Productivity and Pay: is the link broken?

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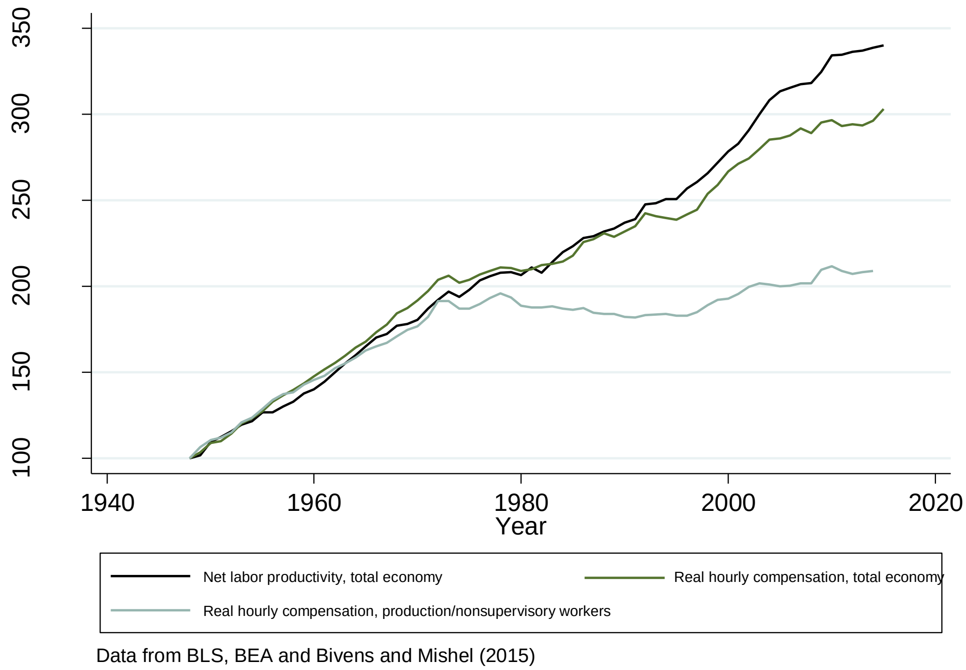
1. Introduction

After growing in tandem for nearly 30 years after the second world war, since 1973 an increasing gap has opened between the compensation of the average American worker and her/his average labor productivity[1]. Brynjolffson and McAfee (2014) use the phrase "the great decoupling" to describe this phenomenon; Bivens and Mishel (2015) refer to it as a "historic divergence". In recent years discussion has centered on understanding why this phenomenon has occurred and how policy should respond.

Figure 1: Labor productivity and the compensation of average American workers 1948-2015



This graph shows two measures for the compensation of the "average" American worker: real hourly average (mean) compensation for the total economy, and real hourly average (mean) compensation for production and nonsupervisory workers in the private sector, who comprise 80 percent of private sector employees. Bivens and Mishel (2015) argue that this is a good representation of trends in median compensation, for which data is not available before 1973.

One interpretation of this divergence has been that raising productivity growth does not improve the income of the average American. Bivens and Mishel (2015) write "boosting productivity growth... will not lead to broad-based wage gains unless we pursue policies that reconnect productivity growth and the pay of the vast majority". Bunker (2015) writes that "productivity gains haven't translated into broadly shared gains for the entire workforce". Brynjolffson (2014) states "there's no law that everybody's going to benefit from technology... Ever since the

[1] The timing and size of this gap depends on how average compensation is defined and measured. This will be discussed later in this paper.

Industrial Revolution, we've experienced a rising tide that has helped most people but... those trends have diverged".

Yet just as two time series apparently growing in tandem does not mean that one causes the other, two series diverging may not mean that the causal link between the two has broken down. Rather, other factors may have come into play which appear to have severed the connection between productivity and compensation.

As such one can envision two views of the productivity-pay divergence over recent decades. On the "delinkage" view, increases in productivity growth no longer systematically translate into additional growth in workers' compensation. On the more conventional "linkage" view, productivity growth does translate into pay, holding all other factors constant, but a variety of other factors have been putting downward pressure on workers' compensation even as productivity growth has been acting to lift it.

The productivity slowdown has very different implications under each of the two explanations. Under the "linkage" view, continued slow productivity growth is likely to dampen growth in the average worker's compensation. Under the "delinkage" view, the pace of productivity growth is no longer the key factor determining the average worker's compensation – and so the productivity slowdown is less troubling from this perspective.

Which of the two views is correct? We attempt to tease this out by examining the co-movement of labor productivity and various measures of typical worker compensation in the US since the Second World War.

We find that periods of faster productivity growth over the last seven decades have in general coincided with faster real compensation growth for the average and the median American worker. Our regressions suggest that a one percentage point increase in productivity growth has been associated with between two thirds and one percentage point higher real compensation growth for the median and average worker, and 0.5-0.7 percentage points higher real compensation growth for the average production and nonsupervisory worker. This suggests that factors *not* associated with productivity growth have caused median and average compensation to diverge from productivity.

We then examine the co-movement of labor productivity with the labor share and with the mean-median compensation ratio, to gauge the extent to which technological change may have been responsible for the recent divergence between pay and productivity. The data does not tend to be strongly supportive of the pure technology hypothesis for the pay-productivity divergence, whether looking at the divergence between productivity and average compensation (the decline in the labor share) or looking at the divergence between average and median compensation.

Our paper proceeds as follows. In section 2, we discuss definitions of the productivity-compensation divergence and measurement issues, informed by previous literature on the subject. In section 3, we describe our data and empirical approach. We present our baseline results in section 4. In section 5, we discuss the robustness of our results, testing under alternate specifications and considering the effect of productivity mismeasurement. In sections 6 and 7, we show our baseline regressions for different deciles of the US wage distribution and for other OECD countries respectively. We examine the co-movement of productivity growth with the pay-productivity divergence in section 8. We conclude in section 9.

2. Definitions and measurement

Discussions of the productivity-compensation divergence use various different concepts of productivity and average compensation. The correct concept to use depends on the question being asked[2].

One possible line of inquiry is to examine *whether the labor share of income remained constant.* In this case it is appropriate to ask whether average (mean) hourly compensation diverged from net labor productivity[3]. If examining in real terms, compensation should be deflated by the

[2] Note that regardless of the question, the definition of "compensation" should incorporate both wages and non-wage benefits such as health insurance. The share of compensation provided in non-wage benefits significantly rose over the postwar period, particularly during the 1960s and 1970s, meaning that comparing productivity against wages alone would imply a larger divergence between productivity and pay than has actually occurred (Feldstein 2008).

[3] In the special case of Cobb-Douglas technology, this also tests the marginal productivity theory of labor (whether workers are paid their marginal product by firms). However with non-Cobb-Douglas technologies, a divergence of workers' wages from their average productivity can occur even while workers are being paid their marginal product, for example if capital deepening causes a fall in the labor share.

product price deflator for the relevant sector of the economy, such as the GDP deflator or the implicit price deflator for the output of the nonfarm business sector.

This is the question investigated by Feldstein (2008). He estimated the relationship between productivity and compensation in the US nonfarm business sector, after correcting for two common measurement issues. First, prior literature had compared productivity growth to compensation growth deflated by a consumer price deflator rather than a product price deflator. This resulted in inconsistent deflation of the productivity and compensation series: since firms (in theory) pay workers their marginal revenue product, deflation by a consistent price index is important as the compensation measure should reflect the real cost to firms of employing workers. Second, prior literature had often investigated wage growth only, ignoring the growth in non-wage benefits over the second half of the twentieth century. When using a measure of total compensation which included non-wage benefits, and deflating compensation by the implicit price deflator for the nonfarm business sector, Feldstein found that over 1948 to 2006 labor productivity and average compensation in the nonfarm business sector grew at approximately the same annual rate. As such, the labor share of income stayed roughly constant over the period.

Lawrence (2016) carried out a more recent analysis of this question, correcting in addition for the fact that the productivity measure should be net of depreciation rather than gross: the net measure is a more accurate reflection of the increase in income available for distribution to factors of production. Since depreciation has accelerated over recent decades, using gross productivity figures creates a misleadingly large divergence between productivity and compensation. Lawrence finds that net labor productivity and average compensation grew together until 2001, when they started to diverge i.e. the labor share started to fall. Many other studies also find a decline in the US labor share of income since about 2000, though the timing and magnitude is disputed (see for example Karabarbounis and Neiman 2014, Lawrence 2015, Elsby Hobijn and Sahin 2013, Rognlie 2015, Pessoa and Van Reenen 2013).

A different line of inquiry is to investigate *the extent to which rises in productivity contribute to average workers' welfare*. In this case, net labor productivity should be compared to average compensation deflated by a consumption price deflator such as the CPI or the PCE: the consumption price deflator represents the real value of income to the worker, rather than the real cost of the worker's compensation to the firm. The compensation of the "average" worker could be considered to be the mean or the median, but since mean compensation is skewed by higher incomes and the rate of growth of the highest incomes has exceeded the rest over recent decades, growth in mean compensation does not reflect the experience of most middle-class Americans.

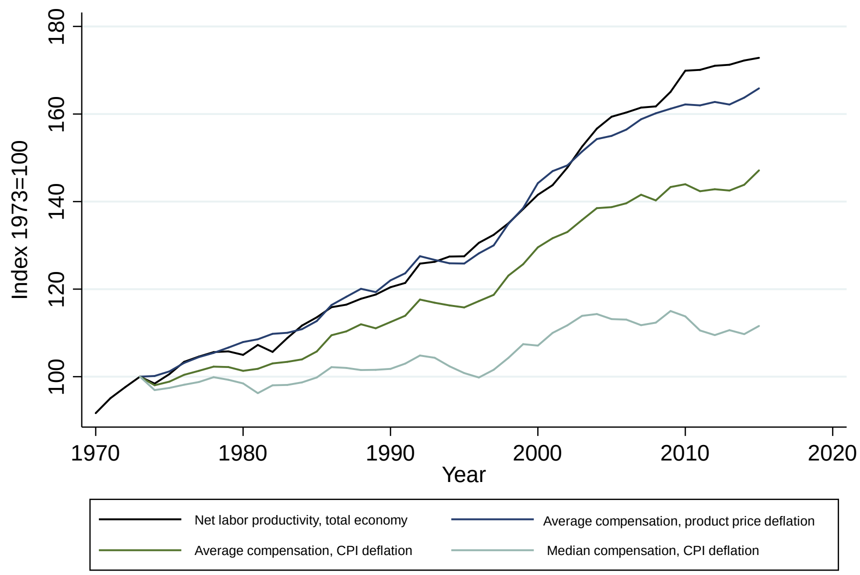
Clarifying the question is important: each question has a very different answer. Over the last forty years, three separate divergences have created today's "wedge" between average net labor productivity and median compensation (Bivens and Mishel 2015). The median worker's compensation has diverged rapidly from the mean as income inequality has risen. The consumption and product price deflators have diverged as consumer prices have grown faster than producer prices[4]. And over the last ten to fifteen years, the income paid to workers and labor productivity have diverged as the labor share of income has fallen.

These wedges are illustrated by the graph overleaf, which is a reproduction of Bivens and Mishel (2015) (Lawrence 2016, Pessoa and Van Reenen 2013, Fleck, Glaeser and Sprague 2011, and Baker 2007 have demonstrated similar wedges[5]). Over 1973-2015, net labor productivity grew by 73%, average compensation deflated by the net domestic product price index grew by 66%, average compensation deflated by the CPI grew by 47%, and median compensation deflated by the CPI grew by only 12%.

[4] The Bureau of Labor Statistics has stated that this divergence is partly because of the aggregation method used: the CPI uses a Laspeyres aggregation and the GDP deflator uses a Fisher ideal aggregation. Other key differences between the series are that the CPI includes import prices, and does not include goods and services purchased by businesses, governments or foreigners (Church 2016). There is a large volume of prior work on the divergence between US price deflators, particularly the CPI and the PCE, which includes Triplett (1981), Fixler and Jaditz (2002), McCully, Moyer and Stewart (2007), Bosworth (2010), Pessoa and Van Reenen (2013).

[5] Lawrence (2016) demonstrates the additional divergences between gross and net productivity and between average compensation and average wages. Pessoa and Van Reenen (2013) distinguish between "gross decoupling" – whether labor productivity has diverged from median real hourly earnings (not compensation) – and "net decoupling" – whether labor productivity has diverged from average real labor compensation.

Figure 2: Productivity-compensation wedge decomposition, total economy, 1973-2015



Data from BLS, BEA and Mishel and Bivens (2015)

In this paper, we are interested in the question: *do average American workers reap the benefits of productivity growth?* We compare net labor productivity to a range of measures of the typical worker's compensation – average compensation, median compensation, and the compensation of production and nonsupervisory workers – deflating incomes by consumption price deflators to reflect the real value to workers of their pay.

3. Empirical estimation

Does productivity growth translate to growth in the average worker's pay?

Under the "linkage" view of productivity and compensation, an increase in average labor productivity should translate into an increase in average (mean) compensation, all else held equal (i.e. if labor is paid its marginal product and the labor share does not change). If this increase in labor productivity is broad-based throughout the economy, pay throughout the income distribution will rise when labor productivity rises - and as such, median compensation should also rise.

If the "delinkage" view is correct – that the transmission mechanism between productivity and compensation has broken down – we may not see increases in labor productivity translating into increases in average or median compensation to the same extent.

At the simplest level, a linear model can relate compensation to productivity (equation (1) below). Under the strong "linkage" view, β=1, and under the strong "delinkage" view, β=0.

$$compensation_t = \alpha + \beta\ productivity_t \qquad (1)$$

The time horizon over which this relationship should hold will depend on both the wage setting process and on the degree to which productivity changes are correctly perceived and anticipated. If firms on average change pay and benefits infrequently, increases in productivity will only translate with a lag into changes in compensation. If it takes some time for firms and workers to discern the extent to which an increase in output is due to a rise in productivity rather than other factors, once again productivity increases will translate into compensation only with a lag. On the other hand, if firms and workers correctly anticipate that there will be a productivity increase in the near future, the rise in compensation may precede the actual rise in productivity.

The combination of these factors means that it is not immediately clear over which time horizon the relationship should hold. As a result we test the relationship in two ways – with moving averages and with distributed lags – and over time horizons from one year to five years. We use the change in logged values of compensation and productivity, rather than their levels, as compensation and productivity are both non-stationary unit root processes but their first differences are stationary[6].

In our baseline moving average specification (equation 2), we regress the three-year moving average of the change in log of real compensation on the three-year moving average of the change in log of labor productivity and the three-year moving average of the change in the unemployment rate. We also present regressions using the two-, four- and five-year moving averages. The parameter of interest is β, the relationship between the moving average of the change in log productivity and the change in log compensation[7].

[6] Dickey-Fuller test results are in Appendix Table 13.
[7] To account for the autocorrelation introduced by the moving average specification we use Newey-West heteroskedasticity and autocorrelation robust standard errors. For our moving average regressions, we specify a lag

$$\frac{1}{3}\sum_0^2 \Delta \log comp_{t-i} = \alpha + \beta \frac{1}{3}\sum_0^2 \Delta \log prod_{t-i} + \gamma \frac{1}{3}\sum_0^2 \Delta unemp_{t-i} + \varepsilon_t \qquad (2)$$

In our baseline distributed lag specification (equation 3), we regress the annual change in log of real compensation on the current and two lagged values of annual productivity growth, as in Feldstein (2008), and control for changes in the unemployment rate. We also present regressions using no lags, one lag and three lags of the change in log of productivity. In this case since we are interested in the cumulative effect of a change in productivity on compensation over a number of years, the parameter of interest is the sum of the β_i estimated coefficients.

$$\Delta \log comp_t = \alpha + \sum_0^2 \beta_i \Delta \log prod_{t-i} + \sum_0^2 \gamma_i \Delta unemp_{t-i} + \varepsilon_t \qquad (3)$$

We control for changes in the unemployment rate in both specifications to minimize the effect of cyclical factors on the estimated productivity-compensation relationship. Changes in unemployment are likely to affect search and bargaining dynamics: a temporary increase in the unemployment rate should enable employers to raise compensation by less than they otherwise would have for a given productivity growth rate, as more unemployed workers search for jobs. In addition, changes in unemployment are likely to reflect broader cyclical economic fluctuations which may affect compensation setting in the short term: a rise in unemployment may signal a downturn, which could bring lower firm revenues, profits and pay rises for a given rate of productivity growth. If changes in unemployment are also related to changes in productivity growth – for example, if the least productive workers are likely to be laid off first – then excluding the unemployment rate would bias the results. We use the unemployment rate of 25-54 year-olds to capture only cyclical effects, rather than the effect of demographic shifts such as an ageing population.

Data

For our baseline analysis (section 4) we use data on net productivity and average compensation since 1948, and on median compensation since 1973, for the total US economy[8]. Our sources are primarily publicly available data from the BEA and BLS, as well as the BLS Total Economy

length of twice the length of the moving average. For our distributed lag regressions, we specify lag length using the "rule of thumb" lags =0.75*$T^{1/3}$ (Stock and Watson 2007).

[8] This includes the private, public and non-profit sectors.

Productivity dataset which is unpublished but available on request. We are grateful to Lawrence Mishel and Josh Bivens of the Economic Policy Institute for providing us with their data on median compensation and on average compensation of production and nonsupervisory workers, which they constructed from a range of datasets (details in the Appendix).

Net labor productivity for the total economy is calculated by dividing Net Domestic Product by the total hours worked in the economy, following Bivens and Mishel (2015). Average compensation for the total economy is from the BLS total economy productivity dataset. Our median compensation series is from Bivens and Mishel (2015), who construct it from the CPS-ORG survey and BEA data on the composition of workers' compensation. Our regressions with the average hourly compensation of production and nonsupervisory workers in the private sector use a series compiled by Bivens and Mishel (2015) from the BLS CES survey and BEA data on the composition of compensation. Bivens and Mishel argue that the average compensation of production and nonsupervisory workers is likely to reflect trends in median compensation before 1973 (a period for which median compensation data is not available). It is also an interesting measure in itself, since this group comprises roughly 80 percent of private sector employees.

The compensation series are deflated by the CPI-U over 1948-1977 and the CPI-U-RS over 1977-2015 (the earliest years for which it is available from the BLS)[9]. As discussed in section 2, many analyses of the productivity-pay divergence have used compensation deflated instead by a product price deflator, to ensure that any divergence measured between compensation and productivity is not caused by price index measurement differences (Feldstein 2008, Sherk 2013). We use a consumer price index deflation method (like Bivens and Mishel 2015) because it measures the actual increases in standards of living experienced by workers, which is the key variable for policy decisions[10].

[9] The choice of price index could affect the results. The most commonly-used consumption deflators are the consumer price index research series for urban consumers, CPI-U-RS (available from the BLS since 1977), and the consumption deflator for personal consumption expenditures, PCE (available from the BEA). We choose to use the CPI-U-RS over the PCE because it is designed to deflate only the consumption of individuals/households, whereas the PCE also includes consumption by non-profits and some purchases of healthcare for individuals by government or employers. Some analysts prefer to use the PCE: Lawrence (2016) for example chooses the PCE over the CPI as it contains arguably more reliable data from establishments rather than consumers, and is a chained measure of inflation. We present results for our regressions using PCE price index deflation in Appendix Tables 3A and 4A: they are similar to the results using the CPI.

[10] We repeat the same analysis using product price deflation in Appendix Tables 3B and 4B.

Productivity is difficult to measure accurately for the entire economy: it comprises government and non-profit institutions, whose output is difficult to conceptualize and measure since it is usually not traded on markets. As such we repeat our analysis with data on only the nonfarm business sector. This is likely to be a more reliable measure of productivity as it excludes the public sector, non-profits and agricultural businesses - but it represents only 75 percent of US GDP.

