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# Estimating a Time-Varying Distribution-Led Regime*

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**ABSTRACT**

This paper estimates the distribution-led regime of the US economy for the period 1947–2019. We use a time varying parameter model, which allows for changes in the regime over time. To the best of our knowledge this is the first paper that has attempted to do this. This innovation is important, because there is no reason to expect that the regime of the US economy (or any economy for that matter) remains constant over time. On the contrary, there are significant reasons that point to changes in the regime. We find that the US economy became more profit-led in the first postwar decades until the 1970s and has become less profit-led since; it is slightly wage-led over the last fifteen years.

**KEYWORDS:** Wage-led; Profit-led; Distribution; Growth; Time-Varying Parameters (VAR)

**JEL CLASSIFICATIONS:** E11; E12; C11; C3

## 1. INTRODUCTION

The introduction of the concept of wage- and profit-led growth by Bhaduri and Marglin (1990) has led to an extensive theoretical literature that extends the basic model as well as a large empirical literature that aims to estimate the regime of various countries. The underlying assumption of most of these theoretical and empirical contributions is that the regime of an economy is constant. An economy is assumed to be *either* wage-led *or* profit-led. For example, the usual practice in the empirical literature is to obtain the data for distribution and utilization or the growth rate for an economy, run a regression for the time period the data are available, and, based on the regression's results, conclude if the economy under examination is wage- or profit-led over this period of time. In the case of the US economy, which is the object of a large portion of these studies, quarterly data are available beginning in 1947. Thus, the implicit assumption in the related regressions is that the regime of the US economy has been constant in the period starting in 1947 and ending in the 1990s, 2000s, or 2010s when the study was conducted.

However, as is explained in Nikiforos (2016b, 2022), it is unlikely that the demand-led regime remains constant over time, as the structure of the economy and income distribution changes. There are important logical, theoretical, and empirical reasons that justify the change of the regime over time. In the aforementioned example, it is unlikely that the reaction of macroeconomic activity to changes in distribution in the United States was the same in the 1950s, the 1970s, the 2000s, and the 2010s.

In particular, Nikiforos (2016b, 2022) puts forward three hypotheses. First, that an economy should become less profit-led (or more wage-led) as the profit share increases. Second, the more powerful a class becomes, the more it is able to push distribution in its favor—thus distribution is unstable. Third, the change in distribution also depends on the regime itself: the more profit-led the economy is, the more likely it is that the profit share will increase and vice versa.

The result of these three hypotheses is cyclical fluctuations in growth and distribution. As the profit (wage) share increases, the economy becomes more (wage-) profit-led and thus eventually a crisis ensues. The crisis becomes the catalyst for a reversal in the direction of the change in income distribution.

In the context of the US economy these hypotheses imply that: (i) the large increase in income inequality and the profit share over the last forty years should have made the US economy less profit-led; and (ii) the profit-ledness of the US economy should have increased in the early postwar decades, a development that contributed to the (profit-squeeze) crisis of the 1970s.

The present paper is, to the best of our knowledge, the first attempt to estimate the regime of an economy while allowing for changes in the regime itself over time. Toward that purpose we employ a time varying parameters (TVP) model and apply it to US data for the period 1947–2019. We employ different specifications. Our estimates confirm that the US economy became more profit-led in the first postwar decades until the 1970s and has become less profit-led over the last four decades, converging to a neutral and eventually a slightly wage-led regime after the early 2000s. These results are robust to different specifications.

Besides the interest these results have in their own right, our paper and its novel methodological approach aims to point toward a new direction for thinking and estimating distribution-led regimes that takes into account potential changes in the regimes over time. These changes are very important for the political economy of the countries under consideration. For example, in the case of the United States, the climax of profit-ledness in the 1970s is crucial for understanding the crisis of the time and the political economy of the period. The same is true for non-profit-ledness or slight wage-ledness of the last two decades.

The rest of the paper proceeds as follows. Section 2 summarizes the theoretical arguments about why the distribution-led regime might change over time, while section 3 and 4 present an overview of the empirical literature and our methodological approach (the time varying parameter model), respectively. In section 5 we discuss our results. Section 6 concludes.

## 2. WAGE- AND PROFIT-LED GROWTH

The closure of the Kaleckian/Structuralist model of growth and distribution (Rowthorn 1981; Taylor 1983; Dutt 1984; Kurz 1990; Bhaduri and Marglin 1990) combines the Keynesian/ Kaleckian emphasis on the autonomous role of aggregate demand and the classical emphasis on institutions and social norms as the main determinants of the distribution of income between workers and capitalists. A change in the distribution of income does not have a certain a priori effect on the level of macroeconomic activity because profitability has differential effects on the various components of aggregated demand. In particular an increase in the profit share: i) has a negative effect on consumption, because workers have a higher propensity to consume; ii) has a positive effect on investment, because profitability is one of the main determinants of investment; and iii) has an uncertain effect on net exports depending how the change in the profit share comes about—although on balance there is an agreement that most likely an increase in the profit share has a positive effect on net exports. Thus, the overall effect will depend on the relative magnitude of these partial effects. An economy is profit-led if the positive effect of an increase in the profit share on investment and exports is stronger than the negative effect on consumption. It is wage-led in the opposite case.

The implicit or explicit assumption of most of the theoretical and empirical literature on wage- and profit-led growth that has followed the early contributions is that the regime of each economy is constant over time. An important change and advancement in that respect are recent contributions that emphasize the possibility of multiple equilibria. If there are multiple equilibria, the regime of the economy is not unique. Nikiforos and Foley (2012) suggest the distributive schedule is nonlinear: the wage share is decreasing for low levels of utilization and increasing for high levels. Coupled with a monotonic demand schedule, there is the possibility of two equilibria. In this case, even if demand is profit-led, an increase in the profit share is contractionary for the low-utilization equilibrium.

Assous and Dutt (2013) propose that the markup and profit rate aren't constant over time because the market structure, workers' power, and firms' concentration change. They thus suggest that distribution has a downward-facing S-shape in the <profit share, growth rate> space. This creates

the possibility of three equilibria. As a result, they conclude that it is necessary to understand that there are small and large changes. Small changes do not move the system to a different equilibrium, but large shocks can do that. Therefore, even if demand is profit-led, a large increase in the relative power of firms might lead to a shift to a low-growth equilibrium (accompanied by a higher profit share). Tavani et al. (2011) use nonparametric methods to determine the distributive schedule and reach similar conclusions.

