The Labor Market Effects of Occupational Licensing in the Public Sector

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ABSTRACT

Occupational licensing is much more prevalent in the public sector in the U.S. relative to the private sector, but the influence of occupational regulation for these workers has not been analyzed in detail. Our study initially examines the influence of occupational licensing on the choice of working in the public sector. We next examine how licensing impacts key labor market outcomes, such as wages, hours worked and employment in the public sector. Our results show that having an occupational license increases the likelihood of working in the public sector. After adjusting the selection bias of choosing into the public sector, we found that being in a licensed occupation in the public sector raises wages by about 6 percent, increases hours worked, but reduces employment, even when controlling for other labor market institutions that also are more prevalent in the public sector such as unionization status. Overall, our estimates suggest that the social welfare effects of licensing in the public sector is similar to that for the whole sample, and it generally results in a welfare loss in this sector of the economy.

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1. Introduction

Occupational licensing has become one of the most important labor market institutions influencing wages and employment in the U.S. For example, occupational licensing has grown from less than 10 percent of the workforce in the 1970s to approximately 25% of U.S. workers that have attained an occupational license from government in order to work for pay. (Kleiner and Krueger, 2010, Cunningham, 2019). The influence of occupational licensing in the public sector may be different for several reasons. First, the percentage of workers who are licensed in the public sector is twice as high as in the private sector (Cunningham, 2019). Second, there are often differences in the methods of wage and hours setting as well as employment in the public and private sectors. (Freeman and Valletta, 2007). Third, job stability and duration of employment is higher in the public sector relative to the private sector resulting in differing characteristics of the workers. Consequentially, there may be differences in the influence of major labor market institutions such as occupational licensing in the public and private sectors. In this study we provide the first in depth analysis and develop models of the role of individuals in their choice of employment in the public or private sectors by their regulatory status. We also examine how occupational licensing influences key labor market outcome variables in the public sector and compare them to the private sector. Finally, we provide estimates of the welfare effects of occupational licensing in the public sector and compare them to results for the whole sample.

As background, there are differences in the process and outcomes of wage and employment determination in the public and private sectors. For example, average wages for public sector workers were $22.55 at the state government level and $22.33 at the local government level compared with that of $21.55 in the private sector (Gittleman and Pierce,

2011). One potential reason for this wage gap is that decision-making on government employment and wages takes place partially in a political setting, but private sector outcomes occur in more of a market environment. More specifically, the decision makers are politicians and bureaucrats in the public sector versus the owners of capital in the private sector (Gregory and Borland, 1999). Given these differences in the methods of wage setting in the sectors, the role of occupational licensing may also have differential effects. Public sector wage and employment setting may respond differently to the regulatory constraints imposed by occupational licensing.

1.1 Review of the Current Literature

The academic literature has examined both the demand and supply implications of the labor market effects of licensing (Bryson and Kleiner, 2020). Kleiner and Krueger (2010) find that licensing generates around a 15% wage premium while not significantly reducing wage dispersion for licensed workers; they further demonstrate even bigger wage effects of 23% when interacted with union effects (Kleiner and Krueger, 2010). Gittleman et al. (2018) find a wage premium of around 5% using Survey of Income and Program Participation (SIPP) data which uses somewhat different questions than the ones asked in other surveys, and they also conclude that licensing is associated with higher probabilities of being employed and receiving health insurance from employers. Blair and Chung (2019) show that licensing reduces equilibrium labor supply by an average of 17% to 27% by estimating market share ratios; and Kleiner and Soltas (2019) find that licensing raises wages and hours but reduces employment by similar percentages. Johnson and Kleiner (2020) show that occupational licensing reduces interstate migration, while Kleiner and Xu (2020) show that licensed workers have lower cross occupational mobility. Han and Kleiner (2021) demonstrate that the duration of the licensing

statute and grandfathering of previously unregulated workers into occupational licensing are positively associated with wage growth but in a nonlinear manner.

In the reduced form estimates between the public and private workers, the literature generally finds that public sector employees generally have a wage premium. However, the wage effect is larger at the federal level but is smaller or even negative at the state and local level (Krueger and Summers, 1988; Belman and Heywood, 1989; Venti and Smith, 2008). When comparing both the wages and benefits between workers in the public and private sectors, public sector workers have higher compensation than private-sector ones. Heywood (1991) finds that working in the public sector increases the probability of an employee's having pension plan, life insurance, sick leave and vacation leave in their compensation; and Gittleman and Pierce (2011) finds ambiguous wage only effects of being in the public sector, but positive overall compensation effects of working in the public sector. The comparisons of earning distributions between the two sectors finds a pattern of higher earning dispersion for private sector employees (Katz and Krueger, 1991; Poterba and Rueben, 1994), while the effects on employment are inconclusive (Gregory and Borland, 1999).

When describing the labor market institution of licensing and its effect on the labor market, it is useful to compare it to the other major labor market institution of unionization. Unions have organized almost 40 percent of the public sector but only 6 percent of the private sector (Hirsch and Macpherson 2003). Like licensing, union workers are paid more than non-union workers and they could restrict labor supply and can negotiate for higher wages through collective bargaining process. Lewis (1986) finds a union wage premium of 20% in 1976. Hirsch and Macpherson (2003) examine the union wage advantage in the public sector and finds that the hourly pay of unionized government workers is 8% higher than that of nonunionized government

workers. This union wage advantage for private-sector workers is 9 percentage points higher than the wage advantage for union workers in the public sector (Hirsch, 2013). Union workers also enjoy a greater variety and higher overall level of fringe benefits. Budd (2004) found that union members are 31 percentage points and 25 percentage points more likely than their nonunion counterparts to have pension and health insurance coverage. More recent work by Knepper (2020) found that newly certified unions increase pension contributions more than wages. Like licensing, unions are associated with generally higher pay and benefits, but the differential is greater in the private sector relative to the public sector.

1.2 Contributions of the Paper

The contributions of this paper is that we are the first paper to look at occupational licensing in the public and private sectors by first analyzing licensing's effects on worker's public or private sector choices and then analyzing licensing's effects on labor market outcomes while controlling for the selection into the sector. Second, we have developed a comprehensive sample from the Current Population Surveys (CPS), covering years of observations from 2015-2021. This was the period that the CPS has included the three new questions relating to occupational licensing. In addition, we use the licensing indicator and labor market outcomes using the imputation strategy developed in Kleiner and Xu (2020).[2] The analysis provides new evidence on the literature of the labor market effects of licensing and their differences in the public and private sectors.

We use propensity score matching (PSM) to match individuals by a series of observable characteristics, adopt a probit maximum likelihood procedure, and find that licensing is

[2] The imputation methods are not perfect, and the authors followed the descriptions in the appendix of Kleiner and Xu (2020) to construct our own cleaning codes. We are responsible for any possible imputation errors that might occur.

positively associated with the probability of choosing to work in the public sector in our preferred specification. To be more specific, licensed workers are about 3.9% more likely to select into the public sector. In order to correct for the selection into different sectors, we adopt a two-stage estimation procedure, and find that overall, for the whole sample, licensing has a positive wage effect, and licensed workers have a wage premium of around 6.5%. Further, occupational licensing increases total weekly hours for workers by 4.3% and reduces employment by around 31.5%. This is consistent with Blair and Chung (2020) and Kleiner and Soltas (2019). Using sub-sample analysis, we find that licensing in the public sector increases wages by 6.4%, raises weekly hours worked by 5%, but reduces employment by 23%. The sub-sample results not only serve as a robustness check for our whole sample, but it can also shed light on licensing's effects in the public sector alone. We also use other methods, including instrumental variable approach (Kleiner and Soltas 2019), as well as using different datasets from SIPP to test the robustness of our results.

Our paper proceeds as follows. Section 2 presents theoretical models of sector choice into the public and private sector, which we use as one of the foundations for our empirical analysis. Section 3 explains the datasets used in the analysis. Section 4 outlines the empirical methodology adopted in analyzing different effects. Section 5 describes the baseline results. Section 6 emphasizes on the breakdown of licensing's effects in the public sector by federal, state and local level, the heterogeneous effects of licensing across different occupational groups, and the union effects. Section 7 presents the robustness checks of our results. In Section 8 we summarize, conclude and present some of the limitations and further research directions of this study.

2. Theoretical Framework

2.1. Probability of Public Sector Choice

We develop a model that posits public sector workers chose sectors where employment risk is lower than the private sector. We specify a simple dynamic model of discrete occupational choice to demonstrate how licensing would affect workers' choice into public and private sector occupations. On one hand, the insurance mechanism of the public sector has made the job security in this sector higher compared with its private counterpart (Rodrik 1997). Therefore, public sector workers are assumed to be more risk averse individuals compared with private sector workers; and individuals with higher degrees of risk aversion will have a higher tendency of selecting into the public sector when holding other factors constant. The probit analysis in Bellante and Link (1981) has provided supporting evidence for this hypothesis. On the other hand, due to the "barrier to entry" aspects of occupational licensing, it can be hypothesized that people who are more risk averse will select into licensing because workers in licensed occupations enjoy job security and economic rents due to tougher entry requirements that restrict the supply of labor (Kleiner 2006). This hypothesis has been found in Gittleman et al. (2018) which provides evidence that licensed individuals have a higher probability of being employed. Therefore, assuming workers prefer employment to unemployment, risk aversion could be measured by licensing status.

Our model takes the form of the occupational choice approach in Lang and Palacios (2018). The difference lies within the risk aversion parameter. Lang and Palacios (2018) use three constructed questions to measure the level of risk-aversion of people who are in the sample, while we will use licensing as an indicator for risk averse individuals. Also, Lang and Palacios (2018) allows for transitions between sectors, but we do not relax our model for this assumption.

We further assume workers will decide each year among working in the public sector, working in the private sector, or not to be employed to maximize their expected lifetime discounted utility. We expect that risk-averse individuals will sort into the public sector, since private sector is based on performance pay or pay at risk, and public sector has less variable pay and more job security. We also use licensing as a proxy for the measure of the risk-aversion parameter based on the assumption that individuals who choose licensed occupations are choosing these occupations based on lower risk compared with the non-licensed workers (Gittleman, et.al. 2019)

We assume that individual i in period t has different utility functions in different sector d, and the utility functions take the general form as below:

$$V_t^d = (U_{it}^d, \delta, E[V_{t+1}])$$

Where V_t^d is the utility function for workers, U_{it}^d is the individual's utility function in different sectors, δ is the discount factor, and since we assume individuals are forward looking, we will consider the effects of their sector choices on their future earnings.

We let the one-period utility function take a quadratic function in earnings:

$$u(w) = aw - Lw^2$$

where $a > 2bw$. If we assume the distribution of the taste shock has a normal distribution with variance of σ_ξ^2, the expected utility becomes as below:

$$E(u) = aE[w] - L(E[w])^2 - b\sigma_\xi^2$$

The equation shows that the utility is increasing at a decreasing rate with the expected earnings and decrease with the variance, which meets the concavity definition of risk aversion. Here L is our measure of licensing and it can capture whether the worker is risk averse.[3]

For U_{it}^{d}, we add socio-demographic controls which does not allow for transitions between sectors. Consequently, the utility function in each state d depends on the sector variables $s_{it} = \{\bar{Z}_{it}^{d}, \xi_{it}^{d}\}$ is described as below:

$$U_{\mathrm{it}}^{d}(s_{it}) = u\left(d, \bar{Z}_{it}^{d}\right) + \xi_{it}^{d}$$

using the utility function, we defined above, it becomes as below:

$$U_{\mathrm{it}}^{d}(s_{it}) = \beta_{u1} E\left[w_{it}^{d}\right] + \beta_{u2}^{d}\left(E\left[w_{it}^{d}\right]\right)^{2} + \beta_{u3}^{d} z_{it} + \xi_{it}^{d}$$

where $E\left[w_{it}^{d}\right]$ is the expected earnings; z_{it} is the worker characteristics of choice. We do not consider the utility of non-employment.

The time periods in this model are finite, starting from time t (normally at age 16) through the retirement age of T (normally at age 64). Taking the time periods into consideration, the choice-specific value function is as below:

$$V_{t}^{d}(s_{it}) = \begin{cases} U_{it}^{d} + \delta E\left[V_{t+1}\left(s_{i,t+1}\right) \middle| s_{it}, d_{it} = d\right] & if\ t < T \\ U_{it}^{d} & if\ t = T \end{cases}$$

We assume that the distribution of ξ_{it}^{d} follow an extreme value type I, using backward induction calculation the probability of choosing occupation d in period t takes a logit form:

[3] Although it does not correspond to a standard coefficient of absolute or relative risk aversion

$$P(d_{it} = d|\bar{Z}_{it}, \beta_u) = \frac{\exp(v_{it}^d)}{\sum_d \exp(v_{it}^d)}$$

where v_{it}^d is the expected choice-specific value.

Although solving this discrete choice dynamic programming model in general equilibrium is out of the scope of this paper. The implication from this model is that the probability of choosing private-sector jobs require larger positive shocks compared with choosing public-sector jobs. The theoretical implications raised in this model will be evaluated empirically in the rest of this paper.

2.2. Economic Model for Occupational Licensing

Bryson and Kleiner (2019) use an adapted licensing model in the context of a labor demand and supply side approach adapted from Kleiner and Soltas (2019), which is also shown in Figure 1. Occupational licensing influences the economic welfare through its impact on the supply of workers and demand for the services of certain occupations. In Figure 1, the supply curve is shifting to the left from S to S' and the quantity of services supplied changes from q to q' due to licensing, meaning that occupational licensing is restricting the supply of the labor market by establishing the "barrier to entry" as discussed in the above section, and only individuals who can meet the licensing requirements from the government can work in the occupation. Therefore, non-qualified workers are blocked out of the labor market, resulting in the reduction in the labor supply and the supply-side deadweight loss as marked in blue shades. On the demand side, occupational licensing is shifting the demand curve to the right from D to D', consequently the price of the services is increasing from p to p'. In the model this is as a result of the perceive quality of services that result from licensing. Therefore, practitioners' increased

inputs into occupational licensing are transformed into higher prices for the services (higher wages for the practitioners) and resulting in a market surplus as shown in the red shaded area. The supply side reduction in the quantity of services is a welfare loss, while the demand side increase in the prices is regarded as a welfare benefit. The total welfare effects of licensing would depend on the magnitude of the deadweight loss caused by the supply-side shift and the market surplus caused by the demand-side shift. We do not derive the general equilibrium parameters for both two models but we mainly use the theoretical models as a guide for our empirical analysis.

