market deregulation, a scaling down of social protection, a lowering of the reservation wage of workers, and a general weakening of the wage bargaining power of unions (Storm and Naastepad 2012). The recent rise in persons 'working in alternative work arrangements' (Katz and Krueger 2016) is merely the culmination of this earlier trend. To empirically illustrate this point, Figure 4 shows that there is a statistically significant (at 1%) positive long-run relation between the degree of unionization and real wage growth in the U.S. (1948-2015). While one should not get carried away by and read too much in the simple correlation appearing in Figure 4,⁴ the association is remarkably strong: all by itself, the secular decline in unionization 'explains' about two-thirds of the long-term

⁴ The U.S. South has always been averse to minimum-wage standards and unions, featuring much lower degrees of unionization than the U.S. North. See Mayer (2004).

fall in real wage growth—which minimally suggests that domestic regulatory changes leading to greater job and income insecurity have contributed to real wage restraint.

The strength of the correlation suggests that declining unionization is capturing some relevant factor explaining the “atypical restraint on compensation increases [that] has been evident for a few years now and appears to be mainly the consequence of greater worker insecurity”, as Alan Greenspan (1997, p. 254) defined the problem before Congress. Unofficially, Greenspan spoke about the traumatized U.S. worker, “someone who felt job insecurity in the changing economy and so was resigned to accepting smaller wage increases. [Greenspan] had talked with business leaders who said their workers were not agitating and were fearful that their skills might not be marketable if they were forced to change jobs” (Woodward 2000, p. 163). Clearly, Greenspan’s ‘traumatized workers’ must be related to the socioeconomic decay of the U.S., to which Gordon (2015) attributes declining TFP growth and stalling business dynamism. Zooming in on the latter factor, dithering business investment does underlie the secular decline in capital-intensity growth and TFP growth—as is shown in Table 4. The contribution to TFP growth of capital deepening declined from 1.1% per year during 1948-72 to 0.84% per year during 1995-2008—a decline of 0.26 percentage points which fully explains the fall in TFP growth from 1.6% per year in the first period to 1.35% per annum during the second period. Likewise, the decline in TFP growth by 0.62 percentage points between 1995-2008 and 2008-15 is almost completely due to declining capital-intensity growth, which in turn is caused by a sharp, crisis-induced, drop in the investment-GDP ratio (see Table 4). Weak investment post 2008 thus caused productivity and potential output growth to collapse (*cf.* Ollivaud, Guillemette and Turner 2016).

Hence, sluggish business investment in the U.S. has been a key factor behind the stagnation of TFP growth as well as responsible for propagating hysteresis-like adverse consequences for TFP and potential output after 2008 (*cf.* Ollivaud, Guillemette and Turner 2016; Hall 2016). This conclusion becomes stronger once we acknowledge the ‘cumulative causation’ at work: sluggish investment weakens aggregate demand and this, in turn, weakens accumulation through the ‘accelerator effect’—which was Kaldor’s argument. This way, (cyclical and/or structural) demand shortfalls must carry over into lower growth of potential output. To summarize: the secular decline in *aggregate* U.S. TFP growth post-1972 is closely hanging together with secular declines in the growth rates of *aggregate* labor productivity, real wages, capital intensity and aggregate demand (mostly investment demand).

guarding (1.5 million workers), childcare (0.6 million employees) and entertainment (0.5 million workers). The fast-food sector alone offers jobs to one-in-four of ‘Rest’ workers.

Table 5 confirms the historical pattern in which labor productivity growth is high during 1948-1972, slows down considerably during 1972-1995, but then accelerates again during 1995-2008—to fall off the cliff following the financial crisis of 2008-9 when productivity growth rates decreased in most industries. Concentrating on the pre-crisis period (1948-2008), we can see that although *aggregate* productivity growth was lower during 1995-2008 than during 1947-72, some key industries experienced an acceleration of productivity growth in the later period as compared to the period 1947-72. Most prominently, labor productivity growth accelerated from 2.7% per year during 1947-72 to 8.7% per year during 1995-2008 in ‘Primary Activities’ following the boom in hydraulic fracking to recover oil and gas from shale rock. But labor productivity growth increased as well in ‘Manufacturing’ (from 2.7% during 1947-72 to 3.2% during 1995-2008) and PBS (from 2.2% per year during 1947-72 to 2.8% per annum during 1995-2008). The dynamic productivity growth performance of ‘Manufacturing’ contradicts the claim of techno-pessimists that U.S. manufacturing and information firms had reached a plateau in technology innovation already well before the financial crisis. They haven’t—as Table 5 shows.

Nor is there any secular stagnation of public sector productivity growth. The crisis in productivity growth appears to be concentrated in just three industries: ‘Utilities and Construction’ (UC), ‘Educational, health and private social services’ (EHS) and the ‘Rest’. Compared to its productivity performance during the period 1947-1972, labor productivity growth in UC during 1995-2008 declined by 2.5 percentage points, in EHS by 1.5 percentage points and in the ‘Rest’ by 1.2 percentage points per year. This conclusion is confirmed by the results from the shift-share analysis appearing in Table 6. Aggregate labor productivity growth in the U.S. economy declined from an average of 2.32% per year during 1947-1972 to 1.92% per year during the years 1995-2008.

Using shift-share analysis, this decline in productivity growth by 0.40 percentage points between these two time periods can be decomposed into (a) *intra-industry changes* in labor productivity growth rates in each of the nine industries (plus government) considered, and (b) *structural change*, which reflects the rise (or decline) in the weight of each industry in aggregate productivity growth. This weight depends on the share in total hours worked (or the

employment share) of the industry under consideration. A first point to observe from Table 6 is that more than four-fifths of the decline in aggregate U.S. labor productivity growth between 1948-1972 and 1995-2008 is due to declining *intra-industry* productivity growth rates—and less than one-fifth of it is due to structural change in favor of non-dynamic industries. The slowdown of productivity growth in UC, EHS and the ‘Rest’, when combined, depressed aggregate labor productivity growth during 1995-2008 by 0.49 percentage points compared to productivity growth performance during 1948-72—which more than ‘accounts for’ the actual decline in aggregate productivity growth.

The (weighted) increases in the growth rates of labor productivity growth in ‘Manufacturing’, PBS and ‘Primary Activities’, while contributing positively to aggregate productivity growth, were too small to offset the productivity growth decline in UC, EHS and the ‘Rest’. The fact that the impact on aggregate productivity growth of structural change was small on balance does not mean that shifts in employment structure (measured in terms of industry shares in total hours worked) were insignificant. As Table 6 shows, deindustrialization (measured in terms of a declining share of hours worked in manufacturing in total hours worked) depressed aggregate productivity growth during 1995-2008 by 0.39 percentage points as compared to growth during 1948-72. As a result of technological progress and offshoring, manufacturing’s share in total hours worked declined from more than 30% around 1950 to less than 10% in 2015. While around 14.4 million industrial workers toiled during 30 billion hours in 1950, their number by 2015 had declined to 12.1 million workers putting in 24.6 billion hours of work—this means that total hours worked in manufacturing declined by 0.3% on average each year during 1950 and 2015. ‘Manufacturing’ has been shedding millions of jobs and reducing hours of work during a period of sixty-five years, when U.S. employment rose by 82.8 million workers—from 58.7 million employed workers on average per year during 1950-59 to 141.4 million employed workers during 2010-15.

These workers had to find jobs in services-sector activities, mostly featuring below-average labor productivity growth: 18.9 workers found work in EHS, 16.2 million persons in PBS, 14.3 million individuals in the ‘Rest’, 13.5 million persons in the public sector, and 5.7 million workers in FIRE. The declining employment share of ‘Primary Activities’, which is a feature shared by all OECD economies and nothing much to be concerned about, depressed aggregate productivity growth between 1948-72 and 1995-2008 by another 0.09 percentage points. The productivity growth-retarding impact of deindustrialization was offset to a large

extent by the increased employment shares of PBS and EHS, which taken together raised aggregate labor productivity growth during 1995-2008 by 0.36 percentage points (compared to the post-war years 1948-72). The changes in the employment shares of UC, WRT, ‘Information’, FIRE, the ‘Rest’ and the public sector, which were all small, had negligible impacts on the productivity growth slowdown.

A major question from a macro perspective is whether stagnant industries are gaining, or losing, shares in either employment or hours worked. Figure 5 shows, using observations on growth of hours worked and labor productivity growth in the nine U.S. industries (1948-2015) included in Table 5, that industries with more rapid productivity growth tend to displace labor and show lower growth of hours. A 1 percentage-point increase in labor productivity growth is associated with a 0.49 percentage-point lower growth in hours worked (Baumol, Blackman and Wolff 1986; Nordhaus 2006, 2015). These results suggest that ‘the most important factor driving differential employment growth has been differential technological change across industries,’ as Nordhaus (2006, p. 26) concludes.

What it means is that millions of workers were pushed out of employment in ‘Primary Activities’ and ‘Manufacturing’, which are industries with above-average productivity growth, and into often non-standard precarious services-sector jobs in PBS, EHS and the ‘Rest’ which feature considerably lower productivity growth (Katz and Krueger 2016). David Weil (2014) has called this the fissuring of the workplace, while Peter Temin (2015, 2017) sees this as a sign of a dual economy. Recognizing what was happening, Paul Samuelson (1998) told a conference sponsored by the Federal Reserve Bank of Boston that “America’s labor force surprised us with a new flexibility and a new tolerance for accepting mediocre jobs.”⁵ Samuelson unfortunately forgot to ask whether this new tolerance had anything to do with the ‘traumatization’ of workers by labor market deregulation and monetary policy. Anthropologist David Graeber (2013) was only more honest when he calls these jobs ‘bullshit jobs’, writing that ‘[h]uge swaths of people [...] spend their entire working lives performing tasks they secretly believe do not really need to be performed. The moral and spiritual damage that comes from that situation is profound. It is a scar across our collective soul.’

⁵ The reference to Samuelson is due to Perelman (2012).

Table 5

Industry-wise TFP growth and hourly labour productivity growth
in the U.S. economy, 1948-2015

	TFP growth (Solow residual)					
	1948-72	1972-95	1995-08	2008-15	1948-08	1948-15
Total economy	1.60	1.06	1.35	0.73	1.34	1.27
Primary Activities	-1.47	-1.02	7.44	-5.04	0.60	0.00
Utilities & Construction	2.35	0.83	0.80	0.38	1.41	1.30
Manufacturing	1.88	0.94	1.19	0.87	1.40	1.32
WRT	1.74	0.74	0.80	1.16	1.15	1.15
Information	1.58	0.74	0.58	-0.26	1.04	0.90
FIRE	1.64	1.63	0.86	2.02	1.46	1.52
PBS	1.69	0.51	2.38	0.30	1.38	1.29
EHS	2.09	1.38	0.81	0.34	1.56	1.44
Rest	0.73	1.29	0.35	1.32	0.90	0.96
<i>PM</i> : Government	1.71	1.17	1.62	0.74	1.48	1.40
	Labor productivity growth					
	1948-72	1972-95	1995-08	2008-15	1948-08	1948-15
Total economy	2.32	1.38	1.92	0.91	1.88	1.78
Primary Activities	2.69	-0.30	8.74	-4.12	2.80	2.06
Utilities & Construction	3.22	1.05	0.77	1.62	1.88	1.85
Manufacturing	2.72	1.78	3.19	1.99	2.46	2.41
WRT	1.74	0.89	1.23	1.30	1.31	1.31
Information	3.77	2.75	2.77	2.01	3.17	3.05
FIRE	2.09	1.89	1.84	2.09	1.96	1.97
PBS	2.21	0.78	2.78	0.12	1.79	1.61
EHS	2.42	1.25	0.93	0.36	1.66	1.52
Rest	1.88	1.25	0.65	1.09	1.38	1.35
<i>PM</i> : Government	1.64	1.40	1.85	0.91	1.59	1.54

Source: Author's estimates based on *BEA* data; see data appendix.

