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# Growth is wage-led in the long run*

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**Abstract**

The literature on the empirical linkages between economic growth (or other measures of macroeconomic performance) and the functional distribution of income is copious on the short run. The sustained and simultaneous decline in average rates of real GDP growth and the labor share of income in the US in recent decades has led to renewed interest in the long run, in light of the hypothesis of inequality-induced secular stagnation. This paper employs a vector error correction model with time-varying parameters and stochastic volatility to estimate the long run interaction between real GDP growth, labor share and the unemployment rate. Our key result indicates that a lower labor share is associated with a decline in the growth rate: economic growth is wage-led in the long run.

**Keywords**: Growth and distribution; stagnation; demand regime.
**JEL Classification**: C32, E12, E25, E32, O40.

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# 1 Introduction

The empirical relationship between economic growth and income distribution has long been a central focus in classical and post-Keynesian literatures that view distributional conflict as integral to the dynamic evolution of capitalism. While extensive research has examined the short-term or cyclical interactions between growth and distribution, their long-term interplay remains comparatively underexplored. Questions about the long run have taken on new weight, given the sustained decline of the labor share and simultaneous persistent weakness in macroeconomic performance.

This paper aims to fill the gap. In short: we employ a vector error correction model with time-varying parameters and stochastic volatility to robustly estimate the long-run interaction between the rate of growth of real GDP, the labor share of income and the rate of unemployment in the post-war US macroeconomy. Our key finding suggests that the sustained, secular decline of the labor share is strongly associated with a sustained, secular decline in the growth rate—or, put differently: that growth is wage-led in the long run.

Specifically, a one percentage point reduction in the labor share goes hand in hand with a decrease in the rate of growth of real GDP ranging from approximately 0.25 to 0.40 percentage points in the long run. This relationship is statistically significant until the mid-Seventies, and increasingly so again since the mid-Nineties. This result points towards possibilities of progressive policy-making. The present study does not investigate specific policy levers, but makes an incremental step towards analysis of the transmission mechanism.

Two main hypotheses exist. First, Blecker (2016) argues that while growth may be profit-led in the short run, persistent consumption effects render it wage-led over the long run (Dutt, 1984; Lavoie, 1996). Second, recent neo-Goodwinian literature also sees the short run as profit-led but attributes the long-run wage-led dynamic to induced technical change (Petach and Tavani, 2020; Rada et al., 2021, 2023; Tavani and Zamparelli, 2025).

To test these two hypotheses, we replace real GDP growth in our baseline model with (i) real consumption growth and (ii) labor productivity growth. Our results show that long-run consumption growth mirrors GDP growth: it is wage-led and statistically significant for most of the sample. Labor productivity growth is also wage-led but becomes statistically significant only after 2000. We see this as a first test of the relative importance of 'consumption versus induced technical change.'

The rest of this paper is structured as follows. Section 2 provides theoretical discussion and motivation, and summarizes relevant empirical literature. Section 3 motivates our empirical approach, and presents core results of the baseline estimations. Section 4 explores the relevant transmission mechanisms. Section 5 contextualizes these findings, and a final Section 6 concludes the paper.

# 2 Background and motivation

To motivate our approach, let us first consider theoretical foundations, and take the Cambridge equation as starting point (Foley et al., 2019). In a classical long period equilibrium, the rate of utilization is at its normal level and the functional distribution of income is predetermined (or conventional). Correspondingly, the profit rate is at its normal level, and, given the savings rate, constrains the rate of accumulation. *Ceteris paribus*, a higher profit share, an improvement in "capital productivity," or an increase in the savings rate could increase it. Clearly, the classical baseline implies that the long run is profit-led.

The original growth cycle of Goodwin (1967) adds a theory of short-run business cycles. This predator-prey model in labor share and employment rate, with a weak form of Say's Law and constant income-capital ratio, is built around profit-squeeze distribution and (short-run) profit-led accumulation and generates a recurring cycle. In the long run, the classical Cambridge equation rules, and warranted and natural rates of growth converge (on average). Specifically, in response to a rise of the exogenous rate of labor productivity growth, profit share and steady state growth increase simultaneously.

Neo-Kaleckian authors, in contrast, have long argued that economic growth instead is likely to be wage-led. Dutt (1984) presents an important early contribution that draws on the notion of a realization crisis. In Dutt's model, savings and investment decisions are independent of each other, so that the rate of utilization becomes the closure variable in the Cambridge equation. Further, the accumulation function implies that a higher labor share increases the rate of economic growth. Bhaduri and Marglin (1990) relaxed key assumptions of this type of framework, which allowed for both wage and profit-led regimes to arise.

Crucially, neither authors focused on a cyclical propagation mechanism. Indeed, Stockhammer (2017a, p. 30) notes that "there is no canonical Kaleckian business cycle model," although investment decisions and their interaction

with productive capacity as well as financial variables—rather than the labor share—tend to assume a central role. Further, Kalecki himself famously argued that the long run is nothing but a sequence of short runs, and that "it has no independent entity." This can be seen as by design, and a strength, but in response to critiques, Lavoie (1996) developed hysteretic models that converge to a long-run equilibrium. Crucially, both traverse and long period feature wage-led demand, i.e. a dominant effect of redistribution towards labor on consumption.[1]

These approaches contrast starkly. In Goodwin (1967), technological conditions fully determine the labor share, short and long-run economic growth are profit-led, and only "manna from heaven" can alleviate relevant constraints. In Lavoie (1996), the labor share is exogenous but institutionally determined, short and long run are wage-led, and "demand policy from government" can help attain preferable equilibria.

Recent (neo-)Goodwinian literature has put a twist on this. Two versions exist; both draw on the idea of induced technical change. First, Shah and Desai (1981) augmented Goodwin's original, to incorporate a Kennedy-Weizsäcker-style innovation possibility frontier, which implies that the rate of labor productivity growth and therewith the rate of natural growth becomes an increasing function of the labor share. However, as in the original, the distribution of income is still fully determined by technology—in this case, the curvature of the innovation possibility frontier.

