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JEL Classification: E32, E37, E44, J20

Keywords: Distribution risk, bargaining shocks, Aggregate fluctuations, partial filter, historical narrative

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Bargaining Shocks and Aggregate Fluctuations

Thorsten Drautzburg, Jesús Fernández-Villaverde, and Pablo Guerrón-Quintana*

March 28, 2021

Abstract

We argue that social and political risk causes significant aggregate fluctuations by changing workers' bargaining power. Using a Bayesian proxy-VAR estimated with U.S. data, we show how distribution shocks trigger output and unemployment movements. To quantify the aggregate importance of these distribution shocks, we extend an otherwise standard neoclassical growth economy. We model distribution shocks as exogenous changes in workers' bargaining power in a labor market with search and matching. We calibrate our economy to the U.S. corporate non-financial business sector, and we back out the evolution of workers' bargaining power. We show how the estimated shocks agree with the historical narrative evidence. We document that bargaining shocks account for 28% of aggregate fluctuations and have a welfare cost of 2.4% in consumption units.

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1 Introduction

In this paper, we argue that the social and political distribution risk between labor and capital is a quantitatively relevant source of aggregate fluctuations. To do so, we begin by documenting political distribution risk in the data, as one specific form of distribution risk. We use three empirical exercises. First, using the volatility of capital shares, we document considerable changes in how income was divided between capital and labor in France, the U.K., and the U.S. over the last century and a half. Second, we analyze the consequences for distribution of the adoption of right-to-work legislation by several U.S. states. We estimate that the introduction of right-to-work legislation in a state is followed, on average, by increases in the state capital share of 1.5-1.6 percentage points (pp.) relative to the U.S. five years after adoption. Third, we focus on the U.S. by estimating a Bayesian proxy-vector autoregression (VAR). We proxy the redistributive shock by legislated changes in the federal and state-level minimum wages. In different specifications, we document the significant effects of these distribution shocks on output, factor shares, and labor markets.

This evidence motivates us to augment a standard stochastic neoclassical growth model with labor search and matching à la Shimer (2010) with shocks to the bargaining power of workers. These shocks are a simple way to capture a central mechanism through which distribution risk operates. Formally, bargaining shocks can be interpreted as arising from social or political influences on the protocol of an underlying dynamic bargaining game (Binmore et al., 1986) through mechanisms such as collective bargaining rules, minimum wage regulations, etc. In our model, this risk is separate from changes due to endogenous movements in the bargaining position of workers and firms, since those movements are reflected in the outside values of the agents.

We identify our model by exploiting the differences in the responses of output and wages to shocks to productivity and the bargaining power of workers. After both a positive shock to productivity and a shock that lowers the bargaining power of workers, output grows. However, wages rise if the former shock occurs, but fall if the latter shock hits the economy. Hence, looking at the comovements of output and wages disentangles one shock from another.

With this identification, we calibrate our model to the U.S. non-financial corporate business sector and the labor market. As a baseline, we look at long-lived bargaining shocks with a half-life of 34 quarters. Thus, our approach deals not only with standard business cycles, but also with medium-term aggregate fluctuations. The half-life of 34 quarters is based on our reading of the changes in the social and political climate regarding the bargaining power of workers in the postwar U.S. and matches the average duration of control of the different branches of the federal government by each party after World War II.

We use U.S. data to back out the bargaining shocks implied by our quantitative model. We do so by applying the *partial information filter* recently introduced by Drautzburg et al. (2021). The central idea of the partial filter is to take one of the key optimality conditions of the model (in our case, the wage-setting equation), substitute the different conditional expectations of a product of variables by their conditional covariance plus the product of conditional expectations of single variables, and approximate those conditional covariances and expectations of single variables from a Bayesian VAR (BVAR). Crucially, the backed-out shocks agree with our narrative evidence for the U.S. since WWII, with peaks at moments of significant labor union victories (e.g., the 1970 GM strike) and troughs at moments of weakness of unions (e.g., the early 2000s).

As a robustness check, we explore the behavior of the model with even more persistent bargaining shocks (half-life of 80 quarters) and with less persistent ones (half-life of 14 quarters, a standard business cycle persistence). The qualitative dynamic properties of the model are not significantly affected by this persistence. However, we find that the higher the persistence of bargaining power shocks, the more significant their impact on real fluctuations and the smaller their impact on the income distribution.

We solve our model using a third-order perturbation since we document how the non-linear features of the solution can be significant. These non-linearities also mean that we must calibrate the model to match the moments of its ergodic distribution and not its steady-state properties. To assess the properties of our economy, we compare it with a version of the model without bargaining shocks, with a benchmark real business cycle (RBC) model with productivity shocks, and with an RBC model augmented with factor share shocks in the production function (as in Danthine et al., 2006, Ríos-Rull and Santaeulàlia-Llopis, 2010, and Lansing, 2015).

Other significant findings of the paper are as follows. First, our model replicates the near acyclicality of wages highlighted by Lucas (1977) as an obstacle for equilibrium business cycle models that want to rely on movements in real wages as a source of fluctuations. In our economy, output can increase either because productivity grows, which raises wages, or because bargaining power shifts toward capital, which lowers wages. This finding allows us to discriminate between models. An RBC model with factor share shocks yields wages that are too pro-cyclical: a shock toward labor makes it more productive and, thus, raises wages.

Second, our model accounts reasonably well for the pro-cyclicality of the capital share and the net capital share (i.e., after depreciation). This stands in stark contrast to the version of the model without bargaining shocks and the RBC models (with and without factor share shocks). This result is robust to reasonable values of the elasticity of substitution between capital and labor in the production function.

Third, the bargaining shocks account for around 28% of the volatility of output, nearly all of the model-generated volatility of the gross capital share, and around 45% of the net capital share. When the model is calibrated to match observations from the U.S. labor market, the surplus of the labor relation is small. Minor variations in how this surplus is allocated induce substantial changes in the number of recruiters firms employ to hire new workers. This leads to lower output and employment but also higher wages. We illustrate this point as follows. The U.S. has benefited from a more stable capital share than other industrialized countries. For example, the overall volatility of the capital share is about 40% lower than in the U.K. If increased distribution risk would cause the capital share to become 40% more volatile, our model predicts that output and consumption volatility would be 15% higher. The welfare cost of bargaining shocks is a sizable 2.4% of consumption, much larger than in Lucas (1991).

Finally, we look at the dynamic effects of a bargaining power shock, and, in an Appendix, we perform an extensive battery of robustness exercises. We document, for example, how our main results are not affected when we partly endogenize the bargaining power process by having bargaining power or unemployment benefits depend directly on the business cycle. Nonetheless, the endogeneity of the bargaining shock (and how it reacts to issues such as technological change, globalization, inequality, and others) is a topic that deserves much further exploration than we can cover in this paper.

Our paper builds on a large literature. The recent evolution of the capital share has commanded much attention (e.g., among many others, Autor et al., 2017; Barkai, 2017; Berger et al., 2019; De Loecker and Eeckhout, 2017; Karabarbounis and Neiman, 2014; Koh et al., 2015). Some of the proposed explanations highlight technological change, the fall in the relative price of capital, increases in firm concentration, globalization, or the role of intellectual property products. For our investigation, we can remain agnostic about these mechanisms. Our point is not that all fluctuations in the capital share have a social or political origin: we only claim that part of them do. Also, we focus on fluctuations around a trend rather than on the trend (although we perform some high-persistence exercises). One should expect that the effects of technological change, increased market power, or structural transformation on factor shares would manifest themselves more clearly in the trend than in middle- and high-frequency movements.

Previous work has also focused on how changes in bargaining power affect factor shares. Examples include Blanchard (1997), Caballero and Hammour (1998), and Blanchard and Giavazzi (2003). The papers cited above are concerned with the trend decline in the labor share in Europe, whereas we focus on aggregate fluctuations. Gertler et al. (2008) and Liu et al. (2013) also allow, in passing, for time-varying bargaining power, but they do not study its implications in full. Foroni et al. (2017) have presented VAR evidence of the importance of bargaining supply shocks in employment fluctuations. Ríos-Rull and Santaeulàlia-Llopis (2010) and Danthine et al. (2006) interpret distribution shocks as technological shocks to the production function. As we will see later, our model outperforms an RBC model with factor share shocks in terms of matching important aggregate fluctuation statistics.

Our bargaining shocks resemble wage markup shocks such as those in Galí et al. (2012). There are some important differences, though. First, our model endogenously generates the equivalent to state-dependent markups over disutility from labor because the surplus of the match is time-varying. Second, we document the importance of higher-order effects related to labor market tightness. These effects are absent in models with markup shocks. Third, we link our shocks to a precise historical narrative. For instance, our partial information filter points out that, from 1950 to the late 1970s, the evolution of bargaining power mostly followed the fate of unions (except for the Kennedy-Johnson wage-posting guidelines). After 1980, changes such as Reagan's regulation, Clinton's welfare reform, immigration, and labor market policies such as minimum wages and unemployment extension played a bigger role.

We also link with papers dealing with wage bargaining and aggregate fluctuations. This literature is too large to do justice to it in a few lines, but we can highlight the textbook treatment in Shimer (2010) and the references there. Interestingly, Shimer (2005) pointed out the potential of bargaining power shocks for resolving the unemployment volatility puzzle, but emphasized the need for clear identification. Our paper focuses much attention on identification and the link between historical evidence and bargaining power shocks.

Finally, our work is closely related to Danthine and Donalson (2002), who study the link between financial and labor markets. Their focus is to understand how time-varying labor shares affect the equity premium. In particular, they show that exogenous and stochastic variation in labor shares faced by workers and firms is essential to account for asset prices. The high welfare cost of the business cycle we find is the dual of the high equity premium documented by these authors. Relative to Danthine and Donalson (2002), first, we provide empirical evidence of the impact of changing bargaining power on the macroeconomy; second, we characterize the bargaining protocol between workers and firms; and third, we analyze the economy's dynamics, including unemployment following a shock to bargaining power. Also, we show the welfare implications of this bargaining process.

The rest of the paper is organized as follows. Section 2 reviews the historical evidence on the variation in factor shares and political interventions in the U.S. Section 3 presents and computes our model. We take the model to the data in Section 4. Section 5 explains our partial information filter. Section 6 presents the quantitative results and Section 7 reports the dynamic effects of bargaining power shocks. Section 8 concludes. An extensive online appendix discusses further details.

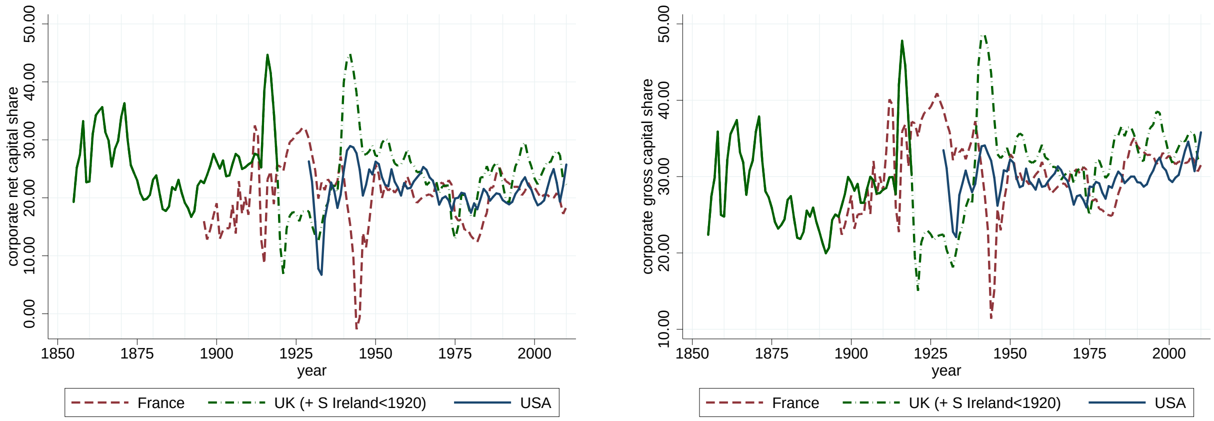
2 Factor shares: Measurement and evidence

Factor shares change over time. Panel (a) of Figure 1 shows the evolution of the net corporate capital share for France, the U.K., and the U.S. since the mid 19th century. Panel (b) plots the same data, except in terms of the gross corporate capital share. The data reveal three facts. First, when we concentrate on the economy's corporate sector –the object of interest in our model– the capital share does not display a trend, except for an increase at the end of the sample.[1] Second, there has been, nevertheless, significant movement in the capital share over time, including larger changes before WWII. Third, the U.S. has exhibited the least volatile capital share among the three countries: 30% less volatile than in France and 40% less than in the U.K.