Unlike these papers, more recent contributions by Nikiforos (2016b, 2022) and Marglin (2017) have emphasized the nonlinearities in demand itself. Marglin (2017) argues that over the course of the business cycle, investment's reaction to profitability varies. During a crisis—at low levels of utilization—entrepreneurs are less sensitive to distribution and are more interested in the economy's performance. Profitability plays a more important role at high levels of utilization. Therefore, Marglin concludes, the regime of the economy is different at different phases of the cycle: an economy tends to be wage-led during a crisis and profit-led at high levels of utilization. Thus, Marglin arrives at the same conclusions as Nikiforos and Foley (2012), albeit from a different path.

Nikiforos (2016b, 2022) examines the evolution of the distribution-led regimes in the long run. He suggests that an economy tends to become less profit-led (or more wage-led) as the profit share is increasing. Since we will use these arguments in the following sections, it is worth going over them quickly. There are at least four set of reasons why the distribution-led regime of an economy cannot be a permanent feature of that economy, irrespective of income distribution and other structural characteristics, including:

*i) Logical reasons*. If an economy is either wage- or profit-led and income distribution did not matter in the determination of the regime, it would follow that the optimal macroeconomic performance would be achieved when the profit or wage share, respectively, is equal to zero. This is clearly absurd.

*ii) Theoretical reasons*. There are several theoretical reasons why the propensity of investment and consumption with respect to the profit share might decrease as the profit share increases.[1] More fundamentally, the very basis for the distinction between wage- and profit-led growth is the dual nature of wages. Wages are at the same time a cost of production, whose increase tends to reduce profitability and thus investment, and the income of the major part of the population (with high propensity to consume) whose increase tends to increase consumption. The argument that an economy is either wage- or profit-led implies that one of these two "natures" of wages are always dominant. However, this contradicts the spirit of the Kaleckian/Structuralist model and the very concept of distribution-led growth.

*iii) Empirical reasons*. There is empirical evidence from other bodies of literature that the propensities of the components of aggregate demand with respect to profitability have changed over time. For example, the financialization literature has shown that over the last four decades there has been a decoupling of profit flows and investment. This piece of evidence is inconsistent with a constant distribution-led regime over that period.

*iv) History-of-thought reasons*. The prevalence of the assumption of the constant regimes is all the more surprising given that the distinction between wage- and profit-led growth emerged from a research project emphasizing that the regime changes over time (Marglin 1988; Marglin and Schor 1990). Marglin and Bhaduri (1990) discuss the changes in the distribution-led regime of the US economy as a factor that contributed to the demise of "The Golden Age of Capitalism."

For all these reasons the hypothesis that an economy becomes more wage-led as the profit share increases and vice versa seems convincing. Given the significant increase in the profit share over the last decades we would expect that economies like the one of the United States have become less profit-led.

[1] A detailed discussion is provided in Nikiforos (2016b: sec. 3.2; 2022: sec. 6)

Finally, regarding the behavior of distribution, Nikiforos (2016b, 2022) assumes that: (i) distribution is unstable—meaning that each class becomes more able to tilt distribution in its favor as its share of income is increasing, and (ii) that the change in distribution is also affected by the distribution-led regime (in a wage-led economy the profit share would tend to decrease, all other things equal, and vice versa). This endogenous change in distribution and the distribution-ledness of the economy are likely to lead to endogenous long-run cycles, with the economy moving endogenously between periods of wage- and profit-led growth.

In the case of the United States this explanation suggests that in the early postwar period the US economy became more profit-led as distribution of income became more egalitarian. This led to the crisis of the 1970s, which was a profitability crisis. It was this crisis that catalyzed the change in the trajectory of income distribution and the increase in income inequality that ensued. At the same time, this increase in inequality and the profit share made the US economy less profit-led and led to the crisis of 2007–9.

## 3. EMPIRICAL LITERATURE

The introduction of the distinction between wage- and profit-led growth has led to a very extensive empirical literature that aims to estimate the regime of various economies around the world. A review of the literature is beyond the scope of the present paper, but a comprehensive review is provided by Blecker (2016). In his terminology, this literature uses two main approaches for the estimation of the regime: the "structural" and "aggregative" approaches. The structural approach decomposes demand into its various components (consumption, investment, and net exports) and estimates the effects of changes in distribution on each of these components individually. The overall regime is then calculated as the sum of these individual effects. On the other hand, the aggregative approach estimates the effect of changes in distribution on the growth rate of total output, or the rate of capacity utilization. Overall, contributions following the first approach tend to produce wage-led results, while contributions following the aggregative approach tend to produce profit-led results.

The obvious benefit of the structural approach is that one can distinguish between the effects of redistribution on the different parts of economic activity, and therefore the process that produces these results is transparent. On the other hand, these contributions suffer from serious endogeneity problems. Since causality between distribution and growth runs both ways, the simple ordinary least square (OLS) regressions that are commonly used capture the correlation between the variables under investigation rather than the causal effect of (changes in) distribution on growth. Another weak point of this approach is that the investment function is famously difficult to estimate. The strategy that is usually employed is that if the coefficient of the regression of growth on distribution is statistically insignificant, it is treated as zero. This can explain why this approach tends to show that economies are wage-led. Alternatively, the aggregative approach has the advantage of dealing with the endogeneity problem, as related contributions usually employ vector autoregressive models (VARs) or use instrumental variables and do not have to specify an investment function—at the cost of not being able to distinguish between the different components of aggregate demand.

The discussion in the previous section reveals another problem in this literature, namely that the regime of the economy is taken to be fixed over the whole period of estimation. The usual strategy is to use data for a country, run a regression, and conclude if the economy is wage- or profit-led. For example, in the case of the United States, data are available in quarterly frequency since 1947. The implicit assumption of most studies is that the distribution-led regime of the economy was the same for the period beginning in 1947 until the last year of the sample (in the 1990s or the 2000s). For the reasons explained in the previous section this is problematic.

