

# The Structural Shift in the Cyclicalities of the Labor Income Share for the United States.

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## Abstract

There is a consensus that the U.S. labor share is countercyclical, reflecting the existence of insurance against unemployment risk. I document a structural change in the cyclicalities of the U.S. labor share, which has become procyclical during the last three decades. I show empirically that the new procyclicality of the labor share is due to the vanishing procyclicalities of labor productivity, to the increase in the volatility of real wages and to the imperfect positive comovement between real wages and average labor productivity. Theoretically, the shift in the cyclicalities of the labor share is a new challenge for a large class of macroeconomic models embedded with labor hoarding and wage rigidity mechanisms. Finally, I present evidence suggesting that the shift in the cyclicalities of the U.S. labor share is not due to changes in industrial composition, contrary to recent cross-country evidence.

Keywords: labor share, labor productivity, labor market insurance, labor hoarding.

JEL Codes: E24, E25, E32.

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# 1 Introduction

The cyclical behavior of labor income is an important topic for macroeconomists. In this paper, I contribute to the macroeconomic literature by reassessing the cyclical behavior of the labor share for the United States over time. Traditionally, the labor’s share is characterized by two stylized facts: (1) the labor share is roughly constant in the long run, as documented by [Kaldor \(1957\)](#); and (2) the labor share moves countercyclically with the business cycle. The “constancy” of the labor share is viewed with skepticism since [Solow \(1958\)](#) and its recent pronounced decline in the U.S. propelled a debate on whether the labor share is mean-reverting or converging towards a new steady state.

On the other hand, there is a strong consensus in the macroeconomic literature on the countercyclicality of the labor share. This countercyclicality of the labor income share is usually explained by the presence of insurance mechanisms for both the households and firms in the wage bargaining process. On the household side, risk averse workers attempt to insure themselves against future income and unemployment risk. On the firm side, the presence of labor hoarding<sup>1</sup> incentives makes the firm be willing to insure themselves against downturns.

I document a structural change in the cyclical movements of the U.S. labor share. Traditionally thought as countercyclical, the labor share started to move procyclically with the business cycle in the last three decades. Looking at the peak-to-trough movements, the labor share decreased on average by 1.157 percentage points on the last three recessions, while it increased on average by 0.386 percentage points on the previous recessions.

The shift in the cyclicity of the labor share can be traced to two key empirical structural changes in the U.S. economy: the vanishing procyclicality of labor productivity and the increase in the volatility of real wages.<sup>2</sup> I show that the shift in the cyclicity of the labor income share is due in 76.8% to the vanishing procyclicality of labor productivity, in 41.4% to the secular increase in the relative volatility of real wages with respect to the volatility of real output. On the other hand,

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<sup>1</sup>Labor hoarding refers to the practice in which a firm does not lay off workers in downturns in order to guarantee these workers’ contribution to the firm’s production in good times. This behavior is most commonly generated under the presence of labor adjustment costs or search and matching frictions. This concept was initially applied to real business cycle fluctuations by [Burnside et al. \(1993\)](#) and [Burnside and Eichenbaum \(1996\)](#).

<sup>2</sup>The decline in the procyclicality of labor productivity and the decline in the correlation between labor productivity and total hours worked is a recent empirical fact documented in [Stiroh \(2009\)](#), [Galí and Gambetti \(2009\)](#), [Gordon \(2010\)](#), [Barnichon \(2010\)](#), [McGrattan and Prescott \(2012\)](#), and [Galí and van Rens \(2017\)](#). The increase in the volatility of real wages is looked at in [Champagne and Kurmann \(2013\)](#).

the relatively stable procyclicality of the average real hourly wage explains -19.8% of the change in the cyclicity of the labor income share.

The shift in the cyclicity of the labor share can also be due to the secular decline in the value added shares for the manufacturing and wholesale and retail trade sectors, and to the corresponding rise of the services and financial activities. [Na \(2017\)](#) observes that differences in sectoral compositions between tradables and non-tradables are an important channel to explain the cross-county heterogeneity in the observed cyclicity of the labor share. Workers in manufacturing and trade industries are subject to a higher unemployment risk due not only to globalization and the competition from international outsourcing, but also to the increasing automation of routine-based tasks and job polarization. This can potentially lead to workers in manufacturing and trade industries requiring a higher degree of insurance when bargaining their contracts with firms. If so, this would imply manufacturing and trade industries having a more countercyclical labor share than the one observed in services and finance.

Under this scenario, and assuming the cyclicity of the sectoral labor shares remain constant over time, the structural change from manufacturing to services is able to generate a decline in the countercyclicality of the aggregate labor share. However, the shift towards a procyclical labor share happens not only for the aggregate labor share but also at the sectoral level. Using a sectoral decomposition analysis for the U.S. economy, I quantify the contributions of variations in the level and cyclicity of sectoral value added shares and sectoral labor shares to the cyclicity of the aggregate labor share. In a counterfactual analysis in which I vary the sectoral composition in the U.S. economy over time, I provide evidence that the structural change from manufacturing to services is not able to explain the shift in the cyclicity of the labor share.

This paper is also related to the growing literature on the changing nature of business cycle fluctuations over time<sup>3</sup> and, more generally, to the literature on structural change in the U.S. economy. It is therefore reasonable to question whether the structural shift in the cyclicity of the labor share is a by-product of another structural change faced by the U.S. economy. Under the context of a real business cycle model I look whether the decline in labor market reallocation rates, the decline in the importance of labor unions, and the growing importance of aggregate

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<sup>3</sup>Refer to [Blanchard and Watson \(1986\)](#), [McConnell and Perez-Quiros \(2000\)](#), [Stock and Watson \(2002\)](#), [Hall \(2007\)](#), [Gali and Gambetti \(2009\)](#), [Garín et al. \(ming\)](#), and [Gali and van Rens \(2017\)](#).

demand shocks to generate business cycle fluctuations can help generating both the decline in the procyclicality of labor productivity and the shift in the cyclicity of the labor share<sup>4</sup>. While these structural changes generate a lower procyclicality of labor productivity under the context of the model, they also trigger counterfactual implications for the cyclicity of the labor share, making it more countercyclical.

This constitutes a new challenge for macroeconomic modeling, which assumes real wages to be almost proportional to (average) labor productivity. To break this proportionality, one can introduce real wage rigidities. These real wage rigidities implement a countercyclical force on the labor share by decreasing the flexibility of the firm in adjusting the real costs of labor input with the business cycle. In this standard model, the increase in wage flexibility is able to reduce the procyclicality of labor productivity and to reduce the countercyclicity of the labor share. However, perfect wage flexibility cannot, by itself, make the labor share become procyclical.

The dynamics of the labor income share are amongst the most important research subjects in macroeconomics during the last decade. The recent trend decline in the labor income share for the United States has sparked a renewed interest in the medium-run dynamics of factor shares. In particular, the literature relates the fall in the labor share to structural changes in the economy. [Elsby et al. \(2013\)](#) argue that the recent decline in the labor share is due to the decline in self-employment and to globalization and offshoring. [Karabarbounis and Neiman \(2014\)](#) show that the decline in the labor share happens at a global level and that it can be explained by a fall in the relative price of investment goods. [Barkai \(2017\)](#) provides evidence that the decline in the labor share is due to an increase in markups. [Autor et al. \(2017\)](#) and [Kehrig and Vincent \(2017\)](#) look to micro-level data and conclude that the fall in the labor share comes from the reallocation of production towards superstar (or hyper-productive) firms. [Grossman et al. \(2017\)](#) claim that the

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<sup>4</sup>Recent work on the decline in labor market fluidity can be found in [Bjelland et al. \(2011\)](#), [Hyatt and Spletzer \(2013\)](#), [Davis and Haltiwanger \(2014\)](#), and [Molloy et al. \(2016\)](#). Deunionization had an accentuated impact on the labor markets, since it implies labor market deregulation and increase in wage flexibility. Moreover, [Acemoglu et al. \(2001\)](#) argue that deunionization increases wage inequality, [Lommerud and Meland \(2009\)](#) argue that it leads to an increase in international outsourcing. [Blau and Kahn \(1999\)](#) provide an excellent overview on the impacts of institutions in the labor market. Demand shocks are important to generate business cycle fluctuations. There is some debate on whether supply or demand shocks are the most important drivers of the business cycles. [Blanchard and Quah \(1989\)](#) find that demand shocks account for two thirds of output variance. [Karabarbounis \(2014\)](#) argues that labor wedge fluctuations are mostly due to fluctuations in decisions taken on the household side of the economy. [Christiano et al. \(2014\)](#) argue that risk shocks are the most important shock driving the business cycle. Francis and Ramey (2005) argue that the business cycles are no longer driven by technology shocks. [Lorenzoni \(2009\)](#) proposes a theory of business cycles driven by demand shocks.

decline in the labor share is due to a global productivity slowdown. Finally, [Martinez \(2018\)](#) focuses on the role of automation to the secular changes in the labor share.

On the other hand, there has been an established consensus in the literature that the labor share is countercyclical. The earlier contributions of [Boldrin and Horvath \(1995\)](#) and [Gomme and Greenwood \(1995\)](#) highlighted the role of labor contracts in generating a countercyclical labor share by providing an insurance mechanism against unemployment risk. On the other hand, [Andolfatto \(1996\)](#) embeds a standard real business cycle model with search and matching frictions and argues that this model generates a countercyclical labor share because these frictions manifest a labor hoarding mechanism. More recently, the literature has shifted away from explaining the cyclicity of the labor share using non-competitive factors towards looking to changes in aggregate technology and in the elasticity of substitution between capital and labor.

In particular, [Ríos-Rull and Santaaulávia-Llopis \(2010\)](#) use a Cobb-Douglas production function with time-varying factor shares and find that the labor share decreases contemporaneously with a technological innovation, but it increases in the medium-run as a result of the same innovation. [Choi and Ríos-Rull \(2009\)](#) assess the relative importance of noncompetitive factor prices and different specifications for the aggregate production function. They argue that the literature should shift away from introducing frictions in the economy and move towards a technological explanation for the cyclicity of the labor share by considering a constant elasticity of substitution (CES) technology.

[Koh and Santaaulávia-Llopis \(2017\)](#) build on this idea and use a production function that is CES in the short-run, but Cobb-Douglas in the long-run. They argue that the cyclicity of the labor share can be explained by a countercyclical elasticity of substitution between capital and labor. In a related paper, [Hansen and Prescott \(2005\)](#) notices how capacity constraints at the plant level will translate into an aggregate production function that is not Cobb-Douglas and generate a countercyclical labor share in a one-sector growth model.

I structure this paper as follows. In section 2, I describe the shift in the cyclicity of the labor share and its robustness across different measurements. In section 3, I propose a decomposition relating the cyclicity of the labor share to the cyclicity of labor productivity and real wages. In section 4, I provide evidence that changes in industry composition are not able to generate the shift in the cyclicity of the aggregate labor share. In section 5, I look to international cross-

country evidence to see how the cyclicalities of the labor share evolved over time in other advanced economies. In section 6, I describe a real business cycle model with labor hoarding, workers' risk aversion and wage bargaining. In section 7, I use this model as a workhorse to test whether the shift in the cyclicalities of the labor share is a by-product of the decline in the procyclicality of labor productivity. I show that in this model the decline in labor market fluidity, deunionization, and a growing importance of demand shocks to generate business cycle fluctuations are able to generate the decline in the procyclicality of labor productivity but not the shift in the cyclicalities of the labor share. Finally, in section 8, I conclude the paper.

## 2 The Structural Shift in the Cyclicalities of the Labor Income Share for the United States.

The labor share is conceptually equal to the ratio of labor compensation to gross value added.

$$\lambda_t = \frac{W_t H_t}{P_t Y_t} \tag{1}$$

where  $W_t$  is the average compensation per hour of work,  $H_t$  the total number of hours worked, and  $P_t Y_t$  the (nominal) gross value added, in which  $P_t$  stands for the price level and  $Y_t$  for the quantity produced. In practice, correctly measuring the labor share is not a trivial task<sup>5</sup>.

The main difficulty lies in the allocation (and imputation) of proprietors' income between capital and labor income. The estimation of the labor compensation for the self-employed encompasses a measurement error component that generates an additional bias in case this income is allocated to the labor share without further adjustment. Additionally, the researcher needs to choose which sectors to include (exclude) from the analysis as there are sectors that have no labor income (housing) or no capital income (government), which can generate further methodological issues. For example, not including the government sector in the analysis raises the question of how to handle the income generated by the net indirect taxes and taxes on production. A related question would be whether to consider the agricultural sector in the analysis, as it is a sector with different features from the rest of the economy. Finally, the researcher needs to decide on whether or not to include depreciation in the measure of output. Although the labor share is a relatively simple

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<sup>5</sup>A more detailed overview of the challenges faced by researchers when measuring the labor share can be found in [Gollin \(2002\)](#), [Gomme and Rupert \(2004\)](#), [Elsby et al. \(2013\)](#), and [Rognlie \(2015\)](#).

concept, it is significantly difficult to measure.

The literature has converged to five alternative methodologies to measure the labor share<sup>6</sup>:

- i. payroll share for employees in the nonfarm business sector;
- ii. headline BLS labor share, following [Kravis \(1959\)](#) labor basis methodology;
- iii. economy-wide labor share measured using the unambiguous income shares;
- iv. payroll share for employees in the corporate business sector;
- v. BLS annual multifactor productivity labor share, which is an updated methodology based on [Kravis \(1959\)](#) asset-basis approach.

Notice that regardless of the measurement used the labor share is a variable that captures the ratio of a measure of aggregate compensation to a related measure of aggregate income.

I construct the time series for the five alternative measurements of the labor share using the Productivity and Costs dataset from the Bureau of Labor Statistics (BLS) and the National Income and Product Accounts (NIPA) from the Bureau of Economic Analysis. I also obtain the corresponding time series for real output from NIPA. I identify business cycle fluctuations by applying the [Christiano and Fitzgerald \(2003\)](#) approximate bandpass filter with frequencies between 6 and 32 quarters<sup>7</sup>. The second column in [Table 1](#) shows the point estimates for the cyclicalities of the labor share for the entire sample for the five different variables considered above. When we look at the entire sample, and regardless of our preferred measurement for the labor share, the labor share is countercyclical. The estimated correlations between the cyclical components for the labor share and real output lie between -0.069 for the payroll share for the nonfarm business sector and -0.274 for the payroll share for the corporate sector. The headline labor share published by the BLS is countercyclical with a correlation of -0.217 with real output.

However, looking to the cyclicalities of the labor share for the entire sample masks a considerable heterogeneity in the cyclical movements of the labor share over time. In fact, the labor share

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<sup>6</sup>A more extensive description for the different methodologies can be found in [Appendix A](#). The construction of the payroll share for the nonfarm business sector is described in [Appendix B](#).

<sup>7</sup>My sample goes from 1947:1 to 2016:4. I extract the cyclical component for the variables of interest after applying the filter to the natural logarithm of the original time series. To understand whether my findings were an artificial result coming from the particular filtering procedure used and not a true structural change in the business cycles dynamics for the U.S. economy, I have performed a robustness check in which I use the filtering methodology proposed in [Hamilton \(2017\)](#). The results are qualitatively the same using this alternative approach.

Table 1: The Cyclicalities of the Labor Share Over Time: Alternative Measures

$\rho(\hat{\lambda}_t, \hat{y}_t)$	1947-2016	1947-1987	1988-2016	Change
Payroll Share NFB	-0.069 [-0.196,0.058]	-0.181 [-0.338, - 0.024]	0.280 [0.094,0.467]	0.461 [0.218,0.704]
Headline Labor Share	-0.217 [-0.341, - 0.093]	-0.361 [-0.504, - 0.217]	0.254 [0.071,0.437]	0.615 [0.383,0.847]
Economy Wide	-0.153 [-0.265, - 0.041]	-0.264 [-0.397, - 0.130]	0.134 [-0.139,0.406]	0.365 [0.121,0.609]
Payroll Share Corporate	-0.274 [-0.392, - 0.155]	-0.411 [-0.542, - 0.281]	0.022 [-0.196,0.239]	0.433 [0.179,0.686]
Asset Basis (MFP)	-0.109 [-0.315,0.098]	-0.232 [-0.492,0.029]	0.266 [0.033,0.498]	0.497 [0.151,0.844]

Sources: Bureau of Economic Analysis, Bureau of Labor Statistics, and author’s calculations. In squared-brackets is shown the 95% confidence interval. The data for the asset basis (MFP) measure is only available annually. The business cycles identified for this variable correspond to fluctuations between 2 and 8 years. Standard errors obtained by using the “Delta Method”.

has become considerably more procyclical in the last three decades. After obtaining the cyclical components for the labor share and real output, I partition the sample and compute the cyclicalities of the labor share for two distinct periods. The earlier period comprises 1947-87 and the latter period 1988-2016<sup>8</sup>.

I present the cyclicalities of the labor share for both sub-samples in the third and fourth column of Table 1. While the labor share is countercyclical in the earlier period, it becomes procyclical in the latter period. The correlation between the headline labor share and real output goes from -0.361 in 1947-1987 to 0.254 in 1988-2016. The shift in the cyclicalities of the labor share towards procyclicality is robust compared to the usage of the alternative measurement methodologies used in the literature. To see this, in the last column of Table 1 I show how the cyclicalities of the labor share changed across sub-samples. To do so, I regress the cyclical component of real output in the cyclical component of the labor share and I interact it with a dummy variable that takes all periods

<sup>8</sup>There is not a clear break point between sub-samples. I calculate the time-varying correlation between the cyclical components of the labor share and real output using rolling windows of 10, 15, 20, and 25 years. Then, I test for a structural break with an unknown date for this series and I retrieve the estimated break (window)date. For the rolling correlations with a 10-year window, the estimated break in the cyclicalities of the labor share occurs in the time interval 1987:3 to 1996:3. The estimated break using rolling correlations with a 25-year window occurs in the time interval 1982:4-2006:4. Therefore, any partition break between 1983:1 and 1987:4 would reflect the shift in the cyclicalities of the labor share.



Table 2: Cyclical Movements of the Headline Labor Share (BLS) in Upturns and Downturns.

