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Do Increases in Labor Productivity Still Drive Wage Growth?

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I. Introduction

In the wake of the 2008 recession and subsequent recovery much has been said surrounding wage growth in the United States. The noise surrounding "the shrinking middle class", "income inequality", and the minimum wage has only gotten louder as the lack of wage growth and how best to address it has become a topic of debate in the political theater. Progressive figures like Bernie Sanders and Elizabeth Warren have hammered rising levels of compensation inequality by citing how low wage growth has impacted the middle and working classes to which most Americans belong. In fact, information on the productivity-pay gap can even be found on Sanders' website.[1] Sanders and Warren have advocated for measures designed to restore wage growth to the average American who relies on their labor compensation as their sole means of income by creating more fluid labor markets by eliminating no-poach and non-compete agreements that help firms retain their talent without increasing their compensation (Rubin 2017).[2] However, current literature on the productivity-pay gap suggests that there is substantial disagreement among scholars in almost all facets surround the productivity-pay gap ranging from its very existence to the most effective tools with which to measure it to its implications for fundamental economic theory that grounds current understanding of wage determination and price setting within the labor market. This analysis seeks to determine the empirical connection between compensation and productivity and how it may have changed over

[1] https://www.sanders.senate.gov/newsroom/must-read/pay-vs-productivity-
[2] Eizabeth Warren policy discussion with Jennifer Rubin of the Washington Post

time. Specifically, whether the extent to which the average worker receives compensation for increases in labor productivity.

The decoupling of wage growth and productivity since 1970 is an interesting economic phenomena because its growth seems to violate current theory on how wage setting occurs in the labor market, mainly that workers are paid according to their marginal revenue productivity. This relationship is defined by the Cobb-Douglas production function:

$$Y = AK^{\alpha}L^{1-\alpha} \tag{1}$$

In this function the relationship of output (Y), capital inputs (K), and labor inputs (L) in production, is defined along with technological progress (A) which is considered constant and exogenous to the model. The marginal product of labor can be found by taking the derivative of the function with respect to labor. By evaluating the derivative for profit maximizing quantities in perfect completion current labor theory indicates that firms last unit of labor is equal in price to the last unit of output produced. Absent perfection competition the equilibrium wage is determined by the marginal revenue product, or the value generated by the final unit of labor.[3] While anyone familiar with economics knows that theory never really manifests itself in reality, the implications of a consistent gap between wage growth and productivity significant.

Beyond theory, growth of real wages has important implications for the growth of living standards and financial stability of average Americans, because they are the main way that productivity growth is passed along from producer to consumers over time. Recent trends following the growth of labor productivity and real wage growth suggest that a smaller portion of

[3] For a more in-depth discussion and theoretical framework in productivity and pay trends see Sharpe, Arsenault, and Harrison (2008).

increased output from labor productivity is being passed on to workers via compensation today relative to the three post-war decade ending in 1970.

The rest of this paper evaluates the strength of the relationship between productivity and pay over-time to determine the size of the gap between labor productivity and real compensation, referred to in the rest of the analysis as the ‘productivity-pay gap’, and subsequently the size of the increase in compensation a worker can expect to see from a rise in labor productivity. This paper relies on a slight modification of distributed lag model used by Stansbury and Summers (2017) to regress log change real compensation onto lagged log changes in labor productivity to determine the cumulative effects on changes in labor productivity on change in compensation, however it furthers their analysis by adding the dimensions of industry and sex to the analysis to determine the extent to which the gap is different across industries and sexes.

The following sections of the paper will recap the current state of literature on the topic in section 2, paying close attention to various measurement issues critical to this analysis. Section 3 will discuss in greater detail the data and empirical strategy used. In section 4 the results of the analysis is presented along with a brief discussion on limitations encountered, and section 5 concludes the analysis and identifies areas for future research

II. Literature Review

The emergence of a productivity-pay gap is relatively recent trend that has emerged since the early 1970s, In the decades following the end of WWII leading up to 1970 inflation adjusted hourly compensation including employer provided benefits rose in conjunction with increases in productivity according to Bivens & Mishel, (2015), but in the years following 1970 growth in real productivity and real wages has slowed. Since 1970 there is some indication that real wage growth has failed to keep up with productivity growth (shown in Bosworth & Perry 1994; Mishel and Sheirholz 2013). In fact, Skare and Skare (2013) show empirically that there has been a "decoupling" of real-wages and real labor productivity by using the Hodrick and Prescott (1997) filter to examine trends in real wages, labor share in GDP, and productivity of labor in a study examining the dynamics within 10 OECD countries. Economists have suggested that this "decoupling" of wages and productivity is complicated and has been influenced by a multitude of factors such as tax and policy changes, declines in unionization, effects of globalization, a decline in labor's share of productivity, worsening terms of trade for workers, as well as technological progress (see Brynjolfsson and McAfee 2013 and references within).