The top panel of Table 1 lists the raw and HP-filtered volatility of the gross capital shares for our three countries. The bottom panel shows that income shares are much more volatile in the U.K. than in the U.S. even after controlling for industry composition (and, hence, reducing the effect of structural transformations and technological change). For France, the same is true only in the raw data, but not after detrending. Lastly, while the standard deviation of the capital share of income fell in the U.S. in the post-WWII period by around 43%, it decreased around 65% in the U.K. and 73% in France.

[1] See Appendix A for details. Notice that our model later in the paper can handle long-lived increases in capital shares (in one calibration, with half-lives up to 80 quarters).

(a) Net capital share　　(b) Gross capital share



The data on the U.K. include Ireland prior to its independence. Source: Piketty and Zucman (2014).

Figure 1: Net and gross corporate capital shares in the long run: The U.K., France, and the U.S.

Table 1: Changes in the gross labor share volatility across time and countries

(a) Historic and cross-country comparison of volatility of the gross labor share

	Raw			HP-filtered		
Country	1929–1949	1950–2010	Difference	1929–1949	1950–2010	Difference
USA	3.28	1.86	1.42	1.79	0.81	0.98
France	7.14	2.50	4.63	2.73	0.75	1.98
UK	10.16	2.72	7.44	2.44	1.14	1.30
Diff.: France – USA	3.85	0.64		0.94	-0.07	
Diff.: UK – USA	6.88	0.86		0.65	0.32	

(b) Within-industry volatility of the gross labor share

	Raw		HP-filtered	
Country	Mean	SE	Mean	SE
USA	4.54	0.52	1.60	0.23
Difference: France – USA	2.78	1.00	-0.06	0.34
Difference: UK – USA	3.77	0.99	0.95	0.37

The data for panel (a) come from Piketty and Zucman (2014) and for panel (b) from the EU KLEMS database and exclude agriculture, mining, and finance. Standard errors in panel (b) clustered by industry and country. HP-filtered with $\lambda = 6.25$.

Next, we argue that part of the variations in factor shares is accounted for by political redistribution by exploiting changes in the right-to-work legislation and minimum wages in the U.S.

2.1 Factor shares and right-to-work legislation in the U.S.

While the U.S. has avoided radical political events that one could use to identify exogenous drivers of labor regulation, there is direct evidence of the effect of policy changes on the labor share at the U.S. state level. Right-to-work legislation was aimed at limiting the bargaining power of unions by allowing employees to opt out of union membership. Did it succeed?

We use data on states that were late to adopt right-to-work legislation to analyze its effects on the capital share. While most right-to-work states enacted the underlying laws in the first decade after 1945, seven states (Idaho, Louisiana, Oklahoma, Wyoming, Indiana, Michigan, and Wisconsin) adopted this legislation between 1963 and 2015, the period for which we have data on private-industry labor shares. Since Wisconsin adopted right-to-work only in March 2015, our most recent useful observations are for Indiana and Michigan, which passed right-to-work laws in 2012.

The data from Idaho, Louisiana, Oklahoma, and Wyoming indicate increases in the capital share after right-to-work legislation was passed, but with different dynamics. However, three to five years after the adoption of right-to-work legislation, the capital share in all four states has risen relative to that in the U.S. (see Figure 2; capital shares are computed as one minus the share of employees' compensation in state GDP net of taxes and subsidies). For Indiana and Michigan, their capital share increased initially and then remained flat in absolute terms, while rising relative to that in the U.S. as a whole, but with only three observations, we must be cautious. Also, we cannot generally control for pre-trends in all states because of data limitations.

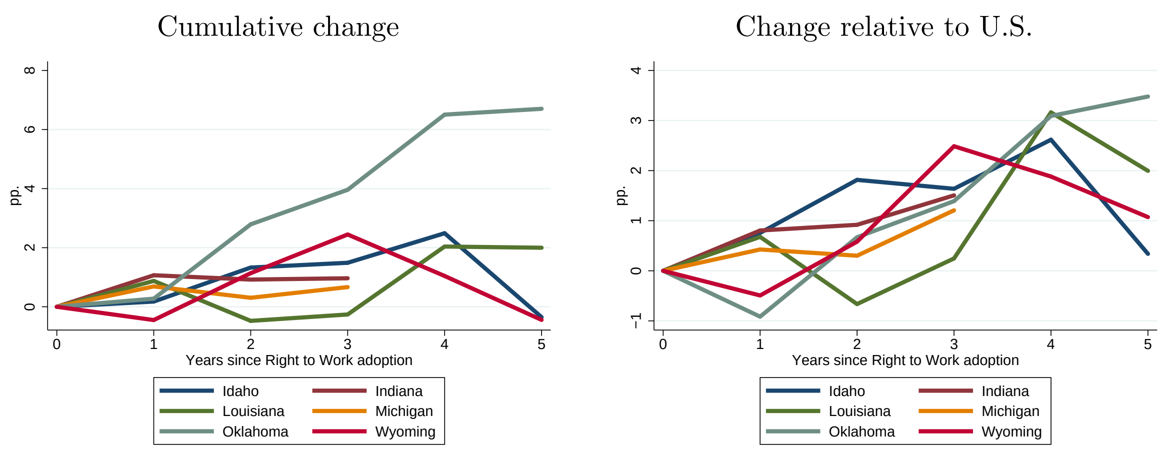


Figure 2: Change in state private-industry capital shares after right-to-work adoption

To gauge the statistical significance of the previous numbers, we also use industry-level variation from these states (Table 2). In most specifications, the increase in the capital share following right-to-work legislation is positive, with two-sided p-values below 0.1 after five years. We can reject the null of decreases in the capital share after right-to-work legislation in most cases.[2] Note that the permanent effect of the right-to-work legislation is ambiguous – potentially because eventually labor-intensive industries disproportionately flock to right-to-work states.

We also look at the effects of right-to-work legislation on state GDP. While the evidence on differences in private-sector real GDP growth is less pronounced, GDP growth weakly increases three to five years after a state adopts right-to-work legislation (see Figure C.6 and Table C.1 in

[2]The point estimates are smaller when we also control for year fixed effects, but highly significant at the four- and five-year horizons. However, the standard errors may be unreliable in these cases and, therefore, we decided not to include the results in the table.

Table 2: State-industry panel regression: Right-to-work laws and gross capital share

Controlling for state FE, and industry FE

	Level	1y change	2y change	3y change	4y change	5y change
Right to Work	0.03					
	(0.98)					
Change in RtW		1.00	1.38	1.88	1.90	1.75
		(0.38)	(0.19)	(0.07)	(0.06)	(0.08)

Controlling for state FE, quadratic trend, and industry FE

	Level	1y change	2y change	3y change	4y change	5y change
Right to Work	-1.43					
	(0.28)					
Change in RtW		0.19	0.75	1.32	1.51	1.55
		(0.78)	(0.17)	(0.06)	(0.05)	(0.04)

Before 1997: Private SIC industries. From 1997: Private NAICS industries. Standard errors are clustered by state and industry. Two-sided p-values are in parentheses.

the Appendix). This finding is consistent with Holmes (1998) and Alder et al. (2014). These papers analyze the effects of right-to-work legislation on the location of manufacturing and find positive effects on manufacturing activity. To provide more detail on the economic dynamics following a distribution shock, we now turn to a VAR estimated for the U.S. economy.

2.2 Factor shares and minimum wages in the U.S.

Besides changing the bargaining power of workers, the government can directly affect how the surplus is split between firms and workers by mandating a minimum wage. As Flinn (2006, p. 1014) points out: "Increases in the minimum wage can be viewed as a way to increase their [i.e., workers'] "effective" bargaining power." Even though less than 10% of hours worked in the U.S. are paid at or below minimum wage (Autor et al., 2016), increases in statutory minimum wages often spill over to higher wage groups due to indexing or tournament wage structures. For the U.S., Lee (1999) estimates that the spillovers are big enough to account for more than 100% of the change in the ratio of the 50th to the 10th wage percentile after a decline in the real minimum wage. More recently, Autor et al. (2016) find spillovers in the order of 30-40%. Similar findings are reported by Harris and Kearney (2014), who argue that the "ripple effects" of an increase in the minimum wage will raise the wages of nearly 30% of the workforce.

Motivated by these results, we analyze how changes in the statutory federal minimum wage impact the capital income share. Figure 3 shows how the corporate non-financial capital share changed relative to the real change in the statutory minimum wage.[3] Once we exclude the outlier in 1950, we find a robust negative relationship between changes in the statutory minimum wage and

[3]We focus on the original federal minimum wage that covered only employees engaged in interstate commerce. From 1961 onward, other federal minimum wage rates were introduced. These were lower until 1978, when a single minimum wage replaced them. See https://www.dol.gov/whd/minwage/chart.pdf. To convert the statutory change to 2000 USD, we divide the change by the level of the PCE deflator relative to the year 2000.

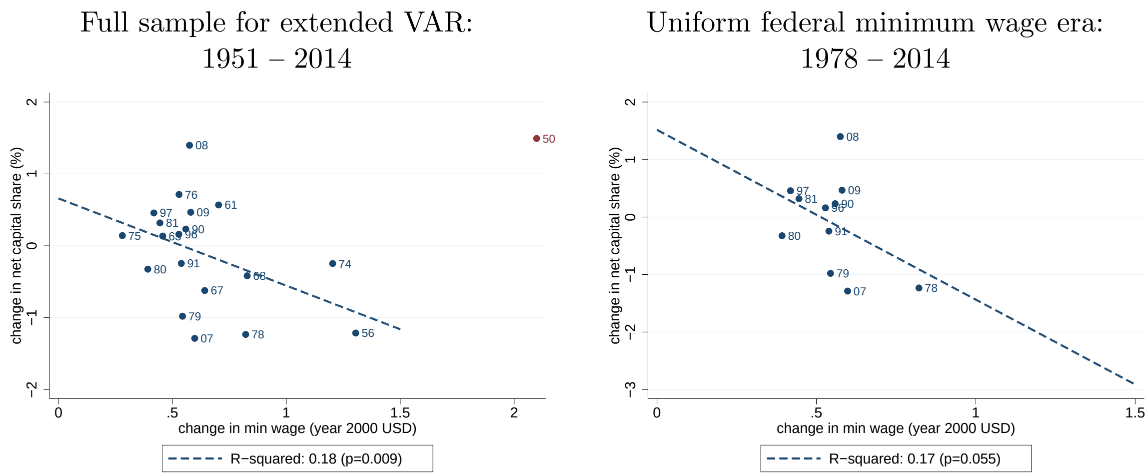


Figure 3: Change in the corporate capital share and real change in the statutory federal minimum wage.

the capital share that explains about 18% of the variation in the observed capital share (reported *p*-values are based on White robust standard errors).[4]

To move from these simple scatter plots to a formal estimation, we use a Bayesian proxy-VAR (see Arias et al., 2018). Our proxy for the distribution shock is the legislated change in the federal minimum wage, converted to constant year 2000 USD - similar to the instrumental variables strategy in Autor et al. (2016). Under the assumption that the federal minimum wage legislation is uncorrelated with other shocks, this procedure identifies the response of the economy.

The assumption that statutory minimum wage changes are uncorrelated with other shocks allows us to identify a distribution shock without any additional restrictions, such as zero restrictions on impulse response functions (IRFs) common in the VAR literature. Technically, our proxy-VAR is a Bayesian version of the original frequentist approach in Stock and Watson (2012) and Mertens and Ravn (2013). We use the Bayesian implementation in Drautzburg (2016) with a flat prior over reduced-form parameters. Under the assumption that the proxy is a valid instrument, the proxy-VAR identifies the IRFs from the covariance of forecast errors and the proxy. The algorithm also allows us to purge the proxy from other predictors, which we exploit in robustness checks.

