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Comparing Wages in the Federal Government and the Private Sector

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Abstract

This analysis used Current Population Survey data from 2005 through 2010 to compare the hourly wages of federal employees and workers in the private sector who have certain similar observable characteristics. In that comparison, we found that the arithmetic average of wages was about 21 percent higher for federal employees than for their private-sector counterparts among workers with no more than a high school education, was about the same in both sectors among workers with a bachelor's degree, and was 23 percent lower in the federal sector among workers with a professional degree or Ph.D. Overall, federal wages were about 2 percent higher, on average, than wages of similar private-sector workers.

We found that the wages of federal employees were much less dispersed than those of employees with similar characteristics in the private sector—particularly among workers with more education. That aspect of the data causes semilog regressions to generate inconsistent estimates of percentage differences in arithmetic means. Consistent estimates of differences in arithmetic means—obtained using a quasi-maximum likelihood estimator that is robust to distributional misspecification—are substantially smaller than differences in geometric means estimated by semilog regressions. The differences in arithmetic means are more relevant for answering questions about how federal spending would change if federal workers were paid wages equal to those of measurably similar workers in the private sector.

The estimates do not show precisely what federal workers would earn if they were employed in the private sector. The difference between what federal employees earn and what they would earn in the private sector could be larger or smaller depending on characteristics that were not included in this analysis because such traits are not easy to measure. The results apply to the cost of employing full-time full-year workers. The analysis focused on those workers—who accounted for about 93 percent of the total hours worked by federal employees from 2005 through 2010—because higher-quality data were available for them than for other workers.

I. Introduction

Numerous researchers have concluded that workers in the federal government are more highly compensated, on average, than those in the private sector with similar education, experience, and other characteristics. This study reexamined data from the Current Population Survey (CPS) to estimate differences in hourly wages and used administrative data on federal pay to more accurately impute high earnings that were top-coded in the CPS. Comparing federal workers with workers in the private sector having certain similar observable characteristics, we estimated that hourly wages were higher in the federal government than in the private sector for high school graduates and lower for people with professional degrees.

What are the average differences in wages between federal and private-sector workers overall? Because of differences in wage dispersion within the sectors for people with similar characteristics, the answer depends critically on the definition of "average." Pooling results from all education levels, we found that the arithmetic mean of hourly wages was about 2 percent greater among federal workers than among similar workers in the private sector. Most of the previous literature comparing federal and private-sector wages examined differences between the mean log wages of those two sectors (and we also found larger differences in those geometric means), but this study focused on differences in the arithmetic means of wages, for both practical and theoretical reasons.

As a practical matter, lawmakers have asked what the implications would be for the federal budget if federal workers were paid the same wages as similar workers in the private sector. With the number of federal hours worked held constant, the answer to that question depends on the difference in arithmetic means between the wages of such workers in the federal and private sectors. Differences in mean log wages do not answer that question.

The basic theoretical model of wage determination derived by Mincer (1974) and others leads to a form for wages (Y) as a function of worker characteristics (X) such that $Y = \exp(X\gamma)$. Although the empirical literature has almost exclusively focused on estimation of the semilog regression model $\ln(Y) = X\beta + \varepsilon$, consistent estimates of β are generally not consistent estimates of γ —as discussed by Blackburn (2007). In particular, differences in wage dispersion between two groups of otherwise similar workers (that is, heteroscedasticity in the log-linear regression models) cause β to be an inconsistent estimate of γ, and we found that wages of federal employees were substantially less dispersed than those of similar workers in the private sector.

The differences in wages between federal and private-sector workers with similar characteristics also depend on the analytical treatment of firm size. Our main specification compared federal workers with private-sector workers in large firms, because we judged those private-sector employees to be doing work more comparable to that done by federal workers. In particular, the workforces of federal agencies and large private firms are both relatively specialized, educated, and skilled compared with those of other employers. In supplemental analyses in which the treatment of other worker characteristics was unchanged, we found that average private-sector wages were lower when they were based on workers in all firms rather than on workers in large firms.

In all of the comparisons, we measured differences between employees with similar observable characteristics; we did not attempt to address other potential questions of interest, such as what the wages of federal workers would have been if those particular workers had never been employed by the federal government, or what their wages would be if they were laid off from the federal government and moved to the private sector. Those types of questions involve various issues (such as unobserved abilities, selection into and out of the federal sector, and impacts of job loss) that we did not have sufficient data or a credible identification strategy to address.

The hourly wages that this paper focuses on are only one component of hourly compensation. Analyzing differences in overall compensation would involve quantifying the value of the fringe benefits—such as pensions or other employer contributions to retirement savings—provided in each sector. That issue is addressed in Falk (2012).

The remainder of this paper consists of six sections. Section II reviews previous research and discusses our interpretation of it. Section III describes the data used in this analysis, and section IV describes the characteristics of the workers in those data. Section V analyzes the distribution of wages for similar workers in the federal and private sectors, and section VI analyzes average wages for those workers. Section VII offers conclusions.

II. Background and Context

Wages of federal employees are determined by a system that emphasizes tenure with the federal government (Belman and Heywood, 1996). Research has consistently found that wages in the federal sector exceed the wages of similar workers in the private sector. Recent studies have used log-linear regression analyses and have reported federal wage premiums of 14 percent to 19 percent. Other research has demonstrated that those methods produce inconsistent estimates of the percentage differences in the arithmetic means of wages, whereas quasi-maximum likelihood methods provide consistent estimates.

A. Previous Research

Two studies have focused on comparing federal and private-sector wages using recent cross-sectional data from the CPS. Sherk (2010) concluded that federal wages were 18 percent higher, on average, than wages in the private sector when controlling for education, age, sex, race, occupation, part-time employment, marital status, immigration status, and location.[1] Biggs and Richwine (2011) concluded that federal wages exceeded private-sector wages by 14 percent when controlling for those same characteristics of employees and including adjustments for firm size. Biggs and Richwine also estimated the wage differential separately for workers at different levels of educational attainment. They estimated that federal wages exceeded private-sector wages by 22 percent among workers with only a high school education and by 4 percent among workers with a graduate degree. Sherk (2010) and Biggs and Richwine (2011) both used

[1] That research also concluded that the wage difference between the federal government and the private sector was 22 percent when the sample of federal employees was restricted to those who reported working in public administration.

censored data on earnings, which can cause bias because the procedure for imputing replacements for censored values does not account for federal employment.[2]

Earlier, Belman and Heywood (2004) used data from 1997–1999 cross sections of the CPS to compare wages between sectors while controlling for workers' education, age, sex, race, part-time employment, marital status, location, union status, and broad occupational classification. They found that federal wages exceeded private-sector wages by 19 percent.[3]

Using different data and a different approach, the Federal Salary Council (FSC) regularly compares the salaries paid for federal jobs that are on the General Schedule with the salaries paid for similar jobs in the private sector to inform the President's recommendation for adjustments to federal pay. The FSC found that the average of federal salaries trailed the average of private-sector salaries by 26 percent in 2011 (Federal Salary Council, 2011). The council does not model wages as a function of workers' education, age, or other attributes measured in the CPS. Instead, it compares salaries for federal and private-sector positions that require similar levels of knowledge and entail similar degrees of complexity.[4] However, Famulari (2002) found that by matching detailed descriptions of positions, the FSC may have ended up comparing federal workers with private-sector workers who have more experience.