Notes: Primary industries = agriculture & mining; UC = utilities (electricity, gas and water supply) and construction; WRT = wholesale, retail and transportation; PBS = professional and business services; FIRE = finance, insurance and real estate; EHS = educational, health and private social services; Rest = art, entertainment, recreation and food services & other services.

Table 6

Shift-share decomposition of the change in U.S. labour productivity growth
between 1948-1972 and 1995-2008

	labour productivity growth (%)			share in employment (defined as total hours worked)			contribution to labour productivity change of:		
	1948-1972	1995-2008	change	1948-1972	1995-2008	Change	intra-industry productivity change	structural change	Total
Total economy	2.319	1.918	-0.402	1.000	1.000	—	-0.337	-0.065	-0.402 (100.0%)
Primary Activities	2.685	8.741	6.056	0.050	0.018	-0.032	0.110	-0.085	0.025 (-6.3%)
Utilities & Construction	3.220	0.770	-2.451	0.059	0.066	0.007	-0.161	0.021	-0.140 (34.8%)
Manufacturing	2.715	3.191	0.476	0.285	0.140	-0.145	0.066	-0.394	-0.128 (81.6%)
WRT	1.739	1.232	-0.507	0.175	0.176	0.000	-0.089	0.000	-0.088 (22.0%)
Information	3.765	2.768	-0.997	0.027	0.026	-0.001	-0.026	-0.005	-0.031 (7.7%)
FIRE	2.087	1.836	-0.251	0.041	0.061	0.020	-0.015	0.041	0.026 (-6.5%)
PBS	2.206	2.782	0.576	0.043	0.122	0.078	0.070	0.173	0.243 (-60.4%)
EHS	2.418	0.925	-1.493	0.042	0.118	0.076	-0.176	0.184	0.009 (-2.1%)
Rest	1.880	0.650	-1.230	0.102	0.122	0.020	-0.150	0.037	-0.113 (28.1%)
<i>PM:</i> Government	1.639	1.849	0.283	0.176	0.153	-0.023	0.032	-0.037	-0.005 (1.1%)

Source: Author's estimates based on *Bureau of Economic Analysis* data; see data appendix.

Notes: Primary industries = agriculture & mining; UC = utilities (electricity, gas and water supply) and construction; WRT = wholesale, retail and transportation; PBS = professional and business services; FIRE = finance, insurance and real estate; EHS = educational, health and private social services; Rest = art, entertainment, recreation and food services & other services. The shift-share analysis is based on the following decomposition of total-economy labour productivity growth:

$$\Delta \hat{\lambda}_{total\ economy} = \sum_{i=1}^{10} \xi_i \Delta \hat{\lambda}_i + \sum_{i=1}^{10} \hat{\lambda}_{0i} \Delta \xi_i$$

where $\Delta \hat{\lambda}_i$ = the change in average labour productivity growth in industry i between 1948-72 and 1995-2008; $\Delta \xi_i$ = the change in the employment share of industry i between 1948-72 and 1995-2008; $\hat{\lambda}_{0i}$ = average labour productivity growth in industry i during 1948-72; and ξ_i = the employment share of industry i during 1995-2008.

The loss of ‘good jobs’ and the polarization of the U.S. labor market (Autor and Dorn 2013) put the middle-classes under severe stress. Alarmed by the loss of stable meaningful work and the vanishing middle class, sociologist Richard Sennett (1998, p. 148) penned down a haunting warning of pending political troubles implied by the ‘New Capitalism’: “... I do know a regime which provides human beings no deep reasons to care about one another cannot long preserve its legitimacy.”

Mediocre jobs and ‘alternative work arrangements’ mean mediocre real wages and working conditions (Weil 2014; Temin 2017)—hence the shift in the U.S. employment structure is one factor behind the slowdown of average real wage growth highlighted in Figure 4. As Table 7 shows, around one-fourth of all U.S. workers are in low-paying jobs, earning a ‘poverty-wage’ that is about two-thirds of the median hourly wage (for all occupations) and only half the mean hourly wage (see the *Note* to Table 7). More than 73% of employees in (fast) food preparation and serving earn this poverty-wage (or less), as do 57% of workers in personal care, 54% of workers in cleaning, and 45% of workers in healthcare support. As shown by Table 7, poverty-wage jobs are concentrated in just ten occupational categories. If we enlarge our definition of ‘mediocre’ jobs (in terms of pay) to include jobs earning up to 200% of the poverty wage, these ten occupations account for 55% of U.S. workers (in 2010). As reported by Thiess (2012), female workers hold 55.1% of the poverty-wage jobs and African Americans are also overrepresented in the poverty-wage workforce.

The shift in employment structure also implies a greater polarization between higher-paying jobs in ‘dynamic’ sectors such as ‘Manufacturing’ and ‘Information’ and lower-paying jobs in UC, EHS and the ‘Rest’. This (wage) polarization (Autor and Dorn 2013) is illustrated in Table 8 which compares real wage growth per worker during 1948-2008 in UC, EHS and the ‘Rest’ to that in ‘Manufacturing’, ‘Information’, FIRE and PBS (the latter two industries offer on average better-paying jobs). The growth in real wages per worker has been decomposed into its constituents: growth of hours worked on the one hand and growth of real wages per hour of work on the other hand. What comes out clearly is that real wages of workers in the stagnant industries UC, EHS and the ‘Rest’ have fallen drastically compared to real wages in ‘Manufacturing’, ‘Information’, FIRE and PBS—in most case by more than 30% over 60 years in cumulative terms. The main source of the rise in wage inequality has been the decline in the relative hourly wage earned in UC, EHS and the ‘Rest’, but in EHS and the ‘Rest’ the reduction in working hours per employee (relative to hours worked in

‘Manufacturing’ and FIRE) also contributed to the decline in relative wage income per employee. Hours worked per employee in EHS have declined from around 1950 per annum in the early 1950s to less than 1700 per year now; hours worked per employee in the ‘Rest’ fell from around 1700 hours per year in the early 1950s to about 1450 hours now. These falls in hours worked per person point to ‘employment sharing’: an increasing number of workers are ‘sharing’, most likely involuntarily, a shrinking number of hours of work in poorly paid ‘mediocre’ ‘alternative work arrangements’ in EHS or the ‘Rest’.

Table 7
Poverty-wage workers in U.S., 2010 and 2020 (projected)

	Share of workers in labor force		Share of employment by wage multiple of poverty wage	
	2010	2020	0% — 100%	>100% to 200%
1. Food preparation & serving related occupations	8.7%	7.5%	73.6%	23.4%
2. Personal care & service occupations	2.7%	3.9%	56.9%	33.8%
3. Building and grounds cleaning and maintenance occupations	3.3%	3.8%	53.7%	39.1%
4. Healthcare support occupations	3.1%	3.4%	44.8%	48.7%
5. Sales & related occupations	10.6%	10.3%	41.9%	35.5%
6. Transportation & material moving occupations	6.7%	6.3%	34.3%	49.0%
7. Production occupations	6.5%	5.5%	27.5%	53.9%
8. Protective services occupations	2.5%	2.2%	24.5%	43.2%
9. Office & administrative support occupations	16.9%	15.2%	24.4%	57.4%
10. Construction & extraction occupations	4.0%	4.7%	19.0%	49.3%
Occupations 1-10 (above)	65.2%	62.8%	25.2%	29.2%
Memo: <i>All occupations</i>	—	—	26.0%	40.8%

Source: Thiess (2012), using *Bureau of Labor Statistics* (BLS) data.

Note: The poverty wage is defined as the wage that a full-time, full-year worker would have to earn to live above the federally defined poverty threshold for a family of four. In 2011, this was \$11.06 per hour of work. The poverty wage is about two-thirds of the median hourly wage (for all occupations) (which was \$ 16.71 in 2012) and only half the mean hourly wage (which equalled \$22.01 in 2012).

Table 8

Sources of rising wage inequality in the U.S. economy, 1948-2008

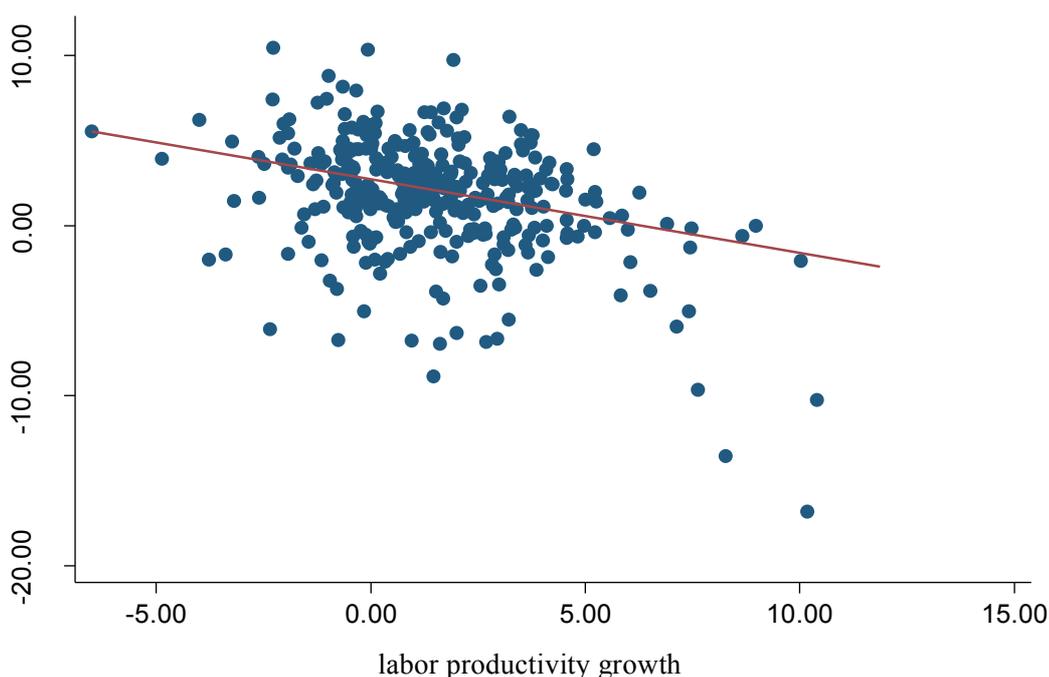
relative to:	growth of real wages per employee in:			growth of hours worked per employee in:			growth of real wages per hour of work in:		
	UC	EHS	Rest	UC	EHS	Rest	UC	EHS	Rest
Manufacturing	-0.10	-0.61	-0.17	0.06	0.01	-0.19	-0.16	-0.62	-0.03
Information	-0.55	-0.62	-0.62	0.23	-0.02	-0.02	-0.79	-0.60	-0.60
FIRE	-0.73	-0.79	-0.80	0.04	-0.18	-0.21	-0.77	-0.59	-0.59
PBS	-0.74	-0.79	-0.80	0.22	0.00	-0.03	-0.97	-0.78	-0.78

Source: Author's estimates based on BEA data; see data appendix.

Note: Growth of real wages per employee can be decomposed into (a) the growth of hours worked per employee; and (b) growth of real wages per hour worked. An average annual decline in the wage in EHS relative to the wage in FIRE by 0.79% during 1948-2008 implies a cumulative relative wage decline of 38%.

