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Are Manufacturing Jobs Still "Good" Jobs? An Exploration of the Manufacturing Wage Premium*

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March 4, 2022

Abstract

This paper explores the factors behind differences in wages between manufacturing and other sectors. Using data from the Current Population Survey, we find that the manufacturing wage premium—the additional pay a manufacturing worker earns relative to a comparable nonmanufacturing worker—disappeared in recent years and that the erosion of the premium has primarily affected workers employed in production occupations, who experienced a wage decline of 2.5 percentage points since the 1990s relative to other workers in production occupations. While the demographic composition and other worker observables introduce level differences in manufacturing premia, our analysis suggests that they are not responsible for the declining trends. A decomposition of the premium by union membership status reveals that declines have been substantially larger across union members. To quantify the role of unionization membership on wage premia, we exploit the heterogeneity in membership status across industries within manufacturing. We find that the decline in union membership explains more than 70 percent of the decline in premia since the 1990s for union members, but the declines in unionization rates have not significantly affected non-union premia, which have instead responded to other factors, such as capital intensity. Our findings suggest that the erosion of "good" manufacturing jobs has contributed to the increase in overall wage inequality and could accelerate the decline of the manufacturing sector.

Keywords: Wage Inequality, Manufacturing, Union Membership.
JEL classification: E24, J31, J51.

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1 Introduction

According to recent polls conducted by Deloitte for the Manufacturing Institute, Americans continue to perceive manufacturing jobs as "good jobs." In 2017, 8 in 10 Americans surveyed believed that the U.S. manufacturing industry was vital toward maintaining the average American's living standard. In addition, manufacturing was ranked third in terms of importance in creating new jobs, and fourth in maintaining a strong national economy.[1] These perceptions reflect the historical role of the manufacturing sector in offering higher wages and benefits than elsewhere in the private sector. However, the manufacturing wage premium—the additional pay a manufacturing worker earns relative to a comparable nonmanufacturing worker—has recently disappeared, and currently manufacturing wages rank in the bottom half of all jobs in the United States. While the hourly earnings of manufacturing workers rose 2.3 percent per year, on average, between 2006 and 2019, private sector earnings increased 2.6 percent per year over the same period. After the level of the two series converged in April 2018, manufacturing wages have remained below those in the private sector.[2] The erosion of the manufacturing wage premium has primarily affected workers employed in production occupations, as also recently noted by Elvery and Dunn [2017]: the wage premium in production occupations—which account for about 70 percent of all manufacturing employment—disappeared in 2006, while supervisory workers in manufacturing have received a 10 percent premium through 2019 relative to workers in similar occupations in other sectors.[3]

This paper explores the factors that contributed to the disappearance of the manufacturing wage premium. First, we rely on worker-level data from the Current Population Survey (CPS) to address the role of worker observable characteristics and the decline in unionization rates on the wage premium. We document that changes in the demographic characteristics of the manufacturing workforce over time have been broadly similar to the

[1] See Ruckelshaus and Leberstein [2014], Giffi et al. [2017], and Langdon and Lehrman [2012].

[2] Recent anecdotes suggested that, with continued differential gains in wage growth, even relatively lower paying jobs in the leisure and hospitality sector have been offering competitive wages and have been able to attract workers previously employed in factories. See, for example, Hufford and Naughton [2021].

[3] See Harris and McCall [2019], who describe in details the patterns in manufacturing hourly wages and in other sectors' wage between 1990 and 2018.

changes in other sectors and do not materially affect the trend in the manufacturing wage premium. After controlling for demographic characteristics, we estimate that the manufacturing wage premium declined 2.5 percentage points (pp) between the 1990s and the 2010s, which is similar to our raw estimate without those controls. Next, we explore the role of unionization rates, which have declined dramatically over the past few decades across most sectors, but the decline has been much more pronounced for the manufacturing sector. In our analysis, we decompose the residual premia—that is, the wage premium that exists after controlling for worker observable characteristics—across unionized and non-unionized workers. We find that, although premia declined significantly in both groups, the decline was much larger across unionized workers: the wage premium for unionized workers in manufacturing moved down 5.5 pp relative to unionized workers in other sectors, while wages for non-unionized manufacturing workers declined only 2.5 pp relative to similar groups outside of manufacturing. Because these estimates could still be affected by changes in sectoral composition and unobservable worker characteristics, we also look at the relationship between changes in the wage premium and changes in union memberships within manufacturing. Overall, changes in premia associated with workers joining or leaving a union account for about 70 percent of the decline in the premium. These effects, however, are identified from a very small number of observations and tend to be marginally significant.

Second, we shift our attention within manufacturing and explore the variation in premia across manufacturing industries to quantify the role of unionization conditional on other industry characteristics—such as productivity, trade exposure, firm size and age distributions, and capital intensity. This is our core empirical strategy, and it relies on lagged union membership rates to address concerns of endogeneity and wage-stickiness. We find that the decline in unionization rates is the most important factor for changes in wage premia; in particular, a one standard deviation (sd) decline in unionization rates—which corresponds to a decrease of 13 pp—is associated with a decline in the wage premium of 1.4 pp. Our analysis is also robust to the impact of other factors, such as the increasing adoption of temporary help services in manufacturing, the presence of exporters, and the imputations in the CPS sample.. To put our quantification exercise in historical context, the

decline in unionization rates since the 1990s explains more than 70 percent of the decline in premia across industries within manufacturing. In addition, looking at the effect on wage premia separately for unionized and non-unionized workers, we find that changes in unionization rates tend to be positively associated with changes in premia for worker groups, as in the literature pioneered by Freeman and Medoff [1981], but the effect is significant only for unionized workers. For non-union members, capital intensity appears to drive the variation in (residual) wage differences.

Finally, our paper connects the trends in manufacturing wages to the wage dispersion across sectors and occupations: borrowing the methodology on decomposing wage dispersion from Davis and Haltiwanger [1991], we find that the declines in manufacturing wages have contributed to the increase in wage inequality between sectors and occupations and, ultimately, have affected overall wage inequality. In sum, the erosion of wages in the manufacturing sector is an important contributor to wage inequality, complementary to the secular decline of the manufacturing sector proposed by Gould [2019].

This paper builds on the evidence on wage differentials across manufacturing and other industries documented by Harris and McCall [2019], Levinson [2019], and Elvery and Dunn [2017]. Our work contributes to the literature on wage inequality and the identification of worker- and firm-level characteristics in the spirit of Abowd et al. [1999]. As in the work by Langdon and Lehrman [2012] and Mishel [2018], we first investigate the role of worker observables on changes in the manufacturing premium. While we lack firm-level data, in a novel second step, we proxy those characteristics with extensive sector-level controls. Because our findings point to the role of trends in unionization rates on wage differences, our work is also closely related to the papers that looked into the role of de-unionization (see Freeman [1992], DiNardo et al. [1996], Card [1996], and Fortin and Lemieux [1997]).[4]

[4]For a more comprehensive literature review on trends in wage inequality, see Katz and Autor [1999] and Goldin and Katz [2001].

2 Data

To analyze wage dynamics in manufacturing and other sectors, our analysis relies on two main sources of data from the Bureau of Labor Statistics (BLS): the Current Employment Statistics (CES) and the Current Population Survey (CPS). The CES survey, based on establishment-level data, is designed to measure broad patterns in sector-level employment and earnings; we draw on the CES statistics to contrast aggregate trends in manufacturing with those in the private sector. Data from the CPS, a household survey with worker-level characteristics, feature in our main empirical analysis to disentangle the effect of demographic trends from other factors.

With differences in scope between the two surveys, we restrict the CPS sample to workers employed in the business sector (NAICS 11–81), as in the CES sample. In our exploratory analysis, our sample covers the period between 1983 and 2019, and, to capture long-term trends, we organize our exploration around the four decades over that time; in our main regressions, however, because of data availability for all controls, the sample spans from 1990 to 2019.[5]

In the CPS data, industry and occupation classifications have been revised over time, and we construct consistent industry and occupation codes. We primarily follow Pollard [2019] to build our concordance.[6] For the mapping of manufacturing industries between CPS and NAICS codes, we introduce three main modifications. First, we split the *Electrical Product Manufacturing* aggregate (NAICS 334-335) into two separate industries, *Computers and Electronic Products Manufacturing* (NAICS 334) and *Electrical Equipment, Appliance, and Component Manufacturing* (NAICS 335), using the post-2002 average employment shares across those 3-digit NAICS industries. Second, we group *Printing and Related Support Activities* (NAICS 323), which is classified under NAICS 511 in the Pollard [2019] classification, with *Paper Manufacturing* (NAICS 322). Third, we exclude from the *Miscellaneous and not Specified Manufacturing* grouping (NAICS 339,31-33) those industries with unspecified

[5] While BLS data are available from 1979 through mid-2021, we exclude earlier years—in which individual and firm-level information tend to be more limited—and the most recent years—when fluctuations in wages and worker flows might be heavily influenced by the COVID-19 pandemic.

[6] In particular, we rely on tables C.5 and C.6.

manufacturing NAICS codes (NAICS 31-33) to separately identify *Miscellaneous Manufacturing*, (NAICS 339).

Finally, we match industry-level data to CPS industry aggregates. In particular, we rely on the Bureau of Labor Statistics (BLS) labor productivity, Federal Reserve Board data on capital expenditures, the Census Bureau's international trade data and Quarterly Workforce Indicators, all sources we collected at the 3-digit NAICS industry detail.

2.1 The Manufacturing Wage Premium

As measured in the CES data, manufacturing average hourly wages for all employees were 3 percent above wages in the private sector in 2006, a difference commonly know as the *manufacturing wage premium*.[7] Since then, manufacturing wages have averaged gains of 2.3 percent per year, while wages in the private sector have risen 2.6 percent per year. As a consequence of faster growth, the level of wages in the private economy caught up with manufacturing wages in April 2018 and has been higher ever since (figure 1).

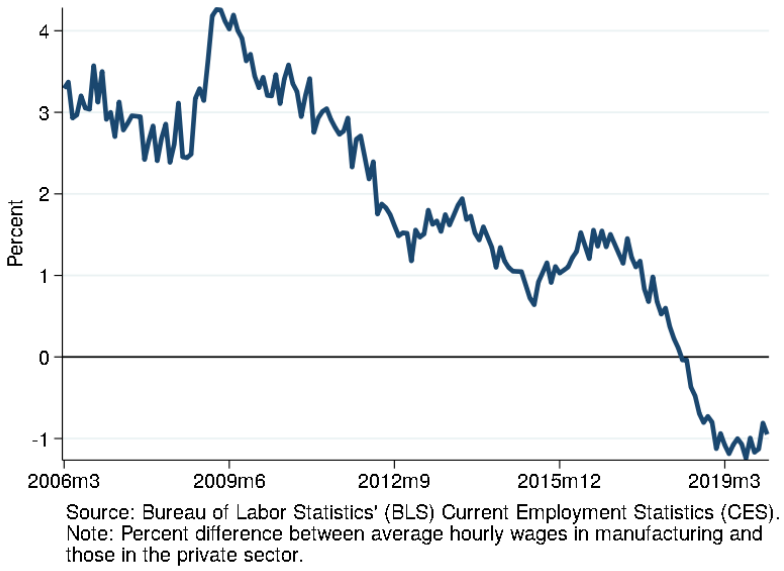


Figure 1: Manufacturing Wage Premium

Notably, the erosion of the manufacturing wage premium has been mostly confined to

[7] While data on production worker wages in manufacturing are available since 1939, data on all workers have been available only since 2006. Our analysis of production worker wages looks at developments since the 1980s for broader data availability.

production occupations, which currently account for about 70 percent of manufacturing employment. Figures 2 and 3 report data on the manufacturing premium as a percent difference relative to private-sector wages by major occupation groups: figure 2 shows production worker wage premia, and figure 3 presents nonproduction/supervisory worker wage premia. While the manufacturing premium has recently also moved down also in supervisory occupations, manufacturing supervisory workers continue to enjoy a 10 percent wage premium. The wage premium across production occupations, instead, had steadily declined since the late 1990s and disappeared in the mid-2000s. In 2019, manufacturing wages for production workers were 5 percent below those of production workers in the rest of the private sector.