Older research examined details of the differences between federal and private-sector pay that may still be relevant. Borjas (2002) and Katz and Krueger (1991) used the CPS to study intertemporal trends in the distributions of wages for the federal, state, and local government sectors in the context of the rapidly increasing wage dispersion that occurred in the private sector during the 1980s and 1990s. Borjas found that the dispersion of wages, as measured by the difference in the logarithms of wages between the 90th and 10th percentiles of the distribution, had grown more slowly in the federal sector than in the private sector. Katz and Krueger found that the difference between the wages of college- and high-school-educated workers had grown more slowly in the federal sector than in the private sector when adjusted for potential experience, sex, race, part-time employment, and location. They also found that, after adjusting for those characteristics, the dispersion of wages had remained roughly constant in the federal

[2] If a worker reports earning over $200,000, the CPS provides an imputed value for earnings instead of the reported value to protect the identity of the worker. The imputation procedure assigns those workers the average of earnings across all workers with top-coded earnings who have the same sex, race/origin, and "work experience" (full-time and full-year or not). That procedure does not distinguish between the averages of earnings for federal and private-sector workers. Consequently, using the imputed values will bias estimates of differences between federal and private-sector wages when differences exist in the underlying averages of censored earnings that would not be eliminated by controlling for measured attributes. In addition, Sherk (2010) excluded workers with wages below $5 per hour or above $60 per hour from his sample, which could further bias estimates if the percentage of workers excluded varied between the two sectors.

[3] The 19 percent difference was based on a specification that controlled for broad occupational distinction. The authors found a difference of 14 percent when comparing for a more detailed occupational distinction and a difference of 23 percent when not controlling for occupation.

[4] Specifically, the FSC matches positions on the basis of indices for "knowledge," "job controls and complexity," "contacts," and "physical environment," although most of the weight is placed on the first two factors. The methodology is described in more detail in the appendix of President's Pay Agent (2002).

sector although it was growing in the private sector. Borjas and Katz and Krueger also found that federal-private wage differentials were larger for women than for men.

B. Approaches to Estimating Differences Between Sectors

In the analyses discussed in the previous subsection (except those by the FSC), researchers regressed the natural logarithm of wages on an additive function of workers' measured attributes to control for differences in those attributes. The coefficients in those log-linearized models were estimated using least squares, and the difference in predicted values of log wages between the federal and private sectors, measured in log points, was interpreted as the percentage difference in wages between sectors—usually by exponentiating the difference in log points, implicitly giving the percentage difference in the geometric means of wages for the sectors.

Those studies did not provide further detail about whether the intent was to measure the percentage difference in the expected value of wages or some other characteristic of the wage distributions. However, an older comparison of federal and private-sector wages by Smith (1977) noted that the difference in log wages yields the percentage difference between the geometric means, which generally does not equal the percentage difference in expected values—that is, in arithmetic means. Moulton (1990) and Gyourko and Tracy (1988) explicitly constructed estimates of the percentage difference in the arithmetic means of wages between the federal and private sectors by accounting for differences in the conditional variances of the federal and private-sector wage distributions. (Those estimates assumed that the error term in the log-linearized model was normally distributed and that the expected value of wages therefore equaled the exponential of the sum of the expected value of log wages and half the variance of log wages.) However, those studies used data that are now over 20 years old.

Arithmetic and Geometric Means. To see why estimates of arithmetic and geometric means might differ, consider an illustrative comparison of wages for two groups, each of which contains two workers (see Table 1). When the wage dispersion within a group is small, as in group A—where the two workers have wages 20 percent above and below the group's arithmetic mean—the arithmetic and geometric means for the group are similar. By contrast, in group B—where the two workers have wages 60 percent above and below the group's arithmetic mean, the wage of worker 1 is twice the geometric mean, and the wage of worker 2 is half that mean—the arithmetic and geometric means differ substantially. We constructed this comparison to illustrate how the geometric mean of wages in group A could be higher than that of group B by 22 percent (or 0.2 log points) even though the arithmetic means are identical.

Returning to our practical motivation for focusing on arithmetic means, if the federal government had a set of workers paid like those in group A and changed their pay to resemble that of group B to make them comparable with similar workers in the private sector, there would be no effect on the federal budget—even though the mean log wage had been 0.2 log points higher in group A. Thus, the difference in the mean log wage is not informative for the question of interest.

More generally, consider the difference in the mean log wage for any two groups (that is, $\mathrm{E}\,[\ln(Y_i^A)] - \mathrm{E}\,[\ln(Y_i^B)]$, where Y_i^A and Y_i^B are wages in groups A and B, respectively). That difference can be decomposed (using a Taylor series evaluated at the expected values of wages)

into the difference in the logs of the arithmetic means of wages (μ) and a remainder that depends on the variance (μ_2) and higher-order central moments as shown in equation (1):

$$(1)\quad \mathrm{E}[\ln(Y_i^A)] - \mathrm{E}[\ln(Y_i^B)] = \ln(\mu_{Y^A}) - \ln(\mu_{Y^B}) - \frac{1}{2}\left[\frac{\mu_{2,Y^A}}{\mu_{Y^A}^2} - \frac{\mu_{2,Y^B}}{\mu_{Y^B}^2}\right] + \frac{1}{3}\left[\frac{\mu_{3,Y^A}}{\mu_{Y^A}^3} - \frac{\mu_{3,Y^B}}{\mu_{Y^B}^3}\right] \ldots$$

The remainder is equal to zero if the shapes of the wage distributions in the two groups are the same, such that all normalized higher-order central moments take on the same values for the two groups (for example, $\frac{\mu_{2,Y^A}}{\mu_{Y^A}^2} = \frac{\mu_{2,Y^B}}{\mu_{Y^B}^2}$). In that case, the percentage difference in the geometric means of the wages of the two groups is equal to the percentage difference in the arithmetic means.

Methods for Estimating Differences in Arithmetic Means. Three studies have focused on inaccuracies in estimating the percentage difference in arithmetic means when using a log-linearized model. Manning and Mullahy (2001) studied the implications of using log-linearized models for data with properties that are common in the field of health economics, such as skewness and heteroscedasticity. Their Monte Carlo simulations showed that the log-linear model resulted in inconsistent estimates of percentage differences in arithmetic means of outcomes when the data were heteroscedastic—a circumstance that also has been found in wage comparisons.[5] Silva and Tenreyro (2006) used Monte Carlo simulation to examine the consequences of using the log-linear model in the context of international trade flows. They found that the log-linear model resulted in inconsistent estimates of the effects of both continuous and categorical explanatory variables when the data were heteroscedastic. Lastly, Blackburn (2007) concluded that using the log-linear model to compare union and nonunion wages overstated the amount by which the arithmetic mean of union wages exceeded that of nonunion wages.

All of those studies traced the inaccuracies in using the log-transformation to the fact that the logarithm of an expected value is not equal to the expected value of logarithms—an instance of a corollary to Jensen's inequality. They suggested using quasi-maximum likelihood estimators with the exponential form of the model, which leaves the dependent variable untransformed. That modeling approach can generate a consistent estimate of the difference in the arithmetic means of wages between two groups in the presence of heteroscedasticity.

III. Data

In this study, we used the Current Population Survey to estimate differences in wages between federal workers and private-sector workers with certain similar observable characteristics. We analyzed federal and private-sector wages using data from the Social and Economic Supplement to the CPS, which is administered each March. The March CPS is a nationally representative survey of the civilian noninstitutionalized population, which is conducted annually by the Census

[5] Borjas (2002) found that the distribution of residuals was less dispersed in the public sector than in the private sector. Card (2001) found evidence suggesting that union wage distributions were less dispersed than nonunion wage distributions.