More precisely, out of the roughly 23 different studies that have published estimates on distribution-led regimes, very few engage with the possibility of time variation of the regimes. Five of them do this by estimating their model for different subperiods of their sample. Barbosa-Filho and Taylor (2006) estimate their model for the postwar period until 2002. The find that demand was less profit-led in the period before 1970. In a similar fashion, Nikiforos and Foley (2012) estimate the regime for the period 1948–2009 and the subperiods before 1960, before 1970, and after 1970, and find that the coefficients for the first two subperiods are not statistically significant while they are (indicating a profit-led economy) for the period after 1970. Carvalho and Rezai (2016) apply a threshold VAR model to data for the period 1967–2010. Using the Gini coefficient as the threshold variable they

identify 1981 as the threshold year; they then find that the US economy was more profit-led in the years after 1981. Alternatively, Barrales and von Arnim (2017) use data for the period 1949–2011. They show that over the whole period of their sample and the period before 1980 an increase in the wage share has a positive effect on macroeconomic activity; this is not the case in the post-1980 period, when an increase in the wage share tends to have a positive effect in the medium run.

In addition to these four studies that have focused on the US economy, Jetin and Kurt (2016) estimate the regime of the Thai economy for the period 1970–2011. They find that the economy was profit-led over the whole period of their sample; they also estimate their model for the period after 1980 and find a lower degree of profit-ledness. Finally, Stockhammer, Onaran, and Ederer (2009) and Stockhammer and Stehrer (2011) investigate potential structural breaks in the data with the use of related tests, but they do not find any.[2]

The results of the present paper are not directly comparable with the results of these studies. As it will become obvious in the following sections, the subperiods under examination (e.g., post-1970, post-1980) are themselves very long and subject to significant change.

## 4. EMPIRICAL STRATEGY

The goal of our paper is to estimate the effect of changes in income distribution on macroeconomic activity. As it is common in the related empirical literature, we used the wage share as a measure of income distribution. In our baseline model we used the growth rate of real gross domestic product (GDP) to measure macroeconomic activity.

The empirical strategy we chose was dictated by two concerns. First is the potential endogeneity of income distribution to macroeconomic activity. For that reason, a simple OLS regression of growth on distribution gives inconsistent estimators, which capture the correlation between the two

[2] In personal discussions, Englebert Stockhammer told me that in many of the various related papers he has coauthored, they estimated the model for different subperiods, but the results were not reported, as they did not find significant changes.

variables rather than the causal effect of changes in distribution on growth. Second, for the reasons explained in section 2, this effect might vary over time. This also raises issues for the consistency of the estimators that do not take these changes into account.

With these concerns in mind, we chose to use a time-varying parameter structural vector autoregressive (TVP-SVAR) model (Primiceri 2005; Nakajima 2011; Fernández-Villaverde et al. 2011; Koop and Korobilis 2010); a brief overview of the method is provided in the appendix. In a nutshell, the main difference between the TVP-SVAR and a conventional SVAR is that the structural parameters of the model are allowed to vary over time and are thus able to capture time variation in the contemporaneous relationship and lag structure of the model. It is then up to the data to determine whether the variation of this structure comes from changes in the size of shocks or the propagation mechanism (Kim and Nelson 1999).

For the estimation of the model, we used the relatively standard methods employing the Kalman filter, Bayesian inference, and a Markov chain Monte Carlo (MCMC) algorithm. We ran 12,000 draws to estimate the conditional posterior distribution of the parameters. To mitigate the initial values, we discarded the first 2,000 draws ("burn-in" simulations). We also experimented with a higher number of draws—up to 100,000—but our results do not change in any meaningful way.

For the identification of the model, we followed the usual Cholesky decomposition, where we assumed that the wage share is exogenous to GDP in the contemporaneous relationship ($t = 0$). As is common in these types of exercises, our results are sensitive to this ordering assumption. We are comfortable with this assumption, as it is consistent with the classical theory of distribution, which is also adopted in the Kaleckian/Structuralist model and posits that income distribution is primarily determined by institutions and social norms.

We used quarterly series up to the last quarter of 2019. On the other hand, we went as far back in time as possible. The time range of each of our models was determined by data availability. Finally,

we chose the number of lags with the usual Schwartz and Hannan-Quin information criteria in a traditional-invariant structural VAR and solved the model in Matlab.[3]

### 4.1 Model Variations

In addition to the baseline model, we estimated—using the same strategy—a series of other models with additional or different variables. These variations can serve as robustness checks and provide some evidence on the sensitivity of the results on the particular specification. They fall into four broad categories.

#### *4.1.1 Including the Debt-to-Disposable-Income Ratio of Households as an Endogenous Variable*

Changes in indebtedness can play an important role in the relationship between distribution and growth, as they can mitigate or exacerbate whatever effect changes in income distribution has on growth. It is likely, for example, that in an otherwise wage-led economy, a decrease in the wage share is associated with no change in the growth rate or even an increase in the growth rate if worker households increase their indebtedness to finance their consumption. The increase in the household debt-to-income ratio before the 2007–9 crisis seems to have played that role and mitigated the negative macroeconomic effects of the—by then—three-decades-long increase in inequality (see Nikiforos [2016a] and references therein). Similarly, in a wage-led economy in a period of household deleveraging, an increase in the wage share might have no effect on growth—or a decrease in the wage share might be associated with decreases in consumption and growth of a higher magnitude than if no deleveraging was taking place. Given that the household debt-to-income ratio has varied a lot over the period of our sample it is important to examine how sensitive the results are to it.

#### *4.1.2 Including Labor Productivity as an Endogenous Variable*

Lavoie (2014, 323–25) has suggested that the estimates in studies that have found profit-led regimes might be biased because they ignore the procyclical behavior of labor productivity—which in turn is the result of overhead labor. Since, by definition an increase in productivity leads (ceteris paribus) to an increase in the profit share, Lavoie argues that the procyclical tendency of the profit

[3] For our simulations we benefited from the Matlab code provided by Koop and Korobilis (2010).

share to increase might be captured as a positive effect of increases in the profit share on macroeconomic activity. Cauvel (2019) finds some empirical support for this hypothesis, which however depends on the ordering of the variables (wage share, utilization, productivity) in his three-dimensional VAR model.

