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Sun-ki Choi
St. Lawrence University, choi@stlawu.edu

John Garen
University of Kentucky, john.garen@uky.edu

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John Garen

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University of Kentucky
244 Gatton College of Business and Economics
Lexington, KY 40506-0034
http://isfe.uky.edu/

Gatton College of
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The Federal-Private Wage Differential: How Has It Evolved?

SUN-KI CHOI[*]
St.Lawrence University

JOHN GAREN[†]
University of Kentucky

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Abstract

Federal, state, and local budget issues in the aftermath of the Great Recession stimulated a revival of interest in government worker pay. In the paper, we study the evolution of the federal-private pay differential from 1995 to 2017 using Current Population Survey data, enabling us to examine the current pay gap and how it has changed over time. Wage regressions are estimated by year for federal and private sector workers and used to calculate the yearly federal-private wage differential. To deal with unobserved heterogeneity, we adopt control function methods. We also estimate of the probability of receiving employer-provided health insurance and a pension plan each year for each sector. The findings imply that the federal pay differential is invariably positive, fell during the 1990s, rose in the early 2000s until 2013, then tended to decrease. There is evidence that the differential is related to federal spending relative to GDP, but not to the business cycle. Federal workers consistently have higher probabilities of having employer-provided pension plans and health insurance.

Keywords: wage differential, public-private, federal wage system, compensation

JEL Classification Codes: J24, J26, J31, J32, J33, J45

1 Introduction

There is long-standing interest in labor economics about the compensation of government workers relative to their private-sector counterparts. The modern, human capital/Mincerian wage equation approach to this topic was pioneered in a series of papers by Smith (1976a,b,1977). There has been recent revival of interest in the issue, with Congressional Budget Office (2012, 2017), Bradley (2012), and Biggs and Richwine (2011) examining the federal-private compensation differential, Gittleman and Pierce (2012), Munnell (2011), and Allegretto and Keefe (2010) studying state and local government pay, and Bewerunge and Rosen (2012) investigating all levels of government compensation. We suspect this increased attention is to the surge in federal deficits and the squeeze on state and local government budgets in the aftermath of the Great Recession. Presumably, any overcompensation of public employees presents potential for government cost savings.

Though the current wage and compensation difference of public and private employees is of interest, this paper produces and examines a time series of the pay differential between federal and private-sector employees. This enables us to determine not only the current pay differential but also if it has changed over time. We study the time period from 1995 to 2017. For wages and salaries, we use the CPS Merged Outgoing Rotation Group (CPS MORG). There are well documented differences in federal and private fringe benefits as well and we examine these using the March Current Population Survey (CPS). For this analysis, we estimate the probabilities that private sector and federal sector workers receive health insurance and pension benefits from their employers.

We find that, over this time period, the federal-private wage differential is always positive but varies from a low of 3.4 percent to a high of 17.7 percent. This differential fell through the late 1990s, rose steadily in the 2000s until 2013, then tended to decrease. An analysis of these differentials suggest some evidence that they grow as federal spending as a share of GDP grows but, once this is accounted for, they are unrelated to the business cycle. Also, federal workers have much higher probabilities of receiving employer-sponsored pension plans and health insurance, though time patterns in these differentials are not as clear.

In our analysis of wages, we deal with unobserved heterogeneity by using control function methods. Naturally, systematic unobserved differences in the abilities of federal and private workers can bias estimates of the wage differentials. The control function approach we adopt allows ability to be two-dimensional rather than one-dimensional. This is consistent with a Roy model, where some workers' unobserved traits make them more suited to one sector and not another. One-dimensional ability is a special case that we test for and reject for many of the years in our data. One-dimensional unobserved ability may be dealt with by instrumental variable (IV) or fixed effects (FE) methods, but because this is frequently rejected in the data, we do not use these methods. Moreover, though the selectivity bias we find is statistically significant in many cases, its magnitude is very small and estimates are nearly identical to those from OLS.

The remainder of this paper proceeds as follows. Section 2.1 briefly reviews the past literature on public-private wage differentials and section 2.2 provides an overview of federal rules on compensation. Section 3 describes the main dataset, the CPS MORG, and presents summary statistics for the main variables. Section 4 presents the results from the OLS wage

equations. The handling of the unobservables and the findings are discussed in Section 5. Section 6 examines how the probability of pension plan and health insurance coverage differ between federal and private workers. In Section 7, we examine how the time path of the federal-private wage differential depends on federal spending, the business cycle, and presidential administration. Lastly, Section 8 concludes.

2 Background

2.1 Past Literature[1]

Wage differentials between public and private sector employees have been well documented starting with Smith's seminal series of papers (1976a, 1976b, 1977). Smith (1976a) found that in 1960, federal workers were paid more than comparable private sector workers and this wage advantage continued in 1970. This difference implied that the earlier reforms made in the federal pay system did not bring federal pay in line with the private sector. Smith (1977) also found that the government wage differential varied by level of government-federal, state, or local - and by gender. Moulton (1990) revisited public-private wage differentials by taking into account better occupational controls and differences in local labor market conditions. He found that doing so reduced that magnitude, but did not eliminate, the federal wage gap.

A number of papers consider the growing skill differential in the private sector, as well as the responsiveness of government pay to market conditions, and how they may affect the

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[1]A more extensive review is in Choi (2016).

public-private wage gap. Katz and Krueger (1991) note that during the 1980s growth in the private-sector skill differential, there was not much change in federal wages in this regard. They indicate, though, that state and local government wages seemed more responsive to local economic conditions. Freeman (1987) also considers the sensitivity of government pay to economic conditions. He finds that that state and local government wages and employment respond to their respective government budgets, but with no clear patterns regarding federal workers. Borjas (2003) examines the skill differential and wage dispersion from 1960 to 2000 in the public and private sectors. The greater growth of wages at higher skill levels in the private sector is verified and he shows that this growth was not matched in the public sector, resulting in relatively less wage dispersion. Borjas (2003) indicates that this has made it more difficult to recruit high skilled workers into government.[2]

Public-private wage differentials also have generated recent research efforts. Bewerunge and Rosen (2012) examine federal, state, and local compensation differentials for 2004 and 2006 with data from the Health and Retirement Survey. They find a substantial wage premium for federal worker but very little differences for state and local workers. However, workers at all levels of government attain more fringe benefit compensation relative to their private-sector counterparts. Biggs and Richwine (2011) and Congressional Budget Office (2012, 2017) investigate wage and fringe benefit differentials between federal and private workers. Biggs and Richwine (2011) consider the 2006 to 2010 time period, while the first Congressional Budget Office study examines 2005 to 2010 and the second considers 2011 to 2015. Each generally finds a positive federal wage premium, though it is much smaller

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[2]See Borjas (1980) for his work on political influences on federal wages.

(or even negative) at very high levels of education. Also, federal fringe benefits are higher for federal workers, though this advantage is less for the highly educated workers. Bradley (2012) summarizes some of this recent work as well as noting methodological issues.

An important issue in this literature is the role of unobserved productivity. For example, suppose federal workers are better on unmeasured dimensions and earn higher compensation as a result. This generates an ability bias, where the positive federal pay gap may, in part, reflect higher ability rather than a true pay premium. Some authors have utilized fixed-effect estimation to deal with this issue. Krueger (1988) does so with two data sets. One is Current Population Survey (CPS) matched data from the mid- to late-1970s. The other is CPS supplements on displaced workers from the mid-1980s. The former data show a small and insignificant effect of federal employment with the fixed effects estimator, compared to a large, positive and significant effect in the cross-sectional analysis. The latter show little difference between estimation methods: a 10.7 percent federal wage premium with fixed effects and a 12.6 percent gap with OLS. Biggs and Richwine (2011) find a 9 percent federal wage gap from a sample of individuals from 2004 to 2008 in the Survey of Income and Program Participation. This compares to their OLS estimate of a 14 percent pay gap using CPS data.

Gyourko and Tracy (1988) deal with unobservables via control function methods. Using data from the 1977 CPS, they estimate the union-nonunion wage differential for the private and public sectors and the government wage differential for union and nonunion workers. They find a substantial wage differential for federal workers, but quite small differentials for state and local government employees. Interestingly, they find positive selection for private,

nonunion workers and negative selection for public, union workers. This suggests that the ability bias may go in direction of underestimating the government wage differential. Also, their approach enables unobservables to affect wages in the different sectors in different ways, i.e., that ability may be multidimensional where someone may good in one sector but not in another. This is an issue that we examine in detail below.[3]

Other work has investigated public-private wage differentials in other countries. Several recent studies in European Union (EU) countries find positive pay differentials in favor of the public sector that are generally higher for women, for workers at the low end of the wage distribution, and in selected sectors. They also find notable differences across EU countries: Greece, Ireland, Italy, Portugal and Spain exhibited higher public sector premia than other countries. See Bargain and Melly (2008), Giordano, et. al. (2011), and Castro, et. al. (2013).

Other recent studies have focused solely on state and local government workers. These include Munnell et. al. (2011), Allegretto and Keefe (2010), and Gittleman and Pierce (2012). As with other related studies, they find no consistent wage differential between state or local government workers and the private sector. However, both groups of government workers are paid more in fringe benefits that similar private sector workers.