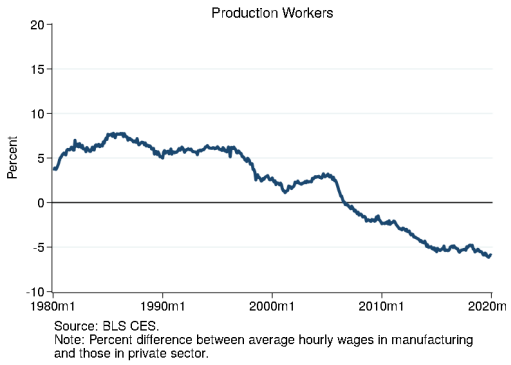


Figure 2: Manufacturing Wage Premium, Production Occupations

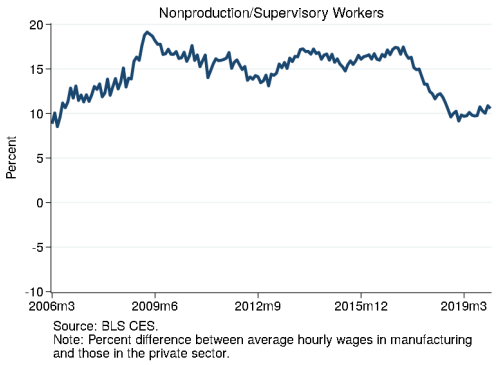


Figure 3: Manufacturing Wage Premium, Supervisory Occupations

Figures 4 and 5 show, respectively, the manufacturing wage premium in production and supervisory occupations using CPS data, the source more extensively used in our empirical analysis. The premia estimates shown in the charts are based on the coefficients of interactions between time indicators and a dummy for the manufacturing sector. To easily identify long-time trends, our baseline estimates look at changes in average premia over four decades, between the 1980s and 2010s.[8] Although the magnitude of the premia are somewhat different between CES and CPS data, the qualitative patterns remain broadly consistent. Supervisory worker premia in manufacturing have been little changed in recent decades—fluctuating around 25 percent in CPS data versus 10 percent in CES data— while production workers employed in the manufacturing sector have experienced

[8]See figures A1 and A2 for trends using yearly data.

a significant decline in wages relative to similar occupations in other sectors: since the 1990s, the manufacturing wage premium for production workers has declined 2.5 pp to 1¼ percent in the 2010s, a point estimate that has remained significantly different from zero. Thus, the CPS data still argue for the decline in the *manufacturing premium* across production occupations althought not for its full disappearance yet.

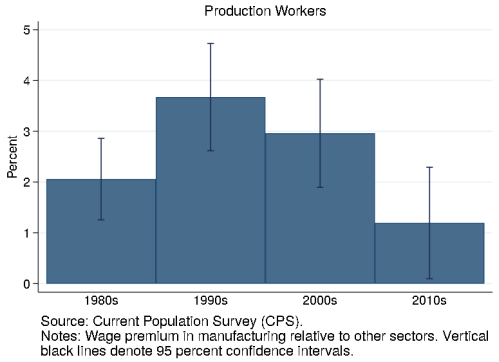


Figure 4: Manufacturing Wage Premium, Production Occupations

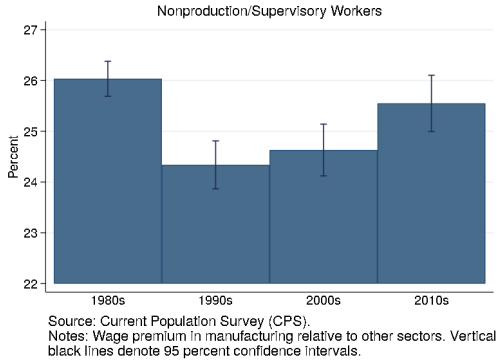


Figure 5: Manufacturing Wage Premium, Supervisory Occupations

2.1.1 The Manufacturing Premium: Weekly Wages and Nonwage Compensation

Differences between manufacturing and other sectors have also been narrowing in weekly wages. Figure A3 shows the percent difference in average weekly wages between manufacturing production workers and production occupations in other sectors as measured in CES data. After rising in the 1980s, differences in production worker weekly wages gradually declined in subsequent decades but still averaged 18.6 percent in the 2010s. While the weekly manufacturing premium remains sizeable, the declining trend appears to be the result of the behavior of average hourly wages. In contrast, differences in average weekly hours between manufacturing and other sectors, as shown in figure A4, have increased over time: in the 1980s, a production employee in manufacturing worked an average of 40.4 hours per week versus 36.2 hours for production workers in other sectors. The workweek difference rose to 8.1 hours in the 2010s, with average weekly hours increasing for manufacturing production workers but decreasing for production workers in other sectors. The increase in hours has partly offset the decline in average hourly wages, resulting in weekly manufacturing wages in manufacturing still above those of other sectors.

Even with recent declines, however, wages represent only one dimension to evaluate manufacturing jobs. Other characteristics—such as benefits, the nonwage component of compensation, and tenure—have historically been higher for manufacturing workers and, thus, have contributed to the view of a *manufacturing premium*. However, while separation rates have remained significantly below those of other sectors, differences in nonwage compensation between manufacturing and other sectors have also been narrowing in recent years.[9]

Figure A5 reports the percent difference in benefits between manufacturing and the private sector; these data, which are from the Employer Cost of Employee Compensation survey, are available only since 2004 and provide separate details for full-time and production workers.[10] The relative decline in benefits is particularly striking for full-time workers: While in the mid-2000s full-time manufacturing workers received 20 percent higher benefits relative to full-time employees in other sectors of the economy, that premium declined 15 pp, to 5 percent, by 2020. Production workers in manufacturing, instead, have continued to enjoy benefits that are 10 percent higher than in other sectors since the mid-2000s. The declines in the nonwage component of compensation has implied that the total compensation of full-time manufacturing workers currently stands 5 percent below that of similar workers in other sectors. In contrast, the little changed levels of benefits for manufacturing production workers partly offset the declines in wages and salaries for a premium in total compensation of 5 percent relative to other sectors. All told, as we focus on full-time production workers in manufacturing, these findings still suggest mildly declining patterns in the benefits and total compensation for that group of manufacturing workers relative to other sectors.

In sum, a few characteristics of manufacturing jobs have deteriorated over time relative to other sectors; in what follows, we analyze differences in average hourly wages to abstract from the variation in hours and in other factors that could affect trends in aggregate wages, and we rely on the richness of the CPS data to explore the role of worker observables.

[9] Using CPS data, we find that separation rates within manufacturing are 5 pp below those of other sectors.

[10] Data for production worker groups are only available since 2006Q4.

2.2 The Role of Worker Observables

This section explores the role of worker observables on wage differences between manufacturing and other sectors. First, we control for demographic trends and other observable characteristics; then, we explore in more detail how trends in unionization rates have shaped the manufacturing premium.

Demographic Trends and Other Observables

The presence of a manufacturing premium appears even more remarkable after considering that manufacturing has historically employed worker groups that typically received lower wages, such as less educated workers. Figures A6-A9 present the distributions of production worker employment by gender, age, education, and race and ethnicity in the 1980s and compare them with the composition of private sector employment at that time. In the 1980s, the average manufacturing production worker was white, male, aged 25 to 34, and a high school graduate. All told, the demographic characteristics of production worker employment exhibit only small differences in comparison with other sectors, with manufacturing production workers slightly more likely to be older, less educated, and less likely to be male.[11]

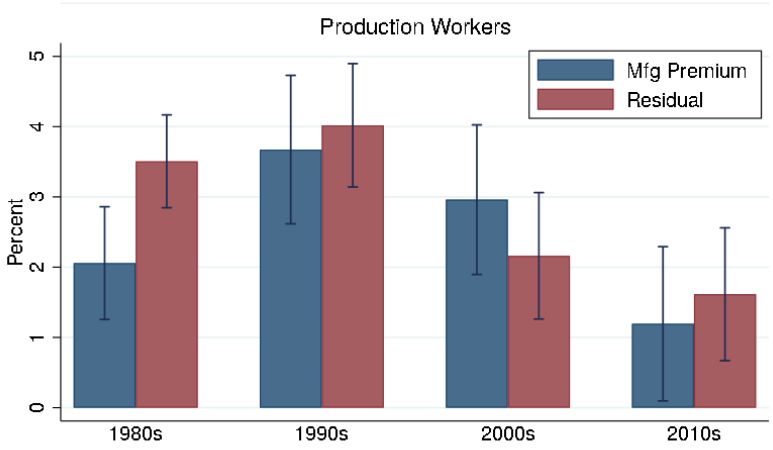
Since the early 1990s, demographic trends within manufacturing have led to an increase in the shares of aged 35 or older, male workers and a decline in the shares of high school graduates and of white employment. Changes in demographics have been mostly consistent with changes elsewhere in the economy; the modest differences in demographic trends—with a relatively larger increase in the share of male employment and of older workers and a relatively larger decrease in the share of high school graduates—actually suggest that the manufacturing premium should have increased since the 1990s, a prediction that is not consistent with our estimates.[12] Figure 6 compares the raw production worker premium with the *residual premium*, an estimate that controls for demographic

[11] Differences in demographics characteristics tend to be much larger for aggregate employment, suggesting that they emanate from employment in supervisory occupations.

[12] Figures A10-A13 show the evolution of production worker shares in manufacturing and contrast it with the evolution of employment distributions in the private sector.

characteristics and several other observables—that is, union membership, marital status, tenure, metropolitan area, and state-year dummies, which absorb all the variation at the state-year level, such as income and migration flows.

Two main findings emerge from our analysis. First, controlling for demographics, we find that residual premia in the 1980s were significantly higher than raw estimates, consistent with disproportionately higher employment of lower-wage workers in manufacturing at that time: we find a premium of 3.5 percent after controlling for demographics, 1.5 pp higher than the raw estimate. Second, controlling for demographics does not affect the magnitude of the overall decline in the manufacturing wage premium: adjusting for level differences, the residual manufacturing premium also declined 2.5 pp, from a peak of 4 percent in the 1990s to 1$^1/_2$ percent in the 2010s. Thus, trends in demographics and other worker observables cannot account for the decline of the manufacturing wage premium.



