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Unions and Wage Inequality: The Roles of Gender, Skill and Public Sector Employment*

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1. Introduction

The relationship between unions and wage inequality continues to attract research and policy interest as analysts struggle to understand the relative importance of market-based and institutional forces in explaining the rise in income inequality throughout the industrialized world. A central issue is whether trends in inequality can be rationalized by technological change and globalization, or whether labour and product market institutions such as minimum wages, collective bargaining and product market deregulation have played some independent role (Fortin and Lemieux, 1997; Card and DiNardo, 2002; Salverda and Checchi, 2015). Numerous studies have concluded that the decline in unions *within* specific countries has contributed to growing inequality.[1] Other research shows that differences in the extent of unionization contribute to cross-country differences in the *level* of wage inequality (e.g. Lemieux, 1993; DiNardo and Lemieux, 1997), and that differences in the rate of de-unionization are correlated with differences in the *growth* of inequality (Card, Lemieux and Riddell, 2004; Gosling and Lemieux, 2004). This evidence has led some pundits (e.g. Stiglitz, 2012) to argue that labour law reforms should be part of any policy response to rising inequality and secular declines in labour's share of national income.

This paper examines the changing nature of the relationship between unionization and wage inequality in Canada and the United States over the past four to five decades. Our study is motivated by profound changes in the composition of the unionized workforce during this period, and the implications of these changes for the wage structure. Historically, union jobs in both countries were largely held by unskilled and semi-skilled men working in private sector industries such as manufacturing, transportation, construction, forestry and mining. With the steady decline in private sector unionization and rising union influence in the public sector, however, union coverage rates are now ***5 times higher*** in the public sector than the private sector in

[1] We present a brief overview of this work in Section II of this paper.

both the U.S. and Canada.[2] As a consequence, though the public sector contains only 15-20% of all jobs in the two economies, half of the unionized workers in both countries are in the public sector. These sectoral changes have been accompanied by a remarkable rise in the share of women in the unionized workforce. Currently, 47% percent of all unionized employees in the U.S., and 53% of those in Canada, are women. A typical union worker today is more likely to be a female teacher or nurse with a university degree than a male factory worker with only a high school education.

A key lesson of earlier research is the importance of accounting for heterogeneity in the rate of union membership and the size of the union effect on wages. The effect of unions on overall wage inequality depends critically on which skill groups are most likely to be represented by unions, and on the extent to which unions raise wages for more versus less highly paid groups (see Card 1992, 1996; Lemieux, 1993). Estimates of this effect are typically lower when these differentials are taken into account than in the simple two sector homogeneous worker model originated by Freeman(1980) in his seminal study of unions and inequality.

While many early studies of unions and inequality focused on male workers, more recent studies examine men and women and reveal striking gender differences. A consistent finding in Canada, the U.S. and the U.K. is that unions tend to reduce wage inequality among men but not among women (e.g., DiNardo, Fortin and Lemieux, 1996; Card, 2001; Card, Lemieux and Riddell, 2004; Gosling and Lemieux, 2004). In this paper we build on this approach and allow for heterogeneity by skill group and gender, but extend the analysis to account for differences across the public and private sectors. Disaggregating by sector also allows us to explore the extent to which differences in union impacts between men and women found in earlier studies are attributable to

[2] See Appendix Table 1 for summary statistics on unionization and public/private sector employment . We use the definitions of the public sector employed by the U.S. Bureau of Labor Statistics and Statistics Canada. In both countries public sector employment includes those who work for a federal, state/provincial or municipal government, for a government service or agency or a government owned public establishment such as a school, college, university or hospital. In Canada this also includes employees of Crown corporations.

public-private differences in the coverage patterns and wage effects, rather than to a gender-specific effect.

We focus on the U.S. and Canada for several reasons. The two countries share a common legal framework that results in a sharp distinction between union and non-union workplaces. In this 'Wagner Act' setting workers have the right to form and join unions, and if a majority of employees agree their chosen union will be certified as the exclusive representative of all workers in the bargaining unit, whether they join the union or not. This framework creates a highly decentralized form of collective bargaining in which most non-managerial employees in a given enterprise are either covered by a union contract, and pay membership dues to the union, or have their wages set by the employer with no influence of unions. In contrast, in Australia and many European countries collective agreements between unions and employer associations are often extended to all workers in a sector, creating large gaps between the fraction of workers whose wages are set by collective bargaining and the fraction of union members (Visser, 2015) and a fuzzy boundary between the union and non-union sectors.[3] In addition, in both Canada and the U.S. the non-union sector is large, yielding a good approximation to the wage structure that would prevail in the absence of unions.

Canada and the U.S. also provide contrasting experiences that are relevant for our study. Although their economies and labour markets have many common features, the level of inequality is lower in Canada than the U.S. during our sample period, and also rose more slowly. Unionization rates in the two countries followed similar trends in the immediate post-war period, and were approximately equal in the early 1960s. Since then, however, unionization rates have diverged – rising in Canada until the early 1980s, followed by a gradual decline to 30% in 2016, but falling steadily in the U.S. to a rate of only 12% in 2016. These differences in the timing of union growth and decline and in levels and movements in wage inequality provide an opportunity to further assess the contribution of institutional change to trends in income inequality.

[3] The extreme example is France where 8 percent of workers in 2010 were union members but 98 percent were covered by collective agreements (Visser, 2015).

An additional objective of this paper is to provide estimates of the impact unions exert on the current wage structure. Previous studies conclude that the decline of unionization has made a significant contribution to rising inequality, but what is the impact of unions on wage inequality at the present time? Because labour law reform – if ever enacted -- would likely influence the extent of union coverage at the margin, estimates of the consequences of such reforms should reflect the dramatic changes that have already taken place in the structure of the unionized workforce.

The next section of the paper reviews the economics literature on unions and wage inequality. We then describe our empirical strategy. Section four describes our data sources and provides our results. The final section concludes.

2. Unions and Wage Inequality: An Overview of the Previous Literature

The impacts of unions on the wage structure and the distribution of earnings have long intrigued social scientists. This section briefly reviews this large literature, focusing on Canada and the U.S.[4]

Prior to the 1980s, most economists agreed that by creating an average pay gap between the union and non-union sectors, unions tended to *increase* overall inequality (e.g., Johnson, 1975).[5] This view was challenged by Freeman (1980), who argued that union wage setting tends to lower wage dispersion among more and less skilled workers, and between higher and lower-paying establishments, leading to a "within sector" inequality effect that may offset the "between sector" effect arising from the average union pay gap. Freeman's (1980) analysis showed that the within-sector effect was large and negative, particularly in the manufacturing sector. For other sectors he concluded that the net impact of unions was smaller, reflecting both a smaller within-sector effect and larger between-sector effect. Subsequent work (e.g., Freeman, 1982 for the U.S.; and Meng, 1990 for Canada) confirmed that wages tend to be less disperse in the union sector, and that the net effect of unions was to lower wage inequality relative to the level in the non-

[4] See Card, Lemieux and Riddell (2004) for a more detailed review up to the early 2000s.
[5] An interesting exception to this general view was Ashenfelter's (1972) study showing that unions tended to lower the black-white pay gap.

union sector. Freeman (1993) used this framework to study the impact of falling union coverage rates on the trend in male wage inequality, concluding that deunionization could explain 20-25% of the rise in wage inequality over the 1980s.

Freeman's (1980) approach was generalized by DiNardo, Fortin and Lemieux (1996) and DiNardo and Lemieux (1997), who introduced a reweighting technique that takes into account potential differences in the union-nonunion pay gap for workers with different observed skill characteristics, and differences in the probability of union coverage for different skill groups. Using this method DiNardo and Lemieux (1997) estimated that in the early 1980s the presence of unions reduced the variance of male wages by 6 percent in the U.S. and 10 percent in Canada. By the late 1980s, their estimates showed that the equalizing effect of unions had fallen to 3 percent in the U.S., but had risen to 13 percent in Canada, contributing to the divergence in pay inequality in the two countries.

DiNardo, Fortin and Lemieux (1996) (hereinafter, DFL) examined wage distributions for both male and female workers in the U.S. in 1979 and 1988. For men, their estimates suggest that shifts in unionization accounted for 10-15 percent of the overall rise in wage dispersion in the 1980s. For women, on the other hand, the estimated contribution of changing unionization is very small.[6]

Card (2001) uses a related skill-grouping approach to compare the effects of unions on trends in male and female wage inequality in the U.S. public and private sectors. His findings suggest that unions had similar equalizing effects on male workers in the two sectors and similarly small effects on wage dispersion for female workers in both sectors. Interestingly, by the end of the sample period in this study (1993) there is some evidence that public sector unions were starting to have a modest dampening effect on wage inequality for female workers in the public sector – a result we re-examine below.

Finally, Card, Lemieux and Riddell (2004) use a DFL style technique to analyse the link between unions and wage inequality in Canada, the U.K. and the U.S. They

[6] Gosling and Lemieux (2004) use the DFL method to compare the effects of unions on trends in wage inequality in the U.S. and the U.K. between 1983 and 1998. Their estimates confirmed that in both countries unions have a much smaller equalizing effect on females than males. They estimate that declining unionization can explain up to 33% of the rise in male wage inequality in the U.K. between 1983 and 1998, and up to 40% of the corresponding rise in the U.S., but very little of the rise in female wage inequality.

show that unions have an equalizing effect on male wage dispersion in all three countries, and that declines in male union coverage can explain a modest share of the rises in male pay inequality between the early 1970s and the early 2000s in the U.S., and between the early 1980s and the early 2000's in the U.K. and Canada. As in earlier studies they find that the effects of unions on female wage inequality are substantially smaller than for men, a result that arises from the tendency for unionized jobs held by women to be relatively high-paying, and from the fact that union-nonunion wage gaps do not seem to be any larger for lower-skilled than higher-skilled women.

A longstanding concern with simple comparisons based on the structure of wages for union and nonunion workers is that unionized workers may have different *unobserved* characteristics than nonunion workers with the same observed skills (e.g., Lewis, 1986). Depending on the selection process determining union status, this could lead to an overstatement of the equalizing effect of unions. One way of addressing this concern is to use longitudinal data to follow workers as they move between sectors. Freeman (1984, 1993) showed that wage dispersion falls when workers enter the union sector and rise when they leave, confirming that unions have an equalizing effect even on the same worker. Nevertheless, his estimates suggested that this effect is smaller than would be inferred from a simple cross-sectional approach.

A problem with longitudinal comparisons is that union status can be mis-measured, leading to a high rate of falsely measured transitions between sectors. Using estimates of this mismeasurement rate to correct the observed longitudinal data Card (1992) concluded that unions still have a significant equalizing effect on male wages, and that the fall in unionization from the early 1970s to the late 1980s explained around 20 percent of the increase in U.S. male wage inequality, not far off Freeman's earlier estimate.

Lemieux (1993) used the 1986-87 Labour Market Activity Survey to study the effects of union sector changes in Canada. His results showed that unionized workers from the lowest skill group are positively selected, whereas those in the upper skill

groups are negatively selected – a pattern similar to the one found in the U.S. by Card (1992). An implication of this pattern is that the between-group "flattening effect" of unions apparent in the raw data is somewhat exaggerated, although there is still evidence that unions raise wages of low-skilled men more than those of high-skilled men. Overall, Lemieux concluded that the presence of unions lowers the variance of male wages in Canada in the late 1980s by about 15 percent.

Lemieux's findings for women in Canada were much different: neither the cross-sectional nor longitudinal estimates showed a systematic flattening effect of unions. Coupled with the fact that union coverage is lower for less-skilled women, these results implied that unions raise the between-group variance of wages for women. This effect is larger than the modest negative effect on the within-group variance, so Lemieux's results imply that on net unions raised wage dispersion among Canadian women.

Lemieux (1998) presented an estimation method that accounts for the potential "flattening" effect of unions on the returns to both observable and unobservable skills. Using data on men who were forced to change jobs involuntarily, he concluded that unions tend to compress the pay associated with observed and unobserved skills. Moreover, the variance of wages around the expected level of pay is lower in the union sector. As a result of these tendencies, Lemieux's results implied that unionization reduced the variance of wages among Canadian men by about 17 percent – not far off the estimate in his 1993 study.

To summarize, we believe the existing evidence points to four main conclusions.

1. Unions tend to reduce wage dispersion for male workers. As a result, declining unionization has contributed to rising wage inequality among men since the 1970s or early 1980s.

2. Unions have little impact -- or even a small disequalizing effect -- on female wage inequality. An unresolved puzzle is whether this is a pure gender effect or due to other factors such as differences between male-dominated and female-dominated types of employment.

3. There is some evidence of non-random selection into union and nonunion jobs. Existing evidence suggests that this selectivity leads to a relatively small over-estimate of the equalizing effect of unions on male workers.

4. Relatively little is known about the impacts of unions on the wage structure in the public sector, and how this differs from the private sector.