We estimate a parsimonious VAR that captures the labor market, the goods market, and the capital share. The VAR has four variables: (1) the real minimum wage, (2) the unemployment rate, (3) the net capital share in the non-financial corporate business sector, and (4) gross value added (GVA) in the overall non-farm business sector. Our data are quarterly and we include four lags. We begin our estimation in 1951, excluding the 1950 outlier and allowing us to keep the sample constant when we later extend the VAR. Here, we focus on specifications without any trend. Figure D.7 in

[4] On January 25, 1950, the minimum wage increased from \$0.40/hour to \$0.75. However, given the limited coverage of minimum wage at the time (it covered only workers employed by firms engaged in interstate commerce) and the prevailing wages in the industry for low-skill workers (well above \$0.40/hour), the real effects of this sharp increase in the minimum wage were likely limited. Furthermore, using a robust regression that drops any observation with Cook's distance greater than 1 (a standard choice in the literature), only the 1950 observation is eliminated.

the Appendix shows that our results change little with a deterministic quadratic trend.

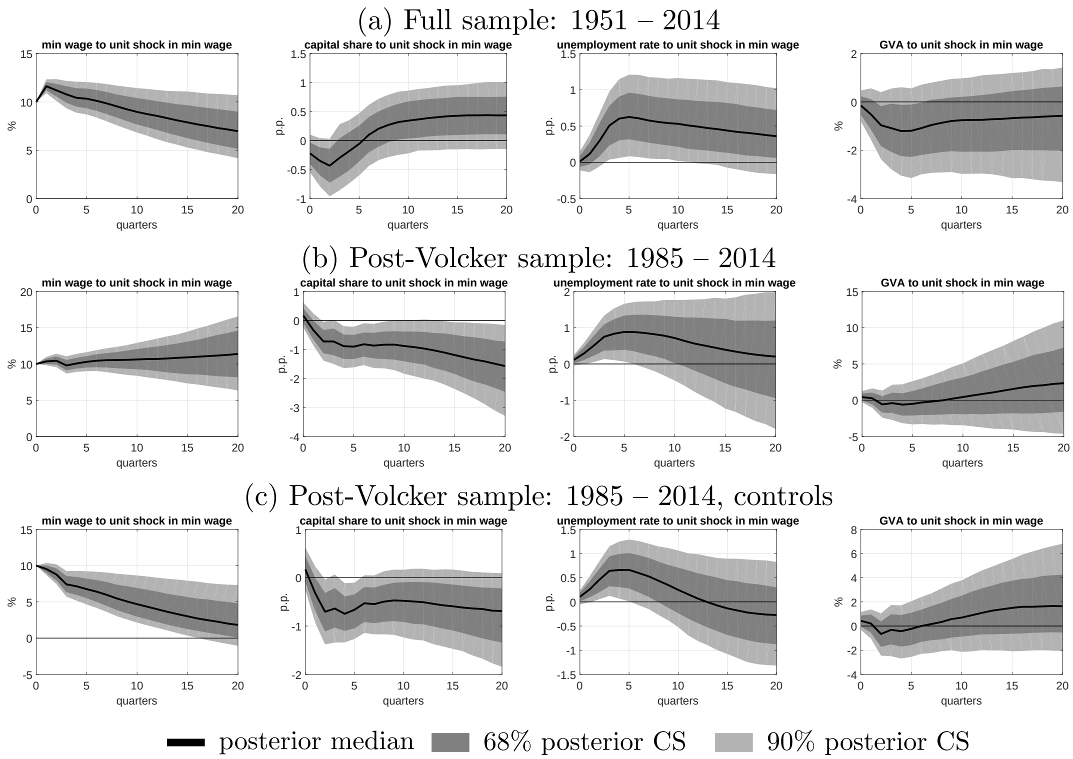


Figure 4: Responses to a 10% real minimum wage shock in VAR.

Figure 4(a) shows the IRFs to a 10% minimum wage increase in the full sample, a typical rise in the postwar period. Both for the full sample (top row) and the post-Volcker era (middle row), statutory minimum wage increases cause the real minimum wage to increase persistently – a redistribution effect. The capital share falls significantly on impact in the full sample by between 0.1 and 0.7 pp. with 68% posterior probability. Unemployment increases with a delay and peaks 0.3 to 0.9 pp. higher after about one year. GVA falls up to 2% one year after the shock. In the post-Volcker era, the effects are similar for the unemployment rate, with a more pronounced effect on the capital share that is delayed by one quarter. Except for the insignificant GVA response, the results are stronger for the post-Volcker sample. The lower share of hours worked at or below the federal minimum wage rate – a peak of 9% in 1980–81 and a low of 3% in 2002–06 (Autor et al., 2016, Table 1B) – may explain the delayed effect on the capital share as indirect equilibrium effects become more important than direct effects. In the post-Volcker sample, there is also some predictability in our shock proxy, i.e., the statutory minimum wage changes. The small-scale VAR does not capture this predictability. Controlling for the level and the square of the capital share, the minimum wage, and the unemployment rate (Figure 4(c)), the IRFs show a shorter, more plausible shape (see the next paragraph for the motivation for these controls).

One concern about our identification procedure could be that Congress increases minimum wages when the labor share is too low or the economy is performing well. However, if the information set in the VAR is rich enough to capture the state of the economy well, our results cannot be explained by current economic conditions. Our estimation is based on the covariance between the statutory minimum wage changes and the VAR forecast errors. Because the forecast errors are orthogonal to the state of the economy as captured by the VAR, our results would not change if we further controlled for any linear combination of the lagged VAR variables in the proxy variable itself. Only variables outside our VAR or non-linear combinations of VAR variables could change our results. To check this, we consider additional non-linear controls to purge our proxy variable and we estimate, in Appendix E, a 10-variable VAR. We also estimate versions of the VAR that incorporate information on changes in state-level minimum wages and with different trends/subsamples. Our results are basically unchanged.

Similar results hold in state-level panel data. Specifically, in Appendix F, we regress outcomes on changes in the applicable nominal minimum wage, converted to real 2010 dollars. We include state fixed effects and consider variants with time fixed effects. Conditioning on state-years with changes in the minimum wage, we find that the capital share declines by a total of 0.8 pp. to 0.9 pp. in the year of and the year after a one-dollar minimum wage increase, before reverting to its mean. The timing of the estimates depends on the fixed effects, but is significant in both cases. Economic activity, measured as GDP growth or changes in the unemployment rate, tends to fall as the minimum wage rises. The estimates for real activity are, however, imprecise when we include year fixed effects and condition on minimum wage changes.

Previewing the results from our structural model in the next sections, we find results consistent with the empirical evidence. Backing out the path of bargaining shocks in the U.S. since the 1950s, we see that they are broadly consistent with our historical narrative and the time VAR. For example, our estimated model-driven bargaining power indicator increases following the defeat of proposed right-to-work laws in several states. Moreover, we uncover a positive correlation between the estimated bargaining process and both the real federal minimum wage and unemployment, which supports our VAR findings.

3 Model

We postulate a business cycle model with labor search and matching *à la* Andolfatto (1996), Merz (1995), and Shimer (2010) to think about how politics influences labor shares. We will have a representative household, a final good producer, and a government. Markets are complete. To make the model closer to the data in terms of income shares and their evolution, we add taxes on labor income and net corporate profits, adjustment costs in capital, and variable capacity utilization. We incorporate exogenous unemployment benefits and a government-mandated minimum wage to disentangle changes in those from the bargaining power shocks that we investigate.

Also, and following Shimer (2010), we will assume a labor matching technology that depends on the number of recruiting workers employed by the firm. This formulation has three advantages with respect to a standard model of vacancy posting. First, the number of recruiting workers will never go to zero: because of the concavity of the recruiting technology, firms always have a positive fraction of recruiters. In comparison, models with vacancy posting can hit the "zero vacancy posting" condition, something that we never observe in the data. Second, our formulation is often easier to handle analytically. Lastly, by avoiding the occasionally binding inequality constraint on posting vacancies, our model can be computed efficiently and accurately using a third-order perturbation.[5]

We postulate social and political shocks to factor income shares as innovations to the bargaining power of workers. This single shock is a parsimonious way to capture various factors. For example, Binmore et al. (1986) show that variations in bargaining power can arise from changes in the bargaining procedure. These changes correspond in the data with innovations in labor law, judicial decisions, and, more generally, the social climate regarding collective bargaining. Also, shocks to the minimum wage and unemployment benefits are, to first order, equivalent to bargaining power shocks (Foroni et al., 2017). As we will see, the steady-state capital income is mostly pinned down by deep parameters other than bargaining power. In contrast, shocks to bargaining power will have significant transient effects. In the next subsections, we present the key model ingredients, while we relegate to Appendix G the full description of the model.

3.1 Households

There is a representative household formed by a continuum of individuals of measure 1. Individuals can be either employed or unemployed, but they are otherwise identical in terms of preferences. The household perfectly insures its members against idiosyncratic risk by equating marginal utilities. Under perfect insurance, the household problem can be recast in terms of the lifetime utility function:

$$U_0 = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\sigma}(1+(\sigma-1)\gamma n_{t-1})^{\sigma}-1}{1-\sigma}, \tag{3.1}$$

and budget constraint:

$$a_0 = \mathbb{E}_0 \sum_{t=0}^{\infty} \left(\prod_{s=0}^{t} m_t \right) (c_t - (1-\tau_n)(w_{\zeta,t} n_{t-1} + \omega_t(1-n_{t-1})) - T_t). \tag{3.2}$$

In the utility function, β is the discount factor, c_t is the average consumption, and $n_{t-1} \in [0,1]$ is the fraction of household members who are employed at time t. This fraction was determined in the previous period (and hence the subindex $t-1$). The variable $w_{\zeta,t} = (1-\zeta_0)w_{h,t} + \zeta_0 w_{\ell,t}$ is the average wage rate. A fraction $1-\zeta_0$ of the employed receive the bargained wage $w_{h,t}$, while the remainder receives the minimum wage $w_{\ell,t}$. Unemployed workers receive unemployment benefits ω_t. The parameter σ determines the relative risk aversion and γ the disutility of working.

In the budget constraint, a_0 is the household's net worth at time 0 and m_t is the stochastic discount factor, with $m_0 = 1$. Net expenditures are given by consumption less after-tax labor income and T_t, the lump-sum transfers from the government and the net profits from firms (capital

[5] Petrosky-Nadeau and Zhang (2017) show how, in a partial equilibrium search-and-matching model with vacancy posting, we need a projection method to capture non-linearities adequately. Our recruiting technology avoids the occasionally binding constraint.

is owned directly by the firm; under complete markets, this is equivalent to capital being owned by the household, but more convenient algebraically). The wage $w_{\zeta,t}$ is taxed at a rate τ_n.

When making its decisions, the household considers that workers lose their jobs at rate x and find new jobs at rate $f(\theta_t)$, where θ_t is the recruiter-unemployment ratio that the representative household takes as given. Thus, the fraction of household members employed next period will be:

$$n_t = (1-x)n_{t-1} + f(\theta_t)(1-n_{t-1}). \tag{3.3}$$

The job finding rate, $f(\theta_t)$, is given by $f(\theta_t) = \xi\theta_t^\eta$, with matching efficiency ξ and elasticity η.

3.2 Firms

A representative firm allocates the matched workers n_{t-1} between recruiting (a fraction ν_t) and producing the final good (the remaining fraction $1-\nu_t$). A fraction $1-\zeta_0$ of workers have one efficiency unit of labor, while ζ_0 workers have $\zeta_1 < 1$ efficiency units. This lower efficiency, which makes the government-mandated minimum wage binding, is revealed after recruiting and it is *iid* over time, so the firm does not have any incentive to fire low-efficiency workers, since they have the same expected future efficiency as current high-efficiency workers. The average number of efficiency units is $1-\bar{\zeta} = 1-\zeta_0(1-\zeta_1)$. The efficiency units of labor are combined with the capital owned by the firm, k_{t-1}, to produce a final good with the technology:

$$y_t = \left(\alpha^{\frac{1}{\varepsilon}}(u_t k_{t-1})^{1-\frac{1}{\varepsilon}} + (1-\alpha)^{\frac{1}{\varepsilon}}(g_z^t(1-\bar{\zeta})z_t(1-\nu_t)n_{t-1})^{1-\frac{1}{\varepsilon}}\right)^{\frac{\varepsilon}{\varepsilon-1}}, \tag{3.4}$$

where ε is the elasticity of substitution between capital and labor. For $\varepsilon \to 1$, we obtain a Cobb-Douglas production function with capital share α. A labor-augmenting trend productivity growth is given by g_z and a productivity shock by z_t. Finally, u_t is capital capacity utilization.