*4.1.3 Including Government Deficit and Trade Balance*

The period under consideration saw significant changes and fluctuations in the trade balance and the government deficit, it is thus important to take them into account and see how and if they change our conclusions.

*4.1.4 Substituting the Rate of Capacity Utilization for the Growth Rate as a Measure of Macroeconomic Activity*

The baseline Kaleckian/Structuralist model uses capacity utilization as a measure of economic activity. Several important contributions discuss separately the effect of a change in distribution on utilization and the growth rate (e.g., Bhaduri and Marglin 1990; Kurz 1990). An important problem with the measures of utilization, which are available for a relatively long period of time and at a quarterly frequency, is that they are constructed in a way that assumes that capacity cannot diverge from output over the medium run. This is an issue with the data on capacity utilization published by the Federal Reserve (Nikiforos 2016c, 2021), but also with the measure of the output gap, which uses the potential output published by the Congressional Budget Office (CBO) as a measure of capacity, and of course statistical measures of utilization that produce potential output using filters, such as the Hodrick-Prescott filter. Because of our methodology, this issue becomes more problematic compared to conventional VAR models. In our estimation we used the measure of the output gap as a proxy for the rate of utilization—for the reasons explained here, the related results should be interpreted with some caution.

In what follows we report the results of these four additional variations. While preparing this paper we ran several models that combined the aforementioned variations without any significant change in the results, and therefore we do not report them here.

Finally, it is worth mentioning that the results of these extensions are not sensitive to the ordering of the variables as long as the wage share remains first, as in the baseline specification.

### 4.2 Data

We used quarterly data for the US economy up to the last quarter of 2019. The data were retrieved from the Federal Reserve Economic Data (FRED) database on November 9, 2021. The series we used are originally published by the Bureau of Economic Analysis (BEA), the Bureau of Labor Statistics (BLS), and the Federal Reserve Board (FRB). More precisely we used the following series: (the FRED code is in parenthesis) [the number in the square brackets represent the first quarter the series is available for]. We calculated the growth rate of real GDP using "Real Gross Domestic Product" (GDPC1) [1947q1]. We used "Nonfarm Business Sector: Labor Share for All Employed Persons" (PRS85006173) [1947q1] as the wage share. The debt-to-income ratio of households was calculated as the ratio of "Households and Nonprofit Organizations; Total Liabilities, Level" (TLBSHNO) [1951q4] over "Disposable Personal Income" (DPI) [1947q1]. We calculated the growth rate of labor productivity based on "Nonfarm Business Sector: Labor Productivity (Output per Hour) for All Employed Persons" (OPHNFB) [1947q1]. The trade balance and government deficit as a percentage of GDP was calculated using "Net Exports of Goods and Services" (NETEXP) [1947q1] and "Net Lending or Net Borrowing (-), NIPAs: Government" (AD01RC1Q027SBEA) [1960q1], respectively, and dividing them by "Gross Domestic Product" (GDP) [1947q1]. Finally, as a measure of capacity utilization we used the output gap, defined as the ratio of real GDP (mentioned above) over "Real Potential Gross Domestic Product" (GDPPOT) [1949q1].

## 5. RESULTS

In a regular VAR model, once the parameters are estimated, the usual way of visualizing the results is by plotting the impulse response functions (IRFs), which show how a shock to a certain variable affects some other (or the same) variable over time. In a TVP-SVAR, the parameters of the model change over time, and therefore so do the IRFs. One thus can present this time varying effect in two ways. First, they can plot the IRFs at different points in time and see if and how they have changed.

For example, in our exercise we could plot the IRFs in 1950q1, 1975q1, 1990q1, and 2015q1 (or any other period we chose) and see if and how these IRFs differ.

Another way is to present the evolution of the IRFs over time at a certain time horizon. In this way, by combining plots of different time horizons one can see how the structure of the model has changed over time. For example, one can plot how a shock to a certain variable affects another variable contemporaneously (or after x periods of time) and how this effect changes over time. We chose to use this (the second) approach because it allows one to visualize the change in the structure of the model continuously over the time period of the sample—albeit at the cost of presenting only a certain number of time horizons; obviously, the opposite is the case in the first approach.

The results of the baseline model are presented in figure 1. The figure presents the effect of a one-unit shock to the wage share on the growth rate at different frequencies: the contemporaneous effect (0 quarters) in subfigure (a) and the effects after one, three, six, nine, and twelve quarters in subfigures (b) to (f), respectively. All six subfigures present the posterior median of the parameters and the 68 percent equal-tailed point-wise posterior probability bands. The subfigure at the bottom summarizes the results of the median at the various frequencies. To interpret the results, we should keep in mind that all variables have been standardized. We can summarize our findings as follows:

**i)** The growth rate of the US economy was becoming more profit-led over the first postwar decades until the 1970s.
**ii)** The degree of profit-ledness has decreased starting in the late 1970s. The profit-ledness of the United States converged to zero during the early 2000s. Eventually the growth rate became slightly wage-led over the last few years of the sample (at least for the longer time horizons).
**iii)** These changes in the regime of the US economy over time are substantial.
**iv)** The effect of changes in distribution on growth at shorter time horizons is weaker than at longer horizons.
**v)** Findings (i) and (ii) above point toward cyclical behavior in the degree of distribution-ledness.
**vi)** Also, given the fact that income inequality started increasing in the second half of the 1970s, these finding are consistent with the hypothesis that an economy becomes more wage-led as distribution becomes more unequal and vice versa.

The results of the additional model variations—presented in figures 2 through 5—have the same overall picture. Not surprisingly, adding more and relatively more-volatile variables makes the median response more volatile as well and, in some cases, widens the 68 percent probability bands. This, however, does not change the validity of the results.