3. Estimating the Effects of Unions on Wage Inequality

Building on DFL and DiNardo and Lemieux (1997), in this section we present a simple framework for studying the effect of unions on wage inequality based on the potential outcomes model widely used in program evaluation (Angrist and Krueger, 1999; Angrist and Pischke, 2009). Assume that each worker faces two potential wages: a log wage in the union sector, W^U, and a log wage in the nonunion sector W^N. At any point in time, a given individual is either in one sector or the other, so one outcome is observed and the other is not. Letting U_i denote an indicator for union status, the observed wage of individual *i* is

$$W_i = U_i W_i^U + (1 - U_i) W_i^N$$

Let W^U and W^N represent the means of the potential wage outcomes in the two sectors, and let V^U and V^N represent the corresponding variances. Finally, let W and V represent the mean and variance of observed wages in the economy as a whole. In this setting, a natural measure of the effect of unions on wage inequality is $V - V^N$: the difference between the observed variance of wages and the variance that would prevail if everyone was paid his or her nonunion potential wage.

We observe V but not V^N -- the variance of wages that would prevail in the absence of a union sector. Although conceptually any given individual in the union sector has a well-defined potential wage in the nonunion sector, if the union sector disappeared, the equilibrium set of wage offers in the nonunion sector could change. Two factors expected to influence the general equilibrium wage distribution in the absence of unions have long been recognized (Lewis, 1963): (i) labour supply spillovers – if unions raise wages, doing so may reduce employment in the union sector, increasing labour supply elsewhere and lowering wages in the nonunion

sector, and (ii) the threat effect – some nonunion employers may raise wages for their employees to reduce the threat of unionization. However, these two effects operate in opposite directions so offset each other to some extent. Note also that V^N is a function of the size of the union sector, $V^N(U)$, where $0<U<1$ indexes the fraction of workers in the union sector. As the size of the nonunion sector increases relative to the union sector, $V^N(U)$ approaches $V^N(0) = V^N$.

Despite its theoretical appeal, it is difficult to develop a credible estimate of $V^N(0)$. Under strong assumptions, however, we can estimate $V^N(U)$, where U is the current fraction of unionized workers. The advantage of this measure is that potential nonunion wage outcomes *under the current level of unionism* are at least partially observed (for all current nonunion workers). Since

$$V - V^N(U) = V - V^N(0) + \{ V^N(0) - V^N(U) \}$$

The difference $V - V^N(U)$ overstates or understates the "true" effect of unions by a term reflecting how much the variance of nonunion wage outcomes would change if the union sector was eliminated. Our key identifying assumption is that this potential bias is likely to be small given the large size of the nonunion sectors in Canada and the U.S.[7] Thus, in the rest of this analysis we focus on comparisons between V, the observed variance of wages, and $V^N(U)$, the variance that would prevail if everyone were paid according to the *current* nonunion wage structure.

Estimating the Variance of Potential Nonunion Wages.

In order to estimate V^N we have to make an assumption about how current union workers would be paid if they worked in the nonunion sector. One starting point is the assumption that union status is "as good as randomly assigned," conditional on observed skill characteristics, gender and sector of employment. In this case, the counterfactual variance V^N can be estimated as the variance of wages for a suitably reweighted sample of nonunion workers. In this section we show how

[7] This assumption is implicit in most of the earlier literature reviewed in the previous section.

the resulting calculations are related to three key factors: the variation in the union coverage rate by wage level in the absence of unions, the size of the union wage effect for different skill groups, and the union-nonunion difference in the variance of wages within skill categories.[8]

Let $W^N(c)$ represent the log wage that individual *i* in skill group *c* would earn in the nonunion sector, and let $W^U(c)$ denote the log wage for the same individual if employed in a union job. Assume that

$$W_i^N(c) = W^N(c) + e_i^N \quad \text{and}$$

$$W_i^U(c) = W^U(c) + e_i^U$$

where $W^N(c)$ and $W^U(c)$ are the mean nonunion and union log wages for individuals in skill group c, respectively, and the random terms e_i^N and e_i^U are independent of actual union status (conditional on gender, sector of employment and the observed skill level c). Let $V^U(c)$ and $V^N(c)$ denote the variances of potential wage outcomes for individuals in skill group c in the union and nonunion sectors, respectively. The union-nonunion gap in average wages for workers in skill group c is

$$D_W(c) = W^U(c) - W^N(c),$$

while the corresponding variance gap is

$$D_V(c) = V^U(c) - V^N(c)$$

Under the independence assumption, $W^N(c)$ and $V^N(c)$ provide unbiased estimates of the mean and variance of nonunion wage outcomes for all workers in skill group *c*, not just those who are actually working in the nonunion sector. The variance of wages in the nonunion sector will not necessarily equal V^N, however, if the distribution of nonunion workers across skill groups differs from the distribution of the overall work force. A simple way to estimate V^N is to reweight individual observations from the nonunion work force to account for this difference. Letting $U(c)$ denote the fraction of workers in skill group c in union

[8] Card, Lemieux and Riddell (2004) discuss how the assumption that union status is independent of unobserved productivity factors can be relaxed.

jobs, the appropriate weight for nonunion workers in group *c* is *1/(1-U(c))*.

Under the conditional independence assumption, the reweighted variance V^N provides an unbiased estimate of the variance of log wages in the absence of unions. The variance of log wages across all groups is the sum of the variance of mean wages across groups and the average variance within groups

$$V = Var(W(c)) + E[V(c)] \quad (1)$$

where $W(c)$ is the mean wage in cell *c* and $V(c)$ is the within cell variance. Similarly, the counterfactual variance V^N is the sum of "between group" and "within group" components

$$V^N = Var(W^N(c)) + E[V^N(c)] \quad (2)$$

where $W^N(c)$ is the mean nonunion wage in cell *c*, $V^N(c)$ is the within cell variance of nonunion wages, and cells are weighted by the fractions of all workers in each cell. Thus the impact of unions on the variance of log wages can be written as the sum of "between group" and "within group" components

$$V - V^N = \{Var(W(c)) - Var(W^N(c))\} + \{E[V(c)] - E[V^N(c)]\} \quad (3)$$

Card, Lemieux and Riddell (2004) further discuss how the between and within group components depend on the wage gap, variance gap, and unionization rate at the cell level. Since $W(c) = W^N(c) + U(c)D_W(c)$, the magnitude of the between group effect depends on how the effect of unions on average wages, or union wage gain, $U(c)D_W(c)$ is distributed across the different skill groups. For example, unions will reduce the between group component if the wage gain is larger for lower than higher skill workers.[9] This can either happen because unions "flatten" the wage structure ($D_W(c)$ declines with the skill level) or because unionization is relatively concentrated among lower skill workers.

In the next section we present evidence on the pattern of union coverage and the magnitude and of the flattening effect. We then report estimates of the

[9] Since $Var[W(c)] = Var[W^N(c) + U(c)D_W(c)] = Var[W^N(c)] + 2Cov[W^N(c),U(c)D_W(c)] + Var[U(c)D_W(c)]$, the union effect on the between group component is $Var(W(c)) - Var(W^N(c)) = 2Cov[W^N(c),U(c)D_W(c)] + Var[U(c)D_W(c)]$. As the variance of the union wage gain is positive, unions can only reduce the between group component if the covariance between the non-union wage and the union wage gain is negative enough to offset the variance term.

total effect of unions on the variance of log wages, including the contributions of the between and within group components.

4. Data and Estimation Results

Data Sources. We use two micro data files – the U.S. Current Population Survey (CPS) and the Canadian Labour Force Survey (LFS) together with supplements to these surveys to study the effects of unions on the wage structure since the early 1970s in the U.S. and the early 1980s in Canada. When suitably weighted these very similar household surveys provide representative samples of the adult population in the two countries. The CPS has been collecting data on wages and union status annually since 1973. We use the pooled May 1973 and May 1974 CPS samples as our first U.S. observation. For later years, we use the monthly earnings supplements data (the "outgoing rotation group" files) for 1984, 1993 and 2015.

The Canadian LFS added questions on wages and union status in 1997. Prior to that time several surveys carried out as supplements to the regular LFS included questions that provide this information. We use the 1984 Survey of Union Membership as a source of information for the early 1980s and combine two smaller surveys – the 1991 and 1995 Surveys on Work Arrangements – as a source of information for the early 1990s. In both the CPS and LFS data the earnings and union status information pertain to an individual's main job as of the survey week.

A key variable for our analysis is the measurement of union status. The 1984 and later CPS files as well as LFS data since 1997 include questions on both union membership and union coverage. The 1973 and 1974 May CPS surveys, however, only ask about union membership. For comparability over time, we therefore focus on union membership as our measure of union status in the U.S. In the case of Canada, we use union coverage as our measure of unionization because consistent information on union membership cannot be recovered from the 1991 and 1995 SWA's. We believe that this choice has little effect on the results, since only about

two percent of Canadian employees are covered by collective agreements but are not union members.[10]

Another difference between the Canadian and U.S. data is that public sector affiliation is not measured in the same way in the two countries. In the CPS workers are asked directly whether they work for the government. [11] In the LFS workers are simply asked "who they work for", with options including the "name of business, government department or agency, or person" and "what kind of business, industry or service this is." Statistics Canada then uses this information to code workers as working in the private or public sector.[12] Despite these measurement differences, Appendix Table 1 indicates that, as expected, a slightly higher fraction of Canadian workers (20%) are classified as working in the public sector than their U.S. counterparts (15.2%). This difference likely reflects true differences in the scope of the public sector, as opposed to the way public sector employment is measured in the two countries. [13]

In the data appendix we explain in detail how we process the various data sets to arrive at our final estimation samples. Generally speaking, our samples include only wage and salary workers age 16 to 64 (15 to 64 in Canada) with non-allocated wages and earnings (except in 1984 and 2015 in Canada). We use hourly wages for workers who are paid by the hour and compute average hourly earnings

[10] For example, in 2015 union membership was 28.6% versus coverage of 30.6%. The two different measures of union density result in nearly identical estimates of the union wage premium in a conventional regression of log wages on union status, education and experience.

[11] The CPS question used to determine the class of worker is: "Were you employed by government, by a private company, a nonprofit organization, or were you self –employed (or working in the family business)?"

[12] Individuals reporting working for a local, provincial or federal government, for a government service or agency, a crown corporation, or an organization that receives the majority of its funding from government such as a school, college, university or hospital are coded as working in the public sector.

[13] The most important difference in the scope of the public sector in the two countries is the health care sector which is overwhelmingly public in Canada, but not in the U.S. This is confirmed by Appendix Table 2 that shows that 9.74% of public sector employees are health care professionals in Canada, compared to only 0.83% in the private sector. By contrast, only 4.68% of public sector employees are health care professionals in the U.S., compared to 6.44% in the private sector. Unlike health care, the education sector is mostly public in both countries, and Appendix Table 2 shows that teachers and other education-related occupations represent a much larger share of the workforce in the public than the private sector in both countries.

for other workers by dividing weekly earnings by weekly hours (or earnings for a longer time period divided by the corresponding measure of hours). We also exclude workers with very low or very high hourly wage values. Sample weights are used throughout.

To implement the methods developed in the previous section we divide workers in each sample into skill groups based on age and educational attainment. The number of skill groups used differs by country, reflecting differences in the sample sizes and the age and education codes reported in the raw data files. In the earlier Canadian data sets, age is only reported in 10-year categories (a total of 5 categories for workers age 15 to 64), and education can only be consistently coded into 5 categories. Thus we use 25 skill groups for Canada. In our U.S. samples, we are able to use a much larger number of skill categories because of the larger sample sizes and detailed age and education information in the CPS. We have re-analyzed the U.S. data using about the same number of skill groups as in Canada, however, and found that this has little impact on our results.

Patterns of Union Coverage. The framework developed in Section 3 suggests that the effect of unions on wage inequality depends in part on how union coverage varies by skill level. Figures 1 and 2 show the unionization rates of men and women in the private and public sectors in the U.S. and Canada, by the level of real hourly wages. These graphs are constructed by calculating union membership/coverage rates for workers in narrow wage bins, and smoothing across bins.[14] The wage values reported on the x-axis range from the 1st to the 99th percentile of the distribution of wages for U.S. males in 2015 (expressed in 2001 dollars). As the wage distribution is approximately log normal, the mid-point on the x-axis is close to the median, while the $6.69 and $34.81 markers are close to the 10th and 90th wage percentiles, respectively.[15]

[14] The densities are estimated using a bandwidth of 0.05. See DiNardo et. al (1996) for more detail.
[15] The 10th, 50th, and 90th percentiles of the 2015 wage distribution for males are $6.9, $14.2, and $35.2, respectively (2001 dollars). While the wage distribution is shifted to the left for women, and to the right

Several noteworthy features of the differences across countries and among the four groups within each country, as well as trends over time, are evident. One prominent development is the gradual disappearance over time of the "hump-shaped" distribution of union coverage among private sector employees in both countries. In the early part of our sample period, unionization rates of men employed in the private sector tended to be low at the bottom and top of the wage distribution and to peak for workers near the middle or upper middle of the distribution. However, by 2015 this hump-shaped pattern had largely disappeared in the U.S. and substantially disappeared in Canada, yielding a distribution of union coverage that is much more uniform across the wage distribution. To the extent that a peak still exists it has also shifted to the right, higher up the wage distribution. A similar, but less dramatic, change has also taken place among women in the private sector.