2.2 Federal Rules on Compensation

The private sector and federal government are potential competitors as employers in the labor market. In light of this, the federal government has devised compensation rules

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[3]Van der Gaag and Vijverberg (1988) apply similar methods in their analysis of public and private wages in the Ivory Coast.

in order to pay comparably to the private sector with both its basic pay system and its adoption of special rates.[4] Here, we give an overview of those systems. According to U.S. Office of Personnel Management (OPM), the basic pay rules are also divided into two parts, General Schedule (GS) and the Federal Wage System (FWS). The GS classification and pay system covers the majority of the civilian white-collar federal employees in professional, technical, administrative, and clerical positions. The GS has 15 grades from GS-1 (lowest) to GS-15 (highest). Each grade is classified by job based on the responsibility, level of difficulty, and qualifications required. Each grade has 10 within-grade steps that are each worth approximately a 3 percent increase in the wage. The FWS was established for Federal blue-collar workers comparable to prevailing private sector rates in each local wage area. The FWS covers Federal trade, craft, and laboring employees. There are two basic principles for FWS: 1) wages are set according to local prevailing rates, and 2) there will be equal pay for equal work and pay distinctions in keeping with work distinctions. For each wage area, OPM identifies a lead agency that is responsible for conducting wage surveys, analyzing data, and issuing wage schedules under the two principals above. Employees are paid the full prevailing rate at step 2 in each grade. The highest step in FWS, step 5, the wage of employees is 12 percent above the prevailing rate of pay.

OPM establishes a higher rate of basic pay for a group or category of GS positions in one or more geographic areas to address existing or likely significant handicaps in recruiting or retaining well-qualified employees. The special rates address staffing problems caused by sig-

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[4]A special rate is higher rate of basic pay for a group or category of General Schedule (GS) positions in one or more geographic areas to address existing or likely significant handicaps in recruiting or retaining well-qualified employees.

nificantly higher non-federal pay rates than those payable by the federal government within the area, location, or occupational group involved. This includes the remoteness of the area or location involved, the undesirability of the working conditions or nature of the work involved, or any other circumstances OPM considers appropriate. Most of GS employees are entitled to locality pay, which is a geographic-based percentage rate that reflects pay levels for non-federal workers in certain geographic areas as determined by surveys conducted by the U.S. Bureau of Labor Statistics (BLS). There are currently 34 locality pay areas, which cover the lower 48 States and Washington D.C., plus Alaska, Hawaii, and the U.S. territories and possessions. For extraordinarily difficult living conditions and undesirable working conditions, the federal government pays both a cost-of-living allowance (COLA) and a post differential. A post differential means an addition to basic pay that is payable in selected non-foreign areas. A post differential is a recruitment incentive based on conditions of the environment in the non-foreign area that differ significantly from conditions in the U.S. as a whole. However, post differentials plus the COLA cannot exceed 25 percent of basic pay. These are reflected in our data on compensation and our examination of federal pay relative to private pay.

In addition, there is an overall COLA that raises basic rates of pay for each pay grade. The amount of this COLA is based on the Employment Cost Index. However, the President may alter or eliminate this pay increase due to unfavorable economic conditions. In fact, for 2011, 2012, and 2013, this COLA was set to zero. This does not mean, however, that federal pay raises during this period were zero. Federal employees may still obtain raises through moving up in steps or grades, as well as through changes in the area-based or other

adjustments noted above.

3   Basic Data

Our primary data source is the Current Population Survey Merged Outgoing Rotation Group (CPS MORG) from the National Bureau of Economic Research (NBER) between 1995 and 2017. In recent years, each monthly CPS has included about 140,000 individuals living in approximately 70,000 households. Using the MORG data instead of the March CPS yields much larger number of observations because the MORG data is monthly. Each month's observations for a given year naturally form the pool of observations we use for that year. From the earnings and hours questions, we compute average hourly earnings and express in inflation-adjusted 2012 dollars. The usual demographic variables are utilized, as well as the sector of employment: private, federal government, or other government. We limit our sample to those who worked at least 35 hours per week and are age 18 to 70.

Table 1 summarizes the mean wages of private workers and public sector workers from 1995 to 2017. Separate columns are presented for private sector workers, along with federal, state, and local government workers, with the latter two categories shown for informational purposes only. The focus of this paper is the federal-private differential. Figure 1 shows the unadjusted federal-private ratio over time. The ratio of average federal to average private sector wages is over 30 percent in each year and is over 40 percent in some years. This ratio fell during the initial years of our sample time frame, then increased over time.

We also examine coverage of workers by employer-provided health insurance and a pension plan. We rely on the annual March supplement of the CPS for this analysis since data

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on these variables are only available then. Table 2 and Figure 2 show the percent of workers covered by employer-based health insurance and pension benefits for the federal and private sectors. In each year, federal worker coverage exceeds that of the private sector for both of these fringe benefits. On average over this period, federal employees have an 12.3 percent higher coverage rate for health insurance (87.1 percent compared to 74.8 percent) and 32.3 percent higher for pension plan coverage (76 percent relative to 43.7 percent).

Table 3 present the summary statistics of variables that are included in our multivariate analysis. All wages in the data are expressed in 2012 dollars. In the entire sample period, 3.2 percent of individuals were working in the federal government. On average, these workers had more schooling, were slightly older, more likely to be unionized, more likely to be black, about equally likely to be female, and more heavily in managerial, professional, and administrative support occupations. Also shown are variables for urban-rural location, regions, and the 34 locality areas that the federal government offers locality wage differentials. Each of these are control variables in our empirical analysis.

Table 4 summarizes mean values of key variables from the CPS MORG data for both sectors over time. The average schooling level has increased in the federal and private sectors by about the same amount, as has average age. Percent female in the two sectors changed little over this time period. We also show the trends in the four occupational groups that comprise roughly 90 percent of federal workers - management, professional, service, and administrative support. The extent of managerial workers varied somewhat over time - falling then rising - among federal workers and rose slightly in the private sector. The percent of professionals rose in both sectors, as did the use of service workers. For

administrative support personnel, the percent of the federal workforce in these occupations fell over time while it changed little in the private sector.

4   Baseline OLS Estimation

This section presents OLS estimation of the federal-private wage differential as a baseline for comparison to estimates that deal with unobserved heterogeneity. We estimate two separate equations, year-by-year; one for federal workers only and one for all private sector workers from 1995 to 2017. The equations that we use to estimate the OLS models are below. Here, the dummy variable d_{it} equals 1 if the worker is employed in the federal sector and 0 otherwise:

$$ln(Y_{it}^f) = \beta_{0t}^f + \beta_{it}^f X_{it} + \epsilon_{it}^f \quad if \quad d_{it} = 1, \ where \ t = 1995, \cdots, 2017 \qquad (1.1)$$

$$ln(Y_{it}^p) = \beta_{0t}^p + \beta_{it}^p X_{it} + \epsilon_{it}^p \quad if \quad d_{it} = 0, \ where \ t = 1995, \cdots, 2017 \qquad (1.2)$$

The variable Y_{it} is average hourly earnings for workers. The term X_{it} is a vector of individual characteristics and demographics including schooling, experience, gender, union status, race, MSA, region, occupation, and locality, and ϵ_{it} is the disturbance term. Their summary statistics are as shown in Table 3 noted above. After obtaining estimated coefficients, the predicted federal-private wage differential is computed, evaluated at sample means.

Table 5 and Figure 3 summarize the estimated wage gap between two sectors. Calculating the wage differentials, year by year, using two separate equations from each sector, we find

that federal government workers received between 3.4 percent and 17.7 percent more than their counterparts in private sector. Each of these differentials is statistically significant, except the lowest value which occurred in 1999. These findings suggest that the federal pay differential is invariably positive and, as can be seen, it fell during the 1990s, began to rise in the early 2000s, and generally continued to rise until 2013. Then it began to decrease to the end of the sample period.

Additional OLS wage regressions are estimated by year and separately for federal and private sector workers with only the four major occupation groups which dominate federal employment: management occupations; professional occupations; service occupations; and administrative support occupations. By focusing on this narrower set of white collar occupations, the sample is more comparable to the federal work force thus we may remove a good deal of unobserved heterogeneity from the estimates and provide a simple robustness check on the previous findings. Table 6 and Figure 4 present the computed federal wage differentials from this analysis. Overall time pattern of the differentials are quite similar to the previous case. However, these federal wage premia are more stable and tend to be slightly higher, varying between 8.2 and 16.9 percent. Note that the wage differentials estimated with this subsample or the entire sample above are in keeping with the magnitude of estimates found in the literature.

5   Dealing with Unobservables

The OLS model assumes that the 'public' variable is uncorrelated with disturbance term, implying that sectoral differences in unobserved characteristics do not affect the estimated

wage differential. Here, we relax this assumption.

Let

$$ln(Y_{it}^f) = \beta_{0t}^f + \beta_{it}^f X_{it} + \phi_i + \theta_i^f + \epsilon_{it}^f \quad if \quad d_{it} = 1 \tag{2}$$

$$ln(Y_{it}^p) = \beta_{0t}^p + \beta_{it}^p X_{it} + \phi_i + \theta_i^p + \epsilon_{it}^p \quad if \quad d_{it} = 0 \tag{3}$$

where ϕ_i indicates the worker's absolute advantage in both the federal and private sectors, reflecting 'ability' such that a worker with a higher ϕ_i can earn a higher wage in both sectors. This is the usual person-specific fixed effect. We generalize this by including the terms θ^f and θ^p, which are relative/comparative advantages indicating how well-matched an individual is to each sector. These are as in a Roy model. For example, a person can be well-suited to government work and not for the private sector, implying a large θ^f and a low θ^p. Naturally, other cases are possible. If $\theta^f = \theta^p$ then this collapses to the special case of absolute advantage with only ϕ_i. Note that the formulation of (2) and (3) allows 'abillty' to be two-dimensional rather than uni-dimensional. The ϵ_{it}^j terms are white noise for each sector. These equations can be re-written as

$$ln(Y_{it}^f) = \beta_{0t}^f + \beta_{it}^f X_{it} + \epsilon_1 \quad if \quad d_{it} = 1 \tag{4}$$

$$ln(Y_{it}^p) = \beta_{0t}^p + \beta_{it}^p X_{it} + \epsilon_0 \quad if \quad d_{it} = 0 \tag{5}$$

where $\epsilon_1 = \phi_i + \theta_i^f + \epsilon_{it}^f$ and $\epsilon_0 = \phi_i + \theta_i^p + \epsilon_{it}^p$. A common way to deal a model like this with two dimensional unobservables is use of the Heckman-Lee method. Other methods such as instrumental variable (IV) and fixed effect (FE) models deal only with unidimen-

sional ability. As shown below, using a control function approach, we can test whether the unobservable ability is one-dimensional or two-dimensional. To do so, we start with original Heckman-Lee assumption of joint normality. We later relax this assumption in our robustness checks.