Figure 5

Growth of hours and labor productivity:
U.S. industries, 1948-2015



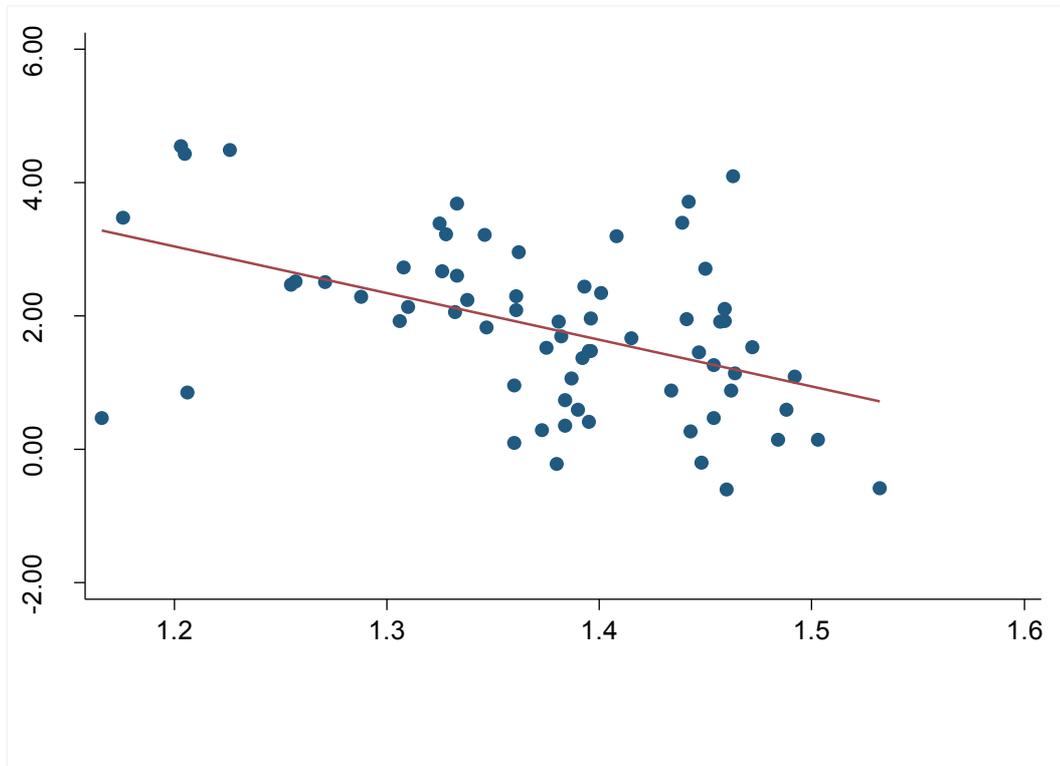
Notes: Industries featuring higher labor productivity growth feature lower growth rate of hours worked (***) is statistically significant at 1%):

$$\text{Growth of hours worked} = 2.82 - 0.49 \text{ labor productivity growth} \quad \bar{R}^2 = 0.16; n = 544$$

$$(17.19)^{***} \quad (7.81)^{***}$$

For similar evidence, see Nordhaus (2006), Table 4 and Figure 4.

Figure 6
Growth of real wages and wage inequality:
U.S. economy, 1948-2015



Notes: Wage inequality (measured on the horizontal axis) is defined as the ratio of the mean to the median real wage. The regression line is based on the following OLS regression (***) is statistically significant at 1%):

$$\text{Growth of hourly real wages} = 10.77 - 6.51 \text{ wage inequality} \quad \bar{R}^2 = 0.13; n = 68$$

$$(2.72)^{***} \quad (2.29)^{**}$$

Either way, the increase in inter-industry wage disparities has contributed to greater wage inequality, as is for instance reflected in the secular increase in the ratio of the mean (hourly) wage to the median (hourly) wage. As is illustrated in Figure 6, the increase in the mean-median wage ratio is strongly correlated with declining real wage growth—that is, along a declining trend, wage inequality has been rising. This means that average U.S. real wage growth becomes a rather meaningless concept—and by implication of equation (9), the same holds true for average U.S. TFP or labor productivity growth.

Clearly then, the U.S. productivity growth crisis is not a generalized crisis of innovation and entrepreneurship, but rather located in particular segments of the U.S. economy. To see this, consider the final column of Table 6, which gives the decomposition of the decline in aggregate labor growth between 1948-72 and 1995-2008 into its industry-specific contributions. Five industries—‘Primary Activities’, WRT, ‘Information’, FIRE and EHS—and the public sector play only a minor role, as their combined net contribution to the aggregate productivity growth decline of -0.40 percentage points is just -0.06 percentage points. In the case of ‘Primary Activities’, the positive impact of accelerating intra-industry productivity growth is largely offset by its declining employment share; in the case of EHS, the negative impact of declining intra-industry productivity growth is almost completely balanced by the increase in its employment share—from 4.2% of hours worked each year during 1948-72 to 11.8% of hours worked each year during 1995-2008.

As the shaded cells of Table 6 indicate, the slowdown of aggregate U.S. productivity growth between 1948-72 and 1995-2008 has three main sources: (a) deindustrialization (the decline in the employment share of an otherwise technologically dynamic manufacturing sector); (b) the sharp decline in labor productivity growth in ‘Utilities & Construction’; and (c) the considerable fall in productivity growth in the ‘Rest’. These atrophying changes were partly offset however by (d) the increase in the employment share of PBS.

With so much empirical detail it is easy to lose sight of the forest for the trees. However, taking a step backwards, the inescapable conclusion is, it seems to me, that the U.S. economy has grown more segmented or ‘dualistic’ over time (*cf.* Temin 2015, 2017). The secular decline in *aggregate* U.S. productivity growth is clearly hiding a growing divergence in productivity performance and technological zing between a ‘dynamic’ sector (in which I include ‘Manufacturing’, ‘Information’, FIRE and PBS) and a ‘stagnant’ sector (in which I include UC, EHS and the ‘Rest’). The growing segmentation, suggesting a Baumol-like pattern of ‘unbalanced growth’ (Baumol 1967; Baumol, Blackman and Wolff 1985), is illustrated in Table 9 and Figure 7.

A first point to note is that the ‘dynamic’ and ‘stagnant’ sectors have a rather stable employment share (share in total hours worked in the U.S. economy) of around 60-65%, when taken together. However, the ‘dynamic’ sector had an employment share of 40% in the 1950s and was *twice* as large (in terms of hours worked) as the ‘stagnant’ sector with an

employment share of just 20%. In terms of output, the ‘dynamic’ sector was *thrice* the size of the ‘stagnant’ sector in 1950—and hence ‘dynamic’ sector labor productivity was 1.5 times higher than that in the ‘stagnant’ sector (Table 8). Over time, the employment share of the ‘dynamic’ sector has come down to 32% on average per year during 2005-2015 and, as with communicating vessels, the employment share of the ‘stagnant’ sector has risen to 33% on average per annum in the same period. In recent times, employment growth in the ‘dynamic’ sector has come to a standstill, as the average annual growth rate of hours worked in the ‘dynamic’ sector equaled a mere 0.15% during 1995-2015—which is likely due not just to recent advances in automation, robotics and artificial intelligence (*e.g.*, Acemoglu and Restrepo 2017) but also to the permanent ‘fissuring of the workplace’ (Weil 2014; Katz and Krueger 2016).

‘Stagnant’ sector output did grow faster than output in the ‘dynamic’ sector: the ratio of ‘dynamic’ to ‘stagnant’ sector output came down from 312% in 1950 to 245% in 2015. Relative output growth of the ‘stagnant’ sector was based on working more hours however—not on higher labor productivity growth. As a result, value added creation per hour of work in the ‘stagnant’ sector which was about one-third less than that in the ‘dynamic’ sector in 1950, declined to less than two-fifths of the ‘dynamic’ sector productivity level by 2015. This productivity divergence was driven by a doubling in capital intensity in the ‘dynamic’ sector relative to the ‘stagnant’ one—from 248% in 1950 to 491% in 2015. Unsurprisingly, the growing segmentation has also pushed up real wage disparity between the ‘dynamic’ and ‘stagnant’ sectors: the difference between the hourly real wages in the ‘dynamic’ and ‘stagnant’ sectors, which amounted to 35% in 1950, increased to almost 60% in 2015.

Part of this must be due to the fact that more workers had to find jobs in the ‘stagnant’ sector, which structurally increased employers’ monopsony power and forced down real wage growth in these activities, particularly following the labor market deregulation of the 1980s and 1990s. Under these circumstances, ‘dynamic’ sector workers also found it hard to claim higher real wage growth and as a result the ‘dynamic/stagnant sector’ wage ratio increased much less than the relative ‘dynamic/stagnant’ labor productivity (Table 8). This implies the profit share of the ‘dynamic’ sector must have increased relative to that of the ‘stagnant’ sector—which in turn must have contributed to the increasing divergence in capital intensities. Figure 7 brings out the structural divergence in sharp relief. As the ‘dynamic’ sector is declining relative to the ‘stagnant’ sector in terms of hours worked, it is taking off in

terms of (faster) productivity growth—while offering an increasingly smaller proportion of workers an increasingly higher real wage.

Table 9
Rising dualism in the U.S. economy, 1950-2015

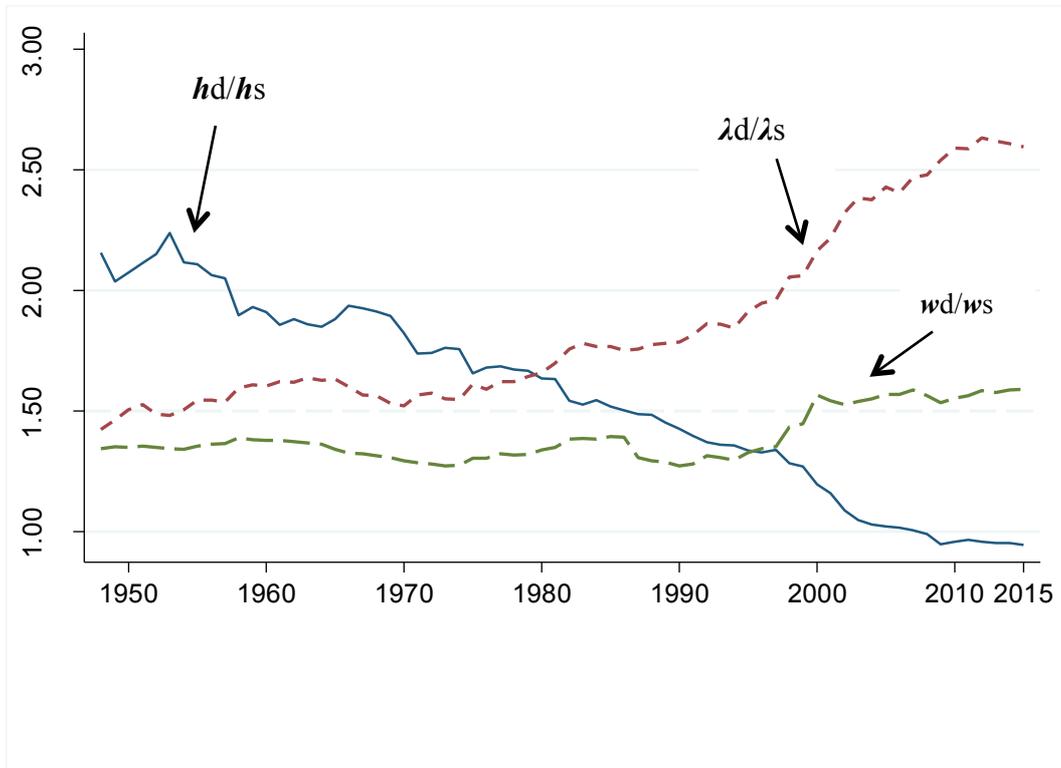
Average annual growth rate of:		1948-1972	1972-1995	1995-2015
\boldsymbol{x}_d and \boldsymbol{x}_s		4.39 / 4.87	3.39 / 3.71	2.46 / 2.68
\boldsymbol{h}_d and \boldsymbol{h}_s		1.42 / 2.26	1.43 / 2.60	0.15 / 1.90
$\boldsymbol{\lambda}_d$ and $\boldsymbol{\lambda}_s$		2.92 / 2.55	1.94 / 1.08	2.31 / 0.76
\boldsymbol{w}_d and \boldsymbol{w}_s		2.66 / 2.93	1.29 / 1.13	2.05 / 1.13
$\boldsymbol{\kappa}_d$ and $\boldsymbol{\kappa}_s$		2.52 / 2.53	1.52 / -0.13	2.01 / 1.01
ratios:	1950	1972	1995	2015
$\boldsymbol{x}_d/\boldsymbol{x}_s$	312%	274%	256%	245%
$\boldsymbol{h}_d/\boldsymbol{h}_s$	207%	174%	134%	94%
$\boldsymbol{\lambda}_d/\boldsymbol{\lambda}_s$	151%	157%	191%	260%
$\boldsymbol{w}_d/\boldsymbol{w}_s$	135%	128%	133%	159%
$\boldsymbol{\kappa}_d/\boldsymbol{\kappa}_s$	248%	251%	366%	491%

Source: Author's estimates based on *BEA* data; see data appendix.