Petach and Tavani (2020), in an extended model with induced technical change that additionally addresses the distribution of wealth, introduced the assumption that labor market bargaining institutions affect the steady state labor share. In consequence, labor suppression and a concomitant decline in the labor share reduces the steady state rate of economic growth: growth is wage-led in the long run. For further theoretical research along such classical lines, see Michl and Tavani (2022).

Second, Barbosa-Filho and Taylor (2006) reimagined Goodwin's original, around a demand-determined rate of capacity utilization and an institutionally determined labor share of income (see also Flaschel, 2009, 2015). Rada et al. (2021) extended and simplified this model, to focus on Harrodian growth rates and

[1]The "Sraffian Supermultiplier" (SSM) approach presents another important strand of literature in heterodox macroeconomics. It features a wage-led rate of utilization in the short run, but the growth rate in steady state is independent of the functional distribution of income (Freitas and Serrano, 2015, p. 259). Hence, SSM does not speak to the issue at hand and we will not consider it further here.

a clear distinction between short and long run. Crucially, in their framework, growth is also wage-led in the long run, through an effect akin to induced technical change from the labor share on the natural rate of growth. For a juxtaposition of the classical and Keynesian version of this model, see Rada et al. (2023); and for a recent contribution with demand-led secular stagnation that incorporates wealth accumulation, see Tavani and Zamparelli (2025).

In summary, the classical, savings-driven, supply-constrained Cambridge equation represents the baseline, with growth being profit-led in the long run. Conversely, neo-Kaleckian and neo-Goodwinian theories posit that growth is wage-led in the long run. Importantly, neo-Kaleckians assume that this arises due to the effect of redistribution on consumption, whereas neo-Goodwinians assume it is due to the effect of redistribution on labor productivity growth. Blecker (2016) contains an influential exposition of the hypothesis that consumption effects matter in the long run. In other words, the former literature situates the mechanism on the demand side, and the latter situates it on the supply side—independently of whether closure choices make the model demand or supply-determined itself.

We can now proceed to consider empirical findings. The literature is voluminous and we will not review it in detail. A categorization might begin with evidence on the short-run interaction between growth (or other measures of macroeconomic performance) and the functional distribution of income. Barrales et al. (2022) presents a survey and exemplary vector autoregressions (VARs) that support the neo-Goodwinian assertion of profit-led economic activity and profit squeeze distribution for the US macroeconomy.[2] Blecker et al. (2022), in contrast, find the short run to be wage-led in their "non-cyclical" (p. 391) application of the general method of moments to US post-war data. Marques and Lima (2022) conduct Granger causality tests in quantiles between the wage share and capacity utilization in twelve developed countries using annual data ranging from 1960 to 2019, and report results consistent with profit-led utilization and profit-squeeze wage share.

A second strand of the empirical literature investigates changes in the patterns of the short-run interaction between growth and distribution. An early example is Carvalho and Rezai (2016), who estimate a threshold VAR and find that the US economy became more strongly profit-led with the rise in income

[2]Section 5.1 of this paper includes a financial state variable in a VAR exercise, which also finds statistically significant profit-led and profit-squeeze effects. No evidence in favor of a pseudo-Goodwin cycle exist, although it is a theoretical possibility (Stockhammer and Michell, 2017; von Arnim and Eick, 2025).

inequality after 1980. Other papers consider sample splits for the "golden age" and the "neoliberal era," and weigh the differential findings (Mendieta-Muñoz et al., 2022; Barrales et al., 2023). Barrales-Ruiz and Mendieta-Muñoz (2024) conduct quantile vector autoregressions in this manner. Overall, this literature finds important reductions of the profit-led effect during the "neoliberal era," while the change in the profit squeeze effect is comparatively more heterogeneous.

A further line of investigation in this area employs time-varying parameter (TVP) regressions. Marques (2022) finds profit-led capacity utilization for the US. Carillo-Maldonado and Nikiforos (2024) report a substantial weakening of this effect over the post-war era. Barrales et al. (2024) extend TVP analysis to incorporate the profit squeeze, and also document an overall weakening of cyclical propagation. Setterfield (2023) provides further impetus to investigate the changing nature of labor bargaining institutions in this context.

A third strand of empirical research is concerned with the long-run interaction between growth and distribution itself. We first note that there is a large and rapidly growing literature that seeks to explain the precipitous secular decline in advanced countries' (and in particular the US's) labor share of income (Elsby et al., 2013; Rognlie, 2015; Stockhammer, 2017b; Koh et al., 2020). For our purposes, empirical evidence that directly links the decline in the labor share to macroeconomic performance is more immediately relevant.

Kiefer and Rada (2015), for example, show evidence for the persistence of the Goodwin pattern around a deteriorating steady state. Kiefer et al. (2020) estimate the decline of the 'potential' rate of growth, conditional on the decline of the labor share. Barrales and von Arnim (2017) and Santos and Araujo (2020) report bivariate Granger tests on wavelet components, which indicate a statistically significant relationship between measures of macroeconomic performance and the labor share in the long run. Though the details in these frequency domain analysis studies differ, Charpe et al. (2020) and Santos and Araujo (2020) specifically conclude that the long run is wage-led (see also Barrales et al., 2022, Sec. 4.2). Further, employing a vector error correction model on US post-war times series, Cruz and Tavani (2023) find evidence that the employment rate is wage-led in the long run.

# 3 Investigating the long-run effects

This section presents our main contribution. We estimate a vector error correction model with time-varying parameters and stochastic volatility (TVP-

VEC-SV) to identify the long-run interaction between the rate of growth of real GDP, the labor share of income and the rate of unemployment. Our core result indicates a positive association between the labor share and economic activity in equilibrium: growth is wage-led in the long run.