Source: CPS.
Notes: Residual wage premium in manufacturing relative to other sectors, after controlling for age variables, sex, union membership, marital status, education, race, tenure, metro area, and state-year dummies. Vertical black lines denote 95 percent confidence intervals.

Figure 6: Manufacturing Wage Premium, Production Occupations: Comparing Premia with and without Worker Observables

Unionization and the Premium

So far, our analysis has included information on union membership among worker observables and has identified average differences in hourly wages between manufacturing and other sectors controlling for union memberships status. However, union membership

deserves a more detailed analysis, as it has undergone significant changes over time and has been typically associated with large differences in wages across workers. In fact, in manufacturing, union membership rates dropped almost 20 pp since the mid-1980s, a significantly larger decline compared to what happened in the rest of the economy–as shown in figure 7. In addition, while unionized production workers continue to enjoy higher wages than non-unionized workers, the wage premia of the unionized production group, summarized in figure 8, also experienced significant declines, moving down from 17 percent in the 1980s to 12 percent in the 2010s.

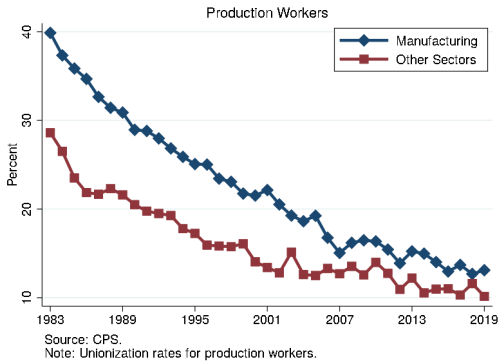


Figure 7: Unionization Rates, Production Workers

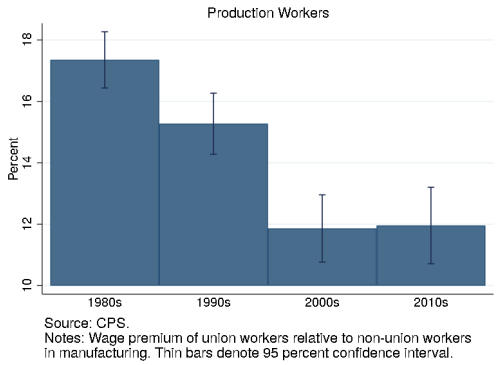


Figure 8: Union Premium, Manufacturing, Production Occupations

While the timing of those declines and the relative movements in unionization rates seems consistent with the evolution of the manufacturing wage premium, significant changes unionization rates and premia also decreased in sectors outside of manufacturing. To quantify the implications of the changes in the union premium on the manufacturing wage premium, we rely on a model that directly compares wages by union status between manufacturing and other sectors across the four decades of our analysis, with decade $j \in \{1980s, 1990s, 2000s, 2010s\}$,

$$\ln w_{it} = \alpha_0 + \alpha_{1,j}\text{Mfg}_{it} + \alpha_{2,j}\text{Union}_{it} + \alpha_{3,j}Mfg_{it} \cdot \text{Union}_{it} + \gamma X_{it} + \epsilon_{it}$$

In our model, $\alpha_{1,j}$ represents the percent difference in wages between manufacturing non-union workers relative to non-union workers in other sectors in decade j, while $\alpha_{1,j} + \alpha_{3,j}$ identifies the percent difference in wages between manufacturing union workers relative

Table 1: Sector-Level Regressions: Wage Premia and Unionization

	Non-union Premium	Union Premium	Union Share	Avg Mfg Premium
1980s	4.6%	-1.1%	34%	2.7%
1990s	5.4%	-2.4%	25%	3.5%
2000s	3.8%	-7.4%	18%	1.8%
2010s	2.9%	-8.1%	14%	1.3%
Δ 2010s - 1990s	-2.5 pp	-5.8 pp	-11 pp	-2.2 pp

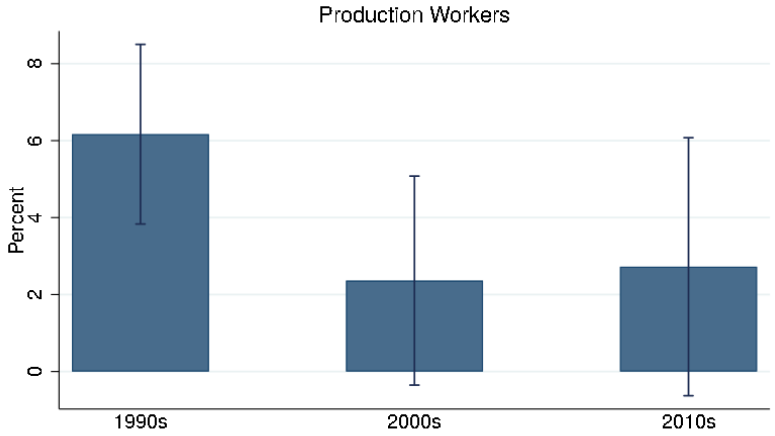
Source: Bureau of Labor Statistics.
Notes: Wage differences are estimated from worker-level regressions that control for age variables, sex, marital status, education, race, tenure, metro-area, and state-year dummies, 1983-2019.

to union workers in other sectors in decade j—controlling for demographics and other worker observables, X_{it}, as in our previous part of our analysis.

Using these estimates, the residual manufacturing wage premium can be proxied by a weighted average of the premia across unionized and non-unionized workers—that is, Average Premium$_j = \alpha_{1,j} + \alpha_{3,j}$*Union Share*$_{it}$. Table 1 summarizes the estimates from our decomposition. Two main findings emerge from this analysis. First, the decline in relative wages across union workers has been more than twofold than across non-unionized members. Second, the decline in the share of unionized workers—which dropped 11 pp since the 1990s—has partly offset the change in the union premium: If union shares had remained at the same average level as in the 1990s, average premia in the 2010s would have been 0.1 percent, translating into declines in premia of more than 3 pp.

Our union premia estimates, however, could confound the effect of sectoral composition and other time-invariant worker unobservable characteristics. To isolate the impact of changes in union memberships from those factors, we separately looked at flows of manufacturing workers into or out of unions by using longitudinally linked observations in the CPS microdata; the results from this analysis are shown in figure 9. Overall, the drop in union membership is associated with a significant decline in the manufacturing premium of about 4 pp between the 1990s and the 2010s. This decline combines two effects. First, workers joining unions in the 2010s tend to have lower wage premia than in the previous decades. Second, workers leaving unions in the 2010s seem not to suffer much of a wage discount; in contrast, workers who left unions in the 1990s were offered (sig-

nificantly, although marginally so) lower wages.[13] This analysis, however, relies on very few observations and, thus, the associated estimates tend to be estimated with very large standard errors.



Source: CPS.
Notes: Residual wage premium in manufacturing relative to other sectors due to changes in union membership, after controlling for age variables, sex, marital status, education, race, tenure, metropolitan area, and state-year dummies. Thin bars denotes 95 percent confidence interval.

Figure 9: Changes in Wage Premia of Unionized Workers in Manufacturing, Production Occupations

3 Empirical Strategy

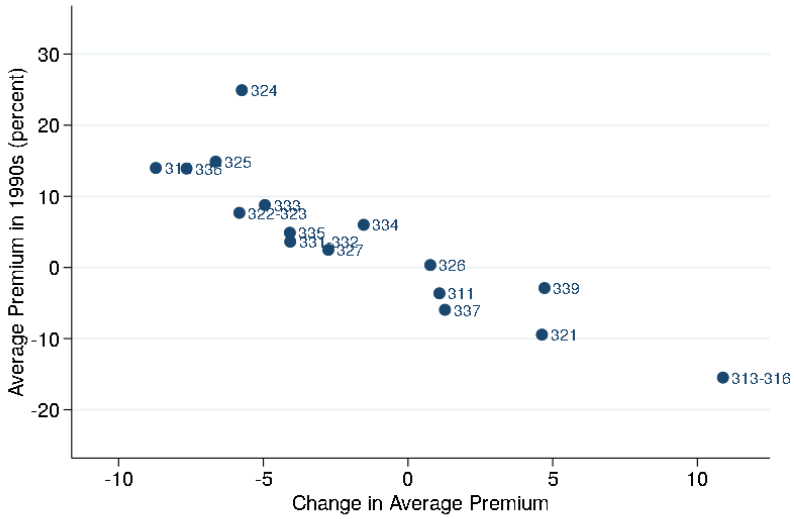
All of our analyses so far have relied on the variation across individuals and over time to identify differences in wages between manufacturing production workers and production workers in other sectors of the economy. We view that part of the investigation, however, as mostly descriptive since it lacks controls on firm or sector characteristics, which the literature has shown to be important determinants of wage premia. Furthermore, an economy-wide analysis of the patterns of wages would not be an ideal setting for further investigations since sector premia are calculated relative to aggregate wages; in fact, while manufacturing wages have declined relative to the rest of the economy, wage gains in some other sectors should have been faster than in the aggregate. To make progress on the factors behind the secular decline of manufacturing wages and to be able to control for

[13] Figure 7 shows a decomposition of the "inflow" and "outflow" effects.

various proxies of firm-level characteristics, we will look at industries within manufacturing, leverage differences in wage premia across those industries, and relate those trends to changes in union membership.

Since the relative decline in manufacturing wages started in the 1990s, this section focuses on the period from the 1990s to the 2010s, a period also covered by all the main controls included in our analysis.

While manufacturing production workers have enjoyed, on average, a 4 percent wage premium since the 1990s, there have been large differences in premia across manufacturing industries. In the 1990s, average wage differences ranged from a 25 percent premium for the *Petroleum and Coal Products Manufacturing* industry (NAICS 324) to a 15 percent *penalty* for *Textile, Apparel, and Leather Manufacturing* (NAICS 313-316). By the 2010s, the range of the average premia had contracted, with wages declining in industries that enjoyed higher premia and increasing in industries that suffered wage discounts. The negative relationship between initial wage differences and subsequent changes, shown in figure 10, points to convergence in premia across industries.[14]



Source: BLS.
Note: Percentage point difference in average premium between 2010s and 1990s.

Figure 10: Convergence in Wage Premia across Manufacturing Industries

The differential trends across industries have been positively correlated with the mag-

[14]Convergence trends are qualitatively similar if comparing the 2010s to the 1980s.