3. Data

In this section, we describe the datasets used in our empirical analysis and the data cleaning and sample selection criteria. One of the biggest challenges in analyzing the effects of labor market institutions such as occupational licensing has been the lack of a comprehensive and consistent national dataset (Gittleman et al., 2018). New questions which address important licensing aspects has recently been added to the CPS, which provides the primary dataset for our analysis.

The Current Population Survey (CPS) is a monthly representative dataset in the US which interviews households following a 4-8-4 pattern (Flood et al., 2017). The 4-8-4 pattern refers to that household will first be interview for 4 months, then it will rotate out of the interviewing sample for 8 months, then comes back for another 4 months of interviews. There is a distinction between sample month (mish) and interview month (month). For example, in CPS, "month 5" refers to the calendar month of when the household is interviewed, while "mish 5" refers to the fifth month the household is in the sample, which may not necessarily be the same as the calendar interview month of the household. Starting in January 2015, the licensing

questions were first asked, which helps form the licensing indicator in our sample. Detailed income questions are asked in the sample in months 4 and 8 in the outgoing rotation group (ORG), and this helps us construct data on labor market outcomes in the sample. The three questions asked about occupational licensing in the CPS are: 1. Do you have a currently active professional certification or a state or industry license? 2. Were any of your certifications or licenses issued by the federal, state, or local government? 3. Is your certification or license required for your job? In 2015, the questions are asked in every month, but starting 2016, they are only asked in sample months 1 and 5. Also, the third question is added in 2016 and is not asked in 2015. To develop our licensing indicator, we say that an individual is licensed if he/she answers "yes" to both of the first two questions, following the convention in the literature.[4] We use the measure of licensing attainment rather than coverage by a licensing statute.[5]

The sample covers 2015 to 2021 of employed workers ages 16-64. It excludes self-employed workers, members of the armed forces and individuals who are unpaid family workers. In order to develop consistent measures in the CPS, we adopt the imputation methods described in Kleiner and Xu (2020) and construct two CPS datasets with different sample month observations. First, we keep worker observations from mish 4 and 8 since these two months have the most accurate measure of wage and hours. We then impute some of the inaccurate licensing status using licensing indicator information from mish 1 and 5. Conversely, we keep workers in mish 1 and 5 with the most accurate licensing indicator and use the wage and hours information

[4] Another way to form the licensing indicator is to think that an individual is licensed if he answers "yes" to all 3 of the questions. But this might be too strict of a standard. Also, since the third question is only asked since 2016, using this criterion will reduce our sample size as well. This indicator can be used as a robustness check for our results.

[5] Gittleman and Kleiner (2016) has used the indictor of licensing coverage to estimate wage effects by mapping the six-digit SOC codes to their corresponding 2000 Census codes in a given state's licensing requirements. Han and Kleiner (2021) also uses licensing coverage as their main treatment variable.

in mish 4 and 8 to match with individuals in mish 1 and 5. We use months 4 and 8 sample to deliver our baseline results. For top-coding issues relating to wage and hours, we follow Autor et al. (2008) to winsorize top-coded earnings and usual weekly hours above 100.[6]

Our baseline sample contains 807,918 observations of 382,970 unique individuals in 442 occupations based on 2010 Census categories. Table 1 shows that the licensing rate in the sample is around 15% and the mean of the real hourly wage of the sample is around $27. These findings are consistent with the literature (Kleiner and Krueger, 2013; Blair and Chung, 2019; Kleiner and Soltas, 2019).

4. Empirical Identification Strategy

4.1 Probability of Sector Choice

One of the main objectives of this paper is to analyze how licensing would affect the outcomes for public and private sector workers. As we have shown in our theoretical section, licensing serving as risk-aversion parameter, would impact worker's choice into the public or private sector. Therefore, we will first start by examining how the probability of an individual choosing into public and private sector can be affected by licensing. The basic linear probability regression is as below:

$$Y_{it} = \beta_0 + \beta_1 L_{it} + \epsilon_{it} \quad (1)$$

where the outcome Y_{it} here indicates the sector choice of specific individuals at year t, and $Y_{it} = 1$ if individuals select into the public sector and 0 otherwise. L_{it} is the licensing indicator and

[6] We also redo the ORG earning's weight by dividing it by 12 because the earner weight is gathered from 12 months from the 2 rotations which two were originally weighted to give a full sample (Autor et al., 2008); and we weight the CPS sample weight with usual hours of work since it can give a better representation of the dispersion of wages for every hour worked in the labor market (Dinardo, Fortin and Lemieux, 1996). All of the wages are adjusted based on CPI factor from BLS.

equals 1 if the individual is licensed as previously discussed in the data and 0 otherwise. The last term ϵ_{it} is the unobservable.

This linear probability model has a couple of issues. First, there may be other factors in the error term that are affecting the outcome. For example, females may prefer the more secure working environment in the public sector more than males, and they might select into the public sector without going through licensing. Similarly, individuals with higher levels of education may select into the public sector because of either more altruistic or meaningful personal achievement associated with public services. If these selection issues were to occur, the coefficient on the licensing variable will be biased. The second issue is that the treatment of licensing is not random. For example, people with higher education may select into licensing since they might be more capable of passing all licensing requirements and exams. Another example would be that in Kleiner and Soltas (2019), they find that workers bare a significant amount of the costs of licensing. As a result, those who evaluate these costs to be greater than the benefits associated with licensing might select away from being in the licensed occupations.

Therefore, we adjust the linear probability model by adding more controls for individual characteristics as well as occupation, state, and year fixed effects. We also implement a propensity score matching strategy (PSM) to get a more balanced distribution between licensed and unlicensed workers. The PSM model specification is as below:

$$Y_{it} = \beta_0 + \beta_1 L_{it} + X_{it}\gamma + \alpha_s \times \mu_o + \theta_t + \epsilon_{it} \quad (2)$$

As discussed in (1), L_{it} is the licensing indicator, and β_1 is our main parameter of the effect of licensing on the probability of being in the public sector. X_{it} is a vector of individual characteristics in time t including age (and age-squared), experience (and experience-squared),

gender, race, education, log wage, region, marital, citizen, union, veteran, and metro status. $\alpha_s \times \mu_o$ denotes the state-by-occupation fixed effects;[7] and θ_t is the year fixed effects. For PSM, we first match individual characteristics on the probability of being licensed, and then we use the generated score as weights in the above linear probability regression.

Beyond the PSM, we also adopt the bound estimate for selection on unobservables approach from Oster (2019), which builds upon Altonji, Elder and Taber (2005) in estimating bound treatment effects to help solve for selection on unobservables. The essence of this method is using bounding to replace the unknown terms with feasible values that can minimize/maximize the average treatment effect. In order to achieve this, several assumptions are needed to tighten the bounds. The first assumption is that the importance of selection on observables equals to that of the selection on unobservables; and the second is to define R_{max} as the R^2 from the regression as if we did observe the unobservables.

4.2 Licensing Effects on Wages and Hours Worked Between Sectors

Next, we turn to the effect of licensing on wage and total hours worked changes for workers in different sectors. Our theory in section 2.1 implicated that the probability of choosing private-sector jobs require larger positive shocks comparing with choosing public-sectors jobs using licensing as an indicator for risk aversion. Although we do not use maximum likelihood estimators to solve the dynamic choice model in that section, we alternatively use regression

[7] Occupational fixed effect includes 22 occupational categories defined based on 2010 Census classification scheme. The 22 occupational categories include: 1. Management in Business, Science, and Arts; 2. Business Operations and Financial Specialists; 3. Computer and Mathematical; 4. Architecture and Engineering; 5. Technicians; 6. Life, Physical, and Social Science; 7. Community and Social Services; 8. Legal; 9. Education, Training, and Library; 10. Arts, Design, Entertainment, Sports, and Media; 11. Healthcare Practitioners, Technicians and Support; 12. Protective Service; 13. Food Preparation and Serving; 14. Building and Grounds Cleaning and Maintenance; 15. Personal Care and Service; 16. Sales and Related; 17. Office and Administrative Support; 18. Farming, Fisheries, and Forestry; 19. Construction and Extraction; 20. Installation, Maintenance, and Repair; 21. Production; 22. Transportation and Material Moving.

analysis and show that there is a positive selection into the public sector for licensed worker compared with unlicensed ones. This means that licensed workers are normally risk averters since licensed jobs, due to the associated entry requirements, can be more reliable compared with unlicensed jobs. The fact that licensed workers tend to select into the public sector shows that public sector workers are risk averters while private sector workers are risk takers. With this kind of selection in place when we examine licensing's effects on labor market outcomes in the public sector. Consequently, OLS will generate a downward bias for the estimates.

Therefore, we use the two-stage correction procedure developed by Heckman (1979) to account for selection bias into the public and private section. In the first stage, we use a probit version of the probability equation in *4.1*. Then we use the predicted values from this first-stage regression to calculate the inverse mills ratio, which can be considered as the transformation of the predicted individual probabilities of being in the public sector. Then we can run the second-stage regression of our preferred specification defined below, including the inverse mills ratio as a control to account for selection issues and to uncover the true average treatment effect. An important condition for Heckman procedure to work is the exclusion restriction, that there needs to be at least one covariate that is in the first-stage regression but is not in the second-stage regression. Here, we use metro status as the exclusion variable, meaning we include metro status variable in the first stage probit regression, but we do not include it in the second-stage linear labor regression.

To test for the effects of licensing and sector on wages and total hours usually worked, we estimate the following regression model based on equation (2) by changing the dependent variable and main independent variables:

$$Y_{it} = \beta_0 + \beta_1 L_{it} + \beta_2 S_{it} + X_{it}\gamma + \alpha_s \times \mu_o + \theta_t + \epsilon_{it} \quad (3)$$

Where Y_{it} is the labor market outcome of interest (either log of wages or total hours worked), L_{it} is still the licensing indicator; S_{it} is the sector indicator and equals 1 if the individual is in the public sector. As above, X_{it} is a vector of individual characteristics, including the inverse mills ratio defined above; $\alpha_s \times \mu_o$ is the state-by-occupation fixed effects; and θ_t is the year fixed effects. We use the PSM score as weights in these estimates as well.

We choose not to use interaction term between license and public; instead, we use a sub-sample analysis in order to find the differential effects of licensing and sector choice. We use six subsamples, including public licensed vs. public private, licensed public vs. licensed private, unlicensed public vs. licensed private, private licensed vs. private unlicensed, unlicensed public vs. unlicensed private, and licensed public vs. unlicensed private. The results from the subsamples can not only reveal some of the differential effects of licensing in different sectors, but they can also serve as robustness checks for the baseline results derived from the whole sample.

5. Baseline Results

5.1 Descriptive Statistics

In this section we will explain the baseline results shown in Table 1-5. We will start with the descriptive statistics displayed in Table 1. For the full sample, the licensing and public sector has similar means, with 14% of the workers are employed in the public sector and around 15% are licensed workers. The biggest education category is high school graduate in the entire sample of around 27%, and there are 24% individuals who have a bachelor's degree. Only 12% of the workers have graduate degrees. The sample is mainly composed of white (77%), and 18% of the entire sample are of Hispanic origin. The marital status and sex are balanced for the entire

sample, and the mean person in the sample is someone who is around 40 years old and has about 20 years of experience. The results in the sample show that the average person, usually works around 42 hours per week and their average real hourly wage adjusted based on the 2015 dollar value is around $27. Only 11% workers in the entire sample are members of labor unions.[8]

Not only do we show the statistics for the full sample, but we also present two types of comparisons in the descriptive statistics: 1. comparisons between licensed and unlicensed groups and 2. comparisons between the public and private sector. In the licensed group, 27% work in the public sector, while only 12% of the workers in the unlicensed group work in the public sector. Licensed workers generally have higher educational levels, with most of them having a bachelor's degree or more, while unlicensed individuals have a much higher percentage of high school graduates. There are more married females who are older and who are also union members in the licensed group, and regulated workers on average earn $7.59 more per hour and work around 2 hours more per week compared with unlicensed workers. Twenty-one per cent of unionized workers are in the licensed group, and the value is about twice as high as those in the whole sample of 11% unionized workers.

Similar trends have been found when comparing the public and the private sector. In the public sector, twenty nine percent of the workers are licensed, which is more than twice the private sector value of thirteen percent. Public workers have higher educational levels relative to private sector workers. The demographics of the public sector show that there are more women (57%) and married workers (61%). However, public sector employees work about 0.82 less hours per week than private sector workers, but the mean workers in both sectors still work full

[8] This is about the same as national estimates.

time of over 40 hours per week. Finally, 37% of public workers are in the unions, but the percent of union members in the private sector is only 7%.

The public sector has considerable heterogeneity among the federal, state, and local governments and, disaggregating these sectors allows to examine labor market outcomes in more detail. Figure 2 shows that Federal government employees are paid significantly more relative to workers in other sectors (of around $38 per hour). Private nonprofit workers on average are the second highest paid category, with an hourly wage around $30. State government workers are paid slightly more than private for-profit workers but less than private nonprofit workers, and local government workers are paid the least at around $26.73 per hour. We also show total weekly hours usually worked for employees in the three government sectors compared with their private counterparts. Federal workers still have the highest weekly working hours on average, while private nonprofit workers on average work much less weekly compared with all the other sectors. But for all of these sectors, the mean total weekly hours worked are over 40 hours per week.

Table 2 shows the estimated annual population employment for selected occupations in two groups: the high state variation group and the low state variation group in terms of licensing attainment. Low state variation in licensing attainment means that most of the states in the U.S. would require by law to either license/unlicensed the occupation, while the high state variation means that different states have different laws regarding whether a certain occupation needs to be licensed. One example is the dispensing opticians, because only 22 states in the U.S. would require the practitioners to have a license in this occupation, while for lawyers it is a universally licensed occupation, and every state would require the practitioners to acquire a license in order to practice. These occupations are also chosen based on the occupational ranks by their

treatment-effect weights as described in de Chaisemartin and D'Haultfoeuille (2019), where they propose a method of calculating the implicit weights on potentially heterogeneous treatment effects by occupation in the two-way fixed effect estimator. This will be discussed more in depth in Section 6. We can see that social worker is an occupation that is rather balanced between workers working in the public or private sector, most workers (74%) are not licensed as social workers, and a total of around 2.5 million workers are working in this occupation. Only 9000 workers are working in as brokerage clerks, and this is a private-sector only occupation. Teachers are included here because based on the implicit weights, this occupation supposedly has large heterogeneous treatment effects, and the annual estimated employment is around 14 million, and teachers are balanced in both licensing and sector choice.[9] For economists, the total estimated annual employment is only around 73,000, and this is almost an entirely not licensed occupation.