In contrast, the shape of the distribution has changed much less over time in the public sector. Unionization rates of public sector women in Canada are low at the bottom of the wage distribution (although there have been noteworthy increases over time at the very bottom), rise to a peak around the middle, and remain about the same for highly paid workers as for those in the middle. This pattern is driven in part by relatively high rates of unionization for teachers, nurses, and other highly skilled public sector workers, who are near the top of the female wage distribution. The U.S. pattern is similar, although there is a small decline in coverage at the very top among public sector women. Among public sector male employees there is a slight hump-shape to the coverage distribution, but the decline in unionization at higher wage levels is modest in both countries and has become less pronounced over time in the U.S.

Comparisons of the unionization rates in different years reveal the rapid decline in union membership among private sector employees in both countries. The

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(in Canadian dollars) for Canadian men, the $6.69, $15.64, and $34.81 markers on the graphs can be thought as generally representing the 10th, 50th, and 90th percentiles of the various wage distributions. Note that the graphs for Canada have been truncated to the right because of the relatively low value of the wage topcode in the 1995 Survey of Work Arrangements (see the Data Appendix for more detail).

declines have been largest in the middle of the wage distribution for both men and women, resulting in a more uniform distribution of union coverage by skill. Also noteworthy are the decreases in coverage among private sector women at the very top of the distribution in both countries.

Perhaps the most striking feature is the different trends in coverage in the public and private sectors. In the U.S. the dramatic decline in private sector unionization contrasts with increased coverage in the public sector, most of which occurred between 1973/74 and 1984. Public sector coverage among U.S. women has remained relatively stable since 1984 but among men there have been further increases in the upper part of the earnings distribution. In Canada public sector unionization has been very stable over time in the upper half of the male and female distributions. In the lower half of the distribution decreases in coverage just below the peak have been offset by increases at the very bottom, a pattern evident for men and women.

Additional information on unionization is provided in the first row of Tables 1 and 2. Tables 1(a) and 2(a) report results for the private and public sectors pooled for U.S. and Canada respectively, while Tables 1(b) and 2(b) contain results separately by sector of employment.

Table 1(a) shows the steady and dramatic decline in union density among men in the U.S. over the past four decades -- from 31% in 1973/74 to 13% in 2015. In contrast, little change in coverage took place among U.S. women – unionization was stable at 13%-14% during this extended period of time. For the U.S. workforce as a whole, male and female union density rates are now approximately equal. The dramatic divergence between the private and public sectors is evident in Table 1(b). In the private sector the male unionization rate fell from 31% in 1973/74 to 9% in 2015, while it rose in the public sector from 29% to 43%, with most of the increase occurring between 1973/74 and 1984. Similarly, union coverage among U.S. private sector women, already low at 13% in 1973/74, declined to 6% in 2015, while the rate in the public sector rose even more than that for men – from 18% to 41%.

The changes over time in Canada exhibit similar patterns but somewhat less dramatic changes. For the labour force as a whole, male union coverage declined by 18 percentage points (from 47% to 29%) between 1984 and 2015 – an even larger decrease than in the U.S. over this time period. The decline for women was much smaller although again was greater than in the U.S. – from 37% to 32%. Private sector unionization fell by almost one-half for both groups – from 37% to 20% for males and 25% to 13% for females. In contrast, rates of union coverage in the public sector were stable for both men and women at 75-80%.

The divergence in union coverage rates between the public and private sectors in both Canada and the U.S. raises questions about the comparability of the various control groups of non-union workers used to compute the potential (or counterfactual) variance V^N. For example, since over 90% of U.S. private sector workers are in the non-union sector in 2015, the wage distribution among these workers is likely very close to the distribution that would prevail if all private sector workers were non-union. By contrast, less than 25% of Canadian public sector workers are in the non-union sector in 2015, which raises potential challenges attempting to extrapolate how the wage distribution would look like if all public sector workers were non-union.

Although we partly address these issues by controlling for observed skills (education and experience) when computing the potential variance, there may still be differences in other observed or unobserved characteristics over different groups of workers. Appendix Table 2 helps alleviate some of these concerns by showing that the pattern of unionization across occupations is surprisingly similar in the public and private sectors in both countries. In particular, the unionization rate in management occupations is always lower than in other occupations in the same sector, while the opposite is true among trade and other blue-collar occupations. Looking across all occupations, the correlation coefficient between the unionization rate in the private

and public sector is 0.63 in Canada, and 0.73 in the U.S.[16]

Union Effects on Mean Wages. The top section in Tables 1 and 2 shows union wage effects for men and women in the two countries, both for the labour force as a whole (Tables 1a and 2a) and separately for the private and public sectors (Tables 1b and 2b). The unadjusted wage gap refers to the mean difference between union and nonunion log wages in the raw data, while the adjusted gap controls for compositional differences in the distribution of skills between the union and nonunion sectors. The adjusted gap is computed by averaging (over the distribution of union workers) the cell-specific wage gap $D_W(c)$. The composition effect reported in the tables represents the difference between the adjusted and unadjusted gap.[17]

Looking first at the estimates for the pooled samples, the unadjusted wage gaps are larger for women than for men in both countries. The adjusted gaps are generally smaller than the unadjusted gaps, and in the U.S. the difference between the two has increased over time, reflecting the decline in union coverage in the middle and lower end of the wage distribution relative to the top, as was seen earlier in Figure 1. The increase over time in the skill composition adjustment is especially large for U.S. women. In Canada the composition effect adjustment is more stable over time, but larger for women than for men. Nonetheless, the adjusted wage gaps remain larger for females than for males in all sample years.

Over time, there is a large decline in the union wage impact in the U.S., especially for female employees (Table 1a). Almost all of this change took place between 1993 and 2015; for example, the adjusted wage gap for men fell from 23% to 15% and that for women from 20% to 9% over this time period. Interestingly, the unadjusted wage gaps actually rose over the 1973/74 to 2015 period for both men

[16] Also, in many instances the public and private sectors hire from the same pool of potential workers, so the private sector nonunion wage structure exerts some influence on its public sector counterpart.

[17] The mean wage in the union sector is $\overline{W}^U = \Sigma\theta^U(c)W^U(c)$, where $\theta^U(c)$ is the fraction of union workers in cell c. Similarly, the non-union wage is $\overline{W}^N = \Sigma\theta^N(c)W^N(c)$. The unadjusted union wage gap can be rewritten as $\overline{W}^U - \overline{W}^N = \Sigma\theta^U(c)\big(W^U(c) - W^N(c)\big) + \Sigma\big(\theta^U(c) - \theta^N(c)\big)W^N(c)$. The first term in the equation is the adjusted union wage gap, while the second term is the composition effect.

and women (although they fell from 1993 to 2015).

One might be tempted to attribute this drop in the union wage impact to the declining importance of unions in the economy. However, Table 1(b) indicates that sectoral changes in the composition of the unionized workforce play an important role. Among men the adjusted union wage impact actually rises over time in the public sector and declines only modestly in the private sector; however, the magnitude of the union-nonunion wage gap is much lower in the public sector (12.5% versus 20.3% in 2015). Thus a key part of the change over time is due to the growing importance of a sector in which unions have a smaller impact on wages. A similar, although less dramatic, compositional effect is occurring over time for women. These results demonstrate the importance of disaggregating by sector of employment for the interpretation of union impacts.

In Canada there is a steady but moderate decline in the union-nonunion wage gap (both unadjusted and adjusted) over the 1984 to 2015 period (Table 2(a)). Disaggregating by sector of employment again reveals noteworthy differences between the public and private sectors. Adjusted union-nonunion wage gaps are much larger in the private sector than in the public sector, especially in 1984 and 1993, but fall sharply between 1993 and 2015. This steep decline in the private sector wage gap is masked by the growing importance of the public sector, where wage gaps are smaller and more stable over time.

The combination of declining unionization and a fall in the adjusted wage differential implies that the average impact of unions on wages – the union wage gain $E[U(c)D_W(c)]$ – has declined subtstantially in both countries in recent decades. For example, the adjusted impact on male wages in the U.S. went from 6.3 percentage points in 1973/74 (unionization rate of 0.307 times an adjusted wage gap of 0.204) to 2.0 percentage points in 2015. For U.S. female workers the average impact went from 3.2 percentage points to 1.1 percentage points. In Canada the average impacts of unions on wages are much larger due to greater union coverage and adjusted wage gaps that are generally larger than their U.S. counterparts. For Canadian men

the average union impacts fell from 11.1 percentage points in 1984 to 4.5 percentage points in 2015, while that for women went from 11.3 percentage points to 7.4 percentage points.

Wage Flattening Effects of Unions. As noted in section 3, the effect of unions on wage inequality depends in part on how the union wage gap $D_W(c)$ varies across the skill distribution. Figures 3a to 3c illustrate the evolution of this dimension of the union and nonunion wage structures by gender and sector of employment for Canada over the 1984 to 2015 period (similar results for the U.S. are available on request). These figures plot mean union wages in a given age – education cell (i.e. $W^U(c)$) by the mean nonunion wage for the same skill group ($W^N(c)$). If union and nonunion workers in the same skill group have the same average wage the points will lie on the 45-degree line (the solid line in the figures). If the mean union wage exceeds its nonunion counterpart, however, the points will lie above the 45-degree line. If, in addition, unions tend to raise the wages of lower skilled workers more than the wages of higher-skilled workers, then the scatter of points will be flatter than the 45 degree line – the so-called "flattening effect" (Lewis, 1986). This tendency of unions to compress skill differences is evident, for example, in the upper left panel of Figure 3a for male workers in the private sector. A similar tendency is evident for males and females in the public sector. For private sector female workers, however, the scatter is nearly parallel to the 45 degree line, suggesting little or no flattening effect.

Comparisons of the graphs for 1984 (Figure 3a), 1993 (Figure 3b) and 2015 (Figure 3c) reveal several interesting facts about the evolution of union wage differentials in Canada. Among private sector men, compression of the union wage structure is strongest in 1984, lessens over time as union coverage among this group declines, and is minimal by 2015. Based on the discussion in Section 3, we would expect these changes to result in a substantially lower effect of unions on the between group component of the variance.

In the case of private sector females, there is very little compression by skill

level of the union wage structure over the sample period. Consistent with Table 2, the primary change has been a decline over time in the union – nonunion wage gap, a gap that is relatively constant across the skill distribution. By 2015 the gap between union and nonunion women in the private sector is very small. The story is very different in the public sector where there is substantial wage compression in all periods for both men and women.

To quantify the extent to which unions compress the wage structure between skill groups we estimate the following regression:

$$D_W(c) = a + b[W^N(c) - \bar{W}^N] + e(c)$$

where $\bar{W}^N$ is the mean nonunion wage (over all cells *c*) and *e(c)* is a random error term. The parameter *a* estimates the union – nonunion wage gap for workers earning the average nonunion wage in cell *c* while the parameter *b* provides an estimate of the extent to which unions flatten the wage distribution across skill groups. If *b* equals zero there is no compression of the union wage distribution relative to the nonunion distribution; with flattening $b < 0$, and the more negative the value of *b* the greater the amount of compression. The results of estimating this equation for the U.S. (approximately 150 skill groups) and Canada (25 skill groups) are shown in Tables 3a and 3b respectively. We also report estimates of the union-nonunion wage gap for low wage workers ($a - 0.5\ b$) -- those earning 50 log points below the mean nonunion wage -- and for high wage workers, those earning 50 log points above the nonunion average wage ($a + 0.5\ b$).

For male workers in the U.S. private sector we see a steady decline over the 1984 to 2015 period in the union – nonunion wage gap estimated at the mean nonunion wage. In contrast, the wage gap for men in the public sector is relatively stable over this time period. There is substantial evidence that unions flatten the male wage structure in both the private and public sectors, with the amount of compression consistently being greater in the public sector. The story is different for

women in the U.S.; compression of the wage structure by skill is lower in the public sector than for men, and close to zero in the private sector after the 1970s. The female union – nonunion wage gap has also fallen dramatically since the early 1990s in both the public and private sectors.