For an investment i_t, capital k_t evolves as:

$$k_t = (1-\delta(u_t))k_{t-1} + \left(1 - \frac{1}{2}\kappa\left(\frac{i_t}{k_{t-1}} - \tilde{\delta}\right)^2\right)i_t, \tag{3.5}$$

where $\tilde{\delta} \equiv g_z^{\frac{1}{1-\alpha}} - (1-\delta(\bar{u}))$ depends on g_z –the growth rate of z_t– and average utilization $\bar{u}$. The utilization cost is:

$$\delta(u) = \delta_0 + \delta_1(u-1) + \frac{1}{2}\delta_2(u-1)^2. \tag{3.6}$$

The firm's value is determined by the discounted flow of post-tax revenue less investment and labor payments:

$$J_0 = \mathbb{E}_0\left[\sum_{t=0}^{\infty}\left(\prod_{s=1}^{t} m_t\right)((1-\tau_k)(y_t - w_{\zeta,t}n_t) - i_t + \tau_k\delta(\bar{u})\bar{q}k_{t-1})\right],$$

where τ_k is the tax on corporate profits net of a depreciation allowance and $\bar{q}$ is the average Tobin's q. Production and capital follow from (3.4) and (3.5) and employment at the firm level satisfies:

$$n_t = (\nu_t(1-\bar{\zeta})\mu(\theta_t) + 1 - x)n_{t-1}, \tag{3.7}$$

where $\mu(\theta_t) = f(\theta_t)/\theta_t$ is the hiring probability per efficiency unit of recruiter.

3.3 Wage determination

Households and firms determine the wage for high types under generalized Nash bargaining. Workers have bargaining power ϕ_t. Exogenous shifts in ϕ_t capture social and political shocks (e.g., an administration that appoints more union-friendly board members to the NLRB or a major decision regarding labor relations by the Supreme Court of the United States), as well as other shocks (for example, a structural change in the economy such as a move from manufacturing factories to harder-to-organize services).[6]

The equilibrium wage, thus, solves:

$$w_{h,t} = \arg\max_{\tilde{w}_t} \tilde{V}_{h,n,t}(\tilde{w}_t)^{\phi_t} \tilde{J}_{h,n,t}(\tilde{w}_t)^{1-\phi_t},$$

where $\tilde{V}_{h,n,t}$ and $\tilde{J}_{h,n,t}$ are, respectively, the marginal values of employment of a high-productivity worker for the worker and the firm given an arbitrary wage $\tilde{w}_{h,t}$ for the current period and $w_{h,t}$ thereafter. In equilibrium, $\tilde{w}_{h,t} = w_{h,t}$. We derive $\tilde{V}_{h,n,t}$ and $\tilde{J}_{h,n,t}$ in the Appendix from the recursive formulation of the household and firm problems.

In comparison, the minimum wage $w_{\ell,t}$ is fixed by government policy and grows at the same rate as labor productivity z_t (unemployment benefits also grow at this rate).[7]

3.4 Exogenous processes

In our economy, two variables evolve exogenously: labor productivity z_t and bargaining power ϕ_t. Labor productivity follows $\ln z_t = \rho_z \ln z_{t-1} + \omega_z \epsilon_{z,t}$, where $|\rho_z| < 1$ and $\epsilon_{z,t}$ is a normalized Gaussian shock. In the Appendix, we allow for the case $\rho_z = 1$.

The transformation $\ln \frac{\phi_t}{1-\phi_t}$ maps the level of bargaining power from $[0, 1]$ to $(-\infty, \infty)$. Then, bargaining power follows:

$$\ln \frac{\phi_t}{1-\phi_t} = (1-\rho_\phi) \ln \frac{\bar{\phi}}{1-\bar{\phi}} + \rho_\phi \ln \frac{\phi_{t-1}}{1-\phi_{t-1}} + \omega_\phi \epsilon_{\phi,t},$$

[6] Binmore et al. (1986) show that the static bargaining problem is the limit point of a sequential strategic bargaining model where ϕ_t reflects asymmetries in the bargaining procedure or beliefs about the likelihood of a breakdown of negotiations. Their model provides a micro-foundation for how policies that change the bargaining procedure induce changes in ϕ_t if the parties to the bargain are impatient.

[7] In Appendix G, we include shocks to the minimum wage and unemployment insurance. Below, we will present an exercise where unemployment benefits and the share of hours worked under the minimum wage vary with the cycle. We could augment the model with endogenous separations and firing costs, such as those existing in Europe. Since we will calibrate the model to the U.S. economy, where these costs are small, we ignore them.

where $\bar{\phi}$ is the average value of the process. Again, $|\rho_\phi| < 1$ and $\epsilon_{\phi,t}$ is a normalized Gaussian shock. We hold the matching efficiency ξ constant to isolate the effects of innovations to bargaining power.

3.5 Market clearing and equilibrium

Aggregate employment follows the law of motion for the representative household (3.3), where the recruiter-unemployment ratio is:

$$\theta_t = \frac{n_{t-1}}{1 - n_{t-1}} \nu_t. \tag{3.8}$$

The production of the final good equals aggregate consumption and investment:

$$y_t = c_t + i_t. \tag{3.9}$$

Finally, aggregate capital has to satisfy the capital law of motion for the representative firm (3.5).

The equilibrium stochastic discount factor is:

$$m_{t+1} = \beta_t \frac{c_{t+1}^{-\sigma}(1 + (\sigma - 1)\gamma n_t)^\sigma}{c_t^{-\sigma}(1 + (\sigma - 1)\gamma n_{t-1})^\sigma}. \tag{3.10}$$

In the Appendix, we derive a more general discount factor that allows for external habit formation.

In equilibrium, households choose consumption and employment optimally, taking the process for the wage rate, the real interest rate, and labor market tightness as given. Similarly, firms choose investment, utilization, capital, production, and recruiting optimally, taking the process for the wage rate, the stochastic discount factor, and labor market tightness as given. The goods market also clears.

In the spirit of Hosios (1990), Appendix G.5 shows that allocations along the balanced growth path (BGP) of the economy are constrained efficient if $\phi = 1 - \eta$, $\tau_n = \tau_k$, and $\zeta_0 = 0$. We will document that our departure from the Hosios condition is inconsequential for our results.

3.6 Mapping theory into data

The measures of the gross and net capital share in our economy are:

$$cs_t \equiv 1 - \frac{n_{t-1} w_{\zeta,t}}{y_t}, \tag{3.11a}$$

$$ncs_t \equiv 1 - \frac{n_{t-1} w_{\zeta,t}}{yr_t} - \bar{\delta}\frac{k_{t-1}}{y_t}. \tag{3.11b}$$

In the model, depreciation changes with the endogenous utilization decisions. In comparison, the depreciation rate in NIPA varies only because the capital stock changes its composition. Since we have a single good in our economy, we measure the NIPA equivalent of the net capital share using the steady-state depreciation rate. This computes the net capital share under the assumption of a constant service life of an asset.[8]

Finally, measured total factor productivity (TFP; hereafter, we will omit "measured," but TFP should always be understood as such) is equal to

$$TFP = GDP_t - cs_t k_{t-1} - (1 - cs_t) n_{t-1}. \tag{3.12}$$

3.7 Solution

First, we HP-detrend all variables as needed. To compute business cycle statistics, we calculate quarterly averages and add the trend to all trending variables before HP filtering. In the model, labor productivity, capital, consumption, investment, the marginal value of employment, the marginal product of labor, and wages grow at the common rate g_z, while all other variables are stationary.

We use a third-order perturbation to solve for the equilibrium of the detrended economy. Thus, we can analyze some non-linear dynamics of interest while guaranteeing high accuracy. For example, the mean Euler equation errors are below 0.25% of consumption and the 99th percentile of Euler errors is below 2% (see Appendix G.11). To ensure stability, we apply the pruning method developed by Andreasen et al. (2018).

In the neighborhood of the calibrated, detrended steady state (see Section 4), the capital share is almost invariant to bargaining power. In the long run, the capital share is overwhelmingly determined by technology and preferences. In our baseline calibration, virtually all of the gross capital share is compensation for depreciation, impatience, and growth. Instead, employment moves to equate the marginal product of labor to the varying wage rate (adjusted for recruiting costs). For the same reason, the rental rate of capital and the marginal product of capital are also nearly invariant to bargaining power for a wide range of calibrations.[9]

4 Identification and calibration

As is customary in the labor-search literature, we calibrate the model to a monthly frequency. When mapping it to U.S. data, we first aggregate the model-generated data to a quarterly frequency. As described in Andreasen et al. (2018), we will match moments in the data to the corresponding moments of the model's ergodic distribution, and not to their steady-state values. We do so because, under a non-linear solution, the latter may not summarize well the properties of ergodic distributions.

[8]Per capita consumption is the sum of real consumer non-durables and consumer services. Per capita investment is real gross domestic private investment plus real durable consumption. Because only nominal or quantity indices are available for private consumption expenditures, we compute real consumption expenditures in 2009 dollars as the product of the per capita quantity index times their average 2009 nominal expenditures. Per capita GDP is real per capita investment plus consumption. See Appendices A and G.8 for details.

[9]When we recalibrate the disutility of working to keep employment constant, the capital shares are independent of $\bar{\phi}$. The matching efficiency ξ is calibrated for any given average employment level $\bar{n}$ to ensure that the BGP recruiter-employment ratio $\bar{\theta}$ is constant across parameterizations. Then, the optimality for recruiting and the production function imply that GDP, wages, the number of recruiters, and capital along the BGP are constant as well.

4.1 Technology and preferences

We select a Cobb-Douglas technology, with $\varepsilon = 1$, as in Cooley and Prescott (1995). Alternatively, we will consider values of $\varepsilon = 1 \pm 0.25$, reflecting the recent work of Karabarbounis and Neiman (2014) and Oberfield and Raval (2014). The former paper estimates an elasticity of substitution of 1.25 using long-run differences across countries. The latter estimates a macro-elasticity of substitution for the manufacturing sector of 0.7 based on a weighted average of micro-elasticities of substitution and demand. Also, after Cooley and Prescott (1995), we select g_z to be 1.6% per year.[10]

We choose the discount factor β, the capital share in production α, and the depreciation rate δ to match three properties of the non-financial corporate business sector: (1) the gross capital share of 31.2%, (2) the ratio of depreciation to gross value added of 12.7%, and (3) the (annualized) ratio of capital to gross value added of 2.3. We calibrate the average corporate tax rate to 30%, the average in the data. Given our choice of g_z, the implied annual depreciation rate is 5.5% and the annualized discount rate is 0.976. In the Cobb-Douglas case, the capital share α is just 0.312. We normalize the average efficiency of investment $\bar{\chi}$ and the average detrended $\tilde{z}$ to 1.

We calibrate the labor market following Shimer (2010). The exogenous separation rate x is 3.3% per month, the average unemployment rate is 5%, and the matching efficiency ξ is such that one recruiter hires, on average, 25 employees per quarter. We set the matching elasticity η and the average bargaining power $\bar{\phi}$ to 0.5. As in Prescott (2004), a labor income tax rate of 40% combines the consumption taxes and the actual labor tax rate. Choosing a conventional value of $\sigma = 2$ implies that the employed consume 30% more than the unemployed.

We calibrate the minimum wage to be one-third of the bargained wage rate along the BGP. In the U.S., the average ratio of the federally mandated minimum wage to the average hourly earnings of production workers and non-supervisory employees was 39.3% from 1964Q1 to 2018Q2, and 34.8% if we look at 2006Q1 to 2018Q2. Relative to all private-sector employees, for whom we have data since 2006Q1, the average ratio is 29.1%. Adjusting the post-1964 average for the composition difference leaves us with 33.8%. Thus, we set $\zeta_1 = 0.25$ and make it binding for 5% of workers following Autor et al. (2016, Table 1B). We also match the average replacement rate for the unemployed of 40%.