The probability of a workers choosing the federal sector depends on the wage differential s/he obtains and exogenous factors such as the ease finding federal relative to private employment. Let the latter factor be represented by the vector Z_i. Then the probability of $d_{it} = 1$ is :

$$Pr(d_i = 1) = X_i\delta + Z_i\gamma + \alpha\phi_i + \tau(\theta_i^f - \theta_i^p) + u_i \tag{6}$$

Equation (6) can be written as

$$d_i = V_i\psi + \epsilon_2 \tag{7}$$

$$d_i = \begin{cases} 1 \ \ if \ \ \epsilon_2 > -V_i\psi \\[2mm] 0 \ \ if \ \ \epsilon_2 \leq -V_i\psi \end{cases}$$

where $\epsilon_2 = \alpha\phi_i + \tau(\theta_i^f - \theta_i^p)$ and $V_i = f(X_i, Z_i)$. Note that equation (6) estimates the probability of being a federal government employee, thus we expect the term τ to be positive. That is, the better the match to federal employment, $(\theta_i^f - \theta_i^p)$, the more likely the person is a federal worker. The expectation of the disturbance terms for federal workers and private sector workers from equations (4) and (5) are

$$E(\epsilon_1|d_i = 1) = E(\epsilon_1|\epsilon_2 > -V_i\psi) = \frac{\sigma_{12}}{\sigma_2}[\frac{f(V_i\psi)}{1 - F(V_i\psi)}] \tag{8}$$

$$E(\epsilon_0|d_i = 0) = E(\epsilon_0|\epsilon_2 \leq -V_i\psi) = \frac{\sigma_{02}}{\sigma_2}[\frac{-f(V_i\psi)}{1 - F(V_i\psi)}] \tag{9}$$

where σ_{12} is the covariance of ϵ_1 and ϵ_2 and σ_{02} is the covariance of ϵ_0 and ϵ_2, f is the standard normal density function and F is the cumulative normal density function. It is these two expression that are the control function, or selection, variables.

Note that

$$\sigma_{12} = Cov(\epsilon_1, \epsilon_2)$$
$$= Cov(\phi_i + \theta_i^f + \epsilon_i^f, \alpha\phi_i + \tau(\theta_i^f - \theta_i^p) + u_i) \tag{10}$$
$$= \alpha\sigma_\phi^2 + \tau(\sigma_f^2 - \sigma_{fp})$$

and

$$\sigma_{02} = Cov(\epsilon_0, \epsilon_2)$$
$$= Cov(\phi_i + \theta_i^p + \epsilon_i^p, \alpha\phi_i + \tau(\theta_i^f - \theta_i^p) + u_i) \tag{11}$$
$$= \alpha\sigma_\phi^2 + \tau(\sigma_{fp} - \sigma_p^2)$$

where σ_{fp} is covariance between θ^f and θ^p, σ_f^2 and σ_p^2 are the variances of θ^f and θ^p, respectively.[5]

If there is only absolute advantage, $\phi_i \not\equiv 0$ and $\theta_i^f \equiv \theta_i^p \equiv 0$, then from equation (10) and (11) :

$$\sigma_{12} = \alpha\sigma_\phi^2 \tag{12}$$

$$\sigma_{02} = \alpha\sigma_\phi^2 \tag{13}$$

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[5]The formulations in (10) and (11) assumes that ϕ is uncorrelated with the two match parameters, θ^f and θ^p. Dropping this assumption changes little in our discussion.

In this case, we have a standard one-diminsional, fixed-effect that can be dealt with via IV or FE estimation. In the Heckman-Lee framework, the coefficients on the selectivity variables are identical. If higher ability employees are more likely to be federal government worker ($\alpha > 0$),, then $\sigma_{02} = \sigma_{12} > 0$. On the contrary, if higher ability employees are more likely to be private sector worker($\alpha < 0$), then $\sigma_{02} = \sigma_{12} < 0$.

With both absolute advantage and comparative advantages, $\phi_i \not\equiv 0$ and $\theta_i^f \not\equiv 0 \not\equiv \theta_i^p$, then depending on the size of each variance and covariance, σ_{12} and σ_{02} can be either sign. Positive values of σ_f^2, σ_p^2, and τ tend to make $\sigma_{12} > 0$ and $\sigma_{02} < 0$, though the other terms in (10) and (11) can generate different outcomes. The nature of the cross-equation correlation is readily tested with the Heckman-Lee methodology; it is a test of the equality of the coefficients on the two selectivity terms.[6]

To estimate the wage equations, we follow the standard Heckman-Lee procedure. We first estimate (7) with probit. For the vector of Z_i variables, we use variables intended to capture the ease of finding private sector jobs relative to federal jobs in each worker's location. To control for business cycle factors that may affect this relative availability, we include the worker's state unemployment rate, the state real GDP growth rate, and the state employment growth rate. We also include the ratio of federal government workers to all employees in the state.

The wage equations we estimate can be written as:

$$ln(Y_{it}^f) = \beta_{0t}^f + \beta_{it}^f X_{it} + \frac{\sigma_{12}}{\sigma_2} \left[\frac{f(V_i\psi)}{1 - F(V_i\psi)} \right] + \nu_1 \quad if \quad d_{it} = 1 \tag{14}$$

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[6]See Garen (1987) for a closely related discussion

$$ln(Y_{it}^p) = \beta_{0t}^p + \beta_{it}^p X_{it} + \frac{\sigma_{02}}{\sigma_2}\Big[\frac{-f(V_i\psi)}{1 - F(V_i\psi)}\Big] + \nu_0 \quad if \quad d_{it} = 0 \qquad (15)$$

where estimated values of the selectivity terms from the probit are substituted in above and ν_1 and ν_0 are the applicable disturbance terms. Here, we can see that this formulation enables a simple test of whether the Roy model is appropriate relative to a unidimensional ability model by testing the equality of the coefficients on the two selectivity term. If they are equal, then IV or FE estimation also may be applied. If they are not equal, then the latter two methods are not appropriate.

Table 7 and Table 8 show the coefficients on the two selectivity coefficients for each year, with the former table for entire sample and the latter for the subsample of four occupations. In Table 7, the coefficients for the private sector are consistently positive and significant. However, the coefficients for the federal sector workers are unstable and tend to be insignificant. The final column of Table 7 shows the t-statistics for the tests of equality of the coefficients. For nearly half of the years, we reject the hypothesis of equal coefficients. With a sample of only four occupations in Table 8, the pattern is similar to that in Table 7. In most cases, the coefficient for the private sector is positive and larger than that for the federal sector. For much of the sample period, the message is that the selectivity coefficients differ.

As is well known, the Heckman-Lee procedure rests on strong functional form assumptions. Thus, we proceeded with a more general control function approach and estimated a variety of models with many functional forms to determine the robustness of our results.[7]

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[7]These procedures are in line with the guidance of Imbens and Wooldridge (2007).

In particular, we estimated equation (7) that determines the worker's sector by linear probability and logit, as well as by probit. From each of these, we formed an estimate of $E(\epsilon_{2i} \mid d_i)$. These were entered linearly, as quadratics, and as cubics in each wage equation. The findings are consistent with the above. There tends to be a positive and significant association of private sector wages and $E(\epsilon_{2i} \mid d_i = 0)$. The association of federal sector wages and $E(\epsilon_{2i} \mid d_i = 1)$ is unstable and generally not statistically significant. Tests of equality of the two effects on wages are mostly rejected. Moreover, when we calculate the federal-private wage differential using estimates with the various control functions, we find nearly identical results. Note that we frequently reject the one-dimensional model of ability. Because IV and FE estimation methods assume one-dimensional ability, it is not generally appropriate to use these methods and we pursue these alternatives no further. Additionally, as described below, we find that unobserved heterogeneity has little effect on the magnitude of the wage differentials.

The federal-private wage differential is calculated with the Heckman-Lee estimation and the results shown in Table 9 and Table 10. The former table is for the entire sample and the latter for the subsample of four occupation groups. The findings are nearly identical to those of OLS. Figure 5 plots the coefficients from Table 9 against the coefficients for the corresponding OLS wage equation of Table 5. Visually, they nearly overlay one another. The wage gap from Heckman-Lee model is at most 1.3 percent larger and is, at minimum, 0.8 percent smaller than that from OLS.

Regarding the four occupation subsample, Figure 6 plots the coefficients of Table 10 against the corresponding OLS coefficients from Table 6. Again, the plots are nearly iden-

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tical. Therefore, though selectivity bias generally is statistically significant, especially for private sector wages, its economic magnitude is so small as to make little difference in the wage differential computation.

Moreover, this indicates that our conclusions from the OLS analysis above continue to hold: the federal wage differential has been positive throughout this period; it fell in the late 1990s and rose fairly steadily though the 2000s until 2013 and then decreased to the end of the sample period; the subsample of four occupations suggests a larger differential in the 1990s with a smaller decline, but quite close to the differential from the entire sample for the later part of the period; the federal-private wage differential during this period was not lower than 3.4 percent and as high as 17.7 percent.