Union impacts on the Canadian male wage structure are broadly similar to those for men in the U.S. The union – nonunion wage gap at the mean of the nonunion wage fell substantially – from 27.4% in 1984 to 11.0% in 2015. As in the U.S. the male wage gap in the public sector is much lower – and close to zero in 2015. However, unions substantially compress the male wage structure in both sectors, with the extent of flattening consistently greater in the public sector. One consequence of substantial compression combined with a small wage differential at the nonunion average wage is that high-skilled unionized men in the public sector earn less than their nonunion counterparts, as is illustrated in Figures 3a to 3c (see also the estimated implied gaps for high wage workers).[18] As in the U.S., compression of the female wage structure in Canada's private sector is minimal – and essentially zero in 1993 and 2015. This contrasts dramatically with the public sector in which there is substantial flattening of female wages across the skill distribution throughout the sample period. However, as is the case in the U.S., the degree of compression of the female public sector wage structure is lower than that for men.

Effects of Unions on Wage Inequality. Our estimates of the impacts of unionization on wage inequality are reported in the two lower panels of Tables 1 and 2. We begin in the first panel by showing the variance of log wages for all workers, the difference between the overall variance and the variance of nonunion wages, and the 'composition effect' associated with reweighting – the difference between the variance of log wages for nonunion workers and the reweighted variance. The estimated effect of unions on wage inequality is then the difference between the

[18] We note that this apparent negative effect may be driven in part by differences in unobserved skills between older and highly educated union and nonunion workers.

overall variance minus the nonunion variance and the composition effect.

Pooled sample results are reported in Tables 1a and 2a. In the U.S. the overall variance of log wages has increased steadily and substantially for both men and women since the early 1970s, as has been observed in many studies of trends in wage inequality. For men the nonunion variance has risen to an even greater extent; as a result, the difference between the overall and nonunion variances has steadily declined. As was found in previous studies, the impact of unionization on U.S. male workers is consistently negative. The composition effect has also fallen over time, and is essentially zero in 2015, reflecting the growing similarity between the skill distributions in the union and nonunion sectors, as illustrated in Figure 1, as well as the decline in unionization.[19] As expected, given the substantial decline in unionization among U.S. men, the impact of unions on male wage inequality fell sharply – from over 10 percent of the variance in the 1970s (-0.026 / 0.258) to 4 percent in 2015 (-0.016 / 0.402).

In the bottom panel we report the results of the decomposition into the between and within group components illustrated in equation (3). Both effects have the same sign and contribute to lower wage inequality in each year. The impact of unions on the variance of average wages across skill groups is generally the more important of the two -- contributing about 60% of the reduction in inequality. But the effect of unions on the average variance of wages within skill groups is also quantitatively important.

Among U.S. female workers the estimated impact of unions on wage dispersion is close to zero from the early 1970s to early 1990s. However, by 2015 unionization among women has a small equalizing effect, reducing the variance by 3.4 percent (-0.012 / 0.349). Most of this estimated impact is associated with differences in the skill composition of the union and nonunion female workforces in the U.S. Although the magnitude of this effect is small it is not much different from the comparable estimate for U.S. males in 2015. Both the between and within group

[19] As the unionization rate gets very low, the skill composition in the nonunion sector has to get increasingly close to the one for the whole workforce, limiting the scope of potential composition effects.

effects contribute, but most of the reduction in inequality arises from the impact of unions on lowering the average variance within skill groups.

The trends for Canadian men are broadly similar to those in the U.S., but there are some noteworthy differences. The overall variance of male wages has been relatively stable, in contrast to the U.S. experience, while the variance of nonunion wages has declined sharply, resulting in an even larger decline in the actual – nonunion variance gap over the 1984 to 2015 period than for U.S. men.[20] As in the U.S., the composition effect has also fallen as the union and nonunion male skill distributions have become more similar. The result is a steady decline in the equalizing impact of unions on male wage inequality – from 16 percent of the variance in 1984 to 3.6 percent in 2015. The within group effect is the dominant factor accounting for the reduction in male wage inequality, especially in the 1990s and 2000s. Consistent with the large decline in the flattening effect illustrated in Table 3b, the between group effect becomes much less important over time, and even turns positive (inequality enhancing effect) by 2015.

Among Canadian women, the total variance of log wages exceeds the nonunion variance -- in contrast to the case for men. This small difference is offset by an even smaller composition effect working in the opposite direction. As a result, unions have a small inequality-increasing effect on female wage inequality in all sample years, similar in size to that found in Card, Lemieux and Riddell (2004) for the 1984 to 2001 period. The decomposition in the bottom panel provides insights into this gender difference: among women, unionization increases the variance in average wages across skill groups and this inequality-increasing effect dominates the reduction in inequality coming from the within-sector effect that contributes to lower wage inequality.

The findings from our analysis of the impacts of unions on wage inequality by gender and sector of employment are reported in Tables 1b and 2b. There are striking differences between the public and private sectors for men and women in

[20] Note that there was a sharp increase in wage inequality in Canada in the early 1980s during the 1981-82 recession. Our sample period begins after this increase.

both Canada and the U.S. These differences have generally become more pronounced over time.

In the U.S., the variance of log wages has increased over time among all four groups and the extent of the increase has been greater in the private sector where union coverage has fallen sharply. The variance of wages is also higher among males in both sectors. In the private sector, unions reduce male wage inequality in each sample year, but after the 1970s the effect is modest in size –- a reduction of 3.0% of the variance in 1984, declining to 1.7% in 2015. In contrast, in the U.S. public sector unionization reduces male wage inequality substantially, especially since the 1970s, with impacts ranging from 15% to 18% of the overall variance for that group. Both the between cell and within cell effects contribute, with the within sector effect being the more important of the two (about 2/3 of the total over the 1984 to 2015 period).

Among U.S. female employees, differences in the impacts of unions on the wage structure in the public and private sectors are equally striking. In the private sector unions have essentially no impact on female wage inequality, a feature that has not changed over the sample period. However, since 1984 unionization has reduced wage inequality among women in the public sector and the magnitude of this effect has grown over time – to 10.7% of the overall variance in 2015. Clearly, the evidence of a modest reduction in female wage inequality that appeared in the pooled sample in 2015 was driven by the public sector. Both the between and within sector effects contribute to this impact, with the within cell effect being the more important of the two.

In Canada the variance of log wages is more stable over time than in the U.S. for all four groups, with the variance of male wages being larger than that of female employees in the private sector, but about the same in the public sector. Unions reduce male wage inequality in both sectors, but the magnitude of the impact is much lower in the private sector. With the decline in union coverage among men in the private sector, the size of the union impact has also fallen – from 9.4% of the

variance in 1984 to 2.3% in 2015. In most sample years the between cell and within cell effects contribute about equally to this reduction. There is also little evidence of union impacts on female wage inequality in the private sector – estimated effects are close to zero in each sample year. In contrast, the effects of unionization in the public sector are very large, and the magnitudes of the estimated impacts are similar for men and women. The size of the effect has fallen over time – from a reduction in the variance of about 70% in 1984 to almost 60% in 1993 to approximately 45% in 2015. A large part of the decline comes from the between cell effect that has fallen by more than 50% between 1984 and 2015. This is again consistent with the large decline in the flattening effect summarized by the slope parameter *b* that went from -0.552 to -0.311 between 1984 and 2015 for men, and from -0.425 to -0.264 for women.

As we noted earlier, the unionization rates among men and women have converged over time due, in large part, to the large decline in unionization in the private sector that used to be concentrated among men. One interesting pattern that emerges from Tables 1b and 2b is that the effect of unions on inequality is also increasingly similar for men and women, especially in the U.S. For instance, by 2015 the effect of unions on inequality is negative, and generally comparable in magnitude, for men and women in the public and private sectors in both countries. In contrast, the equalizing effect of unions on inequality was generally smaller for women in 1984, and often went in the "wrong" direction (inequality enhancing). Thus, one key finding of the paper is that the well documented difference in the equalizing effects of unions for men and women no longer prevails in recent data for the U.S., and is much less important than it used to be in Canada.

5. Conclusions

The relationship between unionization of the workforce and the distribution of labour income has long been of interest to economists and other social scientists. The nature of this relationship has received renewed attention recently as wage

inequality has increased in many developed countries. In these countries, a salient development has been the decline of union influence and a natural question to investigate is whether the rise in inequality and the decline in unionization (as well as other changes in labour market institutions) are linked. Numerous studies reviewed previously in this paper conclude that the decline in union coverage in Canada and the U.S. -- the countries we focus on in this study -- did indeed contribute to increasing wage inequality, although this institutional change was not the only (or even the dominant) factor. Initially most research focused on men employed in the private sector. Subsequent studies examined both male and female employees and reached a puzzling conclusion – that unionization decreases male wage inequality but has no or even a positive effect on female wage inequality.

Another salient development has been the divergence of unionization in the private and public sectors. Over the past four or five decades, unionization has grown or remained stable in the public sector but declined substantially in the private sector. The gap in union coverage is now enormous – 38% in the U.S. public sector vs 7% in the private sector and 76% vs 16% in Canada. As a consequence, almost one-half of unionized workers in each country are employed in the public sector even though that sector accounts for only 15% (U.S.) to 20% (Canada) of total employment.

A central objective of this paper is to investigate the implications of this dramatic divergence for the impacts of unions on the wage structure. With the exception of Card's (2001) study of the U.S., previous studies have either focused on the private sector or pooled together the public and private sectors. A second objective of the paper is to assess whether distinguishing between the public and private sectors might shed light on the puzzling gender difference found in previous studies of the relationship between unionization and wage inequality.

In both countries we find that there are striking differences between the private and public sectors in the effects of unionization on male and female wage inequality. These differences have become more pronounced over time as private

and private sector unionization have diverged. In 2015, the overall effects of unions on the economy-wide wage structure are small – reductions in male wage inequality of 4.0% in the U.S. and 3.6% in Canada, and a reduction in female inequality of 3.4% in the U.S. and an increase in inequality of 2.8% in Canada. However, disaggregating by sector of employment yields striking differences: reductions in male wage inequality in the private sector of 1.7% in the U.S. and 2.3% in Canada versus reductions in male wage inequality in the respective public sectors of 16.2% and 47.4%. Similarly, our estimates imply that unionization reduces female wage inequality by 0.6% and 2.2% in the U.S. and Canadian private sectors respectively but 10.7% and 44.4% in those countries' public sectors. Note also that once we disaggregate by sector the effects of unions on male and female wage inequality no longer differ – union coverage reduces wage inequality among women and men to a similar extent in both sectors and in both countries. The key differences in the impacts of unions are between the public and private sectors – not between male and female employees.

In both Canada and the U.S. the impact of unions on wage inequality has fallen substantially in the private sector. Differences in wage levels between union and nonunion workers are also much smaller now than in the past. With the distributions of union and nonunion wages now very similar in the private sector, it seems unlikely that marginal changes in the extent of private sector unionization will have much impact on inequality.[21] With the decline in employment in traditional areas of union strength such as manufacturing and primary industries, major gains in collective bargaining coverage require making inroads in the service sector. This has proven very difficult in the Wagner Act framework with its emphasis on making

[21] Legree, Skuterud and Schirle (2016) examine this issue for Canada and reach a similar conclusion. They analyse the potential impact of more union-friendly laws on union density and, through that, on the degree of inequality in the wage distribution. Their estimates suggest that if all Canadian jurisdictions adopted the most union-friendly laws among those currently in place, union coverage would increase substantially among male college and university graduates employed in the public sector but would change little among women and less-educated men in either sector. Their simulations suggest that impacts of wage inequality would be small – a 2% reduction in the 90-10 differential for males and no change for females.

collective representation decisions at the enterprise level. Although many service sector firms such as Starbucks, Walmart and retail banks are large employers, individual outlets have few employees and relatively high turnover, both obstacles to union organization. Achieving significant increases in unionization in the service sector probably requires moving outside the Wagner Act framework.

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Table 1a: Summary of Effect of Unions on U.S. Wage Inequality -- Private and Public Sectors Combined

	1973/74		1984		1993		2015	
	male	female	male	female	male	female	male	female
Union Coverage Rate	0.307	0.141	0.236	0.141	0.185	0.132	0.131	0.128
Union Effect on Mean Wages:								
Unadjusted Union Wage Gap	0.196	0.230	0.293	0.329	0.304	0.350	0.234	0.294
Composition Effect[a]	-0.008	0.003	0.066	0.106	0.074	0.149	0.085	0.208
Adjusted Union Wage Gap	0.204	0.227	0.227	0.222	0.230	0.201	0.149	0.086
Union Effect on Variance of Wages:								
Actual Variance	0.258	0.195	0.289	0.223	0.331	0.270	0.402	0.349
Actual - Nonunion Variance	-0.047	0.000	-0.028	0.006	-0.022	0.005	-0.018	-0.002
Composition Effect[b]	0.021	0.000	0.011	-0.005	0.008	-0.006	0.001	-0.010
Total union effect	-0.026	0.000	-0.017	0.001	-0.014	-0.001	-0.016	-0.012
Decomposition of Union Effect on Variance:								
Between cell effect	-0.016	-0.002	-0.010	0.001	-0.006	0.002	-0.012	-0.004
Within cell effect	-0.010	0.001	-0.007	0.000	-0.008	-0.003	-0.004	-0.009

Note: samples include wage and salary workers age 16-64 with non-allocated hourly or weekly pay, and hourly wages between $2.85 and $128.50 per hour in 2001 dollars. Calculations are weighted by CPS Earnings Supplement sample weights.