Bureau. Respondents are asked about their earnings, sector of employment, and a variety of other attributes of themselves and their employers.

For this analysis, we pooled the 2006–2011 cross sections of the March CPS. Because workers report their earnings over the previous year in that survey, the cross sections cover 2005 through 2010. The cross sections were combined to increase the size of the sample and to allow a comparison of wages that spanned periods of economic growth as well as decline. The number of federal workers in the sample used for the analysis was 8,311 and the number of private-sector workers was 211,504.

A. Composition of the Sample

To construct that analytical sample, we made a number of decisions. We opted to compare the wages of federal civilian employees whose compensation is directly funded through Congressional appropriations with the wages of private-sector workers. We did not analyze the wages earned by members of the armed services or by employees of the Postal Service or the Tennessee Valley Authority (TVA). (The Postal Service and the TVA do not receive specific appropriations for compensation of their workers; their operations are primarily funded through revenues from services provided.) To remove those workers from the analysis, we excluded CPS respondents who reported working in the Postal Service or the electric power industry. We also excluded employees of state and local governments, workers under age 16 or over age 64, and self-employed people. The self-employed were omitted because their earnings not only reflect the payments they earn for their labor but also can include the returns on their investments in capital (such as purchasing computers, office space, machinery, etc.).

To improve the accuracy of the analysis, we also excluded part-time and part-year workers and individuals who worked multiple jobs. Wages tend to be measured with more error for people who worked less than 35 hours in a usual week or less than 50 weeks during the previous year, because wages are calculated by dividing earnings by the number of hours worked. Thus, those part-time and part-year workers have smaller denominators, which exacerbate errors in the reporting of their earnings. Those workers accounted for only about 7 percent of the hours worked by federal employees. For CPS respondents who worked multiple jobs, the sector of employment is only reported for their longest job, and hours worked are only reported as a total for all jobs.

Some respondents do not report their earnings, sector of employment, or other measured attributes. The Census Bureau imputes values for those characteristics for many of those respondents. We excluded workers who did not provide their earnings or sector of employment, because the imputed values for those variables do not provide additional information about the relationship between earnings and sector of employment.[6] However, we included workers who had imputed values only for other measured attributes, because their reports of earning and sector provide additional information about the relationship between those variables.

[6] About 16 percent of federal workers and 21 percent of private-sector workers were excluded from the sample because they had imputed earnings.

B. Measuring Wages

We calculated hourly wages by dividing the earnings that workers reported for the previous year by the product of the hours they worked in a usual week and the number of weeks they worked in the previous year. Annual earnings include tips, overtime pay, commissions, and bonuses, as well as salaries and are inflated to 2010 dollars based on the employment cost index for wages and salary in private industry. Roemer (2002) found that the averages of annual earnings in the March CPS were similar to averages calculated from the records of the Social Security Administration. However, Lemeiux (2006) argues that for workers who are paid by the hour, wages calculated from reports of annual earnings are less precise measures than the direct reports of pay rates available for the outgoing rotation groups of the CPS. That argument is unlikely to present an issue for our research as only a small portion of federal employees are paid by the hour. Moreover, the March CPS has two advantages over the outgoing rotation groups: It includes data on the size of the firms employing workers, and it provides more information on the wages of high earners.

In order to accurately capture differences in high wages between the federal and private sectors, we adjusted the values that the Census Bureau had imputed for the 0.7 percent of federal workers and the 1.2 percent of private-sector workers who reported earnings over $200,000. The averages that the Census Bureau provides in place of top-coded earnings do not distinguish between the earnings of federal and private-sector workers.[7,8] We used administrative data that cover most federal employees to calculate the averages of earnings for federal workers making more than $200,000.[9] As with the CPS data, those earnings were averaged within groups of employees having the same sex, race/origin, and full-time full-year status for each year. Those averages were used in place of the values provided by the Census Bureau for federal employees and were also used to adjust the averages that the Census Bureau provided for private-sector workers.[10] The average of earnings across those groups was $238,220 for federal workers and $432,553 for workers in the private sector.

C. Measuring Sector of Employment

The workforce tabulations in the national income and product accounts indicate that data from the March CPS overstate the percentage of the population that works for the federal government, which could bias a comparison of federal and private-sector wages. In the March CPS, federal

[7] See footnote 2 for a more detailed description of the Census Bureau's procedure.

[8] For the 2011 March CPS, the Census Bureau changed its procedure for protecting the identity of high earners, but we were able to follow the procedure for distinguishing between the average earnings of federal and private-sector workers making over $200,000 that we had used for the older cross sections.

[9] For a description of those administrative data, called the Central Personnel Data File, see Congressional Budget Office, *Characteristics and Pay of Federal Civilian Employees* (March 2007), p. 2.

[10] The average for the top-coded earnings of private-sector workers is calculated as a weighted difference between the average of top-coded earnings for all workers and the average of top-coded earnings for federal workers, with the weights based on the portion of top-coded earnings attributed to federal employees. That adjustment removes federal earnings from the average wages used for private-sector workers but leaves the earnings of workers we excluded from the sample. The data did not enable us to estimate the average for the top-coded earnings of workers who were excluded from the sample. The majority of those workers were excluded because they were self-employed.

employees accounted for 2.7 percent of weeks worked by federal and private-sector employees from 2005 through 2010.[11] But according to the national income and product accounts, federal employees accounted for only 1.8 percent of weeks worked by federal and private-sector employees during those years. That discrepancy suggests that some private-sector employees, perhaps those who work for a federal contractor, misclassify themselves as federal employees in the March CPS. However, the average of the earnings for people who report being federal employees in the CPS is similar to the average of the earnings recorded for federal employees in the administrative data.

IV. Characteristics of Workers

The federal workforce tends to be more concentrated in professional occupations—and thus more educated and older—than the private-sector workforce (see Table 2). About a third of federal employees work in professional occupations, such as the sciences or engineering, whereas a larger portion of private-sector employees work in blue-collar occupations or retail sales. Professional occupations often require more formal training or experience than do the occupations more common in the private sector. Partly because of that difference, the average age of federal employees is 4 years higher than that of private-sector employees. The greater concentration of federal workers in professional occupations also means that they are more likely to have a bachelor's degree: 51 percent of the federal workforce has at least that much education, versus 31 percent of the private-sector workforce. Likewise, 21 percent of federal employees have a master's, professional, or doctoral degree, compared with 9 percent of private-sector employees.

The characteristics of employers, as well as of workers, differ between the federal and private sectors. Most federal employees work for large agencies; the biggest, the Department of Defense, employs about 800,000 civilian workers. Nearly all federal employees work for entities that have at least 1,000 workers. In contrast, only about 40 percent of private-sector employees work for entities with at least 1,000 employees.

The federal government and private sector also differ in the extent to which their workers are represented by unions, which can influence employees' compensation. About 21 percent of federal employees are members of unions, whereas the portion of private-sector workers who belong to unions has declined to 8 percent. However, union membership does not appear to provide the same indication of workers' skills and characteristics in the two sectors, in part because the occupations in which union membership is common differ.