6 Fringe Benefit Analysis

Fringe benefits are often a large share of compensation so it is important to compare fringe benefit provision between the federal and private sectors. From the March CPS, the variables available are whether or not the worker has an employer-provided health insurance plan and an employer-sponsored retirement plan. Thus, we estimate the effect of federal sector employment on the provision of each of these, holding constant a host of covariates. In particular, we estimate the probability of receipt of each of these fringe benefits by probit as:

$$P(Y_{it} = 1) = \Phi(X'_{it}\rho + d_{it}\lambda) \tag{16}$$

where i indexes the individual, and t indexes time. In this estimation, Y_{it} is a dummy variable indicating whether the worker has a health insurance plan or a retirement pension plan from his/her current employer, $\Phi(\cdot)$ is the cumulative distribution function for the standard normal. The vector of observable characteristics X_{it} and d_{it} are the same as in the OLS wage equation model. We run separate probit equations by year for health insurance and pension plan provision.

Table 11 shows the marginal effects of federal sector employment on the probability of obtaining each fringe benefit. Federal government workers enjoy a much higher probability of receiving an employer-provided retirement pension. This higher probability ranges from 13.4 to 29.6 percent, depending on the year. It decreased until the early 2000s, but then rose albeit is a somewhat irregular way. Figure 7 shows the plot of these differentials over time. The second column in Table 11 shows the findings is for employer-provided health insurance. The results for health insurance are less dramatic than for pensions. Federal workers generally have a higher probability of receiving health insurance, though by how much varies from year to year. It is as small as -4 percent and as large as nearly 11 percent. These effects are plotted in Figure 8 and show the somewhat irregular pattern just noted. This analysis reinforces earlier findings in the literature that federal workers are compensated with greater fringe benefits.

7   Analyzing the Time Path of Wage Differentials

In this section, we examine the relationship between the yearly estimated federal-private wage differential and national-level economic and political variables. To capture effect of the

business cycle, we use the unemployment rate of 25 to 54 year olds. We also use the federal spending to GDP ratio. This variable may reflect both economic and political influences. Federal spending tends to rise as the business cycle worsens, so it may partially capture business cycle effects. Higher federal spending may also reflect a political environment more favorable to larger government and, naturally, more federal spending may enable higher federal pay. We also use a dummy variable for each presidential administration; Clinton, Bush, Obama, and Trump. These are utilized as explanatory variables to explain the time variation in the federal-private wage differential. The findings are presented in Table 12. For the first two columns, we use only the unemployment rate variable and the ratio of federal spending to GDP as covariates. Regarding the dependent variable, we use the wage differential from the sample of all workers in the first column and that from the subsample of four occupations in the second sample.[8] These are as reported in Tables 9 and 10, respectively. For the first column, we find a positive and significant effect of federal spending on the federal wage differential. For all workers, an additional 1 percent of federal spending to GDP is associated with a 1.7 percent higher federal wage differential.

The unemployment rate variable has a negative though insignificant effect in the first column and positive and insignificant in the second column. One might expect a positive effect since a higher unemployment indicates a slack private labor market and some of the previous literature suggested a widening gap between federal and private wages. However, part of this effect may be captured in the federal spending variable since federal spending typically rises with the unemployment rate.

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[8]Because the wage differentials are estimated, we correct for any potential problem with standard errors by using Huber/White robust standard errors.

In the third and fourth columns of Table 12, we include dummy variables for each presidential administration, with the Clinton administration the omitted category. In the third column, the Bush and Obama administration dummies are both positive, with the former larger than the latter. The Trump administration dummy is negative. Only the Bush administration dummy is significant, though. Regarding the fourth column, the Bush and Obama administration coefficients are both quite small and insignificant, with the former positive and the latter negative. The Trump administration coefficient is negative and significant. Note, though, that these coefficients are reflective of the time pattern of the estimated wage differentials: for the entire sample, the differential fell, then rose throughout the Bush and Obama years and fell again during the Trump years, while for the subsample, the rise was mostly during the Bush years. Additionally, these are effects holding constant federal spending and the unemployment rate which changed substantial across presidential administrations. Regarding those effects, we find a positive effect of the ratio of federal spending to GDP in both columns, though it reaches significance only in the third column. The coefficients on the unemployment rate variable are negative and statistically insignificant.

8   Conclusion

Our empirical analysis of the federal wage differential from 1995 to 2017 reaches several robust conclusions. The differential has been positive throughout this period. It fell in the late 1990s and rose fairly steadily though the 2000s until 2013, and then tended to decrease to the end of the sample period. Our preferred estimate indicate it varied between 3.4 percent

and 17.7 percent. A similar pattern emerges when examining only the four occupations that comprise most of the federal workforce. Results after correction for unobserved heterogeneity with use of control function methods are nearly identical to those from OLS. Additionally, the probabilities of federal workers having a pension plan and employer-sponsored health insurance are persistently higher than for private-sector workers.

Finally, we examine factors that affect the wage differential over time. Among economic indices, the federal spending to GDP ratio tends to be positively related to the wage gap. Once this is accounted for, the effect of the business cycle, as measured by the unemployment rate, has little effect. Holding constant the above two factors, the federal pay differential was higher under Bush and Obama administrations and lower under the Trump administration relative to the Clinton administration. These effects do not consistently attain statistical significance, though.

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Table 1: Real Average Hourly Earnings, by Worker Category, 1995-2017 CPS MORG.

	Federal	State	Local	Privte	Federal/Private	State/Private	Local/ Private
1995	25.842	21.659	22.420	19.609	1.318	1.105	1.143
1996	25.886	21.516	21.964	19.315	1.340	1.114	1.137
1997	25.943	21.778	22.162	19.609	1.323	1.111	1.130
1998	26.635	22.451	22.598	20.476	1.301	1.096	1.104
1999	27.646	22.749	22.956	20.943	1.320	1.086	1.096
2000	27.430	22.722	22.882	20.991	1.307	1.082	1.090
2001	28.212	23.076	22.974	21.582	1.307	1.069	1.064
2002	28.757	23.749	23.300	21.890	1.314	1.085	1.064
2003	28.617	23.600	23.199	21.914	1.306	1.077	1.059
2004	29.615	23.688	23.604	21.932	1.350	1.080	1.076
2005	29.971	23.402	23.100	21.780	1.376	1.074	1.061
2006	30.262	23.349	23.128	21.689	1.395	1.077	1.066
2007	30.594	23.703	23.468	21.833	1.401	1.086	1.075
2008	29.812	23.762	23.518	21.985	1.356	1.081	1.070
2009	30.813	24.074	23.924	22.546	1.367	1.068	1.061
2010	30.594	24.286	24.065	22.339	1.370	1.087	1.077
2011	30.505	23.778	23.873	22.128	1.379	1.075	1.079
2012	31.477	23.579	23.480	22.281	1.413	1.058	1.054
2013	31.772	23.644	23.507	22.198	1.431	1.065	1.059
2014	30.757	23.692	23.487	22.204	1.385	1.067	1.058
2015	31.050	24.206	24.249	22.594	1.374	1.071	1.073
2016	31.229	24.228	24.231	23.078	1.353	1.050	1.050
2017	31.171	24.247	23.965	22.966	1.357	1.056	1.044

Source: Current Population Surveys

Figure 1: Trend of Real Wage Ratio between Federal and Private Sector.
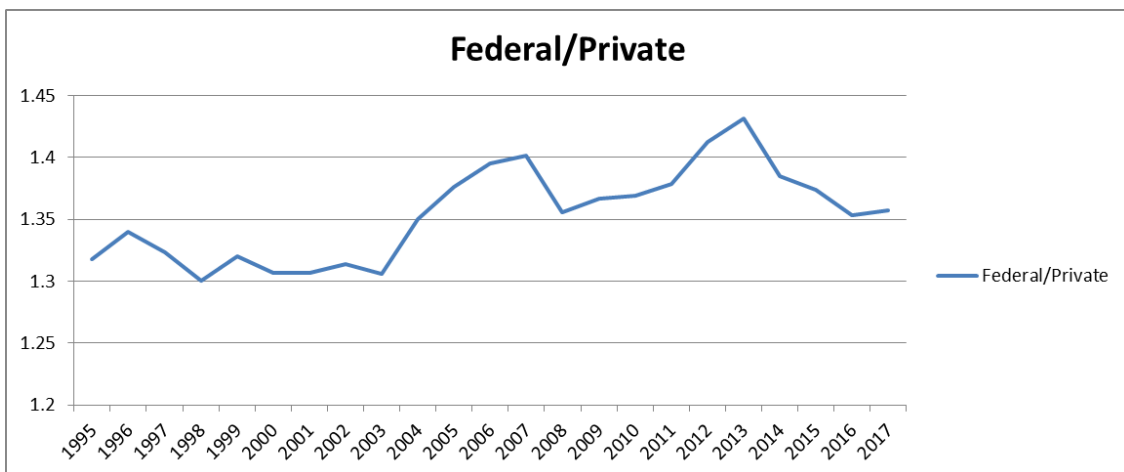
Table 2: Percentage of workers receiving fringe benefit

	Health Insurance		Pension Plan	
	Private	Federal	Private	Federal
1995	0.743	0.890	0.448	0.802
1996	0.763	0.906	0.447	0.830
1997	0.759	0.865	0.449	0.799
1998	0.762	0.881	0.454	0.759
1999	0.768	0.835	0.481	0.786
2000	0.791	0.876	0.480	0.743
2001	0.806	0.910	0.481	0.755
2002	0.810	0.923	0.480	0.760
2003	0.796	0.885	0.461	0.777
2004	0.784	0.895	0.458	0.744
2005	0.768	0.893	0.454	0.771
2006	0.750	0.866	0.449	0.741
2007	0.736	0.896	0.426	0.763
2008	0.746	0.874	0.460	0.778
2009	0.741	0.895	0.444	0.774
2010	0.707	0.881	0.427	0.763
2011	0.710	0.887	0.421	0.795
2012	0.712	0.862	0.432	0.744
2013	0.703	0.893	0.424	0.785
2014	0.706	0.805	0.423	0.762
2015	0.715	0.792	0.390	0.751
2016	0.712	0.842	0.334	0.658
2017	0.706	0.772	0.327	0.643