5.2 Probability of Sector Selection Regression Results

Table 3 shows the results from estimating equation (2). The dependent variable is the probability of one choosing the public sector, and A-E are five different specifications. Column A is basically the estimation of equation (1); column B adds some of the individual characteristics as control variables such as wage, education, sex, and race; column C further adds other controls into the equation; column D adds occupation and state interaction fixed effects and column E adds the year fixed effects. All the specifications include PSM weighting. Across the four specifications, licensing positively affects one's probability of choosing the public sector, with the magnitude of this positive effect keeps decreasing when adding more controls and

[9] Teachers here include multiple occupations and levels of teachers, ranging from postsecondary teachers to special education teachers.

weights. Column E is our preferred specification in this case since it has the highest R-squared and the most comprehensive set of controls. From this result, we can conclude that licensing can increase one's likelihood of working in the public sector by around 3.91%, holding all else constant; and this effect is significant at 99% confidence level.

We also report both the bound estimates of the coefficient under the first assumption described above, and the relative importance of the selection on observables and selection on ubonservables (δ). Following Oster (2017), we choose the value of R_{max} to be R^2 from the fully controlled model times 1.3, and we also choose the value of 0.7 and 1 to add to the robustness of the bound estimates. The results are included in the fully controlled specification under column E, with the higher bounds being the coefficient from the fully controlled model, and the lower bounds being the calculated coefficients using different values of R_{max} and under the assumption of $\delta = 1$. Using the R_{max} of being 0.47 in the first case, the value of δ is 4.51, meaning that the selection on unobservables (such as social values and job satisfaction) associated with being in the public sector must be around 4.5 times more important than the selection on observables for the causal effect of licensing on the probability of being in the public sector to be zero. When increasing the value of R_{max}, the value of δ decreases, and only in the most restrictive case of $R_{max} = 1$ we find that the bound of coefficients start to cover 0. This suggest that our baseline probability results are robust to potential unobservables.

In sum, licensing would yield a positive effect on one's probability of working in the public sector. This result is in accordance with our hypothesis described in Section 2, that licensing can be used to measure one's risk aversion, and licensed individuals are more risk averse. As a result, they will be more likely to select into the public sector.

5.3 Wage and Total Hours Worked Results

Table 4 displays the estimation in equation (3), with the outcome Y_{it} being the log of hourly wage, total weekly hours usually worked, and employment separately in panels A, B and C. The specifications from A-E are the same as described in Section *5.2*, and specification E has the most comprehensive set of controls and thus is our preferred specification. In Table 4, we can see that licensing is associated with a wage premium. Licensed workers on average earn 6.5 log points more compared with unlicensed workers, and this is in accordance with the common findings in the literature; that a worker with a license tends to enjoy a wage premium ranging from 5% to 15% (Kleiner and Krueger, 2013). However, when it comes to the sector comparisons, the private sector employees tend to enjoy a wage premium. From Table 4, shows that public workers earn 4.9 log points less than those in the private sectors. This is contrary to some of the literature and might be due to the over generalization of the public-sector definition. In terms of total hours worked and the employment, licensing increases total weekly hours worked by 4.3 log points, and it decreases employment by around 31.5 log points, which is similar to the estimates in Kleiner and Soltas (2019) of around 29%. Working in the public sector has significant impacts on either hours worked, but the magnitude of this effect is less than 1 log point, and it does not have a significant impact on the employment. The effect of unions on labor market outcomes is similar to occupational licensing, with union workers enjoying a wage premium of 7.3%, union workers work 8.4% more weekly compared with non-union workers, and union has a negative employment effect of around 23%.

In column E we also report the bound estimates of the effect of the main treatment indicator of licensing. we keep adding the control variables from specification A to E, and we conduct the calculation of bounding coefficients under the assumption of $\delta = 1$ and different values of R_{max}.

Still, the R^2 gradually increases as we keep adding more controls, but the magnitude and sign on the coefficients do not follow a regular pattern as those in Table 3. The bound and δ estimates are in column E. In panel A, we can see that licensing has a positive effect on wages, and licensed workers on average earn 6.5% more compared with unlicensed workers. Using the R_{max} being 0.4 in the first case, the value of δ is -16.63, meaning that the selection on unobservables (such as innate ability of the individuals) associated with wage outcome must be around 16 times more important than the selection on observables for the causal effect of licensing on log of hourly wages to be zero. All three bounds for the coefficient estimates do not cover 0, but when increasing the value of R_{max}, the value of δ decrease. In the most extreme cases of $R_{max} = 0.7$, the δ is still around 4, which shows that our results do not suffer from selection on unobservables. Union workers have a slightly larger wage premium of 7.3% compared with licensed workers, while public sector workers earn around 5% less than private sector workers. Panel B reports the labor market outcome effects of log of total weekly hours worked. Licensed workers, in general, work 4.3% more compared with unlicensed workers, and based on the bound estimate, this result is robust if we choose the $Rmax$ to be 1.3 times the R-squared from the controlled regression, and the selection on unobservables ((such as individuals' motivation at work) need to be 6 times more significant compared to the selection on observables for the effect of licensing on weekly hours worked to be zero. For workers in the public sector, they work 0.8 percentage point less than private sector workers, and union workers work 8.4% more per week compared with nonunion workers. For panel C, in order to attain an estimate for employment from CPS data, we conduct the regression at the state-occupation cell level, and therefore no individual covariates are included in this panel. Based on the result, we conclude that for the entire sample, licensing has a negative impact on employment of around 31.5%; working in the

public sector does not have any significant impact on employment; and similar to licensing, union has a negative impact on employment, but the magnitude is smaller than licensing of around 23%.

In table 5-10 we examine six sub-group comparisons for licensing's effects on labor market outcomes, they include licensed public vs. licensed private, public licensed vs. public unlicensed, unlicensed public vs. licensed private, private licensed vs. private unlicensed, unlicensed public vs. unlicensed private and licensed public vs. unlicensed private. However, our focus in this study is licensing's labor market effects in the public sector, therefore, Table 6 contains our main results, which compares the outcomes between the licensed and unlicensed workers in the public sector. We find that licensing in the public sector generally yields a 6.4% wage premium, and this effect is almost the same as the overall licensing wage effect (6.5%). Also comparable to the effects of licensing in the whole sample, licensing in the pulic sector increases weekly hours worked by 5% and reduces employment by 23%. Union effects in the public sector are also comparable to that in the whole sample, with positive wage and hours worked effects and negative employment effect. All of the bounds do not cover 0 and when taking less restrictive value of R_{max}, the value of δ is okay for the labor market outcomes effect not to be zero.[10] Therefore, not only can we conclude that our analysis passes the sub-sample heterogeneity robustness analysis check, but we also find some implications for licensing's labor market effects in the public sector.

Table 11 further separates the public sector into federal and state and local sectors and test for the probability of licensed workers selecting into these sectors. The estimates show that

[10] Although with R_{max} equals to 0.37 in panel A, δ is only 1.32, but this still shows that the unobservables in this case must be 1.32 times more important than the observables for the wage effect to be zero.

licensed workers are 1.7% less likely to select into the federal sector compared with unlicensed workers, while the licensing effect for selecting into the state and local government sector is still positive of around 7.5%, which is higher than the probability of licensed workers selecting into the entire public sector.

Table 12 looks at the licensing effects on labor market outcomes by separating the public sector into detailed sub-sectors, and it can be seen that working in both the federal sector as well as in the state and local sector in general has positive effects on both wages and hours worked. Federal workers in the licensed group earn 4.8 log points more and work around 4 log points more compared with unlicensed workers. These effects have higher magnitudes in the state and local government sector, with state and local workers in the licensed group earn 7.5 log points more and work 4.2 log points more compared to their unlicensed counterparts. Licensing does not have significant impact on employment in the federal sector, but it has a significant impact on state and local sector employment at around 28.7%. Working in the federal sector has a positive wage effect of 9%, does not have significant impact on weekly hours worked, and it is positively affecting the employment, with the effect of being around 44.48%. However, working in the state and local sector has negative wage effect of 8.7%, a negative effect on weekly hours worked (but also less than 1%), and no statistically significant effect on as well as employment.

Because licensing serves as a barrier for new workers entering the occupation, there are potentially monopoly rents in wages for the existing workers. Licensed state and local sector workers earn even higher rents compared with unlicensed workers, implying that being in this sector increases the monopoly power of licensing. This is plausible because of the way licensed practitioners can create monopolies through their power to set licensing requirements for practitioners. The licensing requirements for occupations are mostly set at the state-level

licensing boards, therefore adding to the monopoly power of licensing. Working in the public sector has a negative effect on wages for the whole sample, but when we break down the public sector into sub-sectors, the federal sector has a positive wage effect of around 9%, while the state and local sectors have a negative wage effect of around 8.7%. This indicates that by only looking at the subsectors, different sector has different market power. For the federal government, since it has the highest bureaucratic power, it is possible that in industries or occupations relating to federal public utility services such as public roads, water supply, etc., te federal workers will have monopoly powers due to the lack to competitions. For the state and local sector, from the findings in Gregory (1999), the negativity of the wage effect can be ascribed to the monopsony power existing in this level of the public sector. Examples would be that in a small local geographical area, there would be few options apart from employment in a specific public sector occupation such as teachers, and this would give the state and local sector employees some level of monopsony power. This also indicates that by looking at the whole sample altogether, we might overlook some heterogenous effects existing in different industry/occupation level. Section 6 intended to take a deeper look at this.

6. Heterogeneous Occupational Effects

In this section, we examine how licensing's effects differ across different occupational groups. We are still estimating the baseline specification of equation (2) and (3), but this time separating different sub-samples of occupational groups combined using 2010 Census codes as well as by chosen specific occupations. Before we explain the results for the heterogeneous effects, first we will look at some descriptive figures. Figure 3 illustrates licensing and sector percentages by occupational categories, showing that the health-related and legal occupations have the highest licensing rates. This is as expected because these two groups contain many

universally licensed occupations such as lawyers and doctors.[11] The least licensed occupational group is building and grounds cleaning and maintenance. Most individuals who are in the protective services and social science and services groups are public sector workers, and most of the workers in the sales and production groups are in the private sector. This demonstrates a little about the profit-maximizing attribute of the private sector (and conversely the profit non-maximization of the public sector). Figure 4 shows the mean labor market outcomes by occupational groups. The trends are similar for the hourly wages and total hours usually worked per year, suggesting that those who earn the most work the most.[12] Not surprisingly, workers in the legal, architecture and engineering, computer and mathematical, and management groups earn the most, and they also work the most hours. Individuals in food preparation and serving, building and grounds cleaning and management, and personal care and services earn and work the least. Table 13 further demonstrates the mean descriptive statistics by combined occupations, with the percentages of licensed, unlicensed, public and private sector works shown for each occupational subgroup. We can see that the most licensed categories are still healthcare and legal practitioners. The least licensed categories are computer and mathematical as well as production occupations.

Based on the descriptive statistics, we select six groups to be in our heterogenous effects analysis (marked as blue in Table 13), including: 1. Life, Physical, and Social Science; 2. Community and Social Services; 3. Legal; 4. Education, Training, and Library; 5. Protective Service; 6. Personal Care and Service. The results are in Tables 14 through 17. Table 14 shows that in most of the occupational subgroups, licensing still have significant impact on the

[11] Some paper excludes the universally licensed occupations from the sample, but we did not do that in this paper.

[12] Here we choose to report the total yearly hours worked per year to see the differentials among heterogenous occupations, since total weekly hours worked would not be too much different among these occupations (they would be similar around 40 hours per week).

probability of choosing into the public/private sectors, although for some of the subgroups, the sign for the probability has changed to negative compared with our main results. For occ1 and occ2, licensing does not significantly impact people's sector choices. Based on the selection results, we continue Tables 15 through 17 about the labor market outcome effects. In table 15, the wage effect of licensing in occupational groups match with what we have found in our baseline results. For occ2, occ3 and occ4, licensing has positive significant effect on wages, while for other occupational groups, the effect of licensing on wage are not significant. This is in accoradance with our baseline results. For the effect of working in the public sector, there are mixed signs. For life, physical and social sciences and legal workers, the wage effect is negative for public sector workers and private sector workers have a wage premium. However, for community and social services as well as protective services workers, they would earn more if they choose to work these occupations in the public sector. The contradictory results might be due to the heterogeneous characteristics of these occupations. For example, protective services occupation is mostly a public-sector occupation, therefore, the public sector might have a monopoly power in this occupation for the workers to have a wage premium. Similarly for the community and social services occupations, although most of the workers in these occupations are still working in the private sectors, government plays a significant role in social-work related occupations. Therefore, there can also exit governmental monopoly power in this occupational group, making the public sector workers earn a wage premium. In Table 16, for both licensing and sector's effects on total weekly hours worked, there are mixed evidence of this effect on different occupational groups. Similar mixed employment effects have also been found in Table 17 for licensing and working in the public sector.