The sample consists of the rate of growth of real GDP $g_t$, the labor share of income $\psi_t$ and the rate of unemployment $u_t$, and covers the period 1948:Q1–2023:Q4. Our measure of $g_t$ corresponds to the percentage quarter-on-quarter growth rate of real GDP obtained from the Federal Reserve Economic Data (FRED) database of the Federal Reserve Bank of St. Louis. The labor share $\psi_t$ corresponds to the percentage labor share of income for all employed persons of the nonfarm business sector obtained from the Bureau of Labor Statistics (BLS). Lastly, we utilized the official unemployment rate, also obtained from the FRED database, which corresponds to the U-3 measure of labor underutilization of the BLS' Current Population Survey.[3]

To begin, we provide a descriptive but informative statistical analysis that highlights the potentially relevant long-run interactions between the two key variables, $g_t$ and $\psi_t$. Figure 1 plots the averages of both $g_t$ and $\psi_t$ over seven non-overlapping subsamples, as well as a scatter plot of these seven averages of $g_t$ against the corresponding values for $\psi_t$. Each of the seven subsamples contains eleven years—the only exception being the last subsample (2014:Q1-2023:Q4), which contains ten years. Our objective is to illustrate the history of interactions occurring at lower frequencies than the business cycle, thereby capturing the potential long-term dynamics between growth and distribution.

**[Insert figure 1 about here]**

We observe a clear downward trend in the long-run averages of $g_t$ and $\psi_t$ over the sample period. The relationship between these long-run averages is further illustrated by the scatter plot and regression line. As summarized in Table 1, the regression analysis indicates that economic growth responds positively and significantly to changes in the labor share: in the long run, a one percentage point decline in $\psi_t$ is associated with a 0.24 percentage point decrease in $g_t$.

In summary, the strong positive association between growth and the labor share is evident both in the raw data and in a simple regression analysis. Indeed, this very observation has sparked discussions in the literature about a potential causal link, particularly the hypothesis of inequality-induced secular

[3]The FRED series codes are GDPC1, PRS85006173, and UNRATE, for real GDP, so-called 'headline' labor share and civilian unemployment rate, respectively. Note that FRED reports the labor share only as an index, but the BLS issues the percentage series.

stagnation (Hein, 2016; Kiefer et al., 2020; Rada et al., 2023; Tavani and Zamparelli, 2025).

**[Insert table 1 about here]**

Building on this preliminary analysis, we now conduct a more comprehensive investigation of the long-run effects of the labor share on economic growth. To achieve this, we adopt an empirical framework that: (i) distinguishes between short-run and long-run dynamics within a dynamic model, and (ii) accounts for potential time-varying long-run interactions between the variables. We estimate a TVP-VEC-SV model using the Bayesian methods developed by Koop et al. (2011), which allows for the possibility of time-varying cointegration. Appendix A provides technical details on this class of models, and Appendix B offers an overview of the Bayesian sampling algorithm employed.

**[Insert figure 2 about here]**

Our preferred TVP-VEC-SV model includes three variables: $\psi_t$, $g_t$, and the unemployment rate, $u_t$. This choice is motivated by two main reasons. First, in our empirical applications, we found that incorporating $u_t$ was essential to obtaining theoretically consistent estimates across all estimated TVP-VEC-SV models.[4] Second, including $u_t$ aligns the model specification more closely with the concept of the natural rate of growth. This would be consistent with Okun's law as a statistical tool for estimating long-run output growth rates (see Li and Mendieta-Muñoz, 2020, among others), and would also be consistent with the typically three-dimensional neo-Goodwinian theoretical framework (for examples, see Rada et al., 2021, 2023).[5]

We summarize our main results by examining the two key coefficients in the cointegrating vector, derived from an appropriate linear normalization.

[4]Initially, we estimated a TVP-VEC-SV model with only $g_t$ and $\psi_t$, yielding results similar to those presented in this section. However, when we attempted to analyze long-run effects using specifications akin to those in Section 4, we found that the impact of $\psi_t$ on $g_t$ could not be explained by the dynamics of productivity or consumption unless $u_t$ was included in the estimation. We interpret this as indirect evidence that incorporating $u_t$ helps to better discipline the empirical model. The results from TVP-VEC-SV models excluding $u_t$ are available upon request.

[5]Further, we note that a classically trained econometrician would typically first test whether the variables in the model are $I(1)$—that is, integrated of order one—before testing for cointegration in the TVP-VEC-SV model. However, as discussed by Sims (1988), Bayesian inferential theory for dynamic models remains largely unaffected by the presence of unit roots. This suggests that unit root econometrics are generally not relevant from a Bayesian perspective, as also demonstrated in the empirical application by Koop et al. (2011); see also Koop et al. (2009).

Let $y_t = (\psi_t, g_t, u_t)'$ represent the vector of endogenous variables, and let $\beta_t^* = (\beta_{1,t}^*, \beta_{2,t}^*, \beta_{3,t}^*)'$ denote the unrestricted matrix (without imposed identification) of cointegrating vectors in the TVP-VEC-SV model. We define $B_{1,t} = -\beta_{1,t}^*/\beta_{2,t}^*$ and $B_{3,t} = -\beta_{3,t}^*/\beta_{2,t}^*$, which implies a linear normalization of the cointegrating vector such that $g_t$ is the dependent variable in the long-run relationship:

$$g_t = B_{1,t}\psi_t + B_{3,t}u_t. \tag{3.1}$$

This normalization is appropriate because our primary interest lies in assessing the long-run effect of $\psi_t$ on $g_t$, that is, the impact of the labor share of income on the rate of growth of real GDP. In this context, the time-varying parameter $B_{1,t}$ measures the long-run sensitivity of $g_t$ to $\psi_t$, while $B_{3,t}$ captures the long-run sensitivity of $g_t$ to $u_t$. Figure 2 presents the posterior medians of $B_{1,t}$ and $B_{3,t}$.

First, we observe that the posterior median of $B_{1,t}$ exhibits significant time variation but remains consistently positive. Moreover, its credible interval does not enclose the zero line for most of the sample period, except between the mid-1970s and mid-1990s. These findings suggest that the long-run effect of $\psi_t$ on $g_t$ is predominantly positive—indicative of a long-run wage-led effect—and that this effect is statistically different from zero.