Everyday observation and casual empiricism suggest that declines in unionization could contribute to an increase in the wage-productivity gap. This hypothesis rests on the assumption that as workers collective bargaining power decreases so does their ability to claim their share of additional profits from higher productivity levels increasing the wage-productivity gap. In fact, Ferguson (1996) uses data from 150 industries between 1978 and 1986 to find evidence that a decline in unionization could explain as much as 25% of the increase in the wage-productivity gap between 1981 and 1986 suggesting that a decline in unionization weakened the relationship that tied productivity increases and wage increases together this finding is supported by findings of Millea (2012) that focused on OECD countries.

More recently however, Zavodny (1999) uses manufacturing industry data from 1974 to 1994 to examine changes over five-year intervals to minimize any short-term statistical noise created by year to year changes in productivity and compensation. The study finds that wage increases more closely tracked productivity increases in industries that had higher initial unionization rates. However, the study found less support for the notion that a decline in unionization has contributed to a rise in the wage productivity gap indicating that declining unionization rates, at most, played a small role in the increase of the wage-productivity gap (Zavodny 1999). It should be noted that Zavodny (1999) and Ferguson (1996) use different measures to track how workers are compensated: Ferguson (1996) uses hourly wages while Zavodny (1999) uses total compensation, which includes social security benefits, pensions, health insurance, paid leave, in addition to wages. Therefore at least some of the differences in their findings may be attributable to these differences especially since Zavodny (1999) points out that total compensation has grown slightly faster that wages over the time period measured.

Additionally, changes in labor's share of income and labor's terms of trade have been shown to mediate the relationship between real wages and productivity (see Sharpe, Arsenault, and Harrison 2008a and 2008b). Feldstein (2008) focuses on tracking labor's share of income over time to test whether average compensation has diverged from productivity, finding that real compensation and labor productivity grew together until 2006 when the labor share began to decline in the US non-farm business sector. Since then numerous other studies have documented a decline in the labor share and identified it as a key element of the divergence of the wage productivity gap

(see Elsby, Hobjin, Sahin 2013, Karabarbounis and Neiman 2013, Karanassou and Sala 2014, and Lawrence 2015).

Another factor contributing to the productivity-pay gap is labor's terms of trade refer to price growth of the goods that workers produce versus the price of goods that workers consume. When the prices of goods workers produce grow slower than those that they consume the "terms of trade" worsen. The impact of labor's terms of trade on the wage-productivity gap arises because measures of productivity are usually deflated using producer prices while wages are deflated by consumer prices. Biven and Mishel (2015) estimate that the decline in the labor share contributed 12 percent to the overall wage-productivity gap between 1973 and 2004 while the decline of labor's terms of trade accounted for nearly 30 percent of the wage productivity gap during that same period. This finding is supported by Erumban and de Vries (2016) who also find that worsening terms of trade for labor seem to be the biggest driver of the wage-productivity gap across most industries.

However, there is considerable debate on which price index should be used to deflate nominal wages (consumer price deflators such as the CPI or personal consumption expenditure deflators like the PCE). However regardless of the index used the choice of deflator does not close the wage productivity gap (see Bosworth and Perry 1994).

Regardless, there remains debate within the literature regarding measurement errors and the mismatch between price deflators and the way that wages are measured (see Bosworth and Perry 1994, Anderson 2007, Feldstein 2008). Anderson (2007) in particular points out how the use of average hourly earnings as a measure of worker's wages as opposed to total compensation per hour can significantly overstate the wage productivity gap. This is the case because variable pay as well as other benefits, including: compensation that is connect to a workers performance, overtime, profit sharing, employer benefits, stock options, social security payments, and shift premiums, are excluded from average hourly earnings but are included in total compensation per hour (Anderson 2007). However, Zavodny (1999) points out that even when wages are measured by total compensation as opposed to average hourly earnings the wage-productivity gap still exists.

However, this literature seems to assume that growth in productivity and growth in real wages are related and does investigate whether worker reap the benefits of productivity increases. This paper seeks to expand the current set of literature on the productivity-pay gap in the United States by modifying the model outlined by Stansbury and Summers (2017) to evaluate the strength of the assumed link between productivity and pay across industries and between genders between 1948 and 2010. Doing so will provide insight into how workers reap the benefits of productivity increases through wage growth.

III. Data and Empirical Strategy

Data used for this study is time series data from the World KLEMS database[4]. The data is well suited for this analysis because it covers the total economy but also allows industry-level analysis along 18 major sectors defined at the two-digit level of ISIC rev 3.1 classifications. The data contains time series of various output measures by sector in addition to labor input data along the same classifications. The labor account time series allow for disaggregation within sectors on the along the sex, level of education, age group, and employment class categories[5].