In Table 18-19, we further break down the occupational groups to specific occupations, and these occupations are selected based on Appendix Table A6 in Kleiner and Soltas (2019), in which they report the implicit weights attached to the regression associated with different occupations using the method described in de Chaisemartin and D'Haultfoeuille (2019).[13] Three of the occupations are chosen from panel A of most influential occupations to empirical identification, and three of the occupations are chosen from panel B of most overweighted occupations. Supposedly, the panel A occupations are the ones that will generate the most heterogenous effects when estimating the labor market outcomes, and the occupations in panel B would not have much heterogenous effects. In Table 18 we report the wage effect. We can see that there are only significant effects on the first two occupations of teachers and social workers, which are also panel A occupations. The effects of licensing on wages for these two occupations are similar to our baseline estimates, and licensed teachers earn 5.5% more than unlicensed ones, and licensed social workers have a wage premium of around 8%. For the other occupations, there are no significant effect of licensing on wages (probably due to the small sample size when we break down to specific single occupation), but the signs for the coefficient are mostly positive. In table 19, the significant licensing effects on total weekly hours worked for teachers and bus and ambulance drivers and attendants still correspond to our baseline results, that licensing has a positive effect on hours worked. For both wage and hours worked effects for sector choice and union, there are mixed evidence on their effects on these two outcomes. Due to the fact that the employment variable is estimated at the state by occupation cell level, we are not able to report the employment effects for single occupations here. By looking at the labor market outcomes in

[13] The underlying implication of this method is that if the implicit ratio calculated from the implicit weights are not very large, then the two -way fixed effect estimated treatment effects are not robust to the heterogenous effects exist over time or across group.

the sub-group occupations as well as in specific single occupations, we confirm the robustness of the main licensing effects; however, due to the mixed evidence existing in the sector choice and union effects, we acknowledge the fact that there might be heterogenous effects over time or across group; for further studies, method such as the one in de Chaisemartin and D'Haultfoeuille (2019) can be used to account for this.

7. Robustness Check

In our bassline estimates, we have accounted for the endogeneity in sector choice. Another potentially important problem which might cause concerns is that licensing, as a proxy for the risk-aversion parameter, is not exogenous to the outcome variables as well. Licensed workers may be individuals who have higher abilities and motivations, and they will be more likely to earn more, and work more compared with unlicensed workers. Also, for our baseline estimates, we only use the sample from CPS to derive our results. This section intends to adopt the instrumental variable approach method to tackle the endogeneity problem; we will also use another sample from a different survey to repeat our empirical practice. By doing this, we intend to check the robustness of our baseline results.

7.1 Instrumental Variable Approach

The first method we adopt is the instrumental variable approach, and this is a good method when correcting for selection bias in estimates. Because our licensing indicator might be endogenous with our outcome variables in question, we need to find a variable that can purge the effect of the correlation between licensing and the unobservables. We need to find a variable that have influence on our treatment indicator of licensing without directly affecting any of the outcome variables. Following Kleiner and Soltas (2019), we use the percent of workers who are

licensed in their specific occupation and state group as the instrumental variable. In theory, the share would not have direct impacts on outcome variables such as wages, and it is directly related with licensing. We first regress the state-occupation licensed share on licensing, and we recover the residual from this first-stage regression to replace the treatment indicator in our specified second-stage regression. Now the residual is supposed to be cleansed of the effects of unobservables on treatment.

The results are shown in Table 20, with (1) being the effect of licensing on the probability of being in the public sector, (2) being the effect of licensing and public on log wages, and (3) being the effect of licensing and public on total hours worked. Because we are using license share at the state and occupational level as our instrumental variable, we are unbale to estimate the employment effects. Panel A reports the results for the whole sample. Compared our baseline results, the probability coefficient has similar signs and significance. However, the magnitude for licensing's effect on sector choice is significantly higher, from 4% in baseline estimates to 15% here. The effects on wages in general has the same sign as the baseline results, but the magnitudes also increase significantly. Licensed workers earn 16.6 log points more and work 23.6 log points more compared with unlicensed workers; while public workers earn 11 log points less hourly and work 4 log points less weekly compared with their private counterparts. Panel B reports the sub-sample estimates for licensing's effects on wages and hours worked in the public sector. Similarly, the signs are the same as our baseline sub-sample estimates in the public sector, and the magnitudes of the coefficients here are larger. The table includes the Cragg-Donald Wald F statistics for all three specifications and both of the two panels, and the statistics reject the null hypothesis of weak instrument.

7.2 SIPP Results

In this sector we conduct the robustness check using a different sample from Survey of Income and Program Participation (SIPP) data, which is a nationally representative longitudinal survey of the United States. In this survey, respondents would answer a core group of questions every 4 months about the preceding 4 months, and the questions include detailed monthly information such as wages, demographics, etc. Occupational licensing information is derived from the 2008 panel Wave 13 and 2014 panel Wave 1-4 of the SIPP since they include the Professional Certifications, Licenses and Educational Certificates modules in these periods. Our licensing indicator is based on respondents' response to the following questions: "Do you have a professional certification or state or industry license? Who awarded this certification or license? Is this certification or license required for your current or most recent job?" If the respondents answer "yes" to the first question and answer federal, state or local government to the second question, we believe that the respondent is licensed. Similar to CPS, we are measuring licensing attainment here.

The descriptive statistics for SIPP data are shown in Table 20 and they are comparable to that of CPS. For the full sample, 10% workers are working in the public sector and around 18% are licensed workers (slightly higher than that in CPS). The biggest education category is still high school graduate in the entire sample of around 33%, and there are 25% individuals who some college. Only 3% workers have graduate degrees, which is way lower compared to that in the CPS (12%). The sample is mainly composed of white (79%), and 21% of the entire sample are of Hispanic origin. An average person in the sample is someone who are around 38 years old, have about 18 years of experience, who usually works around 34 hours weekly and whose average hourly wage is around $15 The mean hourly wage is also significantly lower comparing

with that in the CPS ($27). Again, only 11% workers in the entire sample are members of labor unions. Around 14% of the licensed individuals are in the public sector while for unlicensed group this figure is only 9%. Again, licensed workers generally have higher educational levels, and licensed workers on average earn $5.59 more per hour compared with unlicensed workers. 25% of the public workers are licensed, while only 18% of the private workers are unlicensed. Public workers have higher educational level compared with private sector workers, and public workers on average only earn $2.46 more per hour compared with private workers. In the SIPP sample, public workers do not work significantly more than private sector workers weekly.[14]

The sector choice and labor market outcomes are shown in Table 22-24. We can see that in the SIPP sample, licensing is still positively associated with selecting into the public sector, but the magnitude of this coefficient drops from around 4% in the CPS to 1.6% in SIPP. The wage effect for licensing is still positive and almost twice as large compare with that in the CPS (around 11%), and this effect becomes insignificant in the sub-sample results by comparing licensed and unlicensed workers in the public sector alone.[15] In both the whole and sub sample using the SIPP data, we do not find any significant effect of licensing on hours worked and employment.[16] We can conclude that, the SIPP sample does not generate contradictory results for the labor market effects of licensing.

[14] There are no comparable veteran status variable in panel 2014, therefore, veteran status is not included as a control in the SIPP sample.

[15] This might be due to the small sample size associated with the public sector in the SIPP data using the panels and waves selected. The sample size is only around 4000.

[16] For employment effect of licensing, when we use 2008 Wave 13 panel alone, the sign of the employment coefficient is negative, but still not significant even at 10% level.

8. Conclusion

We have examined the effects of licensing on sector choice; and using the sector choice to correct for the endogeneity of worker's selection into public/private setors, we further examined how licensing can affect the labor market outcomes both as a whole and in the public sector alone. We find that licensing is 4% positively associated with the probability of one choosing to work in the public sector. After controlling for this selection, licensing overall has positive wage and hours effect, with licensed workers earning 6.5% more and working 4.3% more weekly than their unlicensed counterparts. Public sector membership generally has a negative wage effect, and individuals in the public sector on average earn 4.9% less compared with individuals in the private sector. Unionization has a larger wage premium of 7.3% and union workers work 8% more weekly compared with non-union workers. For employment effect, licensing in general reduces employment by 31.5% while union reduces employment by a lesser extent of around 23%. For licensing's effect in the public sector, we find that licensing has a similar wage premium of 6.4% and slightly larger hours effect of 5%. Licensing's employment effect in the public sector is relatively smaller (23%).

When thinking of the welfare effects of licensing in the public sector, suppose that the entire 6.5% wage premium for licensing in the public sector is from market power, and further assume that labor supply is perfectly elastic and the labor demand elasticity is 0.5 (Hamermesh, 1993). For May 2018, the total licensing workforce in the public sector is around 6.4 million and the average annual earning is around $50,000 (BLS 2018). Therefore, the annual cost to the public of licensing in the public sector = [$50,000 – ($50,000 / 1.061)] x 6.4 million = $18 billion. The percent change of the welfare effects for licensing in the public sector = welfare

benefit - welfare loss = (1+6.09%) x 5.2% - 28.33% = -23%. In general, licensing in the public the public sector will result in a 23% of welfare loss for the whole society.[17]

From our robustness check, we have found that our baseline results for licensing's effects on labor market outcomes are robust among the methods adopted and sample selected. There exists some mixed evidence for the labor market effects of sector choice and unionization, and there maybe a couple of reasons for this. First, as described in Ramoni-Perazzi and Bellante (2006), the CPS data is too heterogenous to be used to compare wages across sectors. Therefore, when the labor market outcomes are not comparable, it is hard for our estimates to yield consistent robust results. One possible solution is to combine CPS data with other datasets to generate more controls to make the individuals in the sample more comparable. An example would be in Kleiner and Xu (2020), they use O*NET[18] to construct cognitive, manual, and interpersonal skills requirements for each occupation as controls. Other empirical identification can be adopted to look at this issue as well (de Chaisemartin and D'Haultfoeuille, 2019). Another limitation lies within the fact that we have found robust and positive effect of licensing when selecting into the public sector and somewhat proves the risk aversion of workers who choose to be in the public sector. However, the alternative interpretation is not completely ruled out, that employers in the public sector prefer to hire more risk averse workers. More than this, we do not consider the nonpecuniary job benefits such as job injury rate and job satisfaction, and this can affect worker's choices into desirable working environments. Lastly, we look at only wage differential without including fringe benefits, and compensation gains may be more readily seen for benefits than for wages (Hirsch, 2013), and including them could possibly change the

[17] The models of welfare analysis are consistent with Summers, 1989; Chetty, 2009; and Kleiner and Soltas, 2019.

18 O*NET is called Occupational Information Network, which is a database describing occupations in terms of skill or knowledge requirements and worker practices.

signs of our wage effects. The empirical results thus raise some further questions: how would licensing causally affect wage distributions and employments across sectors; how the effects of licensing and sector choice would individually and interactively be on compensations and nonpecuniary job benefits; what policy implications these empirical results would generate. These are all the questions that need to be answered in further research on this topic.

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Table 1. Selected Descriptive Statistics, 2015-2021 CPS

	By Licensing			By Sector		
	Full Sample	Licensed	Unlicensed		Public	Private
Public	0.14	0.29	0.71	Licensed	0.27	0.73
Private	0.86	0.13	0.87	Unlicensed	0.12	0.88
Licensed	0.15	-	-			
Unlicensed	0.85	-	-			
Education Category				*Education Category*		
Less than high school	0.08	0.02	0.10	Less than high school	0.02	0.09
High school graduate	0.27	0.14	0.29	High school graduate	0.18	0.28
Some college	0.18	0.13	0.19	Some college	0.16	0.18
Associate degree	0.10	0.15	0.10	Associate degree	0.11	0.10
Bachelor's degree	0.24	0.28	0.23	Bachelor's degree	0.29	0.23
Graduate degree	0.12	0.28	0.10	Graduate degree	0.25	0.10
Race				*Race*		
White	0.77	0.80	0.77	White	0.76	0.78
Black	0.13	0.12	0.13	Black	0.16	0.13
Asian	0.08	0.07	0.08	Asian	0.06	0.08
Hispanic	0.18	0.11	0.20	Hispanic	0.13	0.19
Personal				*Personal*		
Marital status	0.53	0.62	0.51	Marital status	0.61	0.51
Union status	0.11	0.21	0.10	Union status	0.37	0.07
Female	0.47	0.56	0.46	Female	0.57	0.46
Experience	19.91	20.52	19.80	Experience	22.05	19.55
Age	40.07	42.10	39.71	Age	43.28	39.54
Labor Outcomes				*Labor Outcomes*		
Real hourly wage ($ 2015)	26.87	33.29	25.70	Real hourly wage ($ 2015)	27.86	26.70
Real weekly earning ($ 2015)	987.90	1217.20	946.27	Real weekly earning ($ 2015)	1057.47	976.22
Full-time worker	0.78	0.83	0.78	Full-time worker	0.80	0.78
Total weekly hours worked	41.55	43.29	41.24	Total weekly hours worked	40.85	41.67
Observations	807,918	129,377	678,541	Observations	125,689	682,229

Note: Sample includes individuals aged 16-64, who are not self-employed, not in the armed forces and who are not unpaid family workers. The sample also excludes people with computed hourly wages in the top 1% and bottom 1%. For top-coding issues regarding labor market outcomes, the sample follows Autor et al.(2008) and winsorizes hours, wages and earnings. The real hourly wage and real weekly earnings are in 2015$.

Table 2. Estimated Annual Population Employment

Occupation		% Licensed	% Public
Name	Employment	Mean	Mean
Panel A. High State Variation in Licensing Attainment			
Brokerage Clerks	9,000	15	0
Dispensing Opticians	97,000	28	1
Social Workers	2,500,000	26	49
Fire Inspectors	40,000	35	73
Panel B. Low State Variation in Licensing Attainment			
Teachers	14,000,000	50	60.5
Registered Nurses	6,000,000	75	11
Economists	73,000	1	56
Crossing Guards	110,000	7	54

Note: Sample includes individuals aged 16-64, who are not self-employed, not in the armed forces and who are not unpaid family workers. The sample also excludes people with computed hourly wages in the top 1% and bottom 1%. For top-coding issues regarding labor market outcomes, the sample follows Autor et al.(2008) and winsorizes hours, wages and earnings. The real hourly wage and real weekly earnings are in 2015$. Total employments are estimated from the state-by occupation employment share from the dataset.

Table 3. Control Sensitivity and Treatment Effect bounds—Probability of Sector Choice

	A	B	C	D	E
Variable of Interest					
License	0.0578***	0.0558***	0.0558***	0.0392***	0.0391***
	(0.00727)	(0.00644)	(0.00652)	(0.00277)	(0.00276)
Union	0.417***	0.406***	0.399***	0.308***	0.308***
	(0.0115)	(0.00978)	(0.00980)	(0.00638)	(0.00638)
Bounds and Deltas					
$Rmax = \tilde{R} \times 1.3 = 0.47$					(0.03146, 0.03907), $\delta = 4.51$
$Rmax = 0.7$					(0.01373, 0.03907), δ =1.46
$Rmax = 1$					(-0.01370, 0.03907), δ =0.78
Controls					
Wage, education, sex, race		X	X	X	X
Other controls			X	X	X
Occupation*state, fixed effects				X	X
Year fixed effects					X
PSM Weighting	Yes	Yes	Yes	Yes	Yes
Observations	807,811	807,811	807,811	807,811	807,811
R-squared	0.163	0.201	0.205	0.362	0.362

Note: Date Source: CPS IPUMS. The dependent variable is probability of being in public sector. Other controlled characteristics include age and age-squared, experience and experience-squared, marital status, citizenship, union status, and veteran status. Occupational fixed effects used in the interaction with the state fixed effects are defined by aggregating occ2010 into 22 occupation groups based on IPUMS definition for occ2010. All standard errors are clustered at the state by occupation level.