4.2 Stochastic processes

The stochastic processes for z_t and ϕ_t are indexed by their persistences, ρ_i, and standard deviations, ω_i, for $i \in \{z, \phi\}$. Following Cooley and Prescott (1995), we set $\rho_z = 0.95^{1/3}$. This leaves us three parameters to determine: ρ_ϕ, ω_z, and ω_ϕ. Given that we do not have direct observations of the bargaining shocks, we will proceed in two steps. First, we will describe the source of variation in the data that will give us identification of ω_z and ω_ϕ given ρ_ϕ. Second, we will explore a wide range of values of ρ_ϕ to capture different views on the persistence of bargaining shocks.

Figure 5 illustrates the first step by showing the response of the fraction of recruiters, unemploy-

[10] While the calibration of the model is not fully recursive, in practice, it is nearly so (i.e., we can calibrate one block of parameters, move to calibrate another one, and so on, and only have to do minor readjustments at the end). Thus, to simplify the exposition, we discuss each block separately.

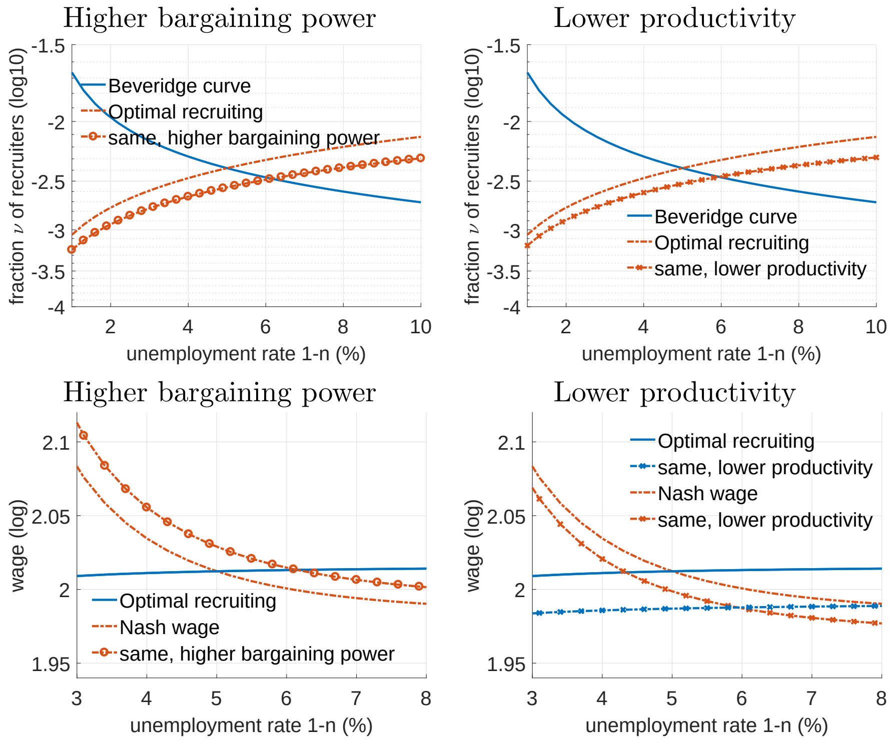


Figure 5: Steady-state response to shocks.

ment rate, and wages to shocks to bargaining power and labor productivity.[11] In the top panels, we see that, after innovations to the shocks that deliver either higher bargaining power for workers, ϕ_t, or lower productivity, z_t, the optimal recruiting decision for the firm that links the unemployment rate, $1 - n_t$, and the fraction of recruiters, ν_t, moves to the right. In both cases, the firm finds it less profitable to recruit new workers: either the firm appropriates a smaller share of the match surplus or workers are less productive. Thus, $1 - n_t$ increases (and output falls) and ν_t falls after both innovations. The bottom panels of Figure 5 document that, in comparison, wages increase after an increase in bargaining power, but fall after a decrease in productivity. Higher bargaining power for workers lowers output and the match surplus, but because their share in the surplus rises enough, workers still take home a higher wage. In summary: higher worker bargaining power and lower productivity lower output, but have an opposite impact on wages.

Thus, we can exploit observations on wages, output, and TFP to pin down the size of bargaining power shocks and productivity shocks. More concretely, given ρ_ϕ, we pick ω_z and ω_ϕ to match the observed correlation between wages and GDP, and the volatility of TFP.[12] Given ω_z, a higher ω_ϕ lowers the correlation of wages and GDP. This trade-off is illustrated by the left panel in Figure

[11] To plot the four panels, we assume permanent shocks, keep consumption constant after each shock, and use our baseline calibration in Table 3. With the full transient dynamics, the panels would be harder to read. However, the intuition of the identification result remains unchanged.

[12] At a quarterly frequency, Cooley and Prescott (1995) find an autocorrelation of 0.95 and a standard deviation of 0.73% for TFP. Averaging monthly observations within quarters, their values correspond to a monthly autocorrelation of $0.95^{1/3}$ and a standard deviation of TFP productivity of 0.73%. We find a value of 0.79%.

6. The green horizontal line gives us the observed correlation between wages and GDP and the decreasing curves give us the model-implied correlation for different values of ω_ϕ (with κ that matches the volatility of investment at the preferred calibration).

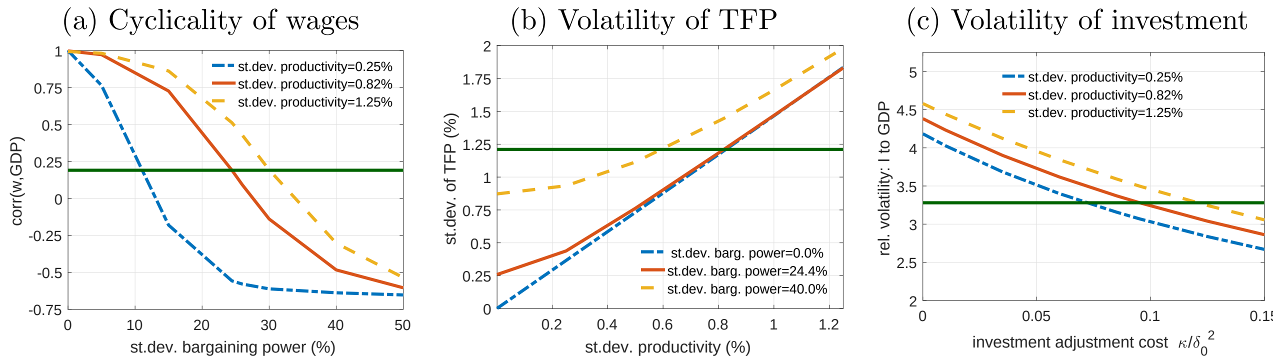


Figure 6: Identifying ω_z, ω_ϕ, and κ/δ_0^2.

We plot three lines, each corresponding to a different value of ω_z (and, as before, conditional on ρ_ϕ). We can improve the sharpness of the identification if we simultaneously calibrate the standard deviation of productivity shocks, ω_z, to match the volatility of TFP (middle panel of Figure 6), and the investment adjustment cost, κ/δ_0^2, to match the relative volatility of investment (right panel). The horizontal lines in the figure indicate HP-filtered data moments (we also set the elasticity of utilization with respect to the marginal product of capital to $\frac{1}{2}$, i.e., $\delta_2 = 2\delta_1$). Intuitively, the larger the standard deviation of productivity, the larger the standard deviation of the bargaining shocks that matches the cyclicality of wages. Since productivity shocks are the primary driver of TFP, we can easily identify these parameters together. Last, the relative volatility of investment to GDP pins down the investment adjustment cost. Changing this parameter has next to no impact on the cyclicality of wages, but a large effect on investment. We match the relative volatility of investment, because recruitment is a quasi-investment activity that we discipline indirectly by getting capital investment right. Figure G.14 plots the additional bivariate relation among these three parameters and documents why we can ignore, for calibration purposes, the omitted plots.

Thus, it only remains to pick the persistence of the bargaining shock, ρ_ϕ. Since we are agnostic about how persistent this shock is in the data, we select three cases. As a baseline medium-term case, we set $\rho_\phi = 0.98^{1/3}$. This value implies a half-life of the shock of 34 quarters.[13] From 1948 to 2016, the average duration of a party's control of the presidency was 30.2 quarters, of the Senate 38.9 quarters, and of the House of Representatives 24.7 quarters. Our numbers are slightly biased downward because of left- and right-censoring: in 1948, the Democrats were already in control of the presidency and the current spell of Republican control of the Senate lasted until 2020.[14] Given

[13] Note that 34 quarters is above the conventional 32-quarters cut-off of business cycle frequencies. Thus, we are dealing with a shock that generates medium-term business cycles. To allow a comparison with the literature, most of our quantitative results will focus on business cycle fluctuations. We will make some references, however, to the longer-lived effects of the shock.

[14] Coding the control of the Supreme Court is harder, as justices drift across time (John Paul Stevens started in 1975 as a Republican and ended in 2010 as a solid liberal) and across cases (think of Anthony Kennedy's pivots).

that the changes in party control that resulted in small changes in policy (Truman followed by Eisenhower, the first Bush followed by Clinton) have been roughly the same as the changes that resulted in substantial policy shifts (Carter by Reagan, the second Bush by Obama), 34 quarters is a reasonable duration for the half-life of the middle-run political cycle in the U.S. after WWII. Given this $\rho_\phi = 0.98^{1/3}$, the monthly standard deviation of the bargaining power shock of 6.1 pp. (or 24.5% for the logit transform) and $\kappa = 0.095/\delta_0^2$. Besides, $\rho_\phi = 0.98^{1/3}$ replicates the features of the U.S. labor income share's medium-term dynamics documented by Growiec et al. (2018). Table 3 summarizes this baseline calibration.

Parameter	Value
Risk aversion σ	2
Discount factor β	$0.976^{1/12}$
Disutility of working γ	such that $\bar{n} := 0.95$
Capital share α	0.312
Elasticity of substitution ε	1
Depreciation δ_0	0.055/12
Avg. efficiency of investment $\bar{\chi}$	1
Avg. detrended $\tilde{z}$	1
Trend productivity growth g_z	$1.016^{1/12}$
Investment adjustment cost κ	$0.101 \times (\delta_0)^{-2}$
Capacity utilization cost δ_1	such that $\bar{u} = 1$
Capacity utilization cost δ_2	$2\delta_1$ (BGP ela. w.r.t. $\frac{mpk_t}{u_t}$ of $\frac{1}{2}$)
Bargaining power $\bar{\phi}$	0.5
Matching elasticity η	0.5
Matching efficiency ξ	2.3
Separation rate x	0.033
Steady-state replacement rate $\frac{\bar{\omega}}{\bar{w}_\zeta}$	0.4
Probability of low productivity ζ_0	0.05
Efficiency units of low-productivity workers ζ_1	0.25
Low-productivity wage $\frac{\bar{w}_\ell}{\bar{w}_\zeta}$	0.33
Labor income tax rate τ_n	0.4
Corporate tax rate τ_k	0.3
Productivity shock persistence ρ_z	$0.95^{1/3}$
Bargaining shock persistence ρ_ϕ	$0.98^{1/3}$
Bargaining power s.d. ω_ϕ	24.5%
Labor productivity s.d. ω_z	0.79%
Implied gross capital share $\overline{cs}$	31.2%
Implied net capital share $\overline{ncs}$	18.5%

Table 3: Parameter values for the baseline persistence of bargaining shock.

Second, as a high-persistence scenario, we choose $\rho_\phi = 0.9914^{1/3}$. This value gives a half-life of the bargaining shock of 80 quarters, which corresponds to long-run movements in the political climate related to party realignments, demographic changes, etc.. We recalibrate all other parameters of the model accordingly.

Third, as a low-persistence scenario, we set $\rho_\phi = 0.95^{1/3}$, which yields a half-life of around 14 quarters. This low-persistence case matches the same persistence for the bargaining shock as for the productivity shock, and thus it embodies a degree of parsimony and "standard" business cycle properties. For this persistence, we recalibrate all other parameter values.