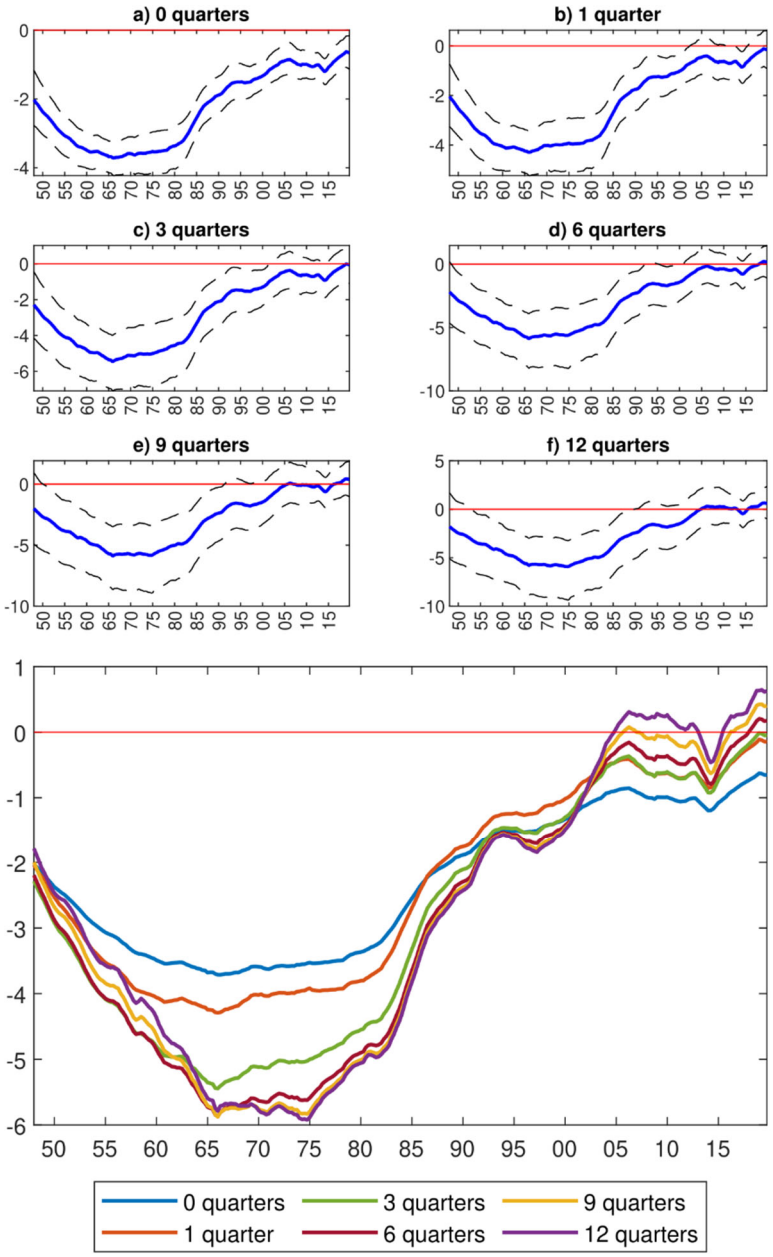
The inclusion of debt-to-disposable-income ratio and labor productivity does not make our estimates more wage-led. In the model that includes the government and trade balance, distribution-ledness converges toward zero slightly earlier compared to the other models. Finally, the model with the output gap also presents a broadly similar picture.

## 6. CONCLUSION

This paper estimated the distribution-led regime of the US economy for the period 1947–2019. Our methodology was dictated by the concern that the regime of an economy might not remain stable over time. There are several reasons—logical, theoretical, empirical, and what we called history-of-economic-thought reasons—why the regime of an economy in general or the US economy in particular might have changed over the period under examination.

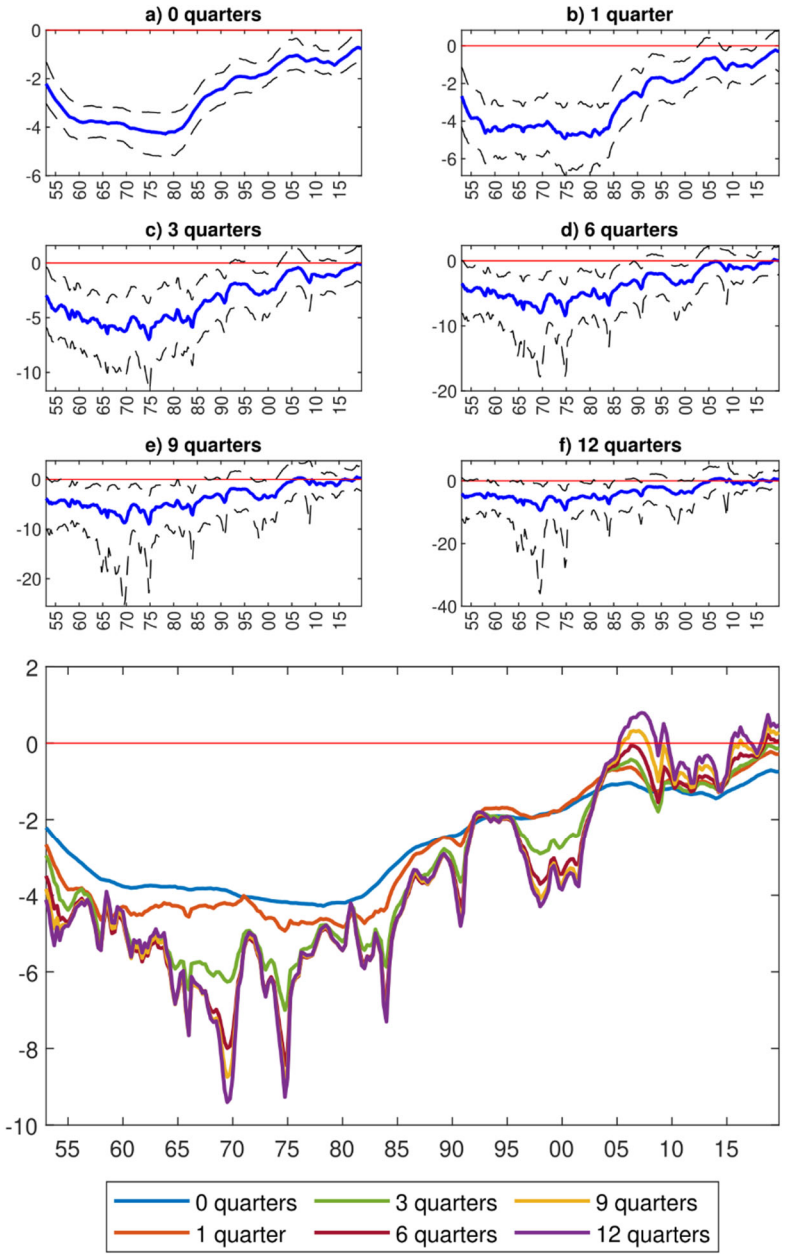
For that purpose, we employ a TVP vector autoregressive model to estimate the (time-varying) effect of changes in distribution on macroeconomic activity. This is, to the best of our knowledge, the first attempt to estimate the regime of an economy while allowing for changes in the regime itself over time. We utilize various specifications, and we find that the effect of changes in income distribution on the rate of growth have changed significantly over the postwar period. More specifically we find that the US economy has become less profit-led over the last four decades, while in the first three postwar decades profit-ledness was increasing or remained roughly constant. These results are in line with theories of growth and distribution that emphasize the changing cyclical character of the distribution-led regime.