For nonfarm business sector productivity, we use BLS data on the real output per hour of the nonfarm business sector (gross productivity). The ideal productivity measure would be net of depreciation, as used for the total economy regressions, since net productivity represents only the productivity gains which are available to distribute to factors of production (as discussed in Lawrence 2016). Unfortunately this measure is not calculated for the nonfarm business sector. Using gross productivity may bias our results if changes in the depreciation rate are correlated with changes in productivity and compensation. For compensation, we use BLS data on average hourly compensation in the nonfarm business sector, deflated by the CPI-U-RS over 1977-2015 and the CPI-U prior to 1977.

Our analysis of different percentiles of the wage distribution in section 6 uses data on wages from the Economic Policy Institute State of Working America Data Library. The data is constructed from the CPS-ORG survey and starts in 1973.

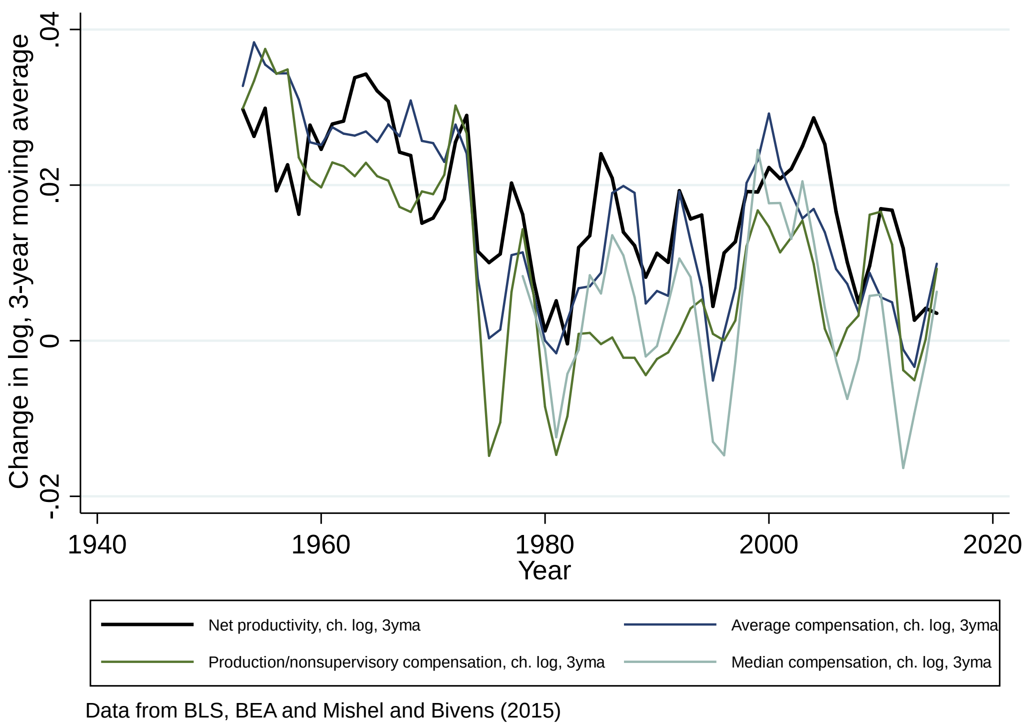
For our analysis of the other major advanced economies in section 7, unless otherwise specified we use OECD data on labor productivity per hour worked and average compensation per hour worked, deflated by the consumer price index for the country in question, as well as using OECD data on the aggregate unemployment rate. For Germany pre- and post-reunification, we use data on hourly labor productivity, hourly compensation and unemployment from the German Federal Statistical Office.

4. Baseline results

Total economy

We first present results for the total economy. Figure 3 illustrates the relationship between compensation and productivity in the total economy, plotting the 3-year moving average of median and mean compensation growth and of productivity growth (all in change in log form). While compensation consistently grows more slowly than productivity since the 1970s, the series move largely together.

Figure 3: Change in log labor productivity and compensation, total economy (3-year moving averages)



Data from BLS, BEA and Mishel and Bivens (2015)

Tables 1 and 2 below display our regression results for the total economy, table 1 using the moving average specification and table 2 the distributed lag specification. Both tables use as their dependent variables the growth in average compensation (since 1948), median compensation (since 1973) and production and non-supervisory compensation (since 1948). We show coefficients for the whole period as well as on either side of 1973. 1973 is often identified as the beginning of the modern productivity slowdown, as well as the date when many authors suggest that the relationship between compensation and productivity started to break down[11]; in our data a Quandt likelihood ratio test also identifies a structural break at 1973. Since our median compensation data only goes back to 1973, splitting the sample then also makes it easier to compare the results on average and median compensation.

As Tables 1 and 2 show, over both 1950-2015 and 1973-2015 there has been a strongly positive and significant association between changes in log productivity and changes in log average and median compensation. The moving average regressions (table 1) suggest that over 1973-2015, a 1 percentage point increase in the growth rate of productivity was associated with a 0.80 percentage point increase in the growth rate of average compensation and a 0.86 percentage point increase in the growth rate of median compensation. The distributed lag regressions (table 2) suggest that over 1974-2015 the three-year cumulative effect of a 1 percentage point increase in the growth rate of productivity – the sum of the β_i coefficients – was 0.97 for average and 0.89 for median compensation. All four of these coefficients are strongly significantly different from zero, and none are significantly different from one. These tend to support the "linkage" hypothesis that productivity growth translates close to one-for-one into compensation growth.

The relationship between productivity and the average production and nonsupervisory worker's compensation is smaller – for the period 1973-2015, the coefficient estimate from the moving average regression is strongly significant at 0.60 and from the distributed lag regression is only weakly significant at 0.55. The coefficient estimate in the moving average regression is strongly significantly different from zero and also significantly different from one; the coefficient estimate in the distributed lag regression is weakly significantly different from zero (at the 10% level only) and not significantly different from one. As such, any conclusions that can be drawn from these regressions must be more speculative. These results suggest that some proportion of increases in productivity did feed through to the compensation of production and nonsupervisory workers during this period, but that this relationship is likely to have been less than one-for-one.

[11] The Economic Report of the President (2015), Bivens and Mishel (2015), Baker (2007), Bosworth and Perry (1994) are among the authors who identify a break at 1973 when discussing trends in US productivity and compensation.

Table 1: Moving average regressions – total economy
Compensation variables: average compensation, median compensation, and production/nonsupervisory compensation

Dependent variables are the 3-year moving average of the Δ log compensation	(1a) Average comp 1950-2014	(1b) Average comp 1950-1973	(1c) Average comp 1975-2014	(1d) Median comp 1975-2014	(1e) Production/nonsupervisory comp 1950-2014	(1f) Production/nonsupervisory comp 1950-1973	(1g) Production/nonsupervisory comp 1975-2014
Δ log productivity, 3-year moving average	**0.98*** (0.08)**	**0.42* (0.24)**	**0.80*** (0.16)**	**0.86*** (0.18)**	**1.04*** (0.13)**	**0.61** (0.25)**	**0.60*** (0.18)**
Δ unemployment (25-54), 3-year moving average	0.03 (0.16)	0.40 (0.24)	-0.11 (0.10)	0.05 (0.16)	0.22 (0.26)	0.75* (0.37)	0.14 (0.33)
Constant	-0.00 (0.00)	0.02** (0.01)	-0.00 (0.00)	-0.01*** (0.00)	-0.01*** (0.00)	0.01 (0.01)	-0.01 (0.00)
Observations	65	24	40	40	65	24	40
F-test: is coefficient on productivity significantly different from 1?							
Test statistic	0.08	5.85**	1.47	0.57	0.10	2.46	4.58**
Prob>F	0.78	0.02	0.23	0.46	0.76	0.13	0.04

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: the year is listed as the middle year of the moving average. A regression over "1950-2014" implies the first observation is the three-year moving average of the change in logged variable in 1949, 1950 and 1951 and the last observation is the three-year moving average of the change in logged variable in 2013, 2014 and 2015.

Table 2: Distributed lag regressions - total economy
Compensation variables: average compensation, median compensation, and production/nonsupervisory compensation

Dependent variables are all in Δ log form	(2a) Average comp 1951-2015	(2b) Average comp 1951-1973	(2c) Average comp 1974-2015	(2d) Median comp 1974-2015	(2e) Production/nonsupervisory comp 1951-2015	(2f) Production/nonsupervisory comp 1951-1973	(2g) Production/nonsupervisory comp 1974-2015
Δ log productivity	0.77***	0.07	0.86***	0.81***	0.67***	-0.01	0.66***
	(0.15)	(0.33)	(0.17)	(0.20)	(0.20)	(0.29)	(0.23)
Δ log productivity, 1 year lag	0.22**	-0.14	0.24**	0.45***	0.28**	-0.01	0.11
	(0.11)	(0.15)	(0.10)	(0.17)	(0.12)	(0.22)	(0.13)
Δ log productivity, 2 year lag	0.05	0.07	-0.13	-0.37**	0.03	-0.00	-0.22
	(0.11)	(0.10)	(0.15)	(0.18)	(0.17)	(0.16)	(0.21)
Δ unemployment (25-54)	0.27**	-0.06	0.32*	0.72***	0.17	-0.26	0.29
	(0.12)	(0.14)	(0.18)	(0.15)	(0.23)	(0.24)	(0.32)
Δ unemployment (25-54), 1 year lag	-0.36***	-0.14	-0.50***	-0.71**	-0.01	0.37	-0.29
	(0.13)	(0.18)	(0.18)	(0.28)	(0.20)	(0.28)	(0.28)
Δ unemployment (25-54), 2 year lag	-0.21	-0.05	-0.27	-0.32*	-0.09	0.03	-0.01
	(0.17)	(0.30)	(0.19)	(0.18)	(0.19)	(0.37)	(0.19)
Constant	-0.00	0.03**	-0.00	-0.01**	-0.01*	0.02**	-0.00
	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)
Observations	65	23	42	42	65	23	42
Sum of Δ log productivity coefficients[12]	**1.04*** **	**-0.05**	**0.97*** **	**0.89*** **	**0.98*** **	**-0.02**	**0.55***
	(0.13)	**(0.34)**	**(0.23)**	**(0.27)**	**(0.18)**	**(0.35)**	**(0.28)**
F-test: is coefficient significantly different from 1?							
Test statistic	0.09	8.67***	0.02	0.18	0.01	8.38**	2.59
Prob>F	0.76	0.01	0.90	0.69	0.92	0.01	0.12

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: the year is listed as the year of the dependent variables. A regression over "1951-2015" has its first observation of the change in logged dependent variable in 1951 and the last observation of the change in logged dependent variable in 2015.

Break-point tests suggest a statistical break in the compensation-productivity relationship in 1973[13]. This break however is the opposite of what would have been expected under the hypothesis of a breakdown in the productivity-compensation relationship. There is only a weak quantitative relationship between changes in average compensation and productivity during 1949-1973 in the moving average regressions, and no evidence of a significant relationship at all in the distributed lag regressions, even though during this period the levels of productivity and

[12] The standard error for the sum of coefficients is estimated using the standard error from running the following regression: $\Delta \log comp_t = \alpha + \beta_0 \Delta\Delta \log prod_t + \beta_1 \Delta\Delta \log prod_{t-1} + \beta_2 \Delta \log prod_{t-2} + \sum_0^1 \gamma_i \, \Delta unemp_{t-i} + \varepsilon_t$
[13] A Quandt likelihood ratio test identifies a break at 1973; a Wald test is significant at the 0.1% level for a break at 1973.

compensation did not diverge. On the other hand the relationship since 1973 is strongly positive, even though in levels productivity and median and average compensation did diverge.

The absence of the hypothesized productivity-compensation relationship before 1973 is puzzling. Since the 1949-1973 sample size is small and standard errors are relatively large, we cannot draw strong conclusions from the failure of the relationship to hold. We do note that there is almost no co-movement between compensation and productivity in the late 1950s and early 1960s in particular. This was a period of strikingly low variation in the rates of productivity and compensation growth, as shown in figures 4 and 5. If you re-run our distributed lag regression from 1948-1973 but exclude 1956-63, you get a strongly significant cumulative dynamic multiplier of productivity on average compensation of approximately 0.6. It may be the case that the low underlying variation in productivity and compensation during the late 1950s and early 1960s magnified the effects of noise in the productivity-compensation relationship.

Figure 4: Change in log average compensation
7-year backward-looking rolling standard deviation

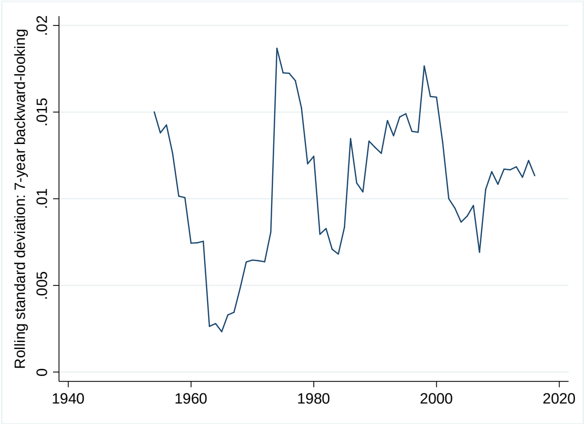
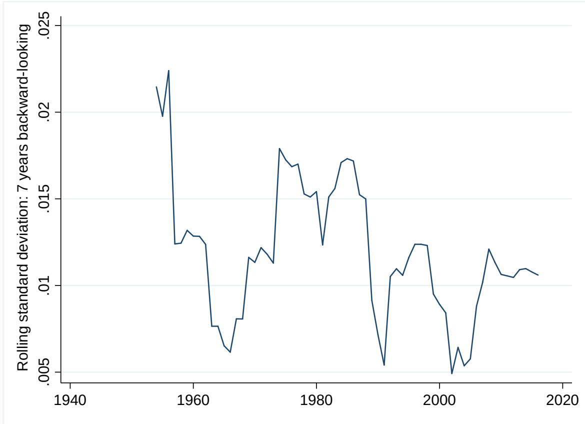


Figure 5: Change in log productivity
7-year backward-looking rolling standard deviation



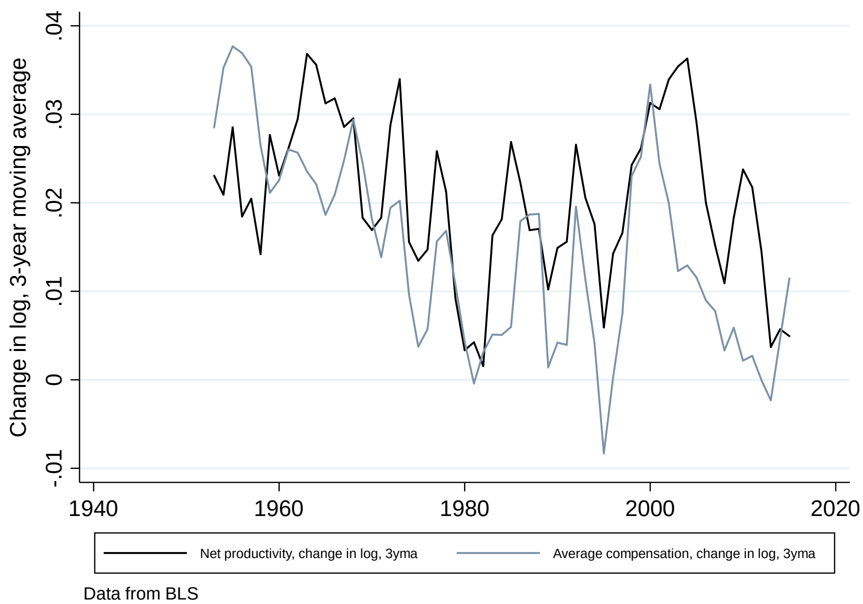
Whatever the reason for the weak estimated relationship between productivity and compensation in the pre-1973 period, our evidence does *not* support the theory of a strong compensation-productivity relationship before 1973 and a breakdown *since* 1973[14].

[14] Just as the late 1950s/early 1960s appear to have driven the pre-1973 result, the productivity boom of the late 1990s may drive the post-1973 result. Running our baseline regression since 1973, excluding all years from 1995-2000, gives strongly significant coefficients on average and median compensation of 0.65-0.78, and coefficients in the 0.47-0.53 range for production and nonsupervisory compensation, depending on the specification. This suggests to us that our estimates are -as would be expected- partly driven by this period, but that the strong, large and positive relationship between productivity growth and the pay of middle-income workers exists also outside this period.

Nonfarm business sector

We next examine the nonfarm business sector. Figure 6 below shows the relationship between compensation and productivity in the nonfarm business sector, plotting 3-year moving averages of the change in log of average compensation against the change in log of productivity for the nonfarm business sector. The co-movement of compensation and productivity growth once again appears stronger in the period since the 1970s, although the growth rate of compensation has consistently been lower than that of productivity.

Figure 6: Change in log labor productivity and compensation, nonfarm business sector, 3-year moving average



Tables 3 and 4 present our regression results for the nonfarm business sector. As discussed in section 3, the nonfarm business sector data covers only 75 percent of GDP, but its productivity data is likely to be better measured than that of the total economy. The nonfarm business sector productivity data is gross not net, however, so coefficient estimates may be biased if changes in the rate of depreciation are related to changes in both productivity and compensation growth[15]. Once again we show estimates split at 1973.

The point estimates on the coefficients of these nonfarm business sector regressions are slightly smaller than in the total economy regressions, with the coefficient for the full sample period 0.73

[15] As a reference point for the likelihood of this happening: the depreciation rate in the *total* economy is strongly significantly negatively correlated with total economy productivity growth, but is not significantly correlated with total economy compensation growth.

in the moving average specification and 0.76 in the distributed lag specification, and the coefficients for the post-1973 period 0.65 in the moving average specification and 0.72 in the distributed lag specification. They are strongly significantly different from zero and the distributed lag regression coefficients are not significantly different from one. Once again there is strong evidence of a structural break around 1973[16], and little evidence of a strong relationship between productivity and compensation growth over 1950-1973[17].

Table 3: Moving average regressions – nonfarm business sector

Dependent variables are the 3-year moving average of the Δ log compensation	(3a) Average comp 1950-2014	(3b) Average comp 1950-1973	(3c) Average comp 1975-2014
Δ log productivity, 3-year moving average	**0.73*** (0.11)**	**0.10 (0.25)**	**0.65*** (0.18)**
Δ unemployment (25-54), 3-year moving average	-0.18 (0.20)	0.09 (0.30)	-0.31** (0.15)
Constant	-0.00 (0.00)	0.02** (0.01)	-0.00 (0.00)
Observations	65	24	40
F-test: is coefficient significantly different from 1?			
Test statistic	6.10**	12.9***	3.59*
Prob>F	0.02	0.00	0.07

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: the year is listed as the middle year of the moving average.

[16] A Quandt likelihood ratio test finds the most likely structural break at 1969, but we show the break at 1973 here for consistency with the total economy results. A Wald test for a structural break at 1973 is significant at the 0.1% level.

[17] We do not include median compensation or the compensation of production and nonsupervisory workers in these regressions because these measures are taken from the total economy, whereas this productivity measure only covers the nonfarm business sector. If you do run these regressions with median compensation as the dependent variable, the point estimates are 0.76 and 0.74 for the median worker (for the moving average and distributed lag regressions respectively) and 0.56 and 0.52 for the average production and nonsupervisory worker.

Table 4: Distributed lag regressions – nonfarm business sector

	(2a) Average comp 1951-2015	(2b) Average comp 1951-1973	(2c) Average comp 1974-2015
Δ log productivity	0.62*** (0.15)	-0.23 (0.41)	0.76*** (0.15)
Δ log productivity, 1 year lag	0.13 (0.11)	-0.18 (0.20)	0.08 (0.10)
Δ log productivity, 2 year lag	0.02 (0.10)	-0.19 (0.16)	-0.12 (0.12)
Δ unemployment (25-54)	0.05 (0.16)	-0.53** (0.24)	0.13 (0.26)
Δ unemployment (25-54), 1 year lag	-0.41*** (0.14)	-0.07 (0.31)	-0.63*** (0.17)
Δ unemployment (25-54), 2 year lag	-0.15 (0.20)	-0.16 (0.35)	-0.13 (0.20)
Constant	-0.00 (0.00)	0.04** (0.02)	-0.00 (0.00)
Observations	65	23	42
Sum of Δ log productivity coefficients	**0.76*** (0.17)**	**-0.60 (0.56)**	**0.72*** (0.21)**
F-test: is coefficient significantly different from 1?			
Test statistic	1.90	8.22**	1.71
Prob>F	0.17	0.01	0.20

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: the year is listed as the year of the dependent variables.