Second, the posterior median of $B_{3,t}$ also varies over time and remains consistently negative. This suggests the existence of a long-run Okun coefficient. However, its credible interval encloses the zero line for most of the sample period, with the exception of the 1990s. These results indicate that although the long-run effects associated with Okun's law are generally not statistically different from zero, their significance appears to have increased over time.

# 4 Exploring the long-run effects

In this section, we present key findings that enhance our understanding of the effects discussed in the previous section. To recap, Section 3 provided evidence that increases in $\psi_t$ are associated with increases in $g_t$, supporting the existence of a long-run wage-led effect. To further investigate this relationship, we examine two potential transmission channels. We emphasize that we see this as a first step and certainly not the last word in exploring competing hypotheses.

First, following Blecker (2016), we explore the role of consumption growth. A higher $\psi_t$ implies a greater economy-wide marginal propensity to consume,

and therefore greater aggregate consumption, for two main reasons. Middle- and working-class households in the USA predominantly spend their wage income on current consumption, whereas wealthier households—such as rentiers receiving dividends and interest—exhibit higher savings rates (see Carvalho and Rezai, 2016, for evidence). Additionally, firms retain a portion of profits to finance investments or other activities (e.g., stock buybacks, mergers, and acquisitions), with retained earnings recorded as corporate savings in the National Income and Product Accounts (NIPA).

A secular change in $\psi$ has a secondary effect on long-run consumption growth via changes in the distribution of wealth. The more unequal wealth is distributed the lower consumption growth is expected to be. All in all, what Blecker (2016) proposes is a demand-side mechanism linking the labor share of income and long-run growth via consumption growth.[6]

Second, following Rada et al. (2021, 2023) and related literature, we consider the induced technical change effect. This mechanism suggests that higher real wages relative to labor productivity incentivize profit-maximizing firms to reduce labor costs, thereby influencing the direction of technical change. Consequently, there exists a positive relationship between $\psi_t$ and productivity growth *in steady state*.

Our primary objective is to analyze the impact of $\psi_t$ on consumption and productivity growth. To this end, we estimate two separate TVP-VEC-SV models. The first model incorporates $y_{c,t} = (\psi_t, c_t, u_t)'$, where $c_t$ represents the percentage quarter-on-quarter growth rate of real consumption. The second model includes $y_{a,t} = (\psi_t, a_t, u_t)'$, where $a_t$ denotes the percentage quarter-on-quarter growth rate of labor productivity.[7]

**[Insert figure 3 about here]**

**[Insert figure 4 about here]**

[6]Engel effects might be an additional mechanism at play here. Due to non-homothetic preferences, a secular decline in $\psi$ could be expected to lead to changes in patterns of consumption and therefore production, as relatively poorer wage-income households start to dominate overall consumption. These households may spend most of their income on necessities rather than goods and services produced by technologically advanced sectors, thus stunting expansion of these 'growth-driving' sectors.

[7]The real consumption series was constructed using NIPA data from the Bureau of Economic Analysis (BEA): nominal personal consumption expenditures from Table 1.1.5., divided by its implicit price deflator from Table 1.1.9. The labor productivity series corresponds to the output per hour index (2017=100) for the nonfarm business sector from the BLS. Thus, $c_t$ and $a_t$ reflect the percentage quarter-on-quarter growth rates of real consumption and labor productivity, respectively.

Using a linear normalization of the cointegrating vector, as implemented in Section 3, we specify $c_t$ as the dependent variable in the long-run relationship for the model including $y_{c,t}$, yielding the equation: $c_t = B_{1,c,t} * \psi_t + B_{3,c,t} * u_t$. Similarly, for the model including $y_{a,t}$, we define $a_t$ as the dependent variable: $a_t = B_{1,a,t} * \psi_t + B_{3,a,t} * u_t$. Our primary focus is on the time-varying parameters $B_{1,c,t}$ and $B_{1,a,t}$, which measure the long-run sensitivity of $c_t$ and $a_t$ to $\psi_t$, respectively.

Figure 3 presents the posterior medians of $B_{1,c,t}$ and $B_{3,c,t}$, while Figure 4 depicts the posterior medians of $B_{1,a,t}$ and $B_{3,a,t}$.

Key results can be summarized as follows. The posterior median of the time-varying effect of the labor share on consumption growth, $B_{1,c,t}$ in Figure 3, varies over time but remains consistently positive. Its credible interval excludes zero, except from the late 1970s to the early 1990s. This indicates that the long-run effect of $\psi_t$ on $c_t$ is generally positive and statistically significant. Notably, the trajectory of $B_{1,c,t}$ closely mirrors that of $B_{1,t}$ from the previous section, with similar magnitudes.

The posterior median of the time-varying effect of the labor share on labor productivity growth, $B_{1,a,t}$ in Figure 4, is generally positive, though its credible interval includes zero for most of the period, except from the early 2000s onward. This suggests that while the ITC effect tends to be positive, it has only been statistically significant in recent decades. Moreover, $B_{1,a,t}$ is smaller in magnitude compared to both $B_{1,t}$ and $B_{1,c,t}$.

Additionally, the parameters $B_{3,c,t}$ and $B_{3,a,t}$, which measure the long-run sensitivity of $c_t$ and $a_t$ to the unemployment rate $u_t$, tend to be negative and time-varying. The credible interval for $B_{3,c,t}$ excludes zero since the mid-1980s, highlighting an increasing inverse relationship between $u_t$ and $c_t$. This trend could reflect the growing impact of declining disposable income due to job losses, decreasing consumer confidence, and could be interpreted as long-run reverse multiplier effects.