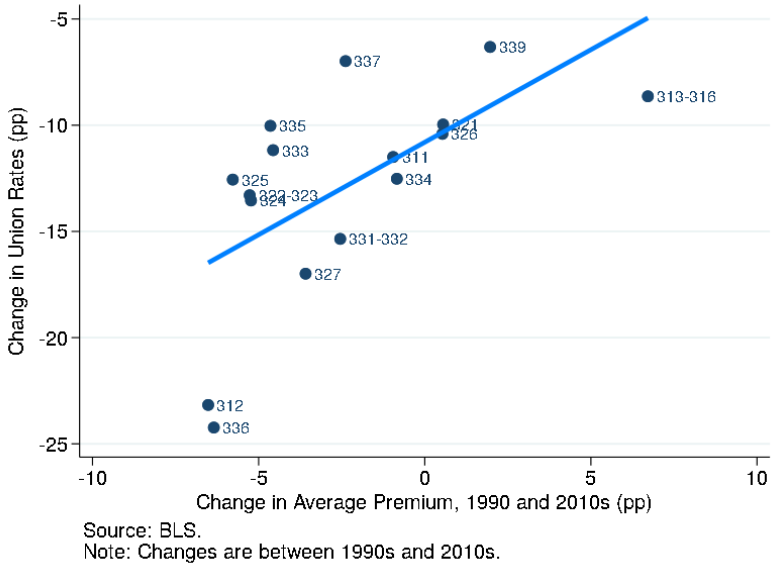


Figure 11: Wage Premia and Unionization Rates across Manufacturing Industries

nitude of the decline in union memberships. Although unionization rates declined across all manufacturing industries, figure 11 shows that those industries that experienced the largest declines in union memberships between the 1990s and the 2010s—such as, *Beverage and Tobacco Product Manufacturing* (NAICS 312) and *Transportation Equipment Manufacturing* (NAICS 336)—also displayed the largest declines in wages relative to the rest of the economy.[15]

The large heterogeneity in premia and unionization rates within manufacturing industries and reduced form evidence on long-term trends suggest that those industries provide a natural setting to extend our investigation. Thus, our main empirical strategy will exploit the variation in the declines in wages and unionization rates across manufacturing industries. In particular, our baseline equation relates the industry-level residual wage premium—that is, the estimate of wage differences relative to sectors outside of manufacturing that controls for demographic characteristics and other available worker observables—to the unionization rates, conditional on a variety of other factors,

$$\text{Res. Premium}_{st} = \beta_0 + \beta_1 \text{Union Rate}_{s,t-1} + \gamma X_{st} + d_s + d_t + \varepsilon_{st} \tag{1}$$

[15] As with the premia convergence, the relationship between changes in premia and changes in unionization rates is qualitatively similar if looking relative to the 1980s.

where s indicates a 3-digit NAICS industry within manufacturing, Res. Premium denotes the residual wage premium of an industry, and Union Rate represent the unionization rate of production workers within the same industry. β_1 is our coefficient of interest: We exploit within-industry variation in union membership to identify average changes in wages across manufacturing industries relative to other sectors. To address concerns of endogeneity as well as possible time lags between changes in union membership status and effects on wages, we rely on lagged union membership rates as our main regressor.

In addition, our specification includes industry fixed effects, time dummies, the industry employment share relative to total manufacturing employment—to abstract from the dynamics introduced by shrinking industries that could depress wage and unionization membership—and various other industry-level controls that capture average firm-level differences across manufacturing industries. In particular, following the trends in wage premia at large firms documented by Bloom et al. [2018], we control for the share of large (500+ employees) firms across manufacturing industries. Similarly, as Haltiwanger et al. [2012] points to an increase in the employer age premium, we include in our model the share of young (5 years or less) firms in the industry.

Furthermore, recent strands of the trade literature have advocated for a simultaneous role of export exposure and technology in determining labor demand patterns and have highlighted the importance of outsourcing and import competition on wage conditions.[16]. Thus, (1) includes the share of exports out of total production and the import share in domestic absorption–that is, the share of imports out of domestic consumption.

Finally, we control for labor productivity and capital intensity, "traditional" labor market features that tend to drive wage differences across manufacturing industries.

4 Results

Table 2 presents our main results. We find that the lagged unionized share of employment is strongly positively associated with the manufacturing wage premium. Adding industry-

[16]See, for example, Verhoogen [2008] and Bustos [2011] on the impact of exporting on labor demand and Feenstra and Hanson [1996] and **?** on the channels for the impact of imports.

level controls to our basic specification lowers only modestly our estimated effect of the unionized share and keeps it statistically significant. The effect of changes in unionization on wages is also economically significant: Using the coefficient from column (7)—our preferred specification—reducing the share of union members in an industry from 100% to 0 would lead to a 10% decline in the wage premium. While this hypothetical shock may not be considered realistic, expressing it in terms of standard deviations of the explanatory variables—a common approach to quantify results—still points to economically meaningful magnitudes. A one-standard-deviation decrease in the (lagged) unionization rate—which correspond to a decline of almost 13 pp—implies that the dependent variable would move down 1.4 pp. To convert this result in terms of standard deviations, we divide this effect by the standard deviation of the dependent variable, Res. Premium, implying a decline of 0.17 (or 17 percent) standard deviation. As a final quantification exercise, we looked at how our results map into historical trends. Between 1990 and 2019, unionization rates declined, on average, almost 18 pp. Our preferred estimate implies a decline in the wage premium of 1.9 pp, thus explaining more than 70 percent of the observed decline in the premium over the same period.

Among explanatory variables that we control for, we find that capital intensity and the export share of production have a positive effect on the manufacturing wage premium. While the export share is only marginally statistically significant, capital intensity appears to be an important factor driving the variation in residual premia: with a calculation similar to what we have outlined in the case of our main regressor, a one-standard-deviation decline in capital intensity is associated with a decline in wages of 23 percent of a standard deviation. The effect of capital intensity appears slightly larger than that of our baseline regressor; however, capital intensity has remained roughly unchanged between 1990 and 2019 and, thus, cannot explain the dynamics in the wage premia across manufacturing industries.

Aggregate Effects

While the patterns in wages and unionization within the manufacturing sector and the related data availability implies that manufacturing industries are an ideal setting to study

Table 2: Sector-Level Regressions: Wage Premia and Unionization in Manufacturing

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Variables	Residual Wage Premium$_t$						
Union Share$_{t-1}$	0.211***	0.158**	0.157**	0.128**	0.148**	0.118**	0.110**
	(0.065)	(0.055)	(0.054)	(0.056)	(0.054)	(0.044)	(0.043)
Empl Share$_t$	-0.399	-0.332	-0.329	-0.246	-0.284	-0.167	-0.190
	(0.442)	(0.328)	(0.330)	(0.253)	(0.296)	(0.236)	(0.232)
Top Share$_t$		0.109	0.108	0.119	0.109	0.121	0.128
		(0.162)	(0.162)	(0.146)	(0.159)	(0.131)	(0.125)
Young Share$_t$		-0.220	-0.220	-0.161	-0.202	-0.155	-0.134
		(0.240)	(0.242)	(0.209)	(0.229)	(0.194)	(0.193)
G Lab Prod$_t$			-0.012				-0.013
			(0.050)				(0.044)
Exp/Prod$_t$				0.090			0.101*
				(0.054)			(0.051)
Imp/Abs$_t$					0.035		-0.070
					(0.059)		(0.043)
Cap Int						0.066***	0.055**
						(0.021)	(0.020)
Year	y	y	y	y	y	y	y
Sector FE	y	y	y	y	y	y	y
Obs.	464	464	464	464	464	464	464
R^2	0.237	0.272	0.272	0.289	0.274	0.304	0.313
Number of Sectors	16	16	16	16	16	16	16

Source: Bureau of Labor Statistics and Census Bureau.
Residual Wage Premium: wage premium after controlling for age variables, sex, education, race, tenure, marital status, state and metropolitan area.
Union Share$_{t-1}$: unionized share of employment, lagged.
Empl Share: sector share of manufacturing employment.
Top Share: share of large (500+ employees) firms in the sector.
Young Share: share of young (less than 5 years old) firms in the sector.
G Lab Prod: labor productivity, growth rate.
Exp/Prod: export share of production.
Imp/Abs: import share of domestic absorption.
Cap Int: log ratio of capital stock to shipments.
Legend: *** significant at 1%, ** at 5%, * at 10%.
Notes: Sector-level FE regressions, 1990-2019, across 3-digit NAICS sectors within manufacturing. Standard errors are clustered at the sector level.

the importance of unionization trends on the wage premium, this section, nonetheless, extends our empirical analysis to the entire private sector and evaluates whether similar dynamics occurred in sectors outside of manufacturing. Table A1 presents the estimates from our baseline model when the unit of observation is a 2-digit NAICS sector.[17] In this setting, our model includes a more restricted set of control; in fact, we exclude controls on exports and import penetration because data on those characteristics for most service sectors are extremely limited. Our results continue to point to a positive correlation between the lagged unionization rate and the wage premium within a sector, but the coefficients are much less precisely estimated. Indeed, while unionization rates have been largely declining across most sectors—with few cases where rates have remained little changed—many service sectors have, instead, experienced a relative rise in their wage premium. Furthermore, the sample of union workers in most sectors outside of manufacturing appears fairly small, leading to large variability in the estimates of unionization rates from one year to the next. If limiting the analysis to the sectors that have experienced above-the-median declines in unionization through their history and smoothing through the volatility in unionization rates, we find that the magnitude of the effect of unionization on wage premia is notably higher—suggesting that declines in unionization rates could explain around 70 percent of the decline in the wage premia even across those sectors—although significant only at the 10 percent confidence level.[18]

Among other factors, only labor productivity emerges as a significant determinant of wage differences across 2-digit NAICS sectors.

Union vs. Non-union Premia: Decomposing the Impact of Unionization

The estimates in table 2 combine the effects on wages for union and non-union mem-

[17] Specifically, our regression includes 18 sectors: *Agriculture, Forestry, Fishing, and Hunting* (NAICS 11), *Mining* (NAICS 21), *Utilities* (NAICS 22), *Construction* (NAICS 23), *Manufacturing* (NAICS 31-33), *Wholesale Trade* (NAICS 42), *Retail Trade* (NAICS 44-45), *Transportation and Warehousing* (NAICS 48-49), *Information* (NAICS 51), *Finance* (NAICS 52), *Real Estate* (NAICS 53), *Professional, Scientific, and Technical Services* (NAICS 54), *Administrative and Support and Waste Management and Remediation Services* (NAICS 56), *Education Services* (NAICS 61), *Health Care and Social Assistance* (NAICS 62), *Arts, Entertainment, and Recreation* (NAICS 71), *Accommodation and Food Services* (NAICS 72), and *Other Services* (NAICS 81).

[18] Above-the-median declines in unionization rates occurred in the following sectors: *Agriculture, Forestry, Fishing, and Hunting* (NAICS 11), *Mining* (NAICS 21), *Utilities* (NAICS 22), *Construction* (NAICS 23), *Manufacturing* (NAICS 31-33), *Wholesale Trade* (NAICS 42), *Retail Trade* (NAICS 44-45), *Transportation and Warehousing* (NAICS 48-49), and *Information* (NAICS 51).