5. Robustness of baseline results

Alternate specifications

As a robustness check, we repeat these regressions in a number of other specifications:

- Excluding the unemployment control
- Including a time trend
- Including dummy variables for each decade
- Varying the moving average bandwidth/distributed lag length

We do this for the total economy using average compensation and production/nonsupervisory compensation since 1948 and median compensation since 1973, and for the nonfarm business sector using average compensation since 1948. Table 5 shows a summary of these results for the coefficient on the change in log productivity in the moving average regressions, and Table 6 shows a summary of these results for the cumulative dynamic multiplier of productivity growth on compensation growth in the distributed lag regressions (the sum of the estimated coefficients on current and lagged change in log productivity). We show the full regressions in the Appendix. In general we find our results relatively robust to these alterations.

Table 5: Moving average regressions: Coefficient on productivity, various specifications

Cumulative dynamic multiplier, Δ log productivity		Total economy							Nonfarm business		
		Average comp			Median c	Production/nonsupervisory comp			Average comp		
		1949-2015	1949-1973	1974-2015	1974-2015	1949-2015	1949-1973	1974-2015	1949-2015	1949-1973	1974-2015
(5a)	Initial regression (Tables 1 and 3)	0.98*** (0.08)	0.42* (0.24)	0.80*** (0.16)	0.86*** (0.181)	1.04*** (0.16)	0.61** (0.25)	0.60*** (0.19)	0.73*** (0.11)	0.10 (0.25)	0.65*** (0.18)
(5b)	Without unemployment	0.98*** (0.08)	0.32 (0.21)	0.79*** (0.16)	0.87*** (0.181)	1.02*** (0.119)	0.40* (0.21)	0.61*** (0.16)	0.73*** (0.10)	0.08 (0.25)	0.61*** (0.16)
(5c)	With time trend	0.74*** (0.16)	0.10 (0.24)	0.80*** (0.17)	0.87*** (0.19)	0.84*** (0.18)	0.28 (0.36)	0.58*** (0.14)	0.54*** (0.16)	-0.03 (0.16)	0.68*** (0.18)
(5d)	With decade dummy variables	0.57*** (0.16)	0.21 (0.20)	0.73*** (0.17)	0.83*** (0.20)	0.58*** (0.18)	0.43 (0.25)	0.52*** (0.11)	0.43** (0.16)	0.05 (0.14)	0.64*** (0.22)
(5e)	2-year moving average	0.87*** (0.08)	0.19 (0.19)	0.71*** (0.16)	0.80*** (0.17)	0.97*** (0.11)	0.37 (0.26)	0.61*** (0.16)	0.66*** (0.10)	0.08 (0.24)	0.60*** (0.18)
(5f)	4-year moving average	1.09*** (0.09)	0.48* (0.25)	0.86*** (0.15)	0.97*** (0.19)	1.15*** (0.15)	0.74** (0.30)	0.66*** (0.18)	0.81*** (0.12)	-0.16 (0.28)	0.65*** (0.17)
(5g)	5-year moving average	1.18*** (0.08)	0.53** (0.23)	0.93*** (0.13)	1.01*** (0.16)	1.25*** (0.17)	0.76*** (0.26)	0.67*** (0.17)	0.87*** (0.13)	-0.22 (0.33)	0.67*** (0.16)

Newey-West (HAC) standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Cells that are significantly different from one at the 5% level are highlighted in grey. All others are not significantly different from one at the 5% level. Underlying regressions are in Tables 1 and 3 and Appendix Tables 1A-1C and 5A-5C.

Table 6: Distributed lag regressions: Cumulative dynamic multipliers on productivity, various specifications

		Total economy							Nonfarm business		
		Average comp			Median comp	Production/nonsupervisory comp			Average comp		
	Cumulative dynamic multiplier, Δ log productivity	1951-2015	1951-1973	1974-2015	1974-2015	1951-2015	1951-1973	1974-2015	1951-2015	1951-1973	1974-2015
(6a)	Initial regression (Tables 2 and 4)	1.0*** (0.13)	-0.05 (0.34)	0.97*** (0.23)	0.89*** (0.27)	0.98*** (0.18)	-0.02 (0.35)	0.55* (0.28)	0.76*** (0.17)	-0.60 (0.56)	0.72*** (0.21)
(6b)	Without unemployment control	0.93*** (0.12)	0.05 (0.25)	0.72*** (0.24)	0.47 (0.30)	0.92*** (0.19)	0.17 (0.25)	0.43 (0.31)	0.69*** (0.15)	-0.11 (0.42)	0.57 (0.21)
(6c)	With time trend	0.86*** (0.18)	-0.36 (0.37)	0.96*** (0.24)	0.88*** (0.27)	0.80*** (0.27)	-0.43 (0.40)	0.50** (0.25)	0.58*** (0.18)	-0.66 (0.49)	0.73*** (0.22)
(6d)	With decade dummy variables	0.75*** (0.26)	-0.19 (0.31)	1.20*** (0.25)	1.2*** (0.36)	0.35 (0.25)	-0.23 (0.28)	0.41 (0.27)	0.56** (0.27)	-0.55 (0.52)	1.02*** (0.26)
(6e)	No lags of Δ log productivity	0.70*** (0.09)	0.31 (0.23)	0.62*** (0.16)	0.46** (0.19)	0.69*** (0.10)	0.21 (0.16)	0.53*** (0.16)	0.54*** (0.12)	0.14 (0.26)	0.55*** (0.17)
(6f)	1 lag of Δ log productivity	0.99*** (0.18)	0.16 (0.18)	0.99*** (0.18)	1.05*** (0.24)	0.93*** (0.16)	0.07 (0.26)	0.69** (0.29)	0.76*** (0.14)	-0.08 (0.33)	0.76*** (0.19)
(6g)	3 lags of Δ log productivity	1.12*** (0.18)	0.71** (0.27)	0.76*** (0.23)	0.68** (0.27)	1.08*** (0.25)	0.89 (0.51)	0.30 (0.29)	0.79*** (0.24)	0.28 (0.98)	0.57** (0.21)

Newey-West (HAC) standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Cells that are significantly different from one at the 5% level are highlighted in grey. All others are not significantly different from one at the 5% level.
Underlying regressions are in Tables 2 and 4 and Appendix Tables 2A-2C and 6A-6C.

As Tables 5 and 6 show, in the post-1973 period in most specifications there is a positive relationship between productivity growth and compensation growth which is significant at the one percent level. In almost all specifications for average and median compensation in this period, the coefficient on productivity growth exceeds 0.5 and in the majority of specifications the coefficient is close to and not significantly different from one. (Cells shaded grey have a coefficient that is significantly different from one at the 5% level). The coefficient estimates suggest overall that a one percentage point increase in the rate of productivity growth has been associated with between two thirds and one percentage point higher compensation growth for the median and average worker.

For production and non-supervisory worker compensation since 1973, the coefficients on productivity growth are slightly lower but still positive: they are consistently in the 0.4-0.7 range and often significantly different from both zero and one. This bears further investigation: average compensation growth trends for production and nonsupervisory workers do not appear to reflect productivity growth to the same extent as compensation for the median worker – in spite of the fact that in terms of levels, the two series are relatively similar throughout the postwar period[18].

Estimating only the contemporaneous relationship between productivity growth and compensation (6e), as expected, reduces the magnitude of the estimated effect of productivity growth on compensation growth: insufficient time may be allowed by this specification for firms to pass through productivity growth to workers' compensation. Whether including a two, three, four or five-year moving average (5e, 5a, 5f and 5g respectively), or using one, two or three lags of productivity growth however (6f, 6a and 6g respectively), does not make much difference to the estimated effect in most specifications.

Excluding the unemployment control (5b, 6b) reduces the magnitude of the estimated effect of productivity growth on compensation growth, although the estimates are mostly still not significantly different from one. The coefficient on median compensation is more strongly affected in the distributed lag regressions, which seems reasonable if average (mean) income is disproportionately affected by higher-income earners and large changes in the unemployment rate are more likely to be concentrated on middle- and lower-income groups.

Overall, the evidence is largely supportive of the hypothesis that for middle class workers, increases in productivity growth feed through substantially to increases in real compensation growth and therefore in standards of living.

Productivity mismeasurement?

There is debate over the extent to which the productivity statistics are mismeasured. Mismeasurement may occur, for example, if innovations in IT are under-measured, or if quality improvements or the introduction of new goods and services are hard to value. Feldstein (2017) and others have suggested that US productivity growth is underestimated; Aeppel (2015) and Hatzius (2015) have posited that this mismeasurement might explain the recent productivity slowdown, although Byrne, Fernald and Reinsdorf (2016) and Syverson (2017) find that it cannot.

[18] Champagne, Kurmann and Stewart (2015) address the divergence in US wage series from three different data sources: the LPC, the CES (from which Bivens and Mishel construct the compensation of production and nonsupervisory workers used in this paper), and the CPS (from which Bivens and Mishel construct the median compensation series used in this paper).

The degree of mismeasurement in the productivity statistics should not affect our conclusions. We are comparing real output per hour – labor productivity – to real compensation per hour. The labor productivity series are constructed by deflating nominal aggregate output by the appropriate implicit price deflator, and dividing by total hours worked. These implicit price deflators are constructed as an aggregate of sector- or product-specific producer and consumer price indexes from the BLS and BEA. The average real compensation series is constructed by deflating nominal aggregate compensation by the CPI, and dividing by total hours worked. We have no reason to believe that there is substantial mismeasurement in the nominal series: output and compensation. Since both series are divided by the same metric of hours worked, we also need not be concerned that mismeasurement in hours will affect our conclusions. The only major causes for concern with mismeasurement are the price deflators. But since we are investigating the relationship between changes in productivity and changes in real compensation, as long as the *relative* degree of mismeasurement in the price deflators for output and consumption has not changed, mismeasurement should not affect our conclusions[19]. Indeed to the extent that measurement error in the independent variable (productivity growth) results in attenuation bias, our estimated coefficients should be biased towards zero.

[19] This argument is stronger if we deflate the compensation series by the implicit price deflator for output. In that case, both the compensation and productivity series are deflated by the same price index and so the underlying relationship between the two should remain in spite of any mismeasurement. These regressions are presented in Appendix tables 3B and 4B: the cumulative dynamic multipliers on productivity remain mostly highly significant, close to one and not significantly different from one.

6. The rest of the income distribution

We have shown evidence that the compensation of the "typical" American worker – as defined by the average in the total economy and nonfarm business sector, and the median in the total economy – is strongly related to changes in productivity.

What about the rest of the income distribution? We are able to test the relationship between productivity and wages at each decile of the wage distribution using data from the Economic Policy Institute's *State of Working America Data Library*, constructed from CPS-ORG microdata. This data estimates hourly wages at each decile of the distribution rather than total hourly compensation, so is likely to understate compensation growth as benefits have grown faster than wages for much of the postwar period (as discussed in e.g. Feldstein 2008, Lawrence 2016).

We repeat our baseline regressions for each decile of the wage distribution below in tables 7 and 8 (moving average specification) and tables 9 and 10 (distributed lag specification). The evidence from both specifications shows that the wages of the workers at the 20th, 50th and 60th percentiles co-move significantly with productivity, with a coefficient relatively close to one. Evidence on the other deciles of the income distribution is less consistent across specifications: there is some weak evidence of co-movement of productivity with wages at the 10th, 30th and 40th percentiles, and less evidence of this co-movement for workers at the 70th percentile and above.

Table 7: Moving average regressions – total economy – 10th to 50th percentile wages

Dependent variables are the 3-year moving average of the Δ log wage	(1) 10th p. wage 1975-2014	(2) 20th p. wage 1975-2014	(3) 30th p. wage 1975-2014	(4) 40th p. wage 1975-2014	(5) Median wage 1975-2014
Δ log productivity, 3-year moving average	**0.61 (0.43)**	**0.93*** (0.28)**	**0.37 (0.33)**	**0.50** (0.23)**	**0.70*** (0.19)**
Δ unemployment (25-54), 3-year moving average	-0.61 (0.44)	-0.28 (0.30)	-0.20 (0.28)	-0.19 (0.30)	-0.25 (0.17)
Constant	-0.01 (0.01)	-0.01*** (0.00)	-0.01 (0.00)	-0.01*** (0.00)	-0.01*** (0.00)
Observations	40	40	40	40	40
Test statistic	0.81	0.06	3.58*	5.00**	2.40
Prob>F	0.37	0.80	0.07	0.03	0.13

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: the year is listed as the middle year of the moving average.

Table 8: Moving average regressions – total economy – 50th to 90th percentile wages

Dependent variables are the 3-year moving average of the Δ log wage	(1) 60th p. wage 1975-2014	(2) 70th p. wage 1975-2014	(3) 80th p. wage 1975-2014	(4) 90th p. wage 1975-2014	(5) 95th p. wage 1975-2014
Δ log productivity, 3-year moving average	**0.57*** (0.21)**	**0.38** (0.18)**	**0.42** (0.16)**	**0.46** (0.17)**	**0.37 (0.23)**
Δ unemployment (25-54), 3-year moving average	-0.10 (0.25)	-0.02 (0.26)	-0.04 (0.22)	-0.12 (0.21)	-0.31 (0.21)
Constant	-0.01** (0.00)	-0.00 (0.00)	-0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Observations	40	40	40	40	40
Test statistic	4.30**	11.2***	13.6***	9.73***	7.42***
Prob>F	0.05	0.00	0.00	0.00	0.01

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: the year is listed as the middle year of the moving average.

Table 9: Distributed lag regressions – total economy – 10th to 50th percentile wages

Dependent variables are all in Δ log form	(1a) 10th p. wage 1973-2015	(1b) 20th p. wage 1973-2015	(1c) 30th p. wage 1973-2015	(1d) 40th p. wage 1973-2015	(1e) Median wage 1973-2015
Δ log productivity	0.48	0.83***	0.30	0.35	0.56***
	(0.32)	(0.13)	(0.22)	(0.26)	(0.18)
Δ log productivity,	0.63**	0.66***	0.53***	0.44**	0.51***
1 year lag	(0.29)	(0.17)	(0.19)	(0.17)	(0.15)
Δ log productivity,	-0.19	-0.35**	-0.20	-0.27	-0.25
2 year lag	(0.25)	(0.17)	(0.19)	(0.22)	(0.16)
Δ unemployment (25-54)	-0.48	0.13	0.29*	0.17	0.37*
	(0.41)	(0.19)	(0.15)	(0.23)	(0.20)
Δ unemployment (25-54),	-0.08	-0.56*	-0.59***	-0.35	-0.44
1 year lag	(0.43)	(0.29)	(0.18)	(0.32)	(0.28)
Δ unemployment (25-54),	-1.30***	-0.89***	-0.88***	-0.71***	-0.61***
2 year lag	(0.32)	(0.24)	(0.21)	(0.22)	(0.15)
Constant	-0.01	-0.01***	-0.01	-0.01	-0.01**
	(0.01)	(0.00)	(0.01)	(0.00)	(0.00)
Observations	42	42	42	42	42
Sum of Δ log	**0.92**	**1.15*** **	**0.63**	**0.52**	**0.83*** **
productivity coefficients	**(0.63)**	**(0.33)**	**(0.45)**	**(0.34)**	**(0.25)**
F-test: is coefficient significantly different from 1?					
Test statistic	0.02	0.20	0.69	2.00	0.47
Prob>F	0.90	0.67	0.41	0.17	0.50

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: the year is listed as the year of the dependent variables.

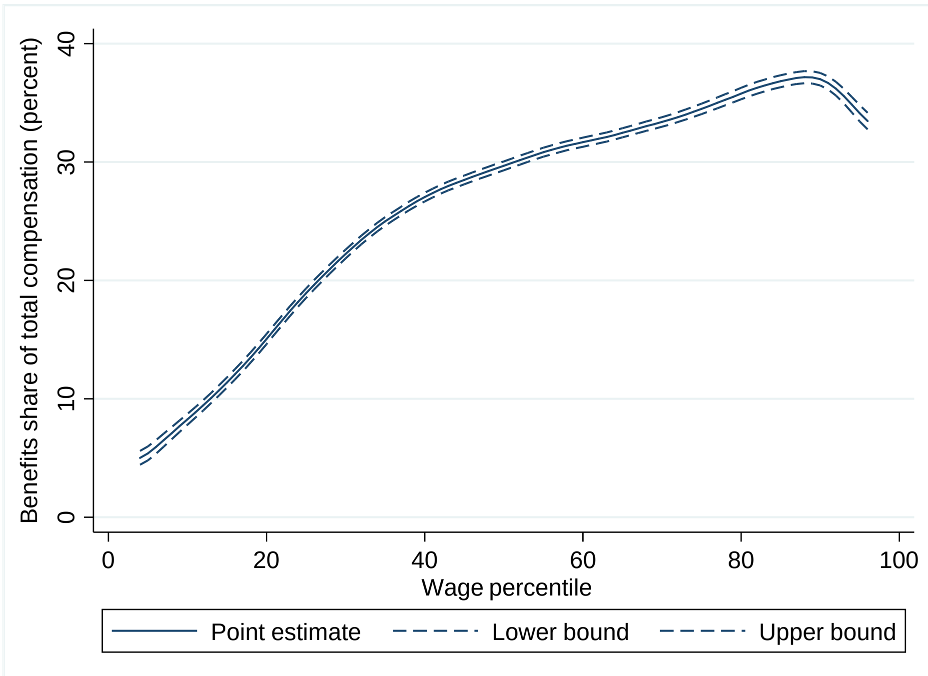
Table 10: Distributed lag regressions – total economy – 50th to 90th percentile wages

Dependent variables are all in Δ log form	(1a) 60th p. wage 1973-2015	(1b) 70th p. wage 1973-2015	(1c) 80th p. wage 1973-2015	(1d) 90th p. wage 1973-2015	(1e) 95th p. wage 1973-2015
Δ log productivity	0.55**	0.35	0.57***	0.29	0.50
	(0.24)	(0.24)	(0.14)	(0.29)	(0.30)
Δ log productivity, 1 year lag	0.36**	0.19	0.13	0.19	-0.42*
	(0.14)	(0.16)	(0.13)	(0.15)	(0.23)
Δ log productivity, 2 year lag	-0.19	-0.16	-0.42**	-0.14	-0.01
	(0.19)	(0.23)	(0.18)	(0.23)	(0.28)
Δ unemployment (25-54)	0.27	-0.01	0.49**	-0.08	0.15
	(0.27)	(0.33)	(0.19)	(0.34)	(0.28)
Δ unemployment (25-54), 1 year lag	-0.34	0.02	-0.95***	0.05	-0.87***
	(0.33)	(0.46)	(0.22)	(0.37)	(0.29)
Δ unemployment (25-54), 2 year lag	-0.59***	-0.57*	0.21	-0.49**	0.17
	(0.21)	(0.32)	(0.15)	(0.23)	(0.32)
Constant	-0.01**	-0.00	0.00	0.00	0.01
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)
Observations	42	42	42	42	42
Sum of Δ log productivity coefficients	**0.72*** (0.23)**	**0.38 (0.31)**	**0.27 (0.25)**	**0.34 (0.32)**	**0.07 (0.41)**
F-test: is coefficient significantly different from 1?					
Test statistic	1.52	4.10*	8.40***	4.16**	5.00**
Prob>F	0.23	0.05	0.01	0.05	0.03

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: the year is listed as the year of the dependent variables.

A significant caveat in interpreting these regressions is that these data are for wages not for total compensation. Non-wage benefits make up a vastly different share of total compensation for workers at different points of the income distribution, as demonstrated in figure 7.