$\Delta \hat{\lambda}$		1947-2016	1947-1987	1988-2016
Payroll	Upturns	-0.115 s.d.	-0.265 s.d.	0.102 s.d.
Share NFB	Downturns	0.123 s.d.	0.275 s.d.	-0.113 s.d.
Headline	Upturns	-0.374 s.d.	-0.665 s.d.	0.046 s.d.
Labor Share	Downturns	0.372 s.d.	0.678 s.d.	-0.104 s.d.
Economy	Upturns	-0.099 s.d.	-0.396 s.d.	0.330 s.d.
Wide	Downturns	0.173 s.d.	0.428 s.d.	-0.224 s.d.
Payroll Share	Upturns	-0.211 s.d.	-0.361 s.d.	-0.006 s.d.
Corporate	Downturns	0.233 s.d.	0.416 s.d.	-0.015 s.d.

starting from the first quarter of 1988 into account,

$$\hat{y}_t = \alpha_0 + \alpha_1 \cdot \mathbb{1}[\text{year} \geq 1988] + \beta_1 \cdot \hat{\lambda}_t + \beta_2 \cdot \hat{\lambda}_t \cdot \mathbb{1}[\text{year} \geq 1988] + \epsilon_t \quad (2)$$

where  $\hat{\alpha}_0$  and  $\hat{\alpha}_1$  are approximately equal to zero. Using the estimates for  $\hat{\beta}_1$  and  $\hat{\beta}_2$ , I calculate the changes in the correlations over time and its statistical significance by using the “Delta Method”. The shift towards a procyclical labor share is largest for the headline labor share and smallest for the economy-wide labor share. However, for all measurements of the labor share considered,  $\hat{\beta}_2$  is positive and statistically significant, which reflects a structural change in the cyclicity of the labor share.

I characterize also the cyclical behavior of the labor share by looking at its behavior during upturns and downturns. In particular, I define a downturn as the peak-to-trough (and upturn as trough-to-peak) movements in the cyclical component of real output. In Table 2 I present the cumulative variation in the cyclical component for the labor share for each upturn and downturn, across the different measurements of the labor share<sup>9</sup>.

The results for the entire sample reflect that the labor share decreases in upturns and increases in downturns, reinforcing the traditional consensus on the countercyclicity of the labor share. The variations in the labor share in both upturns and downturns almost double in 1947-1987 in

<sup>9</sup>I use the entire sample to obtain the standard deviation of the labor share. Then, I normalize the changes in the cyclical component of the labor share in each upturn and downturn by dividing its absolute value by previously calculated standard deviation.

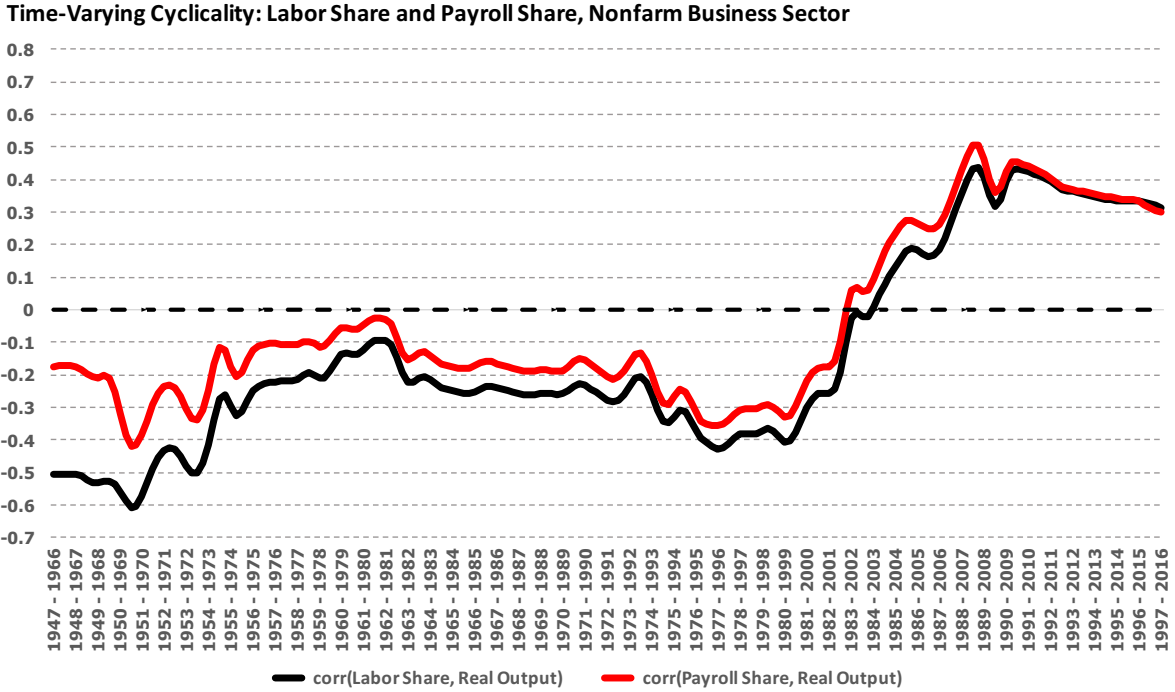


Figure 1: Time-Varying Cyclicity of the Headline Labor Share (BLS) and the Payroll Share for the Nonfarm Business Sector.

comparison to the average variations observed in the entire sample. On the other hand, the cyclical movements in the labor share completely shift after 1988. In the last three decades, an upturn has been associated with an increase in the labor share, while a downturn with a decrease in the labor share. The evidence in Table 2 confirms the idea that there is a structural shift in the cyclical movements of the labor share and its robustness across measurement methodologies.

To study the stability of the shift in the cyclicity of the labor share over time, in Figure 1, I plot the correlation between the headline labor share and the real value added for the nonfarm business sector over time using 20-year rolling windows. The labor share is countercyclical in the initial part of the sample, but it has become clearly procyclical over the last three decades. The recent procyclicality of the labor share does not disappear even in the aftermath of the Great Recession.<sup>10</sup>

One interesting result is that the shift in the cyclicity of the labor share is driven by changes

<sup>10</sup>The shift in the cyclicity of the labor share from countercyclical to procyclical is also robust compared to the size of the rolling windows shown. In particular, the shift in the cyclicity of the labor share is starker when we consider 30-year rolling windows instead of the 20-year windows shown in this paper.

in the labor market conditions for employees. In Figure 1 I also plot the time-varying cyclicality of the payroll share for the nonfarm business sector. The inclusion of self-employment introduces a countercyclical pressure on the cyclicality of the labor share throughout the entire sample, but it does not affect its shift towards procyclicality in the late period. The two series track each other very closely, and almost exactly in the latter periods of the sample since the relative share of hours worked by self-employed workers decreases from roughly 15% in 1947 to 8% in 2016. This is an important result as [Elsby et al. \(2013\)](#) argues that “one third of the decline in the headline labor share appears to be a by-product of the methods employed by the BLS to impute the labor income of the self-employed.”. The methodology followed by the BLS is also affected by the decline in the relative share of total hours worked by self-employed workers in the economy<sup>11</sup>.

In fact, it is quite likely that the shift in the cyclicality of the labor share is related to its trend decline. In Figure 2, I plot the time-varying cyclicality of the headline labor share, as well as its average level for the same time period. The labor share declined by two percentage points from 1947-1966 to 1983-2002, but it decreased by 2.5 percentage points from 1983-2002 to 1997-2016. This acceleration in the fall of the labor share occurs at the same time the labor share shifts from countercyclical to procyclical.

Figure 2 provides the main empirical motivation for the remainder of the paper. The dynamics of the labor share are characterized by two main stylized facts: the apparent constancy of the labor share over time, and its countercyclicity. In the last three decades, the labor share started to fall at an accelerated rate and has become procyclical. This suggests that both the level and cyclical movements of the labor share are affected by another structural change in the U.S. economy which is making the labor share converge to a new steady state. The robustness of the shift in the cyclicality of the labor share across different measurement methodologies and the unimportance of cyclical movements in the labor input provided by self-employed workers hint that the main explanation for these two facts lie in a structural change to the labor market conditions for employees.

In the following section, I trace the shift in the cyclicality of the labor share to two key facts: the vanishing procyclicality of labor productivity, and the imperfect and positive relationship between

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<sup>11</sup>Throughout the remainder of this paper, I use the nonfarm business sector payroll share as my preferred measure for the labor share. The shift in the cyclicality of the labor share is robust compared to the methodology used to measure the labor share and the payroll share provides a clearer interpretation of the labor share and a deeper analysis at the industry level.

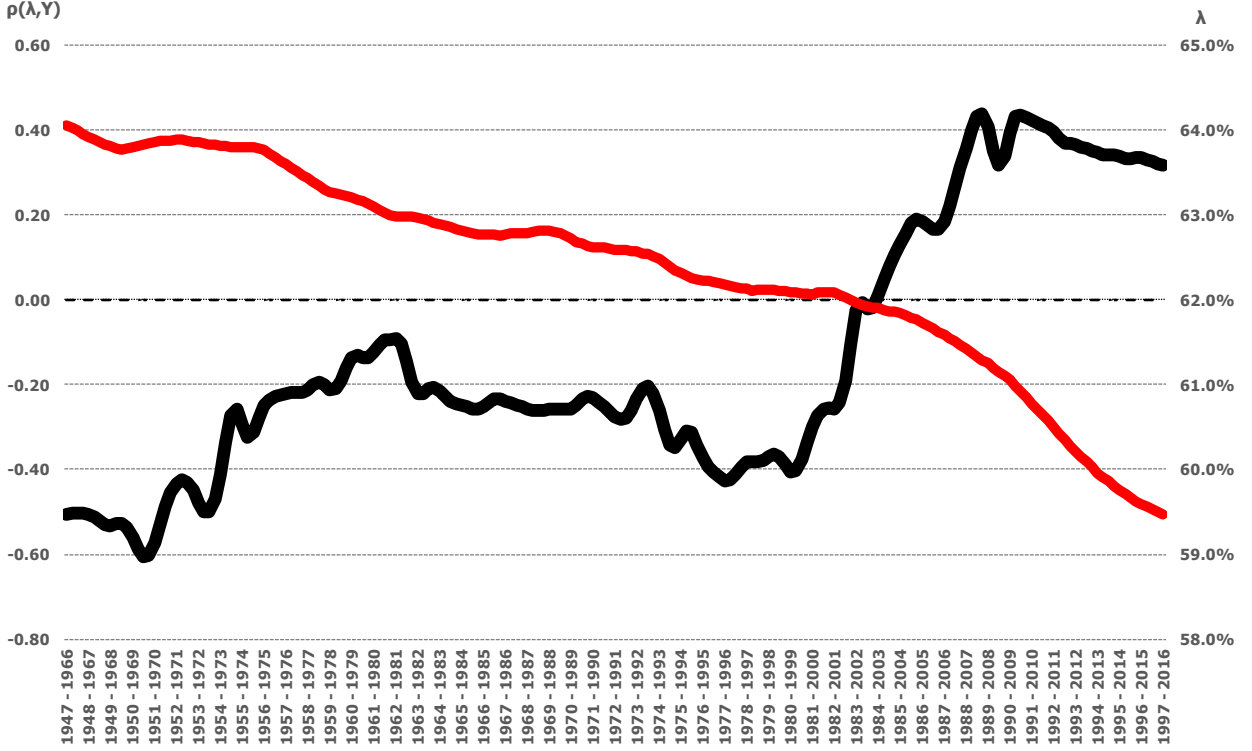


Figure 2: The Structural Shift in the Stylized Facts for the Labor Share.

real wages and labor productivity. This empirical evidence imposes discipline to macroeconomic models that attempt to replicate the cyclical dynamics of the U.S. economy.

### 3 Cyclicity of Real Wages and Labor Productivity.

The definition for the labor share described in (1) can be reinterpreted as the ratio between the real wages earned per hour of work ( $W_t/P_t$ ) and labor productivity, defined as the number of units of output produced per hour of work ( $Y_t/H_t$ ). This reinterpretation implies the following decomposition for the cyclicity of the labor share

$$\rho(\hat{\lambda}_t, \hat{y}_t) = \frac{\sigma(\hat{w}_t)}{\sigma(\hat{\lambda}_t)} \cdot \rho(\hat{w}_t, \hat{y}_t) - \frac{\sigma(\hat{y}_t - \hat{h}_t)}{\sigma(\hat{\lambda}_t)} \cdot \rho(\hat{y}_t - \hat{h}_t, \hat{y}_t) \quad (3)$$

where  $\hat{w}_t \equiv \hat{W}_t - \hat{P}_t$  is the cyclical component for the real hourly wage,  $\hat{y}_t - \hat{h}_t$  is the cyclical component for labor productivity,  $\hat{h}_t$  is the cyclical component for the total number of hours worked

by employees, and  $\hat{\lambda}_t$  is the cyclical component for the labor share<sup>12</sup>.

Table 3 explores how each component in (3) has changed over time. There are three key features in the data, which are important when explaining the shift towards a procyclical labor share in the U.S. economy.<sup>13</sup>

1. The “vanishing procyclicality” of labor productivity: labor productivity was historically procyclical but it has become acyclical in the last three decades. This reflects a perfect comovement between total hours and real output in the latter period and is associated with a decline in labor hoarding at the firm level and an increase in labor market flexibility.
2. The increase in the relative volatility of real wages: after the Great Moderation, the volatility of output almost halved, but the volatility of real wages increased over time. This finding contrasts with the slow and steady decline in the relative volatility of labor productivity over time.

The first two empirical facts generate a procyclical force to the cyclicity of the labor share since the real wages are procyclical throughout the sample and their relative volatility with respect to the volatility of the labor share increases over time. The decline in the cyclicity of real wages is not as strong as the one observed by the cyclicity of labor productivity, which is in contrast to the predictions of a large class of real business cycle models that assume real wages to be (almost) proportional to labor productivity<sup>14</sup>. This notion motivates the introduction of a third key fact.

3. The imperfect comovement between real wages and labor productivity and its constancy over time: real wages and labor productivity are positively but not perfectly correlated. Moreover, the imperfect relationship between real wages and labor productivity is constant over time.

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<sup>12</sup> $\rho(x, z)$  is defined to be the correlation between variables  $x$  and  $z$ , and  $\sigma(x)$  the standard deviation of variable  $x$ .

<sup>13</sup>These facts are known to the literature but they are usually analyzed in separate contexts. The vanishing procyclicality of labor productivity is first exposed and studied in [Stroh \(2009\)](#), [Galí and Gambetti \(2009\)](#), [Barnichon \(2010\)](#), [McGrattan and Prescott \(2012\)](#), and [Galí and van Rens \(2017\)](#). The increase in the relative volatility of real wages is documented in [Champagne and Kurmann \(2013\)](#). It is also known that real wages and labor productivity are not perfectly correlated. However, the literature usually introduces a formulation for wage rigidity to break the relationship between the two variables. As argued in the text, this would violate one of the three empirical facts. It is therefore important to consider an environment in which the three facts are considered jointly, which adds further discipline to standard real business cycle models.

<sup>14</sup>In the following chapter, I show that a model with wage bargaining and labor hoarding is able to generate a decline in the cyclicity of labor productivity but not the shift to a procyclical labor share. The main justification for this is that real wages are tightly linked to labor productivity. Attempts to introduce wage rigidity to break the proportionality of these two variables considerably decreases the relative volatility of real wages and makes the labor share more countercyclical.

Table 3: The Cyclicity of Real Wages and Labor Productivity

$$\rho(\hat{\lambda}_t, \hat{y}_t) = \frac{\sigma(\hat{w}_t)}{\sigma(\hat{\lambda}_t)} \cdot \rho(\hat{w}_t, \hat{y}_t) - \frac{\sigma(\hat{y}_t - \hat{h}_t)}{\sigma(\hat{\lambda}_t)} \cdot \rho(\hat{y}_t - \hat{h}_t, \hat{y}_t)$$

	1947-2016	1947-1987	1988-2016	Change
$\rho(\hat{\lambda}_t, \hat{y}_t)$	-0.069 [-0.196,0.058]	-0.181 [-0.338,-0.024]	0.280 [0.094,0.467]	0.461 [0.218,0.704]
$\rho(\hat{w}_t, \hat{y}_t)$	0.365 [0.240,0.490]	0.460 [0.314,0.605]	0.270 [0.115,0.425]	-0.189 [-0.402,0.023]
$\rho(\hat{y}_t - \hat{h}_t, \hat{y}_t)$	0.352 [0.221,0.484]	0.451 [0.298,0.604]	0.012 [-0.170,0.194]	-0.439 [-0.676,-0.202]
$\rho(\hat{w}_t, \hat{y}_t - \hat{h}_t)$	0.460 [0.369,0.550]	0.444 [0.316,0.572]	0.529 [-0.411,0.647]	0.085 [-0.089,0.259]
$100 \times \sigma(\hat{y}_t)$	2.047	2.436	1.325	-1.111
$100 \times \sigma(\hat{\lambda}_t)$	0.970	1.044	0.859	-0.185
$100 \times \sigma(\hat{w}_t)$	0.806	0.710	0.927	0.217
$100 \times \sigma(\hat{y}_t - \hat{h}_t)$	1.025	1.144	0.833	-0.311

Sources: BEA, BLS, and author's calculations. In squared-brackets is shown the 95% confidence interval.