Table 4. Control Sensitivity and Treatment Effect bounds—Labor Market Outcomes

	A	B	C	D	E
Panel A. Log of Wage					
License	-0.0487***	0.0133	0.0543***	0.0677***	0.0652***
	(0.00882)	(0.00917)	(0.0121)	(0.00887)	(0.00861)
Public	-0.113***	-0.0994***	-0.0920***	-0.0506***	-0.0492***
	(0.00890)	(0.00794)	(0.00788)	(0.00564)	(0.00560)
Union	-0.522***	-0.177***	0.0830*	0.0663*	0.0733**
	-0.0487***	0.0133	0.0543***	0.0677***	0.0652***
Bounds and Deltas					
$Rmax = \tilde{R} \times 1.3 = 0.39$					(0.06518, 0.10624), $\delta = -16.63$
$Rmax = 0.5$					(0.06518, 0.33057), $\delta = -7.45$
$Rmax = 0.7$					(0.06518, 14.53875), $\delta = -3.74$
Observations	807,551	807,551	807,551	807,551	807,551
R-squared	0.068	0.195	0.204	0.289	0.299
Panel B. Log of Total Weekly Hours					
License	0.0329***	0.0249***	0.0301***	0.0427***	0.0428***
	(0.00379)	(0.00334)	(0.00440)	(0.00419)	(0.00418)
Public	-0.00993**	-0.00866**	-0.00758**	-0.00879***	-0.00879***
	(0.00394)	(0.00362)	(0.00360)	(0.00300)	(0.00300)
Union	0.0184***	-0.0252***	0.00884	0.0839***	0.0839***
	(0.00665)	(0.00890)	(0.0189)	(0.0182)	(0.0183)
Bounds and Deltas					
$Rmax = \tilde{R} \times 1.3 = 0.08$					(0.04281, 0.05683), $\delta = 6.29$
$Rmax = 0.5$					(0.04281, 39.96590), $\delta = 0.28$
$Rmax = 0.7$					(0.04281, 60.67866), $\delta = 0.19$
Observations	807,317	807,317	807,317	807,317	807,317
R-squared	0.003	0.030	0.033	0.063	0.063
Wage, education, sex race		X	X	X	X
Other controls			X	X	X
Occupation*state fixed effects				X	X
Year fixed effects					X
Panel C. Log of Employment					
%License					-0.315***
					(0.0922)
%Public					0.0722
					(0.0776)
%Union					-0.228***
					(0.0648)
Clusters					24,374
Occupation, year fixed effects					Yes
PSM Weighting	Yes	Yes	Yes	Yes	Yes
Two-stage Correction	Yes	Yes	Yes	Yes	Yes

Note: Date Source: CPS IPUMS. For Panel A and B, the regression is at individual level. Other controlled characteristics include age and age-squared, experience and experience-squared, marital status, citizenship, union status, and veteran status. Occupational fixed effects in these two panels are defined by aggregating occ2010 into 22 occupation groups based on IPUMS definition for occ2010. For Panel C, the regression is at the state-occupation cell level. Therefore, no individual covariates or other fixed effects are included in Panel C regression, just the normal occupation and state fixed effects. All standard errors are clustered at the state by occupation level.

Table 5. Sub-Sample Bound Estimates for Licensed Public vs. Licensed Private

	A	B	C	D	E
Panel A. Log of Wage					
Licensed Public vs. Private	-0.150***	-0.142***	-0.124***	-0.0505***	-0.0482***
	(0.0127)	(0.0116)	(0.0114)	(0.00849)	(0.00847)
Licensed Union vs. Non-union	-0.458***	-0.177***	0.115*	0.0798	0.0906
	(0.0252)	(0.0343)	(0.0640)	(0.0566)	(0.0552)
Bounds and Deltas					
$Rmax = \tilde{R} \times 1.3 = 0.38$					(-0.04816, 0.00312), $\delta = 0.94$
$Rmax = 0.5$					(-0.04816, 0.07986), $\delta = 0.39$
$Rmax = 0.7$					(-0.04816, 0.21522), $\delta = 0.20$
Observations	129,374	129,374	129,374	129,374	129,374
R-squared	0.077	0.184	0.200	0.280	0.290
Panel B. Log of Total Hours					
Licensed Public vs. Private	0.0117**	0.0142***	0.0166***	0.00852*	0.00843*
	(0.00580)	(0.00525)	(0.00518)	(0.00437)	(0.00437)
Licensed Union vs. Non-union	0.0222**	-0.0298**	-0.00584	0.0633**	0.0632**
	(0.0103)	(0.0132)	(0.0296)	(0.0279)	(0.0280)
Bounds and Deltas					
$Rmax = \tilde{R} \times 1.3 = 0.09$					(0.00730, 0.00843), $\delta = 6.12$
$Rmax = 0.5$					(-0.05232, 0.00843), $\delta = 0.31$
$Rmax = 0.7$					(-0.42487, 0.00843), $\delta = 0.21$
Observations	129,333	129,333	129,333	129,333	129,333
R-squared	0.002	0.027	0.030	0.073	0.073
Wage, education, sex race		X	X	X	X
Other controls			X	X	X
Occupation*state fixed effects				X	X
Year, fixed effects					X
Panel C. Log of Employment					
Licensed %Public					0.125
					(0.0878)
Licensed %Union					-0.303***
					(0.0720)
Clusters					15,967
Occupation, year fixed effects					Yes
PSM Weighting	Yes	Yes	Yes	Yes	Yes
Two-stage Correction	Yes	Yes	Yes	Yes	Yes

Note: Date Source: CPS IPUMS. For Panel A and B, the regression is at individual level. Other controlled characteristics include age and age-squared, experience and experience-squared, marital status, citizenship, union status, and veteran status. Occupational fixed effects in these two panels are defined by aggregating occ2010 into 22 occupation groups based on IPUMS definition for occ2010. For Panel C, the regression is at the state-occupation cell level. Therefore, no individual covariates or other fixed effects are included in Panel C regression, just the normal occupation and state fixed effects. All standard errors are clustered at the state by occupation level.

Table 6. Sub-Sample Bound Estimates for Public Licensed vs. Public Unlicensed

	A	B	C	D	E
Panel A. Log of Wage					
Public Licensed vs. Unlicensed	-0.0587***	-0.00306	0.0503***	0.0650***	0.0641***
	(0.00973)	(0.0106)	(0.0150)	(0.0112)	(0.0109)
Public Union vs. Non-union	-0.446***	-0.117***	0.174***	0.100*	0.114**
	(0.0240)	(0.0330)	(0.0633)	(0.0526)	(0.0514)
Bounds and Deltas					
$Rmax = \tilde{R} \times 1.3 = 0.37$					(0.06412, 0.34491), $\delta = -1.32$
$Rmax = 0.5$					(0.06412, 4.92053), $\delta = -0.53$
$Rmax = 0.7$					(0.06412, 14.58192), $\delta = -0.28$
Observations	125,678	125,678	125,678	125,678	125,678
R-squared	0.066	0.178	0.191	0.276	0.286
Panel B. Log of Total Hours					
Public Licensed vs. Unlicensed	0.0489***	0.0395***	0.0419***	0.0504***	0.0503***
	(0.00401)	(0.00411)	(0.00604)	(0.00567)	(0.00566)
Public Union vs. Non-union	0.00960	-0.0398***	-0.0276	0.0471*	0.0471*
	(0.0101)	(0.0130)	(0.0291)	(0.0271)	(0.0271)
Bounds and Deltas					
$Rmax = \tilde{R} \times 1.3 = 0.10$					(0.05029, 0.08286), $\delta = 1.60$
$Rmax = 0.7$					(0.05029, 75.56798), $\delta = 0.09$
$Rmax = 1$					(0.05029, 114.09790), $\delta = 0.06$
Observations	125,634	125,634	125,634	125,634	125,634
R-squared	0.007	0.029	0.031	0.077	0.078
Wage, education, sex race		X	X	X	X
Other controls			X	X	X
Occupation*state fixed effects				X	X
Year fixed effects					X
Panel C. Log of Employment					
Public %Licensed					-0.229**
					(0.109)
Public % Union					-0.252***
					(0.0666)
Clusters					14,181
Occupation, year fixed effects					Yes
PSM Weighting	Yes	Yes	Yes	Yes	Yes
Two-stage Correction	Yes	Yes	Yes	Yes	Yes

Note: Date Source: CPS IPUMS. For Panel A and B, the regression is at individual level. Other controlled characteristics include age and age-squared, experience and experience-squared, marital status, citizenship, and veteran status. Occupational fixed effects in these two panels are defined by aggregating occ2010 into 22 occupation groups based on IPUMS definition for occ2010. For Panel C, the regression is at the state-occupation cell level. Therefore, no individual covariates or other fixed effects are included in Panel C regression, just the normal occupation and state fixed effects. All standard errors are clustered at the state by occupation level.

Table 7. Sub-Sample Bound Estimates for Unlicensed Public vs. Licensed Private

	A	B	C	D	E
Panel A. Log of Wage					
Unlicensed Public vs. Licensed Private	0.0730***	0.109***	0.113***	0.0558***	0.0523***
	(0.0154)	(0.0148)	(0.0205)	(0.0180)	(0.0176)
Union	-0.512***	-0.249***	-0.133*	-0.134*	-0.126*
	(0.0209)	(0.0307)	(0.0759)	(0.0752)	(0.0741)
Bounds and Deltas					
$Rmax = \tilde{R} \times 1.3 = 0.36$					(-0.29137, 0.05230), $\delta = 0.34$
$Rmax = 0.5$					(-4.52863, 0.05230), $\delta = 0.12$
$Rmax = 0.7$					(-11.95002, 0.05230), $\delta = 0.07$
Observations	182,988	182,988	182,988	182,988	182,988
R-squared	0.058	0.162	0.177	0.263	0.274
Panel B. Log of Total Hours					
Unlicensed Public vs. Licensed Private	0.0331***	0.0242***	0.0408***	0.0507***	0.0511***
	(0.00674)	(0.00588)	(0.00887)	(0.00828)	(0.00825)
	-0.000592	-0.0567***	0.0529	0.0694**	0.0685**
Union	(0.00777)	(0.0146)	(0.0342)	(0.0334)	(0.0334)
Bounds and Deltas					
$Rmax = \tilde{R} \times 1.3 = 0.10$					(0.05111, 0.11752), $\delta = 2.89$
$Rmax = 0.5$					(0.05111, 24.88506), $\delta = 0.17$
$Rmax = 0.7$					(0.05111, 37.65829), $\delta = 0.12$
Observations	182,919	182,919	182,919	182,919	182,919
R-squared	0.003	0.030	0.037	0.079	0.079
Wage, education, sex race		X	X	X	X
Other controls			X	X	X
Occupation*state fixed effects				X	X
Year, fixed effects					X
Panel C. Log of Employment					
%Unlicensed Public vs.% Licensed Private					-0.366***
					(0.0911)
%Union					-0.284***
					(0.0692)
Clusters					18,744
Occupation, year fixed effects					Yes
PSM Weighting	Yes	Yes	Yes	Yes	Yes
Two-stage Correction	Yes	Yes	Yes	Yes	Yes

Note: Date Source: CPS IPUMS. For Panel A and B, the regression is at individual level. Other controlled characteristics include age and age-squared, experience and experience-squared, marital status, citizenship, union status, and veteran status. Occupational fixed effects in these two panels are defined by aggregating occ2010 into 22 occupation groups based on IPUMS definition for occ2010. For Panel C, the regression is at the state-occupation cell level. Therefore, no individual covariates or other fixed effects are included in Panel C regression, just the normal occupation and state fixed effects. All standard errors are clustered at the state by occupation level.

Table 8. Sub-Sample Bound Estimates for Private Licensed vs. Private Unlicensed

	A	B	C	D	E
Panel A. Log of Wage					
Private Licensed vs. Unlicensed	-0.00376	0.0520***	0.0636***	0.0641***	0.0588***
	(0.0129)	(0.0118)	(0.0159)	(0.0140)	(0.0137)
Private Union vs. Non-union	-0.640***	-0.278***	-0.130**	-0.0870	-0.0916
	(0.0160)	(0.0241)	(0.0598)	(0.0585)	(0.0574)
Bounds and Deltas					
$Rmax = \tilde{R} \times 1.3 = 0.44$					(-0.11431, 0.05878), $\delta = 0.47$
$Rmax = 0.7$					(-0.42106, 0.05878), $\delta = 0.28$
$Rmax = 1$					(-5.74341, 0.05878), $\delta = 0.13$
Observations	681,874	681,874	681,874	681,874	681,874
R-squared	0.074	0.222	0.230	0.325	0.335
Panel B. Log of Total Hours					
Private Licensed vs. Unlicensed	0.0113**	0.00655	0.00915	0.0366***	0.0369***
	(0.00547)	(0.00461)	(0.00669)	(0.00626)	(0.00625)
Private Union vs. Non-union	0.0253***	-0.0323***	-0.00667	0.0681***	0.0680***
	(0.00535)	(0.00937)	(0.0269)	(0.0259)	(0.0259)
Bounds and Deltas					
$Rmax = \tilde{R} \times 1.3 = 0.10$					(0.03695, 0.06517), $\delta = -26.04$
$Rmax = 0.5$					(0.03695, 30.60634), $\delta = -1.46$
$Rmax = 0.7$					(0.03695, 47.28218), $\delta = -0.99$
Observations	681,684	681,684	681,684	681,684	681,684
R-squared	0.001	0.039	0.043	0.078	0.078
Wage, education, sex race		X	X	X	X
Other controls			X	X	X
Occupation*state fixed effects				X	X
Year, fixed effects					X
Panel C. Log of Employment					
Private %Licensed					-0.508***
					(0.0891)
Private % Union					-0.156*
					(0.0872)
Clusters					23,271
Occupation, year fixed effects					Yes
PSM Weighting	Yes	Yes	Yes	Yes	Yes
Two-stage Correction	Yes	Yes	Yes	Yes	Yes

Note: Date Source: CPS IPUMS. For Panel A and B, the regression is at individual level. Other controlled characteristics include age and age-squared, experience and experience-squared, marital status, citizenship, union status, and veteran status. Occupational fixed effects in these two panels are defined by aggregating occ2010 into 22 occupation groups based on IPUMS definition for occ2010. For Panel C, the regression is at the state-occupation cell level. Therefore, no individual covariates or other fixed effects are included in Panel C regression, just the normal occupation and state fixed effects. All standard errors are clustered at the state by occupation level.