Source: Current Population Surveys

Figure 2 : Percentage of workers receiving Fringe Benefits (Fed. Vs. Private)

Health Insurance

Pension Plan
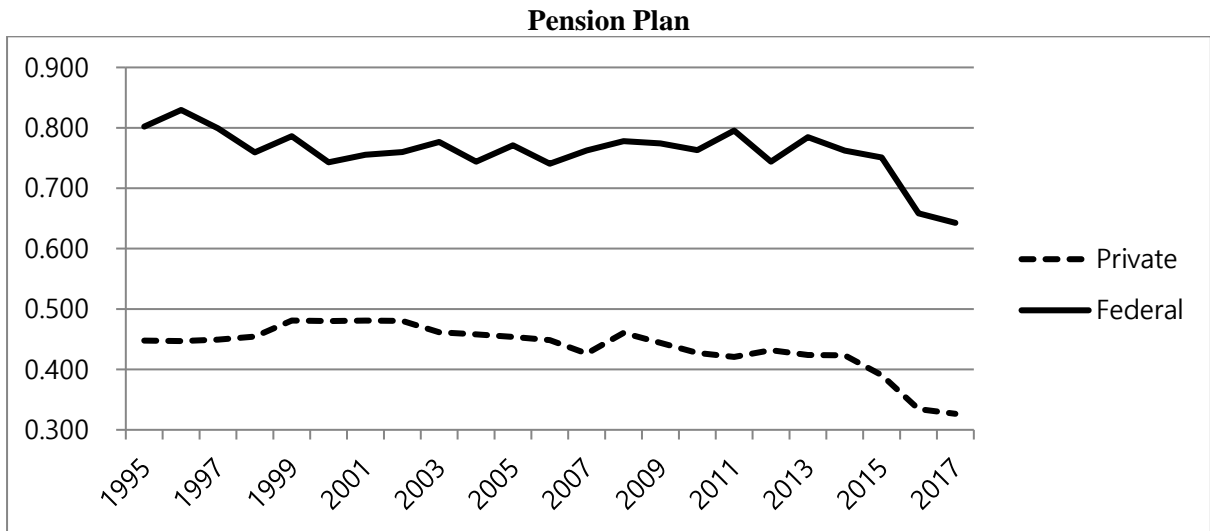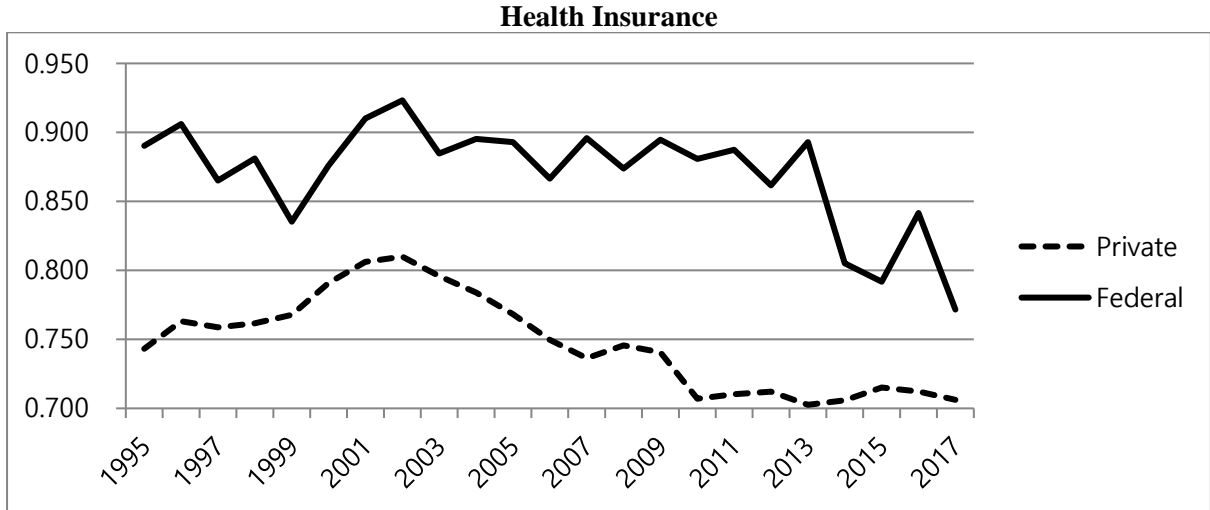
Table 3: Summary Statistics, 1995-2017 Current Population Survey Merged Outgoing Rotation Group.

	Entire Sample		Federal		Private	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Wage	21.933	13.384	29.459	15.059	21.669	13.243
Health Insurance	0.757	0.429	0.873	0.333	0.753	0.431
Pension Plan	0.452	0.498	0.759	0.428	0.441	0.497
Federal Employee	0.032	0.177				
School	13.474	2.587	14.908	2.496	13.426	2.577
Age	40.492	12.179	44.360	11.234	40.362	12.188
Female	0.437	0.496	0.457	0.498	0.436	0.496
Union	0.089	0.285	0.180	0.384	0.086	0.281
Msa						
Metropolitan	0.284	0.451	0.336	0.472	0.289	0.453
Balance	0.478	0.500	0.455	0.498	0.479	0.500
Non-Metropolitan	0.231	0.422	0.209	0.407	0.232	0.422
Experience	21.018	12.321	23.452	11.507	20.936	12.339
Region						
Northeast	0.203	0.402	0.120	0.325	0.207	0.405
Midwest	0.242	0.428	0.150	0.357	0.245	0.430
South	0.316	0.465	0.455	0.498	0.311	0.463
West	0.238	0.426	0.275	0.446	0.237	0.425
Race						
White	0.730	0.444	0.673	0.469	0.727	0.445
Black	0.091	0.288	0.160	0.366	0.089	0.285
Asian	0.046	0.208	0.051	0.220	0.045	0.208
Others	0.137	0.344	0.117	0.321	0.138	0.345
Occupation						
Management	0.158	0.365	0.253	0.435	0.162	0.368
Professional	0.215	0.411	0.328	0.469	0.171	0.377
Service	0.132	0.339	0.118	0.323	0.123	0.328
Sales	0.097	0.296	0.016	0.124	0.116	0.320
Administrative support	0.139	0.346	0.164	0.371	0.138	0.345
Farming, fishing, and forestry	0.011	0.102	0.008	0.087	0.012	0.108
Construction	0.055	0.229	0.021	0.142	0.061	0.240
Installation, maintenance, and repair	0.042	0.200	0.036	0.187	0.046	0.209
Production	0.083	0.275	0.026	0.160	0.097	0.296
Transportation	0.067	0.250	0.030	0.170	0.075	0.263
Locality						
Atlanta	0.012	0.108	0.008	0.091	0.012	0.109
Boston	0.016	0.125	0.008	0.088	0.016	0.126
Buffalo-Niagara	0.003	0.052	0.002	0.040	0.003	0.053
Chicago	0.027	0.161	0.012	0.108	0.027	0.162
Cincinnati	0.006	0.077	0.004	0.059	0.006	0.077
Cleveland	0.009	0.093	0.005	0.069	0.009	0.094
Columbus	0.005	0.069	0.003	0.057	0.005	0.070

Table 3 (cont'd)

Variable	Entire Sample		Federal		Private	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Locality (cont'd)						
Dallas	0.014	0.116	0.008	0.087	0.014	0.117
Dayton	0.003	0.051	0.005	0.071	0.003	0.051
Denver	0.012	0.107	0.011	0.105	0.012	0.107
Detroit	0.015	0.121	0.006	0.080	0.015	0.122
Hartford	0.005	0.072	0.001	0.037	0.005	0.073
Houston	0.012	0.108	0.004	0.064	0.012	0.109
Huntsville	0.002	0.043	0.005	0.070	0.002	0.042
Indianapolis	0.005	0.069	0.004	0.060	0.005	0.070
Los Angeles	0.033	0.180	0.017	0.128	0.034	0.181
Miami	0.012	0.108	0.006	0.079	0.012	0.109
Milwaukee	0.006	0.079	0.002	0.047	0.006	0.080
Minneapolis	0.013	0.114	0.005	0.071	0.014	0.115
New York	0.045	0.208	0.022	0.145	0.046	0.210
Philadelphia	0.021	0.145	0.016	0.124	0.022	0.145
Phoenix	0.010	0.097	0.005	0.069	0.010	0.098
Pittsburgh	0.007	0.084	0.003	0.058	0.007	0.084
Portland	0.008	0.088	0.004	0.065	0.008	0.089
Raleigh	0.004	0.067	0.003	0.051	0.005	0.067
Richmond	0.003	0.056	0.004	0.061	0.003	0.055
Sacramento	0.004	0.061	0.003	0.051	0.004	0.061
San Diego	0.006	0.077	0.010	0.098	0.006	0.076
San Jose	0.014	0.119	0.009	0.094	0.014	0.120
Seattle	0.010	0.098	0.008	0.088	0.010	0.098
Washington	0.039	0.194	0.213	0.409	0.033	0.180
State of Alaska	0.011	0.103	0.031	0.174	0.010	0.099
State of Hawaii	0.012	0.110	0.029	0.167	0.012	0.107
Rest of U.S.	0.606	0.489	0.527	0.499	0.600	0.490

Source: Current Population Surveys

Note: Definitions of Variables: **Hourly Wage**: The wage rate is used, if reported. Otherwise, this is reported earning divided by reported usual hours over that time span. **Public:** This variable is created from the 'Class of Job' survey question. State and local government workers are dropped from sample. As a result, federal government workers have value for this variable equal to 1 and 0 for private sector workers. **School**: This variable indicates the number of years of education the workers attained. **Experience**: Potential experience (= Age- School -6). **Female**: If a worker who interviewed is female, then the value for this variable is 1 and 0. **Union**: equal 1 for union members, 0 otherwise. **Race**: There are four race dummy variables one each for White, Black, Asian, others. **Region**: There are four region dummy variables, one each Northeast, Midwest, South, and West. **MSA**: This variable defines the 'Metropolitan Statistical Area' status. Separate dummies are created in the city of an MSA, the balance of the MSA, and non-metropolitan location. **Occupation**: Dummies variables are created for ten major occupations. **Locality**: This variable indicates 33 separate metropolitan locality pay areas and one variable for "Rest of U.S.". Federal government offers 34 different wage schedules which are depending on the location and cost of living.