To quantify the contribution of real wages and labor productivity to the shift in the cyclicity of the labor share, I re-write the decomposition in (3) in terms of OLS regression coefficients defined by regressing the variable of interest in the cyclical component of real output<sup>15</sup>.

$$\beta_{\hat{\lambda}, \hat{y}} = \beta_{\hat{w}, \hat{y}} - \beta_{\hat{y} - \hat{h}, \hat{y}} \quad (4)$$

The results are described in Table 3 and Table 4. Table 3 provides the intuition in terms of correlations and standard deviations. Table 4 quantifies the contributions of real wages and labor

<sup>15</sup>Notice that equation (3) can be re-written in terms of covariances as  $\text{cov}(\hat{\lambda}_t, \hat{y}_t) = \text{cov}(\hat{w}_t, \hat{y}_t) - \text{cov}(\hat{y}_t - \hat{h}_t, \hat{y}_t)$ . Dividing both sides of this new equation by the volatility of real output, we obtain  $\frac{\text{cov}(\hat{\lambda}_t, \hat{y}_t)}{\sigma(\hat{y}_t)^2} = \frac{\text{cov}(\hat{w}_t, \hat{y}_t)}{\sigma(\hat{y}_t)^2} - \frac{\text{cov}(\hat{y}_t - \hat{h}_t, \hat{y}_t)}{\sigma(\hat{y}_t)^2}$ . Since  $\frac{\text{cov}(X, Z)}{\sigma(Z)}$  is by definition the ordinary least squares coefficient for the regression  $X = \alpha + \beta_{x,z} \cdot Z + \nu$ , the previous equation implies a very simple decomposition in terms of OLS regression coefficients:  $\beta_{\hat{\lambda}, \hat{y}} = \beta_{\hat{w}, \hat{y}} - \beta_{\hat{y} - \hat{h}, \hat{y}}$ .

productivity to the shift in the cyclical of the labor share. Looking first to the entire sample, the labor share is mildly countercyclical<sup>16</sup>. The cyclical of real wages is roughly the same as the cyclical of labor productivity. Therefore, the countercyclical of the labor share comes from the fact that real wages are less volatile than labor productivity. This scenario is usually the one predicted by standard real business cycle models. These models are embedded with a labor hoarding or a wage bargaining mechanism and do a great job explaining these aggregate facts. The imperfect comovement between the real wages and labor productivity and the lower volatility of real wages are obtained by introducing some degree of wage rigidity.

In the earlier partition of the sample, when output is one percentage point above trend, the labor share is 0.076 percentage points below its trend. The intuition behind the countercyclical of the labor share is the same as for the entire sample. The countercyclical of the labor share is larger in the earlier period due to the larger differences in the volatilities of real wages and labor productivity. As the volatility of real wages increases over time, this shuts down the standard channel for the countercyclical of the labor share. However, from 1988-2016, when output is one percentage point above trend, the labor share is 0.182 percentage points above trend. The procyclical of the labor share comes from two different sources. First, there was a decline in the procyclical of real wages, but real wages remain procyclical in the last three decades. This contrasts with the behavior of labor productivity, which passed from procyclical to acyclical<sup>17</sup>. Second, real wages are now more volatile than labor productivity. The increase in the volatility of real wages provides a procyclical force to the cyclical of the labor share.

Using the results in Table 4, we can decompose the change in  $\beta_{\lambda, \hat{y}}$  by looking at the changes in the coefficients for real wages and labor productivity.  $\beta_{\hat{w}, \hat{y}}$  is positive for the entire sample and it increases slightly by 0.062 percentage points between the early and late samples, due to the increase in the relative volatility of real wages. On the other hand,  $\beta_{\hat{y} - \hat{h}, \hat{y}}$  declines by 0.205 percentage points, making labor productivity shift from procyclical to acyclical. These changes imply that the vanishing procyclical of labor productivity explains 76.8% of the shift in the cyclical of the labor share. The remaining 23.2% of the shift in the cyclical of the labor share come from the decline in the procyclical of real wages and from the increase in the relative

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<sup>16</sup>I consider here the labor share to be the payroll share for the nonfarm business sector.

<sup>17</sup>Notice that labor productivity being acyclical implies that total hours are proportional to real output. Therefore, this means that a 1% change in output is translated into a 1% change in total hours over the business cycle.

Table 4: Cyclicalilty of Labor Share, Real Wages, and Labor Productivity (OLS).

$$\beta_{\hat{\lambda}, \hat{y}} = \beta_{\hat{w}, \hat{y}} - \beta_{\hat{y} - \hat{h}, \hat{y}}, \text{ where } \hat{x}_t = \beta_{\hat{x}, \hat{y}} \cdot \hat{y}_t + \nu_t, \text{ for } \hat{x} \in \{\hat{\lambda}, \hat{w}, \hat{y} - \hat{h}\}$$

	1947-2016	1947-1987	1988-2016	Change	%-Contribution
$\beta_{\hat{\lambda}, \hat{y}}$	-0.033	-0.076*	0.182**	0.258	
$\beta_{\hat{w}, \hat{y}}$	0.142**	0.131**	0.193**	0.062	23.2%
$\beta_{\hat{y} - \hat{h}, \hat{y}}$	0.176**	0.212**	0.007	-0.205	76.8%

\*\* denotes statistical significance at 1% level, \* is statistical significance at 5%.

volatility of the real wages with respect to real output. The increase in the relative volatility of wages and the slight decline in the procyclicality of real wages account for 41.4% and -19.8% of the shift in the cyclicalilty of the labor share, respectively <sup>18</sup>. The impact of the increase in the volatility of the real wages on the cyclicalilty of the labor share is dampened by the decline in the cyclicalilty of real wages. However, this decline is not as strong as the recent acyclicalilty of labor productivity.

In the earlier work of [Burnside et al. \(1993\)](#) and [Burnside and Eichenbaum \(1996\)](#) labor hoarding was captured by a very procyclical factor utilization. Figure 3 shows that the vanishing procyclicalilty of labor productivity is reflected in a stark decline in the usage of labor hoarding in the U.S. economy, as measured by the recent acyclicalilty of factor utilization<sup>19</sup>.

This may imply a structural change in the labor market turnover behavior at the firm level or a shift in the sectoral composition (or firm distribution) in the U.S. economy. There is considerable evidence that there has been a decline in labor market fluidity for the U.S. economy, [Davis and Haltiwanger \(2014\)](#) and [Molloy et al. \(2016\)](#). One potential explanation for this decline in the

<sup>18</sup>I considered the following exercise: Let the cyclicalilty of real wages and labor productivity be that which was observed in the data but fix the relative volatility of real wages and labor productivity to the value observed in the earlier part of the sample ( $\sigma(\hat{w})/\sigma(\hat{y}) = 0.710/2.436$  and  $\sigma(\hat{y} - \hat{h})/\sigma(\hat{y}) = 1.144/2.436$ ). The counterfactual  $\beta_{\hat{w}, \hat{y}}$  and  $\beta_{\hat{y} - \hat{h}, \hat{y}}$  that would be observed in this scenario are equal to 0.079 and 0.006, respectively. The corresponding counterfactual  $\beta_{\hat{\lambda}, \hat{y}}$  would be equal to 0.073, representing an increase of 0.158 percentage points with respect to  $\beta_{\hat{\lambda}, \hat{y}}$  in the early period of the sample. This would make the contribution of real wages to the shift in the cyclicalilty of the labor share be counterfactually equal to -19.8%. Since the actual contribution is 23.2%, this means that the increase in the volatility of real wages explains 41.4% of the shift in the cyclicalilty of the labor share. Finally, notice that the change in the relative of labor productivity has almost no impact on  $\beta_{\hat{y} - \hat{h}, \hat{y}}$ .

<sup>19</sup>I use the time series for factor utilization from the total factor productivity data from the Federal Reserve Bank of San Francisco, which is described in [Fernald \(2014\)](#). I follow [Fernald \(2014\)](#) and assume factor utilization to be 0 (in logs) for 1987:4. After re-constructing the time series for the logarithm of factor utilization, I pass it under a bandpass filter, identifying the business cycles between 6 quarters and 32 quarters, to obtain the filtered series for factor utilization.



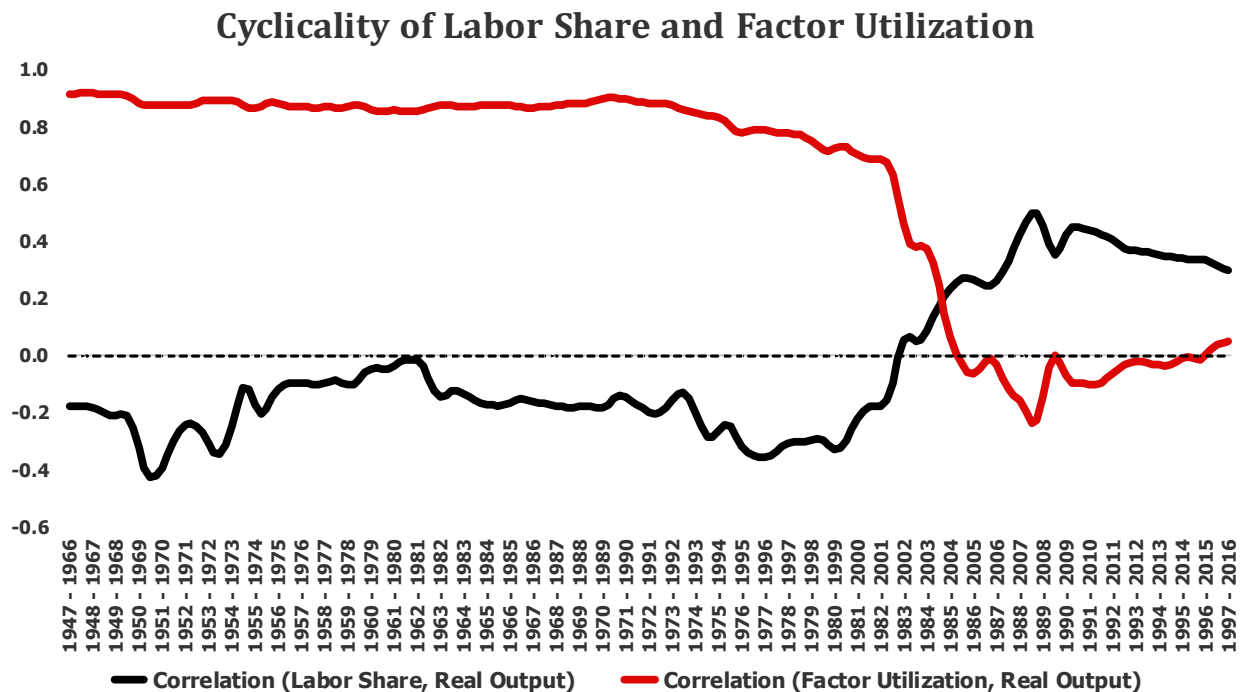


Figure 3: The Vanishing (Pro)Cyclicality of Factor Utilization in the U.S.

labor market reallocation rates is the increase in the average size and age for the firms in the U.S. economy, which would be translated in a shift in the U.S. firm distribution. However, further research needs to be done to conciliate this observed increase in the average size and age for the firms in the U.S. economy with the appearance of hyper-productive capital-intensive firms in the U.S. economy, which is an explanation advanced by [Autor et al. \(2017\)](#) and [Kehrig and Vincent \(2017\)](#) for the recent decline in the level of the labor share.

Finally, one can think that secular changes in sectoral composition may be important to explain the shift in the cyclicality of the labor share. Examples of these changes in sectoral composition can be the shift in production from manufacturing to services, the increase in the importance of the financial activities sector, or the impact of globalization and outsourcing on the wholesale and retail trade sectors. I show in the following section that changes in industrial composition are not driving the shift in the cyclicality of the labor share.

## 4 Are Changes in Industrial Composition Driving the Shift in the Cyclicity of the Labor Share?

I provided evidence that the shift in the cyclicity of the labor share is driven by three aggregate phenomena: the vanishing procyclicality of labor productivity, the increase in the relative volatility of wages, and the fact that real wages and labor productivity are not proportional to each other. I have shown by means of a counterexample that these features introduce further discipline to macroeconomic modeling and that they constitute a challenge for the traditional literature that ends up relying on labor hoarding and wage bargaining mechanisms. However, the shift in the cyclicity of the labor share can alternatively be due to secular changes in industrial composition of the U.S. economy, such as the secular decline in manufacturing and trade sectors and the corresponding rise of services and financial activities.

In a related paper, [Na \(2017\)](#) observes that differences in sectoral compositions between tradables and non-tradables are an important channel to explain the cross-county heterogeneity on the observed cyclicity of the labor share. This will be the case if workers in manufacturing and trade industries are subject to a higher unemployment risk than workers in the services sector. One possibility for this to occur is the increased competition to manufacturing from international outsourcing and, more generally, from globalization. This would lead workers in manufacturing and trade industries to require a higher degree of insurance when bargaining their contracts with firms. If so, manufacturing and trade industries would have a more countercyclical (or less procyclical) labor share than in services and finance.

On the other hand, [Elsby et al. \(2013\)](#) provide evidence that the recent trend decline in the aggregate payroll share comes from declines in the payroll shares within sectors, and not due to changes in the composition of these sectors. If the trend decline and the shift in the cyclicity of the labor share are related, then the shift in the cyclicity of the labor share would happen at the sectoral level, and it would not be a byproduct of secular changes in the industrial composition.

In this section, I extend my previous analysis and quantitatively show that the shift in the cyclicity of the labor share is not due to changes in the industrial composition of the U.S. economy. In fact, the shift in the cyclicity of the labor share happens not only for manufacturing and for wholesale and retail trade, but also in the professional and business services and financial activities

industries. To quantify the impact of sectoral composition on the shift in the cyclicity of the labor share, I use a decomposition that relates the cyclicity of the aggregate labor share to the cyclicity of the sectoral labor shares and sectoral value added shares.

I construct a dataset with the labor share and value added shares for the nonfarm private sector at the two-digit industry level. This data is taken from NIPA at an annual frequency from 1947 to 2015<sup>20</sup>. In order to build some intuition that the shift towards a procyclical labor share is not an aggregate result, Figure 4 shows the time-varying cyclicity of the labor share for manufacturing, wholesale and retail trade, financial activities, and professional and business services. The value added share in manufacturing decreased by 20.1 percentage points between 1947 and 2015, while the value added share for wholesale and retail trade declined by 9.5 percentage points over the same period. On the other hand, the value added share for professional and business services increased by 12.4 percentage points and it increased for financial activities by 5.2 percentage points. The cyclicity of the labor share has increased considerably in the last three decades for each of these industries. More strikingly, the cyclicity of the labor share for the manufacturing sector closely resembles the cyclicity of the aggregate labor share.

In order to quantify the impacts of structural change on industrial composition to the shift in the cyclicity of the labor share, I decompose the aggregate labor share as a weighted average of each sector's labor share, where the weights are given by the nominal value added shares of each sector. Suppose there are  $K \in \mathbb{N}$  industries in the economy. The aggregate labor share is

$$\lambda_t = \sum_{i=1}^K \left( \frac{P_t^i \cdot Y_t^i}{P_t \cdot Y_t} \right) \cdot \left( \frac{W_t^i \cdot H_t^i}{P_t \cdot Y_t} \right) \equiv \sum_{i=1}^K \gamma_t^i \cdot \lambda_t^i \quad (5)$$

where  $P_t^i Y_t^i$  is the nominal value added for industry  $i$ ,  $P_t Y_t$  the nominal value added for the nonfarm private sector,  $W_t^i H_t^i$  the total compensation for industry  $i$ , defined as the product of the nominal wage per hour of worker with the total number of hours worked in industry  $i$ . Using these definitions,  $\gamma_t^i$  is the value added share of industry  $i$  and  $\lambda_t^i$  is the labor share in industry  $i$ . Then, it can be

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<sup>20</sup>The labor share is defined to be the payroll share. There is a structural break in the classification of industries in 1987, when the classification passed from the Standard Industrial Classification (SIC) to the North American Industry Classification System (NAICS). I divide the nonfarm private sector in 14 industries: Mining, Construction, Manufacturing, Utilities, Transportation and Warehousing, Wholesale and Retail Trade, Financial Activities, Real Estate, Information, Professional and Business Services, Leisure and Hospitality, Educational Services, Health Care and Social Assistance, and Other Services. Appendix C describes in detail the methodology and cross-walk tables used to construct consistent time series for sectoral labor shares and real value added shares.



Figure 4: The Shift in the Cyclicality of the Labor Share across U.S. Industries.

shown that the aggregate cyclicity of the labor share can be approximated by a weighted average of the cyclicity of labor and value added shares at the sectoral level.

$$\rho(\hat{\lambda}_t, \hat{y}_t) = \sum_{i=1}^K \left( \frac{\gamma^i \lambda^i}{\lambda} \right) \cdot \left[ \frac{\sigma(\hat{\gamma}_t^i)}{\sigma(\hat{\lambda}_t)} \cdot \rho(\hat{\gamma}_t^i, \hat{y}_t) + \frac{\sigma(\hat{\lambda}_t^i)}{\sigma(\hat{\lambda}_t)} \cdot \rho(\hat{\lambda}_t^i, \hat{y}_t) \right] \quad (6)$$

where  $\gamma^i$ ,  $\lambda^i$  and  $\lambda$  denote the trend values for the sectoral value added share, sectoral labor share, and aggregate labor share (respectively).  $\hat{\gamma}_t^i$  is the cyclical component of the value added share for industry  $i$ ,  $\hat{\lambda}_t^i$  is the cyclical component of the labor share in industry  $I$ ,  $\hat{y}_t$  is the cyclical component for real output in the nonfarm private sector, and  $\hat{\lambda}_t$  the cyclical component for the labor share in the nonfarm private sector.

In practice, this decomposition provides an approximation to the cyclicity of the aggregate labor share. In particular, it assumes: (1) that the trend component is not correlated with the cyclical component for any of the time series in the decomposition. If the trend and cycle are correlated, this generates a measurement bias in the sectoral decomposition. (2) it depends on the non-linearity of the filtering procedure. If we use linear detrending to separate the trend from the cyclical component, the trend terms will reflect steady state values. When the filter is more non-linear, as is the case with the bandpass filter, these trends change over time. This generates a bias if the trend components change considerably over time. (3) if we are working with small-samples. The decomposition converges to equality as the sample size goes to infinity. Since I detrend the data by applying a bandpass filter identifying the business cycle to contain fluctuations between 2 and 8 years, and since I apply the decomposition to a relatively small sample, it would not be surprising if there is an approximation error.

The first two rows in Table 5 show the cyclicity of the aggregate labor share when it is directly measured from the aggregate nonfarm private sector data and when it is obtained from the sectoral composition in (6). For the entire sample, the sectoral decomposition predicts the aggregate labor share to be mildly countercyclical, with a correlation of -0.072 with real aggregate output. On the other hand, when directly estimated from the data, the cyclicity of the labor share is equal to 0.050. The difference between these two point estimates corresponds to the approximation error.