Table 9. Sub-Sample Bound Estimates for Unlicensed Public vs. Unlicensed Private

	A	B	C	D	E
Panel A. Log of Wage					
Unlicensed Public vs. Private	-0.0435***	-0.0417***	-0.0417***	-0.0284***	-0.0279***
	(0.00949)	(0.00801)	(0.00810)	(0.00700)	(0.00693)
Unlicensed Union vs. Non-union	-0.622***	-0.200***	-0.0773	-0.105**	-0.103**
	(0.0142)	(0.0219)	(0.0549)	(0.0469)	(0.0466)
	-0.0435***	-0.0417***	-0.0417***	-0.0284***	-0.0279***
Bounds and Deltas					
$Rmax = \tilde{R} \times 1.3 = 0.43$					(-0.04986, -0.02794), $\delta = -1.46$
$Rmax = 0.7$					(-0.06830, -0.02794), $\delta = -0.83$
$Rmax = 1$					(-0.12763, -0.02794), $\delta = -0.38$
Observations	678,177	678,177	678,177	678,177	678,177
R-squared	0.062	0.213	0.218	0.318	0.327
Panel B. Log of Total Hours					
Unlicensed Public vs. Private	-0.0304***	-0.0267***	-0.0267***	-0.0110***	-0.0110***
	(0.00360)	(0.00345)	(0.00350)	(0.00345)	(0.00345)
Unlicensed Union vs. Non-union	0.00784*	-0.0272***	-0.00452	0.0693***	0.0693***
	(0.00464)	(0.00896)	(0.0223)	(0.0215)	(0.0215)
Bounds and Deltas					
$Rmax = \tilde{R} \times 1.3 = 0.09$					(-0.01095, -0.00836), $\delta = 3.56$
$Rmax = 0.5$					(-0.01095, 2.42311), $\delta = 0.18$
$Rmax = 0.7$					(-0.01095, 10.34952), $\delta = 0.12$
Observations	677,984	677,984	677,984	677,984	677,984
R-squared	0.002	0.035	0.038	0.072	0.072
Wage, education, sex race		X	X	X	X
Other controls			X	X	X
Occupation*state fixed effects				X	X
Year, fixed effects					X
Panel C. Log of Employment					
Unlicensed %Public					-0.00687
					(0.0846)
Unlicensed % Union					-0.109
					(0.0729)
Clusters					23,992
Occupation, year fixed effects					Yes
PSM Weighting	Yes	Yes	Yes	Yes	Yes
Two-stage Correction	Yes	Yes	Yes	Yes	Yes

Note: Date Source: CPS IPUMS. The dependent variable is probability of being in public sector. Other controlled characteristics include age and age-squared, experience and experience-squared, marital status, citizenship, union status, and veteran status. Occupational fixed effects are defined by aggregating occ2010 into 22 occupation groups based on IPUMS definition for occ2010. All standard errors are clustered at the state level. For Panel A and B, the regression is at individual level; for Panel C, the regression is at state-occupation cell level.

Table 10. Sub-Sample Bound Estimates for Licensed Public vs. Unlicensed Private

	A	B	C	D	E
Panel A. Log of Wage					
Licensed Public vs. Unlicensed Private	-0.156***	-0.0731***	-0.0157	0.0361***	0.0349***
	(0.0106)	(0.0101)	(0.0141)	(0.0105)	(0.0103)
Union	-0.520***	-0.144***	0.172***	0.139***	0.145***
	(0.0198)	(0.0280)	(0.0539)	(0.0434)	(0.0421)
Bounds and Deltas					
$Rmax = \tilde{R} \times 1.3 = 0.40$					(0.03489, 0.04455), $\delta = -3.52$
$Rmax = 0.7$					(0.03489, 0.05432), $\delta = -1.74$
$Rmax = 1$					(0.03489, 0.07446), $\delta = -0.85$
Observations	624,563	624,563	624,563	624,563	624,563
R-squared	0.067	0.202	0.210	0.302	0.311
Panel B. Log of Total Hours					
Licensed Public vs. Unlicensed Private	0.0182***	0.0119***	0.0119**	0.0234***	0.0234***
	(0.00454)	(0.00437)	(0.00543)	(0.00512)	(0.00511)
Union	0.0210***	-0.0220**	-0.0191	0.0779***	0.0781***
	(0.00745)	(0.0101)	(0.0219)	(0.0209)	(0.0209)
Bounds and Deltas					
$Rmax = \tilde{R} \times 1.3 = 0.09$					(0.02288, 0.02343), $\delta = 54.06$
$Rmax = 0.5$					(0.01267, 0.02343), $\delta = 2.51$
$Rmax = 0.7$					(0.00841, 0.02343), $\delta = 1.72$
Observations	624,398	624,398	624,398	624,398	624,398
R-squared	0.004	0.031	0.032	0.066	0.067
Wage, education, sex race		X	X	X	X
Other controls			X	X	X
Occupation*state fixed effects				X	X
Year, fixed effects					X
Panel C. Log of Employment					
%Licensed Public vs. %Unlicensed Private					-0.287***
					(0.0997)
% Union					-0.209***
					(0.0661)
Clusters					23,599
Occupation, year fixed effects					Yes
PSM Weighting	Yes	Yes	Yes	Yes	Yes
Two-stage Correction	Yes	Yes	Yes	Yes	Yes

Note: Date Source: CPS IPUMS. The dependent variable is probability of being in public sector. Other controlled characteristics include age and age-squared, experience and experience-squared, marital status, citizenship, union status, and veteran status. Occupational fixed effects are defined by aggregating occ2010 into 22 occupation groups based on IPUMS definition for occ2010. All standard errors are clustered at the state level. For Panel A and B, the regression is at individual level; for Panel C, the regression is at state-occupation cell level.

Table 11. Licensing Effects by Sectors—Sector Choice

	Probability	
	Federal	State & Local
License	-0.0173***	0.0751***
	(0.00257)	(0.00518)
Union	0.0225**	0.378***
	(0.0114)	(0.0243)
Constant	0.0967*	-0.489***
	(0.0540)	(0.107)
Controls	Yes	Yes
Fixed Effects	Yes	Yes
PSM Weighting	Yes	Yes
Observations	807,811	807,811
R-squared	0.101	0.370

Note: Date Source: CPS IPUMS. Controlled characteristics include age and age-squared, experience and experience-squared, log income, sex, race, education, region, marital status, citizenship, union status, and veteran status. Fixed effects include occupation * state fixed effect and year fixed effect. Occupational fixed effects are defined by aggregating occ2010 into 22 occupation groups based on IPUMS definition for occ2010. All standard errors are clustered at the state level.

Table 12. Licensing Effects by Sectors—Labor Market Outcomes

	Log Wages		Log Hours		Log Employment	
	Federal	State & Local	Federal	State & Local	Federal	State & Local
License	0.0477***	0.0754***	0.0401***	0.0420***	-0.203	-0.287**
	(0.00850)	(0.00852)	(0.00417)	(0.00414)	(0.141)	(0.112)
Federal	0.0901***		-0.00431		0.444***	
	(0.00930)		(0.00398)		(0.123)	
State and local		-0.0870***		-0.00661**		0.0720
		(0.00622)		(0.00303)		(0.0853)
Union	0.0972***	0.0714*	0.0860***	0.0852***	-0.225**	-0.280***
	(0.0374)	(0.0373)	(0.0183)	(0.0183)	(0.103)	(0.0636)
Constant	1.272***	1.450***	3.021***	3.029***	11.92***	12.78***
	(0.178)	(0.178)	(0.0990)	(0.0990)	(0.0574)	(0.0675)
Controls	Yes	Yes	Yes	Yes	No	No
Fixed Effects	Yes	Yes	Yes	Yes	No	No
PSM Weighting	Yes	Yes	Yes	Yes	Yes	Yes
Two-stage Correction	Yes	Yes	Yes	Yes	Yes	Yes
Observations/Clusters	807,551	807,551	807,317	807,317	7,450	12,140
R-squared	0.299	0.301	0.063	0.063	0.940	0.968

Note: Date Source: CPS IPUMS. Controlled characteristics include age and age-squared, experience and experience-squared, log income, sex, race, education, region, marital status, citizenship, union status, and veteran status. Fixed effects include occupation * state fixed effect and year fixed effect. Occupational fixed effects are defined by aggregating occ2010 into 22 occupation groups based on IPUMS definition for occ2010. All standard errors are clustered at the state level.

Table 13. Mean Descriptive Statistics by Occupations

	Licensed	Unlicensed	Public	Private	Observations
1. Management in Business, Science, and Arts	0.12	0.88	0.12	0.88	88,798
2. Business Operations and Financial Specialists	0.13	0.87	0.13	0.87	41,917
3. Computer and Mathematical	0.05	0.95	0.12	0.88	29,445
4. Architecture and Engineering	0.15	0.85	0.11	0.89	15,062
5. Technicians	0.09	0.91	0.13	0.87	3,055
6. Life, Physical, and Social Science	0.14	0.86	0.32	0.68	9,079
7. Community and Social Services	0.25	0.75	0.35	0.65	14,965
8. Legal	0.48	0.52	0.24	0.76	8,146
9. Education, Training, and Library	0.43	0.57	0.61	0.39	47,797
10. Arts, Design, Entertainment, Sports, and Media	0.06	0.94	0.08	0.92	13,435
11. Healthcare Practitioners, Technicians and Support	0.55	0.45	0.10	0.90	60,995
12. Protective Service	0.28	0.72	0.68	0.32	16,936
13. Food Preparation and Serving	0.05	0.95	0.05	0.95	45,225
14. Building and Grounds Cleaning and Maintenance	0.04	0.96	0.14	0.86	28,554
15. Personal Care and Service	0.17	0.83	0.14	0.86	23,565
16. Sales and Related	0.08	0.92	0.01	0.99	78,782
17. Office and Administrative Support	0.06	0.94	0.16	0.84	107,111
18. Farming, Fisheries, and Forestry	0.05	0.95	0.03	0.97	6,654
19. Construction and Extraction	0.11	0.89	0.06	0.94	39,639
20. Installation, Maintenance, and Repair	0.13	0.87	0.08	0.92	28,070
21. Production	0.05	0.95	0.03	0.97	50,497
22. Transportation and Material Moving	0.13	0.87	0.07	0.93	50,190

Note: Date Source: CPS IPUMS

Table 14. Licensing Effects by Occupations—Sector Choice

	Selected Occupations					
	occ1	occ2	occ3	occ4	occ5	occ6
License	0.0380	-0.0346	-0.0640*	0.0293**	-0.100***	-0.0530**
	(0.0360)	(0.0233)	(0.0387)	(0.0149)	(0.0196)	(0.0207)
Union	0.359**	0.199**	0.169	-0.138**	-0.453***	0.352***
	(0.150)	(0.0974)	(0.162)	(0.0564)	(0.0968)	(0.0812)
Constant	1.045	1.779***	1.175*	2.517***	3.062***	0.0441
	(0.739)	(0.519)	(0.675)	(0.277)	(0.494)	(0.394)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
PSM	Yes	Yes	Yes	Yes	Yes	Yes
Observations	9,079	14,965	8,146	47,794	16,935	23,560
R-squared	0.214	0.266	0.158	0.178	0.257	0.179

Note: Date Source: CPS IPUMS. The occupations are: 1. Life, Physical, and Social Science; 2. Community and Social Services; 3. Legal; 4. Education, Training, and Library; 5. Protective Service; 6. Personal Care and Service. Controlled characteristics include age and age-squared, experience and experience-squared, log income, sex, race, education, region, marital status, citizenship, union status, and veteran status. Fixed effects include state fixed effect and year fixed effect. All standard errors are clustered at the state level.

Table 15. Licensing Effects by Occupations—Log of Wages

	Selected Occupations					
	occ1	occ2	occ3	occ4	occ5	occ6
License	-0.0319	0.0976***	0.284***	0.0823***	-0.0276	0.0603
	(0.0541)	(0.0359)	(0.0741)	(0.0159)	(0.0350)	(0.0720)
Public	-0.105***	0.0985***	-0.172***	0.00712	0.217***	0.0223
	(0.0403)	(0.0175)	(0.0581)	(0.0107)	(0.0308)	(0.0251)
Union	-0.154	0.316**	0.625**	0.301***	-0.255	0.372
	(0.230)	(0.153)	(0.281)	(0.0822)	(0.165)	(0.332)
Constant	1.784	-0.000104	-0.738	0.649	3.178***	-0.0779
	(1.103)	(0.768)	(1.410)	(0.410)	(0.861)	(1.448)
Observations	9,079	14,963	8,146	47,787	16,929	23,551
R-squared	0.279	0.185	0.223	0.192	0.223	0.171

Note: Date Source: CPS IPUMS. The occupations are Education, Training, and Library; 5. Protective Service: 1. Life, Physical, and Social Science; 2. Community and Social Services; 3. Legal; 4. Education, Training, and Library; 5. Protective Service; 6. Personal Care and Service. Controlled characteristics include age and age-squared, experience and experience-squared, log income, sex, race, education, region, marital status, citizenship, union status, and veteran status. Fixed effects include state fixed effect and year fixed effect. All standard errors are clustered at the state level.