Table 4 : Detailed Summary of Key Variables in Federal Government and Private Sector Workers, Year-by-Year, 1995-2017 CPS MORG

	School		Age		Female		Union		White		Management		Professional		Sevice		Administation	
	Federal	Private	Federal	Private	Federal	Private	Federal	Private	Federal	Private	Federal	Private	Federal	Private	Federal	Private	Federal	Private
1995	14.3520	13.1231	42.4799	38.1402	0.4721	0.4291	0.1915	0.1153	0.7019	0.7849	0.2809	0.1464	0.2937	0.1449	0.0840	0.1014	0.2059	0.1472
1996	14.3688	13.1070	43.0279	38.3341	0.4679	0.4309	0.1890	0.1114	0.7076	0.7789	0.2771	0.1477	0.2940	0.1448	0.0838	0.1034	0.1976	0.1453
1997	14.4591	13.1132	42.8133	38.4340	0.4667	0.4328	0.1779	0.1070	0.7200	0.7689	0.2695	0.1506	0.2990	0.1488	0.0938	0.1022	0.1985	0.1416
1998	14.4598	13.1454	43.3043	38.6617	0.4695	0.4326	0.1893	0.1054	0.7098	0.7631	0.2780	0.1526	0.2947	0.1520	0.0938	0.1037	0.1957	0.1420
1999	14.5862	13.1630	43.9659	38.8884	0.4572	0.4308	0.1873	0.1049	0.7039	0.7564	0.2945	0.1557	0.2993	0.1546	0.0916	0.1044	0.1803	0.1378
2000	14.5201	13.1698	43.9679	38.9645	0.4402	0.4314	0.1761	0.0998	0.7013	0.7412	0.2705	0.1560	0.3102	0.1552	0.0857	0.1035	0.1906	0.1394
2001	14.6314	13.2293	44.1584	39.3028	0.4558	0.4328	0.1921	0.0983	0.7020	0.7436	0.2753	0.1603	0.3173	0.1601	0.0901	0.1057	0.1699	0.1366
2002	14.6452	13.2728	44.3165	39.6607	0.4746	0.4348	0.1849	0.0945	0.6835	0.7515	0.2768	0.1638	0.3129	0.1622	0.1056	0.1073	0.1745	0.1339
2003	14.6188	13.2896	44.3450	39.9761	0.4790	0.4379	0.1840	0.0895	0.6788	0.7451	0.2368	0.1505	0.3164	0.1624	0.1211	0.1251	0.1822	0.1509
2004	14.6744	13.3073	44.6819	40.1246	0.4604	0.4355	0.1735	0.0866	0.6773	0.7375	0.2322	0.1509	0.3248	0.1635	0.1345	0.1289	0.1615	0.1467
2005	14.7823	13.3197	44.7881	40.2127	0.4494	0.4349	0.1699	0.0845	0.6800	0.7313	0.2319	0.1510	0.3158	0.1647	0.1330	0.1277	0.1725	0.1460
2006	14.8534	13.3316	45.0279	40.3514	0.4515	0.4338	0.1719	0.0804	0.6737	0.7183	0.2285	0.1528	0.3276	0.1644	0.1268	0.1302	0.1797	0.1446
2007	14.9815	13.3927	44.7131	40.5955	0.4449	0.4372	0.1559	0.0803	0.6592	0.7136	0.2399	0.1573	0.3355	0.1676	0.1239	0.1289	0.1622	0.1424
2008	14.9397	13.4673	44.7791	40.8612	0.4634	0.4377	0.1768	0.0826	0.6614	0.7164	0.2352	0.1611	0.3384	0.1737	0.1180	0.1308	0.1619	0.1409
2009	14.9973	13.5470	44.8439	41.3024	0.4676	0.4424	0.1793	0.0774	0.6686	0.7188	0.2473	0.1678	0.3208	0.1823	0.1334	0.1364	0.1556	0.1390
2010	15.0283	13.5974	44.2943	41.4373	0.4512	0.4442	0.1750	0.0758	0.6533	0.7142	0.2282	0.1656	0.3322	0.1870	0.1419	0.1381	0.1601	0.1397
2011	15.1276	13.6381	44.6907	41.6339	0.4502	0.4418	0.1800	0.0750	0.6678	0.7113	0.2422	0.1684	0.3447	0.1873	0.1281	0.1362	0.1495	0.1375
2012	15.2929	13.6938	44.6459	41.7773	0.4527	0.4363	0.1675	0.0713	0.6668	0.7067	0.2505	0.1755	0.3602	0.1876	0.1267	0.1359	0.1416	0.1319
2013	15.3905	13.7482	44.9923	41.8899	0.4501	0.4383	0.1796	0.0724	0.6449	0.7033	0.2557	0.1760	0.3489	0.1909	0.1347	0.1338	0.1404	0.1311
2014	15.4022	13.7482	44.8234	41.9066	0.4590	0.4369	0.1858	0.0717	0.6324	0.6954	0.2497	0.1746	0.3526	0.1918	0.1320	0.1334	0.1401	0.1298
2015	15.4354	13.7598	44.9279	41.8763	0.4666	0.4380	0.1846	0.0702	0.6402	0.6839	0.2363	0.1757	0.3595	0.1952	0.1376	0.1332	0.1391	0.1277
2016	15.4070	13.7987	44.7671	41.8243	0.4353	0.4375	0.1799	0.0675	0.6453	0.6764	0.2622	0.1783	0.3547	0.1965	0.1338	0.1358	0.1241	0.1252
2017	15.4471	13.8502	45.0219	41.9834	0.4379	0.4393	0.1826	0.0685	0.6310	0.6753	0.2495	0.1800	0.3604	0.2007	0.1376	0.1331	0.1300	0.1203

Source: Current Population Surveys

Table 5: Wage Differential, OLS, Year-by-Year, 1995-2017 CPS MORG

	OLS Wage Differential
1995	0.123***
	(0.016)
1996	0.123***
	(0.018)
1997	0.096***
	(0.019)
1998	0.052**
	(0.022)
1999	0.034
	(0.028)
2000	0.080***
	(0.015)
2001	0.083***
	(0.014)
2002	0.079***
	(0.015)
2003	0.119***
	(0.018)
2004	0.094***
	(0.016)
2005	0.132***
	(0.015)
2006	0.154***
	(0.017)
2007	0.157***
	(0.015)
2008	0.152***
	(0.014)
2009	0.160***
	(0.014)
2010	0.163***
	(0.015)
2011	0.144***
	(0.017)
2012	0.155***
	(0.020)
2013	0.177***
	(0.018)
2014	0.132**
	(0.053)
2015	0.114***
	(0.016)
2016	0.135***
	(0.016)
2017	0.122***
	(0.018)

Note: standard errors in parentheses*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Source: Current Population Surveys

Table 6: Wage Differential, OLS, Year-by-Year, 4 Occupations, 1995-2017 CPS MORG

	OLS Wage Differential (4 Occ.)
1995	0.139***
	(0.013)
1996	0.133***
	(0.012)
1997	0.132***
	(0.013)
1998	0.100***
	(0.015)
1999	0.099***
	(0.014)
2000	0.086***
	(0.015)
2001	0.114***
	(0.013)
2002	0.118***
	(0.012)
2003	0.082***
	(0.014)
2004	0.108***
	(0.014)
2005	0.123***
	(0.014)
2006	0.147***
	(0.014)
2007	0.160***
	(0.015)
2008	0.154***
	(0.013)
2009	0.148***
	(0.014)
2010	0.156***
	(0.014)
2011	0.136***
	(0.014)
2012	0.151***
	(0.019)
2013	0.169***
	(0.016)
2014	0.147***
	(0.039)
2015	0.116***
	(0.015)
2016	0.118***
	(0.015)
2017	0.104***
	(0.017)

Note: standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.