Most of the approximation error comes from the earlier period of the sample, in which the sectoral composition overestimates the countercyclicity of the labor share. However, this approx-

imation error disappears in the later period of the sample, and the sectoral decomposition is able to accurately predict the shift in the cyclicity of the labor share. The sectoral decomposition predicts a shift in the cyclicity of the labor share from -0.196 in 1947-1987 to 0.443 in 1988-2015. The true aggregate data shows that the cyclicity of the labor share shifts from -0.096 in 1947-1987 to 0.410 in 1988-2015. Therefore, the sectoral decomposition is a good laboratory to study the impact of structural changes in the industrial composition of the U.S. economy on the cyclicity of the labor share.

In order to do so, I perform a counterfactual analysis. Instead of considering the actual value added shares observed in the data, I impute constant counterfactual value added shares to each sector. In counterfactual 1, I replace the observed value added shares with their average values between 1947 and 1987, that is  $\gamma_{it} = (1/41) \cdot \sum_{t=1947}^{1987} \gamma_{i,t}$ , for all time periods  $t$ . In counterfactual 2, I replace the observed value added shares with their average values between 1988 and 2015, that is  $\gamma_{it} = (1/28) \cdot \sum_{t=1988}^{2015} \gamma_{i,t}$ , for all time periods  $t$ . I use the time series in the nominal output for the nonfarm private sector to obtain the nominal output for each industry. Then, I compute counterfactual time series for the sectoral labor shares by dividing the actual compensation data by the counterfactual nominal income. I estimate the cyclicity of the counterfactual value added shares and labor shares, and I apply the sectoral decomposition to obtain the counterfactual cyclicity of the aggregate labor share<sup>21</sup>.

Table 5 shows the results of this analysis. Under both counterfactuals, the cyclicity of the labor share shifts from countercyclical in 1947-1987 to procyclical in 1988-2015. This confirms the intuition from Figure 4 that the shift in the cyclicity of the labor share is not an aggregation result, but also occurs at the industry level. The shift in the cyclicity of the labor share is actually larger under counterfactual 2, where I impose the industrial composition to be equal to its average value in the last three decades. Moreover, the cyclicity of the labor share is always more negative under counterfactual 2 than under counterfactual 1. This countercyclical pressure on the labor share, which comes from changes in the industrial composition of the U.S. economy, is not the correct force to explain the shift in the cyclicity of the U.S. labor share. Therefore, future research needs to track the reasons that caused a joint shift in the cyclicity of the labor share at

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<sup>21</sup>Since the counterfactual value added shares are constant throughout the entire sample, the differences over time in the cyclicity of the aggregate labor share is driven solely by changes in the cyclicity of the sectoral labor shares and not by changes in sectoral composition.

Table 5: Sectoral Composition and the Cyclicity of the Labor Share.

$$\rho(\hat{\lambda}_t, \hat{y}_t) = \sum_{i=1}^K \left( \frac{\gamma^i \lambda^i}{\lambda} \right) \cdot \left[ \frac{\sigma(\hat{\gamma}_t^i)}{\sigma(\hat{\lambda}_t)} \cdot \rho(\hat{\gamma}_t^i, \hat{y}_t) + \frac{\sigma(\hat{\lambda}_t^i)}{\sigma(\hat{\lambda}_t)} \cdot \rho(\hat{\lambda}_t^i, \hat{y}_t) \right]$$

Nonfarm Private Sector	1947-2015	1947-1987	1988-2015
Aggregate Data: $\rho(\hat{\lambda}_t, \hat{y}_t)$	0.050	-0.096	0.410
Sectoral Decomposition	-0.072	-0.196	0.443
Counterfactual 1 ( $\gamma_t^i = \gamma_{1947-1987}^i$ )	0.002	-0.191	0.516
Counterfactual 2 ( $\gamma_t^i = \gamma_{1988-2015}^i$ )	-0.172	-0.406	0.443

the industry level. Given the analysis in this section, it seems reasonable to restrict the attention to aggregate structural, technological or policy changes that affect the U.S. labor markets.

## 5 Cross-Country Evidence: U.S. and Western Europe.

In this section I investigate whether the shift in the cyclicity of the labor income share is specific to the U.S. economy. To do so, I use KLEMS data for 12 Western European countries and for the U.S.<sup>22</sup>. In Figure 5 and 6 I show respectively the cyclicity of the labor share and labor productivity for each of these countries in 1970-1987 and in 1988-2015.

The cross-country evidence shows that the shift in the cyclicity of the labor share towards procyclicality did not occur in the vast majority of the Western European countries considered. The lower labor market flexibility in Western Europe is translated into higher hiring and firing costs for firms and induce a more established practice of labor hoarding at the firm level across Western European countries. The usage of labor hoarding is reflected in Figure 6 in the observed procyclical labor productivities across Western Europe countries. The procyclicality of labor productivity did

<sup>22</sup>This data was obtained from <http://www.euklems.net/>. I took the data for the European countries that had the longest time series available. These 12 Western European countries are Austria (AT), Belgium (BE), Denmark (DK), Finland (FI), France (FR), Germany (DE), Italy (IT), Netherlands (NL), Portugal (PT), Spain (ES), SE (Sweden), and the United Kingdom (UK). The data is annual and comprises the years 1970-2015. The only exception is Finland, for which data is available between 1975 and 2015. For each country, I construct time series for real value added, labor productivity, and labor share. I then apply logarithms and filter the data using a bandpass filter identifying the business cycles between 2 and 8 years.

### The Cyclicity of the Labor Share: Cross-Country Evidence

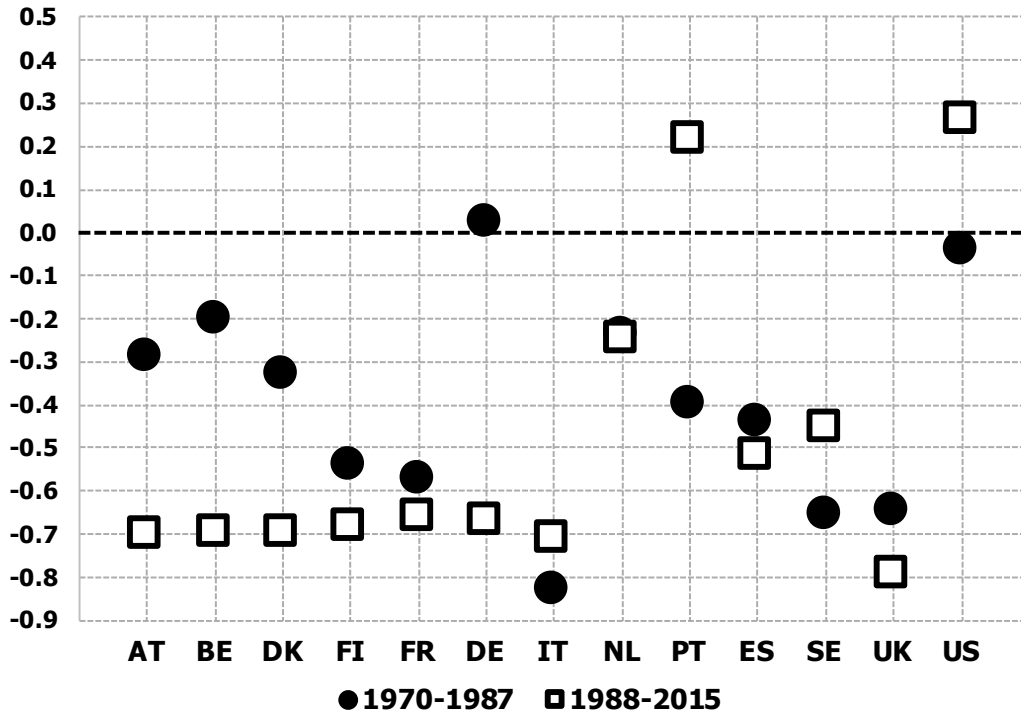


Figure 5: The Cyclicity of the Labor Share: Cross-Country Evidence.

### The Cyclicity of Labor Productivity: Cross-Country Evidence

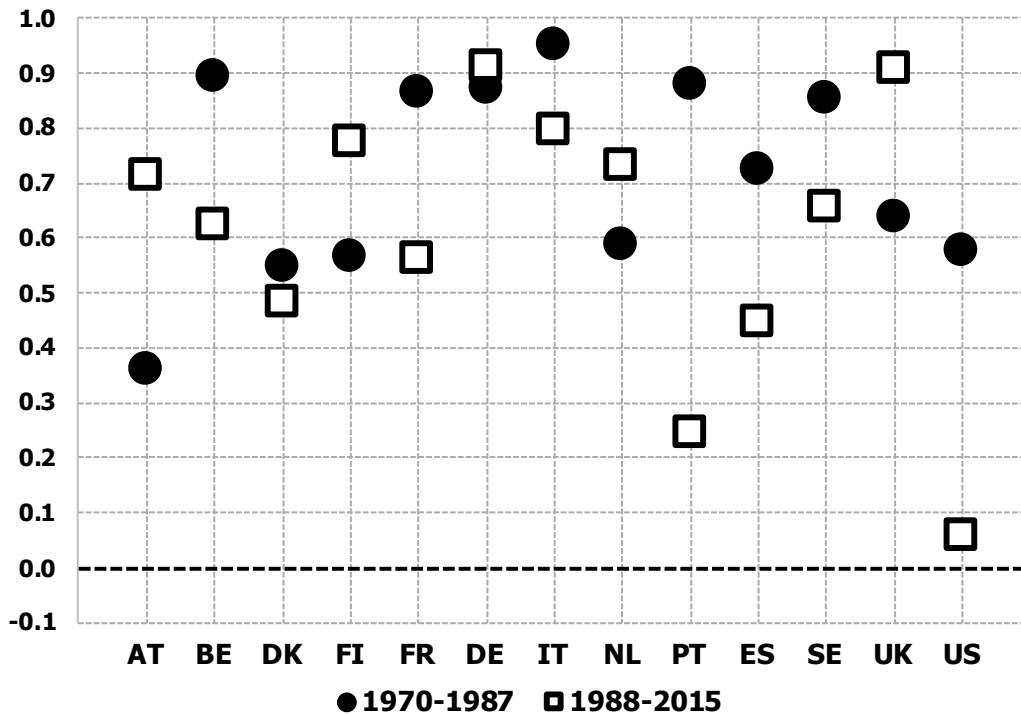


Figure 6: The Cyclicity of Labor Productivity: Cross-Country Evidence.



not vanish for these 12 countries and remained procyclical both in 1970-1987 and in 1988-2015. On the other hand, the higher interlinkage across these countries over time from a higher labor market integration and the adoption of a single currency in the European Union has strengthened the integration of these separate nationwide labor markets into a unique European labor market. This is reflected in the convergence of the (counter)cyclicalities of the labor share in 1988-2015 around -0.7 for the European countries and provides evidence that the workers in the European Union are better insured against downturns than their counterparts in the United States.

Two interesting case studies arise from this analysis. The first is the case of Portugal, which looks very similar to the United States. The Portuguese labor share shifted from being countercyclical in 1970-1987 to being procyclical in 1988-2015. This shift was accompanied by a stark reduction in the procyclicalities of labor productivity, which reflects a decline in the usage of labor hoarding at the firm level. However, even if these economies behave in a similar manner according to the cyclicalities of the labor share and labor productivity, a note of caution should be taken since employment protection is higher in Portugal than in the United States. Therefore, the puzzling similarity for the cyclicalities of the labor share and labor productivity between Portugal and the U.S. needs to be studied in a greater detail, in the spirit of [Blanchard and Portugal \(2001\)](#).

The second is the case of Germany, in which the cyclicalities of the labor share moves from acyclical to countercyclical. At the same time, the cyclicalities of labor productivity remains very procyclical in Germany, suggesting a widespread usage of labor hoarding at the firm level. The difference between Germany and the U.S. is better understood when looking to the changes in total hours worked during Great Recession. While in the U.S. the decline in total hours worked is due solely to a decline in employment and a large increase in the unemployment rate, in Germany the decline in total hours worked does not come from employment but from a decline in the average hours worked per employee. [Burda and Hunt \(2011\)](#) show that total hours in the U.S. economy decreased by 8.4 percentage points between 2008:1 and 2009:4. Out of this decline, there was a decline in 2.2 percentage points in the number of hours per worker and a decrease in 6.1 percentage points in the employment rate. During the same period in Germany, total hours declined by 2.4 percentage points, almost 25% of the decline in total hours for the U.S. economy. Out of this decline for Germany, there was a decline in 2.6 percentage points in hours per worker and an increase in 0.4 percentage points in the employment rate. According to [Burda and Hunt \(2011\)](#), the success of

Germany during the Great Recession in minimizing fluctuations in employment is partly due to a decrease in the price of adjusting working time accounts by changing the intensive margin (rather than employment, the extensive margin) at the firm level. The implication is that Germany was able to avoid a large decline in the employment rate by providing firms with more incentives for labor hoarding and simultaneously allowing for a higher flexibility in the labor market.

This evidence suggests that there is a very close relationship between the cyclicalities of labor productivity and the cyclicalities of the labor share at a cross-country level. Still, further research is needed to better understand the time and cross-sectional variations in the cyclicalities of the labor share. From the evidence presented in this chapter, the most important factors are the degree of labor hoarding used at the firm level and changes in the volatility and cyclicalities of real wages.

## 6 A Stylized RBC Model with Labor Hoarding, Workers' Risk Aversion and Wage Bargaining

In this chapter, I briefly describe a stylized model embedded with a labor hoarding mechanism and wage bargaining, which I borrow from [Galí and van Rens \(2017\)](#). This is a relatively simple model that incorporates a labor hoarding mechanism and wage bargaining between workers and firms, the traditional mechanisms in the literature to generate a countercyclical labor share. In particular, labor hoarding is modeled as convex hiring costs and wage bargaining as a perfectly flexible Nash bargaining procedure. This stylized model is the perfect laboratory to study the shift in the cyclicalities of the labor share, since it is able to predict a decline in the procyclicality of labor productivity through a decline in the reallocation rates in the labor market<sup>23</sup>.

### 6.1 Households

There is a continuum of identical number of households on a unit interval. Additionally, there is perfect insurance within the household. That is, the representative household assigns equal

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<sup>23</sup>The decline in the reallocation rates in the labor market is consistent with the recent evidence on the decline in labor market fluidity [[Davis and Haltiwanger \(2014\)](#) and [Molloy et al. \(2016\)](#)]. The most common explanation for the decline in the labor market reallocation rates comes from the increase in the average size and age for the firms in the U.S. economy. Older and larger firms are less likely to hire and fire employees. In the model, the decline in the labor market reallocation rates is mimicked by a reduced form decline in the exogenous separation rate faced by an employed worker. The decline in the exogenous separation rates increases the relative cost of an additional hire and leads to a decline in the number of workers hired in each period. These changes imply a reduction in the transition rates from employment to unemployment and from unemployment to employment.

consumption to all members in order to perfectly share consumption risk within the household. Therefore, we can look to the choices made by a representative household.

The preferences for the representative household are defined by

$$U = \mathbb{E}_0 \left[ \sum_{t=0}^{\infty} \beta^t \cdot \left( \frac{Z_t \cdot C_t^{1-\eta}}{1-\eta} - g^H(N_t, \epsilon_t) \right) \right] \quad (7)$$

where  $C_t$  is consumption for the household,  $N_t$  the mass of employed individuals<sup>24</sup> within the household,  $\epsilon_t$  the effort exerted by employed workers on their jobs, and  $Z_t$  a preference shock acting as a (residual) demand shock.  $\ln Z_t$  is assumed to be a AR(1) process with white noise innovations.

$$\ln Z_t = \rho_z \cdot \ln Z_{t-1} + \sigma_z \cdot \nu_t^z \quad (8)$$

where  $\nu_t^z \sim \text{WN}(0, 1)$ ,  $\rho_z \in [0, 1)$ , and  $\sigma_z > 0$ . The disutility from work affecting the employed members of the household is represented by  $g^H(N_t, \epsilon_t)$ . Galí and van Rens (2017) set this function to be  $g^H(N_t, \epsilon_t) = \gamma \cdot L_t(N_t, \epsilon_t)$ , where  $L_t$  is the amount of labor services provided by the employed workers and is defined as

$$L_t = \int_0^{N_t} \frac{1 + \xi \cdot \epsilon_{it}^{1+\phi}}{1 + \xi} di = \frac{1 + \xi \cdot \epsilon_{it}^{1+\phi}}{1 + \xi} \cdot N_t \quad (9)$$

The household is assumed to own the representative firm and is subject to a sequence of budget constraints

$$C_t \leq \int_0^{N_t} W_{it} di + \Pi_t = W_t \cdot N_t + \Pi_t \quad (10)$$

for all periods  $t$ . The household problem can then be written as the choice of consumption  $C_t$  and a supply of exerted effort for the employed individuals  $\epsilon_t$  to maximize their utility subject to the

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<sup>24</sup>The relevant measure of labor input in the context of the model is labor services. This is composed by employment at the extensive margin and effort at the intensive margin. Although the exertion of effort is not enforceable, the firm and the worker set the amount of effort within the bargaining process. Therefore, the wage payments that are the outcome of the wage bargaining will be such that workers are willing to exert the optimal amount of effort in equilibrium. This optimal allocation can be obtained by creating a market for effort and introducing performance pay compensation, as in Galí (1999). Total compensation would then be the sum of two components: the base wage, which is independent of the effort exerted, and the performance pay component. The labor share is countercyclical in this scenario. The (flexible) performance pay component can be shown to be acyclical in this scenario and the base wage component is countercyclical, reflecting the willingness of both workers and firms to insure themselves against downturns.

sequence of budget constraints, to the functional form for the disutility of labor, and for the law of motion for the preference shock.

## 6.2 Firms

There is a continuum of identical firms on a unit interval. Each firm employs workers in order to maximize profits. Since all firms are equal we analyze the actions of a representative firm.