Figure 7: Benefits share of total compensation by wage percentile, 2014



Data from Monaco and Pierce (2015), using Bureau of Labor Statistics National Compensation Survey

To the extent that non-wage compensation grew more quickly than wage compensation for much of the period we investigate, our data on wages at different percentiles underestimates total real compensation growth. If the growth in non-wage benefits is correlated with both the growth rate in wages and the growth rate of aggregate productivity, our coefficient estimates will be biased. This is very plausible: firms are more likely to increase non-wage benefits when they are increasing overall total compensation, and this may be more likely to occur during periods of high productivity growth. In this case, the coefficient estimates in our wage regressions above will be biased downwards. Evidence from the median worker supports this: the regressions of the median *wage* on productivity 0.70 and 0.83 for the moving average and distributed lag regressions respectively, compared to 0.86 and 0.89 for the regressions of median *compensation* on productivity. The coefficient estimates for the 40th and 60th percentiles may be similarly understated.

Evidence from the Bureau of Labor Statistics shows that the benefit share of compensation grew differently at different percentiles of the wage distribution over time, particularly at the tails, suggesting the possibility that our coefficient estimates may be biased differently for different parts of the wage distribution. The BLS calculates the total changes in the benefit share of compensation at different wage percentiles over 1987-1997, 1997-2007 and 2007-2014 (Pierce 2010, Monaco and Pierce 2015). During the 1990s and 2000s, those at the lower tail of the wage distribution saw much lower growth in non-wage compensation than those in the middle or higher tail. Since benefits grew faster for those higher in the income distribution, our estimates understate compensation growth *more* for high wage earners than for low wage earners. However while the tails of the distribution exhibit very different patterns of non-wage compensation growth relative to wage growth, the middle of the distribution generally appear to have received increases in non-wage compensation roughly proportionate to their increases in wage compensation.

This evidence leads us to suggest that for the *middle* of the wage distribution our regression results can be considered rough approximations for the relationship between total compensation and productivity, but likely with the coefficients slightly underestimated. For these workers – particularly for those at the 50th and 60th percentiles of the wage distribution – the evidence suggests a strong and positive link between productivity growth and wages, of between 0.57 and 0.83 percentage points increase in wage growth for every percentage point rise in productivity growth. In addition, the weak estimated relationship between productivity and wages for higher percentiles of the wage distribution provides little evidence to support the notion that productivity growth has disproportionately benefited the rich (and not the middle class).

7. Other countries

In the cross-section, the relationship across countries between average labor productivity and average compensation appears extremely strong: Lawrence (2016) finds that of 32 countries, the relationship between average labor productivity and average compensation in manufacturing is close to one-for-one. At the same time, median compensation has diverged from average productivity in most OECD countries over the last two decades (Schwellnus, Kappeler and Pionnier 2017, International Labor Organization 2015). While most countries have experienced some rise in mean-median income inequality and some fall in the labor share, the proportion of the median compensation-productivity divergence that each of these two trends explain, and the timing and magnitude of the trends, are very different across countries[20] (Sharpe and Uggucioni 2017). The mechanism which translates productivity growth into average compensation is likely to be specific to each country's labor market and institutional context. Nonetheless in any market-based economy over the medium term the "linkage" hypothesis would suggest that productivity and average compensation should move together.

We present results for our baseline moving average and distributed lag regressions for major advanced economies[21] in tables 11 and 12, focusing only on the relationship between productivity and average compensation due to an absence of comparable median hourly compensation data for all countries. These regressions show a mixed picture. The relationship between average compensation and productivity in Canada, France, West Germany (pre-reunification), and the USA appears to fit the "linkage" hypothesis: coefficients on the change in log of productivity are strongly significant, close to one and not significantly different from one in both the moving average specifications and the distributed lag specifications. Italy and Japan have positive but variable coefficients with large standard errors. The only country which shows no relationship is Germany post-reunification.

[20] Sharpe and Uggucioni (2017) and Schwellnus et al (2017) provide more details of this breakdown for OECD countries. For more international evidence on the labor share decline, see e.g. Cho, Hwang and Schreyer 2017, Karabarbounis and Neiman 2014, Azmat, Manning and Van Reenen 2011, Blanchard and Giavazzi 2003, Bentolila and Saint-Paul 2003.

[21] We use the G7 but exclude the United Kingdom because of a lack of comparable hourly compensation and productivity data.

Table 11: Moving average regressions – major advanced economies – average compensation and productivity

Dependent variables are the 3-year moving average of the Δ log compensation	(11a) Canada 1972-2015	(11b) France 1972-2015	(11c) West Germany 1972-1990	(11d) Germany 1993-2015	(11e) Italy 1985-2015	(11f) Japan 1997-2014	(11g) USA 1950-2015
Δ log productivity, 3-year moving average	**1.07******	**0.90******	**1.06******	**0.01**	**0.34**	**0.42**	**0.98******
	(0.37)	**(0.19)**	**(0.29)**	**(0.39)**	**(0.28)**	**(0.34)**	**(0.08)**
Δ unemployment (25-54), 3-year moving average	-0.08	0.16	-0.94*	0.25	-0.70*	-0.28	0.03
	(0.26)	(0.46)	(0.46)	(0.52)	(0.37)	(0.79)	(0.16)
Constant	-0.00	-0.00	-0.00	0.01	0.00**	-0.00	-0.00
	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)
Observations	44	44	19	23	31	21	65
F-test: is coefficient significantly different from 1?							
Test statistic	0.04	0.29	0.05	6.54**	5.66**	2.09	0.08
Prob>F	0.85	0.59	0.83	0.02	0.02	0.17	0.78

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: the year is listed as the middle year of the moving average.

Table 12: Distributed lag regressions – major advanced economies – average compensation and productivity

Dependent variables are all in Δ log form	(12a) Canada 1973-2016	(12b) France 1973-2016	(12c) West Germany 1973-1991	(12d) Germany 1994-2016	(12e) Italy 1986-2016	(12f) Japan 1996-2015	(12g) USA 1951-2015
Δ log productivity	1.08***	0.72***	0.04	-0.33*	0.16	-0.05	0.77***
	(0.30)	(0.21)	(0.39)	(0.19)	(0.23)	(0.94)	(0.15)
Δ log productivity, 1 year lag	-0.06	0.33*	0.64	-0.14	-0.27	1.01	0.22**
	(0.15)	(0.18)	(0.50)	(0.20)	(0.24)	(0.69)	(0.11)
Δ log productivity, 2 year lag	-0.16	-0.16	0.32	0.07	0.56***	-0.31	0.05
	(0.24)	(0.19)	(0.40)	(0.23)	(0.15)	(0.74)	(0.11)
Δ unemployment (25-54)	0.07	0.82**	-0.30	0.75	-0.97***	-2.83	0.27**
	(0.22)	(0.38)	(0.83)	(0.59)	(0.32)	(4.11)	(0.12)
Δ unemployment (25-54), 1 year lag	-0.50**	-0.40	-0.65	-1.05**	0.82**	2.80	-0.36***
	(0.21)	(0.33)	(0.82)	(0.49)	(0.40)	(4.83)	(0.13)
Δ unemployment (25-54), 2 year lag	-0.47***	-0.72***	0.20	0.32	-0.50	-1.74	-0.21
	(0.17)	(0.24)	(0.42)	(0.79)	(0.31)	(1.98)	(0.17)
Constant	0.00	-0.00	-0.00	0.01	0.00	-0.01	-0.00
	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.00)
Observations	44	44	19	23	31	20	65
Sum of Δ log productivity coefficients	**0.85****	**0.89*****	**1.00****	**-0.41**	**0.45**	**0.65**	**1.04*****
	(0.41)	**(0.16)**	**(0.40)**	**(0.45)**	**(0.33)**	**(0.77)**	**(0.13)**
F-test: is coefficient significantly different from 1?							
Test statistic	0.13	0.52	0.00	9.81***	2.80	0.20	0.09
Prob>F	0.72	0.47	0.99	0.01	0.11	0.66	0.76

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: the year is listed as the year of the dependent variables.

A closer look at the German data suggests a speculative explanation for the apparent zero/negative relationship between compensation and productivity since reunification. Through most of the 2000s, German real average compensation fell even as labor productivity rose. At the same time, the unemployment rate fell and labor force participation rate rose significantly. The explicit adoption of wage moderation policies by government, employers and unions in the early 2000s, alongside the far-reaching Hartz-IV welfare reforms, could well explain this pattern if productivity increases translated into higher employment rather than higher wages. In addition, the German data shows a sharp negative correlation between hourly compensation growth and hourly productivity growth during the Great Recession. This could be attributable to the

Kurzarbeit policy, where firms were incentivized during the recession to keep on workers, whose pay was subsidized by the government.

The lack of significant relationship between compensation and productivity in the Italian data is driven mechanically by the opposite movement of compensation and productivity in the years 1993-1995. A distributed lag regression excluding these years has a strongly significant coefficient on the cumulative change in log of productivity of around 0.7. The Italian economy was hit by a series of shocks in these years: a recession in 1992, the lira leaving the European Exchange Rate Mechanism in September 1992, and the Tripartite agreement decentralizing wage bargaining in July 1993. Once again, it is possible that these macro shocks and policy changes could explain the apparent lack of relationship between compensation and productivity in Italy over recent years.

Overall, the results for the major advanced economies provide only qualified support for the "linkage" hypothesis, with Canada, France, West Germany and the US apparently conforming to the hypothesis, Japan and Italy less clearly conforming, and post-reunification Germany not conforming.

8. Technological change and the productivity-compensation divergence

As discussed in section 2, three separate divergences have created today's gap between average labor productivity and median compensation (Bivens and Mishel 2015): the divergence between median and mean compensation (one aspect of rising labor income inequality), the divergence between mean compensation and productivity (equivalent to a fall in the labor share), and the divergence between consumption and product price deflators.

Several prominent theories focus on technological change to explain the two inequality-related components of the productivity-compensation divergence: the falling labor share, and rising top-half labor income inequality.

Falling labor share (productivity/mean compensation divergence):

The growing "wedge" between labor productivity and mean compensation is equivalent to a falling labor share of income:

$$\%\Delta\frac{Labor\ productivity}{Mean\ compensation} = \%\Delta\left(\frac{real\ output}{hours\ worked}\Big/\frac{total\ real\ compensation}{hours\ worked}\right) = \%\Delta\frac{1}{labor\ share}$$

Karabarbounis and Neiman (2014) argue that the labor share has fallen in the US and around the world as a result of a fall in the price of investment goods. This, combined with an elasticity of substitution between labor and capital greater than one, would cause capital deepening and a fall in the labor share[22]. Acemoglu and Restrepo (2016) and Brynolfsson and McAfee (2014) have argued that capital-augmenting technological change – enabling the mechanization and automation of production – may be responsible for the decline in the labor share; assumptions about economic structure and the endogeneity of technological progress then determine whether this fall in the labor share is temporary or permanent. The IMF World Economic Outlook (2017) attributes about half the fall in the labor share in advanced economies to technological progress, with the fall in the price of investment goods and advances in ICT encouraging automation of routine tasks.

[22] This possibility was raised by Jones (2003), who argued that differences between the short- and long-run elasticities of substitution between capital and labor could explain trends in the labor share and relative price of investment goods.

Lawrence (2015) has a contrasting technology-based explanation: that the falling labor share is a result of rapid labor-augmenting technological change which has led to a fall in the effective capital-labor ratio. This, combined with an elasticity of substitution between labor and capital less than one, would cause a fall in the labor share.

On the other hand, many authors argue that technological change is not the primary driver of the decline in the labor share – or not a driver at all (e.g. Mishel and Bivens 2017). Non-technology focused theories of the decline in the labor share include the effect of offshoring of labor-intensive production tasks (Elsby, Hobijn and Sahin 2013), capital accumulation (Piketty 2014, Piketty and Zucman 2014), reductions of worker bargaining power as a result of changing labor market institutions (e.g. Levy and Temin 2007, Solow 2015, Mishel and Bivens 2015, OECD 2012, Bental and Demougin 2010), industrial structure explanations including increased firm concentration in "winner-take-most" markets (Autor et al 2017) and increased markups (Barkai 2017), and dynamics in the housing market (Rognlie 2015).

Rising top-half labor income inequality (mean/median compensation divergence):
Since labor income inequality has increased along various dimensions at different times over the last fifty years, it has many competing and complementary explanations. At a broad-brush level, the US income distribution widened monotonically through the 1970s and 1980s, then began to polarize from the 1990s onwards with the 50-10 ratio stable while the 95-50 wage ratio increased steadily. In addition, the top 1% income share has increased rapidly since around 1980[23]. The aspects of labor income inequality relevant to the mean/median compensation divergence are only those affecting top half of the income distribution: trends which have increased mean compensation relative to the median by increasing the amount of income top-half workers receive.

Pure technology-based explanations of rising labor income inequality focus on changes in the pace or nature of technological change. Examples of these are capital-skill complementarity (Griliches 1969, Krusell et al 2000), computerization increasing the pace of skill upgrading (e.g. Autor, Katz and Krueger 1998), routine-biased technological change altering task demand and

[23] See, for example, Goldin and Katz (2007), Lemieux (2008), Autor, Katz and Kearney (2008) and Atkinson, Piketty and Saez (2011) for descriptions of these trends.

contributing to the "hollowing out" of middle-skill jobs (e.g. Autor 2010), and automation and the use of robots (e.g. Acemoglu and Restrepo 2017).

In contrast, Goldin and Katz (2007) argue that rising labor income inequality in the late twentieth century was not caused by technology alone: rather, against a roughly constant pace of skill-biased technological change, the rate of increase in the number of Americans getting high school and college degrees slowed, leading to rising education premia and rising income inequality as a result.

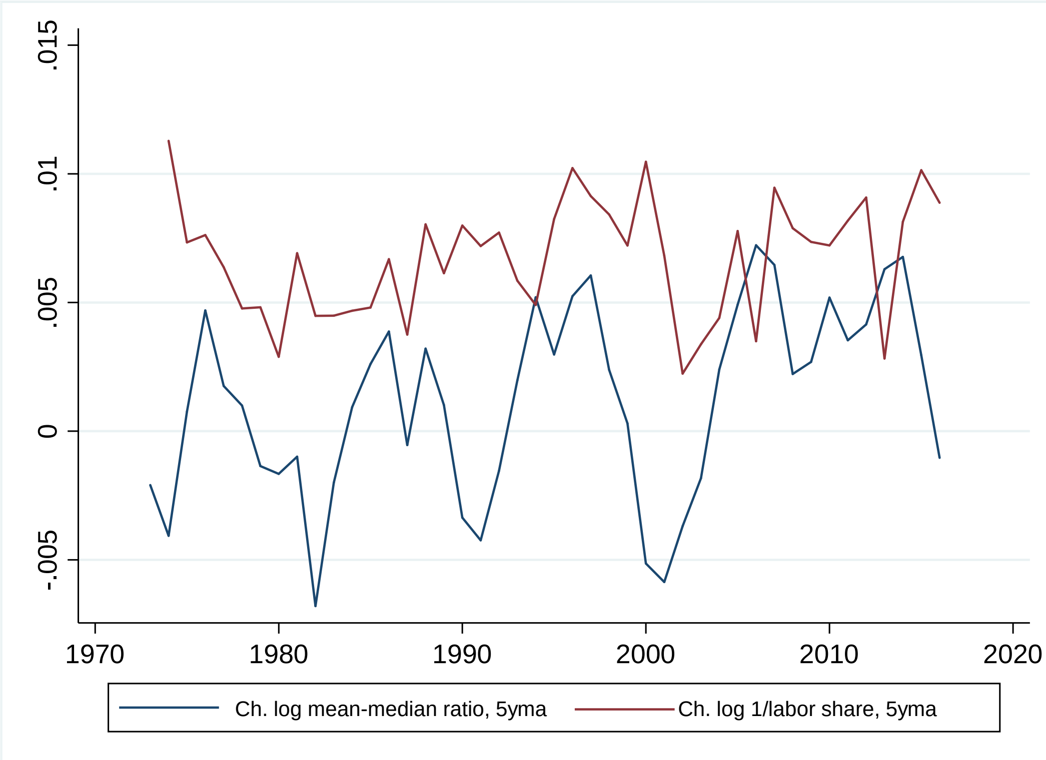
Non-technological explanations of rising top-half labor income inequality include declining unionization (e.g. Freeman et al 2016, Rosenfeld et al 2016[24]), lower top marginal tax rates (Piketty et al 2014), globalization, including rising trade with China and other low-cost manufacturing hubs (e.g. Autor et al 2013), increased low-skill immigration (e.g. Borjas 2003), and the "superstar" effect as globalization or technological change increase market size and returns to being the best (e.g. Rosen 1981, Gabaix et al 2016, Jones and Kim forthcoming).

Co-movement between the labor share and mean-median compensation ratio

It is interesting to note that periods of fast growth in mean-median inequality do *not* on the whole coincide with periods of fast decline in the labor share. The correlation coefficient between the annual change in the log of the mean-median income ratio and the labor share is 0.06 and is not significant at any level. As shown in figure 8 below, which shows the 5-year backward-looking moving averages of the change in log of the mean-median compensation ratio and the productivity-mean compensation ratio (the inverse of the labor share: a direct measure of capital-labor inequality), the only period where both types of inequality were clearly moving in the same direction was the late 1990s and early 2000s. This would weigh against the hypothesis that a single factor is causing both trends.

[24] In earlier work, Freeman (1993) and DiNardo, Fortin and Lemieux (1996) among others argue that the decline in unionization significantly increased labor income inequality during the 1980s/1990s.

Figure 8: 5-year moving averages of changes in log mean-median ratio and 1/labor share



Implications of technology-based theories of rising inequality

In general, any pure technology-based theory of the falling labor share or rising top-half wage inequality has a testable implication. If the fall in the labor share has been caused by technological change, we should expect the labor share to fall more quickly in periods where labor productivity growth is more rapid, under the natural assumption that the technological change in question also increases labor productivity. Similarly if the rise in the mean/median compensation ratio has been caused by technological change, we should expect that ratio to rise faster in periods of faster labor productivity growth.

Over a medium-term horizon, the opposite has occurred in the US (Table 13). During the productivity boom of 1996-2003, the labor share actually rose, and the mean/median compensation ratio increased less quickly than in the periods of slower productivity growth before and afterwards. Indeed the period over which the labor share has fallen most in recent decades has been a period of productivity slowdown.

Table 13: average annual productivity growth and changes in inequality

	Average annual productivity growth	**Annual percentage change in labor share**	**Annual change in mean/median ratio**
1948-1973	2.74%	-0.007%	.
1973-1996	1.17%	-0.08%	0.70%
1996-2003	2.25%	0.16%	0.21%
2003-2015	1.05%	-0.28%	0.84%

Data from FRED

In work close to this, Mishel and Bivens (2017) marshal a variety of evidence to suggest that the pure technology-based theories for rising US income inequality are weak. They argue that a number of indicators of the pace of automation – productivity growth, capital investment, and IT and software investment – increased rapidly in the late 1990s and early 2000s, a period which saw "the best across-the-board wage growth for American workers in a generation", while in periods of rapidly widening inequality from 1973-1995 and 2005-present these indicators increased more slowly. They show in addition that occupational employment polarization has not occurred during the 2000s (Autor 2014) and that occupational employment shifts have been less rapid during the 2000s than during any decade in the 1900s (Atkinson and Wu 2017) – both of which facts point to a slowing rate of the effect of automation on employment.

While this suggests that periods of more rapid technological change do not correspond to periods of more rapidly rising inequality, it may be the case that these medium-term correlations mask the true underlying relationship. Short-term fluctuations in productivity growth provide us a simple natural quasi-experiment to test the implications of pure technology-based theories of rising income inequality: when productivity growth is faster, the labor share should fall faster, and the mean/median compensation ratio should increase faster.