Notes: The 'dynamic' sector includes 'Manufacturing', 'Information', FIRE and PBS. The 'stagnant' sector includes UC, EHS and the 'Rest'. *Symbols:* $\boldsymbol{x}_d/\boldsymbol{x}_s$ = the ratio of real GDP of the dynamic sector to real GDP of the stagnant sector; $\boldsymbol{h}_d/\boldsymbol{h}_s$ = the ratio of hours worked in the dynamic sector to hours worked in the stagnant sector; $\boldsymbol{\lambda}_d/\boldsymbol{\lambda}_s$ = the ratio of hourly labor productivity in the dynamic sector to hourly labor productivity in the stagnant sector; $\boldsymbol{w}_d/\boldsymbol{w}_s$ = the ratio of the hourly real wage earned in the dynamic sector to the hourly real wage in the stagnant sector; and $\boldsymbol{\kappa}_d/\boldsymbol{\kappa}_s$ = the ratio of capital intensity in the dynamic sector to capital intensity in the stagnant sector

This is dualism, big time. The phenomenon of secular stagnation of (potential) growth has to be understood in the context of this dualization of the U.S. economy, because—as I will argue in the next section—the technological dynamism in the one segment is causally related to the productivity growth stagnation in the other segment. The (simple) regressions reported below Figure 7 illustrate this point: higher real wages in the 'dynamic' sector (relative to the 'stagnant' sector) reduce hours worked and raise labor productivity in the 'dynamic' sector (relative to the 'stagnant' sector). A 1%-point rise in $\boldsymbol{w}_d/\boldsymbol{w}_s$ leads to a 0.63%-point decline in the ratio $\boldsymbol{h}_d/\boldsymbol{h}_s$, while being associated with a 1%-point rise in relative productivity $\boldsymbol{\lambda}_d/\boldsymbol{\lambda}_s$. The causal interactions between the two segments will be analyzed and explored in the next section.

Figure 7
Growing dualism in the U.S. economy, 1948-2015



Notes: The ‘dynamic’ sector includes ‘Manufacturing’, ‘Information’, FIRE and PBS. The ‘stagnant’ sector includes UC, EHS and the ‘Rest’. *Symbols:* see *Notes* to Table 8.

Using the data of Table 8, the following Prais-Winsten AR(1) regressions results have been obtained (where *** is statistically significant at 1%):

$$\begin{aligned}
 \mathbf{hd/hs} &= 0.95 & - & 0.63 \mathbf{wd/ws} & + & 0.54 \mathbf{xd/xs} & - & 0.01 \mathbf{Time} & & \bar{R}^2 = 0.98; n = 68 \\
 & (4.55)^{***} & & (5.19)^{***} & & (7.37)^{***} & & (8.29)^{***} & & \\
 \mathbf{\lambda d/\lambda s} &= & & 1.00 \mathbf{wd/ws} & + & 0.18 \mathbf{xd/xs} & + & 0.02 \mathbf{Time} & & \bar{R}^2 = 0.97; n = 68 \\
 & & & (8.42)^{***} & & (2.93)^{***} & & (7.02)^{***} & &
 \end{aligned}$$

7. ‘Baumol revisited’: stagnation in times of robotization and AI

Baumol’s (1967) model of unbalanced growth is known for its prediction of a ‘cost disease’: the inevitable rise in relative unit costs and prices in the non-progressive tertiary activities arising from two stylized facts: productivity growth is structurally lower in these activities than in manufacturing, and the demand for these services is hardly price-elastic (which means consumers are willing to pay the higher prices). More controversial is the ‘secular stagnation’, induced by ‘non-progressive’ structural change, which Baumol’s model also implies: since aggregate productivity growth is a weighted average of the industry-wise productivity growth rates (with the weights provided by the nominal value added shares), Baumol predicted that the rate of aggregate productivity growth will come down over time as the weight of the non-progressive industries with low productivity growth does rise (Nordhaus 2008; Hartwig 2013). However, unlike Baumol’s prediction and as shown in Tables 6 and 8, the secular stagnation of productivity growth in the U.S. after 1972 was not so much due to ‘non-progressive’ structural change, but to a drop in intra-industry productivity growth in what I called the ‘stagnant’ sector.

Moreover, whereas Baumol assumed that real wages grow at the same rate in the two segments of the economy, Figure 7 shows a continuous decline in the ‘stagnant-sector’ wage relative to the wage earned in the ‘dynamic’ sector. In other words, Baumol’s ‘cost disease’, thought likely to occur, did not happen as ‘stagnant-sector’ wages fell relative to ‘dynamic-sector’ wages. Any theoretically plausible and empirically convincing explanation of the secular stagnation of *aggregate* labor productivity growth in the U.S. must explain these facts.

This is the intention of the two-sector model of unbalanced growth summarized in Table 10. Variables are defined as (logarithmic) growth rates indicated by a circumflex. Unlike Baumol (1967), output in each sector is determined by demand. The technologically dynamic sector is indicated by subscript ‘*d*’, while the technologically stagnant sector has subscript ‘*s*’. The model operates on the assumption of full employment⁶—because in the absence of unemployment insurance and social security worth the name, workers must find jobs, if not in

⁶ In reality, many ‘discouraged’ workers drop out of the labor force in recessions or times of crisis, as happened in response to the crisis of 2008-09, and many of them do not return if job opportunities remain weak or absent. Six years after the crisis, the *Economic Policy Institute* counted more than 3 million ‘missing workers’ who, due to weak job opportunities, are neither employed nor actively looking for a job. See: <http://www.epi.org/publication/missing-workers/>

the better remunerated core, then in a poorly paid job in some peripheral activity. Equation (M1) specifies dynamic-sector output growth \hat{x}_D as a function of demand for its output, which in turn depends on real wage incomes earned in the dynamic and the stagnant sector and autonomous demand growth for dynamic-sector goods (or $\hat{\Theta}_D$), which includes investment demand. Real wage-income growth in the dynamic sector is by definition equal to the sum of the growth rate of hours worked $\hat{\ell}_D$ and the growth rate of the hourly real wage \hat{w}_D ; the same holds true for real wage income growth in the stagnant sector. As explained in the Appendix, γ_D is the dynamic-sector income elasticity of demand for dynamic-sector output, multiplied by the weight of the dynamic sector in GDP; likewise, γ_S is the stagnant-sector income elasticity of demand for dynamic-sector output, multiplied by the weight of the stagnant sector in GDP. It should be noted that I have omitted from equation (M1) the impact on demand of a change in the dynamic-sector price relative to the stagnant-sector price, as is usual in two-sector models—for reasons explained in the Appendix.

Table 10
A model of unbalanced growth

‘dynamic’ sector	‘stagnant’ sector
M1. $\hat{x}_D = \hat{\Theta}_D + \gamma_D (\hat{w}_D + \hat{\ell}_D) + \gamma_S (\hat{w}_S + \hat{\ell}_S)$	M5. $\hat{x}_S = \hat{\Theta}_S + \varepsilon_D (\hat{w}_D + \hat{\ell}_D) + \varepsilon_S (\hat{w}_S + \hat{\ell}_S)$
M2. $\hat{\lambda}_D = \kappa \hat{x}_D + \hat{\lambda}_0, \quad 0 < \kappa < 1$	M6. $\hat{\lambda}_S = \hat{x}_S - \hat{\ell}_S$
M3. $\hat{\ell}_D = \hat{x}_D - \hat{\lambda}_D = (1 - \kappa) \hat{x}_D - \hat{\lambda}_0$	M7. $\hat{\ell}_S = -\vartheta \hat{\ell}_D = -\vartheta(1 - \kappa) \hat{x}_D + \vartheta \hat{\lambda}_0,$ $0 < \vartheta = \ell_D / \ell_S < 1$
M4. $\hat{w}_D = \hat{w}_D$	M8. $\hat{w}_S = \hat{w}_0 - \pi \hat{\ell}_S, \quad \pi > 1$

Note on parameter values: The parameterization, based on the preceding empirical analysis for the U.S. economy, is as follows: $\kappa = 0.5$ (see Note to Figure 7); $\pi \approx 2$ (see Note to Figure 3); $\vartheta = 1$ (during 2010-15, see Figure 7). If I assume that the wage-income elasticities of demand are unity, then $\gamma_D = \varepsilon_D \approx 0.7$ and $\gamma_S = \varepsilon_S \approx 0.3$ (based on the ratio x_D/x_S in 2015, see Table 8). It then follows that $\gamma_D - \gamma_S \vartheta(1 - \pi) = 1$ (see main text for elaboration).

Equation (M2) defines dynamic-sector labor productivity growth $\hat{\lambda}_D$ as a function of $\hat{\lambda}_0$, which represents, in Schumpeterian fashion, exogenous labor productivity growth due to ‘technology-push’ innovation based on public spending on basic research, private RD&D, and entrepreneurship, both private and public (Lazonick 2009, 2014; Mazzucato 2013). Importantly, however, part of $\hat{\lambda}_D$ is endogenous and depends on dynamic-sector demand growth through the Kaldor-Verdoorn coefficient κ . This link, which forms the heart of Adam Smith’s interpretation of the British Industrial Revolution, reflects the fact that a greater division of labor allows for greater specialization and differentiation of production, which raises productivity directly and indirectly—in the latter case, by promoting learning by doing and leading to process and product innovation (Young 1928; Kaldor 1966; Basu and Foley 2011; Storm and Naastepad 2012). At the firm level, the Kaldor-Verdoorn effect captures the impact of what Jacob Schmookler (1966) labelled ‘demand-pull’ innovations. Equation (M3) defines dynamic-sector hourly employment growth $\hat{\ell}_D$ as the difference between output growth and labor productivity growth. An increase in the technology-push factor $\hat{\lambda}_0$ leads to labor shedding from the dynamic core, as $\hat{\ell}_D$ declines. To simplify the analysis, dynamic-sector (hourly) real wage growth is assumed exogenous in equation (M4); the point is not that real wages in the dynamic sector do not respond to higher productivity growth, but that if they increase, they are likely to increase less than labor productivity increases (*cf.* Section 4).