Source: Current Population Surveys

Figure 3 : Wage Differential, OLS, Year-by-Year, 1995-2017 CPS MORG
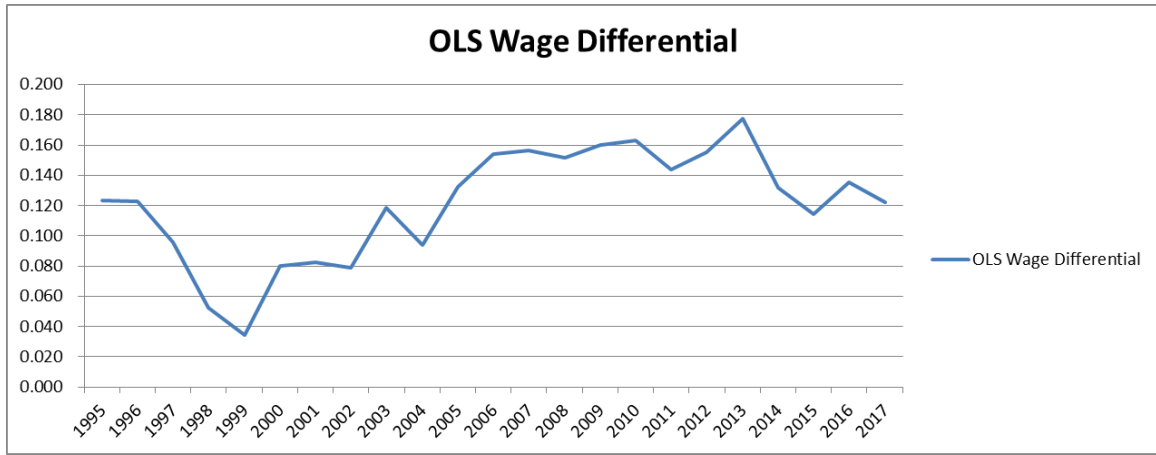
Figure 4: Wage Differential, OLS, Year-by-Year, 4 Occupations, 1995-2017 CPS MORG
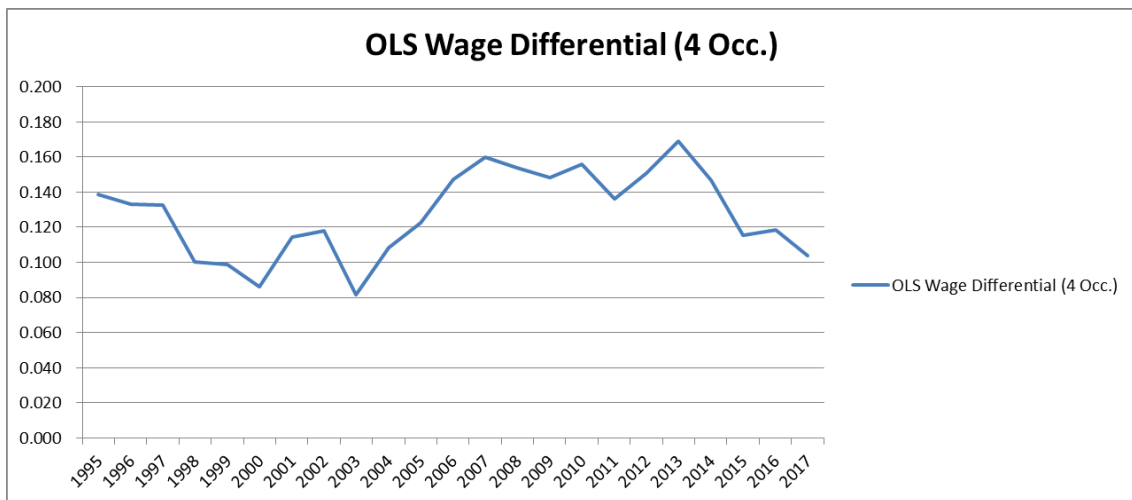
Table 7: Differences in Coefficients of inverse Mills ratio, Year-by-Year, Each Sector

	Federal IMR Coefficient	Private IMR Coefficient	Difference
1995	0.147	0.262***	-0.114
	(0.096)	(0.044)	(0.124)
1996	0.180	0.296***	-0.116
	(0.133)	(0.041)	(0.123)
1997	0.256**	0.418***	-0.162
	(0.119)	(0.041)	(0.139)
1998	-0.148	0.376***	-0.524**
	(0.201)	(0.046)	(0.211)
1999	-0.083	0.205***	-0.288
	(0.210)	(0.043)	(0.188)
2000	-0.399***	0.402***	-0.801***
	(0.132)	(0.044)	(0.171)
2001	0.116	0.510***	-0.394***
	(0.085)	(0.042)	(0.131)
2002	0.025	0.253***	-0.228***
	(0.084)	(0.039)	(0.086)
2003	0.108	0.300***	-0.192
	(0.104)	(0.047)	(0.122)
2004	0.297***	0.352***	-0.056
	(0.108)	(0.043)	(0.121)
2005	0.123	0.286***	-0.163
	(0.150)	(0.043)	(0.144)
2006	0.005	0.225***	-0.221*
	(0.125)	(0.043)	(0.127)
2007	0.093	0.235***	-0.142
	(0.100)	(0.046)	(0.111)
2008	-0.066	0.196***	-0.262***
	(0.083)	(0.045)	(0.072)
2009	-0.115	0.182***	-0.297***
	(0.106)	(0.047)	(0.107)
2010	-0.006	0.373***	-0.379**
	(0.130)	(0.049)	(0.145)
2011	0.232**	0.199***	0.032
	(0.097)	(0.045)	(0.121)
2012	0.009	0.176***	-0.167
	(0.134)	(0.046)	(0.159)
2013	-0.017	0.133***	-0.150
	(0.104)	(0.044)	(0.112)
2014	-0.237	0.075	-0.162
	(0.222)	(0.084)	(0.181)
2015	0.153	0.208***	-0.055
	(0.118)	(0.046)	(0.122)
2016	-0.062	0.249***	-0.311**
	(0.114)	(0.047)	(0.116)
2017	-0.089	0.156***	-0.245**
	(0.132)	(0.048)	(0.101)

Note: standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1

Source: Current Population Surveys

Table 8: Differences in Coefficients of inverse Mills ratio, Year-by-Year, Each Sector, 4 Occupations

	Federal IMR Coefficient	Private IMR Coefficient	Difference
1995	0.117	0.153**	-0.036
	(0.119)	(0.044)	(0.117)
1996	0.314*	0.268***	0.046
	(0.161)	(0.060)	(0.148)
1997	0.353**	0.331***	0.022
	(0.158)	(0.063)	(0.214)
1998	0.036	0.087	-0.050
	(0.215)	(0.073)	(0.252)
1999	-0.287	0.080	-0.367
	(0.288)	(0.063)	(0.509)
2000	-0.387***	0.253***	-0.640***
	(0.136)	(0.063)	(0.220)
2001	0.157	0.434***	-0.277**
	(0.106)	(0.055)	(0.140)
2002	0.093	0.177***	-0.084
	(0.099)	(0.056)	(0.088)
2003	0.087	0.389***	-0.301**
	(0.114)	(0.065)	(0.118)
2004	0.290**	0.360***	-0.070
	(0.119)	(0.061)	(0.151)
2005	0.220	0.206***	0.014
	(0.158)	(0.062)	(0.196)
2006	0.013	0.151**	-0.138
	(0.126)	(0.061)	(0.110)
2007	0.097	0.138**	-0.041
	(0.099)	(0.063)	(0.114)
2008	-0.091	0.212***	-0.302***
	(0.095)	(0.058)	(0.098)
2009	-0.126	0.161**	-0.288***
	(0.128)	(0.065)	(0.105)
2010	0.059	0.405***	-0.347**
	(0.156)	(0.069)	(0.147)
2011	0.231**	0.149**	0.082
	(0.106)	(0.061)	(0.101)
2012	-0.049	0.176***	-0.225*
	(0.149)	(0.064)	(0.134)
2013	-0.021	0.181***	-.203*
	(0.108)	(0.058)	(0.112)
2014	-0.388	-0.020	-0.368*
	(0.237)	(0.107)	(0.192)
2015	0.100	0.226***	-0.127
	(0.117)	(0.062)	(0.169)
2016	-0.042	0.197***	-0.239**
	(0.126)	(0.064)	(0.120)
2017	-0.088	0.091	-0.180
	(0.145)	(0.064)	(0.116)

Note: standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1

Source: Current Population Surveys

Table 9: Wage Differential using Heckman Selection Model, Year-by-Year, CPS ORG

	Wage Differential (Heckman)
1995	0.131***
	(0.021)
1996	0.129***
	(0.018)
1997	0.101***
	(0.020)
1998	0.048**
	(0.025)
1999	0.034
	(0.029)
2000	0.079***
	(0.019)
2001	0.082***
	(0.015)
2002	0.079***
	(0.015)
2003	0.118***
	(0.019)
2004	0.099***
	(0.016)
2005	0.133***
	(0.015)
2006	0.154***
	(0.015)
2007	0.158***
	(0.017)
2008	0.148***
	(0.015)
2009	0.152***
	(0.017)
2010	0.161***
	(0.017)
2011	0.158***
	(0.018)
2012	0.155***
	(0.021)
2013	0.177***
	(0.019)
2014	0.124**
	(0.050)
2015	0.112***
	(0.016)
2016	0.138***
	(0.019)
2017	0.125***
	(0.018)

Note: standard errors in parentheses*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Source: Current Population Surveys

Table 10: Wage Differential using Heckman Selection Model, Year-by-Year, 4 Occupation, CPS ORG

	Wage Differential(Heckman, 4 Occupation)
1995	0.146***
	(0.018)
1996	0.143***
	(0.017)
1997	0.144***
	(0.018)
1998	0.101***
	(0.023)
1999	0.097***
	(0.018)
2000	0.084***
	(0.017)
2001	0.112***
	(0.012)
2002	0.118***
	(0.012)
2003	0.080***
	(0.014)
2004	0.105***
	(0.014)
2005	0.122***
	(0.016)
2006	0.147***
	(0.013)
2007	0.160***
	(0.014)
2008	0.154***
	(0.012)
2009	0.146***
	(0.015)
2010	0.156***
	(0.014)
2011	0.140***
	(0.015)
2012	0.150***
	(0.020)
2013	0.170***
	(0.019)
2014	0.153***
	(0.043)
2015	0.112***
	(0.017)
2016	0.123***
	(0.016)
2017	0.110***
	(0.017)

Note: standard errors in parentheses*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Source: Current Population Surveys