Table 16. Licensing Effects by Occupations —Log of Total Hours Worked

	Selected Occupations					
	occ1	occ2	occ3	occ4	occ5	occ6
License	0.0306	-0.0410**	-0.00741	0.0637***	0.0381**	0.0503
	(0.0264)	(0.0203)	(0.0273)	(0.00949)	(0.0154)	(0.0755)
Public	-0.0538***	0.0221**	-0.0801***	0.0491***	0.0374**	-0.0107
	(0.0161)	(0.00887)	(0.0115)	(0.00807)	(0.0148)	(0.0259)
Union	0.0881	-0.218**	-0.171	-0.0228	0.00574	-0.0939
	(0.102)	(0.0950)	(0.119)	(0.0411)	(0.0780)	(0.270)
Constant	2.782***	4.697***	4.275***	3.501***	3.925***	4.152***
	(0.533)	(0.504)	(0.599)	(0.243)	(0.436)	(1.511)
Observations	9,079	14,960	8,146	47,756	16,926	23,538
R-squared	0.066	0.049	0.082	0.055	0.083	0.068

Note: Date Source: CPS IPUMS. The occupations are: 1. Life, Physical, and Social Science; 2. Community and Social Services; 3. Legal; 4. Education, Training, and Library; 5. Protective Service; 6. Personal Care and Service. Controlled characteristics include age and age-squared, experience and experience-squared, log income, sex, race, education, region, marital status, citizenship, union status, and veteran status. Fixed effects include state fixed effect and year fixed effect. All standard errors are clustered at the state level.

Table 17. Licensing Effects by Occupations —Log of Employment

	Selected Occupations					
	occ1	occ2	occ3	occ4	occ5	occ6
%License	-0.925***	-0.312	2.480***	2.170***	0.256	0.0643
	(0.204)	(0.303)	(0.132)	(0.372)	(0.253)	(0.230)
%Public	-0.896***	-0.407*	-4.182***	0.407	-2.085***	4.110***
	(0.201)	(0.213)	(0.418)	(0.275)	(0.267)	(0.563)
%Union	-1.128*	0.422	-1.963	0.136	1.855***	-1.382
	(0.566)	(0.413)	(2.000)	(0.578)	(0.265)	(1.036)
Constant	11.72***	12.06***	12.44***	11.76***	12.55***	11.60***
	(0.0816)	(0.0829)	(0.112)	(0.115)	(0.0968)	(0.141)
Clusters	51	51	51	51	51	51
R-squared	0.613	0.491	0.855	0.641	0.627	0.543

Note: Date Source: CPS IPUMS. The occupations are: 1. Life, Physical, and Social Science; 2. Community and Social Services; 3. Legal; 4. Education, Training, and Library; 5. Protective Service; 6. Personal Care and Service. Controlled characteristics include age and age-squared, experience and experience-squared, log income, sex, race, education, region, marital status, citizenship, union status, and veteran status. Fixed effects include state fixed effect and year fixed effect. All standard errors are clustered at the state level.

Table 18. Licensing Effects by Specific Occupations—Log of Wages

	Selected Occupations					
	Teachers	Social workers	Registered Nurses	Bus and Ambulance Drivers and Attendants	Fire Inspectors	Dispensing Opticians
License	0.0550***	0.0794*	0.0105	0.0292	0.282	-0.0448
	(0.0164)	(0.0443)	(0.0278)	(0.0656)	(0.997)	(0.178)
Public	0.0163	0.0704***	-0.0211	0.102***	-0.0309	-0.0709
	(0.0113)	(0.0238)	(0.0162)	(0.0381)	(0.257)	(0.174)
Union	0.306***	0.201	-0.280**	0.564*	0.793	-0.0357
	(0.0887)	(0.194)	(0.131)	(0.331)	(3.973)	(0.858)
Constant	0.693	-0.303	3.414***	0.892	-6.711	2.737
	(0.456)	(1.173)	(0.766)	(1.643)	(20.33)	(3.268)
Observations	38,650	6,595	16,271	2,704	121	272
R-squared	0.176	0.232	0.171	0.247	0.893	0.653

Note: Date Source: CPS IPUMS. Panel A occupations (teachers, social workers and registered nurses) are the most influential occupations according to the implicit weights on potentially heterogeneous treatment effects by occupation in the two-way fixed effect estimator, as derived by de Chaisemartin and D'Haultfoeuille (2019). Panel B occupations are overweighted occupations, as defined by the ratio of the implicit weight and the occupation's sample share of workers. Controlled characteristics include age and age-squared, experience and experience-squared, log income, sex, race, education, region, marital status, citizenship, union status, and veteran status. Fixed effects include state fixed effect and year fixed effect. All standard errors are clustered at the state level.

Table 19. Licensing Effects by Specific Occupations —Log of Total Hours Worked

	Panel A: Most Influential Occupations			*Panel B: Most Overweighted Occupations*		
	Teachers	Social workers	Registered Nurses	Bus and Ambulance Drivers and Attendants	Fire Inspectors	Dispensing Opticians
License	0.0455***	-0.0161	-0.00674	0.169**	-0.183	-0.154
	(0.00955)	(0.0270)	(0.0166)	(0.0773)	(0.184)	(0.193)
Public	0.0560***	0.0385***	0.0350***	-0.0751*	0.0203	0.285
	(0.00874)	(0.0126)	(0.00948)	(0.0394)	(0.110)	(0.227)
Union	-0.0574	-0.192	0.158	1.033***	-0.668	-0.713
	(0.0437)	(0.134)	(0.0997)	(0.393)	(0.752)	(0.997)
Constant	3.795***	4.361***	2.754***	-0.210	2.926	9.086***
	(0.262)	(0.640)	(0.488)	(2.399)	(4.188)	(3.155)
Observations	38,627	6,594	16,266	2,702	121	272
R-squared	0.046	0.072	0.041	0.208	0.863	0.401

Note: Date Source: CPS IPUMS. Panel A occupations (teachers, social workers and registered nurses) are the most influential occupations according to the implicit weights on potentially heterogeneous treatment effects by occupation in the two-way fixed effect estimator, as derived by de Chaisemartin and D'Haultfoeuille (2019). Panel B occupations are overweighted occupations, as defined by the ratio of the implicit weight and the occupation's sample share of workers. Controlled characteristics include age and age-squared, experience and experience-squared, log income, sex, race, education, region, marital status, citizenship, union status, and veteran status. Fixed effects include state fixed effect and year fixed effect. All standard errors are clustered at the state level.

Table 20. Instrumental Variable Results

	(1) Public	(2) Log Wage	(3) Log Hours
Panel A: Whole Sample			
License	0.150***	0.166***	0.236***
	(0.00345)	(0.0276)	(0.0148)
Public		-0.109***	-0.0401***
		(0.00605)	(0.00322)
Union	0.399***	0.478***	0.708***
	(0.00229)	(0.0956)	(0.0511)
Constant	-0.0438*	-1.116***	0.130
	(0.0263)	(0.429)	(0.228)
Observations	804,655	804,396	804,163
R-squared	0.194	0.212	0.004
Cragg-Donald Wald F statistic	2.5e+05	7.6e+04	7.6e+04
Panel B: Public Sector Sub-Sample			
License		0.0956**	0.397***
		(0.0428)	(0.0237)
Union		0.348**	1.220***
		(0.154)	(0.0859)
Constant		-0.298	-2.146***
		(0.706)	(0.389)
Observations		125,107	125,063
R-squared		0.201	-0.066
Cragg-Donald Wald F statistic		9333	9338
PSM Weighting		Yes	Yes
Two-state Correction		Yes	Yes

Note: Date Source: CPS IPUMS. Not shown controlled characteristics include age and age-squared, experience and experience-squared, log income, sex, race, education, region, marital status, citizenship, union status, and veteran status. Fixed effects include occupation, state fixed effect and year fixed effect (since the IV is generated by state by occupation cell). Occupational fixed effects are defined by aggregating occ2010 into 22 occupation groups based on IPUMS definition for occ2010. All standard errors are robust SE.

Table 21. Selected Descriptive Statistics, SIPP

		By Licensing			By Sector	
	Full Sample	Licensed	Unlicensed		Public	Private
Public	0.10	0.14	0.09	Licensed	0.25	0.18
Private	0.90	0.86	0.91	Unlicensed	0.75	0.82
Licensed	0.18	-	-			
Unlicensed	0.82	-	-			
Education Category				*Education Category*		
Less than high school	0.11	0.03	0.13	Less than high school	0.05	0.12
High school graduate	0.33	0.23	0.36	High school graduate	0.28	0.34
Some college	0.25	0.24	0.25	Some college	0.24	0.25
Associate degree	0.14	0.22	0.12	Associate degree	0.15	0.14
Bachelor's degree	0.13	0.20	0.12	Bachelor's degree	0.21	0.13
Graduate degree	0.03	0.08	0.02	Graduate degree	0.07	0.03
Race				*Race*		
White	0.79	0.80	0.79	White	0.77	0.79
Black	0.13	0.13	0.13	Black	0.13	0.13
Asian	0.04	0.04	0.04	Asian	0.05	0.04
Hispanic	0.21	0.12	0.23	Hispanic	0.15	0.21
Personal				*Personal*		
Union status	0.11	0.16	0.10	Union status	0.32	0.09
Female	0.50	0.58	0.48	Female	0.57	0.49
Experience	17.69	19.74	17.23	Experience	21.30	17.29
Age	37.73	40.31	37.16	Age	41.41	37.33
Labor Outcomes				*Labor Outcomes*		
Hourly wage	15.39	19.96	14.37	Hourly wage	17.61	15.15
Weekly hours worked	33.65	35.15	33.31	Weekly hours worked	32.93	33.73
Observations	46,785	8,269	38,516	Observations	4,783	42,002

Note: Date Source: SIPP 2008 Panel Wave 13 & 2014 Panel Wave 1-4.

Table 22. SIPP Results—Probability of Sector Choice

	A	B	C	D
Variable of Interest				
License	0.00688	0.00933	0.00663	0.0160**
	(0.00665)	(0.00713)	(0.00665)	(0.00601)
Union	0.244***	0.254***	0.241***	0.233***
	(0.0221)	(0.0227)	(0.0223)	(0.0238)
Bounds and Deltas				
$Rmax = \tilde{R} \times 1.3 = 0.34$				(0.01602, 0.01892), $\delta = -6.97$
$Rmax = 0.5$				(0.01602, 0.02543), δ =-2.31
$Rmax = 0.7$				(0.01602, 0.03509), δ =-1.26
Controls				
Wage, education, sex, race		X	X	X
Other controls			X	X
Occupation*state, fixed effects				X
PSM Weighting	Yes	Yes	Yes	Yes
Two-stage Correction	Yes	Yes	Yes	Yes
Observations	46,743	46,743	46,743	46,743
R-squared	0.069	0.082	0.088	0.262

Note: Date Source: SIPP 2008 Panel Wave 13 & 2014 Panel Wave 1-4. The dependent variable is probability of being in public sector. Other controlled characteristics include age and age-squared, experience and experience-squared, marital status and citizenship. Occupational fixed effects used in the interaction with the state fixed effects are defined by aggregating occupational classification code into 22 occupation groups based on SOC. All standard errors are clustered at the state by occupation level.

Table 23. SIPP Results—Labor Market Outcomes Whole Sample

	A	B	C	D
Panel A. Log of Wage				
License	0.201***	0.172***	0.173***	0.110***
	(0.0135)	(0.0119)	(0.0118)	(0.0135)
Public	-0.0767***	-0.0659***	-0.0654***	-0.0370***
	(0.0177)	(0.0144)	(0.0143)	(0.0137)
Union	0.277***	0.233***	0.239***	0.210***
	(0.0193)	(0.0150)	(0.0164)	(0.0137)
Bounds and Deltas				
$Rmax = \tilde{R} \times 1.3 = 0.6$				(0.09423, 0.10983), $\delta = 6.68$
$Rmax = 0.7$				(0.08333, 0.10983), $\delta = 4.03$
$Rmax = 1$				(0.04971, 0.10983), $\delta = 1.81$
Observations	46,561	46,561	46,561	46,561
R-squared	0.109	0.235	0.245	0.464
Panel B. Log of Total Weekly Hours				
License	0.0145	0.0141	0.0152	0.0101
	(0.0114)	(0.0131)	(0.0131)	(0.0147)
Public	-0.00821	0.00165	0.000269	0.0217
	(0.0235)	(0.0201)	(0.0199)	(0.0195)
Union	0.0952***	0.0575***	0.0506***	0.0881***
	(0.0216)	(0.0195)	(0.0188)	(0.0174)
Bounds and Deltas				
$Rmax = \tilde{R} \times 1.3 = 0.46$				(0.01003, 0.01012), $\delta = 92.58$
$Rmax = 0.7$				(0.00982, 0.01012), $\delta = 28.96$
$Rmax = 1$				(0.00956, 0.01012), $\delta = 15.44$
Observations	44,663	44,663	44,663	44,663
R-squared	0.010	0.090	0.093	0.357
Wage, education, sex race		X	X	X
Other controls			X	X
Occupation*state fixed effects				X
Panel C. Log of Employment				
%License				0.113
				(0.0848)
%Public				-0.108
				(0.102)
%Union				0.0635
				(0.0864)
Clusters				5,286
Occupation, state fixed effects				Yes
PSM Weighting	Yes	Yes	Yes	Yes
Two-stage Correction	Yes	Yes	Yes	Yes

Note: Date Source: SIPP 2008 Panel Wave 13 & 2014 Panel Wave 1-4. For Panel A and B, the regression is at individual level. Other controlled characteristics include age and age-squared, experience and experience-squared, marital status and citizenship. Occupational fixed effects in these two panels are defined by aggregating occupational classification code into 22 occupation groups based on SOC. For Panel C, the regression is at the state-occupation cell level. Therefore, no individual covariates or other fixed effects are included in Panel C regression, just the normal occupation and state fixed effects. All standard errors are clustered at the state by occupation level.