4.3 An RBC model calibration

For comparison purposes in the results section, we formulate an RBC model *à la* Hansen (1985)-Rogerson (1988) where we eliminate the search and matching frictions. We calibrate the model using the same targets as for our baseline economy to pin down the ω_z and κ (given the known properties of this model, we need to give up on matching the cyclicality of wages). In that way, we can benchmark our model against the behavior of a well-understood environment. For better comparison, labor supply is determined one period in advance, but wages are set in spot markets. The counterpart model is described in detail in Appendix G.14 and its quantitative properties are reported in the rows labeled "RBC model" in Table 5. In Subsection 6.1, we will calibrate a version of this RBC model where we add exogenous shocks to the factor shares in the production function (as in Danthine et al., 2006, Ríos-Rull and Santaeulàlia-Llopis, 2010, and Lansing, 2015).

5 Quantitative results I: Historical bargaining power

This section argues that the data broadly confirm our empirical approach to the bargaining power process's calibration. To do so, we use the *partial information filter* recently proposed by Drautzburg et al. (2021) to back out the bargaining power process. The partial filtering strategy exploits the structure of the key equations of our economy to deliver a simple statistical model that recovers bargaining power. Indeed, Drautzburg et al. (2021) call the filter *partial* because the researcher does not have to filter all the states: the partial information filter uses only some of the equilibrium conditions of the model. The main idea of this methodology is to move from unobserved expectations in the equilibrium conditions to conditional first and second moments that can be described using (potentially time-varying) VARs.

The partial information filter is an attractive alternative to a full-information particle filter –such as in Fernández-Villaverde et al. (2016)– when the latter is hard to implement. First, our model is a two-shock economy without the bells and whistles present in New Keynesian models designed to account for many observables. Second, our pruned non-linear solution features a large number of state variables.

With the partial information filter, we document that the bargaining power process's statistical properties closely match our model. Also, we show that the implied bargaining power process covaries meaningfully with historical U.S. events. If anything, the model-implied bargaining power covaries too strongly at higher frequencies, a fact we use to inform one of our model extensions.

5.1 The partial information filter

Bargaining power enters into our model only through the wage-setting equation (G.32) (see Appendix G for the derivation of this equation). Hence, it is natural to use this equation to recover the historical bargaining power implied by the theory and data. The challenge is, however, that this equation features firms' expectations. Specifically, we need to model the expectation of the discounted future value of employment to firms times their relative bargaining power.

We use an auxiliary statistical model and firms' optimality conditions to model the expectations taking advantage of two results. First, for any two random variables (x_t, y_t), we have that $\mathbb{E}_t[x_{t+1}y_{t+1}] = \text{Cov}_t[x_{t+1}, y_{t+1}] + \mathbb{E}_t[x_{t+1}]\mathbb{E}_t[y_{t+1}]$. Second, firms' equilibrium conditions allow us to write the product of the conditional expectations in terms of time t observables. This leaves only the unknown covariance of the random variables, which we estimate with a statistical model. Given an estimate, the bargaining power is the value that makes the wage-setting equation hold.

Specifically, Appendix G.12 shows that we can re-write the wage-setting equation as:

$$w_{\zeta,t} = \zeta_0 w_{\ell,t} + \frac{e^{\tilde{\phi}_t}}{1+e^{\tilde{\phi}_t}} mpl_t \frac{1-\zeta_0}{1-\bar{\zeta}}\left(1+\frac{1-x}{\mu(\theta_t)}\right) + \frac{1-\zeta_0}{1+e^{\tilde{\phi}_t}}\omega_t + \frac{1}{1+e^{\tilde{\phi}_t}}\frac{1-\zeta_0}{1-\tau_n}\left(\frac{c_t}{1+(\sigma-1)\gamma n_{t-1}}\right)\gamma\sigma$$
$$-(1-x-f_t(\theta_t))\frac{1}{1+e^{\tilde{\phi}_t}}\left(T1(X_t,\tilde{\phi}_t,\hat{\Sigma},\hat{A}) + \frac{\bar{\zeta}}{1-\bar{\zeta}}T2(X_t,\tilde{\phi}_t,\hat{\Sigma},\hat{A}) - \zeta_0 T3(X_t,\tilde{\phi}_t,\hat{\Sigma},\hat{A})\right), \tag{5.1}$$

where mpl_t is the marginal product of labor, κ_ϕ is a constant, and the T functions depend on the state of the world (other than bargaining power) X_t, bargaining power, and parameters of the statistical process: the covariance matrix Σ and the dynamic coefficients A. When $\zeta_0 = 0$, so that $\bar{\zeta} = 0$, only $T1$ remains, which captures the expectation of the discounted future match surplus to the firm and its covariance with bargaining power.

To take equation (5.1) to the data, we exploit that, in our baseline calibration, mpl_t is proportional to the average product $\frac{y_t}{n_t}$. We use real GVA in the non-farm business sector to compute $\frac{y_t}{n_t}$. Employment n_t is one minus the unemployment rate.[15] The wage rate w_t is the real hourly compensation in the same sector. Consumption c_t equals real per capita expenditures on non-durables and services. The stochastic discount factor m_t is a function of consumption and employment. Labor market tightness θ_t is the ratio of vacancies to the unemployed. Then, we use a Bayesian VAR that includes the discounted match surplus and the implied bargaining power to estimate this covariance.

A Gibbs sampler solves the problem of needing the bargaining power process to estimate the covariances and those, in turn, to back out bargaining power. The sampler starts with an arbitrary guess of the covariances and allows us to address the estimation uncertainty. More concretely, for $d = 1, \ldots, D$, we iterate on the following steps:

1. Given the previous draw of the bargaining power sequence:
   (a) Draw $\rho_\phi^{(d)}$ and the VAR coefficients given $\Sigma^{(d-1)}$ from a normal standard SUR posterior.

[15] In the model y_t excludes recruiting activities, whereas GVA does not. This discrepancy is, however, minimal.

(b) Draw the (inverse of the) covariance matrix $\Sigma^{(d)}$ from a Wishart distribution given $\rho_\phi^{(d)}$ and the corresponding VAR coefficients.

2. Given observables, $\Sigma^{(d)}$, $\rho_\phi^{(d)}$ and VAR coefficients, solve (5.1) period by period for $\left(\frac{\phi_t}{1-\phi_t}\right)^{(d)}$.

For details, see Appendix G.12.[16] There we describe how we scale the observed variables to match the steady state of our model. By construction, we match the positive steady-state surplus to households and firms in our model, but these match surpluses would turn negative in some periods. We guarantee that the discounted match surplus is positive by first adjusting mpl_t so that it lies weakly above the real wage. We then lower the average disutility of working, such that the implied bargaining power averages 0.5 in our sample when the covariance terms are set to zero. Last, we adjust the frequency of the model to quarterly data. We use a flat prior in the estimation.

5.2 Results

The blue solid line charted against the left axis in Figure 7 shows the path of the bargaining power process generated by our partial filter. We focus, first, on the medium-term fluctuations. Our sample starts at the time of a large victory for labor, the so-called "Reuther's Treaty of Detroit," a 5-year contract between General Motors (GM) and the United Automobile Workers (UAW), named after the UAW's president, Walter Reuther. As one astute contemporary economist observed: "The inclusion of the modified union shop in a five-year contract and the conciliatory approach of the corporation in bargaining have finally convinced the union leadership, it appears, that GM has accepted the UAW on a realistic and permanent basis" (Harbison, 1950, p. 404). The Treaty of Detroit opened two decades of gains for U.S. workers across many industries and sectors (Levy and Temin, 2007). Even Eisenhower appointed Martin P. Durkin, a former union leader, as his first Secretary of Labor, and his second Secretary of Labor, James P. Mitchell, has been inducted into the Labor Hall of Honor. Proposed right-to-work laws were defeated in California, Ohio, Colorado, Idaho, and Washington (Dubofsky and Dulles, 2017, loc. 7891). In line with these events, our bargaining power increases from 0.5 to 0.9 by the end of the 1950s.

However, the early 1960s saw the start of a relative decline in workers' power. Several factors contributed to it. First, the American Federation of Labor (AFL) and the Congress of Industrial Organizations (CIO) merged in 1955. The merger led, after a few years, to a more moderate attitude by the unions formerly associated with the CIO and a smaller effort to increase unionization rates. Richard Lester, a prominent Princeton labor economist at the time, labeled the new AFL-CIO a "sleepy monopoly." Also, the merger of the two organizations facilitated the purge of the remaining communist sympathizers at the CIO. Second, many firms, worried by increasing foreign competition and rising costs, adopted the so-called "hard-line" position of 1958, which, after several years of industrial conflict (as in the steel industry in 1959), led to some victories for management. Third,

[16] We initialize the process at our calibrated parameters and discard draws from a burn-in period. A time-varying VAR would yield a time-varying sequence of covariances that would match our non-linear model more closely. We abstract from this non-linearity because the covariance terms are small and the posterior uncertainty about the in-sample bargaining power is negligible.

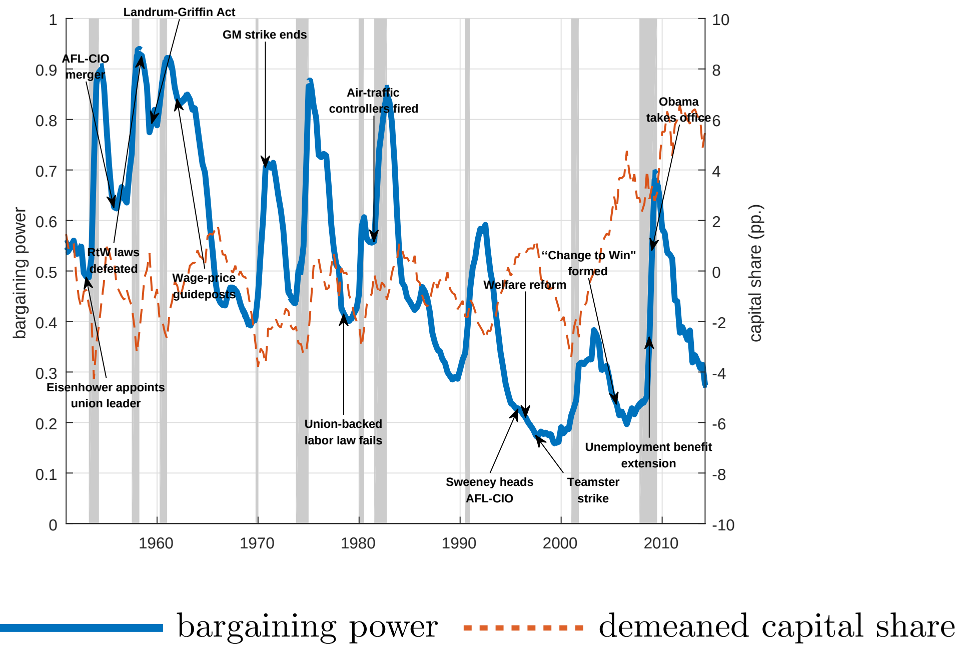


Figure 7: Bargaining power process implied by the baseline calibration

the Landrum-Griffin Act of 1959, a response to corruption and racketeering in the labor movement, imposed additional guarantees regarding the internal behavior of unions and tightened the rules regulating secondary boycotts, "hot cargo" agreements, and recognitional picketing. These measures curbed the tactics of some unions, which called for fewer strikes in the early 1960s than in the late 1950s. As Walter Reuther put it in 1960: "We are going backward."

The decline in workers' bargaining power continued until the late 1960s, when it was at 0.4. This trend was helped by the wage-price guideposts started by Walter Heller at the Council of Economic Advisers in 1962 and pushed by Johnson as an essential tool of the economic policy of his administration. Although often remembered because of the fight between Kennedy and the steel industry in 1962, the wage-price guideposts slowed down wage increases relative to productivity growth (see the narrative in Slesinger, 1967).

The late 1960s witnessed, in comparison, lower unemployment and an economy running at high utilization rates. It also saw the renewed strength of unions, often led by a younger, more militant generation that had experienced the civil rights struggles, the anti-war movement, and the radicalizing influence of the New Left.

One of these new union leaders, Leonard Woodcock (the successor of Walter Reuther as president of the UAW after Reuther's untimely death), organized the nationwide UAW strike against GM in September 1970, which lasted for 67 days. This strike was one of the biggest victories of the post-WWII labor movement: UAW members received full cost-of-living wage adjustments and a "30-and-out" retirement plan (i.e., full pension after 30 years of work regardless of age). Our partial filter identifies this spike of labor's power.