The technology used by the representative firm is

$$Y_t = A_t \cdot F(N_t, \epsilon_t) \equiv A_t \cdot \left( \epsilon_t^\psi \cdot N_t \right)^{1-\alpha} \quad (11)$$

where  $A_t$  is a standard TFP shock, assumed to be a AR(1) process with white noise innovations.

$$\ln A_t = \rho_a \cdot \ln A_{t-1} + \sigma_a \cdot \nu_t^a \quad (12)$$

with  $\nu_t^a \sim \text{WN}(0, 1)$ ,  $\rho_a \in [0, 1)$ , and  $\sigma_a > 0$ .  $\epsilon_t$  is the average effort exerted by the workers, and  $N_t$  is employment.  $\alpha$  controls for the degree of decreasing returns to scale in the labor input, and  $\psi \in (0, 1)$  introduces fatigue in production for high levels of effort.

We introduce incentives for labor hoarding. In particular, employment is not easily adjustable and firms need to pay a hiring cost when making job offers to workers in the unemployment pool. Aggregate employment follows the law of motion

$$N_t = (1 - \delta) \cdot N_{t-1} + E_t \quad (13)$$

where  $\delta$  is the exogenous separation rate and  $E_t$  the number of net hires in period  $t$ , chosen by the firm. As mentioned above, hiring is assumed to be costly for the firm. In particular, [Galí and van Rens \(2017\)](#) assume convex adjustment costs of hiring, defined as  $g^F(E_t)$ . Therefore,  $g_E^F(E_t) > 0$  and  $g_{EE}^F(E_t) > 0$  for  $E_t > 0$  and  $g^F(0) = g_E^F(0) = 0$ .

The representative firm chooses how many workers to hire in each period,  $E_t$ , and the average effort exerted by their workers  $\epsilon_t$  to maximize its expected value of profits

$$\max_{E_t, \epsilon_t} \mathbb{E}_0 \left[ \sum_{t=0}^{\infty} \Gamma_{0,t} \cdot \left( Y_t - W_t \cdot N_t - g^F(E_t) \right) \right] \quad (14)$$

subject to the law of motion for employment (13).  $W_t$  is the real wage (in consumption units) of an additional worker,  $\Gamma_{0,t}$  is the discount factor required by the owners of the firm (the household) and it is defined by the marginal rate of substitution of consumption,

$$\Gamma_{t,+1} \equiv \beta \cdot \frac{Z_{t+1}}{Z_t} \cdot \left( \frac{C_{t+1}}{C_t} \right)^{-\eta} \quad (15)$$

This condition can be achieved by let the household optimize their savings' using risk-free bonds and firm shares. The household requires the returns of both assets to be the same by the law of non-arbitrage, which equals the stochastic discount factor formula above.

The firm maximizes the expected discounted value of their profits subject to their technology, the law of motion for employment, the convex hiring costs, and the required stochastic discount factor by the households. The optimality conditions from the firm's problem result on a demand function for effort and on a demand function for new hires.

### 6.3 Efficient Effort and Wage Bargaining

The household and the representative firm jointly decide on wages and effort. The firm wants to maximize the average effort exerted by their workers, while each worker has incentives not to provide effort due to the increase in their disutility of working. Therefore, in the bargaining process the firm needs to compensate the workers for them to be willing to exert that optimal level of effort<sup>25</sup>, in the sense that the contract is incentive compatible for the workers to provide the amount of effort required by the firm.

The efficient effort set by workers and firms in the bargaining process is given by

$$\epsilon_t^{1+\phi} = \Psi_\epsilon \cdot \frac{Z_t}{C_t^\eta} \cdot \frac{Y_t}{N_t} \quad (16)$$

with  $\Psi_\epsilon = \frac{\psi}{1+\phi} \cdot \frac{1+\xi}{\xi} \cdot \frac{(1-\alpha)}{\gamma}$ .

The firm's demand for new hires and the efficient effort decision generate a job creation equation. When hiring a worker, the firm takes into account that increasing employment changes the effort

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<sup>25</sup>The bargaining process for effort can be microfounded by considering an efficiency wage model in which firms have the possibility of catching shirkers, as in [Alexopoulos \(2004\)](#). The optimal allocation for effort can also be obtained by considering effort to be observable and a market for effort, which is the approach followed by [Galí \(1999\)](#).

exerted by the remaining workers and incorporates that decision in the marginal benefits of hiring an additional worker. The optimal job creation satisfies

$$g_E^F(E_t) = (1 - \Psi_F) \cdot (1 - \alpha) \cdot \frac{Y_t}{N_t} - W_t + (1 - \delta) \cdot \mathbb{E}_t [\Gamma_{t,t+1} \cdot g_E^F(E_{t+1})] \quad (17)$$

where  $1 - \Psi_F = (1 + \phi - \psi) / (1 + \phi - (1 - \alpha) \cdot \psi)$ .

$g_E^F(E_t)$  represents the firm's surplus in the bargaining process. The representative firm is willing to offer up to  $g_E^F(E_t)$  to hire another worker. These offers represent a sunk cost after they are made. Therefore, the firm will only hire a new worker when it is certain this worker will accept, as the firm does not want to pay the sunk offer cost not to be able to hire that additional employee.

The maximum wage the firm is willing to pay is

$$W_t^{\text{UB}} = (1 - \Psi_F) \cdot (1 - \alpha) \cdot \frac{Y_t}{N_t} + (1 - \delta) \cdot \mathbb{E}_t [\Gamma_{t,t+1} \cdot (W_{t+1}^{\text{UB}} - W_{t+1})] \quad (18)$$

This is the highest wage offer that makes the firm indifferent between hiring an additional worker or not. This equation comes from the job creation equation  $g_E^F(E_t) = W_t^{\text{UB}} - W_t$ .

On the household side, a potential new hire generates benefits and costs. The current-period benefit of having an additional member employed is the increase in average consumption for all household members. The current loss is described by the increase in disutility of working faced by the household. Dynamically, the household understands that this new employed household member continues to be employed next period with a probability of  $T_N^N(N_{t-1}, E_t)$  and becomes unemployed again with a probability  $1 - T_N^N(N_{t-1}, E_t)$ , where<sup>26</sup>

$$T_N^N(N_{t-1}, E_t) = 1 - \delta + \delta \cdot \frac{E_t}{1 - (1 - \delta) \cdot N_{t-1}} \quad (19)$$

The marginal value of an additional employed member satisfies

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<sup>26</sup>The timing of the model is such that separation occurs on the beginning of the period before any other decision is taken, the new pool of unemployment is formed, and then hiring decisions are made. After hires and wages are bargained and decided, effort decisions are taken and production occurs. Therefore, the employed worker becomes unemployed with  $\delta$  probability and gets rehired with a probability defined by the number of hires in the current period divided by the pool of unemployment, since all household members are the same and job offers are set to a random household member in the unemployment pool.

$$\begin{aligned}
V_t^N &= W_t - \frac{\gamma}{1+\xi} \cdot \frac{C_t^\eta}{Z_t} - \Psi_H \cdot (1-\alpha) \cdot \frac{Y_t}{N_t} \\
&+ \beta \cdot \mathbb{E}_t [T_N^N(N_t, E_{t+1}) \cdot V_{t+1}^N + (1 - T_N^N(N_t, E_{t+1})) \cdot V_{t+1}^U]
\end{aligned} \tag{20}$$

where  $\Psi_H = [\psi/(1+\phi)] \cdot [1 - (1+\phi) \cdot (\eta/(1+\phi-\psi))]$ .

Another cost for the household is the loss of an unemployed member. Unemployed workers do not generate any income for the household, they only consume. However, in the future, the unemployed worker may become employed and generate value for the household. The marginal loss for the household of having one less unemployed worker is

$$V_t^U = \beta \cdot \mathbb{E}_t [T_N^U(N_t, E_{t+1}) \cdot V_{t+1}^N + (1 - T_N^U(N_t, E_{t+1})) \cdot V_{t+1}^U] \tag{21}$$

where

$$T_N^U(N_{t-1}, E_t) = \frac{E_t}{1 - (1-\delta) \cdot N_{t-1}} \tag{22}$$

is the probability an individual becomes employed in period  $t$  conditionally on being unemployed in period  $t-1$ . The household surplus of an additional hire is the difference between the marginal benefit of an additional hire to the marginal loss of having one additional household member in the pool of unemployed workers.

$$\begin{aligned}
V_t^N - V_t^U &= W_t - \frac{\gamma}{1+\xi} \cdot \frac{C_t^\eta}{Z_t} - \Psi_H \cdot (1-\alpha) \cdot \frac{Y_t}{N_t} \\
&+ (1-\delta) \cdot \mathbb{E}_t \left[ \Gamma_{t,t+1} \cdot \left( 1 - \frac{E_{t+1}}{1 - (1-\delta) \cdot N_t} \right) \cdot (V_{t+1}^N - V_{t+1}^U) \right]
\end{aligned} \tag{23}$$

The reservation wage for the worker is the lowest wage offer making the household member indifferent between accepting the offer or remaining unemployed.

$$\begin{aligned}
W_t^{\text{LB}} &= \frac{\gamma}{1 + \xi} \cdot \frac{C_t^\eta}{Z_t} + \Psi_H \cdot (1 - \alpha) \cdot \frac{Y_t}{N_t} \\
&= -(1 - \delta) \cdot \mathbb{E}_t \left[ \Gamma_{t,t+1} \cdot \left( 1 - \frac{E_{t+1}}{1 - (1 - \delta) \cdot N_t} \right) \cdot (W_{t+1} - W_{t+1}^{\text{LB}}) \right]
\end{aligned} \tag{24}$$

in which I have used the definition of the household surplus  $V_t^N - V_t^U = W_t - W_t^{\text{LB}}$ .

To close the model, we need to set how wages are bargained. Galí and van Rens (2017) consider a perfectly flexible Nash Bargaining as their preferred wage bargaining rule, which sets wages as

$$W_t = \theta \cdot W_t^{\text{UB}} + (1 - \theta) \cdot W_t^{\text{LB}} \tag{25}$$

where  $\theta$  reflects the workers' bargaining power in the wage determination process.

Notice that in this formulation real wages will be almost proportional to the definition of labor productivity in the model<sup>27</sup>. The bargaining set is shifted upwards when labor productivity is high and downwards when labor productivity is low, implying a close linkage between real wages and labor productivity in this model. This feature has important implications for the ability of the model to be able to jointly predict the decline in the procyclicality of labor productivity and the decline in the countercyclicality of the labor share.

## 7 Structural Change, the Cyclicity of Labor Productivity, and the Cyclicity of the Labor Share.

In this section I assess the performance of the stylized model introduced in the previous section in its ability to predict a decline in the procyclicality of labor productivity. The model is able to do so following a decline in the labor market reallocation rates, an increase in the volatility of demand shocks, and a decrease in the workers' bargaining power in the wage bargaining process. These changes in the structural parameters of the model are an attempt to capture qualitatively known structural changes in the U.S. economy after the mid-1980s, such as the decline in the labor market

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<sup>27</sup>Since the model considers employment as the measure of labor input and not total hours, labor productivity is here defined in terms of employment. This means that we should not expect the model to be able to fit the data described in section 3. Since this model is highly stylized, I am more interested in the qualitative implications of the model, like a decline in the procyclicality of labor productivity, or any shift in the cyclicity of the labor share from countercyclical to procyclical, independently of its magnitude.



fluidity, the high importance of demand shocks for business cycle fluctuations, and the fall in the importance of labor unions. The qualitative implications for the cyclicity of labor productivity introduce some confidence in the usage of the model as a laboratory to study the effects of these structural changes on the cyclicity of the labor share.

I calibrate the model similarly to Galí and van Rens (2017), and I compare the resulting simulated moments of the model to the business cycle moments for the U.S. data in 1947-1987<sup>28</sup>. Under this calibration, the exogenous separation rate is calibrated to  $\delta = 0.35$  and changes in this parameter vary the labor market reallocation rates. I set the workers' bargaining power to  $\theta = 0.5$ , and the volatility of both aggregate supply and demand shocks to  $\sigma_a = 0.0195$ , and  $\sigma_z = 0.0242$ , respectively. These shocks are assumed to be uncorrelated. Under this scenario, the model predicts the volatility of output to be  $\sigma(\hat{y}_t) = 0.0303$ , a value that is slightly higher than the average volatility of output in the U.S. data in the earlier period. The calibrated steady state efficiency loss from hiring costs equals 2.73% of aggregate output.

Although this calibration provides a good fit to the cyclicity of the labor share and to the volatility of output, the model is still very stylized and it does not perform well with respect to other moments. In particular, the model underestimates the relative volatility of the labor share and it overestimates the volatility and the procyclicality of both the real wages and labor productivity. Introducing real wage rigidities helps to fit the cyclicity and volatility of real wages, but since there are no consequent changes to the cyclicity and volatility of labor productivity, it makes the model to predict a very countercyclical labor share. These features are shared by a large class of models in the real business cycle literature.

Without real wage rigidities, the model predicts real wages and labor productivity to be almost proportional to each other, which starkly contrasts the empirical evidence. This limitation is the main reason for the model not to be able to jointly generate the decline in the procyclicality of labor productivity and the shift in the cyclicity of the labor share. When the procyclicality of labor productivity declines, the procyclicality of real wages declines almost by the same amount,

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<sup>28</sup>The moments generated by the model can be compared to the empirical evidence in Table 3 under the assumption that employment is defined as “full-time equivalent employees”. I use the model to simulate 200,000 data points and I apply the Hodrick-Prescott Filter to the simulated data to obtain the simulated correlations and standard deviations. I apply the HP-Filter to the simulated data for numerical convenience, as the application of a bandpass filter to such a large number of observations is not feasible computationally. The model calibrated parameters can be found on Appendix D.

which keeps the labor share countercyclical due to labor hoarding and wage bargaining. Therefore, the failure of this model in account qualitatively for the changes in the cyclicity of the labor share after a decline in the procyclicality of labor productivity implies that the shift in the cyclicity of the labor share introduces further discipline in modeling real business cycle fluctuations.

## 7.1 Decrease in Labor Market Reallocation Rates

Following Galí and van Rens (2017), I perform a comparative statics analysis in which I reduce the exogenous separation rate  $\delta$  from the calibrated value of  $\delta = 0.35$  to the (almost) frictionless version of the model ( $\delta = 0.01$ ). The decline in the exogenous separation rate increases the likelihood of an employed worker to remain employed in the following period and, by doing so, it decreases the amount of hires in the economy. At the limit, when  $\delta \rightarrow 0$ , the transition rate  $T_N^N(N_{t-1}, E_t)$  converges to one, which by (19) implies a stark reduction in the amount of hires in the economy ( $E_t \rightarrow 0$ ).

In Figure 7, I plot the cyclicity of the labor productivity and labor share for different values of the exogenous separation rate. The procyclicality of labor productivity decreases with a fall in the exogenous separation rate, a prediction consistent with the empirical evidence. On the other hand, the cyclicity of the labor share moves in the opposite direction to the data. The labor share becomes more countercyclical in the model with a decrease in labor market reallocation rates for values corresponding to the pre-1987 ( $\delta = 0.35$ ) and to the post-1987 ( $\delta = 0.2$ ). This is the first sign that the cyclicity of the labor share and labor productivity are moving in the opposite direction in the model. I illustrate quantitatively this result in column 3 to 5 of Table 6. The fall in  $\delta$  implies an increase in the volatility of labor productivity and almost no changes in the volatility of real wages, which creates a countercyclical pressure to the cyclicity of the labor share. Moreover, the correlation between real wages and labor productivity is above 0.960, which imply both variables to be almost proportional to each other. The increase in the volatility of labor productivity then makes the labor share more countercyclical.

For low labor market reallocation rates the labor share becomes slightly less countercyclical while the cyclicity of labor productivity continues to decrease. When the economy converges to a frictionless labor market, the model generates a countercyclical labor share due to the impact of the aggregate demand shocks in the worker's reservation wage. The higher volatility of demand shocks,

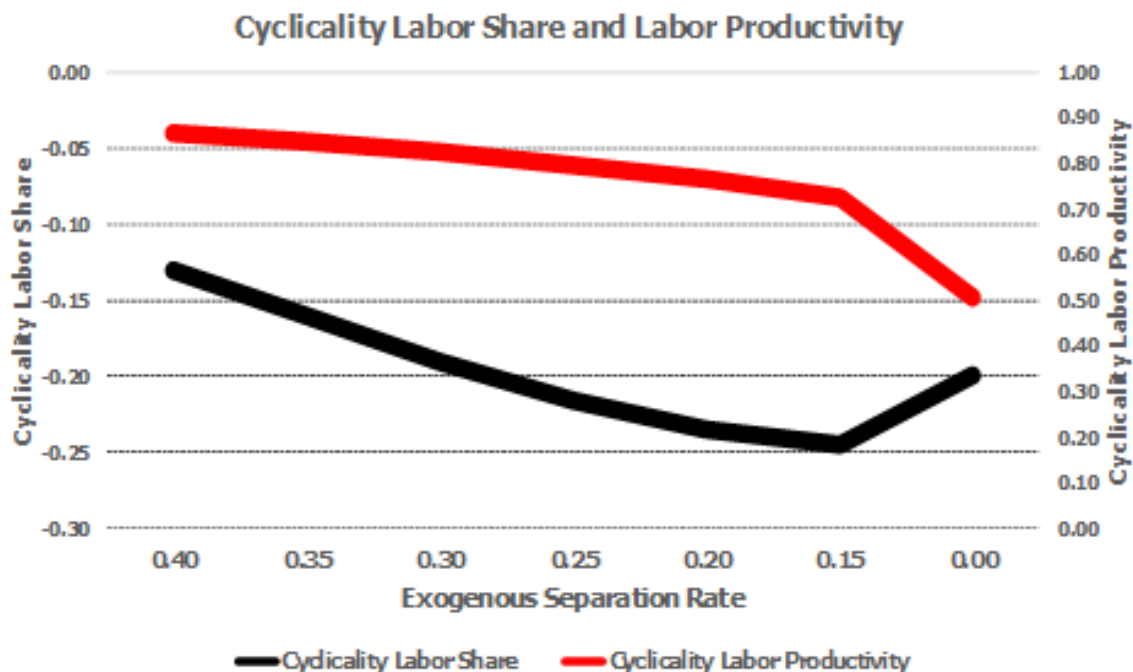


Figure 7: Changes in the Labor Market Reallocation Rate.

with respect to TFP shocks, and the existence of wage bargaining determine the countercyclicality of the labor share without any incentives for labor hoarding.