[4] The data set, published by Jorgenson, Ho, Samuels (2012), is a set of industry level production accounts that have been developed to create a consistent time series along ISIC rev 3.1 classifications between 1947-2010.
[5] Employment class is used to distinguish the self-employed from the broader labor force

Other studies of the productivity-pay gap within the United States tend to use a combination of data from the BEA NIPA tables, the BLS CES and CPS-ORG, in addition to unpublished BLS Total Economic Productivity data that includes measures of the entire economy as opposed to the non-farm business sector that is normally covered. Use of KLEMS data in this analysis is somewhat limiting as the results from this analysis cannot easily be compared to other studies that have analyzed the BEA and BLS data due to different industry classification systems used across agencies. The wage and productivity data published by the BEA and BLS data is classified according to SIC and NAICS classifications depending on the year the series was published[6]. The KLEMS data used in this study was produced by Jorgenson, Ho, and Samuels (2012) and is available on the World KLEMS website[7]. The KLEMS data was produced using series of detailed concordance tables in addition to other aggregation methods to integrate multiple historic and current BLS and BEA time series into a single, constant time series running from 1947-2010[8].

In order to maintain consistency over time the KLEMS data remains aggregate at the industry level. This level of aggregation among the KLEMS time series consist of aggregate data that is not possible to construct a measure of median compensation that has been used in past analysis of the productivity-pay gap (Harrison 2009; Bivens and Mishel 2016; Mishel and Gee 2012) to develop a measure of compensation inequality by tracking change in the median to average hourly compensation ratio[9]. However, these time series are often incomplete as shown in

[6] Historical data is generally available along SIC classifications, but most new data is published according to NAICS classifications. Some series are published in both historical SIC and current NAICS classifications, however detailed concordance tables are needed in order to bridge the classification transition and create a consistent time series.
[7] http://www.worldklems.net/data.htm
[8] For full methodology as well as the concordance tables used to merge the time series across different classification systems see Jorgenson, Ho, and Samuels (2012).
[9] This measure helps to separate wage growth of the typical worker from extreme wage growth in the top bracket of income that tend to pull up averages. This is something to keep in mind going forward in this analysis.

Bivens and Mishel (2015) and Mishel and Gee (2012) and require additional assumptions in order to create time series long enough to evaluate the difference in productivity and pay growth rates.[10] Compensation inequality is a relevant component of the productivity-pay gap and tracking median wages over time allows for a more precise picture of the impact of productivity on the average American. Unfortunately, the use of KLEMS aggregate, industry-level time series limits analysis to discussion of averages and broad, industry-wide trends. Results presented in this analysis will be evaluated at the level of average compensation per hour compared to measures other studies that have been able to analyze the trends in average hourly earnings built from survey data. A final limitation of data used in this study is that it omits measures of deprecation. Depreciation is often subtracted from gross measures of output to calculate a net productivity, a figure that more accurately represents the portion of output that is available to be passed on to workers. By using gross figures instead of net figures there is potential that productivity measures are overestimated across time.

In order to evaluate the strength of the relationship between productivity and pay the following model, also used in Stansbury and Summers (2017), is used to evaluate the strength of the relationship between the change in log real compensation per hour and log change in productivity, defined as value added per hour: Real compensation is calculated as total compensation divided by total hours worked and deflated by the CPI-U-RS.[11] Labor productivity is calculated as the total nominal compensation divided by total value added.

$$\Delta\, Ln(\,Real\ Compensation_{ti)} = \sum_0^2 \beta_1 \Delta Ln(\,Productivity\ _{t-i)} + \sum_0^2 \beta_2 \Delta Unemployment_{t-i} + \varepsilon_{ti} \qquad (2)$$

[10] Both Bivens and Mishel (2015) and Mishel and Gee (2012) use the average hourly earnings of production and nonsupervisory employees as a proxy for median wage when a median measure is not available.

[11] Later regressions are industry specific and thus calculate each variable according to the industry account provided in the KLEMS data unless otherwise noted.

This model allows for evaluation of the cumulative effect of changes in productivity on pay by modeling lagged productivity change terms. Additionally, the model is run within various sub-periods within the time series, doing so will help to determine whether the link between productivity and pay has decayed, meaning that changes in productivity increases no appear drive as large an effect on changes in compensation, or whether there another force that is mediating the relationship between productivity and pay. Under a third scenario it is entirely possible that the two series simply grew at relatively similar rates between the years 1949-1970 and there was no initial link or bond which has recently been broken. Under the first scenario where productivity and pay are no longer linked, as they seemed to be in ‘50s, ‘60s, and ‘70s β_1 would fall closer to 0 indicating the potential that a shift occurred that fundamentally altered the way productivity and wages interact.