The early 1970s were an Indian summer for U.S. unions. The oil shocks and a changing political climate eroded the bargaining power of workers by the late 1970s, perhaps best represented by the failure of the 1978 proposed reform of labor law, an endeavor in which the AFL-CIO had invested considerable political capital, and the peak in unionization coverage and membership percentages in 1979 (Hirsch and MacPherson, 2003).

This process sharply accelerated with Reagan's arrival at the White House and his notorious firing of striking air-traffic controllers in 1981.Q3, the full repercussions of which were only felt in the second half of the 1980s. For the next two decades, our backed-out bargaining power series nearly uninterruptedly drops to well below 0.5. Reagan was followed by the first Bush and Clinton, a pro-business Democrat who worked with a Republican-controlled Congress to pass the Welfare Reform Act in 1996.Q3, lowering workers' outside option at the time of bargaining. Simultaneously, the large immigration of the 1980s-2000s (spurred by the somewhat delayed effects of the 1965 Hart-Celler Act) created many service-sector workers with fewer links to the labor movement.

The late 1990s and early 2000s saw, according to our partial filter, a stop in the negative trend of workers' bargaining power. The 1997 Teamsters strike, the arrival of John Sweeney to the leadership of the AFL-CIO, and the creation of the Change to Win Federation in 2005 did not return organized labor to its former glory, but it did stabilize bargaining power. Bargaining power partially recovered in 2008.Q4, when the unemployment benefit extensions raised workers' outside option (these benefits peaked in mid-2010), with the election of Obama –the most pro-union president in a generation– and later with the slowdown in immigration and early successes of the "fight for $15."

While our stylized two-shocks economy has no hope of matching the richness of the data, our comparison of Figure 7 with the historical narrative above demonstrates a surprising level of agreement. In Appendix G.12, we compare our results with an alternative bargaining power index proposed by Levy and Temin (2007). The fact that both indexes display a correlation of 0.40 reinforces our positive assessment of our exercise.

Of course, there are aspects that we miss. For example, our filter shows increases in workers' bargaining power during recessions (shaded lines in Figure 7). Without bargaining power increases, our model could not explain the relative stability of wages during recessions. While the model is consistent with the data, our baseline model may miss aspects such as unemployment benefits with endogenous duration that, in a richer model, would affect the outside option, but not necessarily bargaining power. Some measured increases in bargaining power may thus be partly systematic. We consider both possibilities in extensions below, without changing the main thrust of our results.[17]

Besides the previous narrative, the statistical properties of the bargaining power process are very close to the model; see Table 4. With a flat prior, the median posterior persistence is 0.9783 per quarter with a 90% credible set of $(0.9541, 0.9949)$. The posterior for the conditional standard deviation is 0.2229 $(0.2051, 0.2458)$. These values come close to our calibration of $\rho_\phi = 0.9800$ and $\omega_\phi = 0.2445$. Appendix G.12 shows that an alternative implementation of the filter that factors

[17] Specifically, we consider endogenous variation in the minimum wage and in the replacement rate in one extension, and a reduced-form policy rule for bargaining power, which matches the business cycle frequency correlation between bargaining power and unemployment rates coming from our filter. In the presence of additional heterogeneity with job-ladders or on-the-job learning, an interpretation of our results in Figure 7 is that the series represents the "aggregate" bargaining power that such models would imply.

Table 4: Implied bargaining power process moments
Productivity based on complement of the unemployment rate, no detrending

	Median	5th percentile	95th percentile
Posterior autocorrelation	0.9783	0.9541	0.9949
Posterior AR(1) st.dev.	0.2229	0.2051	0.2458
In-sample average bargaining power	0.4987	0.4961	0.5014

the expectational terms differently produces a very similar result. In levels, the two series have a correlation of 0.98, and 0.88 in changes. Also, we find only small changes in our results when we use the wage of new hires or the employment-to-population ratio. The same appendix computes a counterfactual unemployment rate generated by our filtered bargaining shock and discusses the positive correlation of our bargaining power index with the federal minimum wage, in agreement with our VAR exercise in Section 2.2. For instance, the decline in the estimated bargaining power in the 1980s coincides with a sharp decline in the real federal minimum wage.

6 Quantitative results II: Business cycle statistics

We move now to assess the business cycle properties of the model. Table 5 compares U.S. business cycle statistics to those of our search and matching (S&M) model (with and without bargaining shocks) and its RBC counterpart. We focus on statistics that describe the volatility, cyclicality, and persistence of aggregate variables. All business cycle statistics are based on HP-filtered quarterly variables, averaged across three months in the model simulations. We take the log of level variables before filtering, but filter variables that are ratios as such. We construct GDP per capita as the sum of real per capita consumption and investment to match the data with our model.

In the data, the volatility of (log) GDP is nearly 2.0%. Investment is 3.28 times as volatile as GDP, whereas consumption is only 60% as volatile. With correlations of 0.91 and 0.84, both investment and consumption are highly pro-cyclical. Similarly, both the gross and the net capital share are moderately pro-cyclical, with a correlation of 0.57 and 0.36, respectively. All variables are very persistent, with quarterly autocorrelations of 0.67 to 0.90.

How does our model compare to the data? Recall that we calibrated the standard deviation of productivity and the capital adjustment cost to match the volatility of TFP (1.21%) and the relative volatility of investment (3.28) and consumption (0.58). Thus, it is not surprising that this calibration nearly replicates the level of GDP volatility (1.91). An important finding is that, if we eliminate the bargaining shock (but keep all the other parameters, including adjustment costs, at their baseline value), the volatility of output drops 29% to 1.35.[18]

Regarding capital shares, our baseline model can account for 31% of the volatility of the gross and 20% of the volatility of the net capital share in the data (leaving room for other factors, such as

[18] As a robustness check, we calibrated the model with productivity shocks and no bargaining shocks. Then, we measured the effects of adding bargaining shocks while keeping the other parameters constant. The results were nearly identical.

Table 5: Business cycle statistics: 1947Q1–2015Q2

	Y [%]	$\frac{\text{std(I)}}{\text{std(Y)}}$	$\frac{\text{std(C)}}{\text{std(Y)}}$	std(ncs) [pp.]	std(cs) [pp.]	std(w) [%]	std(u) [%]	std(TFP) [%]
	Volatility							
U.S. data	1.99	3.28	0.58	1.07	0.86	0.95	0.83	1.21
	Models							
S&M model: baseline	1.91	3.28	0.62	0.33	0.17	1.45	1.89	1.21
S&M model: no bargaining shock	1.35	3.33	0.57	0.18	0.01	1.13	0.24	1.20
RBC model: baseline	1.90	3.28	0.60	0.24	0.00	0.91	1.03	1.21
RBC model with factor share shock	1.76	3.28	0.60	0.31	0.11	0.88	0.85	1.21
	Cyclicality							
	Y	I	C	ncs	cs	w	u	TFP
U.S. data	1.00	0.91	0.84	0.57	0.36	0.19	-0.76	0.78
	Models							
S&M model: baseline	1.00	0.96	0.97	0.80	0.13	0.19	-0.67	0.67
S&M model: no bargaining shock	1.00	0.99	0.99	0.98	0.78	1.00	-0.95	1.00
RBC model: baseline	1.00	0.98	0.99	0.98	NaN	0.97	-0.96	0.99
RBC model with factor share shock	1.00	0.98	0.99	0.94	0.57	0.97	-0.93	0.98
	Persistence							
	Y	I	C	ncs	cs	w	u	TFP
U.S. data	0.87	0.82	0.78	0.76	0.74	0.67	0.90	0.78
	Models							
S&M model: baseline	0.81	0.77	0.83	0.80	0.71	0.80	0.70	0.79
S&M model: no bargaining shock	0.81	0.81	0.80	0.80	0.48	0.79	0.83	0.79
RBC model: baseline	0.80	0.80	0.80	0.82	NaN	0.77	0.79	0.79
RBC model with factor share shock	0.80	0.80	0.80	0.81	0.79	0.78	0.78	0.79

Note: Quarterly data, HP-filtered with smoothing parameter $\lambda = 1,600$. We average the monthly model-generated data first within quarters before HP-filtering.

technological change or structural transformation, that might also drive these shares). The baseline model can also generate closer cyclicality and persistence of the capital shares than any of the other alternative models we consider. In comparison, the model without bargaining shocks fails to create any meaningful fluctuations in the gross capital share and explains only around 17% of the fluctuations in the net capital share. It also does considerably worse regarding the cyclicality of the capital shares, with correlations to output counterfactually close to 1. Without bargaining shocks, the only moves in the capital shares come from changes in capital and the outside value in the bargaining protocol, and both mechanisms are weak. That also means that the model with "no bargaining shock" does worse matching the autocorrelations of the net and gross capital shares.

By construction, our baseline model generates a nearly acyclical wage: the correlation between output and wages is 0.19 both in the model and in the data. The bargaining shocks compensate for the pro-cyclicality of wages in productivity-driven models (higher productivity increases the marginal productivity of labor and, with it, wages). A shock that lowers wages is also expansionary: it increases the returns to capital and, thus, investment in physical capital and recruiting and, with them, output in the following periods. This mechanism is sufficiently strong to wipe out the correlation between wages and output.

6.1 Comparison with an RBC model

Could a standard RBC model account for the same features of the data as our baseline model with bargaining shocks? The rows "RBC model" in Table 5 answer this question by reporting the quantitative properties of the RBC model à la Hansen-Rogerson introduced in Subsection 4.3 (see also Table G.12 for the corresponding numbers with non-unitary elasticities of substitution and Figures G.29 to G.31 for the corresponding generalized impulse-response functions, or GIRFs). The RBC model fails to account for the cyclicality of wages and unemployment and for the fluctuations in the net capital share induced by changes in depreciation (this RBC model does not generate any volatility in the gross capital share when $\varepsilon = 1$; we will relax this assumption below).

Early work by Danthine and Donalson (2002) demonstrated that distribution shocks in an RBC model deliver asset price dynamics consistent with the data.[19] Hence, one could follow their approach (or that of Ríos-Rull and Santaeulàlia-Llopis, 2010, and Lansing, 2015) and introduce shocks to the factor shares in production within the RBC model. However, these shocks move real wages in the same direction as output. A negative shock to the factor share of capital lowers the productivity of capital and, via the marginal product of labor, the real wage. Thus, the real wage remains perfectly pro-cyclical even with the additional shock.

To illustrate this point, we calibrate a version of the RBC model with factor share shocks to generate the same volatility of TFP and relative volatility of investment as our baseline model (see rows "RBC model with factor share shock" in Table 5). Because both factor share shocks and productivity shocks generate pro-cyclical wages and highly volatile TFP, their volatility is not identified by our calibration strategy. Instead, we set the volatility of productivity to 0.05% and calibrate the volatility of the factor share to match the volatility of TFP. The correlation of the real wage is unchanged after such a shock relative to the standard RBC model. Figure G.32 shows that the real wage remains pro-cyclical in response to factor share shocks.

6.2 Possible endogeneity of bargaining power

One concern about our interpretation of bargaining shocks is that alternative labor market regulations could be the endogenous responses of the political process to changing unemployment rates. In Appendix G.16, we address this concern in two ways. First, we let bargaining power vary with the unemployment rate in a reduced form that matches the empirical correlation between the unemployment rate and bargaining power in the model and the partial filter. This version of the model explains a slightly larger share of the capital share volatility, but a somewhat smaller share of output volatility.

Second, we let the share of hours worked at the minimum wage and unemployment benefits vary with the unemployment rate, matching regression coefficients in the model with those in the data.

[19] Danthine and Donalson (2002) model time-varying labor shares as a stochastic and exogenous wedge between the marginal utility of labor for workers and the marginal utility of labor for investors. Importantly, economic agents cannot react to the shifts in labor shares.

Here, we find that it diminishes the effect of bargaining shocks on the capital share, but increases the share of output volatility explained by bargaining power shocks.

While the topic of the endogeneity of bargaining power deserves further exploration, our reduced-form exercises suggest that bargaining power shocks are likely to remain significant even when accounting for the fact that the bargaining shocks react to issues such as inequality, technological change, demographic fluctuations, globalization, and demand effects.