## 7.2 Increase in the Volatility of Demand Shocks

It is then natural to question how decreasing the relative volatility of aggregate demand shocks shifts the cyclical labor share and labor productivity. In the first (second) column of Table 7, I set the volatility of the TFP shock to be higher than (equal to) the volatility of the aggregate demand shock. I calibrate the model by keeping the same structural parameters as in the calibrated version of the model, and I change the volatility of both demand and supply shocks to keep the volatility of output equal to the calibrated version of the model. When  $\sigma_a > \sigma_z$  I set arbitrarily the ratio between both parameters ( $\sigma_a/\sigma_z$ ) to be the inverse of the same ratio under the calibrated version of the model. To complement the analysis, Figure 8 shows the changes in the cyclical labor productivity and labor share for a unilateral increase in  $\sigma_z$ , without keeping the volatility of output constant.

The higher volatility of aggregate demand shocks introduces a countercyclical force in the cycli-

Table 6: Model Performance and Empirical Evidence: Variations in  $\delta$  and  $\theta$ .

	U.S. Data		Calibration	Model Performance			
	1947-1987	1988-2016		$\delta = 0.2$	$\delta = 0.01$	$\theta = 0.25$	$\theta = 0.75$
$\rho(\hat{\lambda}_t, \hat{y}_t)$	-0.181	0.280	-0.161	-0.239	-0.220	-0.210	-0.090
$\rho(\hat{y}_t - \hat{n}_t, \hat{y}_t)$	0.451	0.012	0.847	0.765	0.560	0.779	0.914
$\rho(\hat{w}_t, \hat{y}_t)$	0.460	0.270	0.713	0.655	0.506	0.545	0.868
$\rho(\hat{w}_t, \hat{y}_t - \hat{n}_t)$	0.444	0.529	0.960	0.963	0.982	0.916	0.990
$100 \times \sigma(\hat{y}_t)$	2.436	0.013	3.034	3.023	3.178	3.079	2.996
$\sigma(\hat{\lambda}_t) / \sigma(\hat{y}_t)$	0.429	0.648	0.247	0.237	0.162	0.400	0.112
$\sigma(\hat{y}_t - \hat{n}_t) / \sigma(\hat{y}_t)$	0.470	0.629	0.775	0.826	0.846	0.781	0.766
$\sigma(\hat{w}_t) / \sigma(\hat{y}_t)$	0.291	0.670	0.864	0.879	0.866	0.962	0.795
$\delta$			0.350	0.200	0.010	0.350	0.350
$\theta$			0.500	0.500	0.500	0.250	0.750
$100 \times \sigma_a$			1.954	1.954	1.954	1.954	1.954
$100 \times \sigma_z$			2.424	2.424	2.424	2.424	2.424
$\bar{R}$			0.000	0.000	0.000	0.000	0.000
Hiring Costs / Output			0.027	0.010	0.000	0.033	0.019

quality of both the labor share and labor productivity. Moreover, it implies a decrease in the relative volatility of real wages and labor productivity. However, as demand shocks became more important, the workers' reservation wage will be more volatile and the wage bargaining process ends up making the realized wage to be more dependent on these shocks and less procyclical. The larger fall in the procyclicality of wages leads to a more countercyclical labor share. Notice that the model is able to generate a procyclical labor share if the volatility of supply shocks is high enough in comparison to the volatility of demand shocks. However, the shift in the volatilities of shocks is not promising as an explanation of the cyclicity of the labor share, as the higher volatility of supply shocks also increases the procyclicality of labor productivity, which is at odds with the data.

### 7.3 Deunionization

Another related question is on how deunionization affects the cyclicity of the labor share. Intuitively, the decrease in the importance of labor unions for the labor market decrease the workers' bargaining power in the wage bargaining process and so, it increases the flexibility of wages in the economy. I use the model from Galí and van Rens (2017) to analyze separately both changes. I find that a decrease in the workers bargaining power decreases the cyclicity of labor productivity and makes the labor share more countercyclical. This is so because the bargained wages get closer to

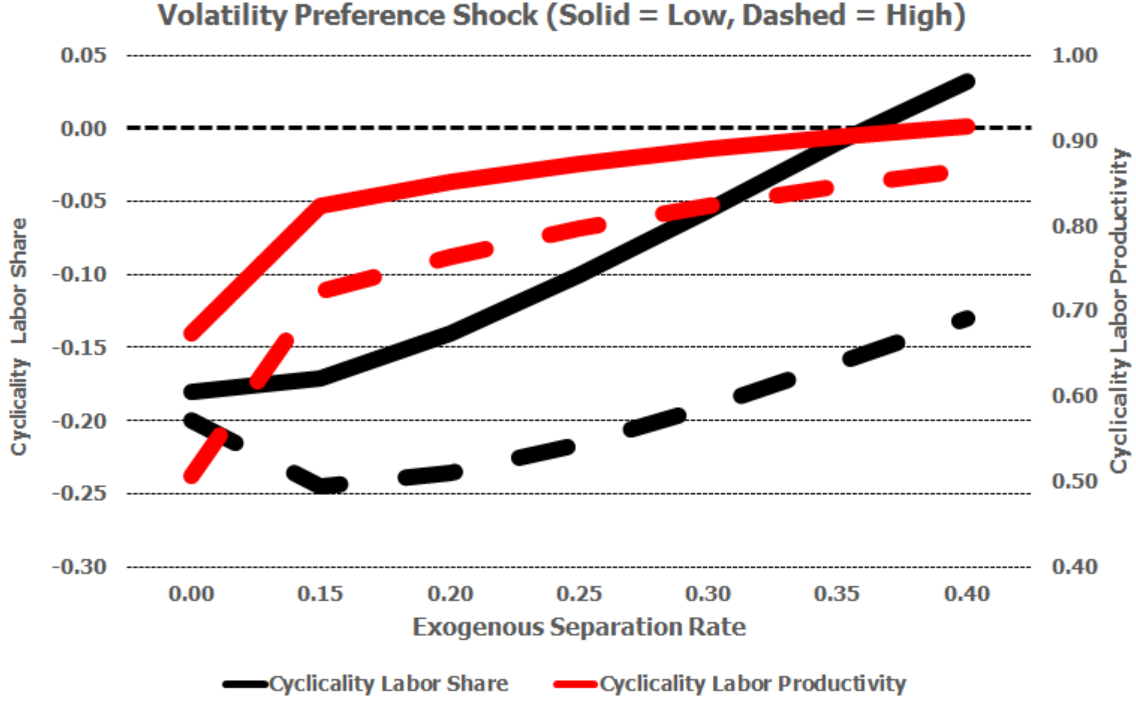


Figure 8: Changes in the Volatility of Demand Shocks.

the workers' reservation wage, which depends not only from supply shocks but also from the impact of demand shocks to the households' marginal substitution rate between consumption and labor services. Since demand shocks provide a countercyclical force to the labor share and disentangle the real wages from labor productivity in this setup, the procyclicality of real wages declines more than the procyclicality of labor productivity making the labor share more countercyclical. To reflect one possible impact of deunionization to the cyclicity of labor productivity and to the cyclicity of the labor share, Figure 9 shows how a decline in the workers' bargaining power implies again a decline in the procyclicality of labor productivity but a counterfactual increase in the countercyclicality of the labor share.

At the same time, the increase in wage rigidity decreases the volatility of real wages, introducing a countercyclical pressure to the cyclicity of the labor share<sup>29</sup>. The last two columns of table 5

<sup>29</sup>Real wage rigidities are introduced as  $W_t = R_{t-1} \cdot W_{t-1} + (1 + R_{t-1}) \cdot W_t^*$ , where  $W_t^*$  is the standard Nash Bargaining considered in the main text.  $W_t^* = \theta \cdot W_t^{UB} + (1 - \theta) \cdot W_t^{LB}$ . I use a reduced-form equation for wage rigidity

$$R_t = \bar{R} \cdot \left( 1 - \frac{W_t - W_t^*}{0.5 \cdot (W_t^{UB} - W_t^{LB})} \right)^{2\rho}$$

which makes wages to adjust more when they are on close to the boundaries of the bargaining set.

This formulation follows [Thomas and Worrall \(1988\)](#), [MacLeod and Malcomson \(1993\)](#), [Hall \(2003\)](#), and [Galí and](#)

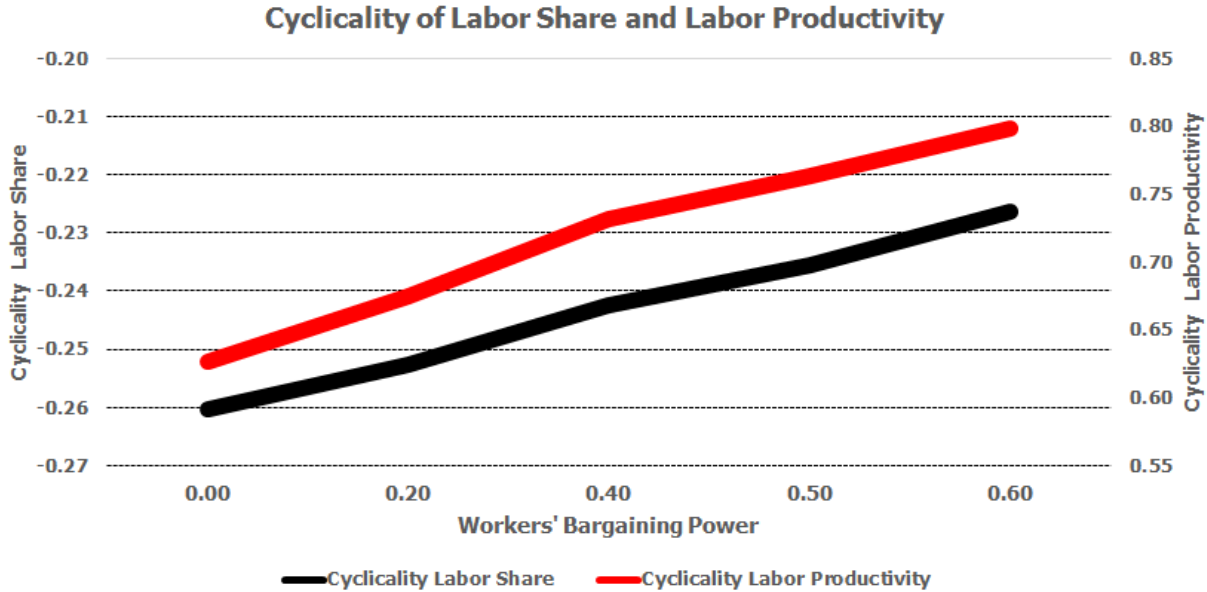


Figure 9: Changes in the Workers' Bargaining Power.

show a numerical example for a low and a high level for the workers' bargaining power. When  $\theta$  decreases from 0.75 to 0.25, the labor share becomes more countercyclical, due to a larger decline in the cyclicity of real wages in comparison to the decline in the procyclicality of labor productivity. The last two columns of Table 7 show a numerical example for increases in wage rigidity in the model, through an increase in  $\bar{R}$ . Introducing real wage rigidities in the model decreases sharply the procyclicality of real wages, without changing the cyclicity of labor productivity, generating a more countercyclical labor share. A graphical representation of the effects of real wage rigidities on the cyclicity of the labor share and labor productivity is shown in Figure 10. The main conclusion is that a decrease in real wage rigidities decreases the procyclicality of labor productivity while making the labor share less countercyclical. This suggests that the cyclicity of the labor share and labor productivity are important variables to pin down the degree of real wage rigidities in the economy. I leave for future research a more quantitative study of the impact of real wage rigidities to the cyclicity of the labor share.

van Rens (2017) (in a previous working paper version).

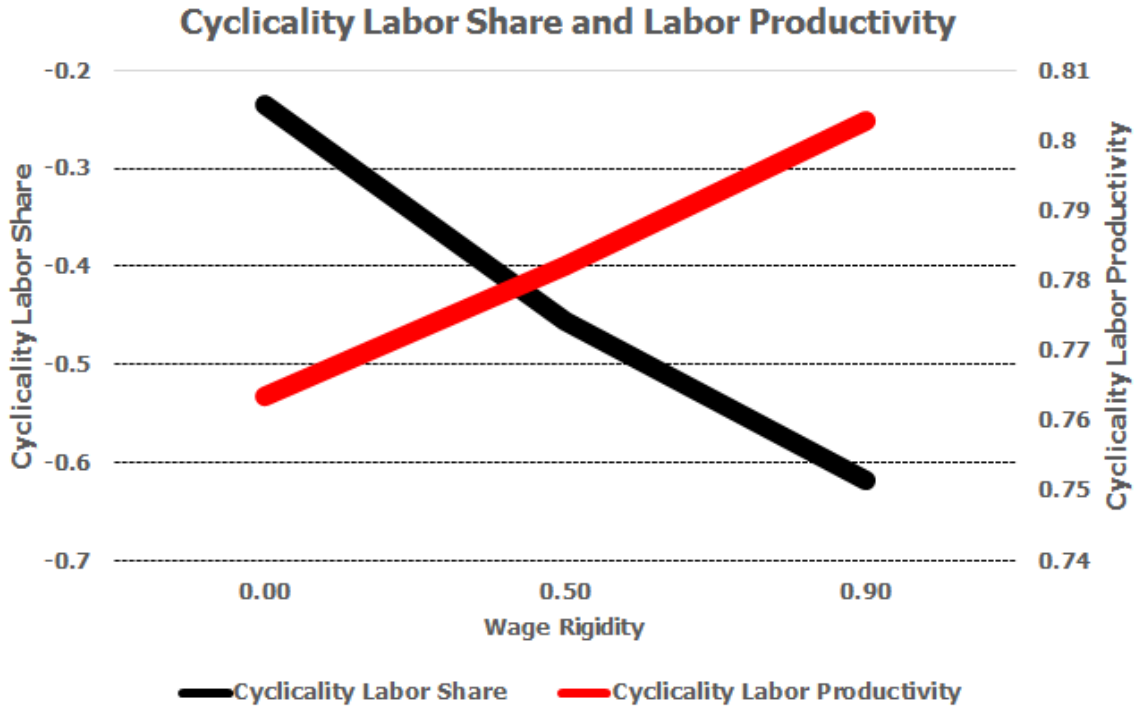


Figure 10: Changes in the Degree of Wage Rigidity.

Table 7: Model Performance and Empirical Evidence: Variations in  $\sigma_a$ ,  $\sigma_z$  and  $\bar{R}$ .

	Model Performance			
	$\sigma_a > \sigma_z$	$\sigma_z = \sigma_a$	$\bar{R} = 0.5$	$\bar{R} = 0.9$
$\rho(\hat{\lambda}_t, \hat{y}_t)$	0.080	-0.041	-0.419	-0.705
$\rho(\hat{y}_t - \hat{n}_t, \hat{y}_t)$	0.929	0.895	0.865	0.882
$\rho(\hat{w}_t, \hat{y}_t)$	0.867	0.803	0.679	0.438
$\rho(\hat{w}_t, \hat{y}_t - \hat{n}_t)$	0.982	0.973	0.920	0.652
$100 \times \sigma(\hat{y}_t)$	3.034	3.034	3.191	3.720
$\sigma(\hat{\lambda}_t) / \sigma(\hat{y}_t)$	0.178	0.210	0.273	0.318
$\sigma(\hat{y}_t - \hat{n}_t) / \sigma(\hat{y}_t)$	0.820	0.801	0.674	0.414
$\sigma(\hat{w}_t) / \sigma(\hat{y}_t)$	0.895	0.882	0.691	0.322
$\delta$	0.350	0.350	0.350	0.350
$\theta$	0.500	0.500	0.500	0.500
$100 \times \sigma_a$	2.080	2.027	1.954	1.954
$100 \times \sigma_z$	1.676	2.027	2.424	2.424
$\bar{R}$	0.000	0.000	0.500	0.900
Hiring Costs / Output	0.027	0.027	0.027	0.027

## 7.4 Discussion

In this section, I have studied whether the shift in the cyclical nature of the labor share can be obtained qualitatively as a byproduct of other important structural changes observed for the U.S. economy after the mid-1980s. The answer is that it cannot. Out of my results, the most promising interpretation for the shift in the cyclical nature of the labor share is that the labor market became more flexible.

However, the perfect flexibility of wages is not a sufficient condition for the labor share to become procyclical. This evidence suggests that there is a technological change in the economy affecting the cyclical nature of the labor share. In particular, this technological change is changing the incentives for labor hoarding at the firm level. The incentives for labor hoarding policies are identified from the procyclical nature of the intensive margin of factor inputs, defined as factor utilization<sup>30</sup>.

In order to check whether the procyclical nature of factor utilization has changed over time, I look to the factor utilization series provided by the San Francisco Fed. This dataset provides a quarterly series on total factor productivity for the U.S. business sector, which is adjusted for variations in factor utilization as measured by labor effort and capital's workweek<sup>31</sup>. Figure 3 shows the cyclical nature for both the labor share and for the factor utilization series for the nonfarm business sector over time using 20-year rolling windows. The factor utilization series remained procyclical for most of the sample, consistent with the existence of a strong labor hoarding mechanism in the economy. However, in the last three decades, factor utilization became acyclical. This means that both labor effort and capital workweek became independent from the business cycles and that firms are not adjusting the intensive margins of factor production depending on whether there is a recession or an expansion.

There are two potential justifications for this. The first is that there are currently no incentives for labor hoarding, which lets firms to optimize factor utilization independently of the business cycles. The advances in logistics and supply chain management technologies can contribute to the

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<sup>30</sup>Refer to [Burnside et al. \(1993\)](#), [Burnside et al. \(1995\)](#), and [Burnside and Eichenbaum \(1996\)](#) for the earlier literature on the cyclical nature of factor utilization. In particular, [Burnside et al. \(1995\)](#) studies the implications of procyclical capital utilization rates for inference regarding cyclical movements in labor productivity and the degree of returns to scale.