The credible interval of $B_{3,a,t}$ has excluded zero since the mid-1960s, indicating a strengthening inverse relationship between $u_t$ and $a_t$. This trend is possibly driven by the progressive skill deterioration of workers. Extended unemployment or labor force withdrawal of discouraged workers leads to skill erosion, particularly in rapidly evolving technological sectors. When these workers re-enter the labor force, their productivity is lower due to outdated skills and lack of recent experience. This finding aligns with recent discussions on the growing importance of hysteresis effects in the U.S. labor market (see Li and

Mendieta-Muñoz, 2024; Furlanetto et al., 2025, for recent research).

# 5 Discussion and implications

In this section, we summarize and contextualize the empirical findings of the preceding sections. First, our core result of Section 3 indicates a time-varying wage-led effect in the long run, i.e. a positive response of $g_t$ to $\psi_t$ in equilibrium. Crucially, our empirical findings denote that this positive response of the rate of growth to the labor share has historically been statistically different from zero. The period from the mid-1970s to the mid-1990s proves the exception. Interestingly, this period corresponds to the transition from the golden age to neoliberal capitalism in the US. The loss of significance may reflect a structural break associated with this transition, although further research is needed to explore this hypothesis.

Over the course of the post-war era, a one percentage point decrease in $\psi_t$ is associated with a decrease in $g_t$ ranging from approximately 0.25 to 0.40 percentage points in the long run. In the context of the methodology applied here, the estimated long-run relationship represents the equilibrium toward which the system's variables converge over time. In this sense, the long-run equilibrium tends to be wage-led. The slow-moving trajectory of this relationship underscores its long-term nature.

Importantly, evidence of a long-run wage-led effect reported here is not in contradiction with the short-run profit-led effect, which remains an established finding in previous literature that also employs dynamic model estimation (Blecker, 2016; Barrales et al., 2022, 2024). However, studies in this literature typically rely on recursive (lower-triangular Cholesky decomposition) identification strategies within vector autoregression models. While informative, these methods capture only short-run dynamic interactions. In contrast, our use of a TVP-VEC-SV model allows us to distinguish between short-run dynamics and the potentially distinct long-run equilibrium that governs the system. Our core result indeed suggests that the US economy is profit-led in the short run, but wage-led in the long run.

Further, this core result is estimated based on a sample that is dominated by a simultaneous long-term decline in real GDP growth and the labor share of income. This raises the question whether the effect is potentially different for sustained decreases (as observed in the sample) or increases (as *not* observed in the sample) of the labor share. For the sake of the argument, suppose that there is a long period labor share that appropriately reflects technology,

institutions, and the corresponding necessary social consumption to reproduce labor power. Additionally, suppose that the US golden age labor share was—roughly—at this level. Our methodology and the available sample then indicate that a decline of the labor share from this level erodes and weakens growth.

However, it could be seen as a stretch to argue on the basis of the available sample that an increase from such a level would lead to faster growth. Instead, the literature in the Seventies suggested that capitalist crises were partially due to a secular (rather than cyclical) profit squeeze.[8] Independently of this question, our core result suggests that a secular increase and "recovery" of the labor share should have a positive impact on long-run growth.

Section 4 offers a first attempt to investigate the transmission mechanism of the time-varying long-run wage-led effect. In summary, we find a positive impact of the labor share $\psi_t$ on both consumption growth $c_t$ and labor productivity growth $a_t$, where, however, the effect of $\psi_t$ on $c_t$ is more pronounced and more strongly significant than its effect on $a_t$. To utilize the same estimation structure as for our core result in Section 3, we substituted growth rates of consumption and labor productivity for that of real GDP. In light of limited degrees of freedom in the sample and resulting constraints to run the TVP-VEC-SV, and as a first step, we believe that this is justifiable.

However, the consumption series exhibits covariance with the real GDP series that is more than twice as strong as that of the labor productivity series.[9] In other words, the fact that consumption represents an expenditure component of real GDP might bias these results, especially since the rate of growth of real GDP is not any longer included in the estimations of Section 4. Put simply, when excluding GDP from the model, consumption mimics its dynamics more closely than that of labor productivity. Future research should further explore the "consumption vs. ITC" transmission mechanism and evaluate the

[8]Controversy over the measurement of the labor share presents a further complication. As with the measurement of the profit rate, no consensus on a preferable approach exists. Crucially, short-run fluctuations of the labor share remain unaffected by measurement choices, but long-run trends are not. The labor share could be measured gross or net, and include or exclude (portions of) the income streams of the self-employed or the top sliver of salary earners (which are biased by stock boni, and, arguably, rents), etc. See Elsby et al. (2013); Mendieta-Muñoz et al. (2021) for discussions and references on these issues. Barrales et al. (2022, p. 476ff) specifically emphasize that measurement choices make the long-run pattern of the US post-war labor share either "hump-shaped" or "stable-then-downward."

[9]The correlation coefficient of $g_t$ with $c_t$ and $a_t$ is 0.81 and 0.37, respectively. The covariance of $g_t$ with $c_t$ and $a_t$ is 4.58 and 1.75, respectively.

robustness of the findings presented here.[10]

Similarly, the present study does not develop an argument regarding specific policy levers. Mendieta-Muñoz et al. (2022), among other research, suggest that the decline of the labor share throughout the neoliberal era is largely due to adverse shocks to the institutions that govern real wage bargaining. In other words, deregulation of labor markets in general and weakening of pro-labor institutions in particular appear to be key factors in the secular downward trend of the labor share of income (see also Setterfield, 2023).

Elsby et al. (2013) place emphasis on offshoring and globalization more broadly as a key determinant. Mendieta-Muñoz et al. (2021) document the importance of structural change, i.e. the pronounced shift in employment from manufacturing and other "progressive activities" to stagnant services. Autor et al. (2020) put forth data that highlights tendencies for sectoral concentration in value added. Stockhammer (2017b) additionally find financialization to matter greatly—and the list goes on. Further research could seek to identify specific factors, policies and institutions that have driven the labor share down over recent decades *within the confines of a macroeconometric dynamic model*, and potentially explore the question which levers might reverse its precipitous decline.