Table 3: The Impact of Unionization on Union Wage Premia

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Variables	Residual Union Premium$_t$						
Union Share$_{t-1}$	0.230***	0.216***	0.226***	0.225***	0.242***	0.249***	0.263***
	(0.057)	(0.057)	(0.058)	(0.062)	(0.050)	(0.070)	(0.059)
Empl Share$_t$	-0.456	-0.486	-0.519	-0.512	-0.604*	-0.618*	-0.726**
	(0.280)	(0.318)	(0.297)	(0.301)	(0.291)	(0.332)	(0.309)
Top Share$_t$		0.056	0.068	0.053	0.055	0.047	0.064
		(0.152)	(0.151)	(0.154)	(0.160)	(0.148)	(0.143)
Young Share$_t$		-0.009	-0.012	-0.027	-0.053	-0.062	-0.066
		(0.216)	(0.213)	(0.210)	(0.245)	(0.223)	(0.221)
G Lab Prod$_t$			0.128				0.102
			(0.100)				(0.106)
Exp/Prod$_t$				-0.027			0.093
				(0.049)			(0.068)
Imp/Abs$_t$					-0.087		-0.120
					(0.059)		(0.094)
Cap Int						-0.053*	-0.055*
						(0.028)	(0.028)
Year	y	y	y	y	y	y	y
Sector FE	y	y	y	y	y	y	y
Obs.	464	464	464	464	464	464	464
R^2	0.227	0.228	0.231	0.228	0.231	0.233	0.239
Number of Sectors	16	16	16	16	16	16	16

Source: Bureau of Labor Statistics and Census Bureau.
Residual Union Premium: wage premium for unionized workers after controlling for age variables, sex, education, race, tenure, marital status, state and metropolitan area.
Union Share$_{t-1}$: unionized share of employment, lagged.
Empl Share: sector share of manufacturing employment.
Top Share: share of large (500+ employees) firms in the sector.
Young Share: share of young (less than 5 years old) firms in the sector.
Exp/Prod: export share of production.
Imp/Abs: import share of domestic absorption.
Cap Int: log ratio of capital stock to shipments.
Import Ratio: ratio of imports to revenues.
Legend: *** significant at 1%, ** at 5%, * at 10%.
Notes: Sector-level FE regressions, 1990-2019, across 3-digit NAICS sectors within manufacturing. Standard errors are clustered at the sector level.

bers. In the analysis that follows, we estimate equation (1) separately for each group. In particular, in table 3, we show results for the manufacturing wage premium of unionized workers. The lagged unionized share of employment has even stronger effects on the manufacturing wage premium for this group, with the point estimates in the specification with all controls included being about twice as large as the point estimate in table 2. In terms of magnitudes, a one-standard-deviation decline in union membership is associated with a 26 percent of a standard deviation (sd) decline in the wage premium of unionized workers, a higher decline compared with the effects in our baseline regressions, but not twice as large since the variability of residual wages across union members tends to be larger. The explanatory power of the change in unionization rates over time appears to be particularly important for union members: the almost 18 pp drop in membership rates is able to explain about 40 percent of the reduction in the residual wages of union members.[19] Interestingly, the effect of capital intensity is negative for unionized workers—in contrast with our expectation and earlier results—but the effect is only marginally significant. Beyond changes in employment shares, which display a somewhat non-intuitive negative correlation with the dependent variable, no other control appears to have a meaningful impact on the residual wage premium across unionized members, after controlling for the membership status.

The falling rate of unionization may have lowered wages not only because workers may lose higher wages after leaving the union, but also because there is less pressure on nonunion employers to raise wages.

Table 4 contains results for the manufacturing wage premium of non-unionized workers. While the basic specification shown in column 1 finds similar results as in the case of overall manufacturing and unionized workers, the effect of the lagged unionized share of employment remains positive but becomes statistically insignificant after including most other controls.

Among other variables, capital intensity emerges as the most relevant factor influencing wages for non-union members. A one-standard-deviation decline in capital intensity is associated with a 35 percent standard deviation decline in the wage premium of non-

[19] Between 1990 and 2019, residual wage premia of unionized workers declined about 10 pp.

Table 4: The Impact of Unionization on Nonunion Wage Premia

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Variables	Residual Non-Union Premium$_t$						
Union Share$_{t-1}$	0.182**	0.110	0.109	0.077	0.089	0.046	0.039
	(0.068)	(0.069)	(0.068)	(0.071)	(0.075)	(0.053)	(0.055)
Empl Share$_t$	-0.287	-0.240	-0.238	-0.145	-0.145	0.020	0.030
	(0.510)	(0.370)	(0.374)	(0.289)	(0.315)	(0.245)	(0.248)
Top Share$_t$		0.173	0.173	0.184	0.174	0.192	0.196
		(0.204)	(0.206)	(0.186)	(0.199)	(0.147)	(0.143)
Young Share$_t$		-0.255	-0.255	-0.189	-0.220	-0.152	-0.134
		(0.253)	(0.254)	(0.219)	(0.233)	(0.181)	(0.181)
G Lab Prod$_t$			-0.007				0.004
			(0.052)				(0.046)
Exp/Prod$_t$				0.100			0.047
				(0.064)			(0.073)
Imp/Abs$_t$					0.070		-0.011
					(0.072)		(0.065)
Cap Int						0.103***	0.096***
						(0.028)	(0.031)
Year	y	y	y	y	y	y	y
Sector FE	y	y	y	y	y	y	y
Obs.	464	464	464	464	464	464	464
R^2	0.234	0.280	0.281	0.296	0.287	0.337	0.339
Number of Sectors	16	16	16	16	16	16	16

Source: Bureau of Labor Statistics and Census Bureau.
Residual Non-Union Premium: wage premium for non-unionized workers after controlling for age variables, sex, education, race, tenure, marital status, state and metropolitan area.
Union Share$_{t-1}$: unionized share of employment, lagged.
Empl Share: sector share of manufacturing employment.
Top Share: share of large (500+ employees) firms in the sector.
Young Share: share of young (less than 5 years old) firms in the sector.
G Lab Prod: labor productivity, growth rate.
Exp/Prod: export share of production.
Imp/Abs: import share of domestic absorption.
Cap Int: log ratio of capital stock to shipments.
Legend: *** significant at 1%, ** at 5%, * at 10%.
Notes: Sector-level FE regressions, 1990-2019, across 3-digit NAICS sectors within manufacturing. Standard errors are clustered at the sector level.

union members. However, over the period of analysis, the non-union wage premium moved down, while capital intensity edged up, suggesting that this factor cannot explain the trend in residual wages.

Robustness Checks

Our specification includes several sector-specific factors that tend to affect wages patterns. In this section, we show that our results are robust to two additional characteristics.

First, the trade literature since the seminal contribution by Bernard et al. [1995] has highlighted that exporters are not only larger, more productive, and more capital intensive compared to non-exporting establishments, but also pay higher wages and benefits. Thus, while we control for the export share of production in our baseline specification, cross-sector differences in the prevalence of exporters could account for further differences in wages. Tables A3, A4, and A5 address this concern by controlling for the (log-) number of exporters as well as the average export value across exporters.[20] Since those variables are available only since 1996, the first column across all tables replicates the baseline results for the shorter sample and can be directly compared to the magnitudes of estimates in columns (2)-(4), which includes the export-related controls. After including those controls, the impact of unionization on the wage premium is not significantly different from the results in column (1); we also continue to observe that unionization is an important factor on the wage of unionized workers (table A4, but does not play a role for non unionized workers (table A5).

Among other controls, table A3 points to a role for trade variables and for the share of young firms in the sector; these results, however, are not robust to estimating the premia separately for unionized and non-unionized workers. The regression results in tables A4 and A5 continue to highlight the role of capital intensity in affecting residual wages: while capital intensity is puzzlingly negatively correlated with wages of union workers, the impact on non-union wages remains positive and significant.

A second factor we consider in our robustness exercises is the role of temporary help workers. In fact, a shift in the number of jobs that are filled through temporary help work-

[20] According to the trade literature, the value of exports is likely to correlate with skilled labor demand, as highlighted when we characterized our empirical strategy.

ers could affect the wage premia of other workers in the sector; the impact on wages largely depends on which types of occupations are filled with those workers. To understand the effect of temporary help workers on wages, we rely on yearly data from the Quarterly Survey of Plant Capacity (QSPC), which collects the share of temporary help workers across manufacturing industries only since 2014.[21] Figure A15 plots the share of temporary help workers in each 3-digit NAICS industry against the industry-specific residual wage premia. As highlighted by the fitted line, the correlation between temporary help employment and wage premia is positive: intuitively, as with higher exposure to offshoring, firms are likely to fill the least skill-intensive–and likely least well-paying–occupation with outside help, implying that the wage premia for other workers in the sectors would raise. However, because the QSPC data point to an increase, on average, in the share of temporary help workers between 2014 and 2019, and, more generally, the reliance on temporary help within manufacturing has significantly increased relative to the early 1990s, this factor is unlikely to account for the decline in the manufacturing wage premium over the period of our analysis.[22]

We perform a final robustness check following the work by Hirsch and Schumacher [2004] and Bollinger and Hirsch [2006], which point to biased estimates for union wage gaps, in particular, when imputed CPS wage data are included in the estimation. Following Bollinger and Hirsch [2006], we restrict our analysis to the respondent sample with observations weighted by (inverse of) the probability of response.[23] Tables A6 and A7 present our results. The decline in unionization continues to be the most important factor for the decline in the wage premium for union workers across manufacturing industries; looking at column (7), the coefficient estimates is only marginally significantly different–at the 10 percent level–compared with our baseline estimates shown in table 3. Reweighted regressions highlight a more prominent role of international trade, but the historical movements in import and export shares–with import and export shares rising over time–are

[21] QSPC data on temp help workers are also available for 2013q3 and 2013q4, but we exclude these data from the analysis since they do not cover a full year.

[22] Before 2014, data on temporary help services are available from the CPS supplement in 1995, 1997, 1999, 2001, and 2005.

[23] Specifically, in estimating wage premia, we first run a probit equation with response as the binary dependent variable and all regressors used in our wage premium estimation. We then weight the observed sample by the inverse of the estimated probability of response.

counterfactual to the patterns in manufacturing wages. Similarly, export shares appear to drive residual wages of non-union workers in table A7, but, as with capital intensity, their movements over the recent decades cannot explain the declining trends in manufacturing wages. Beyond the puzzling negative impact of labor productivity on non-union residual wages, the share of top firms in the sector appear marginally significant and has a sign which is consistent with the trends in wages documented by Bloom et al. [2018]. However, the impact of the share of large firms in an industry is not robust across various specifications.

5 Implications for Wage Inequality

The trends in unionization and the resulting patterns in wages have also important implications in terms of wage inequality, the focus of this section. In fact, the patterns that we document imply that, within the manufacturing sector, there has been a widening of the gap between the higher-paid supervisory workers and the relatively lower-paid production workers and point to rising inequality across occupations. Furthermore, the declines in the wages of manufacturing production workers relative to workers in other sectors point to rising inequality between manufacturing and the rest of the economy. All told, those results point to rising wage inequality between sectors and occupations.

The data confirm these conjectures. Looking first at general trends, shown in figure 12, measures of aggregate inequality have increased since the 1980s, while inequality within sectors and for a given occupation—hereafter, *within inequality*—has moved down.[24] As a result, the inequality between sectors and occupations—or *between inequality*, defined as the difference between aggregate inequality and the within sector-occupation measure—rose 0.12 log point (or about 12 percent). Measures of inequality that control for demographic characteristics reveal similar patterns, as shown in figure 13, with an increase in between inequality of about 4.5 percent.

[24]Our wage inequality decomposition largely follows Davis and Haltiwanger [1991].