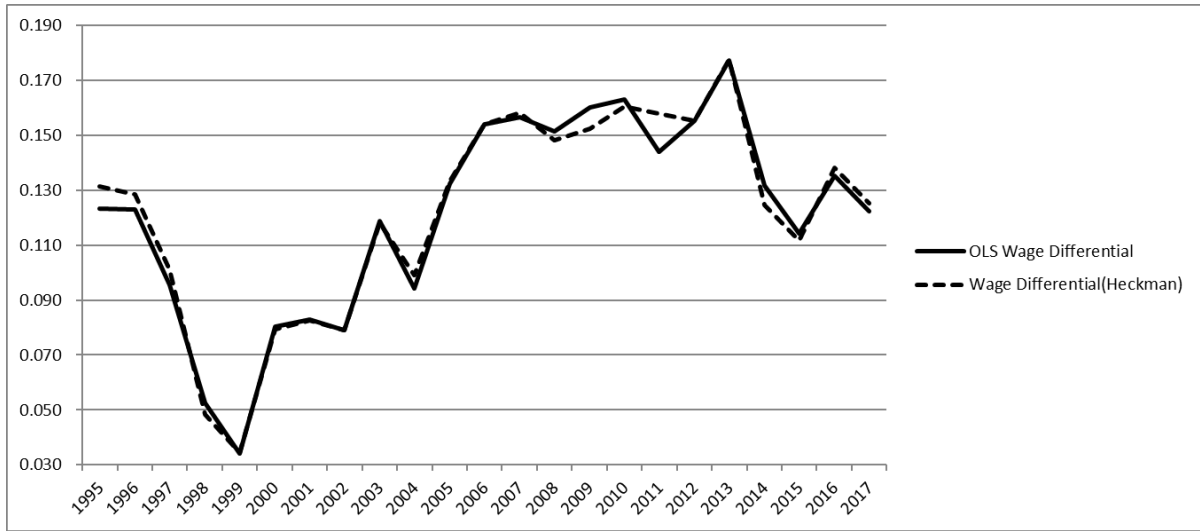**Figure 5: Comparing Wage differentials (OLS vs. Heckman)**

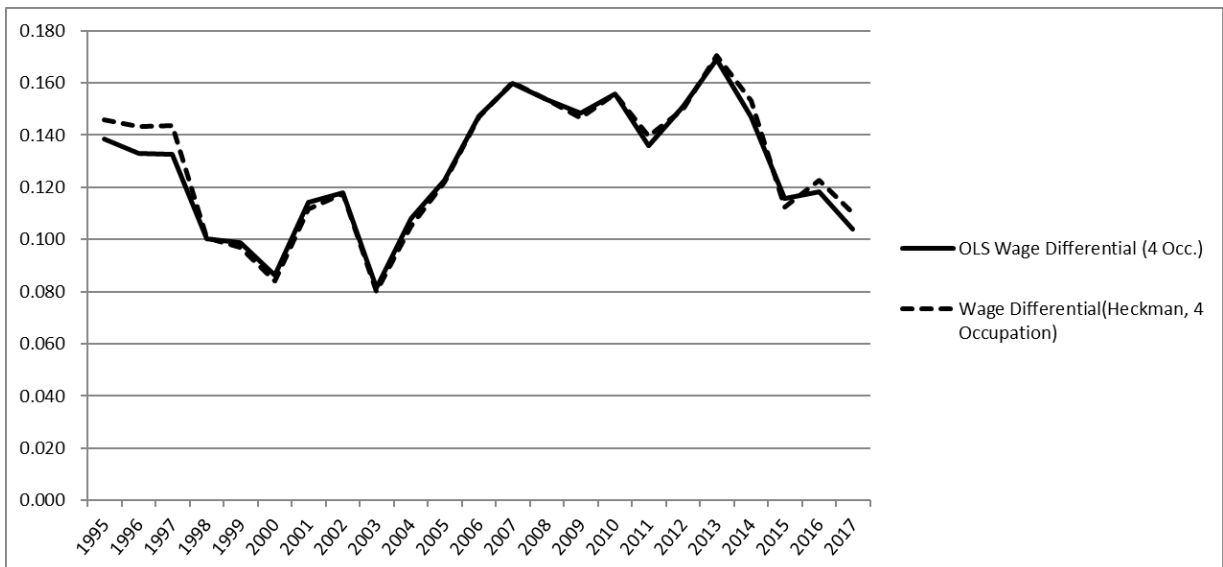**Figure 6: Comparing Wage differentials (OLS vs. Heckman, 4 Occupation)**

Table 11: Fringe Benefit Differential from Probit model

	Pension Plan	Health Insurance
1995	0.252***	0.095***
	(0.032)	(0.023)
1996	0.291***	0.087***
	(0.034)	(0.024)
1997	0.263***	0.029
	(0.036)	(0.029)
1998	0.260***	0.058**
	(0.036)	(0.028)
1999	0.214***	0.002
	(0.037)	(0.031)
2000	0.134***	-0.003
	(0.036)	(0.028)
2001	0.182***	0.064***
	(0.026)	(0.016)
2002	0.193***	0.055***
	(0.026)	(0.017)
2003	0.244***	0.019
	(0.025)	(0.019)
2004	0.208***	0.047**
	(0.026)	(0.019)
2005	0.250***	0.064***
	(0.032)	(0.024)
2006	0.189***	0.034
	(0.032)	(0.026)
2007	0.233***	0.094***
	(0.032)	(0.024)
2008	0.204***	0.041
	(0.033)	(0.028)
2009	0.259***	0.057**
	(0.032)	(0.027)
2010	0.262***	0.102***
	(0.030)	(0.024)
2011	0.296***	0.109***
	(0.031)	(0.025)
2012	0.238***	0.062**
	(0.033)	(0.028)
2013	0.255***	0.099***
	(0.032)	(0.026)
2014	0.246***	-0.020
	(0.030)	(0.029)
2015	0.268***	-0.043
	(0.032)	(0.030)
2016	0.224***	0.050*
	(0.031)	(0.027)
2017	0.222***	-0.036
	(0.032)	(0.030)

Note: standard errors in parentheses*** $p<0.01$, ** $p<0.05$, * $p<0.1$
Source: Current Population Surveys

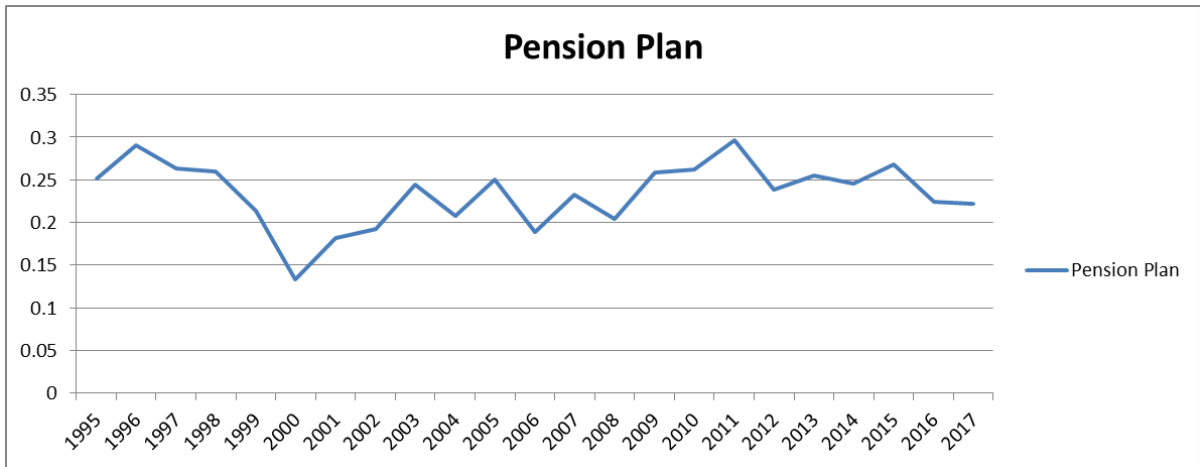**Figure 7: Trend of Pension Plan Differentials, Year-by-Year, March CPS**

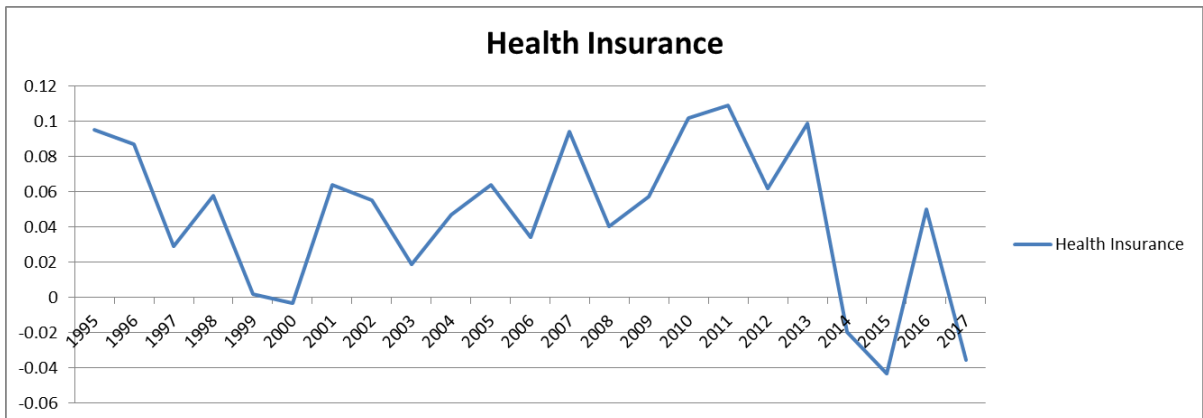**Figure 8: Trend of Health Insurance Differentials, Year-by-Year, March CPS**

Table 12 : Time series analysis of Wage Differentials

	Specification 1		Specification 2	
	All	**4 Occ.**	**All**	**4 Occ.**
	Coef.	**Coef.**	**Coef.**	**Coef.**
Unemployment Rate (Age 25~54)	-0.003	0.001	-0.011	-0.005
	(0.006)	(0.006)	(0.008)	(0.009)
Fed. Spending to GDP	0.017***	0.007	0.025**	0.013
	(0.005)	(0.006)	(0.011)	(0.009)
Bush			0.034**	0.005
			(0.014)	(0.013)
Obama			0.011	-0.004
			(0.024)	(0.021)
Trump			-0.014	-0.036*
			(0.025)	(0.020)
Constant	-0.196**	-0.009	-0.337*	-0.109
	(0.076)	(0.083)	(0.171)	(0.138)

Note: Huber/White robust standard errors in parentheses , *** p<0.01, ** p<0.05, * p<0.1