[a]Composition effect measures component of the union non-union wage gap attributable to non-random coverage, and is measured by difference between fraction of union workers and fraction of nonunion workers in each age/education cell, multiplied by mean wage of non-union workers in the cell.

[b]Composition effect measures component of the variance of nonunion wages that is due to nonrandom coverage, and represents the difference between the actual variance of wages for non-union workers and a reweighted variance that weights nonunion workers in each age/education cell by the fraction of the overall labor force in the cell.

Table 1b: Summary of Effect of Unions on US Wage Inequality -- by Gender and Private and Public Sectors

	1973-1974				1984				1993				2015			
	Public Sector		Private Sector		Public Sector		Private Sector		Public Sector		Private Sector		Public Sector		Private Sector	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Union Coverage Rate	0.289	0.180	0.311	0.130	0.396	0.334	0.206	0.094	0.392	0.369	0.147	0.071	0.428	0.413	0.087	0.062
Union Effect on Mean Wages:																
Unadjusted Union Gap	0.095	0.230	0.217	0.202	0.165	0.272	0.308	0.276	0.197	0.297	0.288	0.238	0.160	0.237	0.188	0.192
Composition Effect[a]	-0.008	0.049	-0.008	-0.028	0.058	0.133	0.028	-0.001	0.041	0.123	0.017	0.008	0.035	0.125	-0.014	0.074
Adjusted Union Wage Gap	0.103	0.181	0.225	0.230	0.107	0.139	0.281	0.277	0.156	0.174	0.270	0.230	0.125	0.111	0.203	0.118
Union Effect on Variance of Wages:																
Actual Variance	0.233	0.204	0.260	0.173	0.229	0.200	0.295	0.218	0.264	0.235	0.333	0.263	0.296	0.289	0.411	0.352
Actual - Nonunion Variance	-0.041	0.000	-0.046	-0.003	-0.059	-0.002	-0.022	0.002	-0.063	-0.009	-0.017	0.000	-0.063	-0.026	-0.011	-0.001
Composition Effect[b]	0.014	0.002	0.023	0.002	0.018	-0.006	0.013	0.003	0.021	-0.002	0.011	0.001	0.015	-0.005	0.005	-0.001
Total union effect	-0.027	0.002	-0.023	-0.001	-0.041	-0.009	-0.009	0.005	-0.041	-0.012	-0.006	0.001	-0.048	-0.031	-0.007	-0.002
Decomposition of Total Union Effect on Variance:																
Between cell effect	-0.016	-0.001	-0.014	-0.003	-0.027	-0.001	-0.006	-0.001	-0.026	-0.002	-0.003	0.000	-0.033	-0.012	-0.007	-0.001
Within cell effect	-0.011	0.002	-0.009	0.002	-0.014	-0.008	-0.003	0.006	-0.015	-0.010	-0.003	0.001	-0.016	-0.018	0.000	-0.001

Note: samples include wage and salary workers age 16-64 with non-allocated hourly or weekly pay, and hourly wages between $2.85 and $128.50 per hour in 2001 dollars. Wages are deflated by CPI-U. Calculations are weighted by CPS Earnings Supplement sample weights.

[a]Composition effect measures component of the union non-union wage gap attributable to non-random coverage, and is measured by difference between fraction of union workers and fraction of nonunion workers in each age/education cell, multiplied by mean wage of non-union workers in the cell.

[b]Composition effect measures component of the variance of nonunion wages that is due to nonrandom coverage, and represents the difference between the actual variance of wages for non-union workers and a reweighted variance that weights nonunion workers in each age/education cell by the fraction of the overall labour force in the cell.

Table 2a: Summary of Effect of Unions on Canadian Wage Inequality -- Private and Public Sectors Combined

	1984		1993		2015	
	male	female	male	female	male	female
Union Coverage Rate	0.467	0.369	0.408	0.353	0.293	0.320
Union Effect on Mean Wages:						
Unadjusted Union Wage Gap	0.330	0.428	0.312	0.399	0.230	0.337
Composition Effect[a]	0.091	0.123	0.120	0.127	0.075	0.107
Adjusted Union Wage Gap	0.238	0.305	0.191	0.272	0.155	0.230
Union Effect on Variance of Wages:						
Actual Variance	0.231	0.218	0.234	0.228	0.222	0.214
Actual - Nonunion Variance	-0.048	0.019	-0.031	0.011	-0.011	0.012
Composition Effect[b]	0.011	-0.010	0.005	-0.006	0.003	-0.005
Total union effect	-0.037	0.009	-0.025	0.005	-0.008	0.006
Decomposition of Union Effect on Variance:						
Between cell effect	-0.014	0.014	-0.001	0.015	0.003	0.015
Within cell effect	-0.024	-0.005	-0.024	-0.010	-0.011	-0.009

Note: samples include wage and salary workers age 15-64 with hourly wages between $2.50 and $44.00 per hour in 2001 dollars. Calculations are weighted by LFS sample weights.

[a]Composition effect measures component of the union non-union wage gap attributable to non-random coverage, and is measured by difference between fraction of union workers and fraction of nonunion workers in each age/education cell, multiplied by mean wage of non-union workers in the cell.

[b]Composition effect measures component of the variance of nonunion wages that is due to nonrandom coverage, and represents the difference between the actual variance of wages for non-union workers and a reweighted variance that weights nonunion workers in each age/education cell by the fraction of the overall labor force in the cell.

Table 2b: Summary of Effect of Unions on Canadian Wage Inequality -- by Gender and Private and Public Sectors

	1984				1993				2015			
	Public Sector		Private Sector		Public Sector		Private Sector		Public Sector		Private Sector	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Union Coverage Rate	0.810	0.780	0.374	0.251	0.794	0.770	0.320	0.239	0.750	0.771	0.198	0.132
Union Effect on Mean Wages:												
Unadjusted Union Gap	0.114	0.294	0.307	0.339	0.107	0.229	0.272	0.317	0.097	0.144	0.156	0.089
Composition Effect[a]	0.056	0.086	0.048	0.070	0.048	0.080	0.074	0.077	0.076	0.043	0.031	0.027
Adjusted Union Wage Gap	0.058	0.208	0.259	0.269	0.059	0.149	0.198	0.239	0.021	0.100	0.125	0.062
Union Effect on Variance of Wages:												
Actual Variance	0.150	0.150	0.234	0.198	0.147	0.153	0.233	0.211	0.171	0.151	0.216	0.183
Actual - Nonunion Variance	-0.164	-0.103	-0.034	0.009	-0.129	-0.080	-0.024	0.004	-0.122	-0.082	-0.009	-0.004
Composition Effect[b]	0.051	-0.001	0.012	-0.002	0.044	-0.007	0.008	-0.001	0.041	0.015	0.003	0.000
Total union effect	-0.114	-0.104	-0.022	0.008	-0.085	-0.088	-0.015	0.002	-0.081	-0.067	-0.005	-0.004
Decomposition of Total Union Effect on Variance:												
Between cell effect	-0.054	-0.030	-0.012	0.005	-0.046	-0.017	-0.003	0.006	-0.019	-0.013	-0.002	0.000
Within cell effect	-0.060	-0.074	-0.010	0.002	-0.039	-0.071	-0.013	-0.003	-0.062	-0.054	-0.003	-0.004

Note: samples include wage and salary workers age 15-64 with hourly wages between $2.50 and $44.00 per hour in 2001 dollars. Calculations are weighted by LFS sample weights.

[a]Composition effect measures component of the union non-union wage gap attributable to non-random coverage, and is measured by difference between fraction of union workers and fraction of nonunion workers in each age/education cell, multiplied by mean wage of non-union workers in the cell

[b]Composition effect measures component of the variance of nonunion wages that is due to nonrandom coverage, and represents the difference between the actual variance of wages for non-union workers and a reweighted variance that weights nonunion workers in each age/education cell by the fraction of the overall labour force in the cell.

Table 3a: Summary of Flattening Effect of Unions on Between-Group Wages in the U.S., by Gender and Sector

	1973-74		1984		1993		2015	
	Private	Public	Private	Public	Private	Public	Private	Public
Models for Male Workers:								
Intercept[a]	0.185	0.110	0.224	0.126	0.215	0.163	0.162	0.118
(standard error)	(0.008)	(0.009)	(0.009)	(0.009)	(0.010)	(0.008)	(0.012)	(0.012)
Coefficient on Non-Union Wage[b]	-0.388	-0.440	-0.306	-0.468	-0.253	-0.420	-0.305	-0.388
(standard error)	(0.021)	(0.030)	(0.023)	(0.025)	(0.025)	(0.023)	(0.029)	(0.034)
R-squared	0.526	0.460	0.348	0.556	0.314	0.652	0.349	0.528
Implied Gap: 0.5 below mean[c]	0.379	0.329	0.377	0.360	0.341	0.373	0.314	0.312
Implied Gap: 0.5 above mean[d]	-0.009	-0.110	0.071	-0.108	0.088	-0.047	0.010	-0.076
Models for Female Workers:								
Intercept[a]	0.213	0.197	0.252	0.172	0.210	0.203	0.123	0.136
(standard error)	(0.008)	(0.013)	(0.007)	(0.008)	(0.009)	(0.007)	(0.011)	(0.011)
Coefficient on Non-Union Wage[b]	-0.261	-0.154	-0.044	-0.301	-0.022	-0.281	-0.100	-0.249
(standard error)	(0.040)	(0.049)	(0.029)	(0.031)	(0.029)	(0.026)	(0.031)	(0.035)
R-squared	0.137	0.044	0.008	0.283	0.003	0.399	0.054	0.290
Implied Gap: 0.5 below mean[c]	0.343	0.274	0.273	0.322	0.221	0.344	0.173	0.260
Implied Gap: 0.5 above mean[d]	0.082	0.120	0.230	0.021	0.199	0.062	0.073	0.011

Note: See Tables 1a and 1b for description of samples. Entries are estimated intercept and slope coefficient (plus R-squared and standard errors) from regressions of mean union-non-union wage gap for a particular skill group on the deviation of the mean nonunion log wage for the skill group from the mean log wage for all nonunion workers. Each skill group is based on single year of education (up to 14 categories) and single year of age (up to 48 categories). Regressions are estimated by weighted least squares using number of nonunion workers in cell as weight.

[a]Estimated intercept from between-skill-group regression is interpretable as union-nonunion wage gap for workers in skill group earning mean nonunion wage.

[b]Estimated coefficient on deviation of skill-group-specific mean nonunion wage from overall mean wage for nonunion workers of same gender and sector.

[c]Implied union-nonunion wage gap for workers in skill group with mean nonunion wage 50 log points ***below*** overall mean nonunion wage.

[d]Implied union-nonunion wage gap for workers in skill group with mean nonunion wage 50 log points ***above*** overall mean nonunion wage.

Table 3b: Summary of Flattening Effect of Unions on Between-Group Wages in Canada, by Gender and Sector

	1984		1993		2015	
	Private	Public	Private	Public	Private	Public
Models for Male Workers:						
Intercept[a]	0.274	0.080	0.197	0.083	0.110	0.033
(standard error)	(0.008)	(0.016)	(0.013)	(0.020)	(0.020)	(0.020)
Coefficient on Non-Union Wage[b]	-0.475	-0.552	-0.321	-0.585	-0.227	-0.311
(standard error)	(0.027)	(0.041)	(0.044)	(0.055)	(0.081)	(0.065)
R-squared	0.929	0.888	0.699	0.838	0.253	0.535
Implied Gap: 0.5 below mean[c]	0.512	0.356	0.357	0.376	0.223	0.188
Implied Gap: 0.5 above mean[d]	0.037	-0.196	0.037	-0.209	-0.004	-0.123
Models for Female Workers:						
Intercept[a]	0.285	0.226	0.242	0.163	0.061	0.113
(standard error)	(0.012)	(0.014)	(0.011)	(0.016)	(0.013)	(0.016)
Coefficient on Non-Union Wage[b]	-0.163	-0.425	-0.019	-0.346	-0.022	-0.264
(standard error)	(0.059)	(0.054)	(0.049)	(0.066)	(0.064)	(0.064)
R-squared	0.248	0.739	0.006	0.559	0.005	0.450
Implied Gap: 0.5 below mean[c]	0.367	0.438	0.252	0.336	0.071	0.245
Implied Gap: 0.5 above mean[d]	0.203	0.013	0.233	-0.010	0.050	-0.019

Note: See Tables 2a and 2b for description of samples. Entries are estimated intercept and slope coefficient (plus R-squared and standard errors) from regressions of mean union-non-union wage gap for a particular skill group on the deviation of the mean nonunion log wage for the skill group from the mean log wage for all nonunion workers. Skill groups are based on five education categories and five age groups. Regressions are estimated by weighted least squares using number of nonunion workers in cell as weight.