However, if the relationship between the two variables remains strong but real wage growth is being prevented by some other factor β_1 will be closer to 1. For the purposes of econometric analysis the logs both rates are taken to linearize the trends across variables. Additionally, the log transformation is appealing from an interpretation point of view as the difference between two log values is a close approximation to the percent change in the level of the values across years. Additionally, this allows for an interpretation of regression coefficients that relates an *‘X’*% in labor productivity to a $\beta_1 X$% change in compensation. Evaluating sub-periods within the time series will allow for an evaluation of the change in the coefficient over time, notably before and after 1970.

Following Stansbury and Summers (2017), I account for uncertainty regarding the timeline in which productivity increases may or may not be realized as changes in real compensation by adding two lagged Δlog labor productivity terms to account for a delayed realization of wage growth attributable to productivity growth. Additionally, this regression allows for evaluation of the effect of cumulative change in labor productivity on a single-period change in compensation by summing the coefficients of the Δlog labor productivity terms. Change in log unemployment is included in attempt to reduce the amount of cyclicality in the model due to macroeconomic factors that may bias results.[12]

IV. Results

Table 1: Productivity and Pay Among Males and Females

	Average All Employees			Average Female Comp			Average Male Comp		
	1949-2010	1949-1972	1973-2010	1949-2010	1949-1972	1973-2010	1949-2010	1949-1972	1973-2010
ΔLog Labor Productivity	0.023	0.033	-0.004	.078***	.071**	0.086	.0486*	0.015	0.022
	(0.021)	(0.085)	(0.020)	(0.022)	(0.022)	(0.018)	(0.051)	(0.041)	(0.022)
ΔLog Labor Productivity lagged 1-yr	0.035	0.013	.0379*	-0.019	0.001	-0.057	0.000	-0.076	0.016
	(0.021)	(0.044)	(0.016)	(0.020)	(0.014)	(0.040)	(0.019)	(0.084)	(0.022)
ΔLog Labor Productivity lagged 2-yr	0.021	-0.020	0.016	0.050	0.032	0.060	0.026	0.064	0.007
	(0.015)	(0.072)	(0.014)	(0.027)	(0.026)	(0.032)	(0.023)	(0.058)	(0.017)
Sum ofΔ Log Coefficients	0.078	0.025	0.012	0.031	0.034	0.090	0.026	0.003	0.045
Is the sum of Δ log productivity coefficients significantly different than 0?									
F-stat	1.480	0.280	2.57*	4.59**	5.46**	2.4*	1.73	1.74	1.01
Prob > F	0.230	0.830	0.070	0.006	0.003	0.1	0.17	0.19	0.40

Newey West standard errors in parentheses, ***p<.001, **p<0.05, *p<0.1
Number of lags g is determined by the "rule of thumb" L = 0.75*($T^{1/3}$)
Some of Δlog terms may not sum due to rounding

[12] Potential biases could emerge from patterns in firm hiring and termination practices across peaks and troughs in the business cycle.

Table 1 shows the results of the Δlog labor productivity terms in the first regression that was run to estimate the Δlog compensation of all employees, all male employees, and all female employees for the three time periods shown.[13] Results in Table 1 suggest little to no consistent statistical relationship between the log difference terms of productivity and compensation across the different regressions presented. When evaluating the sums of the Δlog productivity terms for significance with an f-test we find the four of the sums to be significantly different than 0. Three of the sums are from the regression of female compensation across the time periods identified and the final significant value is produced from the regression of all employees' compensation within the 1973-2010 period.

One interesting trend in our results is the relative weakness of the Δlog productivity coefficients in the 1949-1972 period across all groups considering this is the period during which where labor productivity and real compensation tracked closely together. Specifically, it is interesting that the summed Δlog productivity coefficients of the 1949-1972 period are less than those for the 1973-2010 period for both male and female groups. This seems odd considering that the 1942-1972 period was the period where real wage increases seemed to track relatively closely with productivity growth.

Equally surprising was the relative strength of the relationship between the Δ log terms in the 1973-2010 period considering that this is the period where the growth rates between the two measures have diverged. This would seem to imply a greater share of real wage growth is becoming attributable to increases in labor productivity as their growth begins to diverge. Because of the small sample size used in this model it is entirely possible that certain extreme

[13] See appendix for full table.

events contained within the observations could bias results. One such event that may be a source of bias in the results presented is the rise of technology and the internet during the late '90s. If the link between the Δ log variables is weak, a large scale advance in technology such as could boost productivity and wages enough to impact our results. The unemployment term would hopefully help control for events like these that have impacts on the labor market on a large scale, but it cannot account for the increased in productivity attributable to new high-tech capital that has boosted the average workers productivity since the 1970s. Due to the relatively small sample size and large standard errors it is difficult to draw any strong conclusions regarding sub-periods within this model.