We run the following regressions (using both moving average and distributed lag specifications):

$$\frac{1}{3}\sum_0^2 \Delta \log labor\ share_{t-i} = \alpha + \beta\ \frac{1}{3}\sum_0^2 \Delta \log prod_{t-i} + \gamma \frac{1}{3}\sum_0^2 \Delta unemp_{t-i} + \varepsilon_t \quad (4)$$

$$\Delta \log labor\ share_t = \alpha + \sum_0^2 \beta_i \Delta \log prod_{t-i} + \sum_0^1 \gamma_i\ \Delta unemp_{t-i} + \varepsilon_t \quad (5)$$

$$\frac{1}{3}\sum_0^2 \Delta \log \frac{mean}{median} compensation_{t-i} = \alpha + \beta\ \frac{1}{3}\sum_0^2 \Delta \log prod_{t-i} + \gamma \frac{1}{3}\sum_0^2 \Delta unemp_{t-i} + \varepsilon_t \quad (6)$$

$$\Delta \log \frac{mean}{median} compensation_t = \alpha + \sum_0^2 \beta_i \Delta \log prod_{t-i} + \sum_0^1 \gamma_i \, \Delta unemp_{t-i} + \varepsilon_t \qquad (7)$$

If pure technology-based theories of rising inequality are correct, we should expect to see a negative and significant coefficient on the change in log of productivity in the labor share regressions and a positive and significant coefficient the change in log of productivity in the mean/median compensation regressions.

In addition, particular technology-based theories lend themselves to particular testable implications. Karabarbounis and Neiman (2014) argue that the labor share has fallen because as the relative price of investment goods has fallen, firms have substituted capital for labor (under the assumption of an elasticity of substitution between labor and capital greater than one). Under the same logic as above, this should imply that in periods where the relative price of investment goods falls more quickly, the labor share should fall faster. We run the following regressions to test this:

$$\frac{1}{3}\sum_0^2 \Delta \log labor\ share_{t-i} = \alpha + \beta \ \frac{1}{3}\sum_0^2 \Delta \log rel\ price\ inv\ goods_{t-i} + \gamma \frac{1}{3}\sum_0^2 \Delta unemp_{t-i} + \varepsilon_t \ (8)$$

$$\Delta \log labor\ share_t = \alpha + \sum_0^2 \beta_i \Delta \log rel\ price\ inv\ goods_{t-i} + \sum_0^1 \gamma_i \, \Delta unemp_{t-i} + \varepsilon_t \qquad (9)$$

Measurement of the labor share

We use the Penn World Tables measure of the labor share, which covers labor compensation for the total US economy as a share of Gross Domestic Product. As raised by Johnson (1954), Kravis (1959) and others, the imputation of the income of self-employed proprietors to labor or capital matters for the level and changes in the labor share. Gollin (2002) discusses a variety of approaches to the imputation of mixed income: imputing all mixed income to labor, imputing based on the average labor share in the rest of the economy, or calculating the labor share based on the assumption that the average self-employed person earns the same compensation as the average employee[25]. Our preferred measure of the labor share is Gollin's second measure, which imputes mixed income of the self-employed to labor according to the average labor share in the

[25] Kravis (1959) introduces a similar set of approaches: the "labor basis" approach which assumes that self-employed proprietors earn the same labor income as employees do, the "all to labor" approach which assumes that all income of self-employed proprietors is labor income, the "asset basis" approach which assumes that the return on self-employed proprietors' capital is the same as in the rest of the economy, and the "economy-wide basis" approach which assumes that the labor share in the self-employed sector is the same as in the overall economy.

rest of the US economy. This is the measure chosen by the Penn World Tables and appears to be the most plausible measure for the US, based on the occupational demographics of the self-employed (Feenstra, Inklaar and Timmer 2015, Elsby, Hobijn and Sahin 2013). Our approach to proprietors' income is consistent with much of the literature on the labor share[26]. However others including the BLS use different approaches[27], and so for robustness, we also present our results in the Appendix with the BLS measures of the labor share for the total economy and the nonfarm business sector. The BLS imputes the compensation of proprietors based on the assumption that compensation per hour of proprietors is the same as that of the average employee in each sector (BLS 2008, Giandrea and Sprague 2017).

Productivity and the labor share: results

Tables 14 and 15 show our baseline specifications of a 3-year moving average (14) and a 3-year distributed lag (15). Tables 16 and 17 show the coefficient estimates on productivity in regressions with varying moving average bandwidths (16) or distributed lag lengths (17).

The majority of specifications show a negative relationship between changes in productivity growth and changes in the labor share, as would be predicted by technology-based theories of the labor share decline. The contemporaneous coefficient estimate of productivity growth on the labor share is significant in some of the specifications. When using a 3-, 4- or 5-year moving average, or 1, 2 or 3 lags of productivity growth, the coefficients tend to become smaller and insignificant at the 10% level for the post-1973 period (the period in which the labor share declined). It seems more likely that the regressions with some moving average or lag of productivity growth are a better estimate of the effect of technological progress on the labor

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[26] This approach is followed by Elsby et al (2013), who argue strongly against a wage-based approach and instead favor a labor share imputation or the Kravis "asset basis" approach. Some other recent examples using this approach include Koh et al (2016), Valentinyi and Herrendorf (2008), Caselli and Feyrer (2007), Gomme and Rupert (2004). Rognlie (2015) and Piketty and Zucman (2014) follow a very similar method, assuming that the noncorporate sector (excluding housing) has the same net capital share as the corporate sector. Krueger (1999) describes a common convention since Johnson (1954) to impute 2/3 of mixed income to labor, which approximates the US economy-wide labor share: this has been used by Christensen (1971), Abel et al (1989) and Geerolf (2013) among others.

[27] Bentolila and Saint-Paul (2003) use a wage-based imputation. Bridgman (2014) and Karabarbounis and Neiman (2014) only investigate the corporate labor share, which avoids the need to impute the income of self-employed proprietors to either labor or capital.

share than the purely contemporaneous regressions, given that it is likely to take firms some time to adjust their compensation practices after an (unanticipated) improvement in technology[28].

The magnitude of the estimated coefficients is between -0.16 and 0.06 when incorporating at least one lag/2-year moving average bandwidth, implying that a one percentage point increase in the rate of productivity growth is associated with between a 0.16% fall and a 0.06% rise in the labor share. The labor share began to fall significantly in the early 2000s, falling by a total of 4.5 percentage points or by 6.5% over 2001-2014 (an annual rate of 0.49% per year). Since the average annual rate of labor productivity growth over 2001-2014 was 1.3%, the most negative coefficient estimate – even if interpreted as statistically significant, which it is not – would not go far to explain the fall in the labor share over this period.

Since the imputation method for self-employed proprietors' income affects the change in the labor share over some parts of our time period, we present the 3-year moving average and 2-lag distributed lag regressions using the BLS labor share measure for the total economy in Appendix Tables 9A and 9B and for the nonfarm business sector in Appendix Tables 10A and 10B. The post-1973 coefficient estimates in the moving average regressions are -0.22 and -0.21 for the total economy and nonfarm business sector respectively, and -0.08 and -0.11 for the distributed lag regressions. None of them are statistically significant even at the ten percent level. These magnitudes are slightly larger in absolute terms than those of the regressions with our preferred labor share measure, but the difference is not so large as to substantially alter our conclusions.[29]

Overall the general tendency from these regressions does not provide strong support for pure-technology based theories as being the most important driver of the recent decline in the US labor share.

[28] Indeed, you would mechanically expect a significant negative coefficient on contemporaneous productivity growth, as a positive unanticipated productivity shock would translate into higher firm income in the current year, but would be unlikely to feed through to worker compensation until the next year when compensation is re-set – resulting in a temporary fall in the labor share in years where productivity growth is unexpectedly high.

[29] Bridgman (2014) shows that the use of gross rather than net labor shares can have a significant impact on calculations of the US labor share decline. Calculating the labor share using Net Domestic Product rather than Gross Domestic Product does not significantly alter the outcomes of our regressions.

Table 14: Moving average regressions – productivity and the labor share

Dependent variable: 3-year moving average of Δ log labor share	(13a) 1950-2013	(13b) 1950-2013	(13c) 1950-1973	(13d) 1950-1973	(13e) 1975-2013	(13f) 1975-2013
Δ log productivity, 3-year moving average	**0.05**	**0.02**	**-0.13**	**-0.25**	**-0.09**	**-0.07**
	(0.11)	**(0.10)**	**(0.32)**	**(0.31)**	**(0.20)**	**(0.21)**
Δ unemployment (25-54), 3-year moving average		-0.37***		-0.43**		-0.37***
		(0.09)		(0.18)		(0.11)
Constant	-0.00	-0.00	0.0	0.01	-0.00	-0.00
	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)
Observations	65	65	24	24	40	40

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: the year is listed as the middle year of the moving average.

Table 15: Distributed lag regressions – productivity and the labor share

Dependent variable: Δ log labor share	(14a) 1951-2014	(14b) 1951-2014	(14c) 1951-1973	(14d) 1951-1973	(14e) 1974-2014	(14f) 1974-2014
Δ log productivity	-0.35***	-0.17	-0.79***	-0.67***	-0.24	-0.10
	(0.11)	(0.137)	(0.08)	(0.110	(0.15)	(0.20)
Δ log productivity, 1 year lag	0.25***	0.18**	0.19***	-0.06	0.23	0.23*
	(0.07)	(0.08)	(0.07)	(0.10)	(0.14)	(0.13)
Δ log productivity, 2 year lag	0.15*	-0.00	0.25***	0.01	0.05	-0.08
	(0.08)	(0.09)	(0.07)	(0.11)	(0.12)	(0.14)
Δ unemployment (25-54)		-0.14		-0.43**		-0.16
		(0.11)		(0.18)		(0.16)
Δ unemployment (25-54), 1 year lag		-0.42***		-0.53***		-0.33*
		(0.14)		(0.18)		(0.17)
Δ unemployment (25-54), 2 year lag		-0.05		-0.04		-0.17
		(0.12)		(0.06)		(0.17)
Constant	-0.00	-0.00	0.1*	0.02***	-0.00	-0.00
	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)
Observations	64	64	23	23	41	41
Sum of productivity coefficients	**0.05**	**0.00**	**-0.34****	**-0.71*****	**0.03**	**0.05**
	(0.01)	**(0.10)**	**(0.16)**	**(0.19)**	**(0.29)**	**(0.29)**

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: the year is listed as the year of the dependent variables.

Table 16: Moving average regressions with varying bandwidths– productivity and the labor share

Dependent variable: X-year moving average of Δ log labor share	1950-2014	1950-1973	1975-2014
2-year moving average	-0.09	-0.54*	-0.16
	(0.09)	(0.27)	(0.18)
3-year moving average	0.02	-0.25	-0.07
	(0.10)	(0.31)	(0.21)
4-year moving average	0.07	-0.14	-0.04
	(0.10)	(0.44)	(0.19)
5-year moving average	0.07	-0.23	0.04
	(0.09)	(0.40)	(0.17)

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Independent variable is X-year moving average of change in log productivity.
Regressions include unemployment control.
Underlying regressions are in Table 13 and Appendix Tables 7A-7C.

Table 17: Distributed lag regressions with varying lag lengths – productivity and the labor share

Dependent variable: Δ log labor share	1950-2014	1950-1973	1975-2014
No lags	-0.29***	-0.90***	-0.26
	(0.10)	(0.08)	(0.16)
One lag	-0.00	-0.72***	0.06
	(0.10)	(0.14)	(0.25)
Two lags	0.00	-0.71***	0.05
	(0.10)	(0.19)	(0.29)
Three lags	-0.05	-0.77***	-0.14
	(0.12)	(0.24)	(0.29)

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Independent variables are current and lagged change in log productivity.
Coefficient listed is the cumulative dynamic multiplier on all the productivity variables.
Regressions include unemployment control.
Underlying regressions are in Table 14 and Appendix Tables 8A-8C.

Falling relative price of investment goods and the labor share: results

As discussed above, one of the dominant technological theories of the decline in the labor share relates to the falling relative price of investment goods (Karabarbounis and Neiman 2014). If the falling relative price of investment goods is driving the decline in the labor share as firms substitute capital for labor, one should expect to see periods of faster decline in the relative price of investment goods coinciding with periods of faster decline in the labor share. As shown in tables 18 and 19, there is no significant relationship between the percentage change in the labor share and the percentage change in the relative price of investment goods in a moving average or distributed lag specification. Moreover the coefficient estimates are negative, implying that a fall in the relative price of investment goods is actually associated with a rise in the labor share, although not statistically significantly. This also holds when repeating these regressions for the BLS measures of the labor share for the total economy and nonfarm business sector, shown in Appendix Tables 11A, 11B, 12A and 12B.

Table 18: Moving average regressions – relative price of investment goods and the labor share

Dependent variable: 3-year moving average of Δ log labor share	(15a) 1950-2014	(15b) 1950-2014	(15c) 1975-2014	(15d) 1975-2014
Δ log relative price investment goods, 3-year moving average	**-0.03** **(0.13)**	**-0.01** **(0.12)**	**-0.23** **(0.14)**	**-0.22** **(0.15)**
Δ unemployment (25-54), 3-year moving average		-0.37*** (0.10)		-0.37*** (0.10)
Constant	-0.00 (0.00)	-0.00 (0.00)	-0.00** (0.00)	-0.01** (0.00)
Observations	65	65	40	40

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: the year is listed as the middle year of the moving average.

Table 19: Distributed lag regressions – relative price of investment goods and the labor share

Dependent variable: change in log labor share	(16a) 1951-2015	(16b) 1951-2015	(16c) 1974-2015	(16d) 1974-2015
Δ log rel price of investment goods	-0.07 (0.11)	-0.11 (0.08)	-0.21** (0.09)	-0.24*** (0.08)
Δ log rel price of investment goods, 1 year lag	0.06 (0.07)	0.14*** (0.05)	-0.00 (0.06)	0.13 (0.08)
Δ log rel price of investment goods, 2 year lag	-0.06 (0.08)	-0.11* (0.07)	-0.06 (0.11)	-0.16 (0.11)
Δ unemployment (25-54)		-0.08 (0.09)		0.01 (0.19)
Δ unemployment (25-54), 1 year lag		-0.63*** (0.09)		-0.60*** (0.17)
Δ unemployment (25-54), 2 year lag		0.15 (0.09)		0.09 (0.17)
Constant	-0.00 (0.00)	-0.00 (0.00)	-0.01*** (0.00)	-0.01*** (0.00)
Observations	64	64	41	41
Sum of rel. price inv. goods coefficients	**-0.07** **(0.15)**	**-0.08** **(0.11)**	**-0.27*** **(0.16)**	**-0.27*** **(0.14)**

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: the year is listed as the year of the dependent variables.

Productivity and the mean/median ratio: results

Tables 20 and 21 show that there is no significant relationship between productivity growth and changes in the mean/median compensation ratio. The coefficient estimates are positive in the distributed lag specifications, as would be predicted by technological theories of rising top-half income inequality, but are negative in the moving average specifications.

In addition, the magnitude of the coefficients is very small relative to the overall trend. Mean and median compensation began to diverge in the early 1970s as part of a broader increase in labor income inequality. The mean/median compensation ratio rose at an average of 0.66% per year over 1973-2015. Taking the coefficient estimates from (21b), a one percentage point increase in the productivity growth rate is associated with a 0.09% increase in the mean/median compensation ratio. Since labor productivity growth over 1973-2015 was an average of 1.33% per year, even if taking this coefficient estimate to be statistically significant, we could explain only a small proportion of the divergence between mean and median compensation.

Table 20: Moving average regressions – productivity and the mean-median compensation ratio

Dependent variable: 3-year moving average of Δ log labor share	(20a) 1975-2014	(20b) 1975-2014
Δ log productivity, 3-year moving average	**-0.07 (0.07)**	**-0.06 (0.08)**
Δ unemployment (25-54), 3-year moving average		-0.16 (0.11)
Constant	0.01*** (0.00)	0.01*** (0.00)
Observations	40	40

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: the year is listed as the middle year of the moving average.

Table 21: Distributed lag regressions – productivity and the mean-median compensation ratio

Dependent variable: change in log mean/median compensation ratio	(21a) 1974-2015	(21b) 1974-2015
Δ log productivity	0.15* (0.09)	0.05 (0.11)
Δ log productivity, 1 year lag	-0.10 (0.12)	-0.21 (0.14)
Δ log productivity, 2 year lag	0.19* (0.10)	0.25* (0.13)
Δ unemployment (25-54)		-0.39*** (0.12)
Δ unemployment (25-54), 1 year lag		0.21 (0.17)
Δ unemployment (25-54), 2 year lag		0.05 (0.13)
Constant	0.00 (0.00)	0.01** (0.00)
Observations	42	42
Sum of productivity coefficients	**0.25** **(0.17)**	**0.09** **(0.17)**

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: the year is listed as the year of the dependent variables.

Overall, therefore, there does not appear to be a strong short-term or medium-term relationship between measures of technological progress and changes in the labor share or changes in the mean-median compensation ratio.

9. Implications

Over the last four decades in the US, average compensation growth has been slow and median compensation almost stagnant. Real compensation per hour for the average worker rose by 47% between 1973 and 2015, or at an annual growth rate of only 0.9% per year. Real median compensation per hour rose only 12% in total between 1973 and 2015. During the same period hourly labor productivity rose by 73% or 1.3% per year.

In contrast, over the period 1948-1973, average pay for Americans rose both much more quickly and in line with productivity. Real compensation per hour for the average worker rose by 106% or at a 2.9% annual rate, and real hourly compensation for workers in the nonfarm business sector rose by 91% or at a 2.6% annual rate. Real compensation per hour for production and nonsupervisory workers – whose pay is likely to have been similar to that of the median worker over the period (Bivens and Mishel 2015) – also rose at a 2.6% annual rate. And hourly labor productivity rose at a 2.7% or 2.8% annual rate for the total economy or the nonfarm business sector, respectively.

As such, a period of slower productivity growth since 1973 has coincided with a period of even slower pay growth. Productivity has grown relatively slowly, average pay slower still, and median pay barely at all.

In the introduction, we discussed two alternative views of this productivity-pay divergence: the "delinkage" view where productivity growth no longer systematically translates into growth in workers' compensation, or the "linkage" view where productivity growth does translate into pay growth but a variety of other factors have been putting downward pressure on workers' compensation.

Our regressions of compensation growth on productivity growth tend to support the view that productivity growth does translate into growth in pay. Increases in productivity growth have been strongly associated with increases in real compensation for the median and the average worker, whether measured in the nonfarm business sector or the whole economy, whether investigated since 1950 or only since 1973, and whether or not including controls for changes in unemployment, a time trend, or decade dummy variables: a one percentage point increase in the rate of productivity growth is associated with an increase in the growth rate of compensation for the median or average worker of two thirds to one percent. For the average production or nonsupervisory worker, our regressions suggest that a one percentage point increase in productivity growth is associated with between 0.5 and 0.7 percentage points higher compensation growth. Evidence on different deciles of the wage distribution shows large and significant positive co-movement between US productivity and wages at the 50^{th} and 60^{th} percentiles of the distribution, and there has been large and significant positive co-movement between productivity and average compensation in half of the other G7 economies. Overall, we interpret this evidence as providing more support for the "linkage" view than the "delinkage" view: the link translating productivity growth into pay appears to have remained throughout the postwar period.

Rather, our results suggest that other factors are likely to be responsible for creating the wedge between productivity and pay in the US economy, suppressing typical workers' incomes even as productivity growth acts to increase them. The increasing wedge between productivity and median compensation has two key components: rapidly rising labor income inequality has caused mean and median compensation to diverge, and a falling labor share has caused productivity and mean compensation to diverge.

Many different explanations have been proposed to explain these two divergences. Several explanations focus on the role of technological change – both to explain the divergence in mean and median compensation, and to explain the falling labor share. These pure technology-based theories would imply that in periods where productivity growth is faster, productivity and median pay should diverge more rapidly. Our evidence is a puzzle from the perspective of these hypotheses. Using the natural quasi-experiment of fluctuations in productivity growth, we find little significant evidence of co-movement between productivity growth and the labor share in the US over the last seven decades. The standard errors, however, are quite large, suggesting that a lack of significant evidence alone is not enough to reject technology-based hypotheses. Depending on the specification used and the measure of the labor share used, our coefficient estimates could imply anywhere between a small rise or a moderate decline in the labor share, but none are large enough to explain the entire decline in the labor share over recent decades. The evidence on the relationship between the mean-median ratio and productivity growth is stronger: we find no significant co-movement between productivity growth and the mean/median compensation ratio over the last four decades, and very small coefficient estimates.