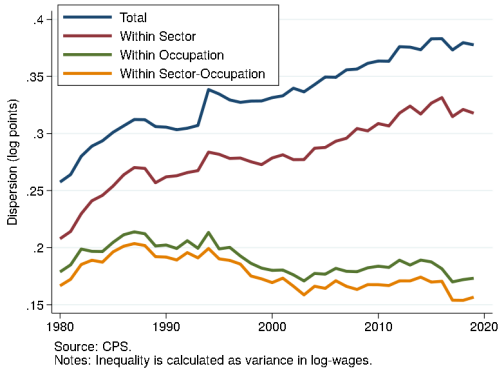


Figure 12: Wage Inequality

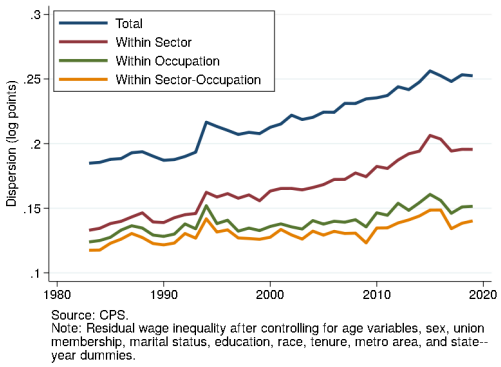


Figure 13: Residual Wage Inequality

In addition, changes in wage premia have directly contributed to the recent trends in wage inequality. Results from table 5 quantify the impact of the decline in the premium by occupation group on the increase in aggregate and *between* wage inequality. While the impact of premia for nonproduction workers on inequality is not robust across specifications, we find that a one-standard-deviation decline in the premium for production workers is associated with an increase in overall inequality of about 10 percent of a sd and an increase in between inequality of about 15 percent of a sd. The fact that only changes in production worker premia matter for inequality is consistent with the findings from the previous sections.

Tying these effects to historical trends, the decline in manufacturing production worker wages since the 1990s explains 10 percent—or about 0.5 pp—of the increase in (between and overall) wage inequality over the same period, after controlling for changes in demographics characteristics. In turn, the effect of the wage premium on inequality is primarily driven by the dynamics in unionization rates; in fact, changes in unionization rates ultimately account for about 0.35 pp of the changes in wage inequality.

While changes in unionization rates and manufacturing wages explain only a small part of the total increase in wage inequality, the fact that a similar mechanism might be at play also in some other sectors—as pointed out by our aggregate analysis—and the secular decline of the manufacturing sector, possibly exacerbated by recent wage trends, suggest that our estimate should be interpreted as a lower bound.

Table 5: Inequality and Wage Premia

	(1)	(2)	(3)	(4)
			Inequality	
Variables	Total		Between Sectors-Occupations	
Premium, Production	-0.102***		-0.099**	
	(0.038)		(0.047)	
Premium, Supervisory	0.124*		0.075	
	(0.065)		(0.097)	
Residual Premium, Production		-0.125***		-0.180***
		(0.044)		(0.059)
Residual Premium, Supervisory		0.025		-0.191*
		(0.077)		(0.110)
Month Dummies	y	y	y	y
Obs.	432	432	432	432
R^2	0.218	0.224	0.226	0.243

Source: Bureau of Labor Statistics.
Premium, Production: wage premium for production workers.
Premium, Supervisory: wage premium for supervisory/nonproduction workers.
Residual Premium, Production: wage premium for production workers after controlling for age variables, sex, education, race, tenure, marital status, state and metropolitan area.
Residual Premium, Supervisory: wage premium for supervisory/nonproduction workers after controlling for age variables, sex, education, race, tenure, union status, marital status, state and metropolitan area.
Legend: *** significant at 1%, ** at 5%, * at 10%.
Notes: Time-series regressions, 1980m1-2019m12. Robust standard errors are reported in parenthesis.

6 Conclusions

The conventional wisdom that manufacturing jobs are "good jobs" is less true than it used to be. While manufacturing workers used to receive a premium relative to workers in other sectors, that premium has disappeared in recent years for most manufacturing jobs. Our results indicate that the decline in unionization rates is responsible for more than 70 percent of the drop in the manufacturing wage premium. Notably, the unionization effect remains significant even after accounting for a large set of worker and sectoral characteristics.

Our findings also point to a widening of wage inequality across occupations within manufacturing and with respect to the entire private sector. In particular, we find that, after controlling for demographics characteristics, the decline in manufacturing production worker wages since the 1990s explains 10 percent—or about 0.5 pp—of the increase in wage inequality over the same period, with the largest portion of this effect attributable to the decline in unionization rates. Our estimates of the impact on wage inequality, however, are likely only a lower bound. Beyond suggestive evidence that the a similar relationship between unionization and wages could be at play in other sectors, the decline in unionization rates and in the wage premium might exacerbate the structural decline of the manufacturing sector—one of the sectors that made the middle class—and further raise wage inequality.