# 6 Concluding remarks

This study contributes to the understanding of the long-term empirical relationship between economic growth and income distribution, an area still comparatively underexplored in classical and post-Keynesian literatures. Using a vector error correction model with time-varying parameters and stochastic volatility, we find evidence that the sustained decline in the labor share has led to a lower growth rate: the long run is wage-led.

Specifically, a one percentage point decrease in the labor share is associated with a 0.25 to 0.40 percentage point decrease in real GDP growth over the long run. This relationship is statistically significant until the mid-1970s and resurfaces with increasing strength from the mid-1990s onward. While this study does not examine specific policy levers, the findings highlight the potential

[10]Moreover, we note that neo-Goodwinian theoretical models of cyclical growth offer a clear distinction of short and long-run dynamics. Specifically, the long run is defined by convergence of Harrod's growth rates, and steady state effects depend on how realized, warranted and natural rates of growth are determined and interact. No analog theoretical framework along Blecker's lines of long-run wage-led consumption effects has been developed.

for progressive policy-making and emphasize the importance of distributional dynamics in shaping macroeconomic performance.

To explore transmission mechanisms, we analyze the relationship between labor share and real consumption growth as well as between labor share and labor productivity growth. Consumption growth closely mirrors GDP growth, confirming a wage-led dynamic throughout most of the sample period. Labor productivity growth also exhibits a wage-led pattern but becomes statistically significant only in the last twenty-five years. These results provide insights into the relative roles of consumption and induced technical change, warranting further research on the mechanisms underlying wage-led growth.

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# Figures

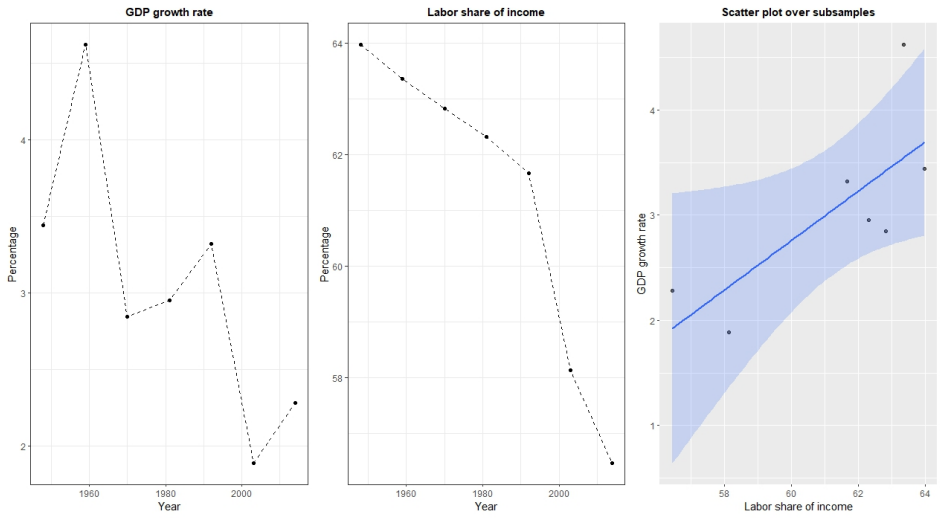


**Figure 1: Descriptive statistics for growth and distribution, 1948:Q1–2023:Q4**. The left (middle) panel reports average growth rates of real GDP (averages of the labor share of income) over non-overlapping subsamples. The right panel shows a scatter plot of the same data, and an OLS regression line with 95% confidence interval in the shaded area.

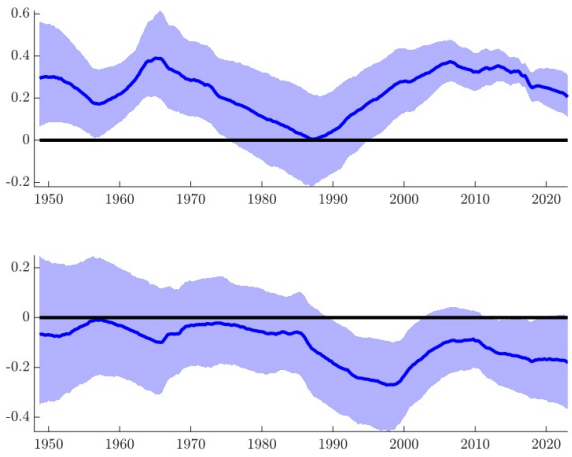


**Figure 2: Baseline model.** Time-varying long-run sensitivity of the growth rate of GDP to the labor share of income (upper panel) and the unemployment rate (lower panel). We report the posterior medians of the time-varying cointegration vector normalized as a real GDP growth rate equation. The shaded area represents the 68% credible intervals of the posterior median estimates. The upper panel shows the time-varying cointegration coefficient on the labor share of income. The lower panel shows the time-varying cointegration coefficient on the unemployment rate.

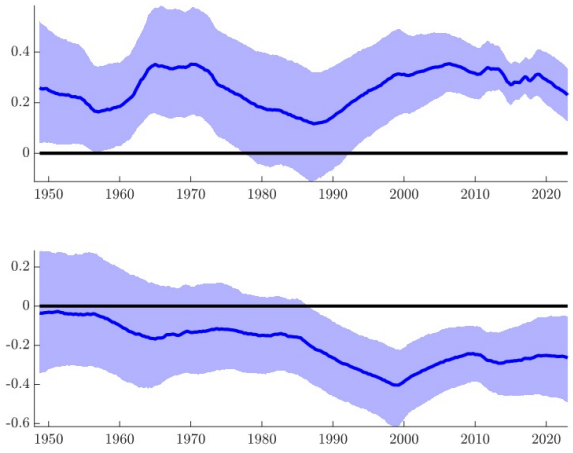


**Figure 3: Consumption model.** Time-varying long-run sensitivity of the growth rate of consumption to the labor share of income (upper figure) and the unemployment rate (lower figure). We report the posterior medians of the time-varying cointegration vector normalized as a consumption growth rate equation. The shaded area represents the 68% credible intervals of the posterior median estimates. The upper figure shows the time-varying cointegration coefficient on the labor share of income. The lower figure shows the time-varying cointegration coefficient on the unemployment rate.