**Figure 1. Time-Varying Effects of a Wage Share Shock on Real GDP Growth Rate at Different Horizons (1947–2019)—Baseline Specification: Wage Share, Real GDP Growth Rate**



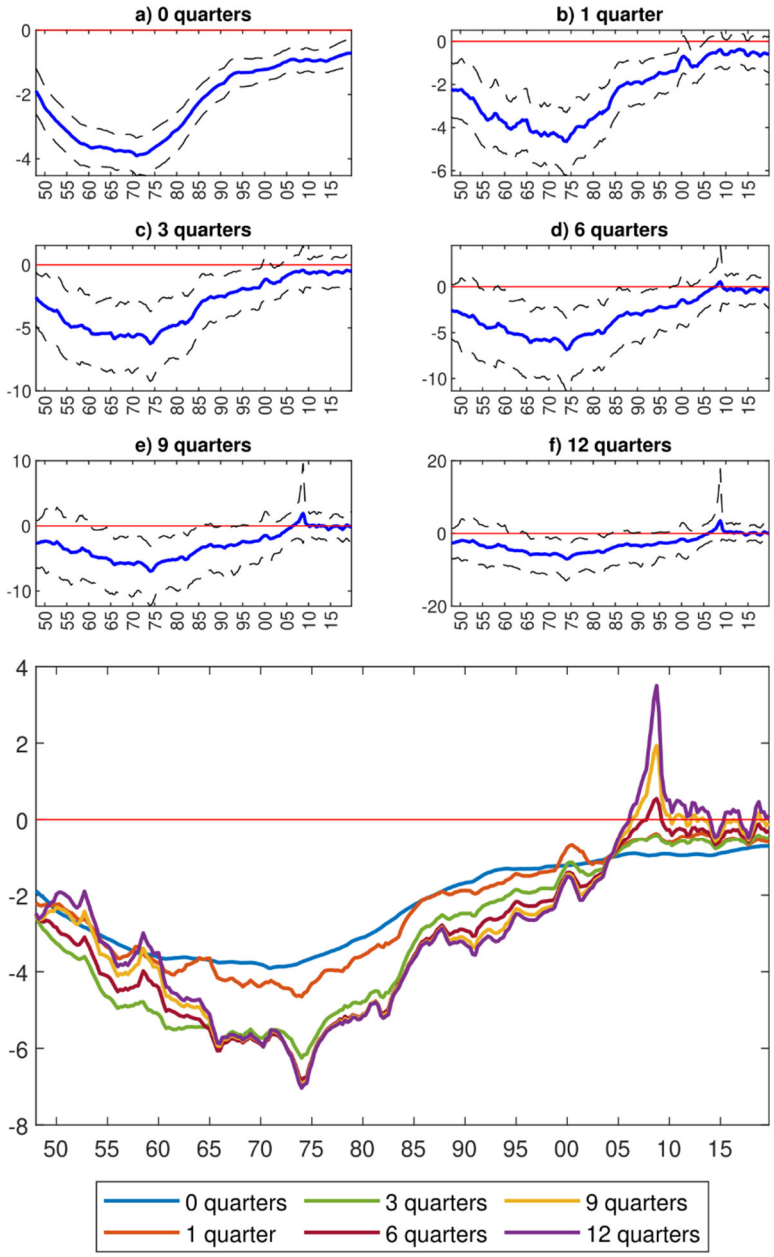

**Note:** The solid line depicts the posterior point-wise median response of GDP. The dashed lines define the 68 percent equal-tailed point-wise posterior probability bands.

**Figure 2. Time-Varying Effects of a Wage Share Shock on Real GDP Growth Rate at Different Horizons (1951–2019)—Specification: Wage Share, Growth Rate of Household Debt-to-Disposable-Income Ratio, Real GDP Growth Rate**