Federal employees work in a wide variety of locations, because the services they deliver are required across the nation. For example, nurses and doctors who work at hospitals run by the Department of Veterans Affairs, security screeners at airports, and air traffic controllers are spread throughout the United States. In total, about 14 percent of federal employees work in the

[11] For comparability with the national income and product accounts, we calculated the percentage of hours worked by federal employees from a broader sample than was used for the rest of the analysis. The broader sample only excludes employees of state governments, local governments, government-sponsored enterprises, and the armed forces.

Washington, D.C., metropolitan area; the other 86 percent (2 million people) are located throughout the country in roughly similar proportions to workers in the private sector.

The attributes of the federal workforce are more like those of private-sector workers at large firms than those of workers at small firms, because both large firms and federal agencies require a workforce that is more specialized and educated than small firms do. Many federal employees have expertise in specific roles, as over 95 percent of them work in agencies that divide tasks among more than 100 occupations. That degree of specialization is not possible for small employers. In addition, only 27 percent of workers at small firms have at least a bachelor's degree; whereas the proportion of workers with that level of education is greater at large firms (37 percent) and in the federal government (51 percent).

V. Distributions of Wages

To construct descriptive statistics of the wage distributions of federal workers and of private-sector workers who have similar observable characteristics to federal workers, we estimated weights that were used to reweight the private-sector sample, following an approach developed by DiNardo, Fortin, and Lemieux (1996) and Fortin, Lemieux, and Firpo (2011, pp. 63–69). Specifically, in equation (2) below, let D^* be a latent variable such that a worker is employed in the federal government if $D^* > 0$ and in the private sector otherwise, and let X be a set of worker characteristics.[12]

$$(2)\ D^* = X\pi^s + \varepsilon$$

We estimated separate logit models based on equation (2) for each of five major categories of educational attainment (s): high school diploma or less, some college, bachelor's degree, master's degree, and professional degree or doctorate. We then multiplied the CPS weights of private-sector workers by $\exp(X\pi^s)$ for each major education category and normalized those new weights so that they summed to the share of federal workers within each of those categories.

Using that approach to compare wages in the federal government at the 10th, 25th, 50th, 75th, and 90th percentiles of the distribution with those in the private sector for people who have similar observable characteristics, we found that federal wages were higher among workers with no more than a high school education at all percentiles we examined (see Figure 1). For workers with a bachelor's degree, federal wages were higher from the 10th through 75th percentiles but were lower at the 90th percentile. For workers with a professional degree or Ph.D., federal wages were lower at each percentile and were about half as much at the 90th percentile. On a related note, we found that the dispersion of federal wages, as measured by the ratio of the 90th to 10th

[12] The worker characteristics included here were a fourth-order polynomial in potential experience and indicators for more-detailed levels of educational attainment: 9th grade or less, 10th grade, 11th grade, 12th grade, high school diploma, vocational associate's degree, academic associate's degree, bachelor's degree, master's degree, professional degree, and doctorate. In addition, we included a set of 12 indicators representing all combinations of race/origin (Hispanic, black, and white), sex (males and female), and marital status (married and single). Other characteristics were indicators for being an immigrant; being a noncitizen; living outside a metropolitan area; 5 categories for firm size, by number of employees (1–9, 10–99, 100–499, 500–999, and 1,000+); 24 occupational categories; 5 regions; and 6 calendar years.

percentiles, was smaller than the dispersion of private-sector wages for workers with at least a bachelor's degree—especially for those with a professional degree or Ph.D.

VI. Average Wages

As discussed in section II, the recent literature comparing federal and private-sector wages has most commonly taken the approach of examining differences in log wages between the sectors after controlling for covariates. In this section, we first show how that approach produces inconsistent estimates of the percentage difference between the arithmetic means of wages in those sectors. Second, we outline our method for providing consistent estimates of that difference by directly modeling the conditional mean function. Third, we present the results from implementing that method. And fourth, we assess the sensitivity of those results. Because previous research indicated that the relationship between wages and education varied substantially by level of educational attainment, we estimated differences for each major education category and then constructed a weighted average of those differences for the overall estimates reported throughout this section.

A. Inconsistent Estimation from the Semilog Model

Let *D* be an indicator for federal employment, *X* be the same set of worker characteristics as defined for equation (2), and *Y* be the hourly wage. A typical estimate of the percentage difference in the arithmetic means of wages between the federal and private sectors within a major education category would be $\hat{\Delta}^s = \exp(\hat{\beta}_1^s) - 1$, where $\hat{\beta}_1^s$ is the estimated parameter based on equation (3).

(3) $\ln(Y) = D\beta_1^s + X\beta_2^s + \varepsilon$

As noted by Blackburn (2007), however, $E[\exp(\varepsilon)|D, X]$ may depend on *D* and *X* even if $E[\varepsilon\,|D, X] = 0$ and therefore may enter into the calculation of Δ^s as in equation (4).

(4) $\Delta^s = \frac{E_X[E[Y|D=1,X]]}{E_X[E[Y|D=0,X]]} - 1 = \exp(\beta_1^s)\frac{E_X[E[\exp(\varepsilon)|D=1,X]]}{E_X[E[\exp(\varepsilon)|D=0,X]]} - 1$

The Taylor series for the expected value of the exponential of the error term when evaluated at zero is $\mathrm{E}[\exp(\varepsilon)\,|\mathrm{D}, \mathrm{X}] = 1 + \frac{1}{2}\sigma^2_{\varepsilon|D,X} + \frac{1}{6}\sigma^3_{\varepsilon|D,X} + \cdots$. Using the second-order expansion of that series, Δ^s depends on the conditional variance of the error term as in equation (5).

(5) $\Delta^s = \exp(\beta_1^s)\frac{1+E_X[Var(\varepsilon\,|D=1,X)/2]}{1+E_X[Var(\varepsilon\,|D=0,X)/2]} - 1$

We tested the equality of the expectations of the conditional variance for each sector within each major education category using a linear approximation by estimating equation (6), employing the squared residuals from equation (3) in our estimates of $Var(\varepsilon|D, X)$.

(6) $Var(\varepsilon|D, X) = \lambda_0^s + D\lambda_1^s + DX\lambda_2^s + X\lambda_3^s + \eta$

We rejected the null hypothesis that $\lambda_1^s = \lambda_2^s = 0$ within each major education category. That evidence of heteroscedasticity implies that $\Delta^s \neq \exp(\beta_1^s) - 1$ under the assumptions used to construct the approximations in equations (5) and (6).

B. Consistent Estimation of the Conditional Mean Function

We estimated the percentage difference in the arithmetic averages of wages between the federal and private sectors in four main steps. Our approach compared federal wages with the predicted value of private-sector wages for a worker with the same observable characteristics. We estimated a full interaction between sector of employment and worker characteristics—that is, the differences between sectors were allowed to vary for each characteristic. Because we used a nonlinear model, we then integrated over the distribution of worker characteristics to obtain our estimates.

First, we directly modeled the conditional mean function within each major education category *s*. In equation (7), let *Y, D,* and *X* be wages, sector, and worker characteristics as defined above, and let $\tilde{X} = X - E[X|D = 1]$.

(7) $E[Y|D, X] = \exp\left(\gamma_0^s + D\gamma_1^s + D\tilde{X}\gamma_2^s + \tilde{X}\gamma_3^s\right)$

In equation (7), the joint null hypothesis that $\gamma_2^s = 0$ is a test of whether worker characteristics have a different association with wages in the federal and private sectors beyond the federal-sector main effect γ_1^s for a worker with average characteristics for the federal sector. We estimated the parameters of equation (7) using quasi-maximum likelihood estimation (QMLE) methods that provide consistent parameter estimates when the underlying distribution of the data differs from that assumed in the estimation (Gourieroux, Monfort, and Trogan, 1984). Specifically, for our main specification, we used Poisson QMLE, which Silva and Tenreyro (2006) found had a lower mean squared error than several other QMLE methods in simulations.