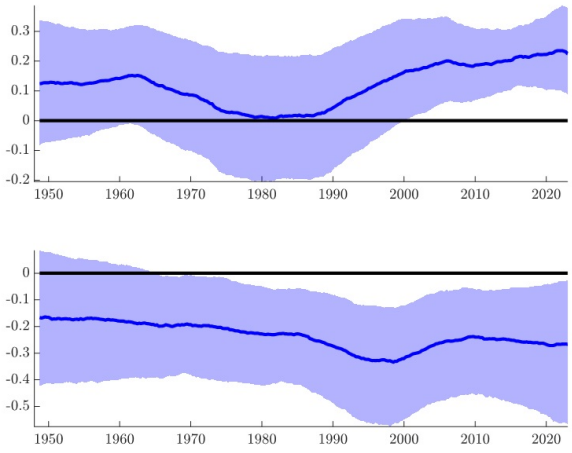


**Figure 4: Labor productivity model.** Time-varying long-run sensitivity of the growth rate of labor productivity to the labor share of income (upper figure) and the unemployment rate (lower figure). We report the posterior medians of the time-varying cointegration vector normalized as a labor productivity growth rate equation. The shaded area represents the 68% credible intervals of the posterior median estimates. The upper figure shows the time-varying cointegration coefficient on the labor share of income. The lower figure shows the time-varying cointegration coefficient on the unemployment rate.

# Tables

**Table 1:** GDP GROWTH RATE EQUATION, $g_t = \beta_0 + \beta_1 \psi_t + e_t$

| Period | Intercept: $\beta_0$ | Coefficient on labor share of income: $\beta_1$ |
|---|---|---|
| 1948:Q1-2023:Q4 | -11.365* | 0.235** |
| | (4.946) | (0.082) |

*Notes*: Assuming that $e_t$ represents the error term, we report the OLS regression coefficients of the GDP growth rate, $g_t$, as a function of the labor share of income, $\psi_t$, using the data for the scatter plot shown in the rightmost panel of Figure 1. Heteroscedasticity and autocorrelation consistent (HAC) standard errors are shown in parentheses. We report three decimal points to summarize the results. * and ** denote significance at the 5% and 1% level, respectively.

# A Time varying cointegration

In order to study the possibility of time-varying cointegration, we consider a variant of the unrestricted TVP-VEC-SV models studied by Koop et al. (2011). For $t = 1, 2, ..., T$, we summarize these models as follows:

$$\Delta y_t = \Pi_t y_{t-1} + \sum_{h=1}^{l} \Gamma_h \Delta y_{t-h} + \phi d_t + \varepsilon_t, \tag{A.1}$$

where $y_t$ denotes the vector that contains the endogenous variables; $\Pi_t$ is the time-varying coefficient matrix of cointegrating relationships; $\Gamma_h$ are the coefficient matrices on the lags of the differenced endogenous variables $\Delta y_{t-h}$; $d_t$ is a vector of deterministic terms; $\phi$ is the corresponding coefficient matrix associated with the latter; and $\varepsilon_t \sim \text{i.}\mathcal{N}(0, \Omega_t)$ contains the reduced-form shocks, where $\Omega_t$ is the time-varying covariance matrix.

The term $\Pi_t y_{t-1}$ in equation (A.1) can be regarded as the error correction term. Essentially, by relating $\Delta y_t$ to $y_{t-1}$, it captures the deviation of the endogenous variables in $y_t$ from their long-run equilibrium relationships. The time-varying matrix $\Pi_t$ can be written as the time-varying matrix product $\Pi_t = \alpha\beta_t'$. This means that the error correction term corresponds to $\alpha\beta_t' y_{t-1}$. In other words, the error correction term is composed of two matrices: (i) the time-varying cointegration matrix $\beta_t$, which contains the information on the equilibrium relationships between the variables in $y_t$; and (ii) the loading matrix $\alpha$, which contains constant parameters that describe the speed at which the endogenous variables converge back to their equilibrium values.

We clarify the following specifications and criteria used to estimate all our TVP-VEC-SV models depicted by equation (A.1). First, we included intercepts as the only deterministic terms, so that $d_t = 1$.

Second, we fixed the number of lags at two, that is, $l = 2$. This choice was motivated by the fact that, in our empirical applications, we found that the TVP-VEC-SV models with two lags were the most parsimonious models that allowed for a VEC representation, *i.e.*, these models showed that the endogenous variables in $y_t$ converged back to their equilibrium values with the least number of parameters estimated. This information can be summarized by the coefficients in the loading matrix $\alpha$, which are presented in table C.1. The latter shows that, in each of the three estimated TVP-VEC-SV models, the relevant adjustment is carried out by the variable that was selected to be the dependent variable in the long-run relationships, *i.e.*, $g_t$, $c_t$ and $a_t$.

Third, we only incorporated time-varying parameters for the covariance matrix $\Omega_t$ and the cointegration matrix $\beta_t$. On the other hand, we incorporated fixed parameters for the matrices $(\alpha, \Gamma_1, \Gamma_2, \phi)$. In other words, our models incorporated SV and time-varying cointegration; while the rest of the parameters were assumed to be constant. This specification was selected because, in our empirical applications, we found that fully-flexible models that also incorporated time-varying parameters in all the other matrices, such that $(\alpha_t, \Gamma_{1,t}, \Gamma_{2,t}, \phi_t)$, did not allow for a VEC representation (that is, we did not find that the endogenous variables in $y_t$ converged back to their equilibrium values in these fully-flexible TVP-VEC-SV models). We interpret these results as indirect evidence showing that allowing for time-variation in $\Omega_t$ and $\beta_t$ is, overall, sufficient to capture the relevant long-run time-varying dynamics of the variables; while allowing for time variation in all the parameters of the TVP-VEC-SV model, *i.e.*, $\Omega_t$, $\beta_t$ and $(\alpha_t, \Gamma_{1,t}, \Gamma_{2,t}, \phi_t)$, introduces too much unnecessary modeling flexibility (additional results available on request).