It is interesting to compare the relative magnitude of changes in compensation inequality, the labor share and productivity growth using some simple counterfactuals. If the ratio of the mean to median worker's hourly compensation in 2015 had been the same as it was in 1973, and mean compensation remained at its 2015 level, the median worker's pay would have been around 32% higher. If the ratio of labor productivity to mean compensation[30] in 2015 had been the same as it was in 1973 (i.e. the labor share had not fallen), the average and median worker would both have had around 5% more hourly compensation all else constant. Assuming the relationship between compensation and productivity estimated in Tables 1 or 2 hold, if productivity growth had been as fast over 1973-2015 as it was over 1949-1973, (i.e. if net total economy productivity had grown at an average of 2.7% per year, rather than 1.3% per year), mean compensation would have been 59%-76% higher and median compensation 65%-68% higher in 2015, holding other factors constant. These point estimates suggest that that the potential effect of raising productivity growth on the average American's pay may be as great as or greater than the effect of policies to reverse trends in income inequality. Conversely they suggest that a continued productivity slowdown should be a major concern for those hoping for increases in real compensation for middle income workers.

Overall, our central conclusion is as follows: the substantial variations in productivity growth that have taken place during recent decades have been associated with roughly equivalent changes in median and mean real compensation. This supports the "linkage" view of productivity and compensation, and suggests that if productivity accelerates for reasons relating to technology or to policy, the likely impact will be increased pay growth for the typical worker. Rather than productivity growth failing to translate into pay growth, our evidence suggests that other factors are suppressing typical workers' incomes even as productivity growth acts to increase them. We do not find substantial evidence that productivity growth has been systematically associated with changes in the labor share or the mean/median income ratio. This raises questions for the theories that posit technological progress as the key driver of the pay-productivity divergence – and

[30] Adjusted by the product price deflator.

instead suggests the importance of factors *not* associated with the rate of productivity growth in the stagnation of middle class living standards.

Our results suggest that productivity growth still matters substantially for middle income Americans. Nonetheless the evidence of the past four decades, with stagnating compensation for the median worker and production and nonsupervisory workers, demonstrates that productivity growth alone is not necessarily enough to raise living standards. As such strategies that focus both on productivity growth and on labor market or redistributive policies are likely to have the greatest impact.

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Appendix

Data Sources

Labor productivity (USA)

Net labor productivity per hour, total economy: BEA real Net Domestic Product, divided by BLS Total Hours, Total Economy (unpublished).

Gross labor productivity per hour, nonfarm business sector: BLS Output Per Hour of All Persons, Non-Farm Business Sector

Compensation and wages (USA)

Average compensation per hour, total economy: BLS Average Hourly Compensation, Total Economy, deflated by the CPI-U-RS since 1977 and the CPI-U before 1977.

Median compensation per hour, total economy: Data obtained from EPI who calculated it as follows: Nominal median hourly wages, estimated using microdata from the CPS-ORG, multiplied by ratio of real compensation to wages obtained from BEA NIPA data. Further details in Bivens and Mishel (2015). We deflated this series by the CPI-U-RS/CPI-U rather than using the EPI compensation deflator (which deflates the non-cash portion of compensation by a combination of PCE deflators instead of the CPI-U-RS), so that it was comparable with our other series.

Average compensation per hour, production and non-supervisory workers: Data obtained from EPI who calculated it as follows: Average hourly earnings for production/nonsupervisory workers from BLS CES since 1964, estimated pre-1964 using average hourly earnings for production workers, multiplied by compensation-wage ratio. Further details in Bivens and Mishel (2015). Once again, deflated by the CPI-U-RS/CPI-U rather than the EPI compensation deflator.

Average compensation per hour, non-farm business sector: BLS Compensation Per Hour, Non-Farm Business Sector, deflated by the CPI-U-RS since 1977 and the CPI-U before 1977.

Wages by decile of the wage distribution: Data obtained from EPI State of Working America Data Library, which calculates nominal hourly wages by percentile from the CPS-ORG survey and deflates by the CPI-U-RS.

<u>Other data (USA)</u>

Unemployment rate: Unemployment rate ages 25-54, Bureau of Labor Statistics.

Labor share: our baseline measure is the share of labour compensation in GDP from the Penn World Tables, obtained from the FRED database. We also use the Bureau of Labor Statistics measures of the labor share for the total economy (available on request from the BLS in the Total Economy Productivity dataset) and for the nonfarm business sector (available from the BLS website or FRED database).

Relative price of investment goods: we use Di Cecio's measure from DiCecio (2009). "Sticky wages and sectoral labor comovement," Journal of Economic Dynamics and Control, 33(3): 538-53, available from the FRED database. This is calculated as the investment deflator divided by the consumption deflator. We cross-check against Karabarbounis and Neiman's (2014) measure: the two are very similar.

<u>Labor productivity (Other G7 countries)</u>

Gross labor productivity per hour – Canada, France, Italy, Japan: OECD GDP per hour worked.

Gross labor productivity per hour – Germany: labor productivity per hour, German Federal Statistical Office. Available in the DeStatis publication "Volkswirtschaftliche Gesamtrechnungen: Inlandsproduktberechnung Lange Reihen ab 1970".

<u>Compensation (Other G7 countries)</u>

Compensation per hour – Canada, France, Italy, Japan: OECD average compensation per hour worked.

Compensation per hour – Germany: average labor compensation per hour, German Federal Statistical Office. Available in the DeStatis publication "Volkswirtschaftliche Gesamtrechnungen: Inlandsproduktberechnung Lange Reihen ab 1970".

Other data (Other G7 countries)

Unemployment – Canada, Italy, Japan: OECD harmonized unemployment rate, all persons.

Unemployment – France: OECD unemployment rate, ages 15-74.

Unemployment – Germany: unemployment rate as proportion of labor force, German Federal Statistical Office. Available in the DeStatis publication "Volkswirtschaftliche Gesamtrechnungen: Inlandsproduktberechnung Lange Reihen ab 1970".

Regressions: alternate specifications

This section shows robustness checks using alternate specifications for the baseline regressions.

- Appendix Tables 1A-1C show the baseline moving average regressions with different bandwidths: 2, 4 and 5 years.

- Appendix Tables 2A-2C show the baseline distributed lag regressions with different lag lengths: 0, 1 and 3 years.

- Appendix Tables 3A and 3B show the baseline moving average regressions with consumption deflated with the PCE deflator (3A) or by the product price deflator (3B). For product price deflation, for the total economy compensation series we used the Net Domestic Product price index and for the nonfarm business sector compensation series we used the implicit price deflator for the nonfarm business sector.

- Appendix Tables 4A and 4B show the baseline distributed lag regressions with consumption deflated with the PCE deflator (4A) or by the product price deflator (4B).

- Appendix Tables 5A-5C show the baseline moving average regressions with different controls: 5A removes the unemployment control, 5B adds a time trend and 5C adds decade dummies.

- Appendix Tables 6A-6C show the baseline distributed lag regressions with different controls: 6A removes the unemployment control, 6B adds a time trend and 6C adds decade dummies.

- Appendix Tables 7A-7C show the productivity-labor share moving average regressions with different bandwidths: 2, 4 and 5 years.

- Appendix Tables 8A-8C show the productivity-labor share distributed lag regressions with different lag lengths: 0, 1 and 3 years.

- Appendix Tables 9A-10B show the baseline productivity-labor share regressions with the BLS measures of the labor share for the total economy and the nonfarm business sector. Note that we use labor productivity data for the total economy and nonfarm business sector respectively.

- Appendix Tables 11A-12B show the baseline regressions of the labor share and the relative price of investment goods, using the BLS measures of the labor share for the total economy and the nonfarm business sector.

- Appendix Table 13 shows the results of the Dickey-Fuller unit root test for the productivity and compensation series.

Appendix Table 1A: Two year Moving average regressions – total economy

Dependent variables are the 2-year moving average of the Δ log compensation	Total economy Average comp 1949-2015	Total economy Average comp 1949-1973	Total economy Average comp 1975-2015	Total economy Median comp 1975-2015	Total economy Production/nonsupervisory comp 1949-2015	Total economy Production/nonsupervisory comp 1949-1973	Total economy Production/nonsupervisory comp 1975-2015	Nonfarm business Average comp 1949-2015	Nonfarm business Average comp 1949-1973	Nonfarm business Average comp 1975-2015
Δ log productivity,	0.87***	0.19	0.71***	0.80***	0.97***	0.37	0.61***	0.66***	0.08	0.60***
2-year moving average	(0.07)	(0.18)	(0.16)	(0.17)	(0.11)	(0.26)	(0.16)	(0.10)	(0.24)	(0.18)
Δ unemployment (25-54),	0.04	0.11	-0.03	0.17	0.14	0.22	0.08	-0.14	-0.02	-0.20
2-year moving average	(0.13)	(0.24)	(0.13)	(0.17)	(0.25)	(0.45)	(0.36)	(0.16)	(0.32)	(0.15)
Constant	0.00	0.02***	-0.00	-0.01***	-0.01**	0.02*	-0.01*	0.00	0.02***	-0.00
	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)
Observations	66	24	41	41	66	24	41	66	24	41
F-test: is coefficient on productivity significantly different from 1?										
Test statistic	2.86*	19.1***	3.33*	1.40	0.07	5.96**	5.76**	10.8***	14.3***	5.26**
Prob>F	0.10	0.00	0.08	0.25	0.79	0.02	0.02	0.00	0.00	0.03

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: year listed is second year in moving average.

Appendix Table 1B: Four year Moving average regressions – total economy

Dependent variables are the 4-year moving average of the Δ log compensation	Total economy Average comp 1951-2014	Total economy Average comp 1951-1973	Total economy Average comp 1976-2014	Total economy Median comp 1976-2014	Total economy Production/nonsupervisory comp 1951-2014	Total economy Production/nonsupervisory comp 1951-1973	Total economy Production/nonsupervisory comp 1976-2014	Nonfarm business Average comp 1951-2014	Nonfarm business Average comp 1951-1973	Nonfarm business Average comp 1976-2014
Δ log productivity,	1.09***	0.48*	0.86***	0.97***	1.15***	0.73**	0.66***	0.81***	-0.16	0.65***
4-year moving average	(0.09)	(0.24)	(0.15)	(0.19)	(0.15)	(0.30)	(0.18)	(0.12)	(0.28)	(0.17)
Δ unemployment (25-54),	0.01	0.43	-0.17*		0.36	1.11**	0.21	-0.22	-0.30	-0.38***
4-year moving average	(0.19)	(0.27)	(0.09)	(0.14)	(0.25)	(0.47)	(0.27)	(0.24)	(0.28)	(0.13)
Constant	-0.00**	0.02**	-0.00	-0.01***	-0.01***	0.01	-0.01*	-0.00	0.03***	-0.00
	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)
Observations	64	23	39	39	64	23	39	64	23	39
F-test: is coefficient on productivity significantly different from 1?										
Test statistic	0.97	4.49**	0.90	0.03	0.97	0.76	3.73*	2.45	17.0***	4.13**
Prob>F	0.33	0.05	0.35	0.86	0.33	0.39	0.06	0.12	0.00	0.05

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: year listed is third year in moving average

Appendix Table 1C: Baseline regressions with five year moving averages

Dependent variables are the 5-year moving average of the Δ log compensation	Total economy Average comp 1951-2013	Total economy Average comp 1951-1973	Total economy Average comp 1976-2013	Total economy Median comp 1976-2013	Total economy Production/nonsupervisory comp 1951-2013	Total economy Production/nonsupervisory comp 1951-1973	Total economy Production/nonsupervisory comp 1976-2013	Nonfarm business Average comp 1951-2013	Nonfarm business Average comp 1951-1973	Nonfarm business Average comp 1976-2013
Δ log productivity, 5-year moving average	1.18***	0.53**	0.93***	1.01***	1.25***	0.76***	0.67***	0.87***	-0.22	0.67***
	(0.08)	(0.23)	(0.13)	(0.16)	(0.17)	(0.26)	(0.17)	(0.13)	(0.33)	(0.16)
Δ unemployment (25-54), 5-year moving average	0.00	0.09	-0.23***	0.02	0.46*	0.53	0.28	-0.21	-0.60	-0.44***
	(0.22)	(0.40)	(0.06)	(0.13)	(0.25)	(0.37)	(0.24)	(0.31)	(0.46)	(0.13)
Constant	-0.01***	0.01**	-0.00*	-0.01***	-0.01***	0.00	-0.01*	-0.00	0.03***	-0.00
	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)
Observations	63	23	38	38	63	23	38	63	23	38
F-test: is coefficient on productivity significantly different from 1?										
Test statistic	4.69**	3.97*	0.26	0.00	2.07	0.89	3.66	1.01	13.8***	4.04*
Prob>F	0.03	0.06	0.61	0.95	0.16	0.36	0.06	0.32	0.00	0.05

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: year listed is middle year in moving average

Appendix Table 2A: Baseline distributed lag regressions with no lags of productivity growth and unemployment

	Total economy Average comp 1949-2015	Total economy Average comp 1949-1973	Total economy Average comp 1974-2015	Total economy Median comp 1974-2015	Total economy Production/nonsupervisory comp 1949-2015	Total economy Production/nonsupervisory comp 1949-1973	Total economy Production/nonsupervisory comp 1974-2015	Nonfarm business Average comp 1949-2015	Nonfarm business Average comp 1949-1973	Nonfarm business Average comp 1974-2015
Δ log productivity	0.69***	0.31	0.62***	0.46**	0.68***	0.21	0.53***	0.54***	0.14	0.55***
	(0.09)	(0.23)	(0.16)	(0.19)	(0.10)	(0.16)	(0.16)	(0.12)	(0.26)	(0.17)
Δ unemployment (25-54)	0.19	0.12	0.12	0.38**	0.21	0.05	0.16	0.00	-0.07	-0.04
	(0.12)	(0.24)	(0.15)	(0.18)	(0.25)	(0.46)	(0.35)	(0.14)	(0.30)	(0.18)
Constant	0.00	0.02***	0.00	-0.00	-0.00	0.02***	-0.00	0.00	0.02**	-0.00
	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)
Observations	67	25	42	42	67	25	42	67	25	42
F-test: is coefficient on productivity significantly different from 1?										
Test statistic	11.7***	9.37***	5.51**	8.31***	9.12***	23.5***	9.03***	14.2***	10.7***	6.56**
Prob>F	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.01

Appendix Table 2B: Baseline distributed lag regressions with one lag of productivity growth and unemployment

	Total economy Average comp 1950-2015	Total economy Average comp 1950-1973	Total economy Average comp 1974-2015	Total economy Median comp 1974-2015	Total economy Production/ nonsupervisory comp 1950-2014	Total economy Production/ nonsupervisory comp 1950-1973	Total economy Production/ nonsupervisory comp 1974-2015	Nonfarm business Average comp 1950-2015	Nonfarm business Average comp 1950-1973	Nonfarm business Average comp 1974-2015
Δ log productivity	0.85***	0.35	0.85***	0.72***	0.68***	0.06	0.59***	0.69***	0.01	0.74***
	(0.10)	(0.23)	(0.17)	(0.20)	(0.11)	(0.20)	(0.19)	(0.14)	(0.34)	(0.18)
Δ log productivity, 1 year lag	0.14	-0.19	0.14	0.33*	0.25**	0.00	0.10	0.07	-0.08	0.02
	(0.12)	(0.16)	(0.12)	(0.19)	(0.12)	(0.25)	(0.16)	(0.11)	(0.20)	(0.11)
Δ unemployment (25-54)	0.30**	-0.02	0.34	0.70***	0.18	-0.24	0.25	0.05	-0.25	0.11
	(0.14)	(0.16)	(0.20)	(0.22)	(0.23)	(0.25)	(0.36)	(0.17)	(0.18)	(0.25)
Δ unemployment (25-54), 1 year lag	-0.47***	-0.24	-0.53***	-0.59**	-0.06	0.37	-0.14	-0.46***	0.14	-0.58***
	(0.12)	(0.18)	(0.14)	(0.24)	(0.14)	(0.34)	(0.15)	(0.12)	(0.24)	(0.14)
Constant	-0.00	0.02***	-0.00	-0.01***	-0.01*	0.02**	-0.01	-0.00	0.03**	-0.00
	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)
Observations	66	24	42	42	66	24	42	66	24	42
Sum of Δ log productivity coefficients	0.99***	0.16	0.99***	1.05***	0.93***	0.07	0.69**	0.76***	-0.08	0.76***
	(0.12)	(0.18)	(0.18)	(0.24)	(0.16)	(0.26)	(0.29)	(0.14)	(0.33)	(0.19)
F-test: is coefficient on productivity significantly different from 1?										
Test statistic	0.01	21.8***	0.01	0.04	0.19	12.7***	1.14	3.04*	10.9***	1.63
Prob>F	0.92	0.00	0.93	0.84	0.67	0.00	0.29	0.09	0.00	0.21

Appendix Table 2C: Baseline distributed lag regressions with three lags of productivity growth and unemployment

	Total economy Average comp 1952-2015	Total economy Average comp 1952-1973	Total economy Average comp 1974-2015	Total economy Median comp 1974-2015	Total economy Production /nonsupervisory comp 1952-2015	Total economy Production /nonsupervisory comp 1952-1973	Total economy Production /nonsupervisory comp 1974-2015	Nonfarm business Average comp 1952-2015	Nonfarm business Average comp 1952-1973	Nonfarm business Average comp 1974-2015
Δ log productivity	0.76***	-0.04	0.76***	0.76***	0.67***	-0.14	0.59**	0.60***	-0.19	0.67***
	(0.15)	(0.26)	(0.15)	(0.20)	(0.21)	(0.19)	(0.24)	(0.15)	(0.41)	(0.14)
Δ log productivity, 1 year lag	0.28***	0.04	0.31**	0.55***	0.31*	0.29	0.22	0.12	0.05	0.14
	(0.10)	(0.22)	(0.12)	(0.18)	(0.17)	(0.36)	(0.16)	(0.10)	(0.22)	(0.11)
Δ log productivity, 2 year lag	0.11	0.27	-0.03	-0.42**	0.06	0.20	-0.24	0.14	0.14	-0.00
	(0.11)	(0.17)	(0.17)	(0.20)	(0.19)	(0.36)	(0.21)	(0.12)	(0.38)	(0.13)
Δ log productivity, 3 year lag	-0.03	0.44**	-0.27***	-0.21	0.04	0.53*	-0.27	-0.07	0.28	-0.24**
	(0.13)	(0.16)	(0.10)	(0.14)	(0.20)	(0.30)	(0.17)	(0.13)	(0.36)	(0.11)
Δ unemployment (25-54)	0.21	0.05	0.23	0.71***	0.12	-0.13	0.26	-0.03	-0.29	0.03
	(0.13)	(0.16)	(0.19)	(0.17)	(0.25)	(0.28)	(0.34)	(0.15)	(0.38)	(0.25)
Δ unemployment (25-54), 1 year lag	-0.39***	0.32	-0.37**	-0.61*	-0.03	0.97***	-0.16	-0.42***	0.39	-0.44**
	(0.14)	(0.19)	(0.18)	(0.32)	(0.21)	(0.16)	(0.28)	(0.12)	(0.53)	(0.17)
Δ unemployment (25-54), 2 year lag	-0.17	0.33	-0.45***	-0.56***	-0.03	0.46	-0.27*	-0.10	0.24	-0.36**
	(0.22)	(0.26)	(0.14)	(0.13)	(0.23)	(0.41)	(0.16)	(0.21)	(0.45)	(0.17)
Δ unemployment (25-54), 3 year lag	-0.24**	0.24	-0.15	0.17	-0.14	0.38*	0.11	-0.31**	0.02	-0.11
	(0.11)	(0.19)	(0.18)	(0.24)	(0.17)	(0.21)	(0.25)	(0.15)	(0.17)	(0.16)
Constant	-0.00	0.01	0.00	-0.01	-0.01*	0.00	-0.00	-0.00	0.02	0.00
	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.03)	(0.00)
Observations	64	22	42	42	64	22	42	64	22	42
Sum of Δ log productivity coefficients	1.12***	0.71**	0.76***	0.68**	1.08***	0.89	0.30	0.79***	0.28	0.57**
	(0.18)	(0.27)	(0.23)	(0.27)	(0.25)	(0.51)	(0.29)	(0.24)	(0.98)	(0.21)
F-test: is coefficient on productivity significantly different from 1?										
Test statistic	0.45	1.21	1.10	1.37	0.11	0.05	5.66**	0.76	0.54	4.30**
Prob>F	0.51	0.29	0.30	0.25	0.74	0.83	0.02	0.39	0.47	0.05