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A Additional Figures

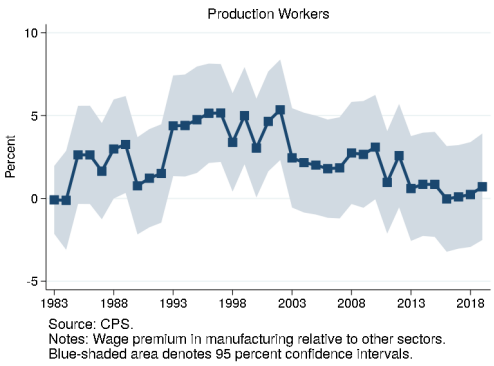


Figure A1: Manufacturing Wage Premium, Yearly, Production Occupations

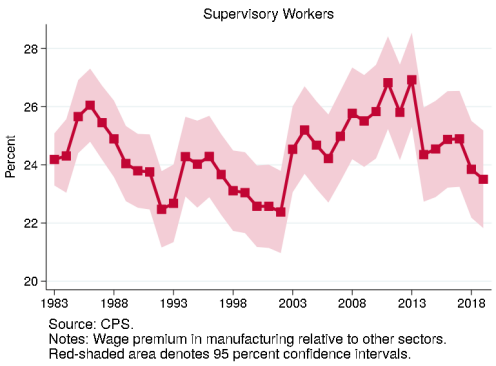


Figure A2: Manufacturing Wage Premium, Yearly, Supervisory Occupations

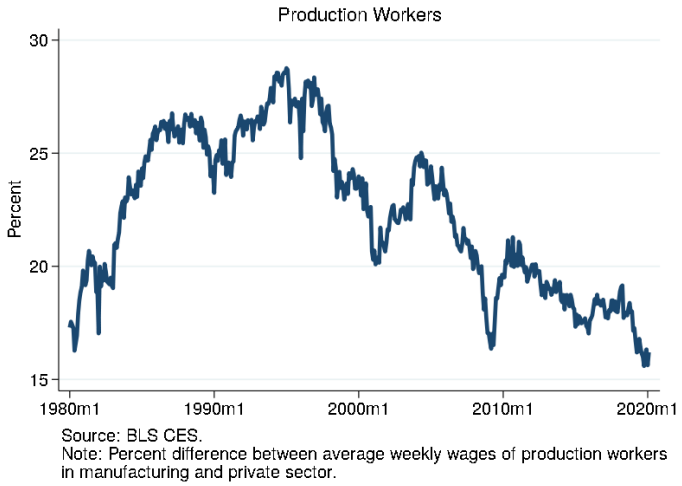


Figure A3: Manufacturing Wage Premium, Weekly Wages

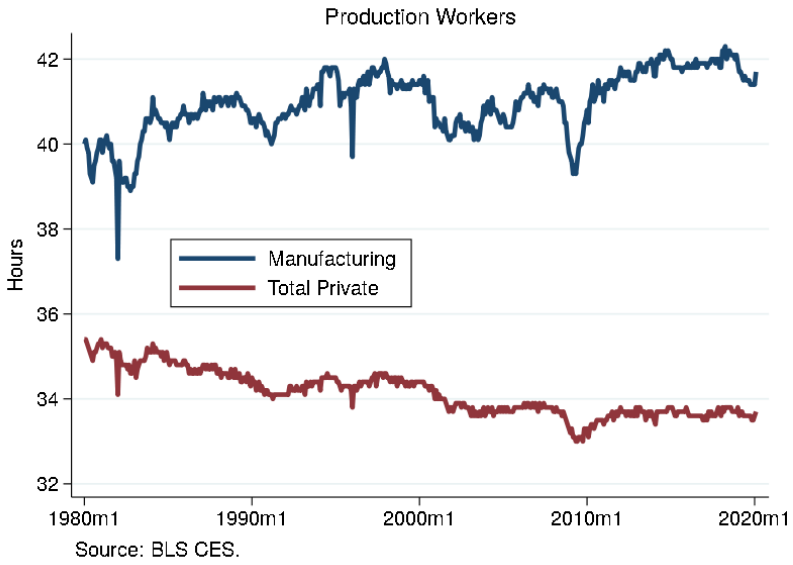


Figure A4: Average Weekly Production Worker Hours

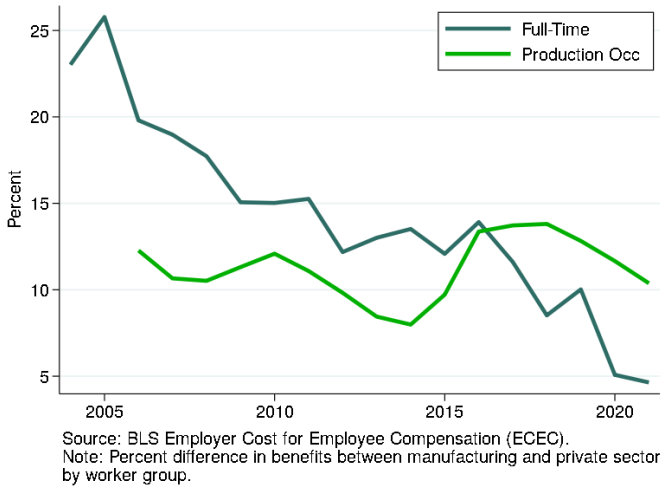


Figure A5: Manufacturing Benefit Premium by Worker Groups

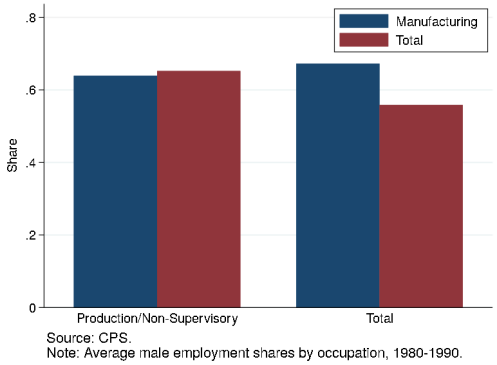


Figure A6: Employment by Gender

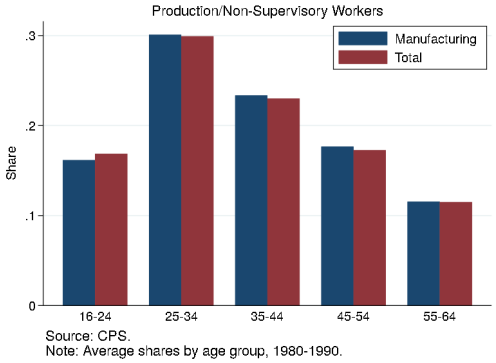


Figure A7: Production Worker Employment by Age

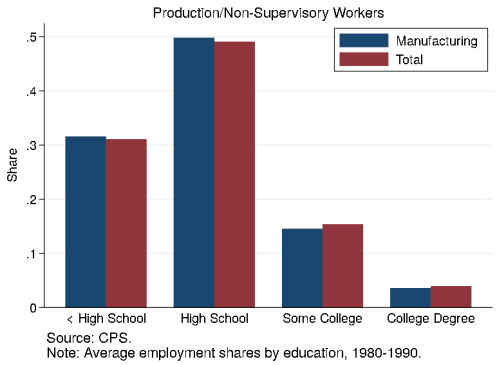


Figure A8: Production Worker Employment by Education

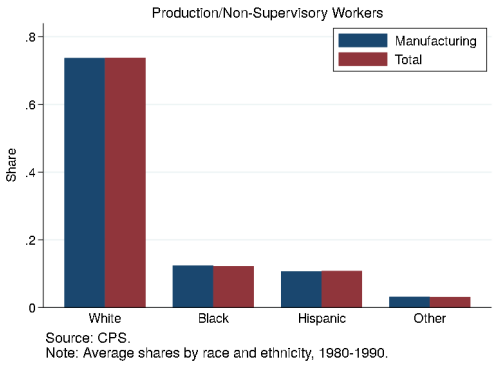


Figure A9: Production Worker Employment by Race and Ethnicity

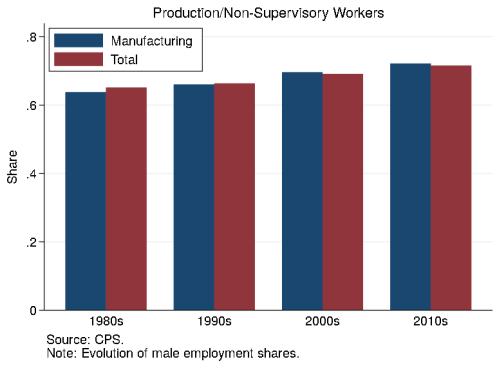


Figure A10: Evolution of Production Worker Employment by Gender

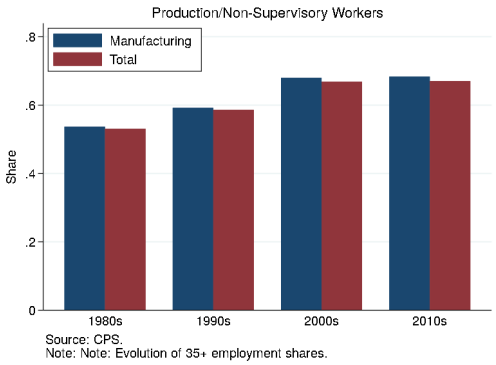


Figure A11: Evolution of Production Worker Employment by Age

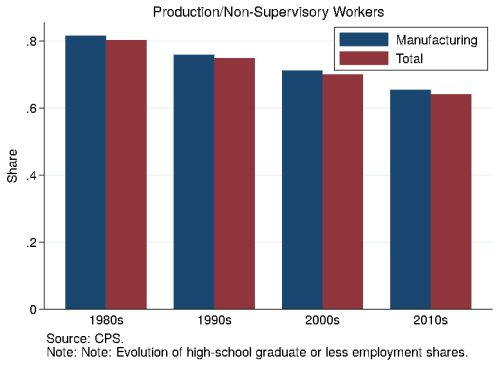


Figure A12: Evolution of Production Worker Employment by Education

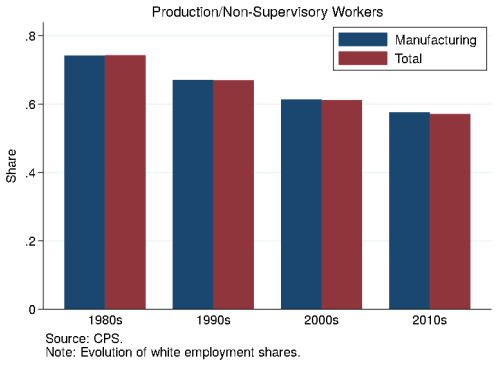
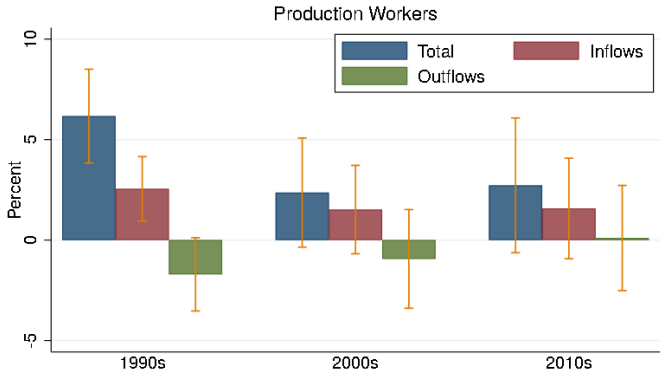
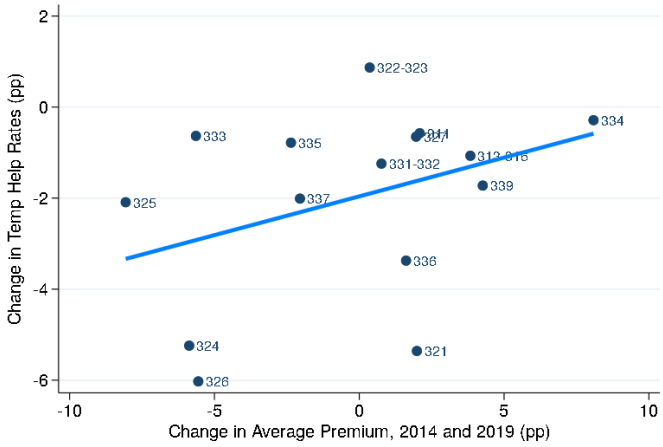


Figure A13: Evolution of Production Worker Employment by Race and Ethnicity



Source: CPS.
Notes: Residual wage premium in manufacturing relative to other sectors due to changes in union membership, after controlling for age variables, sex, marital status, education, race, tenure, metropolitan area, and state-year dummies. Thin bars denotes 95 percent confidence interval.

Figure A14: Manufacturing Premia: Decomposition of Union Inflows and Outflows



Source: BLS.
Note: Changes are between 2014 and 2019.

Figure A15: Temporary Help Services and Wage Premia across Manufacturing Industries

Table A1: Sector-Level Regressions: Wage Premia and Lagged Unionization, Economy-wide Effects

	(1)	(2)	(3)
Variables	Residual Wage Premium$_t$		
Union Share$_{t-1}$	0.075	0.066	0.048
	(0.110)	(0.110)	(0.102)
Empl Share$_t$	0.236	0.307	0.315
	(0.474)	(0.712)	(0.711)
Top Share$_t$		-0.082	-0.097
		(0.372)	(0.367)
Young Share$_t$		-0.273	-0.315
		(0.375)	(0.350)
G Lab Prod$_t$			0.168**
			(0.075)
Year	y	y	y
Sector FE	y	y	y
Obs.	440	440	440
R^2	0.049	0.053	0.060
Number of Sectors	18	18	18

Source: Bureau of Labor Statistics and Census Bureau.
Residual Wage Premium: wage premium after controlling for age variables, sex, education, race, tenure, marital status, state and metropolitan area.
Union Share$_{t-1}$: unionized share of employment, lagged.
Empl Share: sector share of private employment.
Top Share: share of large (500+ employees) firms in the sector.
Young Share: share of young (less than 5 years old) firms in the sector.
G Lab Prod: labor productivity, growth rate.
Legend: *** significant at 1%, ** at 5%, * at 10%.
Notes: Sector-level FE regressions, 1990-2019, across all 2-digit NAICS sectors. Standard errors are clustered at the sector level.

Table A2: Sector-Level Regressions: Wage Premia and Lagged Unionization, Sectors with Largest Declines in Unionization

	(1)	(2)	(3)
Variables	Residual Wage Premium$_t$		
Union Share$_{t-1}$	0.717	0.759*	0.749*
	(0.478)	(0.394)	(0.398)
Empl Share$_t$	-0.198	-0.033	-0.047
	(0.430)	(0.777)	(0.755)
Top Share$_t$		-0.153	-0.148
		(0.462)	(0.454)
Young Share$_t$		0.020	-0.031
		(0.577)	(0.556)
G Lab Prod$_t$			0.148*
			(0.068)
Year	y	y	y
Sector FE	y	y	y
Obs.	239	239	239
R^2	0.135	0.140	0.150
Number of Sectors	9	9	9

Source: Bureau of Labor Statistics and Census Bureau.
Residual Wage Premium: wage premium after controlling for age variables, sex, education, race, tenure, marital status, state and metropolitan area.
Union Share$_{t-1}$: unionized share of employment, lagged.
Empl Share: sector share of private employment.
Top Share: share of large (500+ employees) firms in the sector.
Young Share: share of young (less than 5 years old) firms in the sector.
G Lab Prod: labor productivity, growth rate.
Legend: *** significant at 1%, ** at 5%, * at 10%.
Notes: Sector-level FE regressions, 1990-2019, across 2-digit NAICS sectors that have experienced above-the-median declines in their unionization rates. Standard errors are clustered at the sector level.

Table A3: Wage Premia and Unionization in Manufacturing, Additional Exporters' Controls

	(1)	(2)	(3)	(4)
Variables	Residual Wage Premium$_t$			
Union Share$_{t-1}$	0.075**	0.072**	0.075**	0.069**
	(0.032)	(0.029)	(0.032)	(0.026)
Empl Share$_t$	-0.033	-0.039	-0.021	-0.004
	(0.204)	(0.202)	(0.207)	(0.212)
Top Share$_t$	0.096	0.103	0.098	0.116
	(0.130)	(0.131)	(0.130)	(0.135)
Young Share$_t$	-0.318**	-0.319**	-0.319**	-0.321**
	(0.141)	(0.140)	(0.142)	(0.141)
G Lab Prod$_t$	-0.014	-0.015	-0.016	-0.024
	(0.045)	(0.048)	(0.049)	(0.057)
Exp/Prod$_t$	0.137**	0.139**	0.138**	0.144**
	(0.050)	(0.052)	(0.051)	(0.054)
Imp/Abs$_t$	-0.156***	-0.146**	-0.159***	-0.149**
	(0.051)	(0.056)	(0.054)	(0.058)
Cap Int	0.043**	0.038	0.042**	0.036
	(0.019)	(0.023)	(0.019)	(0.025)
ln Num Exporters		-0.257		-0.401
		(0.406)		(0.592)
ln Avg. Export Value			-0.067	-0.219
			(0.179)	(0.359)
Year	y	y	y	y
Sector FE	y	y	y	y
Obs.	384	384	384	384
R^2	0.210	0.211	0.210	0.212
Number of Sectors	16	16	16	16

Source: Bureau of Labor Statistics and Census Bureau.
Residual Wage Premium: wage premium after controlling for age variables, sex, education, race, tenure, marital status, state and metropolitan area.
Union Share$_{t-1}$: unionized share of employment, lagged.
Empl Share: sector share of manufacturing employment.
Top Share: share of large (500+ employees) firms in the sector.
Young Share: share of young (less than 5 years old) firms in the sector.
G Lab Prod: labor productivity, growth rate.
Exp/Prod: export share of production.
Imp/Abs: import share of domestic absorption.
Cap Int: log ratio of capital stock to shipments.
ln Num Exporters: log number of exporters in the sector; because of data availability, before 2008, the number of exporters for each sector is the number for overall manufacturing.
ln Avg. Export Value: log average export value per exporter within the sector; because of data availability, before 2008, the export value and the number of exporters for each sector are set to the values for overall manufacturing.
Legend: *** significant at 1%, ** at 5%, * at 10%.
Notes: Sector-level FE regressions, 1996-2019, across 3-digit NAICS sectors within manufacturing. Standard errors are clustered at the sector level.