Analogous to (M1), equation (M5) specifies stagnant-sector output growth as determined by autonomous demand growth and dynamic-sector and stagnant-sector real wage income growth. ε_D is the dynamic-sector income elasticity of demand for stagnant-sector output, multiplied by the weight of the dynamic sector in GDP; likewise, ε_S is the stagnant-sector income elasticity of demand for stagnant-sector output, multiplied by the weight of the stagnant sector in GDP. Equation (M6) defines stagnant-sector labor productivity growth as the difference between stagnant-sector output and employment growth (determined in (M7)). This is the first structural difference between the two sectors: stagnant-sector labor productivity growth is not influenced by ‘technology-push’ factors, but adjusts passively to, and absorbs, any changes in \hat{x}_S and $\hat{\ell}_S$. Employment growth in the stagnant sector, in turn, is determined (in M7) by employment growth in the dynamic sector, on the assumption that aggregate labor supply is constant. Hence, if dynamic-sector employment growth goes down (because of faster productivity growth in the dynamic core), more workers have to find

‘mediocre’ jobs in the stagnant services industries—when $\hat{\ell}_D$ goes down, $\hat{\ell}_S$ goes up, and $\hat{\lambda}_S$ must decline (*ceteris paribus*).

This implies a structural interdependence between stagnant and dynamic sectors: in the absence of social security, the stagnant sector constitutes ‘the employer of last resort’, absorbing redundant workers from the dynamic core, by lowering wage and labor productivity growth in stagnant activities. Put differently, the stagnant sector hosts the ‘reserve army of the underemployed’ (see *fn.* 5). In equation (M8), which completes the model, real wage growth in the stagnant sector is a negative function of labor supply growth, which is based on a downward sloping labor demand curve and a vertical—exogenous—labor supply curve (for its derivation, see Appendix). Assuming a ‘buyers’ market’, as all workers searching for a job must find one (in order to survive), the stagnant-sector real wage must be ‘market-clearing’. The model thus operates as a ‘Lewis model in reverse’ (Lewis 1954; Storm 2015). Note further that since π takes a value of about 2 (see Appendix), an increase in peripheral labor supply growth of, say, 1%, depresses peripheral real wage growth by about 2%. The term \hat{w}_0 stands for exogenous (subsistence) real wage growth in the stagnant sector, which would materialize if $\hat{\ell}_S$ is zero.

6.1 ‘Balanced growth’ occurs only as a ‘happy accident’⁷

‘Balanced growth’ between the two sectors is possible in principle, but highly improbable given that there is no mechanism to bring it about—just as there is no mechanism in Harrod’s growth model to ensure steady-state growth at full employment. Such ‘balanced growth’ between dynamic and stagnant sectors requires that $\hat{\ell}_D = 0$, because then sectoral shares in total employment (hours worked) are constant, stagnant-sector real wages grow at \hat{w}_0 and there are no pressures for productivity growth in dynamic and stagnant sectors to change. The balanced-growth scenario is illustrated in Figure 8. If $\hat{\ell}_D = 0$, then from M3 we get the ‘balanced growth’ rates of output and productivity (the vertical line in Fig. 8):

$$(15) \quad \hat{x}_D^* = \hat{\lambda}_D^* = \frac{\hat{\lambda}_0}{(1-\kappa)}$$

⁷ Cf. Hahn and Matthews (1964).

Balanced output and productivity growth in the dynamic sector depend on the exogenous rate of technology-push innovation $\hat{\lambda}_0$ and the Kaldor-Verdoorn coefficient. Equation (15) requires, in turn, that the corresponding growth rate of stagnant-sector real wages is:

$$(16) \quad \hat{w}_0^* = \frac{\hat{\lambda}_0}{(1-\kappa)\gamma_S} - \left[\frac{\hat{\Theta}_D + \gamma_D \hat{w}_D}{\gamma_S} \right].$$

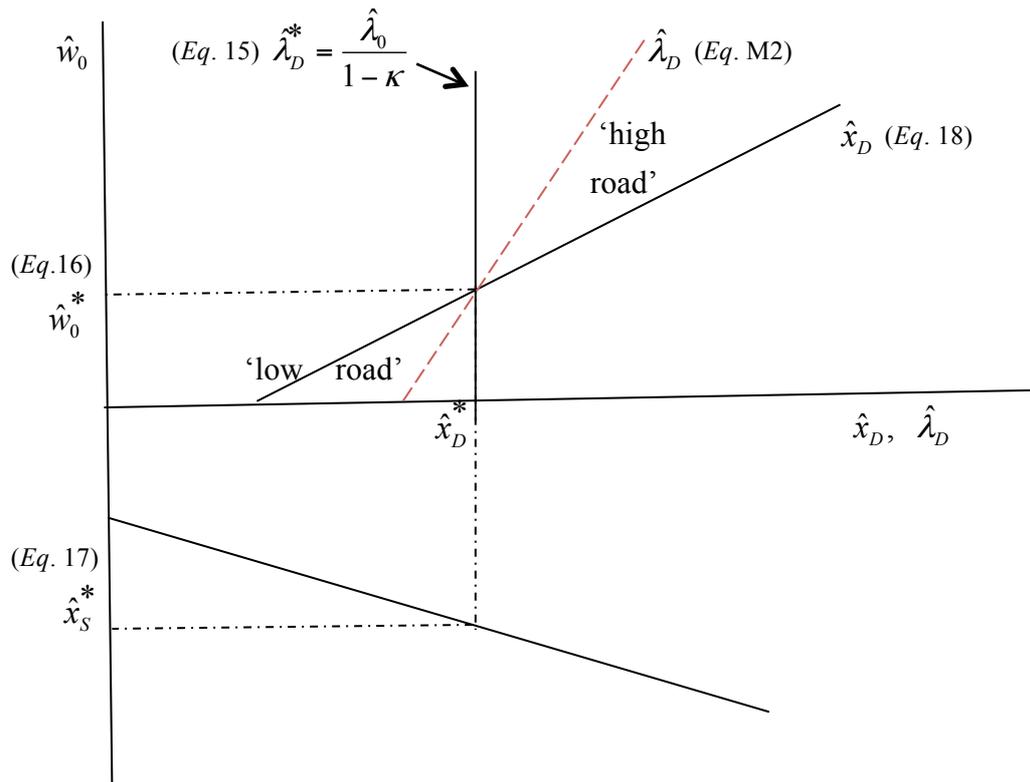
Note that $\hat{\Theta}_D$ and \hat{w}_D are exogenous. \hat{w}_0^* is the growth rate of stagnant-sector real wages that ‘warrants’ balanced growth (see Fig. 8). The condition for balanced growth could alternatively have been expressed in terms of \hat{w}_D or of $\hat{\Theta}_D$ if one assumes that autonomous demand growth is influenced by fiscal and monetary policy. However, I chose \hat{w}_0^* as the ‘numéraire’ because it is stagnant-sector wage growth that is bearing the brunt of the process of unbalanced growth—as shown in Table 8 and Figure 7 in contrast to Baumol (1967). \hat{w}_0^* depends on the difference between $\hat{\lambda}_0$ and autonomous demand growth for dynamic-sector goods. Keeping all other factors constant, higher $\hat{\lambda}_0$ means that hours worked in the dynamic sector go down; this can be prevented from happening by higher \hat{w}_0^* , which raises demand and output for dynamic-sector goods. At \hat{w}_0^* and because $\hat{\ell}_D = \hat{\ell}_S = 0$, stagnant-sector output and labor productivity grow at the following rate:

$$(17) \quad \hat{x}_S^* = \hat{\lambda}_S^* = \hat{\Theta}_S + \varepsilon_D \hat{w}_D + \varepsilon_S \hat{w}_0^*.$$

This ‘balanced growth’ outcome is illustrated in the lower panel of Figure 8. The structure of the growing economy would be constant in terms of hours worked, while relative output levels, productivity levels and (exogenous) real wages would likely diverge. In this balanced growth scenario, there is no secular stagnation of aggregate productivity growth however, because sector-wise productivity growth rates are constant in (15) and (17) and there is no structural change in hours worked (see Appendix for details). But ‘balanced growth’ is improbable, as the model lacks an in-built mechanism to keep stagnant-sector wage growth rate at \hat{w}_0^* ; the norm is ‘unbalanced growth’. If actual $\hat{w}_0 > \hat{w}_0^*$, then $\hat{x}_D > \hat{\lambda}_D$ and the dynamic sector will pull in extra workers from the stagnant sector; this is the ‘high road’ (see

Fig. 8). But the realistic scenario is that $\hat{w}_0 < \hat{w}_0^*$, and hence $\hat{x}_D < \hat{\lambda}_D$ and the dynamic sector will shed workers; the result is the ‘low road’ featuring lower growth overall, depressed stagnant-sector productivity growth and stagnant-sector wage growth \hat{w}_S dropping below \hat{w}_0 .

Figure 8
Balanced growth



The long-run (asymptotic) properties of this process of structural change are predictable and in line with Baumol (1967): aggregate labor productivity growth declines because the GDP and employment shares of stagnant activities (in low-wage services) rises at the cost of the GDP and employment shares of dynamic activities in the (manufacturing) core. But this is not my main point. The implication of the model here is that the secular stagnation of labor productivity is due not simply to such regressive ‘structural change’, but also to a prior slowdown of aggregate demand, which by putting a limit on the ‘extent of the market’ unduly constrains labor productivity growth in both stagnant and dynamic industries. In other words, the secular decline in aggregate productivity growth is not the asymptotic long-run result, but is in process long before the economy has become fully de-industrialized.

6.2 Premature stagnation in the dynamic core

To see this, consider the reduced-form for dynamic-sector output growth (using M1 to M4):

$$(18) \quad \hat{x}_D = \frac{\hat{\Theta}_D + \gamma_D \hat{w}_D + \gamma_S \hat{w}_0 - [\gamma_D - \gamma_S \vartheta(1 - \pi)] \hat{\lambda}_0}{1 - (1 - \kappa)[\gamma_D - \gamma_S \vartheta(1 - \pi)]}$$

Dynamic-sector output growth is driven by $\hat{\Theta}_D$, \hat{w}_D , \hat{w}_0 and by ‘technology-push’ factors captured by $\hat{\lambda}_0$. To make economic sense, the ratio $1/[1 - (1 - \kappa)(\gamma_D - \gamma_S \vartheta(1 - \pi))]$ must be positive so as to reflect the (positive) multiplier impact of higher (autonomous) demand and higher real wage growth on dynamic-sector output growth. Hence, the denominator $1 - (1 - \kappa)[\gamma_D - \gamma_S \vartheta(1 - \pi)] > 0$; which means that ‘higher-rounds’ increases in dynamic-sector demand growth coming from an increase in dynamic-sector real wage income (captured by the term $(1 - \kappa)\gamma_D$) and an increase in stagnant-sector real wage income (given by $-(1 - \kappa)\gamma_S \vartheta(1 - \pi)$) must be smaller than the original demand shock to $\Delta\hat{\Theta}_D = 1$. This makes good sense if only because not all income accrues to wages and not all income is spent—and it also holds true for empirically realistic values for γ_D , γ_S , ϑ , π and κ .

What is clear from (18) is that dynamic-sector output growth does *not* depend on output or job growth in the stagnant sector—on the assumption that \hat{w}_0 is exogenous. Dynamic-sector output growth increases in response to higher autonomous demand growth and real wage growth, but *declines* due to faster technology-push innovation. To understand the latter effect, let me differentiate \hat{x}_D with respect to $\hat{\lambda}_0$:

$$(19) \quad \frac{d\hat{x}_D}{d\hat{\lambda}_0} = \frac{-[\gamma_D - \gamma_S \vartheta(1 - \pi)]}{1 - (1 - \kappa)[\gamma_D - \gamma_S \vartheta(1 - \pi)]} < 0$$

Because the denominator is positive and since $\pi > 1$, $\gamma_D - \gamma_S \vartheta(1 - \pi) > 0$ the sign of (19) is negative. Perhaps the easiest way to understand this is by interpreting ‘technology-push’ innovation as robotization and increased use of AI. The term γ_D captures the negative real-income effect of robotization on the demand growth for dynamic-sector goods, which is due

to the fact that the loss of dynamic-sector jobs is not offset by higher dynamic-sector wages. Likewise, the expression $-\gamma_S \vartheta(1-\pi)$ captures the negative impact of robotization in the ‘dynamic core’ on real income growth in the stagnant sector: as more workers are pushed into ‘mediocre’ jobs, this depresses stagnant-sector real wage growth. Since $\pi > 1$, the decline in stagnant-sector real wage growth is larger (in absolute terms) than the increase in employment growth, and as a result stagnant-sector demand growth for dynamic-sector products is lowered. Figure 9 illustrates the impact of robotization on dynamic-sector growth: due to higher $\hat{\lambda}_0$, the curve for output growth shifts to the left, from \hat{x}_{D-OLD} to \hat{x}_{D-NEW} . For the same \hat{w}_{0-OLD}^* , dynamic-sector output turns out to be lower than before.