The next series of regressions applies the same model to four sectors given in the KLEMS data: manufacturing, utilities[14], construction, and financial intermediation. Sectors were chosen for inclusion based upon a combination of their wage and productivity growth over time[15]. Manufacturing is the sector most often studied in regards to productivity because output is the easiest to measure, it also experienced a significant increase in compensation and productivity over the time period observed. Utilities also experienced a significant increase in measured productivity and compensation over the time periods observed, albeit not as significant as manufacturing. Construction was chosen because it experienced very little productivity growth over time thus providing a good comparison with the other sectors. Financial intermediation was chosen to include a sector within the services portion of the total economy. It should be noted that within the broader services sector productivity is notoriously hard to measure as there is not physical output that can be counted. Financial Intermediation was chosen

[14] Includes electric, gas and water supply.
[15] Figure 1 and Figure 2, shown in the Appendix show an index of productivity and compensation per hour for the four sectors measured.

from other service sectors due to observed productivity growth, significant wage growth, and to attempt to understand how the relationship of productivity and compensation may differ between blue and white collar sectors. Financial Intermediation include the banking sector, which has been at the forefront of the inequality discussion since 2008. This makes the analysis of the link between productivity and pay all the more relevant in that sector.

Table 2: Productivity and Compensation by Industry

	Manufacturing			Utilities			Construction			Financial Intermediation		
	1949-2010	1949-1972	1973-2010	1949-2010	1949-1972	1973-2010	1949-2010	1949-1972	1973-2010	1949-2010	1949-1972	1973-2010
ΔLog Labor Productivity	.11**	0.03	0.11	-0.02	-0.08	0.06	.36**	.58**	0.15	.21*	.19***	.18**
	(0.04)	(0.02)	(0.07)	(0.07)	(0.22)	(0.05)	(0.13)	(0.19)	(0.08)	(0.09)	(0.05)	(0.06)
ΔLog Labor Productivity, lagged 1-yr	.14*	.22***	0.04	0.19	.42*	0.11	0.04	0.21	-0.07	0.08	0.05	0.05
	(0.06)	(0.03)	(0.07)	(0.10)	(0.16)	(0.11)	(0.11)	(0.14)	(0.11)	(0.10)	(0.06)	(0.07)
ΔLog Labor Productivity, lagged2-yr	-0.02	0.00	-0.05	-0.04	-0.10	0.03	0.07	-0.11	0.02	-0.22	-0.03	0.01
	(0.05)	(0.03)	(0.08)	(0.08)	(0.16)	(0.07)	(0.08)	(0.12)	(0.10)	(0.14)	(0.04)	(0.05)
Sum of Δlog terms	0..23	0.25	0.1	0.13	0.24	0.20	0.47	0.66	0.10	0.07	0.02	0.24
Is Δlog productivity coefficient sum significantly different than 0?												
F-stat	3.88**	24.71***	1.56	1.36	6.2**	1.48	3.87**	3.06*	1.37	5.91**	3.22**	3.15**
Prob > F	0.01	0	0.22	0.27	0.005	0.24	.014	0.06	0.27	0.002	0.05	0.04

Newey West standard errors in parentheses, ***p<.001, **p<0.05, *p<0.1
Number of lags is determined by the "rule of thumb" L = 0.75*($T^{1/3}$)
Some of Δlog terms may not sum due to rounding

Table 2 shows the abbreviated results of the industry regression[16]. Coefficients for individual Δ log productivity terms tend to be significant for current Δlog productivity and the one year lag of Δlog productivity suggesting a statistically significant relationship. However,

[16] See Appendix for full table.

standard errors are relatively high indicating that while the sign of the coefficient may be correct, there is still a relatively large amount of uncertainty surrounding the magnitude of the effects. Regardless, there is statistically significant growth in compensation related to growth in productivity in the current year and the previous year. While some coefficients still have negative values that would indicate an inverse relationship between compensation and productivity none are significant. This make sense considering that firms most likely make decision about compensation based on past performance in addition to current expectations.

However, these results differed from those in the first regression series as there was a consistent positive relationship across most time periods and industries in the sum of the Δlog productivity term suggesting that at the industry level the link between productivity and pay may be better defined. This makes sense intuitively as changes in the productivity of a particular industry may have a large impact in pay in that industry but little impact in that of another. These effects are picked up in this regression series but may have been averaged out through the first series.