Second, let the average wages of workers in the private sector with characteristics similar to federal workers be denoted as ω_0^s in equation (8). We estimated ω_0^s by integrating our conditional mean function over the distribution of federal worker characteristics, denoted as $E_{X|D=1}[\cdot]$.

(8) $\omega_0^s = E_{X|D=1}\left[E[Y|D = 0, X]\right] = E_{X|D=1}\left[\exp\left(\gamma_0^s + \tilde{X}\gamma_3^s\right)\right]$

Third, let the average wages of workers in the federal sector be denoted as ω_1^s in equation (9). We estimated ω_1^s in a manner analogous to that used in equation (8).

(9) $\omega_1^s = E_{X|D=1}\left[E[Y|D = 1, X]\right] = E_{X|D=1}\left[\exp\left(\gamma_0^s + \gamma_1^s + \tilde{X}(\gamma_2^s + \gamma_3^s)\right)\right]$

Fourth, for our overall estimate of wages in the private sector, we used a weighted average of the estimates for each major education category for both the federal and private sectors ($d = 1$ and $d = 0$)—where the weights were the share of federal workers in each major education category, Pr $(S|D = 1)$, as in equation (10).

(10) $\omega_d = \sum_s \Pr(S|D = 1)\, \omega_d^s$

Following the method described by Rao (1994), we calculated the standard errors for estimates based on equations (8), (9), (10), and for the percentage difference between federal wages and the wages of private-sector workers with similar characteristics, using replicate weights to account for stratification and cluster sampling variability that occurred in calculating the post-stratification weights used to make the CPS more representative of the U.S. population. Specifically, we calculated each estimate 160 times using each of the 160 weights provided by the Census Bureau; the reported standard errors are proportional to the standard deviation of those estimates from the estimate based on the post-stratification weights.

C. Results

On average, compared with private-sector employers, the federal government paid higher wages for workers with low educational attainment but paid lower wages for workers with high educational attainment (see Table 3). The average wage for federal employees overall was about $32 per hour, about 2 percent higher than the average wage for private-sector workers with the same characteristics. Among workers with a high school diploma or less education, the average wage was 21 percent higher for federal employees than for private-sector workers with the same measured attributes. In contrast, among workers whose education culminated in a doctorate or professional degree, the average wage was 23 percent lower for federal employees than for similar private-sector workers. Between those levels of education, the averages of wages in the two sectors were closer to each other. In particular, the average wage for federal employees with a bachelor's degree was about equal to the average wage for similar private-sector employees.

The federal government paid women higher wages, on average, than private-sector employers did but paid men similar wages (see Table 4). Adjusted for the differences in the other measured attributes, the average wage for female federal employees was 6 percent higher than the average wage for women in the private sector, whereas the average wages for men were similar between the two sectors. Nevertheless, men earned more than women in both sectors, on average, but the difference was smaller for federal employees. If the lower average wages for women resulted from discrimination, then the higher wages that women tended to earn in the federal sector could have been the result of federal employers being less discriminatory. The tendency for women to have earned less might also be explained by less investment in their careers in ways that were not captured by the measured attributes or by a difference between men's and women's tastes for certain careers and jobs.[13] Researchers have had difficulty quantifying the importance of those various hypotheses in explaining the lower earnings of women because the hypotheses are based on attributes of workers and their employers that are difficult to measure and are not available in the CPS or most other data sources.

[13] Altonji and Blank (1999) summarize the research on the importance of discrimination and differences in human capital accumulation in explaining the tendency for women to have lower wages. Bertrand (2011) summarizes the research on the importance of differences in the psychology of male and female workers in explaining the tendency for women to have lower wages.

D. Sensitivity of the Results

The comparisons of average wages are somewhat sensitive to whether adjustments are made for the differences in the size of federal and private-sector employers. Including controls for education, experience, occupation, and demographic traits is standard practice when analyzing wages, but researchers are more divided on whether to control for firm size. (For additional discussion, see Belman and Heywood, 1990.) On the one hand, jobs are likely to be more specialized in the federal government and at large private firms than at smaller firms, so larger private-sector employers might value the specialized skills of federal workers. On the other hand, the higher wages paid by large private firms may not reflect pay for skills that are transferable between the federal and private sectors.

When controls are not included for the size of employers, the average wage for federal workers is 9 percent larger than the average wage for private-sector workers with similar measured attributes (see Table A1). Conversely, average wages are similar in the two sectors if the sample is limited to employers with more than 1,000 workers. In either case, the comparisons of average wages by education level imply that private-sector employers pay a larger wage differential for more-educated workers.

The accuracy of QMLE depends on the expected value of wages being correctly specified in terms of the measured attributes. For example, assuming that the relationships of wages to potential experience are the same in the federal and private sectors could lead to inaccurate comparisons of wages if those relationships differ in the data. We rejected the hypothesis that $\gamma_2^s = 0$ for each of the major education categories, indicating that the interactions between sector and worker characteristics were jointly significant; we allowed for those interactions in our main analyses.

Although we used the Poisson distribution in our main specification for QMLE, we also examined estimates assuming a gamma distribution and a normal distribution. Because QMLE is consistent even if the distribution is misspecified, when distributions differ, QMLE should in principle give similar estimates if the expected value of wages is correctly specified. Using QMLE with either Poisson, gamma, or normal distributions all resulted in intersector wage differentials of about 2 percent (see Table A2). The reweighting approach used in section V to analyze the distribution of wages also produced an estimate of the average intersector wage differential similar to those of the three QMLE methods, as did a model of the level of wages in which differences between the sectors were controlled for using linear regression.

In contrast, the more traditional approach of estimating the log-linear model yields wage differentials that are substantially larger. For perspective, the percentage difference between the average federal wage of about $32 per hour and the average private-sector wage of about $24 per hour is 37 percent, which matches the estimates from the three QMLEs for the level-exponential model when no controls are included for the measured attributes. By comparison, the estimate from the log-linear approach is 52 percent, which is the percentage difference in geometric averages. Once controls are included for the measured attributes, the log-linear approach gives a percentage difference in the geometric averages of 13 percent, whereas the three QMLE methods yield percentage differences in arithmetic averages of about 2 percent.

To test the sensitivity of the results to the choice of wage measures, we replicated the comparison of averages using the wage measure from the outgoing rotation groups (ORGs) of the CPS. Those wage comparisons are less precise because we limited the sample to workers who were in the ORG during March so that we could control for firm size and adjust top-coded wages. ORG wages are calculated from reports of weekly earnings. The Census Bureau imputes weekly earnings of $2,885 ($150,000 per year divided by 52 weeks) for all workers reporting earnings above that threshold. To more accurately measure the wages of high earners, we assumed that those workers' weekly earnings exceeded the top-coding threshold of $2,885 per week by the same percentage that their annual earnings exceeded $150,000. With that adjustment made, the variances of wages based on weekly and annual earnings are similar within both the federal and private sectors. Moreover, the federal-private wage differential estimated for ORG wages is not significantly different from the differential estimated for wages based on annual earnings (see Table A3).