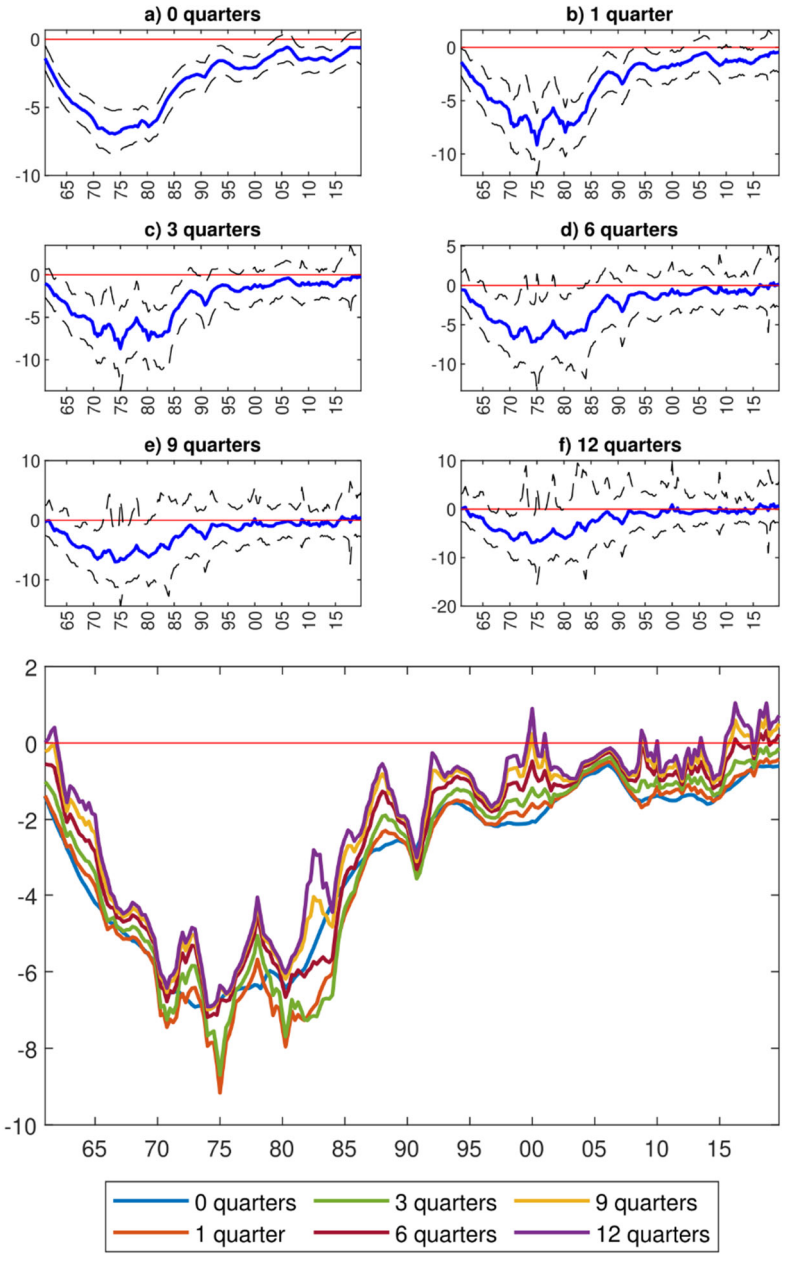

**Note:** The solid line depicts posterior point-wise median response of GDP. The dashed lines in sub-figure (a) define the 68 percent equal-tailed point-wise posterior probability bands.

**Figure 3. Time-Varying Effects of a Wage Share Shock on Real GDP Growth Rate at Different Horizons (1947–2019)—Specification: Wage Share, Productivity Growth Rate, Real GDP Growth Rate**



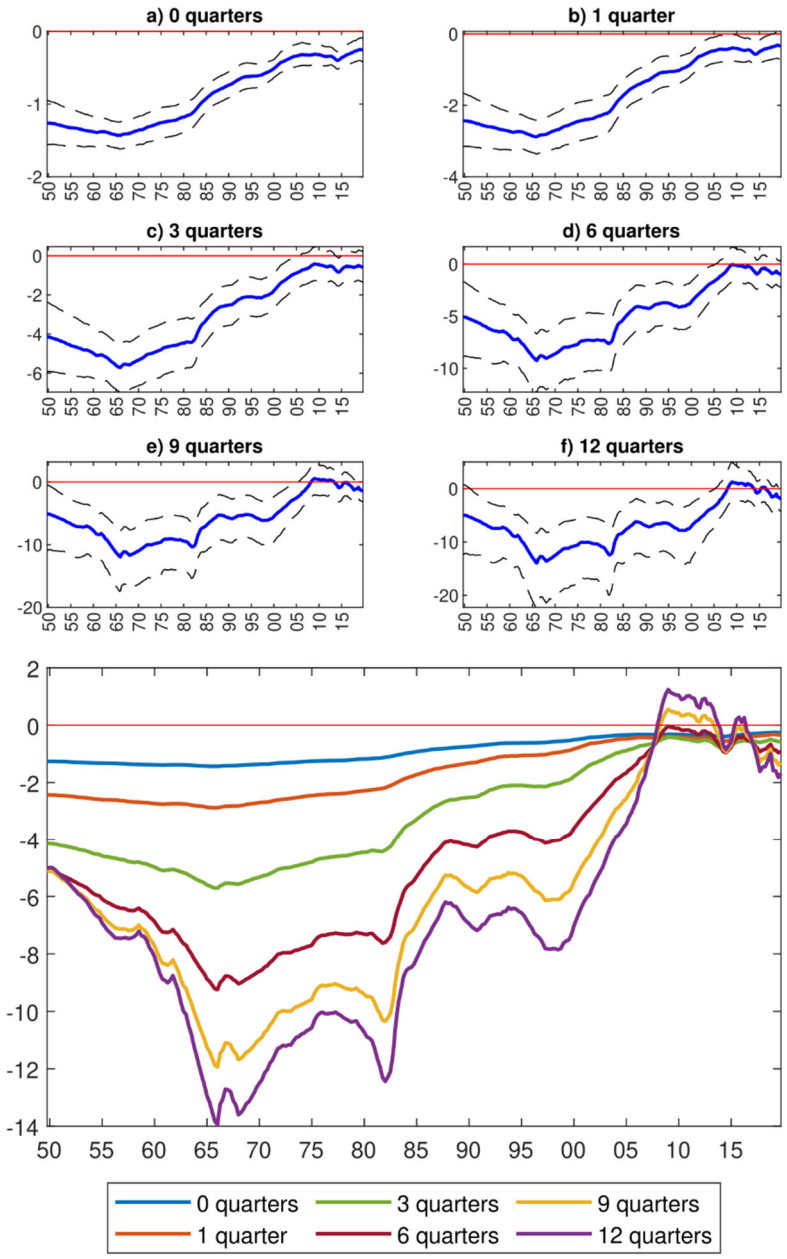

**Note:** The solid line depicts posterior point-wise median response of GDP. The dashed lines in sub-figure (a) define the 68 percent equal-tailed point-wise posterior probability bands.