Appendix Table 3A: Baseline Moving average regressions – ***PCE deflation***

Dependent variables are the 3-year moving average of the Δ log compensation	Total economy Average comp	Total economy Average comp	Total economy Average comp	Total economy Median comp	Total economy Production/ nonsupervisory comp	Total economy Production/ nonsupervisory comp	Total economy Production/ nonsupervisory comp	Nonfarm business Average comp	Nonfarm business Average comp	Nonfarm business Average comp
	1950-2014	1950-1973	1975-2014	1975-2014	1950-2014	1950-1973	1975-2014	1950-2014	1950-1973	1975-2014
Δ log productivity,	0.91***	0.27	0.84***	0.90***	0.97***	0.46*	0.64***	0.71***	0.03	0.71***
3-year moving average	(0.08)	(0.25)	(0.22)	(0.24)	(0.12)	(0.24)	(0.21)	(0.12)	(0.20)	(0.23)
Δ unemployment (25-54),	0.09	0.17	-0.02	0.14	0.28	0.53	0.23	-0.10	-0.06	-0.23
3-year moving average	(0.15)	(0.24)	(0.14)	(0.15)	(0.22)	(0.40)	(0.29)	(0.20)	(0.20)	(0.21)
Constant	0.00	0.02***	0.00	-0.01**	-0.00*	0.01**	-0.00	0.00	0.03***	-0.00
	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)
Observations	65	24	40	40	65	24	40	65	24	40
F-test: is coefficient on productivity significantly different from 1?										
Test statistic	1.32	8.73***	0.55	0.18	0.06	5.29**	2.80	5.72**	23.3***	1.61
Prob>F	0.26	0.01	0.46	0.68	0.82	0.03	0.10	0.02	0.00	0.21

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: year listed is middle year of moving average

Appendix Table 3B: Baseline Moving average regressions – ***product price deflation***

Dependent variables are the 3-year moving average of the Δ log compensation	Total economy Average comp	Total economy Average comp	Total economy Average comp	Total economy Median comp	Total economy Production/ nonsupervisory comp	Total economy Production/ nonsupervisory comp	Total economy Production/ nonsupervisory comp	Nonfarm business Average comp	Nonfarm business Average comp	Nonfarm business Average comp
	1950-2014	1950-1973	1975-2014	1975-2014	1950-2014	1950-1973	1975-2014	1950-2014	1950-1973	1975-2014
Δ log productivity,	0.78***	0.41*	0.64***	0.70***	0.84***	0.59***	0.44**	0.72***	0.17**	0.78***
3-year moving average	(0.10)	(0.20)	(0.23)	(0.24)	(0.11)	(0.19)	(0.17)	(0.12)	(0.08)	(0.23)
Δ unemployment (25-54),	0.05	0.07	-0.01	0.15	0.24	0.42	0.24	-0.16	-0.05	-0.30*
3-year moving average	(0.14)	(0.14)	(0.13)	(0.14)	(0.20)	(0.25)	(0.26)	(0.15)	(0.14)	(0.16)
Constant	0.00	0.02***	0.00	-0.00	-0.00	0.01*	-0.00	0.00	0.02***	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Observations	65	24	40	40	65	24	40	65	24	40
F-test: is coefficient on productivity significantly different from 1?										
Test statistic	5.06**	8.92***	2.53	1.61	1.85	4.68**	10.30***	5.91**	114.4***	0.86
Prob>F	0.02	0.01	0.12	0.21	0.19	0.04	0.00	0.02	0.00	0.36

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: year listed is middle year of moving average

Appendix Table 4A: Baseline distributed lag regressions, ***PCE Deflation***

	Total economy Average comp 1951-2015	Total economy Average comp 1951-1973	Total economy Average comp 1974-2015	Total economy Median comp 1974-2015	Total economy Production/nonsupervisory comp 1951-2015	Total economy Production/nonsupervisory comp 1951-1973	Total economy Production/nonsupervisory comp 1974-2015	Nonfarm business Average comp 1951-2015	Nonfarm business Average comp 1951-1973	Nonfarm business Average comp 1974-2015
Δ log productivity	0.72***	-0.02	0.83***	0.79***	0.62***	-0.10	0.64**	0.59***	-0.20	0.74***
	(0.15)	(0.20)	(0.19)	(0.20)	(0.19)	(0.18)	(0.24)	(0.16)	(0.22)	(0.17)
Δ log productivity, 1 year lag	0.22**	-0.19*	0.28***	0.50***	0.28***	-0.06	0.15	0.15	-0.18	0.13
	(0.09)	(0.09)	(0.09)	(0.17)	(0.09)	(0.13)	(0.13)	(0.10)	(0.12)	(0.10)
Δ log productivity, 2 year lag	0.02	-0.04	-0.14	-0.39**	0.00	-0.11	-0.23	0.02	-0.17	-0.13
	(0.09)	(0.08)	(0.14)	(0.15)	(0.14)	(0.15)	(0.18)	(0.09)	(0.11)	(0.12)
Δ unemployment (25-54)	0.30**	-0.21**	0.39**	0.78***	0.20	-0.41**	0.35	0.10	-0.53***	0.21
	(0.12)	(0.10)	(0.18)	(0.15)	(0.19)	(0.18)	(0.26)	(0.15)	(0.13)	(0.27)
Δ unemployment (25-54), 1 year lag	-0.43***	-0.39**	-0.53***	-0.74**	-0.07	0.12	-0.32	-0.46***	-0.26	-0.66***
	(0.13)	(0.15)	(0.19)	(0.28)	(0.19)	(0.25)	(0.27)	(0.14)	(0.20)	(0.18)
Δ unemployment (25-54), 2 year lag	-0.20	-0.17	-0.27*	-0.32**	-0.09	-0.10	-0.01	-0.15	-0.17	-0.14
	(0.13)	(0.18)	(0.16)	(0.15)	(0.15)	(0.27)	(0.17)	(0.17)	(0.20)	(0.18)
Constant	0.00	0.04***	-0.00	-0.01	-0.00	0.03***	-0.00	0.00	0.04***	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)
Observations	65	23	42	42	65	23	42	65	23	42
Sum of Δ log productivity coefficients	0.97***	-0.25	0.98***	0.89***	0.91***	-0.27	0.56**	0.76***	-0.55	0.74***
	(0.11)	(0.13)	(0.24)	(0.27)	(0.15)	(0.26)	(0.29)	(0.16)	(0.31)	(0.23)
F-test: is coefficient significantly different from 1?										
Test statistic	0.09	42.3***	0.01	0.15	0.35	24.0***	2.31	2.21	24.6***	1.34
Prob>F	0.77	0.00	0.93	0.70	0.56	0.002	0.14	0.14	0.00	0.25

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: the year is listed as the year of the dependent variable

Appendix Table 4B: Baseline distributed lag regressions, ***product price index deflation***

	Total economy Average comp 1951-2015	Total economy Average comp 1951-1973	Total economy Average comp 1974-2015	Total economy Median comp 1974-2015	Total economy Production/nonsupervisory comp 1951-2015	Total economy Production/nonsupervisory comp 1951-1973	Total economy Production/nonsupervisory comp 1974-2015	Nonfarm business Average comp 1951-2015	Nonfarm business Average comp 1951-1973	Nonfarm business Average comp 1974-2015
Δ log productivity	0.53***	0.11	0.57***	0.52***	0.43***	0.03	0.38**	0.68***	0.18**	0.79***
	(0.13)	(0.15)	(0.18)	(0.17)	(0.11)	(0.16)	(0.15)	(0.14)	(0.08)	(0.19)
Δ log productivity, 1 year lag	0.26***	-0.08	0.33***	0.54***	0.32***	0.05	0.19	0.20**	-0.14	0.23**
	(0.07)	(0.09)	(0.09)	(0.14)	(0.07)	(0.12)	(0.12)	(0.08)	(0.14)	(0.09)
Δ log productivity, 2 year lag	0.05	-0.02	-0.05	-0.30**	0.03	-0.09	-0.14	-0.05	-0.09	-0.13
	(0.08)	(0.09)	(0.12)	(0.13)	(0.11)	(0.13)	(0.15)	(0.08)	(0.14)	(0.12)
Δ unemployment (25-54)	0.21*	-0.17**	0.25	0.65***	0.11	-0.37**	0.22	0.05	-0.20	0.01
	(0.12)	(0.07)	(0.19)	(0.15)	(0.15)	(0.17)	(0.20)	(0.15)	(0.13)	(0.26)
Δ unemployment (25-54), 1 year lag	-0.35***	-0.48**	-0.34**	-0.54**	0.01	0.03	-0.13	-0.57***	-0.47***	-0.60***
	(0.12)	(0.22)	(0.16)	(0.21)	(0.13)	(0.23)	(0.21)	(0.13)	(0.15)	(0.19)
Δ unemployment (25-54), 2 year lag	-0.28***	-0.23	-0.37**	-0.42***	-0.17	-0.16	-0.11	-0.15	0.00	-0.22
	(0.10)	(0.18)	(0.14)	(0.14)	(0.13)	(0.30)	(0.16)	(0.14)	(0.18)	(0.20)
Constant	0.00	0.03***	0.00	-0.00	-0.00	0.02***	0.00	0.00	0.03***	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)
Observations	65	23	42	42	65	23	42	65	23	42
Sum of Δ log productivity coefficients	0.84***	0.06	0.85***	0.77***	0.78***	-0.01	0.43*	0.82***	-0.05	0.89***
	(0.10)	0.16	(0.24)	(0.25)	(0.12)	(0.24)	(0.25)	(0.16)	(0.29)	(0.24)
F-test: is coefficient significantly different from 1?										
Test statistic	2.39	38.76***	0.38	0.88	3.08*	17.8***	5.10**	1.29	13.1***	0.23
Prob>F	0.13	0.00	0.54	0.35	0.08	0.00	0.03	0.26	0.00	0.64

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: the year is listed as the year of the dependent variable

Appendix Table 5A: Baseline Moving average regressions – no unemployment control

Dependent variables are the 3-year moving average of the Δ log compensation	Total economy Average comp 1950-2014	Total economy Average comp 1950-1973	Total economy Average comp 1975-2014	Total economy Median comp 1975-2014	Total economy Production/ nonsupervisory comp 1950-2014	Total economy Production/ nonsupervisory comp 1950-1973	Total economy Production/ nonsupervisory comp 1975-2014	Nonfarm business Average comp 1950-2014	Nonfarm business Average comp 1950-1973	Nonfarm business Average comp 1975-2014
Δ log productivity,	0.98***	0.32	0.79***	0.87***	1.02***	0.40*	0.61***	0.73***	0.08	0.61***
3-year moving average	(0.08)	(0.21)	(0.16)	(0.18)	(0.12)	(0.21)	(0.16)	(0.10)	(0.25)	(0.16)
Constant	-0.00	0.02***	-0.00	-0.01***	-0.01***	0.01**	-0.01*	-0.00	0.02**	-0.00
	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)
Observations	65	24	40	40	65	24	40	65	24	40
F-test: is coefficient on productivity significantly different from 1?										
Test statistic	0.10	10.8***	1.76	0.54	0.04	7.83**	6.01**	6.64**	13.9***	5.66**
Prob>F	0.75	0.00	0.19	0.47	0.84	0.01	0.02	0.01	0.00	0.02

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: year listed is middle year of moving average

Appendix Table 5B: Baseline Moving average regressions – with time trend

Dependent variables are the 3-year moving average of the Δ log compensation	Total economy Average comp 1950-2014	Total economy Average comp 1950-1973	Total economy Average comp 1975-2014	Total economy Median comp 1975-2014	Total economy Production/ nonsupervisory comp 1950-2014	Total economy Production/ nonsupervisory comp 1950-1973	Total economy Production/ nonsupervisory comp 1975-2014	Nonfarm business Average comp 1950-2014	Nonfarm business Average comp 1950-1973	Nonfarm business Average comp 1975-2014
Δ log productivity,	0.74***	0.10	0.80***	0.87***	0.84***	0.28	0.58***	0.54***	-0.03	0.68***
3-year moving average	(0.16)	(0.24)	(0.17)	(0.19)	(0.18)	(0.36)	(0.14)	(0.16)	(0.16)	(0.18)
Δ unemployment (25-54)	-0.01	0.17	-0.11	0.04	0.19	0.53	0.16	-0.18	0.04	-0.33**
	(0.13)	(0.30)	(0.10)	(0.17)	(0.29)	(0.53)	(0.26)	(0.15)	(0.29)	(0.14)
3-year moving average										
Time trend	-0.21**	-0.57***	-0.01	-0.06	-0.18	-0.59*	0.27***	-0.29***	-0.77***	-0.12**
	(0.09)	(0.13)	(0.07)	(0.08)	(0.11)	(0.30)	(0.08)	(0.09)	(0.12)	(0.06)
Constant	0.01	0.03***	-0.00	-0.01	0.00	0.03*	-0.02***	0.01**	0.04***	0.00
	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.00)	(0.00)
Observations	65	24	40	40	65	24	40	65	24	40
F-test: is coefficient on productivity significantly different from 1?										
Test statistic	2.70	13.8***	1.43	0.47	0.83	4.05*	9.16***	8.66***	42.0***	3.19*
Prob>F	0.11	0.00	0.24	0.47	0.37	0.06	0.00	0.0	0.00	0.08

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: year listed is middle year of moving average

Appendix Table 5C: Baseline Moving average regressions – with decade dummies

Dependent variables are the 3-year moving average of the Δ log compensation	Total economy Average comp	Total economy Average comp	Total economy Average comp	Total economy Median comp	Total economy Production/nonsupervisory comp	Total economy Production/nonsupervisory comp	Total economy Production/nonsupervisory comp	Nonfarm business Average comp	Nonfarm business Average comp	Nonfarm business Average comp
	1950-2014	1950-1973	1975-2014	1975-2014	1950-2014	1950-1973	1975-2014	1950-2014	1950-1973	1975-2014
Δ log productivity,	0.57***	0.21	0.73***	0.83***	0.58***	0.43	0.52***	0.43**	0.05	0.64***
3-year moving average	(0.16)	(0.20)	(0.17)	(0.20)	(0.17)	(0.25)	(0.11)	(0.16)	(0.14)	(0.22)
Δ unemployment (25-54)	-0.02	0.27	-0.14	0.03	0.15	0.43	0.13	-0.17	0.16	-0.32**
	(0.12)	(0.35)	(0.12)	(0.20)	(0.23)	(0.47)	(0.28)	(0.14)	(0.31)	(0.15)
3-year moving average										
1950s dummy	0.02***	0.01***			0.01***	0.01**		0.02***	0.02***	
	(0.00)	(0.00)			(0.00)	(0.00)		(0.00)	(0.00)	
1960s dummy	0.01***	0.00**			0.01	-0.00		0.01***	0.01***	
	(0.00)	(0.00)			(0.00)	(0.00)		(0.00)	(0.00)	
1970s dummy	0.01		0.00	0.00	0.00		-0.00	0.01***		0.01**
	(0.00)		(0.00)	(0.00)	(0.00)		(0.00)	(0.00)		(0.00)
1980s dummy	0.00		0.00*	0.00	-0.01***		-0.01***	0.00*		0.00*
	(0.00)		(0.00)	(0.00)	(0.00)		(0.00)	(0.00)		(0.00)
1990s dummy	0.00		0.00	0.00	-0.00		-0.00	0.00		0.00
	(0.00)		(0.00)	(0.00)	(0.00)		(0.00)	(0.00)		(0.00)
2000s dummy	0.01**		0.00*	0.00	-0.00		-0.00	0.01*		0.00
	(0.00)		(0.00)	(0.00)	(0.00)		(0.00)	(0.00)		(0.00)
Constant	-0.00	0.02**	-0.00	-0.01***	-0.00	0.01	0.00	-0.00	0.01***	-0.01
	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)
Observations	65	24	40	40	65	24	40	65	24	40
F-test: is coefficient on productivity significantly different from 1?										
Test statistic	7.12***	15.36***	2.42	0.72	5.83**	5.12**	19.3***	12.0***	45.2***	2.65
Prob>F	0.00	0.00	0.13	0.40	0.02	0.04	0.00	0.00	0.00	0.11

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Notation: year listed is middle year of moving average

Appendix Table 6A: Baseline distributed lag regressions without unemployment control

	Total economy Average comp 1948-2015	Total economy Average comp 1948-1973	Total economy Average comp 1973-2015	Total economy Median comp 1973-2015	Total economy Production/nonsupervisory comp 1948-2015	Total economy Production/nonsupervisory comp 1948-1973	Total economy Production/nonsupervisory comp 1973-2015	Nonfarm business Average comp 1950-2015	Nonfarm business Average comp 1950-1973	Nonfarm business Average comp 1974-2015
Δ log productivity	0.60***	0.02	0.61***	0.46**	0.66***	0.29	0.53***	0.47***	-0.05	0.55***
	(0.15)	(0.25)	(0.18)	(0.21)	(0.15)	(0.21)	(0.16)	(0.14)	(0.23)	(0.17)
Δ log productivity,	0.15	-0.10	0.07	0.17	0.22	-0.03	0.04	0.08	-0.07	-0.03
1 year lag	(0.12)	(0.13)	(0.13)	(0.21)	(0.13)	(0.16)	(0.18)	(0.10)	(0.21)	(0.11)
Δ log productivity,	0.18**	0.13	0.04	-0.16	0.04	-0.09	-0.14	0.13	0.01	0.05
2 year lag	(0.09)	(0.09)	(0.13)	(0.16)	(0.13)	(0.19)	(0.15)	(0.08)	(0.12)	(0.10)
Constant	-0.00	0.03***	-0.00	-0.00	-0.01*	0.02**	-0.00	0.00	0.03**	-0.00
	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)
Observations	65	23	42	42	65	23	42	65	23	42
Sum of Δ log productivity coefficients	0.93***	0.05	0.72***	0.47	0.92***	0.17	0.43	0.69***	-0.11	0.57
	(0.12)	(0.25)	(0.24)	(0.30)	(0.19)	(0.25)	(0.31)	(0.15)	(0.42)	(0.21)
F-test: is coefficient significantly different from 1?										
Test statistic	0.33	14.7***	1.37	3.03*	0.17	10.7***	3.47*	4.32**	6.84**	4.31**
Prob>F	0.57	0.00	0.25	0.09	0.68	0.00	0.07	0.04	0.02	0.04

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Notation: the year is listed as the year of the dependent variable