[a]Estimated intercept from between-skill-group regression is interpretable as union-nonunion wage gap for workers in skill group earning mean nonunion wage.

[b]Estimated coefficient on deviation of skill-group-specific mean nonunion wage from overall mean wage for nonunion workers of same gender and sector.

[c]Implied union-nonunion wage gap for workers in skill group with mean nonunion wage 50 log points ***below*** overall mean nonunion wage.

[d]Implied union-nonunion wage gap for workers in skill group with mean nonunion wage 50 log points ***above*** overall mean nonunion wage.

Appendix Table 1
Union Coverage, Composition of Unionized Workforce and Employment by Sector, Canada and US, 2016

Employment by Sector (%)	*Canada*	*U.S.*
Public Sector	20.0	15.2
Private Sector	80.0	84.8

Composition of Unionized Workforce (%)	*Canada*	*U.S.*
Female	52.8	46.5
Male	47.2	53.5
Public Sector	59.5	48.1
Private Sector	40.5	51.9

Union Coverage (%)	*Canada*	*U.S.*
Female	32.2	11.6
Male	28.4	12.3
Public Sector	76.3	37.9
Private Sector	16.1	7.3

Sources:
Canada: Statistics Canada, Labour Force Survey, Cansim series 282-0220, 282-0221, 282-0223, available at www.statcan.ca

U.S.: Current Population Survey, available at www.unionstats.com

Appendix Table 2a: Distribution of Employment and Unionization Rate (in %)
by Sector and Occupation in 2015, U.S.

Occupation:	Employment		Unionization rate	
	Private	Public	Private	Public
Management	10.3	8.0	3.0	22.0
Business and financial operations	4.9	4.5	2.4	23.8
Computer and mathematical science	3.4	2.6	2.7	23.0
Architecture and engineering	2.2	1.6	5.7	26.3
Life, physical, and social science	0.8	2.1	5.0	22.7
Community and social service	1.4	4.0	6.0	39.8
Legal occupations	1.0	1.7	3.3	18.5
Education, training, and library	2.7	27.4	16.4	53.4
Arts, entertainment, and media	1.7	0.8	7.3	27.0
Healthcare professionals and technicians	6.4	4.7	11.5	37.8
Healthcare support	2.7	1.3	8.1	25.2
Protective service	0.8	10.6	9.1	52.5
Food preparation and serving	6.4	2.0	3.9	23.1
Cleaning and maintenance	3.7	3.3	7.6	31.9
Personal care and service	3.2	2.5	4.8	28.9
Sales and related	11.7	0.8	3.6	20.7
Office and administrative support	12.8	13.9	4.9	39.0
Farming, fishing, and forestry occupations	0.8	0.1	2.1	16.5
Construction and extraction	5.3	2.2	17.0	36.6
Installation, maintenance, and repair	3.8	2.0	13.6	40.1
Production occupations	7.1	1.2	12.9	30.6
Transportation and material moving	7.0	2.8	15.3	41.4

Note: Computed using the 2015 CPS

Appendix Table 2b: Distribution of Employment and Unionization Rate (in %)
by Sector and Occupation in 2015, Canada

Occupation:	Employment		Unionization rate	
	Private	Public	Private	Public
Senior management	0.1	0.3	4.0	10.1
Other management	5.9	4.7	3.6	42.4
Professionals in business and finance	3.4	3.2	7.2	57.8
Financial, secretarial and administration	4.5	6.4	7.1	74.3
Clerical, including supervisors	10.2	11.1	11.0	75.3
Natural and applied sciences	8.4	7.3	10.1	69.3
Health professionals	0.8	9.7	31.8	84.4
Technical and assisting health occupations	2.8	8.0	30.2	87.9
Social science, government and religion	4.0	8.6	15.8	72.0
Teachers and professors	0.5	18.3	20.8	86.8
Art, culture, recreation and sport	2.4	2.8	16.2	53.1
Wholesale, insurance and real estate	3.7	0.1	5.7	38.1
Retail salespersons, sales clerks, cashiers	9.4	0.7	10.7	74.8
Cooks and food and beverage service	5.2	0.6	8.3	61.1
Protective services	0.8	4.0	39.1	79.0
Childcare and home support	0.8	3.2	23.6	75.1
Sales and service occupations	10.4	4.7	19.0	80.6
Contractors & superv. in trades & transp.	1.4	0.4	23.9	75.7
Construction trades	2.7	0.4	37.8	92.7
Other trades occupations	6.8	2.0	30.5	86.2
Transport and equipment operators	4.3	2.0	27.0	85.3
Construction and transportation labourers	2.8	0.8	26.8	81.3
Occupations in primary industry	2.2	0.3	13.0	73.6
Machine Operators and Assemblers	5.2	0.4	32.6	73.3
Other labourers	1.3	0.0	30.2	51.0

Note: Computed using the 2015 LFS

Figure 1: Union Coverage by Wage Level, USA

Figure 2: Union Coverage by Wage Level, Canada

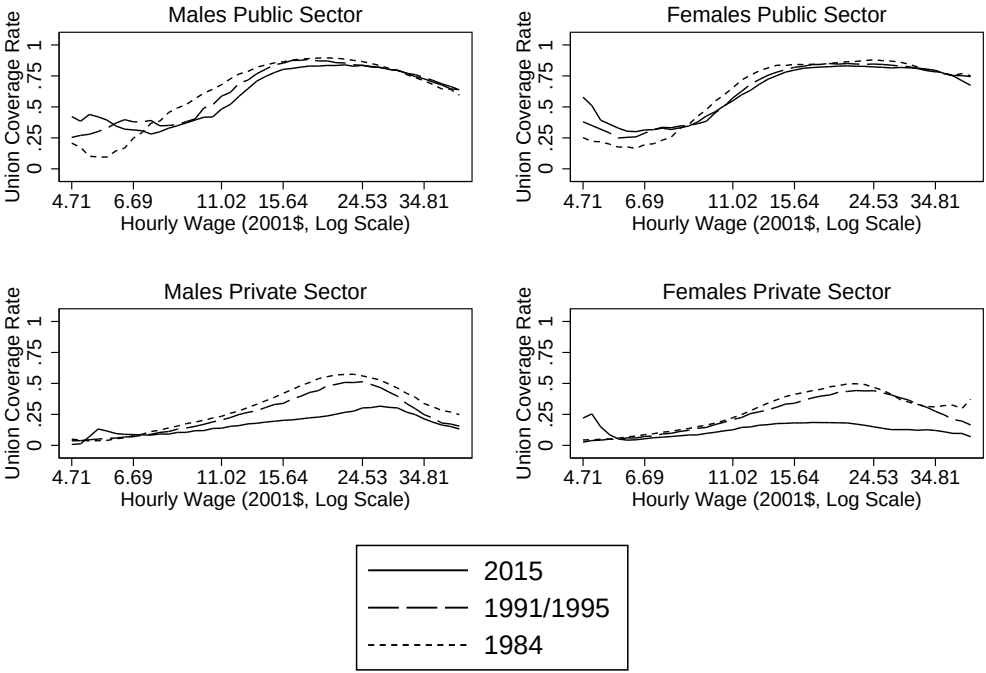
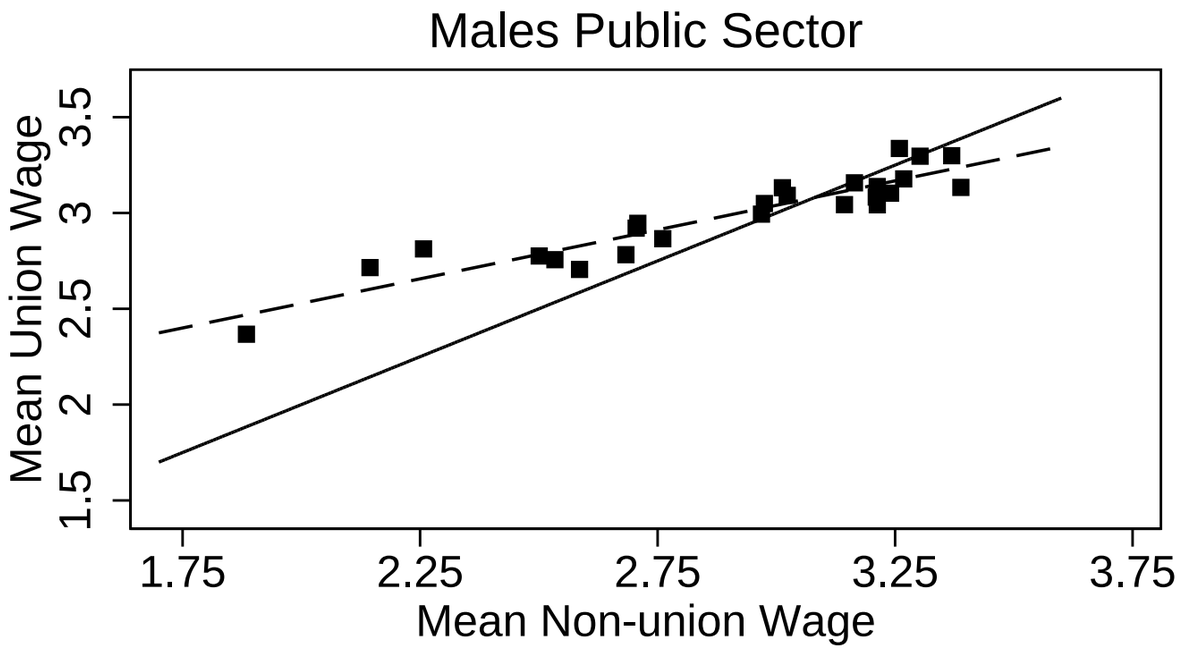
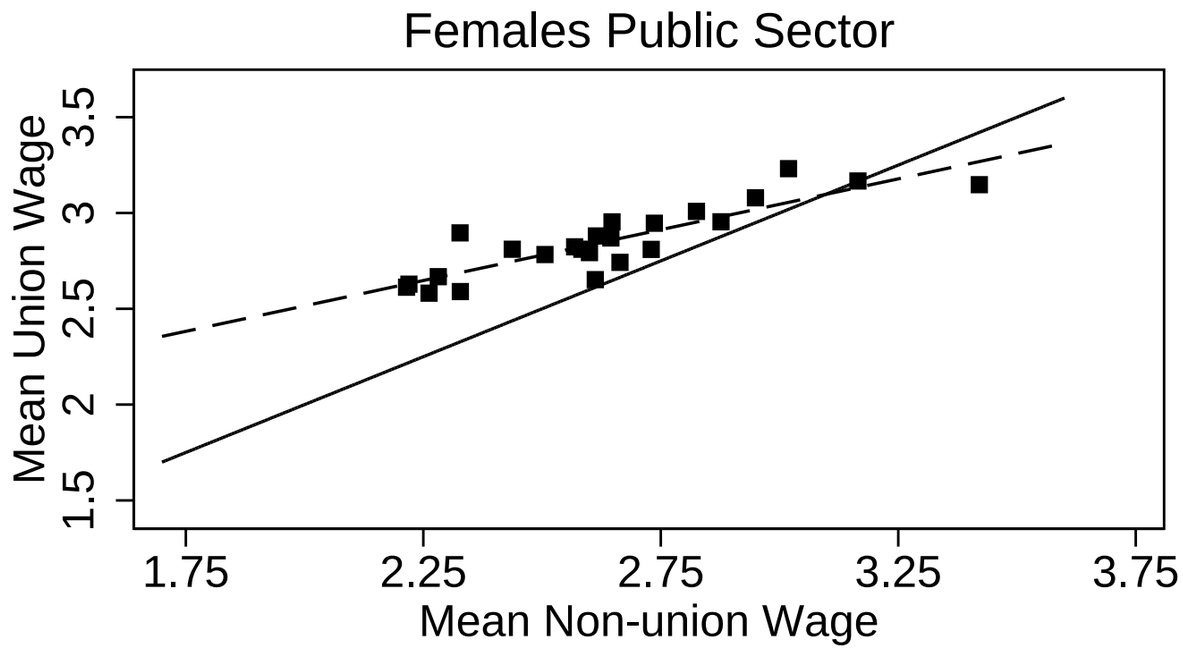
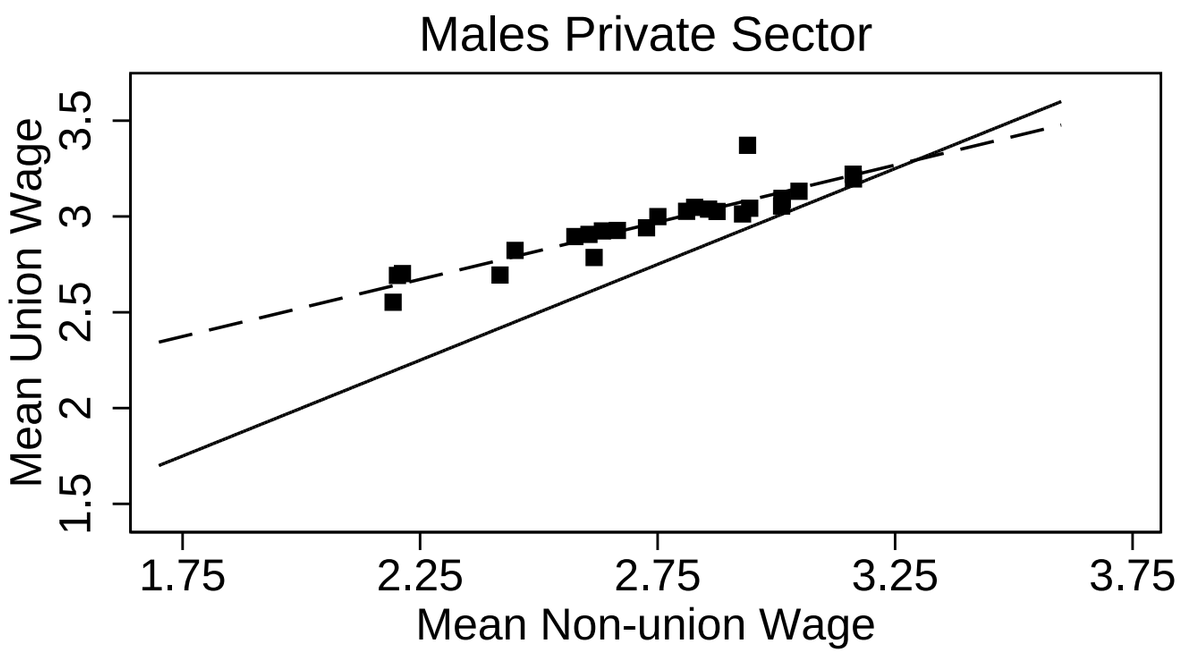
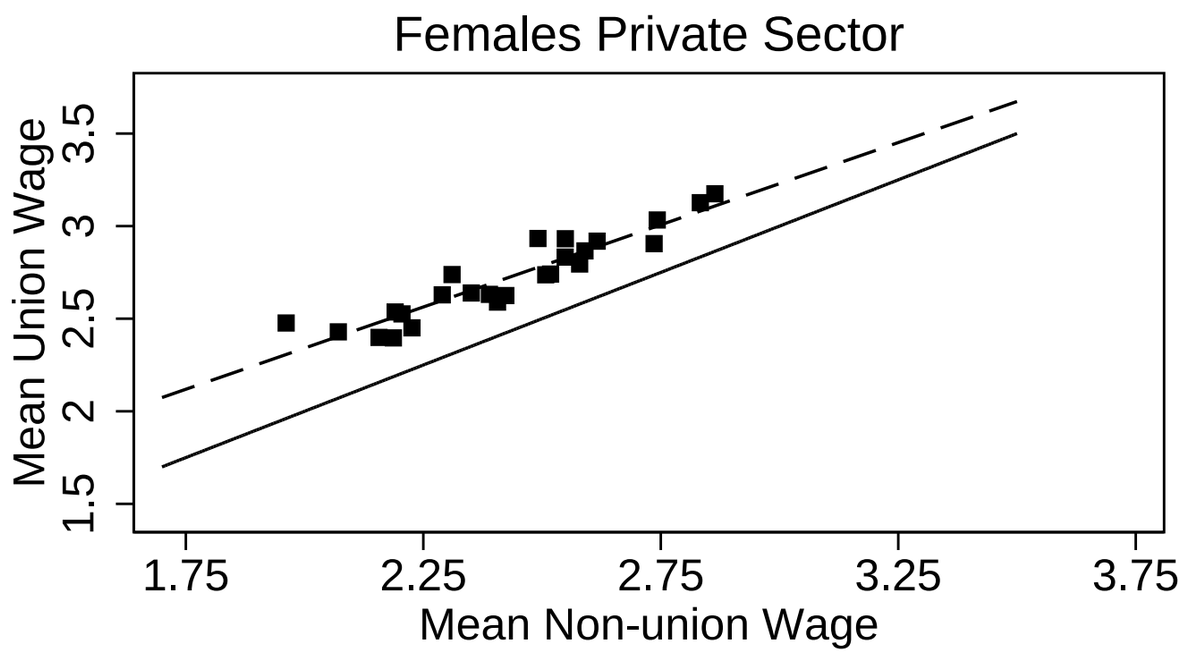