VII. Conclusions

This analysis finds that the differences between federal and private-sector wages vary substantially by educational attainment. Compared with workers in the private sector who have certain similar observable characteristics, federal employees with lower educational attainment have higher wages, those with bachelor's degrees have about the same wages, and those with more education have lower wages.

Wages are less dispersed among federal employees than among private-sector workers with similar characteristics. That heteroscedasticity led us to model the conditional mean of wages directly, rather than using a more common semilog regression, which produces inconsistent estimates of differences in arithmetic means between the sectors in the presence of heteroscedasticity. Our method provides a consistent estimate of the percentage difference in the arithmetic means of wages between federal employees and workers in the private sector with similar characteristics. That difference is more relevant than the difference in the geometric mean for answering questions such as what the effect on total wages would be if federal workers were paid wages equal to those of similar workers in the private sector. The finding that differences in arithmetic means between federal and similar private-sector workers are smaller than differences in geometric means was more prominently featured in older research on this topic than in recent literature.

References

Altonji, Joseph G., and Rebecca M. Blank, "Race and Gender in the Labor Market," *Handbook of Labor Economics,* vol. 3, part C, edited by Orley Ashenfelter and David Card (Amsterdam: Elsevier, 1999), pp. 3144–3259.

Belman, Dale, and John S. Heywood, "The Effect of Establishment and Firm Size on Public Wage Differentials," *Public Finance Quarterly,* vol. 18, no. 2 (1990), pp. 221–235.

———, "The Structure of Compensation in the Public Sector," *Public Sector Employment in a Time of Transition,* edited by Dale Belman, Morley Gunderson, and Douglas Hyatt (Madison, Wisc.: Industrial Relations Research Association, 1996), pp. 127–161.

———, "Public Wage Differentials and the Treatment of Occupational Differences," *Journal of Policy Analysis and Management,* vol. 23, no. 1 (2004), pp. 135–152.

Bertrand, Marianne, "New Perspectives on Gender," *Handbook of Labor Economics,* vol. 4, part B, edited by Orley Ashenfelter and David Card (Amsterdam: Elsevier, 2011), pp. 1546–1592.

Biggs, Andrew, and Jason Richwine, *Comparing Federal and Private Sector Compensation,* Economic Policy Working Paper 2011-02 (Washington, D.C.: American Enterprise Institute, June 2011).

Blackburn, McKinley, "Estimating Wage Differentials Without Logarithms," *Labour Economics,* vol. 14 (July 2007), pp. 73–99.

Borjas, George, *The Wage Structure and the Sorting of Workers into the Public Sector,* Working Paper 9313 (Cambridge, Mass.: National Bureau of Economic Research, October 2002).

Card, David, "The Effect of Unions on Wage Inequality in the U.S. Labor Market," *Industrial and Labor Relations Review,* vol. 54, no. 2 (January 2001), pp. 296–315.

DiNardo, John, Nicole M. Fortin, and Thomas Lemieux, "Labor Market Institutions and the Distribution of Wages, 1973–1992: A Semiparametric Approach," *Econometrica,* vol. 64, no. 5 (September 1996), pp. 1001–1044.

Falk, Justin, *Comparing Benefits and Total Compensation in the Federal Government and the Private Sector,* Working Paper 2012-4 (Washington, D.C.: Congressional Budget Office, January 2012).

Famulari, Melissa, "What's in a Name? Title Inflation in the Federal Government" (draft, University of Texas at Austin, August 2002).

Federal Salary Council, *Level of Comparability Payments for January 2013* (November 22, 2011).

Fortin, Nicole, Thomas Lemieux, and Sergio Firpo, "Decomposition Methods in Economics," *Handbook of Labor Economics,* vol. 4, part A, edited by Orley Ashenfelter and David Card (Amsterdam: Elsevier, 2011), pp. 1–101.

Gourieroux, Christian S., Alain Monfort, and Alain Trogan, "Pseudo Maximum Likelihood Methods: Theory," *Econometrica,* vol. 52, no. 3 (May 1984), pp. 681–700.

Gyourko, Joseph, and Joseph Tracy, "An Analysis of Public- and Private-Sector Wages Allowing for Endogenous Choices of Both Government and Union Status," *Journal of Labor Economics,* vol. 6, no. 2 (April 1988), pp. 229–253.

Katz, Lawrence, and Alan Krueger, "Changes in the Structure of Wages in the Public and Private Sector," *Research in Labor Economics,* vol. 12 (1991), pp. 137–172.

Lemieux, Thomas, "Increasing Residual Wage Inequality: Composition Effects, Noisy Data, Rising Demand for Skill?" *American Economic Review*, vol. 96, no. 3 (June 2006), pp. 461–498.

Manning, Willard, and John Mullahy, "Estimating Log Models: To Transform or Not to Transform?" *Journal of Health Economics*, vol. 20 (March 2001), pp. 461–494.

Mincer, Jacob, *Schooling, Experience, and Earnings* (New York: Columbia University Press, 1974).

Moulton, Brent, "A Reexamination of the Federal-Private Wage Differential in the United States," *Journal of Labor Economics*, vol. 8, no. 2 (April 1990), pp. 270–283.

President's Pay Agent, *Report on Locality-Based Comparability Payments for the General Schedule: Annual Report of the President's Pay Agent* (December 2002).

Rao, J.N.K., "Resampling Methods for Complex Surveys," *Proceedings of the 1994 Joint Statistical Meetings, Survey Research Methods Section, American Statistical Association*, vol. 1 (1994), pp. 35–41.