Let us turn to the impact of robotization—permanently higher $\hat{\lambda}_0$ —on dynamic-sector *productivity performance*. It is clear from (M2) that a higher $\hat{\lambda}_0$ raises $\hat{\lambda}_D$ one-to-one. But this is not the full impact, since part of $\hat{\lambda}_D$ depends on the ‘division of labor’ as determined by demand growth. Dynamic-sector demand growth falls—from (19)—and this, in turn, restricts the scope for harvesting productivity gains from specialization, learning by doing and economies of scale. The full impact of higher $\hat{\lambda}_0$ on $\hat{\lambda}_D$ therefore is less than one-to-one:

$$(20) \quad \frac{d\hat{\lambda}_D}{d\hat{\lambda}_0} = \kappa \frac{d\hat{x}_D}{d\hat{\lambda}_0} + 1$$

The more robotization depresses dynamic-sector demand growth, the smaller will be its impact on dynamic-sector labor productivity growth. Using (M2) and (19), it can be shown that if $\gamma_D - \gamma_S \vartheta(1-\pi) = 1$, then $d\hat{\lambda}_D / d\hat{\lambda}_0 = 0$, and faster robotization does *not* show up in higher dynamic-sector productivity growth. The reason is that the ‘technology-push’ to dynamic-sector productivity growth is completely offset by a negative ‘demand-pull’ impact, caused by the real income losses due to declining working hours in the dynamic core and declining real wage growth in stagnant-sector jobs (Table 8 and Figure 7).

This particular outcome is not unlikely—using parameter values that are realistic for the U.S. economy, I find that $\gamma_D - \gamma_S \vartheta(1-\pi) = 1$ (see note to Table 8). It also squares with Robert Solow’s (1987) aphorism that “you can see the computer age everywhere but in the

productivity statistics.” The momentous consequence is that if $\hat{\lambda}_D$ does not increase, there is also no reason for \hat{w}_D to rise. An even more extreme outcome would be that $d\hat{\lambda}_D/d\hat{\lambda}_0 < 0$, because $1 < \gamma_C - \gamma_P \vartheta(1 - \pi) < 1/(1 - \kappa)$, in which case faster robotization would actually backfire, resulting in a slowdown of dynamic-sector productivity growth (keeping all other variables constant). This outcome is based, in Schmooklerian fashion, on a large negative ‘demand-pull’ impact on dynamic-sector productivity growth—which is more likely, the higher are the (weighted) income elasticities of demand and the more stagnant-sector real wage growth is depressed by the inflow of redundant workers from the ‘dynamic core’.

The key insight is that there is no guarantee that more ‘technology-push’ innovation translates into faster dynamic-sector productivity growth—as Solow’s ‘productivity paradox’ implies. Either way, robotization does lead to a shedding of dynamic-sector workers:

$$(21) \quad \frac{d\hat{\ell}_D}{d\hat{\lambda}_0} = (1 - \kappa) \frac{d\hat{x}_D}{d\hat{\lambda}_0} - 1 < 0$$

The sign of (21) is negative because $d\hat{x}_D/d\hat{\lambda}_0 < 0$ in (19) and given that $0 < \kappa < 1$. Dynamic-sector workers, made redundant by robotics, are pushed into lower-waged stagnant-sector jobs—and the share of the dynamic sector in total hours worked goes down. The macroeconomic impacts of higher $\hat{\lambda}_0$ are illustrated in Figure 9. Faster robotization shifts the higher $\hat{\lambda}_D^*$ to the right—as it raises the rate of ‘balanced’ productivity and output growth in the dynamic sector. Actual productivity growth, however, remains unaffected, because $\gamma_D - \gamma_S \vartheta(1 - \pi) = 1$. As we saw above, the curve for demand-determined output growth \hat{x}_D shifts to the left, since robotization depresses demand at given \hat{w}_0^* . As a result, the dynamic sector sheds labor—in Figure 9 the negative rate of dynamic-sector employment growth is indicated and labeled ‘labor surplus’. The decline in \hat{x}_D in turn depresses stagnant-sector output growth and stagnant-sector productivity and real wage growth declines as well—as will be shown next.

6.3 Secular stagnation in the stagnant sector

To gauge the impacts of a permanent increase in $\hat{\lambda}_0$ on stagnant-sector performance, we start by considering the *semi*-reduced form expression for \hat{x}_S :

$$(22) \quad \hat{x}_S = \hat{\Theta}_S + \varepsilon_D \hat{w}_c + \varepsilon_S \hat{w}_0 - [\varepsilon_D - \varepsilon_S \vartheta(1 - \pi)] \hat{\lambda}_0 + (1 - \kappa)[\varepsilon_D - \varepsilon_S \vartheta(1 - \pi)] \hat{x}_D$$

The asymmetry is obvious: while dynamic-sector output growth does *not* depend on output growth in the stagnant sector, the growth of stagnant-sector activities does hang on dynamic-sector performance—an unmistakable case of dependency. Stagnant-sector output growth is negatively affected by increases in $\hat{\lambda}_0$, or ‘technology-push’ in the dynamic sector:

$$(23) \quad \frac{d \hat{x}_S}{d \hat{\lambda}_0} = -[\varepsilon_D - \varepsilon_S \vartheta(1 - \pi)] + (1 - \kappa)[\varepsilon_D - \varepsilon_S \vartheta(1 - \pi)] \frac{d \hat{x}_D}{d \hat{\lambda}_0} < 0$$

The sign of (23) is negative, because $[\varepsilon_D - \varepsilon_S \vartheta(1 - \pi)] > 0$ (as $\pi > 1$) and $d\hat{x}_D/d\hat{\lambda}_0 < 0$ from (19). The result is due to the assumptions that (i) real wage growth in the dynamic sector stays constant (which is reasonable if $\hat{\lambda}_D$ stays unchanged), while hours worked in the dynamic sector decline; and (ii) real wage growth in the stagnant sector declines more in response to faster robotization than that stagnant-sector employment increases (which is due to $\pi > 1$). In Figure 9, the change is reflected by the upward shift of the curve for \hat{x}_S in the lower panel and the drop in growth \hat{x}_{S-OLD} from to \hat{x}_{S-NEW} .

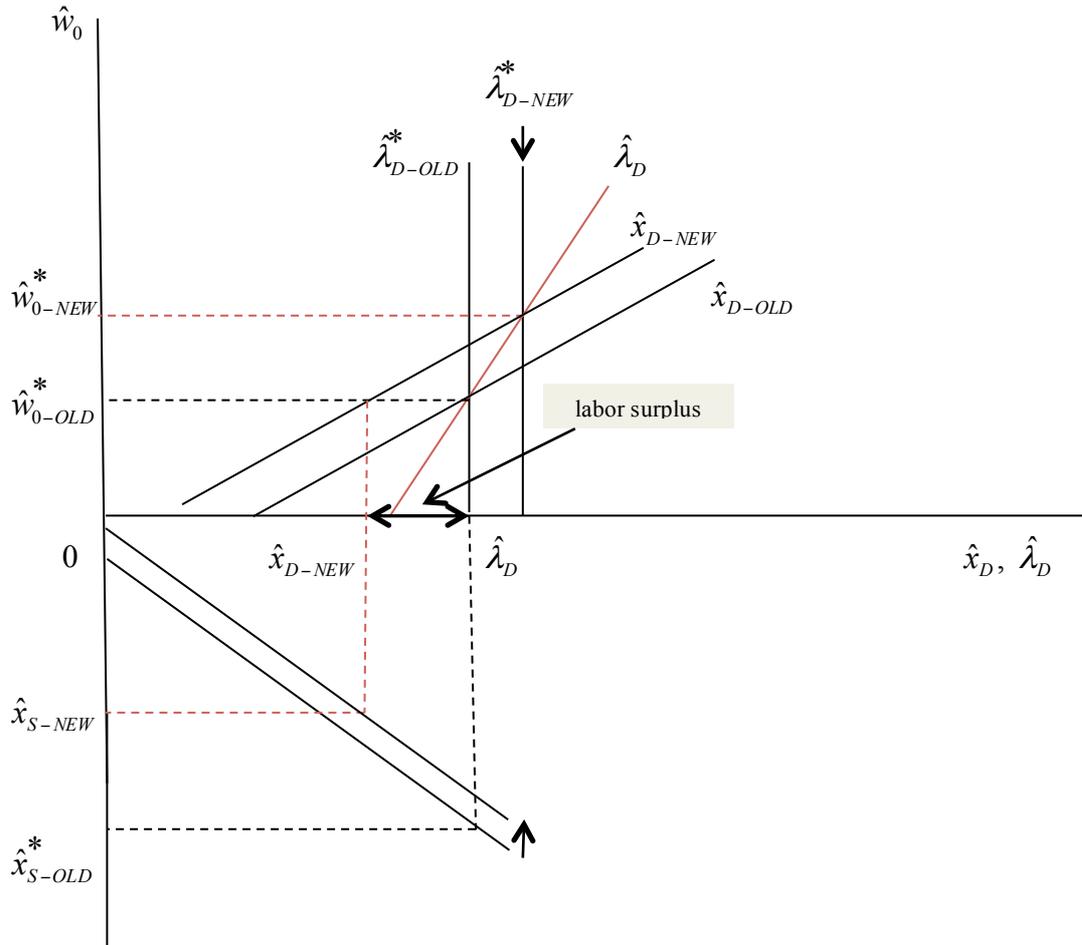
Stagnant-sector labor productivity growth also declines, which is not surprising as surplus workers from the ‘dynamic core’ are finding employment at a time when stagnant-sector output growth is slowing down. Hence, stagnant-sector productivity growth is squeezed from both sides:

$$(24) \quad \frac{d \hat{\lambda}_S}{d \hat{\lambda}_0} = \frac{d \hat{x}_S}{d \hat{\lambda}_0} + (1 - \kappa) \vartheta \frac{d \hat{x}_D}{d \hat{\lambda}_0} - \vartheta < 0$$

Stagnant-sector productivity growth declines more than output growth, since $d\hat{x}_S/d\hat{\lambda}_0 < 0$ from (23) and $d\hat{x}_D/d\hat{\lambda}_0 < 0$ from (19)—as the sector absorbs additional workers. It follows from M8 that the inflow of laid-off dynamic-sector workers causes stagnant-sector real wage

growth to fall; as a result, the real wage inequality between the dynamic and the stagnant sector rises as Figure 7 shows has happened in the U.S. economy.