6.3 Increased volatility

Within countries over time and across countries, we observe large differences in the volatility of the capital share. For example, the volatility of the HP-filtered gross capital share has fallen from 1.79% per year from 1929 to 1949 to 0.81% per year from 1950 to 2010 in the U.S., a drop to less than half. The U.K. and France have seen even larger reductions in volatility. At the same time, the U.K. has a much more volatile capital share than the U.S. post-1950; its HP-filtered capital share has been about 40% (0.31/0.81) higher than that in the U.S. (Table 1(a)). Controlling for industry composition, this difference amounts to 60% (Table 1(b)). What would the consequences be if the U.S. capital share became more volatile due to more social or political attempts to redistribute?

If increased distribution risk made bargaining power volatile enough to raise the capital share volatility by 40%, U.S. output (and consumption) would become 15% more volatile. Given that households prefer smooth consumption, the increased volatility reduces welfare. More volatile bargaining power shocks also lower welfare by reducing the ergodic mean of consumption.

Table 6 reports the sizable welfare effects of distribution risk, which are much larger than conventional measures of the welfare cost of the business cycle (Lucas, 1991). Welfare, expressed in consumption units, drops by 0.7% when we increase the volatility of distribution risk to make the capital share 40% more volatile. To compute consumption equivalents, we hold employment fixed at its ergodic mean. Doubling the volatility of the capital share through increased political risk, thus undoing the decline we saw in the U.S. post-1950, leads to a welfare loss of 1.5% of consumption. Eliminating all distribution risk would increase the welfare of the representative household by 2.4% of consumption.

Table 6: Welfare effects of increased or reduced distribution risk

Specification	std(Y) [%]	$\frac{\text{Std(C)}}{\text{StdY}}$	Std(cs) [%]	Std(n) [%]	Welfare: Δ baseline Consumption units
Baseline	1.91	0.62	0.17	1.89	0
40% higher capital share volatility	2.20	0.62	0.24	2.39	–0.7%
100% higher capital share volatility	2.62	0.62	0.34	3.02	–1.5%
No distribution risk	1.35	0.57	0.01	0.24	+2.4%

Appendix G.15 reports a set of robustness checks, in terms of the cyclical properties of the model and welfare, when we modify how far away the calibration of the model is from satisfying the Hosios rule. In particular, the main factor behind the welfare losses is the persistent bargaining power shock and not the steady-state deviations of the model with respect to the Hosios rule.

7 Quantitative results III: The dynamic effects of a bargaining power shock

In the previous section, we reported the unconditional properties of the model. In this section, we document the conditional responses to a bargaining shock. Figure 8 shows the response to a bargaining shock that strengthens workers' bargaining power. In particular, we plot GIRFs, based on a third-order perturbation following the procedure outlined in Andreasen et al. (2018), to a two standard deviations shock.

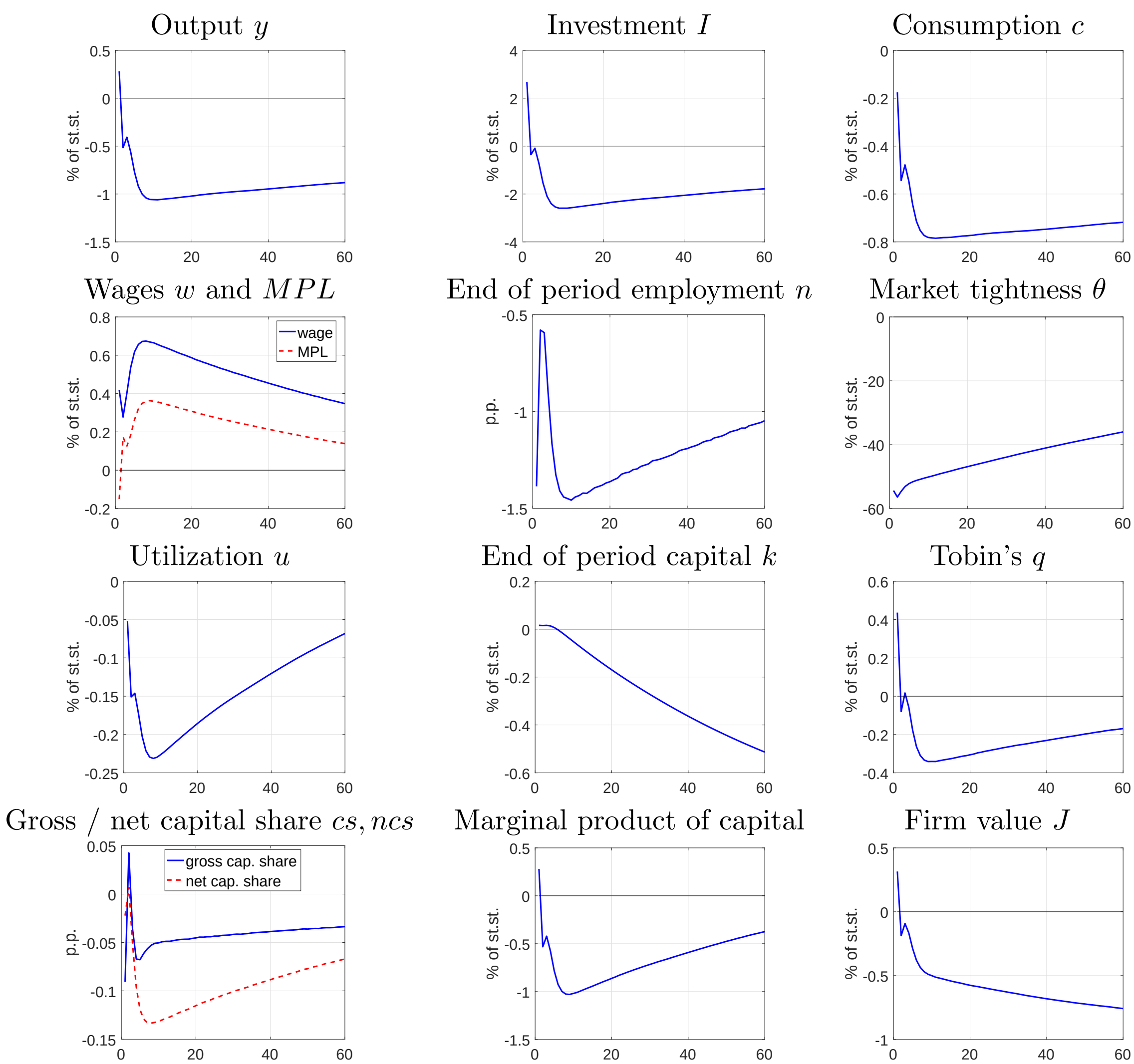
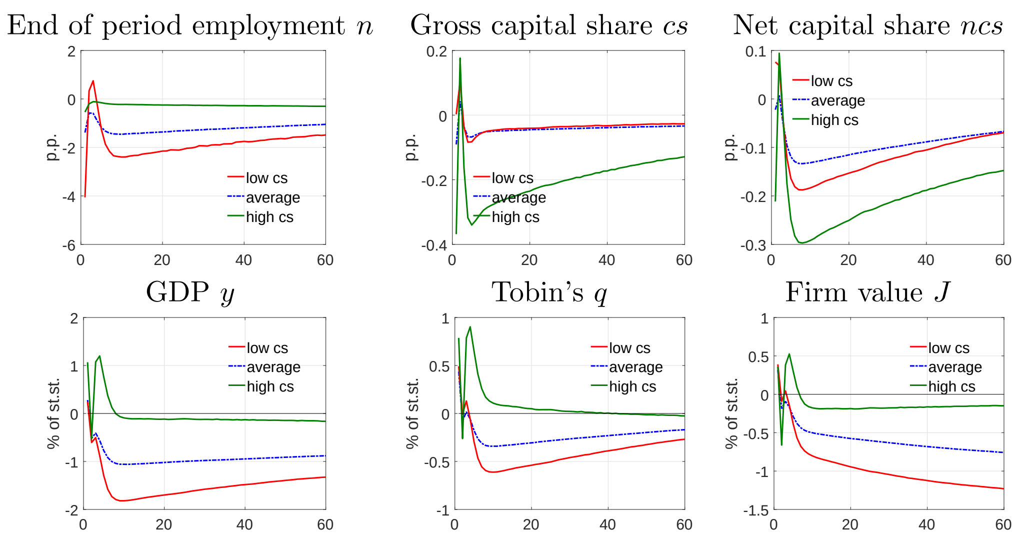


Figure 8: GIRFs to a two standard deviations shock raising workers' bargaining power (in months).

First, after the shock, both the gross and net capital shares fall.[20] Second, output drops persistently: a lower capital share leads to less investment, either in capital or in recruiting, and a lower utilization rate. As recruiting efforts are scaled back, final goods production drops by less than output, but future employment also falls. Third, the value of the firm rises initially, if slightly, as firms shift workers from recruiting to production to raise the output of final goods to take advantage of the existing stocks of workers and capital (this movement also explains the initial increase in the marginal productivity of capital and of Tobin's q). However, as firms reduce their recruiting efforts, employment falls and, with it, the marginal product of labor. This, together with the lower return on capital due to the bargaining shock, leads to lower investment and a declining capital stock. Both a lower capital and a lower share of the surplus contribute to a fall in firm value. Fourth, wages rise more than the marginal product of labor, again reflecting the change in bargaining power. Finally, market tightness decreases. Furthermore, the increase in unemployment and wages following the increase in workers' bargaining power is in line with the VAR evidence in Figure 4.



Note: We compute the conditional IRFs by initializing the economy at the states associated with observing a capital share in the top, bottom, or middle 10% of the ergodic distribution.

Figure 9: State dependence in IRFs to a two standard deviations bargaining power shock with high vs. low initial capital share (in months).

Interestingly, the response of the economy displays a pronounced state dependence. In particular, the capital share at the moment of the shock matters. Figure 9 shows that a given shock to bargaining power has smaller effects on redistribution and causes larger drops in GDP and firm values when starting from a situation that already features a low capital share of income. When the capital share is small, further reductions in its bargaining power have a higher marginal cost to the

[20]In the short run, we have some non-monotonicities: the bargaining shock distributes what used to be profits to workers, lowering profits and keeping output initially fixed. The capital share drops. Next output drops, undoing much of the initial increase in the ratio. Then, marginal labor productivity and wages rise further, leading again to a lower capital share.

firm, but firms do not have space to redistribute much additional income to workers. In contrast, with a high capital share, the initial drop in the capital share is twice that of GDP and, after five years, the response of GDP is only twice that of the capital share. Similarly, drops in employment are more muted when the capital share is already high. In short, the non-linearities in our model imply that the price and quantity effects of bargaining power shocks depend on how polarized the income distribution is.

Our model generates large movements in output relative to those in bargaining power because the match surplus is small. If the model featured efficient bargaining in the presence of product market rents as in Blanchard and Giavazzi (2003), capital shares might become more volatile relative to output.

8 Conclusion

Capital shares of income can be volatile. For the three countries for which we have long historical time series –France, the U.K., and the U.S.– we observe substantial declines in the volatility of the capital share after 1950. This volatility also differs across countries. We argue that social and political factors can be important drivers of fluctuations in the factor income distribution. In particular, for the U.S., we find that capital shares rose after the introduction of right-to-work legislation.

We proceed by building a model where workers bargain with firms over the match surplus in the labor market, and their bargaining power is subject to shocks – which we interpret as social and political shocks. Filtering bargaining power from the data confirms our calibration and highlights the connection of bargaining shocks to social and political events. Also, our model matches the standard U.S. business cycle moments and the cyclicality of the capital share. Bargaining shocks are powerful in our model. Even though they explain only between 12% and 26% of the volatility of the gross capital share in the U.S. when calibrated to our baseline data, they can account for 28% to 46% of the volatility of output, depending on the elasticity of substitution between capital and labor. We use our model as a laboratory to ask what would happen if the U.S. capital share became more or less volatile due to increased political risk. Finally, we document that the dynamic effects of distribution shocks in our model are strong and non-linear.

The empirical and theoretical results suggest, therefore, that bargaining shocks might be a significant source of aggregate fluctuations.

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