Figure 3a: Union and Nonunion Wage Structures, Canada 1984



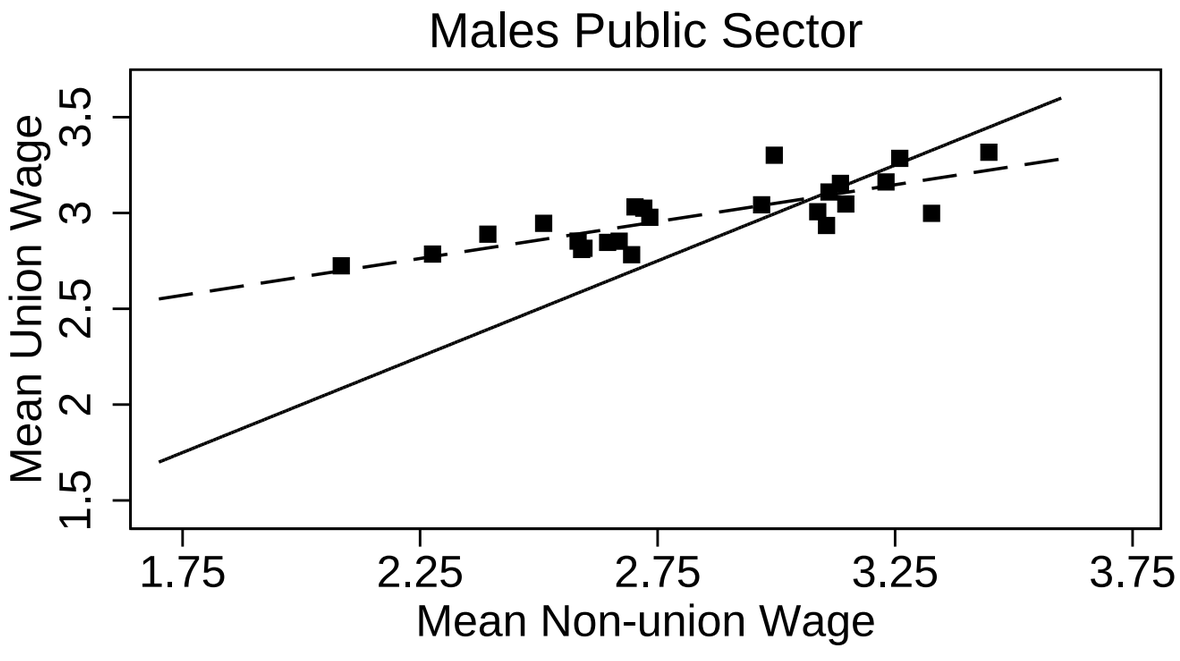


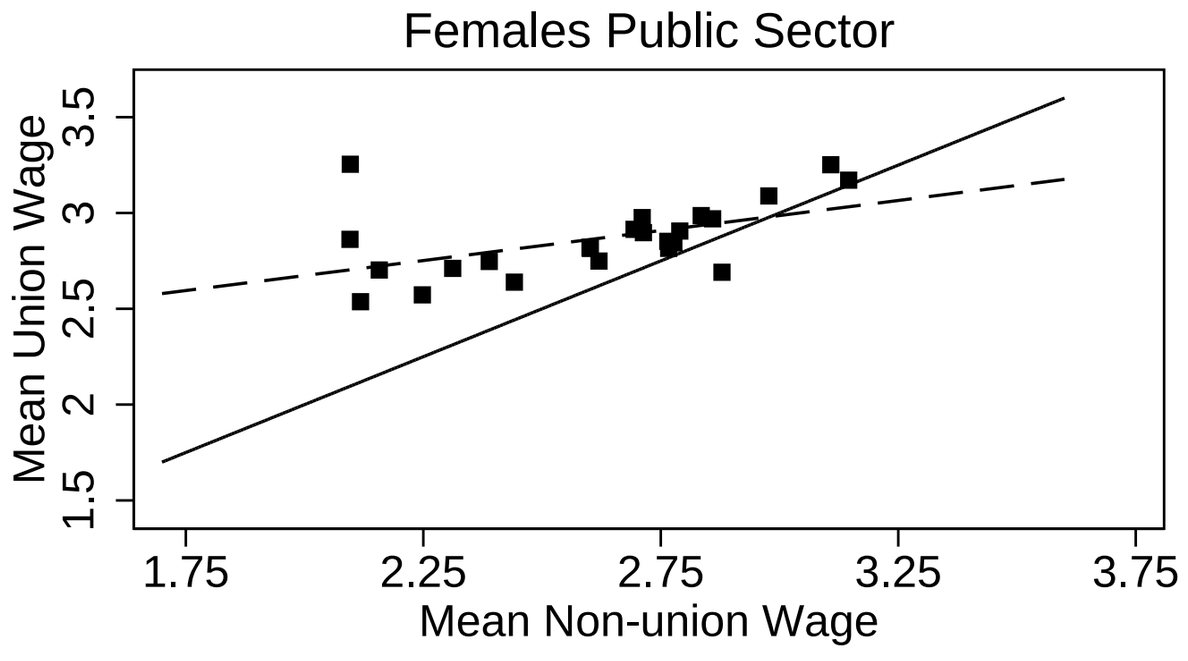


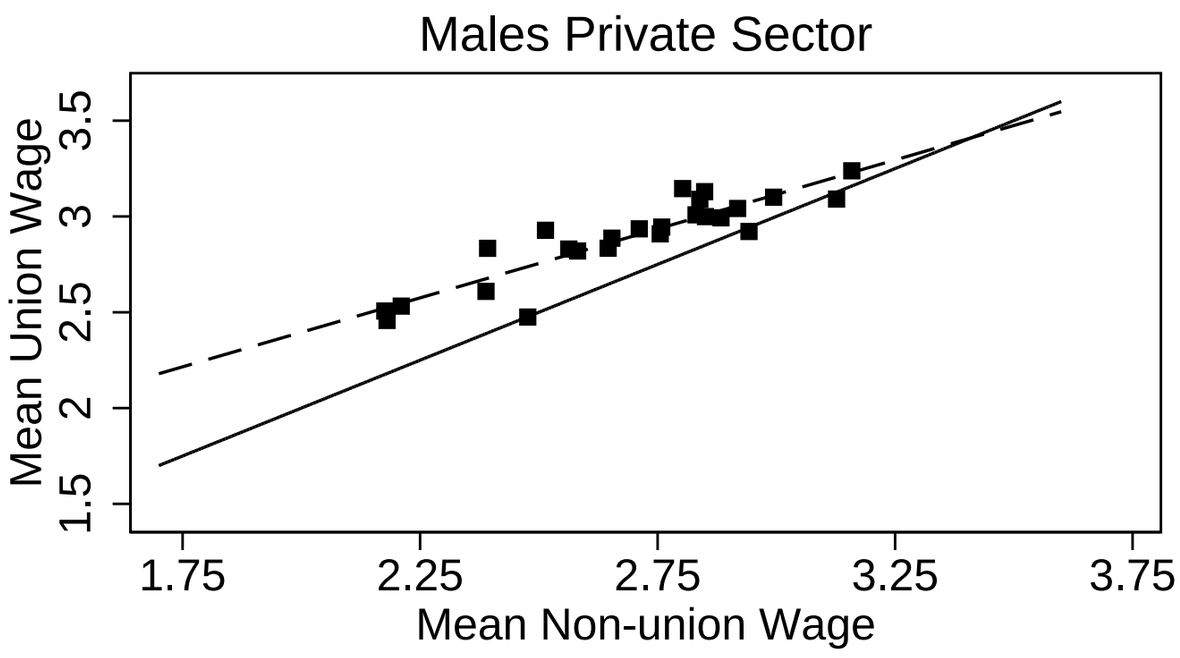


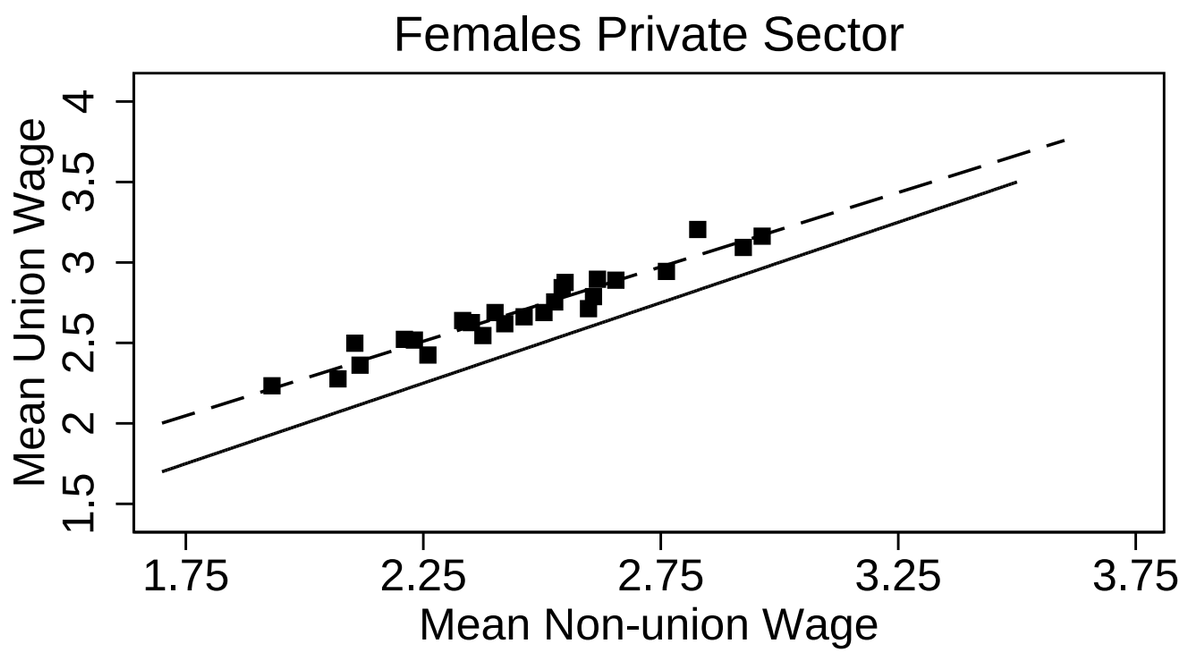
Note: Each point represents an age-education cell. Solid line is the 45 degree line, dashed line is fitted regression line.

Figure 3b: Union and Nonunion Wage Structures, Canada 1993



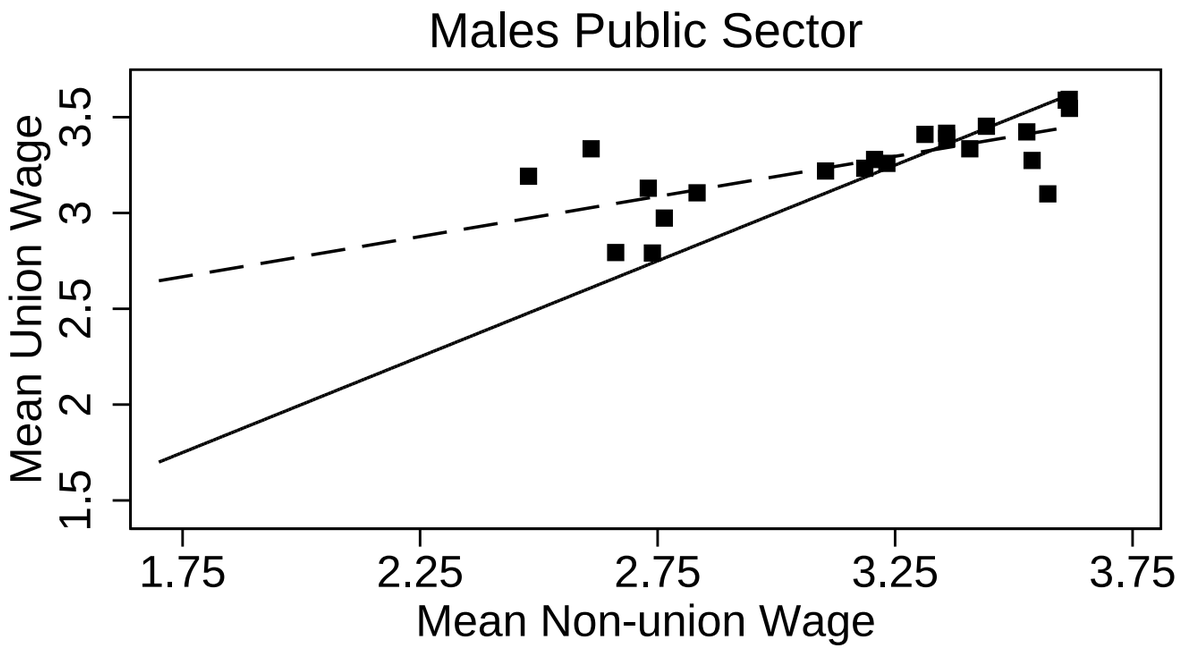