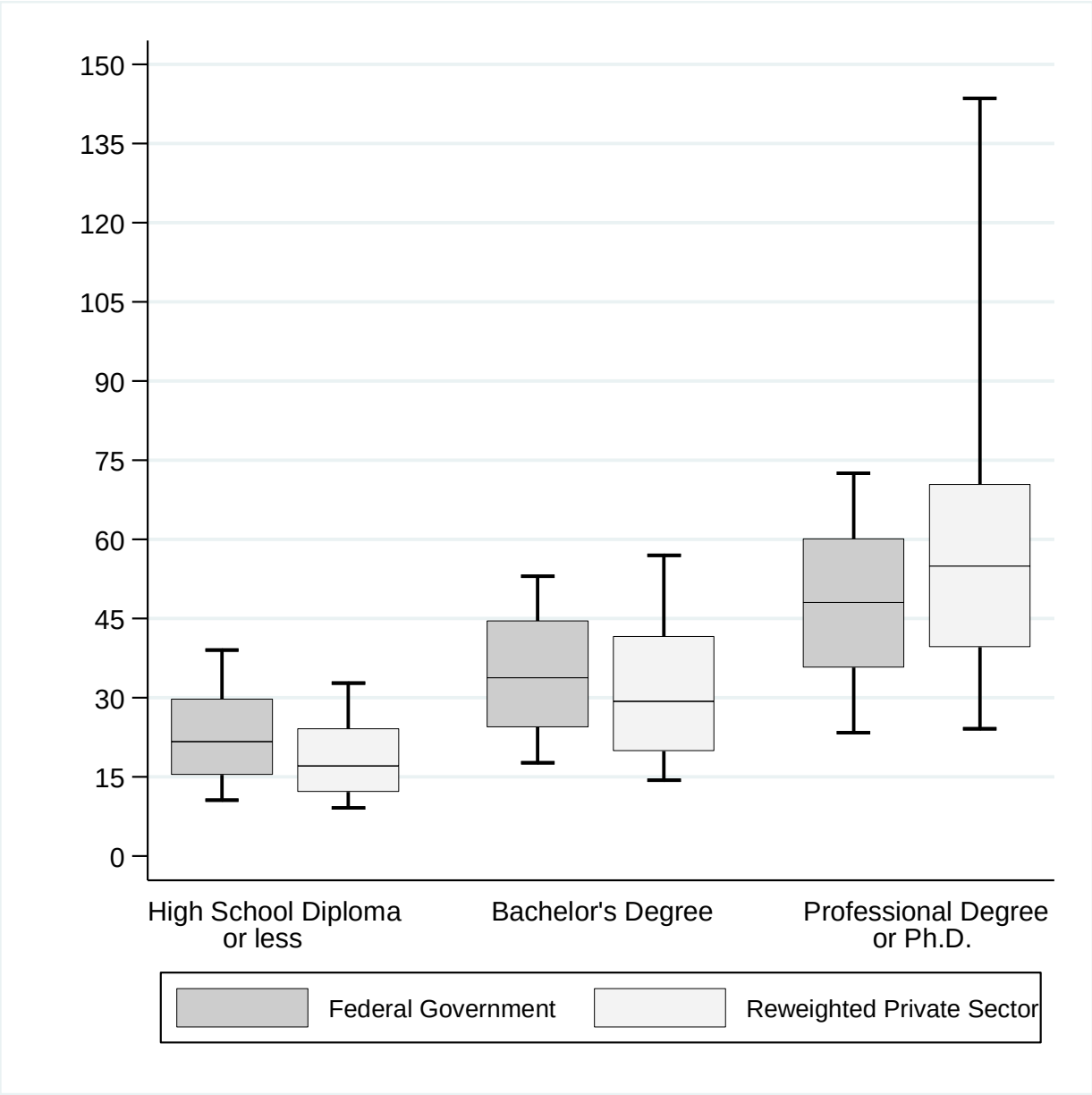
Roemer, Marc, *Using Administrative Earnings Records to Assess Wage Data Quality in the March Current Population Survey and the Survey of Income and Program Participation*, Technical Paper TP-2002-22 (U.S. Census Bureau, Longitudinal Employer-Household Dynamics, November 2002).

Sherk, James, *Inflated Federal Pay: How Americans Are Overtaxed to Overpay the Civil Service*, Working Paper CDA 10-05 (Washington, D.C.: Heritage Foundation Center for Data Analysis, July 2010).

Silva, Santos, and Silvana Tenreyro, "The Log of Gravity," *Review of Economics and Statistics*, vol. 88, no 4 (November 2006), pp. 641–658.

Smith, Sharon, "Government Wage Differential," *Journal of Urban Economics*, vol. 4 (1977), pp. 248–271.

Figure 1. Distribution of Wages by Educational Attainment



Note: The horizontal line in the middle of each shaded box indicates the median wage; the top and bottom of the box mark the 75th and 25th percentiles; and the whiskers above and below the box mark the 90th and 10th percentiles. The percentiles are calculated as described in the text.

Table 1. Illustrative Comparison of Arithmetic and Geometric Means (Dollars per Hour)

	Wage of Worker 1	Wage of Worker 2	Arithmetic Mean: $\frac{(1)+(2)}{2}$	Mean of the logs: $\frac{ln(1)+ln(2)}{2}$	Geometric Mean: $exp\left(\frac{ln(1)+ln(2)}{2}\right)$
	(1)	(2)	(3)	(4)	(5)
Group A	30.0	20.0	25.0	3.2	24.5
Group B	40.0	10.0	25.0	3.0	20.0

Table 2 Composition of the Federal and Private-Sector Workforces

	Federal	Private Sector
Average Wage (dollars per hour)	32.3	23.6
Average Age (years)	44.9	40.8
(percentage of workforce)		
Highest Educational Attainment		
No High School Diploma	1.8	9.7
High School Diploma	18.3	30.9
Some College, No Degree	18.7	18.3
Some College, Associates Degree	9.9	10.4
Bachelor's Degree	30.5	21.6
Master's Degree	14.1	6.5
Professional Degree	2.9	1.4
Doctorate	3.7	1.2
Occupation		
Management, Business, Financial	23.6	17.2
Professional	32.6	18.2
Service	13.5	12.0
Sales	1.6	11.3
Administrative/Office Support	15.3	13.9
Blue Collar	13.3	27.4
Firm Size (# of employees)		
Under 10	0.2	11.5
10 - 99	0.3	26.2
100 - 499	0.3	16.1
500 - 999	0.1	6.4
1,000+	99.1	39.8
Region		
Northeast	12.6	18.1
Midwest	13.6	22.6
South	37.2	34.9
Washington D.C. Metropolitan Area	14.0	2.1
West	22.5	22.4
Other Demographics		
Female	43.0	42.4
Black	17.6	10.1
Hispanic	9.1	16.2
Married	64.4	60.0
Immigrant	9.6	18.1
Not a Citizen	3.1	10.9
Not in a Metropolitan Area	10.8	13.2
Observations	8,311	211,504

Table 3. Comparing Wages by Level of Educational Attainment

	Average Wages (dollars per hour)		Percentage	Sample Size
	Federal	Private-Sector Projections	Difference in Averages	(Federal; Private)
Educational Attainment	(1)	(2)	(3)	(4)
High School Diploma or Less	23.5 *	19.4 *	20.9 *	1,618;
	(0.4)	(0.2)	(1.8)	87,170
Some College	27.1 *	23.6 *	15.0 *	2,339;
	(0.4)	(0.3)	(1.6)	60,954
Bachelor's Degree	35.3 *	34.8 *	1.7	2,503;
	(0.4)	(0.5)	(1.4)	44,380
Master's Degree	41.2 *	43.4 *	-5.2 *	1,207;
	(0.7)	(0.8)	(1.9)	13,565
Professional/Doctorate	48.5 *	63.2 *	-23.3 *	644;
	(1.1)	(2.2)	(2.6)	5,435
All Levels of Education	32.3 *	31.6 *	2.3 *	8,311;
	(0.3)	(0.4)	(1.0)	211,504

Notes: Wages are per hour and include overtime pay, tips, commissions, and bonuses. In column (1), estimates in rows 1-5 are based on equation (9) and estimates in row 6 are based on equation (10). In column (2), estimates in rows 1-5 are based on equation (8) and estimates in row 6 are based on equation (10). Column (3) is {[column (1) / column (2)] – 1}*100. Standard errors are in parentheses, calculated as described in the text. * = p-value < 0.05.

Table 4. Comparing Wages by Sex and Educational Attainment

	Men				Women			
	Average Wages (dollars per hour)		Percentage	Sample	Average Wages (dollars per hour)		Percentage	Sample
Educational Attainment	Federal (1)	Private-Sector Projections (2)	Difference in Averages (3)	Size (Fed; Priv) (4)	Federal (5)	Private-Sector Projections (6)	Difference in Averages (7)	Size (Fed; Priv) (8)
High School Diploma or Less	24.8 * (0.5)	20.9 * (0.3)	18.6 * (2.4)	880; 53,079	21.6 * (0.5)	17.4 * (0.3)	24.2 * (2.6)	738; 34,091
Some College	28.7 * (0.5)	26.1 * (0.4)	10.0 * (2.0)	1,208; 31,362	25.3 * (0.5)	20.8 * (0.3)	21.7 * (2.6)	1,131; 29,592
Bachelor's Degree	37.6 * (0.5)	37.7 * (0.6)	-0.4 (1.7)	1,442; 24,800	32.2 * (0.6)	30.6 * (0.5)	5.4 * (2.1)	1,061; 19,580
Master's Degree	44.4 * (1.0)	48.1 * (1.1)	-7.7 * (2.4)	683; 8,173	36.9 * (0.8)	37.9 * (1.0)	-2.5 (2.7)	524; 5,392
Professional/Doctorate	50.5 * (1.3)	67.5 * (2.6)	-25.1 * (3.0)	400; 3,503	45.6 * (2.0)	59.5 * (3.7)	-23.4 * (4.5)	244; 1,932
All Levels of Education:	34.5 * (0.4)	34.7 * (0.5)	-0.8 (1.1)	4,613; 120,917	29.4 * (0.4)	27.7 * (0.4)	6.3 * (1.5)	3,698; 90,587

Notes: The calculations are the same as those used in Table 3 except that the sample was limited to men in columns (1) through (4) and women in columns (5) through (8). Standard errors are in parentheses, calculated as described in the text. * = p-value < 0.05.