<sup>31</sup>This dataset is described in [Fernald \(2014\)](#) and the utilization adjustments follow the methodology developed in [Basu et al. \(2006\)](#). Using this data, I construct an index variable for the factor utilization series and I assume the factor utilization series to be the same for the U.S. business and nonfarm business sectors.



decrease in factor hoarding through this channel. Without incentives for labor hoarding, firms are able to increase the flexibility of adjustments in employment and real wages, which can potentially make the labor share less countercyclical, or even procyclical if capital and labor inputs are complementary factors of production.

The second is that there is a change in the production process for these firms, or a technological change that modifies the production functions for the average firm in the economy. This technological justification would be consistent with the notions brought by [Choi and Ríos-Rull \(2009\)](#) and [Koh and Santaeculália-Llopis \(2017\)](#) towards a technological explanation to the cyclicity of the labor share. However, in this setup the shift in the cyclicity of the labor share would come from changes in the elasticity of substitution between capital and labor, towards a higher complementarity between the two factors of production. There is an ongoing debate on the measurement for the elasticity of substitution at the micro- and macro- levels. For the macro-elasticity of substitution between factors of production, [Eden and Gaggl \(2017\)](#) looks to the welfare implications of automation and argues that the fall in the price of capital goods happened for the type of capital that is more substitutable with labor. The increase in the usage of this type of capital, and consequent increase in the automation of tasks usually performed by workers, increased the aggregate substitutability between capital and labor inputs over time. In their calibration, capital and labor are always relative substitutes, which generates a countercyclical force to the labor share under a constant elasticity of substitution (CES) production function. This evidence suggests difficulties also for this technological story.

One alternative explanation is that the importance of U.S. industries has changed over time. The structural change in the industrial distribution for the U.S. economy passes by a decline in the value added production of manufacturing and trade sectors, and by the corresponding increase in the services and finance sectors. This would mean that the shift in the cyclicity of the labor share would come from sector reallocation from manufacturing to services, and not from any aggregate phenomenon as considered above. In the following section, I extend my empirical analysis to account for industry composition effects and I show that this is not the case. The shift in the cyclicity of the labor share is not an aggregation result, since it happens not only at the aggregate level but also for the majority of industries in the economy.

Therefore, the shift in the cyclicity of the labor share adds discipline to the real business

cycle literature. An interesting path for future research would be to microfound the shift in the cyclicity of the labor share by looking to an aggregate structural change in the U.S. economy that provokes the vanishing procyclicality of labor productivity and the increase in the volatility of real wages. A difficulty would be to consider a framework not generated by wage rigidity in which real wages and labor productivity are positively (but imperfectly) correlated.

## 8 Conclusion

The labor share is assumed to be a (constant) structural parameter or to be countercyclical over business cycles in the macroeconomic literature. In this paper, I unveil the shift towards a procyclical U.S. labor share in the last three decades, both at the national and sectoral levels. I document that this shift in the cyclicity of the U.S. labor share is due mostly to a decline in labor hoarding at the firm level and an increase in the relative volatility of real wages.

These results suggest not only that there is a decline in the amount of formal insurance against unemployment received by workers, but also that firms are producing under new technology. This technological progress allowed firms to optimize the intensive margin for factor inputs over the business cycle, reducing the incentives for labor hoarding policies and making total hours worked proportional to real output. This technological progress may also be the connection between the fall in the labor share and the shift towards a procyclical labor share.

On the other hand, the shift in the cyclicity of the labor income share for the United States imposes further discipline to real business cycles models embedded with labor hoarding, workers' risk aversion, and wage bargaining. In particular, I show that a decrease in labor hoarding and an increase in the flexibility of the labor market are able to generate a decline in the procyclicality of labor productivity, but result counterfactually in an increase for the countercyclicality of the labor share. A similar results shows up when I consider a decline in the workers' bargaining power in the wage bargaining process, and when I consider an increase in the relative volatility of aggregate demand (labor supply) shocks.

Moreover, standard real business cycle models have real wages to be almost proportional to labor productivity, and they rely on the introduction of real wage rigidities to break this proportionality. While this makes real wages less dependent on labor productivity, it also reduces its volatility.

Therefore, an increase in the degree of real wage rigidities will also result in an increase to the countercyclicality of the labor share. This result suggests that real wage rigidities have become less prevalent in the U.S. labor market in the last three decades.

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## 9 Appendix

### 9.1 Appendix A: Competing Labor Share Measures.

#### 9.1.1 Headline Measure for the Labor Share (BLS)

The headline labor share measure from the BLS looks to the nonfarm business sector and assumes that the average wage for a self-employed worker is the same as the average wage for an employee working on a similar occupation. The associated measurement of the labor share for the nonfarm business sector is

$$\lambda_t^{\text{BLS}} = \left(1 + \frac{\# \text{ hours self-employed}_t}{\# \text{ hours employees}_t}\right) \cdot \frac{\text{Compensation of Employees}_t}{\text{Gross Value Added}_t} = \left(1 + \frac{H_t^S}{H_t^E}\right) \cdot \frac{W_t \cdot H_t^E}{P_t \cdot Y_t}$$

where  $H_t^S$  is the total number of hours worked by the self-employed workers,  $H_t^E$  the total number of hours worked by employees,  $W_t$  the average hourly wage earned by employees, and  $P_t Y_t$  the nominal gross value added. The gross value added for the nonfarm business sector represents  $\approx 75\%$  of the gross value added for the total economy.

That is, the headline measure for the BLS inflates the payroll share to account for the number of hours worked by the self-employed. [Elsby et al. \(2013\)](#) argue that a part of the recent decline in the headline measure of the labor share in the United States is spurious, due to the “labor approach” assumption. For the purposes of my paper, [Elsby et al. \(2013\)](#) state that short-run cyclical movements in the U.S. labor share can be tracked by accounting by the payroll share, which is the measure that I ultimately use.

To understand whether this statement is true, the challenge is to reconstruct the hours worked by the self-employed, as they are not publicly available. To do so, I follow [Elsby, Hobijn, and Şahin \(2013\)](#) and construct a time series for the nonfarm business sector payroll share<sup>32</sup>. Then, the share of hours worked by the self-employed with respect to the hours worked by the employees can be obtained as

$$\frac{H_t^S}{H_t^E} = \frac{\text{ls}_t - \text{Payroll Share}_t^{\text{NFB}}}{\text{Payroll Share}_t^{\text{NFB}}}$$

Additionally, I use a time series on total hours worked ( $H_t^E + H_t^S$ ) for the NFB from the BLS’s Productivity and Costs release to get

$$1 + \frac{H_t^S}{H_t^E} = \frac{H_t^E + H_t^S}{H_t^E} = \frac{1}{H_t^S} \cdot \frac{H_t^E + H_t^S}{H_t^E / H_t^S}$$

implying that the total hours worked by the self-employed can be computed as

$$H_t^S = \left( \frac{\frac{H_t^S}{H_t^E}}{1 + \frac{H_t^S}{H_t^E}} \right) \cdot (H_t^E + H_t^S)$$

and the total hours worked by employees is the difference between total hours worked and the hours worked by the self-employed workers. The quarterly time series for the implied share of total

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<sup>32</sup>For more information on the methodology I use, check Table A5 on [Elsby, Hobijn, and Şahin \(2013\)](#) technical appendix. When necessary, annual data is converted to quarterly using a cubic spline for quarterly interpolation.



hours worker by the self-employed, that is,  $H_t^S / (H_t^E + H_t^S)$ , is shown in figure 1. As in [Elsby et al. \(2013\)](#) we notice a large decline in the share of hours worked by the self-employed, from 14.1% in 1947 to 8.1% in 2016. This decline is mostly driven by a stagnation in the number of hours worked by the self-employed, and it occurs in two phases.

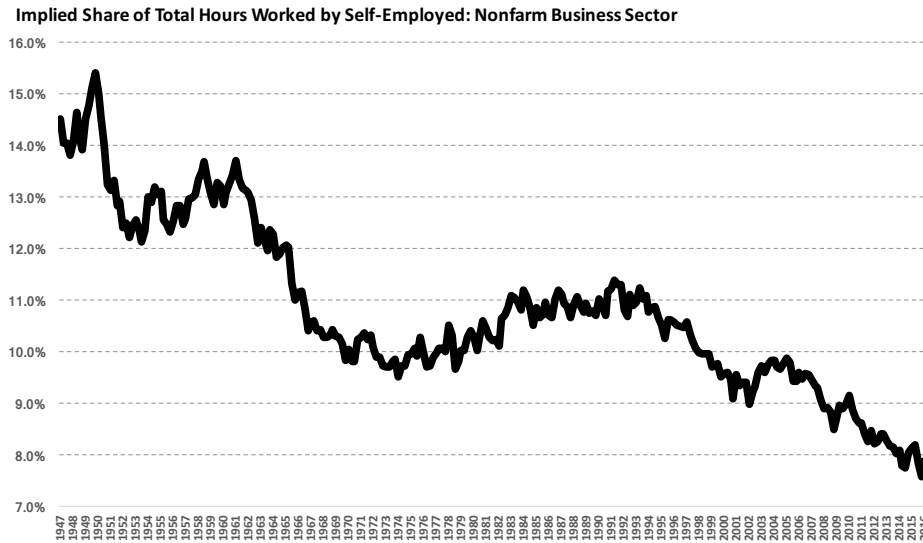


Figure 11: Share of Total Hours Worked by the Self-Employed: Nonfarm Business Sector

The first happens from 1947 to the mid-1970s. In this period, the total number of hours worked by the self-employed remained constant and the total number of hours worked by employees continuously increased, achieving a cumulative increase of 57.7% from 1947 to 1977. This means an increase of 1.86% per year in the number of hours worked by employees. The second phase occurs from the mid-1990s to 2015. Over this time period, the number of hours worked by the self-employed decreased by 22.2%, while the number of hours worked by employees increased by 12.3%. This implies a decrease of 1.17% per year in the number of hours worked by the self-employed and an increase of 0.64% per year in the number of hours worked by employees. The decline in the share of hours worked by the self-employed has an impact in the fall of the headline measure for the labor share.

After describing the other measures used to compute the labor share, I will study whether the share of hours worked by the self-employment has an impact on the cyclicity of the labor share. I reach the conclusion that it has not, and I find that [Elsby et al. \(2013\)](#) statement that the cyclicity

of the labor share can be described by the cyclical of the payroll share is correct.

### 9.1.2 Economy-Wide Labor Share

The economy-wide measure of the labor share is the measure favored by [Gomme and Rupert \(2004\)](#). The main assumption is that the ambiguous income is allocated between labor and capital in the same share as the unambiguous income is allocated between factors of production. Define the unambiguous income in two components. The unambiguous labor income is  $P_t \cdot Y_t^{\text{UL}} = \text{Compensation of Employees}_t$  and the unambiguous capital income is  $P_t \cdot Y_t^{\text{UK}} = \text{Rental Income}_t + \text{Profits}_t + \text{Net Interest}_t + \text{Depreciation}_t$ . The labor share can then be computed as

$$ls_t = \frac{Y_t^{\text{UL}}}{Y_t^{\text{UL}} + Y_t^{\text{UK}}}$$

Under this measure of the labor share, the “ambiguous” income is allocated to labor and capital in the same proportions they represent in the part of national accounting that can be unambiguously assigned to labor and capital. Therefore, the main assumption is that “proprietors” allocate their resources between capital and labor in the same way corporations do, independently of the number of self-employed workers have their own businesses.

However, one can argue that this measure underestimates the labor share. For this statement to be true, we need to consider a world in which firms allocate resources differently between capital and labor according to their size. Moreover, we need to think on this allocation to be more biased towards labor at smaller sizes and towards capital at larger sizes. Another issue with this measure is that there is a disagreement in the literature on the measurement and economic interpretation of residential housing, which decreases the reliability of this measure. The gross unambiguous income for capital and labor represent  $\approx 75\%$  of the gross value added for the total economy.

### 9.1.3 Corporate Business Sector Payroll Share

The corporate business sector is defined as the sector encompassing financial and nonfinancial corporations. The corporate business sector does not include any proprietors’ income in its gross value added, which constitutes a big advantage when we look to the dynamics of the labor share.

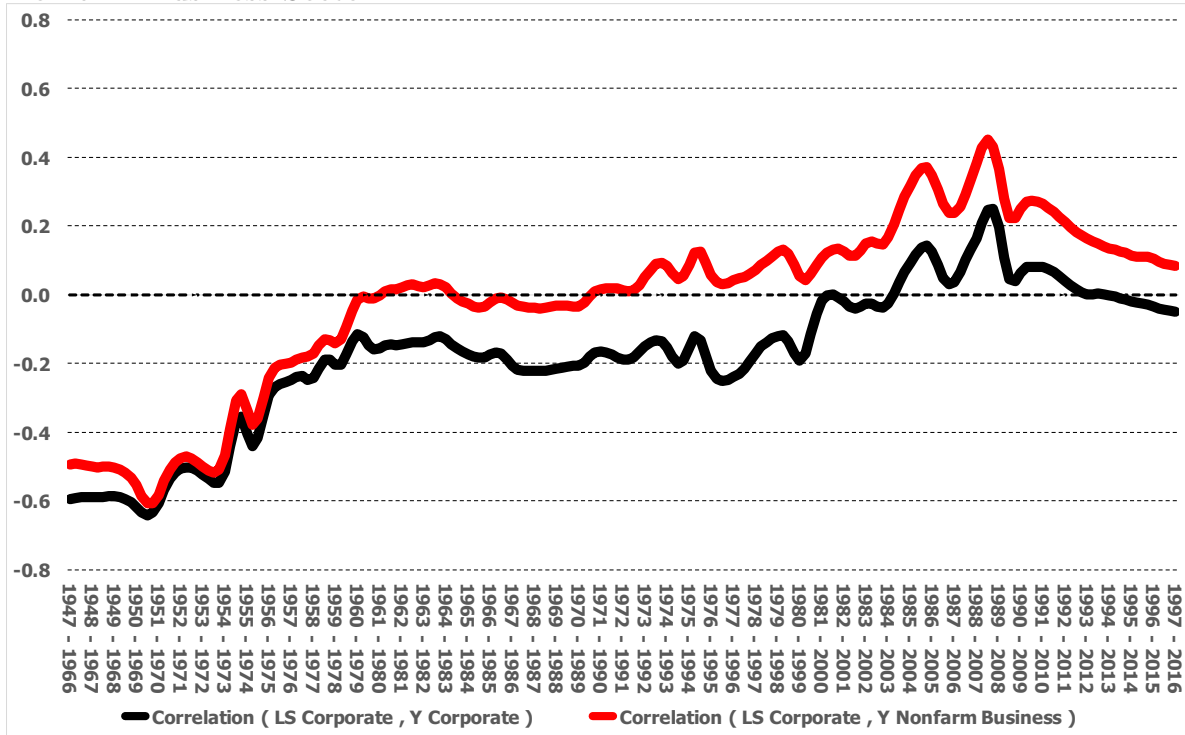
It still has an ambiguous income component from the net indirect taxes, but the payroll share will be equal to the labor share, as it is not affected by the statistical imputation of wages from combined capital and labor income earned by sole proprietors and unincorporated enterprises. This advantage overcomes the measurement issues raised by [Gollin \(2002\)](#) and this measure is the one favored by [Karabarbounis and Neiman \(2014\)](#) to compare the labor share across countries.

The payroll share for the corporate sector is mildly negatively related (or unrelated) with the real value added for the corporate sector, but it comoves procyclically with the real value added for the noncorporate sector. This may imply that firms and workers bargain the workers' compensation by looking to the aggregate real output, instead of looking only to the real production of the corporate sector. Another reason may be that the production in the corporate sector has positive externalities in the noncorporate sector, which show up not on the value added for the corporate sector but on the value added for the noncorporate sector. However, these externalities may have a higher intensity on the compensation of employees in the corporate sector and less on other components of the gross value added for this sector.

On the left panel of the figure above it is plotted the correlation between the payroll share for the corporate sector (LS Corporate) with the real value added for the corporate sector (black line) or with the real value added for the nonfarm business sector (red line). This correlation is plotted for a rolling 20 year window using quarterly data. It is clear that for both series there is a shift in the cyclicity of the labor share for the corporate sector towards procyclicality. Both time-varying correlations move almost in parallel, implying the existence of a stationary bias in these correlations, coming from the non-corporate business sector.

The right panel shows then the time-varying correlation for the payroll share for the corporate sector with the real value added for the corporate sector (black line) or with the non-corporate sector (red line). While the correlation with the real value added for the corporate sector passes from countercyclical to acyclical, the correlation with the real value added for the non-corporate sector passes from acyclical to procyclical. The difference between the two remains relatively constant, with the clear exception for the 20 year rolling windows between 1958-1973 and very briefly for the period in which the Great Recession starts showing up in these time-varying correlations (around 1989-2008). The gross value added for the corporate business sector represents  $\approx 55\%$  of the gross domestic product for the total economy.