The link between productivity and compensation by industry tends to mirror that observed in Table 1 across time periods. The 1949-1972 period coefficients in the industry regressions are consistently smaller than their 1973-2010 counterparts just as in the results presented in Table 1. This is not necessarily surprising considering that the groups measured in Table 1 are present in Table 2 just divided into different categories, but it may suggest that the trend is economy wide and not the result of a single outlying sector in both the 1949-1972 and 1973-2010 periods. Again due to large standard errors it is difficult to identify a source of this trend in the log productivity coefficients.

For both the construction and manufacturing the sum of the Δlog coefficient terms are significant according to F-test results, meaning they are statistically significant from zero. These result often indicate that at least at the industry level the effect of productivity and pay seem to be larger relative to those identified in the results presented in Table 1. However, this is only a general trend due to large standard errors in the terms being summed it is again difficult to identify the magnitude of the effect with any real certainty.

There are few sector-level comparisons with interesting implications in Table 2. First, while the current year log productivity change and 1-year lagged log productivity change are mostly significant across manufacturing, construction, and utilities only current year log productivity change is significant in the financial intermediation sector. This may be a result of differences in the timelines of how workers in different sectors realize compensation growth from increases in their productivity.

V. Conclusion

This paper focused on evaluating the link between productivity and pay between 1948-2010 in addition to the sub-periods of 1949-1972 and 1973-2010. Motivation for the paper stemmed from recently political popularity of the subject as progressive figures like Bernie Sanders and Elizabeth Warren have called for various labor market reform policies designed to raise the minimum wage or otherwise change regulations that insulate employers from the pressure to grow compensation, and recent papers by the Economic Policy Institute that highlight a divergence between productivity and compensation since the 1970s, painting it as the dominant factor contributing to stagnating wages for lower and middle class Americans that depend on labor compensation and the vast majority of their income[17]. To be clear this paper does not analyze the growth in that gap, but rather follows the same avenue of inquiry as Stansbury and Summers (2017) by evaluating how strong the link between productivity and pay is across the entire 1948-2010 timespan as well as how it has changed before and after the divergence observed since 1970. This analysis evaluated this strength by regressing the log annual differences of compensation on the log annual differences as well as two lagged terms to estimate what percentage of growth in compensation is attributable to growth in productivity. This analysis is performed for the total economy, total economy by sex, as well as the manufacturing, utilities, construction, and financial intermediation sectors.

Results from the regression analysis yielded a few unexpected results mainly that across most of the data productivity increases tended to account for a larger portion of compensation increases in the years after 1970 that the years before. This may be the result of a few outlying years in the latter sub-period where there were significant productivity gains attributed to rapid technological advancement, mainly between 1995 and 2000. Across all regression standard errors were relatively high so there remains some uncertainty regarding the magnitude of the effects measured. Comparison of results between sectors like also interesting suggesting that certain sectors like financial intermediation may realize increases in productivity with increased in compensation more quickly that industries such as manufacturing, construction, and utilities. This may be the result of the difficulty in measuring productivity in the services sector of could point to fundamental differences in the link between productivity and pay across the services and non-service sectors. Overall, large standard errors make it difficult to determine the magnitude of the effects measured in any detail finer than general terms.

Further analysis is needed to determine additional effects across sectors. Additionally the KLEMS data used in this study provided compensation information by age group and education

[17] See Mishel and Bivens (2015) , Mishel and Gee (2012)

level further analysis or the link between productivity and pay could evaluate change in the link over time for differing age groups and levels of education attainment to see whether these are factors that contribute to the ability. The results if these studies would have significant policy implications regarding labor market policy. Additionally the results are important to the growth of living standards for the average American.