Fourth, we set the cointegrating rank equal to one, *i.e.*, $r = 1$, where $r$ is the rank of $\Pi_t$. This implies that we assumed that there is only one long-run equilibrium relationship between the endogenous variables in $y_t$.

Fifth, it is well known that only the cointegrating space is identified in the TVP-VEC-SV models described above. This implies that the particular cointegrating vectors are not identified. We achieved identification by imposing $\beta_t$ to be semi-orthogonal: $\beta_t'\beta_t = \mathrm{I}_r$. To understand this, let us define $\beta_t^*$ as the unrestricted matrix (without any imposed identification) of cointegrating vectors. We relate $\beta_t^*$ to the semi-orthogonal $\beta_t$ as follows:

$$\beta_t = \beta_t^*(\kappa_t)^{-1}, \tag{A.2}$$

where $\kappa_t = (\beta_t^{*'}\beta_t^*)^{1/2}$.

# B Bayesian estimation

We estimated the TVP-VEC-SV models described in Appendix A using the Markov chain Monte Carlo (MCMC) sampling algorithm developed by Koop et al. (2011).

To summarize, we group the set of parameters into three main blocks: (i) the time-varying covariance matrices $\Omega_t$; (ii) the models' constant parameters without the cointegrating space $(\alpha, \Gamma_1, \Gamma_2, \phi)$; and (iii) the time-varying parameters defining the cointegrating space $\beta_t^*$. We used standard algorithms in

order to obtain MCMC draws from all of the posterior blocks and, hence, we will only describe them briefly in this appendix.

First, we adopted the priors of the multivariate stochastic volatility specification as well as the MCMC sampling algorithm of Primiceri (2005) for $\Omega_t$, thus generating MCMC draws from the posterior of $\Omega_t$ conditional on the other parameters.

Second, for $(\alpha, \Gamma_1, \Gamma_2, \phi)$ we used both the priors and the simulation smoother for linear normal state space models of Durbin and Koopman (2002) to obtain MCMC draws from its conditional posterior.

Third, for $\beta_t^*$ we used a hierarchical prior that implies that the cointegrating space at $t$ is centered over the cointegrating space at $t-1$. Let us define $b_t^* = \text{vec}(\beta_t^*)$ for $t = 2, ..., T$. We assumed the following:

$$\begin{aligned} b_t^* &= \rho b_{t-1}^* + \eta_t, \\ \eta_t &\sim \mathcal{N}(0, \mathrm{I}_{nr}), \\ b_1^* &\sim \mathcal{N}(0, \mathrm{I}_{nr} \frac{1}{1-\rho^2}), \end{aligned} \tag{B.1}$$

where $|\rho| < 1$ is a scalar and $n$ denotes the number of endogenous variables in $y_t$. The restriction $|\rho| < 1$ guarantees that the current cointegrating space (at time $t$) has a distribution that is centered over last period's cointegrating space (at time $t-1$).[11]

We used the parameter augmented Gibbs sampler developed by Koop et al. (2009) to obtain draws for $\beta_t^*$. However, the hierarchical prior summarized by (B.1) considers that $\rho$ is an unknown parameter. Therefore, it is necessary to add one extra block to this sampling algorithm to obtain draws for the $\rho$ parameter, which is done by implementing a Metropolis-within-Gibbs step. The prior for $\rho$ is uniform over the interval (0.999, 1), which covers a reasonable range of values (see Koop et al., 2011, for further discussion).

Finally, in our empirical analyses, we collected 50,000 posterior samples and discarded the first 5,000 draws to ensure the convergence of the chain using the MCMC sampling algorithm outlined above.

[11] Another possibility would be to specify that the cointegrating space evolves as a random walk, $|\rho| = 1$. This is an assumption that we used for the rest of the parameters in the TVP-VEC-SV models. However, as discussed in Koop et al. (2011), the random walk restriction for the cointegrating space has the undesirable property that $b_t^*$ can wander far from the origin. This implies that the variation in the space spanned by $\beta_t$, $\varrho_t = \text{sp}(\beta_t)$, would shrink until, at the limit, it imposes $\varrho_t = \varrho_{t-1}$.

# C Speed of adjustment parameters

**Table C.1:** Speed of adjustment parameters obtained from the TVP-VEC-SV models

| Equation | $\alpha$ |
|---|---|
| *Model with $\psi_t$, $g_t$ and $u_t$* | |
| $\psi_t$ | 0.003 (0.001)<br>[0.002, 0.005] |
| $g_t$ | **-0.014** (0.005)<br>[−0.019, −0.010] |
| $u_t$ | −0.001 (0.001)<br>[−0.002, −0.001] |
| *Model with $\psi_t$, $a_t$ and $u_t$* | |
| $\psi_t$ | 0.000 (0.001)<br>[−0.000, 0.001] |
| $a_t$ | **-0.008** (0.003)<br>[−0.012, −0.006] |
| $u_t$ | −0.001 (0.000)<br>[−0.001, −0.000] |
| *Model with $\psi_t$, $c_t$ and $u_t$* | |
| $\psi_t$ | 0.002 (0.001)<br>[0.001, 0.003] |
| $c_t$ | **-0.008** (0.004)<br>[−0.013, −0.005] |
| $u_t$ | −0.002 (0.001)<br>[−0.003, −0.001] |

*Notes*: The notation follows the main text, so that $\psi_t$ is the labor share of income, $g_t$ denotes the real GDP growth rate, $u_t$ is the unemployment rate, $a_t$ is the labor productivity growth rate, and $c_t$ denotes the consumption growth rate. We report the posterior medians, the standard deviations in parentheses, and the 68% credible intervals in square brackets. We report three decimal points to summarize the results. Bold numbers indicate that the respective coefficient's credible interval does not include zero, considering two decimal points.