Figure 9
 ‘Lewis-in-reverse’:
 Unbalanced growth due to robotization and AI



Does the technology-push in the ‘dynamic core’ lead to the ‘cost disease’ predicted by Baumol (1967)? The answer is: it depends on the value of the constant-output own wage elasticity of labor demand, or $(1/\pi)$. If $\pi = 1$, stagnant sector real wage growth declines one-to-one with the rise in stagnant-sector labor force growth, or $d \hat{w}_S / d \hat{\lambda}_0 = -d \hat{\ell}_S / d \hat{\lambda}_0 < 0$, which is a smaller drop (in absolute terms) than the decline in productivity growth $d \hat{\lambda}_S / d \hat{\lambda}_0 = (d \hat{x}_S / d \hat{\lambda}_0) - (d \hat{\ell}_S / d \hat{\lambda}_0)$ because of outcome (23). In this case, unit labor cost in the stagnant sector would rise. But for higher values of π , real wage growth may get

depressed more than productivity growth—and Baumol’s cost disease would not occur. The latter scenario seems likely, also because it implies a rise in the stagnant-sector profit share, which would provide motivation to stagnant-sector firms to hire the additional workers.

The long-run outcome of this process of unbalanced growth and regressive structural change is stagnation. But I note that the short-run outcome is a decline in the potential rate of growth—due to the fact that dynamic-sector productivity growth stays unchanged (notwithstanding the rise in $\hat{\lambda}_0$) and stagnant-sector productivity growth declines (see Appendix). This outcome could well be called *premature stagnation*.

How can one prevent such premature stagnation due to an increase in $\hat{\lambda}_0$? One obvious first step is to break the downward spiral in which declining wage growth feeds into declining demand growth. This could be done by turning \hat{w}_0^* into a wage (growth) floor; this means that $\pi = 0$ in the model. This changes (19) into (19#):

$$(19\#) \quad \frac{d\hat{x}_D}{d\hat{\lambda}_0} = \frac{-(\gamma_D - \gamma_S \vartheta)}{1 - (1 - \kappa)(\gamma_D - \gamma_S \vartheta)} < 0$$

The fall in dynamic-sector demand growth due to robotization is now smaller (in absolute terms) than before (in eq. 19). This in turn means that the dynamic sector will be shedding fewer workers than before. However, while this helps to slow down the process of unbalanced growth, it does not stop it. To have balanced growth, the stagnant-sector wage growth floor needs to be raised in tandem with the rise in $\hat{\lambda}_0$:

$$(25) \quad \frac{d\hat{w}_0^*}{d\hat{\lambda}_0} = \frac{1}{(1 - \kappa)\gamma_S} > 0$$

This would be difficult to do, however, because it would mean that the ‘productivity-growth dividend’ of higher dynamic-sector $\hat{\lambda}_0$ fully accrues to stagnant-sector workers in the form of higher wages. A more realistic and fair solution is to link dynamic-sector real wage growth \hat{w}_D to $\hat{\lambda}_0$, and to fix the floor \hat{w}_0^* in turn to \hat{w}_D (see also Duke 2016) This comes close to Baumol’s assumption of a fixed relative wage ratio between the two sectors. What it does

imply is that there is a need for a permanent incomes policy as part of aggregate demand management along lines proposed by Nicholas Kaldor (1996) in his 1984 *Mattioli Lectures*.⁸

6.4 Implications for monetary and fiscal policy

Faster robotization sets in motion a process of unbalanced growth even if \hat{w}_0^* is turned into a wage (growth) floor. Can we use macroeconomic policy to prevent or mitigate the process of unbalanced growth leading to premature stagnation? The answer is that fiscal and monetary policy can in principle prevent the demand shortfall, consequent upon robotization, and thereby stop the unbalanced growth process. Let me assume that fiscal and monetary policies influence the economy through autonomous demand growth in the usual way: fiscal stimulus and/or lower interest rates raise $\hat{\Theta}_D$, and *vice versa*. Higher $\hat{\Theta}_D$ in turn raises output, productivity and employment growth in the dynamic-sector, since:

$$(26) \quad \frac{d \hat{x}_D}{d \hat{\Theta}_D} = \frac{1}{\Omega} > 0; \quad \frac{d \hat{\lambda}_D}{d \hat{\Theta}_D} = \frac{\kappa}{\Omega} > 0; \quad \frac{d \hat{\ell}_D}{d \hat{\Theta}_D} = \frac{1 - \kappa}{\Omega} > 0$$

where $\Omega = 1 - (1 - \kappa)[\gamma_D - \gamma_S \vartheta(1 - \pi)]$. Dynamic-sector employment growth rises in response to macro stimulus, which raises output growth more than labor productivity growth.

In combination with a wage growth floor \hat{w}_0^* and higher \hat{w}_D , fiscal and/or monetary stimulus should be effective in maintaining ‘balanced growth’ following the increase in $\hat{\lambda}_0$, as it allows dynamic-sector and stagnant-sector firms and workers to share the benefits of the productivity-growth dividend. Depending on the exact balance between productivity growth and wage increases, there may be some additional inflation—quite in line with Baumol’s cost disease prediction. But, recalling Gordon’s (1987, p. 154-155) insight (mentioned earlier), because the rate of potential growth goes up, there may be less inflation than expected—and

⁸ To Kaldor (1996, p. 90), this meant “a system of continuous consultation between the social partners – workers, management and the Government – in order to arrive at a social consensus concerning the distribution of the national income that is considered fair and which is consistent with the maintenance of economic growth, reasonable full employment and monetary stability.”

“the case against demand stimulation must rest on convincing evidence that such policies would create an acceptable acceleration of inflation.” This appears unlikely.

The problem is the proposed stabilization policy runs counter to the ‘rule-based’ policy orthodoxy, which recommends adjusting policy instruments only in response to changes in the ‘output gap’. As explained above, robotization will not just depress *actual* growth (due to the ensuing demand shortfall), but also reduce (aggregate) *potential* growth—because stagnant-sector productivity growth goes down, while dynamic-sector productivity growth stays unchanged. The response by central bankers and fiscal policy-makers will be muted, because they observe what looks like a small increase in the gap between potential and actual growth (as both growth rates go down)—and this will lock the economy in into a path of unbalanced growth. (I note here that model parameter $\vartheta = \ell_D / \ell_S$ goes down as a result of robotization, which reinforces the under-consumptionist tendency, as it structurally lowers the contribution of demand coming from stagnant-sector wages). The risk of self-inflicted damage, due to mistaken policy responses, is higher, because deflationary monetary policy and/or fiscal austerity will always drive \hat{x}_D down more than $\hat{\lambda}_D$. This forces surplus workers from the dynamic sector into stagnant-sector jobs, thereby kick-starting a cumulative process of unbalanced growth in which the dynamic sector sheds labor and the deregulated stagnant sector absorbs labor, but at the cost of depressed wage and productivity growth, which in turn depresses \hat{x}_D more than $\hat{\lambda}_D$.

This way, a *temporary* policy of intentional disinflation by the central bank, pursued to bring higher actual growth down to lower potential growth, can create *long-term* damage in terms of a structural fall in the growth rate of potential output—a real-life phenomenon called ‘super-hysteresis’ by Ball (2014) and Blanchard, Cerutti and Summers (2015).

6.5 *Caveat lector*: what the model is not saying

Let me explicitly state (in seven points) what the paper is not saying, lest the preceding argument be misunderstood. First, the argument of the paper is not that simply raising wage growth for stagnant-sector workers is the magic bullet against unbalanced growth, rising inequality, ‘bullshit’ jobs and secular stagnation of potential growth in the U.S. (Duke 2016).

I wish it were. No, the actual argument on wages is twofold. One, if we intentionally create a segmented economy featuring high and rising inequalities and structurally low wages, it should come as no surprise at all that aggregate productivity growth and potential growth will stagnate—either through slowing down ‘wage-cost induced technical change’, depressing investment growth and embodied technological progress and/or reducing the scope for ‘demand-pull’ innovation. Next, the argument is that a coordinated wage policy could help to keep the economy close to ‘balanced growth’—where ‘coordination’ means keeping dynamic and stagnant-sector real wage growth in line with dynamic-sector ‘technology-push’ $\hat{\lambda}_0$, which is the model’s major dynamic. There is no simple ‘golden rule’ to bring this about, but rather what is needed is the institutionalization of the kind of consultative process as proposed by Kaldor (1996), which should lead to agreement on a fair distribution of national income that is consistent with growth, full employment and monetary stability (see *fn 7*).

Second, the outlook of the paper is not Luddite and the argument is not that “artificial intelligence is taking American jobs”. Technical progress is problematic only when it is left unmanaged—when macro policy is not preventing a demand shortfall and halting the unbalanced growth process in its tracks. The lesson from the model analysis is not that the robots should be stopped, but that we will need to confront the political problems of maintaining demand at the full-employment level, engendering a fair distribution of (wage) incomes across industries (and occupations) necessary for balanced growth, and creating sufficient numbers of ‘good’ middle-class jobs—in turbulent times of technological upheaval (Mishel and Shierholz 2017).

Third, the plea for supportive fiscal policy is not a brief for Big Government, large public deficits and unsustainable public debts. There is nothing in the model to support this inference. Rather, the argument is that we need to make sure that governments carry out their proper macroeconomic role, namely actively managing aggregate demand to keep the economy close to ‘balanced growth’, which is critical in the absence of spontaneous self-correction by the system when it is perturbed by faster robotization. Clearly, for such demand management to be effective, the government needs to be solvent and hence, the spending ambitions of the state need to be matched by adequate fiscal revenues. Keynes (1936) appositely called this ‘the socialization of investment’: the scaling up of (progressive) income taxation to enable effective demand management by public spending at the macro level. This

would mean taxing dynamic-sector profits—which may be sold as ‘taxing the robots’. Keynes’ insight has lost none of its relevance—given the unsettling impacts of dynamic-sector technological progress in the U.S. and other advanced economies.

Fourth, the paper does not analyze the impacts of trade and financial globalization on jobs, wages, growth and technical progress (Eichengreen 2015; IMF 2015). This does not mean that I believe that ‘globalization’ is unimportant and inconsequential. It is clear that the decline in U.S. manufacturing jobs is related to the outsourcing and offshoring of production and greater import competition (Autor, Dorn and Hanson 2013; Pierce and Schott 2016). But the biggest influence of ‘globalization’, captured in the model of this paper, has been to traumatize workers by raising job insecurity and making them resign to smaller wage increases, as Greenspan (1997) noted early on. Globalization thus enabled the establishment of a structurally low-wage-growth regime, in combination with domestic labor market deregulation and de-unionization, which hurt workers in stagnant-sector activities most. Financial globalization, in addition, enabled the rich to have their cake (profits) and eat it (by channeling them to offshore tax havens and/or into newly created derivative financial instruments). This way, trade and financial globalization have been essential building blocks of the dual economy (Temin 2017).

Fifth, the argument is not that people should get more pay for ‘mediocre’ or even ‘bullshit’ jobs. The argument is that higher wages should help create decent, meaningful and stable and less insecure employment in the so-called stagnant sector. The point is not just to create ‘full employment’, but rather to create higher-waged ‘good jobs’, ones that could be made into a career. These non-mediocre jobs may be labor-intensive and therefore low-productive, but ‘low-productive’ does by no means imply ‘socially unimportant’. Actually, most of the work in education, health, social services, public infrastructure building and maintenance (including renewable energy systems to safeguard a non-warming future) and cleaning are underpaid relative to the considerable positive external effects these jobs generate (Thiess 2012).

Sixth, the paper’s argument is not that there is some ‘optimal’ solution to the current dual-economy predicament. The argument instead is that the system is inherently unstable and lacks in-built mechanisms to achieve ‘balanced growth’. One thing is clear though: left to itself, our market economy generates unbalanced growth which undermines, rather than promotes, societal goals that correspond to our values and morals (Temin 2017). Unbalanced

growth is the system's default—and the sensible response to this is to coordinate demand so as to move the economy towards outcomes that are superior to the unmanaged default position.