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VII. Appendix

Table 1: Lagged Total Economy Regressions

	Average All Employees			Average Female Comp			Average Male Comp		
	1949-2010	1949-1972	1973-2010	1949-2010	1949-1972	1973-2010	1949-2010	1949-1972	1973-2010
ΔLog Labor Productivity	0.023	0.033	-0.004	.078***	.071**	0.086	.0486*	0.015	0.022
	(0.021)	(0.085)	(0.020)	(0.022)	(0.022)	(0.018)	(0.051)	(0.041)	(0.022)
ΔLog Labor Productivity, lagged 1-yr	0.035	0.013	.0379*	-0.019	0.001	-0.057	0.000	-0.076	0.016
	(0.021)	(0.044)	(0.016)	(0.020)	(0.014)	(0.040)	(0.019)	(0.084)	(0.022)
ΔLog Labor Productivity, lagged 2-yr	0.021	-0.020	0.016	0.050	0.032	0.060	0.026	0.064	0.007
	(0.015)	(0.072)	(0.014)	(0.027)	(0.026)	(0.032)	(0.023)	(0.058)	(0.017)
Unemployment Rate	0.005	0.008	0.002	-0.001	-0.004	0.001	0.001	0.003	-0.001
	(0.003)	(0.005)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
Unemployment Rate, lagged 1-yr	-0.005	-0.004	-.004*	0.003	0.005	-0.003	-0.001	0.004	0.001
	(0.004)	(0.006)	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)	(0.006)	(0.003)
Constant	.017***	.033***	.012***	.012***	.001***	.031***	.017***	.022*	.001**
	(0.003)	(0.006)	(0.002)	(0.003)	(0.002)	(0.003)	(0.004)	(0.008)	(0.003)
Sum of Log Coefficients	0.078	0.025	0.012	0.031	0.034	0.090	0.026	0.003	0.045
Is coefficent sum significantly different than 0?									
F-stat	1.480	0.280	2.570	4.590	5.460	2.400	1.730	1.740	1.010
Prob > F	0.230	0.830	0.070	0.006	0.003	0.100	0.170	0.190	0.400

Newey West standard errors in parentheses, ***p<.001, **p<0.05, *p<0.1 Number of lags g is determined by the "rule of thumb" L = 0.75*($T^{1/3}$)

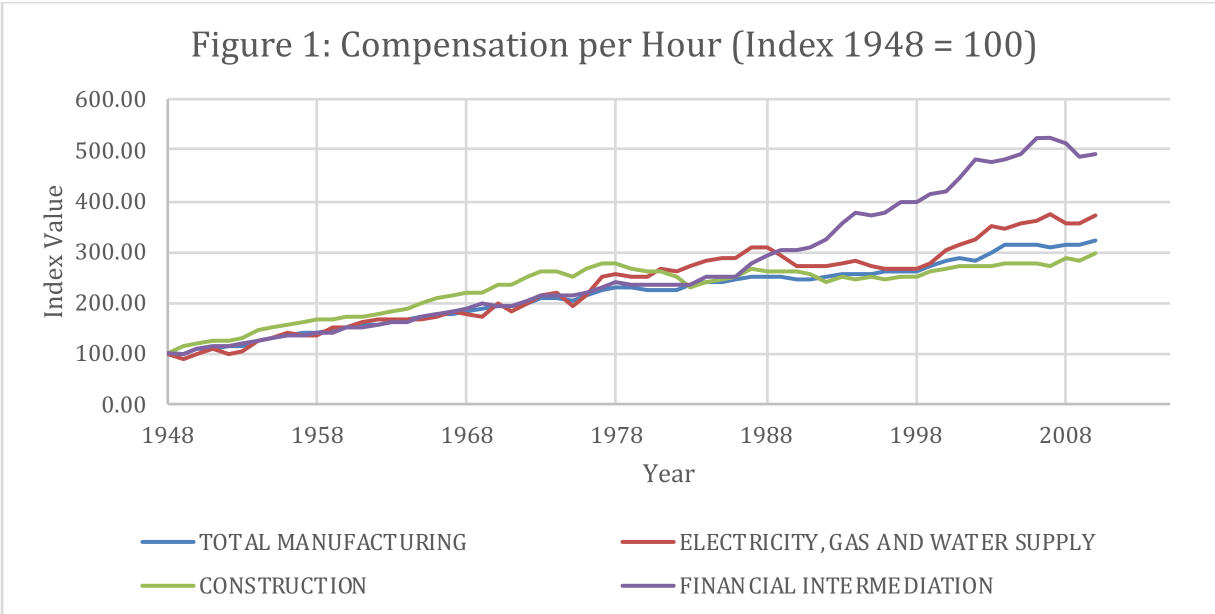
Figure 1: Compensation per Hour (Index 1948 = 100)
600.00
500.00
400.00
300.00
200.00
100.00
0.00
Index Value
1948
1958
1968
1978
1988
1998
2008
Year
TOTAL MANUFACTURING
ELECTRICITY, GAS AND WATER SUPPLY
CONSTRUCTION
FINANCIAL INTERMEDIATION