**Figure 4. Time-Varying Effects of a Wage Share Shock on Real GDP Growth Rate at Different Horizons (1960–2019)—Specification: Wage Share, Trade Balance, Government Balance, Real GDP Growth Rate**




**Note:** The solid line depicts posterior point-wise median response of GDP. The dashed lines in sub-figure (a) define the 68 percent equal-tailed point-wise posterior probability bands.

**Figure 5. Time-Varying Effects of a Wage Share Shock on Output Gap at Different Horizons (1949–2019)—Specification: Wage Share, Output Gap**




**Note:** The solid line depicts posterior point-wise median response of GDP. The dashed lines in sub-figure (a) define the 68 percent equal-tailed point-wise posterior probability bands.

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## APPENDIX: TIME-VARYING PARAMETERS SVAR

### A. Model

Following Primiceri (2005), Nakajima (2011), and Koop and Korobilis (2010), we considered a time-varying parameter structural vector autoregressive (TVP-SVAR) model as

$$A_{0,t}Y_t = \sum_{l=1}^{p} A_{l,t}Y_{t-l} + D_t\varepsilon_t, \quad \text{for} \quad 1 \le t \le T$$

where $Y_t$ is the n × 1 vector of the endogenous variables, $A_{j,t}$ is $n \times n$ matrix of structural parameters for $j = 0, \dots, p$ that vary over time, $D_t$ is $n \times n$ diagonal matrix of standard deviation ($\sigma_{j,t}$) that varies over time, $\epsilon_t$ is the n × 1 vector of structural shocks with mean zero and variance $I$ ($\epsilon \sim \mathcal{N}(0, I)$), $n$ is the number of endogenous variables, $p$ is the number of lags, and $T$ is the sample size. Note that $A_0$ is the lower triangular matrix and $D$ is the diagonal matrix as:

$$A_{0,\mathrm{t}} = \begin{bmatrix} 1 & 0 & \dots & 0 \\ a_{21,\mathrm{t}} & 1 & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1,\mathrm{t}} & a_{n2,\mathrm{t}} & \dots & 1 \end{bmatrix} \qquad D_{\mathrm{t}} = \begin{bmatrix} \sigma_{1,\mathrm{t}} & 0 & \dots & 0 \\ 0 & \sigma_{2,\mathrm{t}} & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \dots & \sigma_{n,t} \end{bmatrix}$$

The structural parameters are meant to capture time variation in the contemporaneous relationship and the lag structure of the model. The degree and the direction of this variation is determined by the data. Like Primiceri (2005), Nakajima (2011), and Koop and Korobilis (2010), we implemented the following process for time-varying parameters (state variables):

$$\alpha_t = \alpha_{t-1} + \eta_t$$
$$B_t = B_{t-1} + \nu_t$$
$$\log\sigma_t = \log\sigma_{t-1} + \xi_t$$

where $\alpha_t$ is the vector of non-zero and non-one elements of the matrix $A_{0,t}$ (stacked by rows), $B_t$ is the vector that results from stacking the matrices $A_{l,t}$ for $l = 1 \dots p$, and $\sigma_t$ is the vector of the diagonal elements of $D_t$.

We also assumed that the innovations components of the model have a jointly normal independent and identical distribution with the variance-covariance matrix as:

$$V = Var\left(\begin{bmatrix}\varepsilon_t \\ \eta_t \\ \nu_t \\ \xi_t\end{bmatrix}\right) = \begin{bmatrix}I_n & 0 & 0 & 0 \\ 0 & Q & 0 & 0 \\ 0 & 0 & S & 0 \\ 0 & 0 & 0 & W\end{bmatrix}$$

where $I_n$ is $n \times n$ identity matrix, and $Q$, $S$, and $W$ are positive definite matrices. We implemented the TVP-SVAR with independent innovations.

**B. Estimation Method**

We estimated the model using the standard method with the Kalman filter and Bayesian inference. We do not describe here the mathematical process but present the algorithm to estimate this state-space model. One can review Kim and Nelson (1999), Primiceri (2005), Nakajima (2011), Fernández-Villaverde et al. (2011), and Koop and Korobilis (2010) for more details.

We estimated the model with Bayesian methods that allow obtaining the distribution of the unknown parameters by algorithms of simulation. We used the Markov chain Monte Carlo (MCMC) algorithms to exploit the blocking structure of state-space form (Kim and Nelson 1999). Conditional on observed data and prior hyperparameters, we implemented the Gibbs sample in four steps:

- Conditional on $A_{0,t}$, $D_t$, and $V_t$, the posterior distribution of $B_t$ can be drawn using the standard Kalman filter.

• Conditional on $B_t$, $D_t$, and $V_t$, the posterior distribution of $A_{0,t}$ is a product of normal (Gaussian) densities and can be drawn with a standard smoother.

• Conditional on $A_{0,t}$, $B_t$, and $V_t$, the posterior distribution of $D_t$ can be drawn transforming a nonlinear and non-Gaussian state-space representation in a linear and approximately normal model, allowing use the standard simulation smoothers.

• Conditional on $A_{0,t}$, $B_t$, and $D_t$, $V_t$ was simulated as the product of independent inverse-Wishart distributions.

Bayesian methods use informative prior information for the estimation of the related models. Following Koop and Korobilis (2010), we used partial information priors to set the initial values:

$$B \sim \mathcal{N}(0, I)$$
$$A_0 \sim \mathcal{N}(0, I)$$
$$D \sim \mathcal{N}(0, I)$$
$$Q \sim \mathcal{IW}(k_Q^2 * I, n + 1)$$
$$S \sim \mathcal{IW}(k_S^2 * I, n + 1)$$
$$W \sim \mathcal{IW}(k_W^2 * I, n + 1)$$

The dimensions of the identity matrix $I$ depend on the rank of the matrices. We also set $k_Q = 0.01$, $k_S = 0.01$ and $k_W = 0.01$ to obtain our results.[4]

We ran 12,000 draws to estimate the conditional posterior distribution of the parameters. To mitigate the initial values, we discarded 2,000 draws ("burn-in" simulations). We also experimented with a higher number of draws—up to 100,00—but our results do not change in any meaningful way. Finally, we present the posterior median of the parameters and the 68 percent equal-tailed point-wise posterior probability bands.

[4] We also implemented ordinary least square and noninformative prior, but the results are similar.