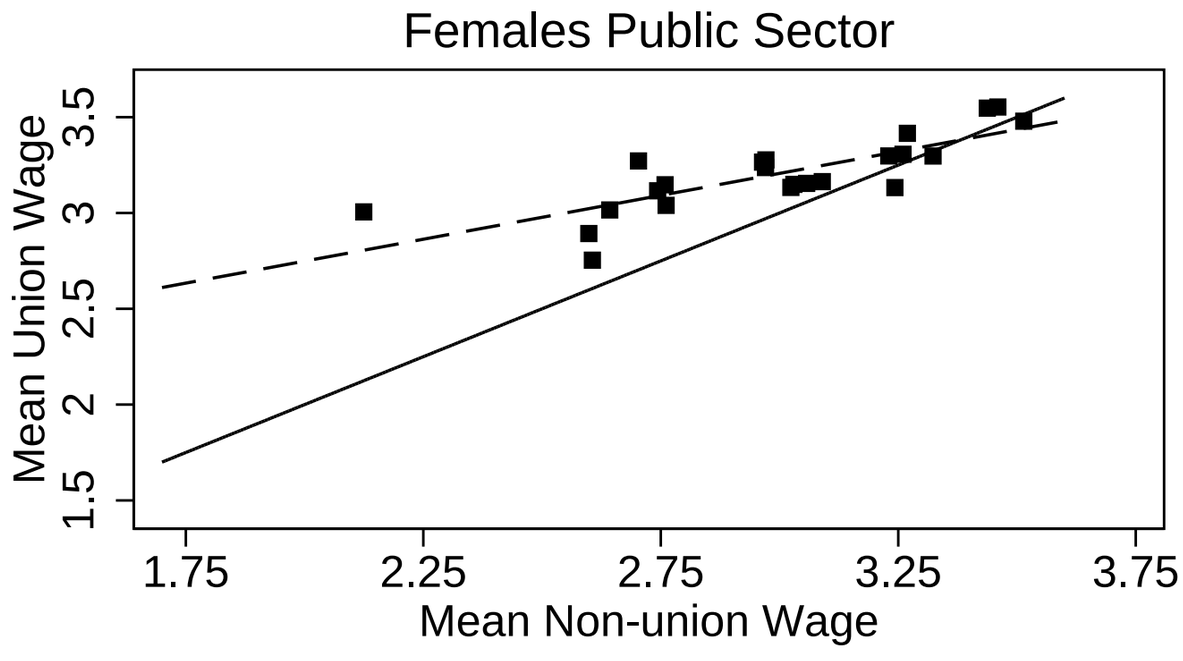


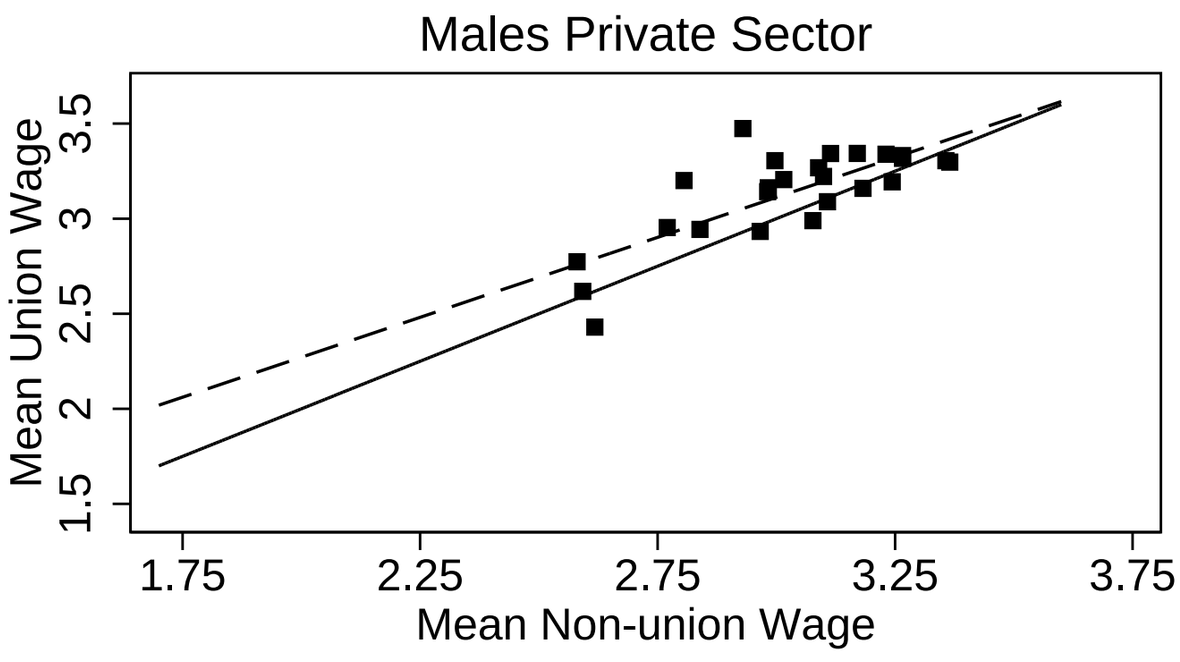


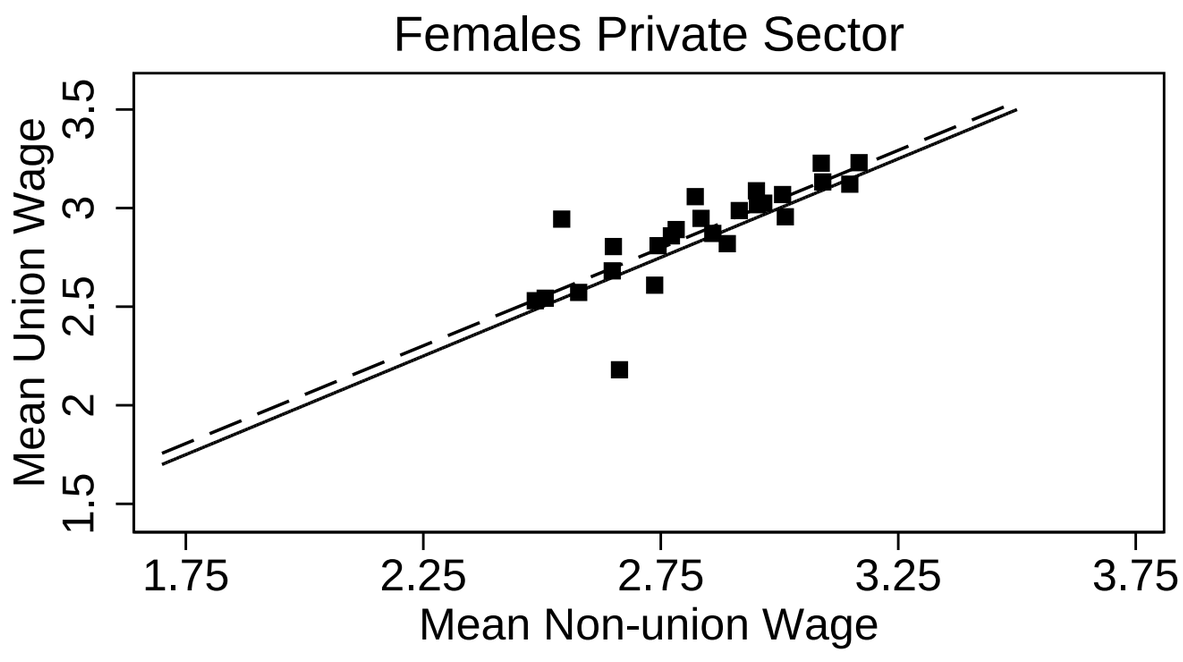
Note: Each point represents an age-education cell. Solid line is the 45 degree line, dashed line is fitted regression line.

Figure 3c: Union and Nonunion Wage Structures, Canada 2015









Note: Each point represents an age-education cell. Solid line is the 45 degree line, dashed line is fitted regression line.