### Nonfarm Business Sector



### Non-Corporate Business Sector

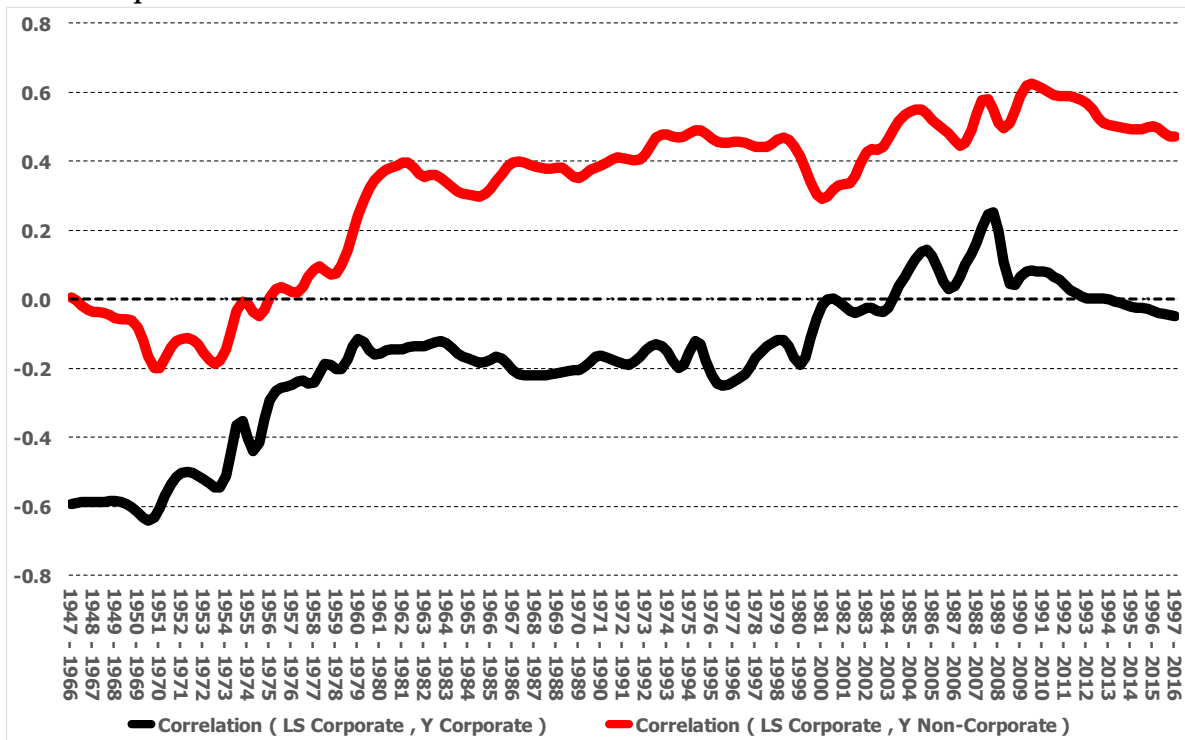


Figure 12: Cyclicity of Payroll Share for Corporate Sector

### 9.1.4 Multifactor Productivity Labor Share (BLS)

This labor share series uses the asset basis approach from [Kravis \(1959\)](#), augmented with a measurement of the user cost of capital advocated by [Jorgenson \(1963\)](#). The main assumption is that returns to capital (captured by its user cost) are the same for the capital used by employees and by the self-employed. This measure is used by [Fernald \(2014\)](#) to construct his real-time growth accounting data set. The BLS Multifactor Productivity (MFP) data infers self-employment labor income in a very similar way, although this data is only available at an annual frequency. To transform the available data into a quarterly time series, I use a cubic spline for quarterly interpolation.

## 9.2 Appendix B: Construction of Variables for the Nonfarm Business Sector.

I construct the nonfarm business sector variables by following [Elsby et al. \(2013\)](#). All data is taken from the National Income and Product Accounts (NIPA) published by the Bureau of Economic Analysis (BEA). I will refer to variables coming from x:y, where x is the number of the corresponding NIPA table and y the number of the row in that NIPA table. The quarterly gross value added for nonfarm business sector is taken from 1.3.5:3. The quarterly compensation of employees for total economy is taken from 1.10:2. The quarterly compensation of employees for the government sector is taken from 3.10.5:4. The compensation of employees for Households and Nonprofit Institutions Serving Households is only available as annual data and it is taken from 1.13:43 (Households) and 1.13:50 (NISH). These variables are then summed to get the aggregate series. To obtain a quarterly time series, I apply to this annual variable a cubic spline for quarterly interpolation. The midpoint for the annual data is assumed to be on the third quarter (Q3) of each year. Since the annual data is only available from 1948 onwards, I adjust the quarterly series for periods 1947Q1 to 1948Q2 using the quarterly growth rate for the gross value added for the Households and NISH sector, taken from 1.3.5:5. The compensation for the farm sector employees is only available at an annual frequency and is obtained from 7.3.5:18. I use the same methodology as for the previous time series by applying a cubic spline for quarterly interpolation. I also apply a cubic spline for quarterly interpolation to the annual gross value added data for the farm sector, taken from 7.3.5:15. This quarterly splined series differs from the quarterly gross value added series for the farm sector taken from 1.3.5:4. I build the ratio of the quarterly series measured from 1.3.5:4 (py-farm) to the quarterly splined

series from 7.3.5:15 (py-farm-spline). Finally, I adjust the splined quarterly compensation for the farm sector by multiplying it by this ratio. Having put together this information, I construct the compensation of employees for the nonfarm business sector by subtracting to the compensation of employees for the total economy, the compensation of employees for the government, household and NISH, and farm sectors. Finally, the payroll share for the nonfarm business sector is the ratio between the compensation of employees for the nonfarm business sector and the gross value added for the nonfarm business sector.

### 9.3 Appendix C: Construction of Industry Level Data

I define the industries for the U.S. economy in terms of the North America Industry Classification System (NAICS) definitions for industries. I look to the industries of Mining; Construction; Manufacturing; Transportation and Warehousing; Public Utilities; Information; Wholesale and Retail Trade; Finance and Insurance; Real Estate; Professional and Business Services; Leisure and Hospitality; Educational Services; Health Care and Social Assistance; and Other Services. The cross-walk between the NAICS industries using the available SIC data from the Bureau of Economic Analysis (BEA) is described on table 8.

The value added share for manufacturing decreased from 34.13% in 1947 to 13.98% in 2015 and the value added share in the wholesale and retail trade sector fell from 23.33% in 1947 to 13.85% in 2015. The value added share for professional and business services increased from 1.83% in 1947 to 14.22% in 2015 and the value added share for financial activities increased from 3.13% in 1947 to 8.33% in 2015. Other significant changes in the value added shares happened for health care and social activities, with an increase in 6.38 percentage points from 1.99% in 1947 to 8.37% in 2015, for real estate with an increase in 5.69 percentage points from 9.54% to 15.22%, and for transportation and warehousing with a decline in 3.70 percentage points, from 7.20% in 1947 to 3.50% in 2015.

To avoid structural breaks in the time series for each industry, due to differences in the industrial classification, and because I am interested in the cyclicity for the value added and payroll shares for each industry, I construct a consistent time-series over time by using both information from the SIC industries and the NAICS industries. Since both classifications have some years in common, 1987 between SIC 72 and SIC 87, and 1997 between SIC 87 and NAICS, I use the information on those years to filter out the differences in the levels of the series over time. The assumption behind

Table 8: Industry Definitions, Cross-Walk Table with SIC, and Value Added Shares for 1947 and 2015.

Nonfarm Private Sector: Industries	NAICS	SIC 72	SIC 87	VA Share (1947)	VA Share (2015)	Change (in p.p.)
Mining	21	10-14	10-14	3.58%	2.11%	- 1.47
Construction	23	15-17	15-17	4.72%	4.72%	- 0.00
Manufacturing	31-33	20-39	20-39	34.13%	13.98%	-20.15
Transportation and Warehousing	48-49	40-42, 44-47	40-42, 44-47	7.20%	3.50%	- 3.70
Public Utilities	22	49	49	1.97%	1.83%	- 0.14
Information	51	48, 78	48, 78	2.51%	5.41%	2.90
Wholesale and Retail Trade	42, 44-45	50-59	50-59	23.33%	13.85%	- 9.48
Finance and Insurance	52	60-64, 67	60-64, 67	3.13%	8.33%	5.20
Real Estate	53	65-66	65-66	9.54%	15.22%	5.69
Professional and Business Services	54-56	73, 81, 84, 89	73, 81, 84, 87, 89	1.83%	14.22%	12.39
Leisure and Hospitality	71	70, 79	70, 79	1.43%	4.57%	3.14
Educational Services	61	82	82	0.38%	1.30%	0.92
Health Care and Social Assistance	62	80, 83	80, 83	1.99%	8.37%	6.38
Other Services	81	72, 75, 76, 86, 88	72, 75, 76, 86, 88	4.25%	2.59%	- 1.67

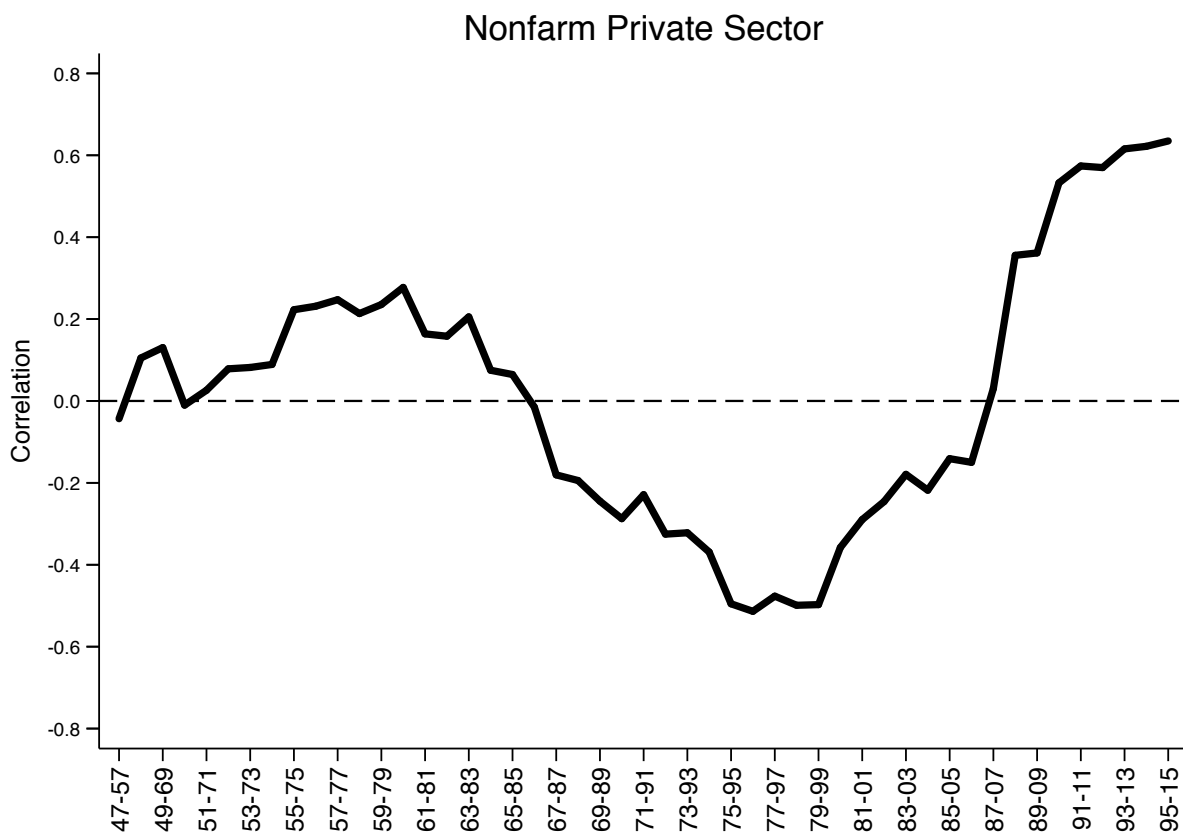


Figure 13: Shift in the Cyclical of the Labor Share: Nonfarm Private Sector

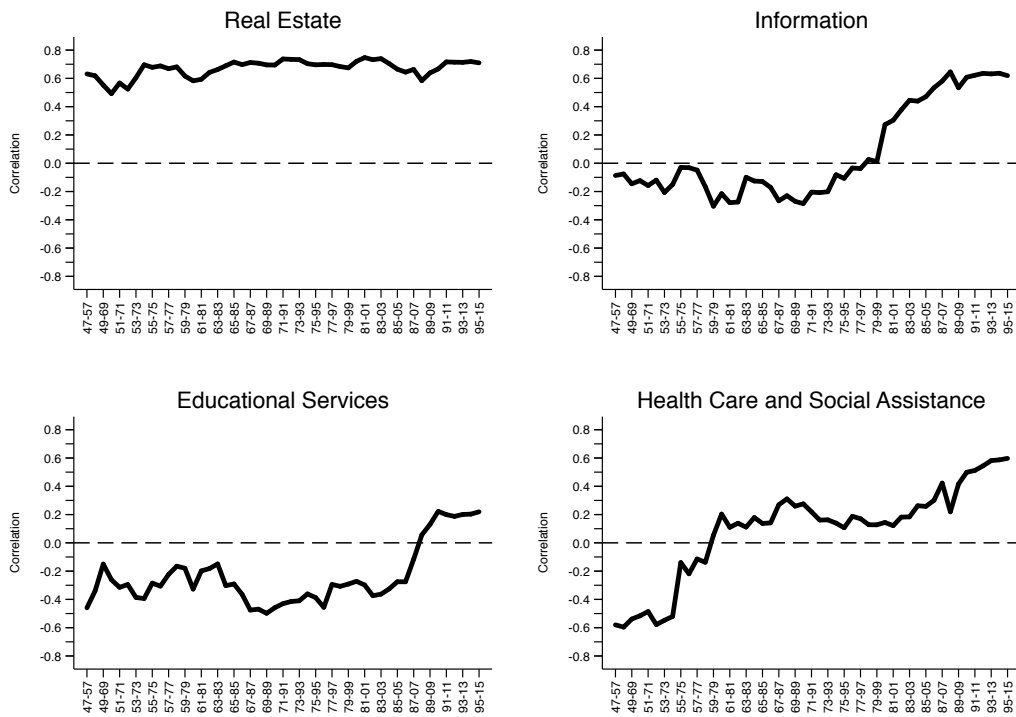


Figure 14: Other Sectors Contributing to a Procyclical Labor Share in the Last Three Decades

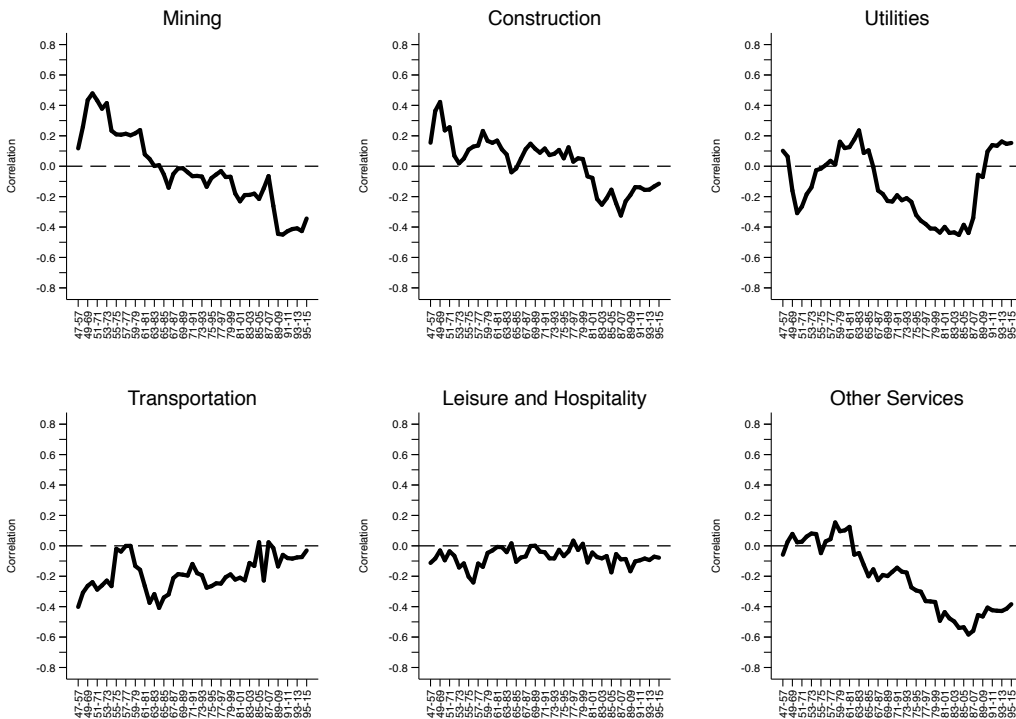


Figure 15: Sectors Without a Clear Shift in the Cyclicity of the Labor Share.



is that industries constructed with the cross-walk defined by table 8 have the same cyclicity. The industry-level data from the BEA is taken from tables 6.2 to 6.9.

Figure 11 shows the shift in the cyclicity of the labor share for the nonfarm private sector data using the industry-level data from the BEA. Figures 8, 12 and 13 shows the cyclicity of the labor share for the industries spanning the nonfarm private sector. The key sectors considered in the text are manufacturing, wholesale and retail trade, financial activities, and professional and business services, and the cyclicity of their sectoral labor share is represented in figure 8. Other sectors that contribute to the shift in the cyclicity of the labor share are Real Estate, Information, Educational Services, and Health Care and Social Assistance, and are represented in figure 12. Finally, the sectors that do not follow the aggregate pattern are represented in figure 13. These are mining, construction, utilities, transportation, leisure and hospitality, and other services. These sectors represent 23.2% and 19.3% of the Value Added for the Nonfarm Private Sector in 1947 and 2015, respectively.

#### 9.4 Appendix D: Model Calibration

The calibration of the model is similar to the one used by Galí and van Rens (2017). the discount factor is set to  $\beta = 0.99$ . It is assumed a log utility over consumption,  $\eta = 1$ . The frictionless employment-population ratio is assumed to be equal to 70%, implying  $\gamma = 1.24$ .  $\alpha = 1/3$  defines the steady state capital share.  $\xi = 0.299$  sets effort equal to one in the frictionless version of the model.  $\delta$  is calibrated to 0.35 to match pre-mid-1980s data, but in experiments I shift it around to 0.2 (post-mid-1980s data) and to 0.01 (“frictionless” model). The workers’ bargaining power is set to 0.5.  $\phi$  is set to zero so that effort is in utility units. I set  $\psi = 0.3$ .  $g^F(E) = [\kappa/(1 + \mu)] \cdot E^{1+\mu}$  are the hiring costs, in which  $\mu = 1.5$  sets these adjustment costs to be convex, and  $\kappa = 3.18825$  aims for the cost of frictions to be 3% of output in the calibrated version of the model. Finally,  $\rho_A = \rho_Z = 0.97$  allow us to look to persistent shocks, and the volatilities of these shocks ( $\sigma_A = 0.01954$ ,  $\sigma_Z = 0.02424$ ) set the standard deviation of output to be roughly 3%.