Appendix Table 6B: Baseline distributed lag regressions with time trend

	Total economy Average comp 1948-2015	Total economy Average comp 1948-1973	Total economy Average comp 1973-2015	Total economy Median comp 1973-2015	Total economy Production/nonsupervisory comp 1948-2015	Total economy Production/nonsupervisory comp 1948-1973	Total economy Production/nonsupervisory comp 1973-2015	Nonfarm business Average comp 1950-2015	Nonfarm business Average comp 1950-1973	Nonfarm business Average comp 1974-2015
Δ log productivity	0.72***	0.04	0.85***	0.80***	0.62***	-0.04	0.63***	0.58***	-0.15	0.77***
	(0.17)	(0.27)	(0.17)	(0.19)	(0.23)	(0.22)	(0.20)	(0.16)	(0.32)	(0.16)
Δ log productivity, 1 year lag	0.14	-0.32	0.24**	0.45***	0.20	-0.22	0.10	0.04	-0.25	0.08
	(0.13)	(0.22)	(0.10)	(0.16)	(0.15)	(0.29)	(0.11)	(0.11)	(0.23)	(0.11)
Δ log productivity, 2 year lag	-0.00	-0.08	-0.13	-0.38**	-0.02	-0.18	-0.23	-0.04	-0.26*	-0.12
	(0.10)	(0.15)	(0.15)	(0.18)	(0.16)	(0.19)	(0.19)	(0.09)	(0.14)	(0.13)
Δ unemployment (25-54)	0.22*	-0.21	0.33*	0.72***	0.12	-0.43	0.32	0.00	-0.58***	0.13
	(0.13)	(0.17)	(0.19)	(0.15)	(0.27)	(0.26)	(0.28)	(0.16)	(0.19)	(0.26)
Δ unemployment (25-54), 1 year lag	-0.37***	-0.26	-0.49***	-0.70**	-0.01	0.23	-0.25	-0.41***	-0.16	-0.63***
	(0.13)	(0.24)	(0.17)	(0.27)	(0.19)	(0.36)	(0.25)	(0.14)	(0.26)	(0.17)
Δ unemployment (25-54), 2 year lag	-0.18	-0.06	-0.27	-0.32	-0.07	0.02	-0.01	-0.10	-0.13	-0.13
	(0.17)	(0.23)	(0.19)	(0.19)	(0.19)	(0.28)	(0.22)	(0.19)	(0.26)	(0.20)
Time trend	-0.15	-0.61*	0.07	0.05	-0.15	-0.71	0.36**	-0.25**	-0.61	-0.06
	(0.10)	(0.33)	(0.09)	(0.14)	(0.15)	(0.55)	(0.16)	(0.10)	(0.35)	(0.11)
Constant	0.01	0.05***	-0.01	-0.01	0.00	0.05**	-0.02**	0.01*	0.05***	-0.00
	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
Observations	65	23	42	42	65	23	42	65	23	42
Sum of Δ log productivity coefficients	0.86***	-0.36	0.96***	0.88***	0.81***	-0.4	0.50**	0.58***	-0.66	0.73***
	(0.18)	(0.37)	(0.24)	(0.27)	(0.27)	(0.401)	(0.25)	(0.18)	(0.49)	(0.22)
F-test: is coefficient significantly different from 1?										
Test statistic	0.64	13.5***	0.02	0.20	0.55	12.7***	4.13*	5.14**	11.7***	1.49
Prob>F	0.43	0.00	0.88	0.65	0.46	0.00	0.05	0.03	0.00	0.23

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Notation: the year is listed as the year of the dependent variable

Appendix Table 6C: Baseline distributed lag regressions with decade dummies

	Total economy Average comp 1948-2015	Total economy Average comp 1948-1973	Total economy Average comp 1973-2015	Total economy Median comp 1973-2015	Total economy Production /nonsupervisory comp 1948-2015	Total economy Production /nonsupervisory comp 1948-1973	Total economy Production /nonsupervisory comp 1973-2015	Nonfarm business Average comp 1950-2015	Nonfarm business Average comp 1950-1973	Nonfarm business Average comp 1974-2015
Δ log productivity	0.71***	0.14	0.92***	0.89***	0.54**	0.07	0.63***	0.61***	-0.07	0.89***
	(0.17)	(0.28)	(0.18)	(0.20)	(0.21)	(0.23)	(0.20)	(0.17)	(0.37)	(0.17)
Δ log productivity,	0.08	-0.28	0.34***	0.57**	-0.02	-0.14	0.05	0.02	-0.27	0.22*
1 year lag	(0.17)	(0.22)	(0.11)	(0.22)	(0.16)	(0.29)	(0.12)	(0.14)	(0.25)	(0.11)
Δ log productivity,	-0.04	-0.06	-0.07	-0.32	-0.17	-0.16	-0.27	-0.07	-0.22	-0.09
2 year lag	(0.11)	(0.18)	(0.16)	(0.20)	(0.16)	(0.22)	(0.22)	(0.10)	(0.19)	(0.13)
Δ unemployment	0.23	-0.16	0.46**	0.87***	0.02	-0.43	0.26	0.04	-0.51**	0.32
(25-54)	(0.16)	(0.18)	(0.21)	(0.20)	(0.24)	(0.25)	(0.32)	(0.20)	(0.23)	(0.29)
Δ unemployment	-0.38***	-0.33	-0.53**	-0.74**	-0.07	0.10	-0.30	-0.45***	-0.19	-0.74***
(25-54), 1 year lag	(0.13)	(0.32)	(0.22)	(0.33)	(0.16)	(0.40)	(0.26)	(0.13)	(0.34)	(0.15)
Δ unemployment	-0.14	-0.03	-0.33*	-0.39**	0.03	-0.03	0.00	-0.08	-0.03	-0.22
(25-54), 2 year lag	(0.20)	(0.27)	(0.18)	(0.19)	(0.18)	(0.32)	(0.24)	(0.22)	(0.33)	(0.20)
1950s dummy	0.01	0.01			0.02**	0.01		0.02*	0.01	
	(0.01)	(0.01)			(0.01)	(0.01)		(0.01)	(0.01)	
1960s dummy	0.01	0.00			0.01	-0.00		0.01	0.01	
	(0.01)	(0.00)			(0.01)	(0.01)		(0.01)	(0.00)	
1970s dummy	-0.00		-0.01	-0.01	0.00		-0.01	0.00		-0.00
	(0.01)		(0.01)	(0.01)	(0.01)		(0.01)	(0.00)		(0.00)
1980s dummy	-0.00		-0.00	-0.00	-0.01		-0.01**	-0.00		-0.01
	(0.00)		(0.00)	(0.01)	(0.00)		(0.00)	(0.00)		(0.00)
1990s dummy	-0.00		-0.00	-0.00	-0.00		-0.00	-0.00		-0.01
	(0.01)		(0.00)	(0.01)	(0.01)		(0.00)	(0.01)		(0.00)
2000s dummy	-0.00		-0.01	-0.01	0.00		-0.00	-0.00		-0.01**
	(0.01)		(0.01)	(0.01)	(0.01)		(0.01)	(0.01)		(0.01)
Constant	0.00	0.03***	-0.00	-0.01	0.00	0.03***	0.00	0.00	0.03*	-0.00
	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)	(0.00)	(0.02)	(0.00)
Observations	65	23	42	42	65	23	42	65	23	42
Sum of Δ log productivity coefficients	0.75***	-0.19	1.20***	1.15***	0.35	-0.23	0.41	0.56**	-0.55	1.02***
	(0.26)	(0.31)	(0.25)	(0.36)	(0.25)	(0.28)	(0.27)	(0.27)	(0.52)	(0.26)
F-test: is coefficient significantly different from 1?										
Test statistic	0.98	15.0***	0.63	0.16	6.93**	19.4***	4.93**	2.67	9.00***	0.01
Prob>F	0.33	0.00	0.43	0.69	0.01	0.00	0.03	0.11	0.01	0.93

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Notation: the year is listed as the year of the dependent variable

Appendix Table 7A: Two-year moving average regressions – productivity and the labor share

Dependent variable: 2-year moving average of Δ log labor share	1950-2015	1950-2015	1975-2015
Δ log productivity,	-0.09	-0.54*	-0.16
2-year moving average	(0.09)	(0.27)	(0.18)
Δ unemployment (25-54),	-0.40***	-0.66***	-0.36***
2-year moving average	(0.11)	(0.18)	(0.12)
Constant	0.00	0.02**	0.00
	(0.00)	(0.01)	(0.00)
Observations	65	23	41

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: the year is listed as the second year of the moving average.

Appendix Table 7B: Four-year moving average regressions – productivity and the labor share

Dependent variable: 4-year moving average of Δ log labor share	1951-2014	1951-1973	1976-2014
Δ log productivity,	0.07	-0.14	-0.04
4-year moving average	(0.10)	(0.44)	(0.19)
Δ unemployment (25-54),	-0.38***	-0.25	-0.43***
4-year moving average	(0.09)	(0.27)	(0.09)
Constant	-0.00	0.00	-0.00
	(0.00)	(0.01)	(0.00)
Observations	64	23	39

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: the year is listed as the second year of the moving average.

Appendix Table 7C: Five-year moving average regressions – productivity and the labor share

Dependent variable: 5-year moving average of Δ log labor share	1951-2013	1951-1973	1976-2013
Δ log productivity,	0.07	-0.23	0.04
5-year moving average	(0.09)	(0.40)	(0.17)
Δ unemployment (25-54),	-0.44***	-0.37	-0.54***
5-year moving average	(0.10)	(0.38)	(0.08)
Constant	-0.00	0.01	-0.00
	(0.00)	(0.01)	(0.00)
Observations	63	23	38

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: the year is listed as the second year of the moving average.

Appendix Table 8A: Technology/productivity distributed lag regressions with no lags of productivity growth and unemployment

	Total economy Average comp 1949-2015	Total economy Average comp 1949-1973	Total economy Average comp 1974-2015
Δ log productivity	-0.29***	-0.89***	-0.26
	(0.10)	(0.08)	(0.16)
Δ unemployment (25-54)	-0.28**	-0.40**	-0.32**
	(0.12)	(0.14)	(0.14)
Constant	0.00*	0.02***	0.00
	(0.00)	(0.00)	(0.00)
Observations	64	23	41

Appendix Table 8B: Technology/productivity distributed lag regressions with one lag of productivity growth and unemployment

	Total economy Average comp 1950-2015	Total economy Average comp 1950-1973	Total economy Average comp 1974-2015
Δ log productivity	-0.16	-0.65***	-0.10
	(0.11)	(0.12)	(0.20)
Δ log productivity, lagged	0.16**	-0.07	0.17
	(0.06)	(0.09)	(0.12)
Δ unemployment (25-54)	-0.13	-0.43**	-0.15
	(0.11)	(0.15)	(0.17)
Δ unemployment (25-54), lagged	-0.44***	-0.55***	-0.35**
	(0.11)	(0.19)	(0.16)
Constant	-0.00	0.02***	-0.00
	(0.00)	(0.00)	(0.00)
Observations	64	23	41
Sum of Δ log productivity coefficients	-0.00	-0.72***	0.06
	(0.10)	(0.14)	(0.25)

Appendix Table 8C: Technology/productivity distributed lag regressions with three lags of productivity growth and unemployment

	Total economy Average comp 1950-2015	Total economy Average comp 1950-1973	Total economy Average comp 1974-2015
Δ log productivity	-0.19	-0.67***	-0.21
	(0.13)	(0.12)	(0.18)
Δ log productivity, 1 year lag	0.21**	-0.09	0.26*
	(0.10)	(0.18)	(0.14)
Δ log productivity, 2 year lag	0.07	-0.00	0.06
	(0.10)	(0.14)	(0.14)
Δ log productivity, 3 year lag	-0.13	-0.00	-0.25*
	(0.10)	(0.09)	(0.13)
Δ unemployment (25-54)	-0.19	-0.42**	-0.31*
	(0.12)	(0.18)	(0.16)
Δ unemployment (25-54), 1 year lag	-0.44***	-0.53**	-0.23
	(0.16)	(0.20)	(0.16)
Δ unemployment (25-54), 2 year lag	-0.09	-0.04	-0.27
	(0.15)	(0.11)	(0.21)
Δ unemployment (25-54), 3 year lag	-0.23*	0.04	-0.32
	(0.14)	(0.16)	(0.20)
Constant	0.00	0.02***	0.00
	(0.00)	(0.01)	(0.00)
Observations	63	22	41
Sum of Δ log productivity coefficients	-0.05	-0.77***	-0.14
	(0.12)	(0.24)	(0.29)

Table 9A: Moving average regressions – productivity and the labor share – total economy BLS measure

Dependent variable: 3-year moving average of Δ log labor share	1950-2015	1950-2015	1975-2015
Δ log productivity, 3-year moving average	-0.12	-0.43**	-0.22
	(0.08)	(0.19)	(0.19)
Δ unemployment (25-54), 3-year moving average	-0.16	-0.10	-0.21*
	(0.11)	(0.15)	(0.10)
Constant	0.00	0.01**	0.00
	(0.00)	(0.00)	(0.00)
Observations	65	24	40

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: the year is listed as the middle year of the moving average.

Table 9B: Distributed lag regressions – productivity and the labor share – total economy BLS measure

Dependent variable: Δ log labor share	1950-2015	1950-1973	1974-2015
Δ log productivity	-0.30**	-0.72***	-0.25
	(0.12)	(0.13)	(0.17)
Δ log productivity, 1 year lag	0.20***	-0.07	0.26**
	(0.07)	(0.09)	(0.10)
Δ log productivity, 2 year lag	0.02	-0.00	-0.09
	(0.08)	(0.11)	(0.12)
Δ unemployment (25-54)	0.00	-0.30***	-0.01
	(0.11)	(0.07)	(0.17)
Δ unemployment (25-54), 1 year lag	-0.35***	-0.51*	-0.29**
	(0.13)	(0.26)	(0.14)
Δ unemployment (25-54), 2 year lag	-0.20**	-0.22	-0.27**
	(0.09)	(0.18)	(0.12)
Constant	-0.00	0.02***	-0.00
	(0.00)	(0.00)	(0.00)
Observations	65	23	42
Sum of productivity coefficients	-0.08	-0.79***	-0.08
	(0.10)	(0.15)	(0.23)

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: the year is listed as the year of the dependent variables.

Table 10A: Moving average regressions – productivity and the labor share – nonfarm business sector BLS measure

Dependent variable: 3-year moving average of Δ log labor share	1950-2015	1950-2015	1975-2015
Δ log productivity, 3-year moving average	-0.28**	-0.83***	-0.21
	(0.12)	(0.08)	(0.24)
Δ unemployment (25-54), 3-year moving average	-0.15	-0.04	-0.29*
	(0.15)	(0.14)	(0.16)
Constant	0.00	0.02***	0.00
	(0.00)	(0.00)	(0.00)
Observations	65	24	40

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: the year is listed as the middle year of the moving average.

Table 10B: Distributed lag regressions – productivity and the labor share – nonfarm business sector BLS measure

Dependent variable: Δ log labor share	1950-2015	1950-1973	1974-2015
Δ log productivity	-0.32**	-0.82***	-0.20
	(0.14)	(0.08)	(0.19)
Δ log productivity, 1 year lag	0.20**	-0.14	0.24**
	(0.08)	(0.14)	(0.09)
Δ log productivity, 2 year lag	-0.06	-0.09	-0.15
	(0.09)	(0.14)	(0.12)
Δ unemployment (25-54)	0.05	-0.19	0.02
	(0.15)	(0.13)	(0.25)
Δ unemployment (25-54), 1 year lag	-0.58***	-0.48***	-0.63***
	(0.13)	(0.15)	(0.19)
Δ unemployment (25-54), 2 year lag	-0.15	0.00	-0.21
	(0.14)	(0.18)	(0.20)
Constant	0.00	0.03***	0.00
	(0.00)	(0.01)	(0.00)
Observations	65	23	42
Sum of productivity coefficients	-0.18	-1.05***	-0.11
	(0.16)	(0.29)	(0.24)

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: the year is listed as the year of the dependent variables.

Table 11A: Moving average regressions – relative price of investment goods and the labor share – BLS total economy measure

Dependent variable: 3-year moving average of Δ log labor share	(15a) 1950-2014	(15b) 1950-2014	(15c) 1975-2014	(15d) 1975-2014
Δ log relative price investment goods, 3-year moving average	0.02	0.02	-0.06	-0.06
	(0.09)	(0.09)	(0.13)	(0.14)
Δ unemployment (25-54), 3-year moving average		-0.14		-0.22*
		(0.11)		(0.13)
Constant	-0.00	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Observations	65	65	40	40

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: the year is listed as the middle year of the moving average.

Table 11B: Distributed lag regressions – relative price of investment goods and the labor share – BLS total economy measure

Dependent variable: change in log labor share	(16a) 1951-2015	(16b) 1951-2015	(16c) 1974-2015	(16d) 1974-2015
Δ log rel price of investment goods	-0.04	-0.09	-0.12	-0.20***
	(0.10)	(0.08)	(0.11)	(0.07)
Δ log rel price of investment goods, 1 year lag	0.07	0.15**	0.03	0.21**
	(0.06)	(0.08)	(0.06)	(0.10)
Δ log rel price of investment goods, 2 year lag	-0.02	-0.06	-0.00	-0.11
	(0.08)	(0.07)	(0.11)	(0.11)
Δ unemployment (25-54)		0.08		0.21
		(0.14)		(0.25)
Δ unemployment (25-54), 1 year lag		-0.65***		-0.70***
		(0.12)		(0.21)
Δ unemployment (25-54), 2 year lag		0.02		0.03
		(0.10)		(0.17)
Constant	-0.00	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Observations	65	65	42	42
Sum of rel. price inv. goods coefficients	0.01	-0.00	-0.09	-0.10
	(0.13)	(0.09)	(0.15)	(0.12)

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: the year is listed as the year of the dependent variables.

Table 12A: Moving average regressions – relative price of investment goods and the labor share – BLS nonfarm business

Dependent variable: 3-year moving average of Δ log labor share	(15a) 1950-2014	(15b) 1950-2014	(15c) 1975-2014	(15d) 1975-2014
Δ log relative price investment goods, 3-year moving average	0.05 (0.13)	0.06 (0.13)	-0.08 (0.18)	-0.07 (0.19)
Δ unemployment (25-54), 3-year moving average		-0.16 (0.17)		-0.34* (0.17)
Constant	-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)
Observations	65	65	40	40

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: the year is listed as the middle year of the moving average.

Table 12B: Distributed lag regressions – relative price of investment goods and the labor share – BLS nonfarm business

Dependent variable: change in log labor share	(16a) 1951-2015	(16b) 1951-2015	(16c) 1974-2015	(16d) 1974-2015
Δ log rel price of investment goods	-0.03 (0.14)	-0.10 (0.11)	-0.14 (0.16)	-0.23** (0.10)
Δ log rel price of investment goods, 1 year lag	0.08 (0.09)	0.19** (0.08)	0.01 (0.09)	0.24* (0.12)
Δ log rel price of investment goods, 2 year lag	0.01 (0.11)	-0.06 (0.08)	0.01 (0.15)	-0.13 (0.14)
Δ unemployment (25-54)		0.10 (0.16)		0.17 (0.31)
Δ unemployment (25-54), 1 year lag		-0.88*** (0.12)		-0.95*** (0.26)
Δ unemployment (25-54), 2 year lag		0.12 (0.12)		0.08 (0.23)
Constant	-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)
Observations	65	65	42	42
Sum of rel. price inv. goods coefficients	0.05 (0.19)	0.03 (0.12)	-0.12 (0.21)	-0.12 (0.15)

Newey-West standard errors (HAC) in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Notation: the year is listed as the year of the dependent variables.

Dickey-Fuller unit root test results

Appendix Table 13 reports the results of Dickey-Fuller unit root tests for the productivity and compensation series, and for their first differences

Appendix Table 13: Dickey-Fuller unit root tests

Series	Dickey-Fuller test statistic	No. observations	1% critical value	5% critical value	10% critical value
Levels					
Total economy productivity	0.17	67	-3.56	-2.92	-2.59
Total economy average compensation	-1.81				
Production/nonsupervisory compensation	-4.08***				
Nonfarm business productivity	2.32				
Nonfarm business average compensation	-1.66				
Total economy median compensation	-0.80	41	-3.64	-2.96	-2.61
First differences					
Total economy productivity	-6.90***	66	-3.56	-2.92	-2.59
Total economy average compensation	-4.93***				
Production/nonsupervisory compensation	-4.88***				
Nonfarm business productivity	-7.01***				
Nonfarm business average compensation	-5.43***				
Total economy median compensation	-5.05***	40	-3.65	-2.96	-2.61

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

The Dickey-Fuller test has a null hypothesis that the series does have a unit root.

This null cannot be rejected for any of the series in levels, but is rejected at the 1% level for all the differenced series.