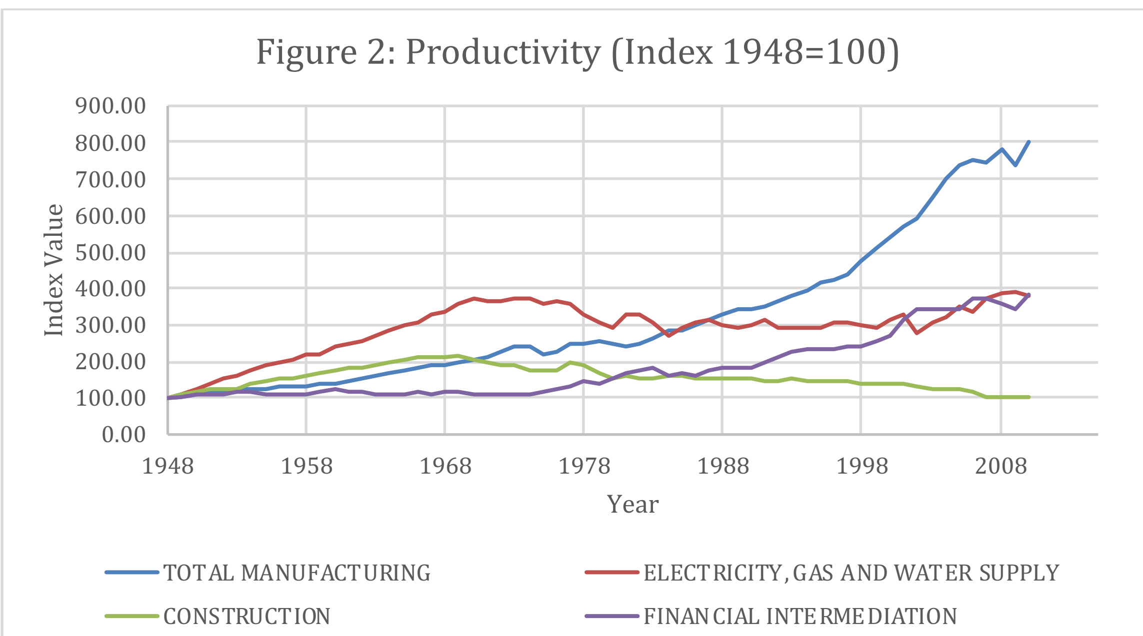
Figure 2: Productivity (Index 1948=100)
900.00
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
Index Value
1948
1958
1968
1978
1988
1998
2008
Year
TOTAL MANUFACTURING
ELECTRICITY, GAS AND WATER SUPPLY
CONSTRUCTION
FINANCIAL INTERMEDIATION

Table 2: Productivity and Compensation by Industry

	Manufacturing			Utilities			Construction			Financial Intermediation		
	1949-2010	1949-1972	1973-2010	1949-2010	1949-1972	1973-2010	1949-2010	1949-1972	1973-2010	1949-2010	1949-1972	1973-2010
ΔLog Labor Productivity	.11**	0.030	0.110	-0.020	-0.080	0.060	.36**	.58**	0.150	.21*	.19***	.18**
	(0.04)	(0.02)	(0.07)	(0.07)	(0.22)	(0.05)	(0.13)	(0.19)	(0.08)	(0.09)	(0.05)	(0.06)
ΔLog Labor Productivity, lagged 1-yr	.14*	.22***	0.040	0.190	.42*	0.110	0.040	0.210	-0.070	0.080	0.050	0.050
	(0.06)	(0.03)	(0.07)	(0.10)	(0.16)	(0.11)	(0.11)	(0.14)	(0.11)	(0.10)	(0.06)	(0.07)
ΔLog Labor Productivity, lagged 2-yr	-0.020	0.000	-0.050	-0.040	-0.100	0.030	0.070	-0.110	0.020	-0.220	-0.030	0.010
	(0.05)	(0.03)	(0.08)	(0.08)	(0.16)	(0.07)	(0.08)	(0.12)	(0.10)	(0.14)	(0.04)	(0.05)
Unemployment	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.000	0.000	0.000
	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)
Unemployment Rate, lagged 1-yr	0.010	.003*	-0.010	-0.010	0.020	-.021*	0.000	0.010	-.011*	-0.010	-.01***	-.01*
	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00	0.00)	(0.00)	(0.00)	(0.00)
Constant	0.010	.01***	0.010	.02**	0.020	0.020	.01*	0.010	0.010	.03***	.02***	.019***
	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)
Sum log terms	-0.020	0.030	0.100	0.130	-0.180	0.200	0.110	0.100	0.100	-0.140	0.020	0.060
Is Δlog productivity coefficient sum significantly different than 0?												
F-stat	3.88**	24.71***	1.56	1.36	6.2**	1.48	3.87**	3.06*	1.37	5.91**	3.22**	3.15**
Prob > F	0.01	0	0.22	0.27	0.005	0.24	.014	0.06	0.27	0.002	0.05	0.04

Newey West standard errors in parentheses, ***p<.001, **p<0.05, *p<0.1

Number of lags is determined by the "rule of thumb" L = 0.75*($T^{1/3}$)

Some of Δlog terms may not sum due to rounding

Unemployment standard errors listed as zero in the table are rounded values <.0055