Table A4: The Impact Unionization on Union Wage Premia in Manufacturing, Additional Exporters' Controls

	(1)	(2)	(3)	(4)
Variables	Residual Union Premium$_t$			
Union Share$_{t-1}$	0.296***	0.288***	0.297***	0.290***
	(0.070)	(0.073)	(0.072)	(0.074)
Empl Share$_t$	-0.517	-0.533	-0.588	-0.567
	(0.406)	(0.396)	(0.429)	(0.452)
Top Share$_t$	-0.127	-0.108	-0.143	-0.121
	(0.278)	(0.271)	(0.278)	(0.262)
Young Share$_t$	-0.423	-0.426	-0.421	-0.425
	(0.355)	(0.354)	(0.355)	(0.357)
G Lab Prod$_t$	0.073	0.070	0.088	0.079
	(0.123)	(0.126)	(0.130)	(0.139)
Exp/Prod$_t$	0.121	0.126	0.114	0.121
	(0.075)	(0.074)	(0.072)	(0.073)
Imp/Abs$_t$	-0.201	-0.175	-0.185	-0.172
	(0.162)	(0.146)	(0.157)	(0.147)
Cap Int	-0.096**	-0.106***	-0.095**	-0.103***
	(0.041)	(0.035)	(0.041)	(0.031)
ln Num Exporters		-0.636		-0.495
		(0.763)		(1.001)
ln Avg. Export Value			0.402	0.214
			(0.519)	(0.685)
Year	y	y	y	y
Sector FE	y	y	y	y
Obs.	384	384	384	384
R^2	0.161	0.162	0.162	0.162
Number of Sectors	16	16	16	16

Source: Bureau of Labor Statistics and Census Bureau.
Residual Union Premium: wage premium for unionized workers after controlling for age variables, sex, education, race, tenure, marital status, state and metropolitan area.
Union Share$_{t-1}$: unionized share of employment, lagged.
Empl Share: sector share of manufacturing employment.
Top Share: share of large (500+ employees) firms in the sector.
Young Share: share of young (less than 5 years old) firms in the sector.
G Lab Prod: labor productivity, growth rate.
Exp/Prod: export share of production.
Imp/Abs: import share of domestic absorption.
Cap Int: log ratio of capital stock to shipments.
ln Num Exporters: log number of exporters in the sector; because of data availability, before 2008, the number of exporters for each sector is the number for overall manufacturing.
ln Avg. Export Value: log average export value per exporter within the sector; because of data availability, before 2008, the export value and the number of exporters for each sector are set to the values for overall manufacturing.
Legend: *** significant at 1%, ** at 5%, * at 10%.
Notes: Sector-level FE regressions, 1996-2019, across 3-digit NAICS sectors within manufacturing. Standard errors are clustered at the sector level.

Table A5: The Impact Unionization on Non-Union Wage Premia in Manufacturing, Additional Exporters' Controls

Variables	(1)	(2)	(3)	(4)
	Residual Non-Union Premium$_t$			
Union Share$_{t-1}$	-0.036	-0.035	-0.037	-0.039
	(0.034)	(0.031)	(0.031)	(0.028)
Empl Share$_t$	0.028	0.030	0.076	0.083
	(0.222)	(0.229)	(0.220)	(0.210)
Top Share$_t$	0.278	0.276	0.289	0.296
	(0.170)	(0.172)	(0.174)	(0.183)
Young Share$_t$	-0.157	-0.157	-0.158	-0.159
	(0.179)	(0.179)	(0.181)	(0.179)
G Lab Prod$_t$	0.012	0.012	0.002	-0.001
	(0.043)	(0.044)	(0.042)	(0.049)
Exp/Prod$_t$	0.093	0.093	0.098	0.100
	(0.075)	(0.076)	(0.072)	(0.078)
Imp/Abs$_t$	-0.086	-0.089	-0.097	-0.093
	(0.066)	(0.059)	(0.057)	(0.056)
Cap Int	0.095***	0.096**	0.094**	0.092**
	(0.032)	(0.039)	(0.033)	(0.042)
ln Num Exporters		0.062		-0.155
		(0.604)		(0.784)
ln Avg. Export Value			-0.271	-0.330
			(0.163)	(0.398)
Year	y	y	y	y
Sector FE	y	y	y	y
Obs.	384	384	384	384
R^2	0.261	0.261	0.263	0.263
Number of Sectors	16	16	16	16

Source: Bureau of Labor Statistics and Census Bureau.
Residual Non-Union Premium: wage premium for non-unionized workers after controlling for age variables, sex, education, race, tenure, marital status, state and metropolitan area.
Union Share$_{t-1}$: unionized share of employment, lagged.
Empl Share: sector share of manufacturing employment.
Top Share: share of large (500+ employees) firms in the sector.
Young Share: share of young (less than 5 years old) firms in the sector.
G Lab Prod: labor productivity, growth rate.
Exp/Prod: export share of production.
Imp/Abs: import share of domestic absorption.
Cap Int: log ratio of capital stock to shipments.
ln Num Exporters: log number of exporters in the sector; because of data availability, before 2008, the number of exporters for each sector is the number for overall manufacturing.
ln Avg. Export Value: log average export value per exporter within the sector; because of data availability, before 2008, the export value and the number of exporters for each sector are set to the values for overall manufacturing.
Legend: *** significant at 1%, ** at 5%, * at 10%.
Notes: Sector-level FE regressions, 1996-2019, across 3-digit NAICS sectors within manufacturing. Standard errors are clustered at the sector level.

Table A6: The Impact Unionization on Union Wage Premia in Manufacturing, Reweighted Observable Sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Variables	Residual Union Premium$_t$						
Union Share$_{t-1}$	0.160*	0.140**	0.147**	0.135**	0.165***	0.160***	0.170***
	(0.078)	(0.054)	(0.056)	(0.058)	(0.054)	(0.051)	(0.048)
Empl Share$_t$	-0.024	-0.174	-0.202	-0.159	-0.299	-0.264	-0.412
	(0.341)	(0.476)	(0.454)	(0.460)	(0.453)	(0.476)	(0.454)
Top Share$_t$		0.147	0.157	0.149	0.146	0.141	0.163
		(0.142)	(0.139)	(0.141)	(0.150)	(0.148)	(0.138)
Young Share$_t$		0.092	0.090	0.103	0.046	0.057	0.064
		(0.457)	(0.455)	(0.470)	(0.456)	(0.470)	(0.456)
G Lab Prod$_t$			0.104				0.067
			(0.084)				(0.085)
Exp/Prod$_t$				0.016			0.183**
				(0.061)			(0.068)
Imp/Abs$_t$					-0.091		-0.203**
					(0.076)		(0.093)
Cap Int						-0.036	-0.045
						(0.034)	(0.037)
Year	y	y	y	y	y	y	y
Sector FE	y	y	y	y	y	y	y
Obs.	464	464	464	464	464	464	464
R^2	0.148	0.150	0.153	0.151	0.154	0.153	0.165
Number of Sectors	16	16	16	16	16	16	16

Source: Bureau of Labor Statistics and Census Bureau.
Residual Union Premium: wage premium for unionized workers after controlling for age variables, sex, education, race, tenure, marital status, state and metropolitan area.
Union Share$_{t-1}$: unionized share of employment, lagged.
Empl Share: sector share of manufacturing employment.
Top Share: share of large (500+ employees) firms in the sector.
Young Share: share of young (less than 5 years old) firms in the sector.
G Lab Prod: labor productivity, growth rate.
Exp/Prod: export share of production.
Imp/Abs: import share of domestic absorption.
Cap Int: log ratio of capital stock to shipments.
ln Num Exporters: log number of exporters in the sector; because of data availability, before 2008, the number of exporters for each sector is the number for overall manufacturing.
ln Avg. Export Value: log average export value per exporter within the sector; because of data availability, before 2008, the export value and the number of exporters for each sector are set to the values for overall manufacturing.
Legend: *** significant at 1%, ** at 5%, * at 10%.
Notes: Sector-level FE regressions, 1990-2019, across 3-digit NAICS sectors within manufacturing, on the respondent sample only, with observation weighted by the probability of response. Standard errors are clustered at the sector level.

Table A7: The Impact Unionization on Non-Union Wage Premia in Manufacturing, Reweighted Observable Sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Variables	Residual Union Premium$_t$						
Union Share$_{t-1}$	0.119	0.056	0.049	0.013	0.045	0.022	0.004
	(0.097)	(0.070)	(0.071)	(0.065)	(0.055)	(0.065)	(0.063)
Empl Share$_t$	0.086	-0.152	-0.127	-0.028	-0.098	-0.005	-0.041
	(0.328)	(0.256)	(0.256)	(0.182)	(0.248)	(0.180)	(0.247)
Top Share$_t$		0.323	0.314	0.338*	0.323	0.333*	0.340*
		(0.197)	(0.203)	(0.171)	(0.192)	(0.164)	(0.162)
Young Share$_t$		0.052	0.055	0.141	0.072	0.111	0.151
		(0.171)	(0.179)	(0.134)	(0.148)	(0.121)	(0.118)
G Lab Prod$_t$			-0.096**				-0.106**
			(0.036)				(0.038)
Exp/Prod$_t$				0.132**			0.199**
				(0.047)			(0.077)
Imp/Abs$_t$					0.040		-0.146
					(0.065)		(0.089)
Cap Int						0.058**	0.038*
						(0.020)	(0.021)
Year	y	y	y	y	y	y	y
Sector FE	y	y	y	y	y	y	y
Obs.	464	464	464	464	464	464	464
R^2	0.250	0.295	0.299	0.320	0.297	0.312	0.342
Number of Sectors	16	16	16	16	16	16	16

Source: Bureau of Labor Statistics and Census Bureau.
Residual Non-Union Premium: wage premium for non-unionized workers after controlling for age variables, sex, education, race, tenure, marital status, state and metropolitan area.
Union Share$_{t-1}$: unionized share of employment, lagged.
Empl Share: sector share of manufacturing employment.
Top Share: share of large (500+ employees) firms in the sector.
Young Share: share of young (less than 5 years old) firms in the sector.
G Lab Prod: labor productivity, growth rate.
Exp/Prod: export share of production.
Imp/Abs: import share of domestic absorption.
Cap Int: log ratio of capital stock to shipments.
ln Num Exporters: log number of exporters in the sector; because of data availability, before 2008, the number of exporters for each sector is the number for overall manufacturing.
ln Avg. Export Value: log average export value per exporter within the sector; because of data availability, before 2008, the export value and the number of exporters for each sector are set to the values for overall manufacturing.
Legend: *** significant at 1%, ** at 5%, * at 10%.
Notes: Sector-level FE regressions, 1990-2019, across 3-digit NAICS sectors within manufacturing, on the respondent sample only, with observation weighted by the probability of response. Standard errors are clustered at the sector level.