Table A1. Sensitivity of Wage Differentials to Firm-Size Adjustments

	No Firm Size Adjustment		Firm-Size Regressors		Large Firms Only	
Educational Attainment	Percentage Difference in Average Wages (1)	Sample Size (Federal; Private) (2)	Percentage Difference in Average Wages (3)	Sample Size (Federal; Private) (4)	Percentage Difference in Average Wages (5)	Sample Size (Federal; Private) (6)
High School Diploma or Less	28.1 *	1,618;	20.9 *	1,618;	19.4 *	1,597;
	(1.9)	87,170	(1.8)	87,170	(1.8)	28,411
Some College	21.2 *	2,339;	15.0 *	2,339;	13.9 *	2,315;
	(1.6)	60,954	(1.6)	60,954	(1.7)	24,688
Bachelor's Degree	8.0 *	2,503;	1.7	2,503;	1.8	2,479;
	(1.5)	44,380	(1.4)	44,380	(1.5)	20,560
Master's Degree	1.4	1,207;	-5.2 *	1,207;	-3.6	1,197;
	(1.9)	13,565	(1.9)	13,565	(2.0)	6,812
Professional/Doctorate	-17.8 *	644;	-23.3 *	644;	-26.0 *	644;
	(2.5)	5,435	(2.6)	5,435	(3.0)	2,373
All Levels of Education	8.7 *	8,311;	2.3 *	8,311;	1.8	8,228;
	(1.0)	211,504	(1.0)	211,504	(1.0)	82,844
Firm-Size Adjustment	None		Include Firm-Size Indicators		Exclude Workers at Firms with Less than 1,000 Employees	

Notes: Column (3) contains the same estimates as in Table 3. Column (1) excludes the indicator of firm size from the controls, *X*. Column (5) excludes people who work at firms with fewer than 1,000 employees from the sample. Standard errors are in parentheses, calculated as described in the text. * = p-value < 0.05.

Table A2. Sensitivity of Wage Differentials to Model

	Percentage Difference in Average Wages	
	Without Controls (1)	With Controls (2)
QMLE with Exponential Conditional Mean		
Poisson	36.9 *	2.3 *
	(1.3)	(1.0)
Gamma	36.9 *	2.8 *
	(1.3)	(1.0)
Normal	36.9 *	2.3 *
	(1.3)	(1.0)
Linear Model of Wages		
Without Reweighting	36.9 *	2.2 *
	(1.3)	(1.0)
With Reweighting	1.5	1.5
	(1.3)	(1.0)
Linear Model of Log Wages	51.9 *	12.7 *
	(1.6)	(1.0)

Notes: QMLE = quasi-maximum likelihood estimator.

In column (2), row 1 is the same estimate as in Table 3. In column (1), row 1 does not include X as controls and uses equation (10a).

(10a) $\omega_d = \sum_s \Pr(S|D = d)\, \omega_d^s$

Rows 2 and 3 are analogous to row 1 except that they use the gamma and normal distributions, respectively, for the QMLE.

Row 4 uses least squares instead of QMLE, based on equations (7a), (8a), (9a).

(7a) $Y = \gamma_0^s + D\gamma_1^s + D\tilde{X}\gamma_2^s + \tilde{X}\gamma_3^s$

(8a) $\omega_0^s = \gamma_0^s$

(9a) $\omega_1^s = \gamma_0^s + \gamma_1^s$

Those equations are used as inputs into equation (10a) above for column (1) and into equation (10) in the text for column (2).

Row 5 uses the same specification as row 4 except that the average wage in the private sector is calculated by integrating over the private-sector observations, which are reweighted using the weights described in equation (11). Those weights take as inputs the odds ratios estimated from equation (2) in the text.

(11) $\sum_s \frac{\Pr(S|D=1)}{\Pr(S|D=0)} \exp(X\pi^s)$

Row 6 uses the same specification as row 4 except that the level of wages is replaced by the log of wages as the dependent variable in equation (7a) and the right-hand sides of equations (8a) and (9a) are exponentiated.

Table A3. Sensitivity to Choice of CPS Wage Measure

	March-Supplement Wages				Outgoing-Rotation-Group Wages			
	Average Wages (dollars per hour)		Percentage Differences in Averages	Sample Size (Federal; Private)	Average Wages (dollars per hour)		Percentage Differences in Averages	Sample Size (Federal; Private)
Educational Attainment	Federal (1)	Private-Sector Projections (2)	(3)	(4)	Federal (5)	Private-Sector Projections (6)	(7)	(8)
High School Diploma or Less	23.5 *	19.4 *	20.9 *	1,618;	22.9 *	19.8 *	15.2 *	198;
	(0.4)	(0.2)	(1.8)	87,170	(0.8)	(0.7)	(4.0)	10,401
Some College	27.1 *	23.6 *	15.0 *	2,339;	27.5 *	24.2 *	13.8 *	300;
	(0.4)	(0.3)	(1.6)	60,954	(0.9)	(0.6)	(3.8)	8,198
Bachelor's Degree	35.3 *	34.8 *	1.7	2,503;	37.3 *	33.4 *	11.6 *	367;
	(0.4)	(0.5)	(1.4)	44,380	(1.1)	(1.1)	(4.3)	6,188
Master's Degree	41.2 *	43.4 *	-5.2 *	1,207;	40.7 *	42.1 *	-3.1	197;
	(0.7)	(0.8)	(1.9)	13,565	(1.6)	(2.5)	(5.7)	1,827
Professional/Doctorate	48.5 *	63.2 *	-23.3 *	644;	52.1 *	61.5 *	-15.3	80;
	(1.1)	(2.2)	(2.6)	5,435	(3.6)	(7.6)	(9.8)	718
All Levels of Education	32.3 *	31.6 *	2.3 *	8,311;	33.7 *	31.8 *	5.9 *	1,142;
	(0.3)	(0.4)	(1.0)	211,504	(0.8)	(1.1)	(2.8)	27,332

Notes: Outgoing-rotation-group wages are based on the usual weekly earnings of workers who were in the outgoing rotation group during the March Current Population Survey (CPS). March-supplement wages are based on the annual earnings of workers from all rotation groups. The Census Bureau imputes replacements for top-coded weekly and annual earnings differently. To reconcile that difference, we assumed that weekly earnings exceeded the top-coding threshold of $2,885 per week by the same percentage that annual earnings exceeded that threshold measured in dollars per year. Top-coded annual earnings were first adjusted using the procedure described in section IIIB.