Finally, I may be accused of being politically naïve and utopian as the argument seems to suggest that such outcome-improving coordination and demand management will be politically possible in the U.S. If this is the accusation, I plead guilty, if only because I think that on present dualizing trends the system cannot preserve its social and political legitimacy for long, which is exactly what Sennett (1998) argued before. There will be change and we had better pro-actively and democratically manage it for the common good—rather than going down the road to a dual economy governed by an ‘illiberal technocracy’ consisting of more, or less, enlightened (Fin-Tech) billionaires.⁹ I do recognize, of course, that, as before, the economics profession is likely to remain motivated “by the internal logic, intellectual sunk capital and aesthetic puzzles of established research programs rather than by a powerful desire to understand how the economy works” (Buiter 2009). It will be hard to change this outlook, which is deeply Panglossian and hostage to TINA—with members of the profession providing sophisticated arguments why the current derailment into unsustainable unbalanced growth is actually still the ‘best of all possible worlds’.

7. Secular stagnation in a dual economy

The secular stagnation of the U.S. economy must be understood as a corollary of the underlying process of dualization. The intentional creation of a structurally low-wage-growth economy, post 1980, has not just kept inflation and interest rates low and led to ‘traumatized workers’ accepting ‘mediocre jobs’ in the stagnant sector—it has also slowed down capital deepening, the further division of labor, and the rate of labor-saving technical progress in the dynamic core (Storm and Naastepad 2012). Household loans and corporate debt, obtained at low interest rates, helped to keep up autonomous demand growth during 1995-2008 and thereby temporarily masked the fact that the U.S. economy was on a long-term downward trend (Charles, Hurst and Notowidigdo 2016). A second factor helping to hide the secular stagnation was the ‘technology push’ originating from the rapid advancement of ICT, AI and robotics—but the technological revolution reinforced the dual nature of the growth process, as

⁹ See Ferguson, Jorgenson and Chen (2017) for a sophisticated econometric analysis of how ‘political money’ is helping finance and big telecom to secure their privileged positions.

it led to labor shedding by the dynamic sector, forced ‘surplus workers’ to find jobs in the stagnant sector and depressed productivity growth in the stagnant sector. Fiscal and monetary policies were far from supporting a shift back to balanced growth—and *de facto* helped the U.S. turn into a dual economy. As the gap between the downward structural trend (and deepened dualism) and debt-financed mass spending bubble became unsustainable, the façade of ‘The Great Moderation’ fell away and the structural problems could no longer stay hidden (Temin 2017).

The model’s main message is that demand growth is likely to be weighed down by ‘robotization’ as it shifts employment from dynamic to stagnant activities, depresses productivity and real wage growth in stagnant activities and raises (wage) inequality. Demand growth, when lowered during a long enough period of time, in turn depresses dynamic-sector productivity growth—and hence potential growth comes down. The short run demand shortfall carries over into the long run and the output gap, the anchor of monetary policy, becomes a moving target. As long as monetary policymakers remain unaware of the endogeneity of their policy anchor, their decisions will contribute to unbalanced growth and premature stagnation. I believe these mechanisms underlie both the secular stagnation and the dualization of U.S. economic growth. The U.S. economy may well be ‘riding on a slow-moving turtle’ (Gordon 2014), but that is because its (monetary) policymakers and politicians have put it there. The secular stagnation is a consequence of ‘unbalanced growth’ and it signals a persistent failure of macroeconomic demand management.

The economy’s *potential* rate of growth is influenced by both supply-side variables (including most prominently dynamic-sector ‘technology-push’ innovation, $\hat{\lambda}_0$) and aggregate demand—which in turn depends on real wage growth and employment growth, income distribution (between sectors), monetary policy, and public and private investment. The secular decline in U.S. labor productivity growth does not constitute an exclusively supply-side problem, as demand and distribution play key roles as well. It is easier to diagnose the problems of ‘unbalanced growth’ and ‘secular stagnation’ than to treat them effectively. I have tried to argue the need for active demand management to keep the economy close to ‘balanced growth’, which is key, since the system does not self-correct when perturbed by faster technical progress. One more thing is clear from the analysis: unless real wages are growing appreciably, it is unlikely that TFP growth and hence *potential growth* will be high.

Higher real wage growth will mean higher inflation—but knowing the societal cost of the ‘low wage/low inflation regime’, Baumol’s ‘cost disease’ should be considered a sign of good health rather than a *pathosis*. What is needed, as argued above, is the establishment of decent minimum wages, the re-institution of ‘normal work arrangements’, and sufficient linkage of wage growth in stagnant-sector activities to wage growth in dynamic-sector activities. Precisely these reforms, implemented during the New Deal era, propelled the U.S. economy into the ‘golden age’ of growth and (almost) full employment of the 1950s and 1960s (Gordon 2015). Hence, we need to ‘manage’ and ‘guide’ the process of technical advance in ways that keep the system ‘balanced’. This can only be done when workers have sufficient ‘countervailing power’ vis-à-vis the powerful vested interests in the dynamic (FinTech) sector (Mishel and Shierholz 2017). In a way, we are back to the times when workers and citizens began to fight back against the excesses of the First Industrial Revolution and for representation—Percy Shelley’s (1819) powerful expression (in “The Mask of Anarchy”) of the task ahead rings true again today:

*“Rise like lions after slumber
In unfathomable number
Shake your chains to earth like dew
That in sleep have fallen on you
Ye are many, they are few.”*

Tellingly, the measures proposed to make robotization work for the common good are the exact opposite of the trade liberalization, labor market deregulation, and business tax reductions proposed by supply-side economists (Eichengreen 2015; Glaeser 2014; Furman 2015), who all believe that potential output is determined by the inexorably exogenous factors of ‘technology’ and ‘demography’. It is high time to write off the intellectual sunk capital invested in this—mistaken—belief. To make America ‘great’ again, it needs to be made ‘whole’ as well.

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Appendix

Sources and methods

The *U.S. Economic Accounts*, compiled and published by the *Bureau of Economic Analysis* (<https://www.bea.gov/>), constitute the source of aggregate and industry-wise data required for the construction of the growth-accounting database for the U.S. economy (1947-2015). The BEA provided time-series information on the following variables: nominal GDP at factor cost; real GDP at factor cost (at constant 2009 U.S. dollars); nominal compensation of employees; and net real capital stock (at constant 2009 U.S. dollars). The BEA also provided aggregate and industry-wise data for the period 1948-2015 on ‘hours worked’ and ‘full-time & part-time employees’. The number of ‘hours worked’ for the base-year 1947 was imputed using industry-wise data on hours worked in Jorgenson, Ho and Samuels (2012). For the years 1947-1999, the ‘hours worked’ in WRT, ‘Information’, PBS, EHS and the ‘Rest’ were estimated based on BEA data on ‘full-time & part-time employees’ for these industries; the assumption is that the average number of hours worked per employee did not change significantly differently across these industries over this period. All other variables, including real compensation of employees, real profit income, the wage share, the profit share, labor productivity per hour worked, capital productivity per unit of net real capital stock, capital-intensity and TFP were calculated using the BEA numbers—based on the definitions given in the main text. Note that all factor incomes were deflated using the GDP deflator, as per equation (8). This not only ensures additivity of productivities across industries but it is also consistent with the fact that the only empirically meaningful interpretation of TFP growth is in terms of factor payments growth (as per equations 9 and 10; see Shaikh 1974; Rada and Taylor 2006). *Figure 4*: Data on union membership (1948-2003) as a percent of employed workers are from Mayer (2004); data on union membership for recent years are from *Bureau of Labor Statistics*.

Notes on the equations

Derivation of equation M1: In equations M1 it is assumed that the demand growth for dynamic-sector goods and services \hat{x}_D is a linear positive function of aggregate real wage-income growth. Aggregate real wage-income consists of real wage-incomes earned in the dynamic sector and the stagnant sector, or $y = y_D + y_S = w_D \ell_D + w_S \ell_S$. In growth rates this gives:

$$(A.1) \quad \hat{y} = \Phi_D(\hat{w}_D + \hat{\ell}_D) + \Phi_S(\hat{w}_S + \hat{\ell}_S)$$

where Φ_D =the share of dynamic-sector real wage-income in aggregate real wage income, and Φ_S =the share of stagnant-sector real wage-income in aggregate real wage income. Using (A.1) and assuming that \hat{x}_D is a linear function of \hat{y} (with income elasticity of demand θ_D):

$$(A.2) \quad \hat{x}_D = \theta_D \hat{y} = \gamma_D (\hat{w}_D + \hat{\ell}_D) + \gamma_S (\hat{w}_S + \hat{\ell}_S)$$

where $\gamma_D = \theta_D \Phi_D$ =the dynamic-sector wage-income elasticity of demand for dynamic-sector goods, weighed by Φ_D ; and $\gamma_S = \theta_S \Phi_S$ =the stagnant-sector wage-income elasticity of demand for dynamic-sector goods, weighed by Φ_S . Equation M5 can be derived in a similar manner.

Derivation of π : Let me denote the constant-output own wage elasticity of labor demand by $(1/\pi)$ and define the following standard labor demand function (in growth rates):

$$(A.3) \quad \hat{\ell}_{DEMAND} = c - (1/\pi) \hat{w}_S$$

According to my estimates (under Figure 3), $(1/\pi) = 0.5$ (see also Gordon 1987; Lichter, Peichl and Siegloch 2014) and hence $\pi = 2$. If we assume that all workers have to find a job and labor supply must equal labor demand, then we can rewrite (A.3) as follows:

$$(A.4) \quad \hat{w}_S = \pi c - \pi \hat{\ell}_S == \hat{w}_0 - \pi \hat{\ell}_S$$

This is equation (M8).

Aggregate labor productivity growth under balanced growth: Total output is the sum of dynamic-sector output and stagnant sector output, or $x = x_D + x_S$. If one divides both sides of this identity by the total labor force ℓ one obtains aggregate labor productivity:

$$(A.5) \quad \lambda = \frac{x}{\ell} = \eta_D \lambda_D + \eta_S \lambda_S$$

where $\eta_D = \ell_D / \ell$ and $\eta_S = \ell_S / \ell$. Under balanced growth ℓ_D and ℓ_S are constant, and hence the employment share η_D and η_S are constant as well. This means that aggregate labor productivity growth is defined as:

$$(A.6) \quad \hat{\lambda} = \eta_D^* \hat{\lambda}_D + \eta_S^* \hat{\lambda}_S$$

where $\eta_D^* = \eta_D / \lambda$ and $\eta_S^* = \eta_S / \lambda$. Since both dynamic-sector and stagnant-sector labor productivity growth are constant under balanced growth (see equations 15 and 17), aggregate productivity growth is constant as well.

A note on relative price change: In (M1) the impact on demand of a change in the dynamic-sector price (p_D) relative to the stagnant-sector price (p_S) was omitted. A first reason to do so is that p_D is unlikely to change in response to an increase in $\hat{\lambda}_0$ since empirically $\gamma_D - \gamma_S \vartheta(1 - \pi) = 1$ (see Note to Table 10). p_S may decline in response to an increase in $\hat{\lambda}_0$ if stagnant-sector real wage growth declines more than stagnant-sector labor productivity growth. In that case, the relative price (p_D / p_S) would rise and depress the growth of \hat{x}_D . This would mean the stagnationist tendencies triggered by the increase in $\hat{\lambda}_0$ would become even stronger than the model now ‘predicts’. There is a further reason why the relative price impact of an increase in $\hat{\lambda}_0$ is difficult to predict, namely: dynamic-sector firms operate under conditions of monopolistic competition and have the market power to raise their mark-ups. Barkai (2016) and Cooper (2016) provide empirical evidence on raising mark-ups. These findings underscore the fact that, even if dynamic-sector firms manage to reduce their unit labor costs, this does not necessarily show up in lower prices.