Table 24. SIPP Sub-Sample Bound Estimates for Public Licensed vs. Public Unlicensed

	A	B	C	D
Panel A. Log of Wage				
Public Licensed vs. Unlicensed	0.0415*	0.0652**	0.0699***	0.0515
	(0.0234)	(0.0251)	(0.0251)	(0.0335)
Public Union vs. Non-union	0.226***	0.190***	0.194***	0.151***
	(0.0290)	(0.0216)	(0.0255)	(0.0283)
Bounds and Deltas				
$Rmax = \tilde{R} \times 1.3 = 0.76$				(0.05148, 0.08075), $\delta = -2.42$
$Rmax = 1$				(0.05148, 0.09425), $\delta = -1.02$
Observations	4,593	4,593	4,593	4,593
R-squared	0.062	0.191	0.202	0.583
Panel B. Log of Total Hours				
Public Licensed vs. Unlicensed	0.0557***	0.0146	0.0174	0.00274
	(0.0179)	(0.0215)	(0.0221)	(0.0303)
Public Union vs. Non-union	0.0983***	0.0646**	0.0495	0.167***
	(0.0313)	(0.0316)	(0.0313)	(0.0476)
Bounds and Deltas				
$Rmax = \tilde{R} \times 1.3 = 0.73$				(-0.00419, 0.00274), $\delta = 0.39$
$Rmax = 1$				(-0.01475, 0.00274), $\delta = 0.15$
Observations	4,593	4,593	4,593	4,593
R-squared	0.010	0.101	0.109	0.558
Wage, education, sex race		X	X	X
Other controls			X	X
Occupation*state fixed effects				X
Year fixed effects				X
Panel C. Log of Employment				
Public %Licensed				0.0906
				(0.133)
Public % Union				0.0355
				(0.122)
Clusters				1,773
Occupation, year fixed effects				Yes
PSM Weighting	Yes	Yes	Yes	Yes
Two-stage Correction	Yes	Yes	Yes	Yes

Note: Date Source: SIPP 2008 Panel Wave 13 & 2014 Panel Wave 1-4. For Panel A and B, the regression is at individual level. Other controlled characteristics include age and age-squared, experience and experience-squared, marital status and citizenship. Occupational fixed effects in these two panels are defined by aggregating occupational classification code into 22 occupation groups based on SOC. For Panel C, the regression is at the state-occupation cell level. Therefore, no individual covariates or other fixed effects are included in Panel C regression, just the normal occupation and state fixed effects. All standard errors are clustered at the state by occupation level.

Figure 1. Welfare Model for Occupational Licensing

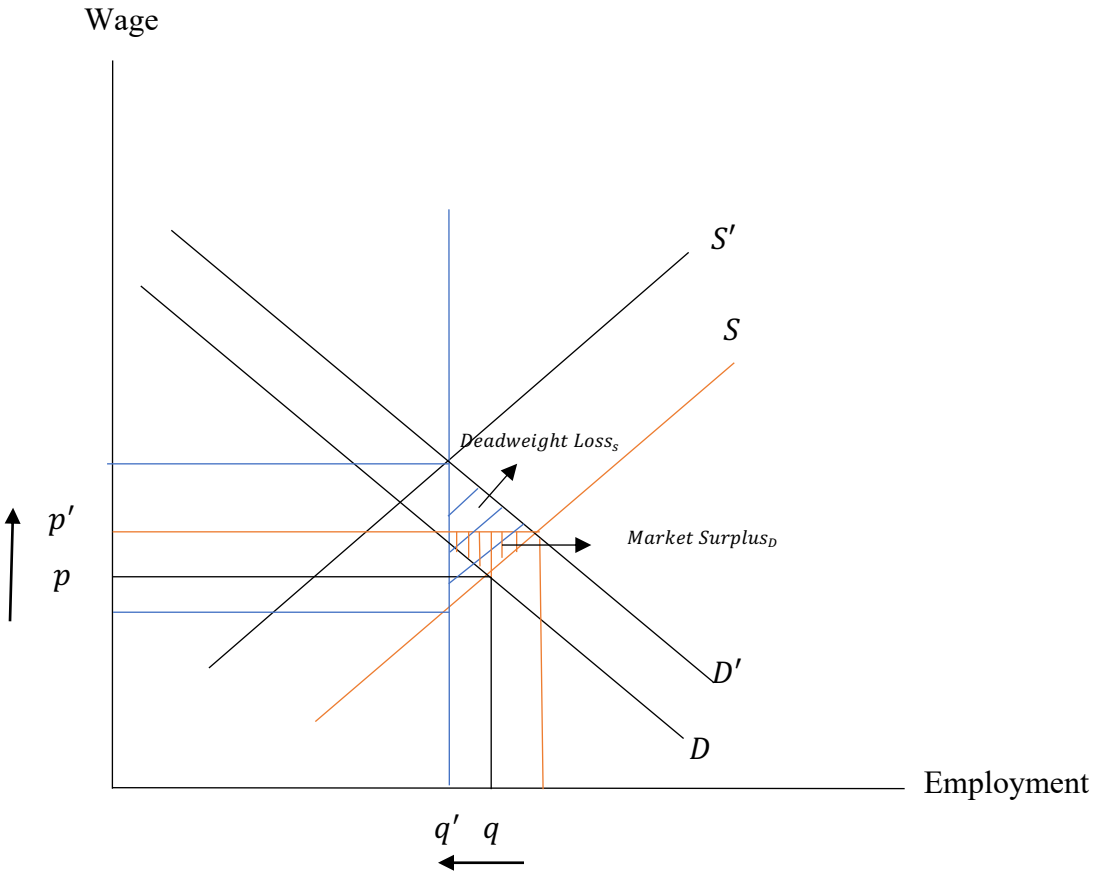
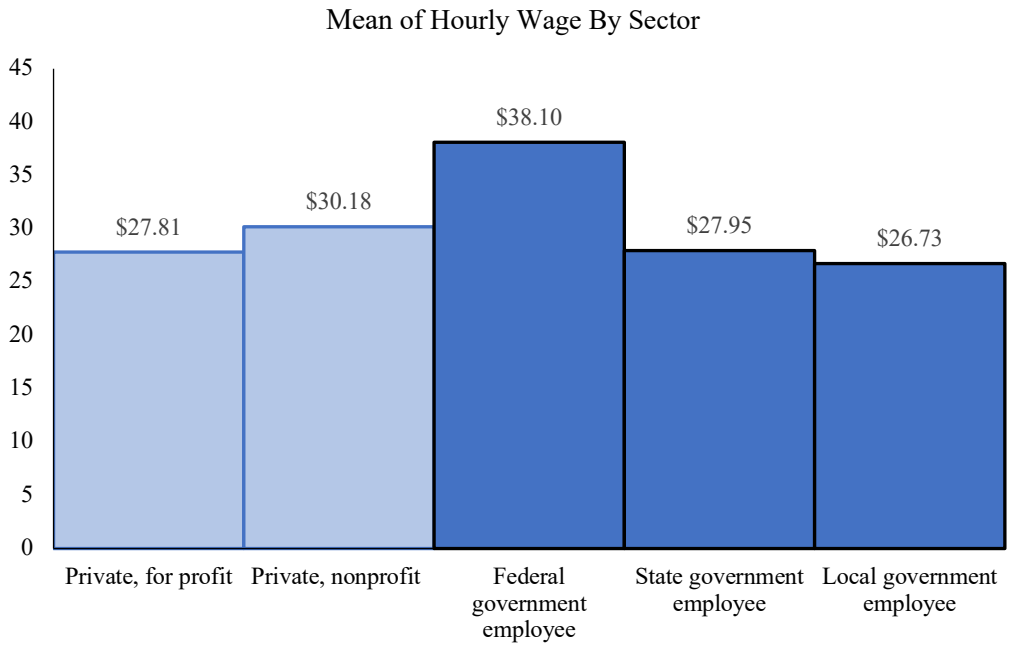


Figure 2. Labor Market Outcomes by Specific Sectors



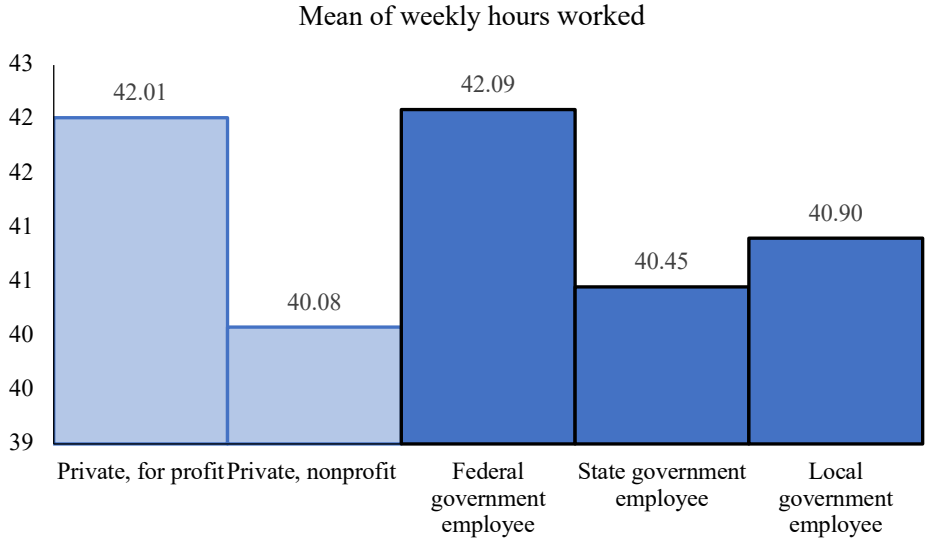
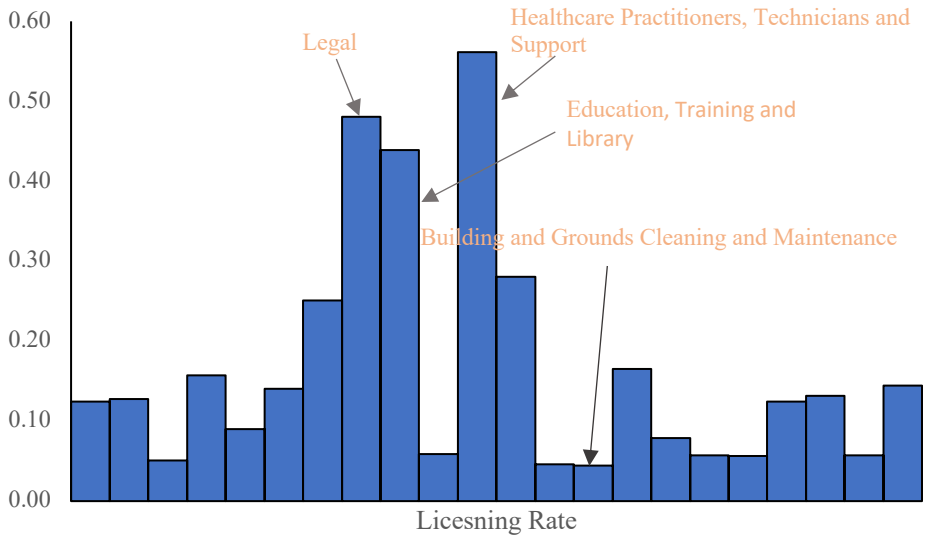


Figure 3. Licensing and Sector Percentage by Occupational Categories


0.60
0.50
0.40
0.30
0.20
0.10
0.00
Legal
Healthcare Practitioners, Technicians and Support
Education, Training and Library
Building and Grounds Cleaning and Maintenance
Licesning Rate

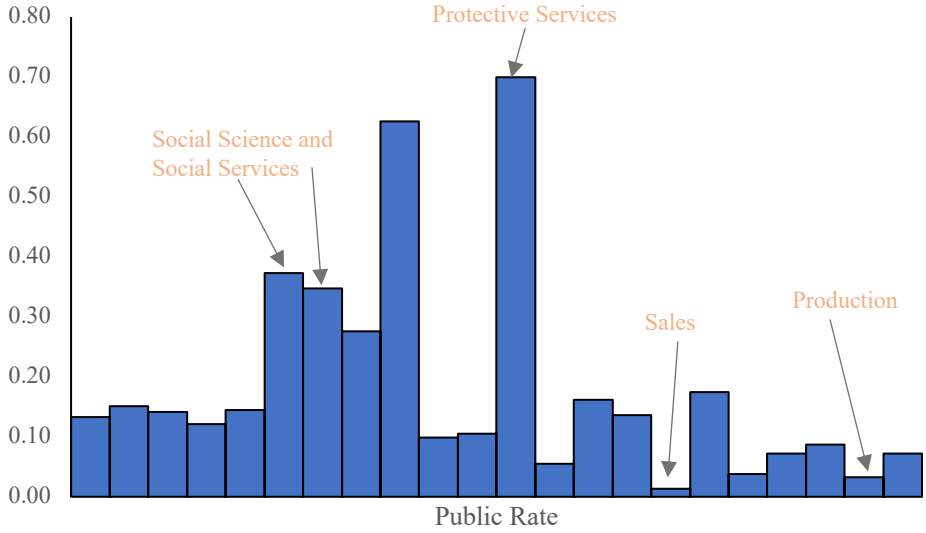
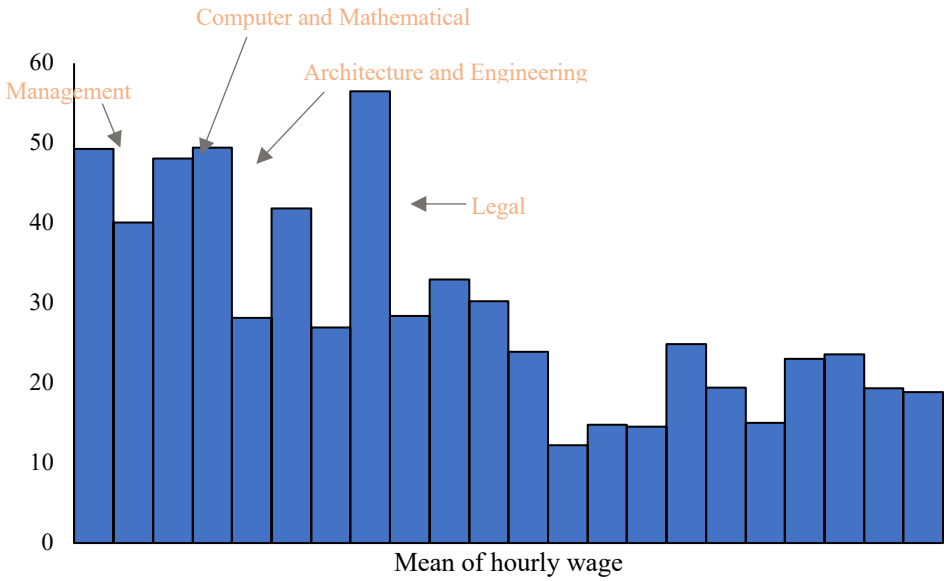

0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Protective Services
Social Science and Social Services
Sales
Production
Public Rate

Figure 4. Labor Market Outcomes by Occupational Categories



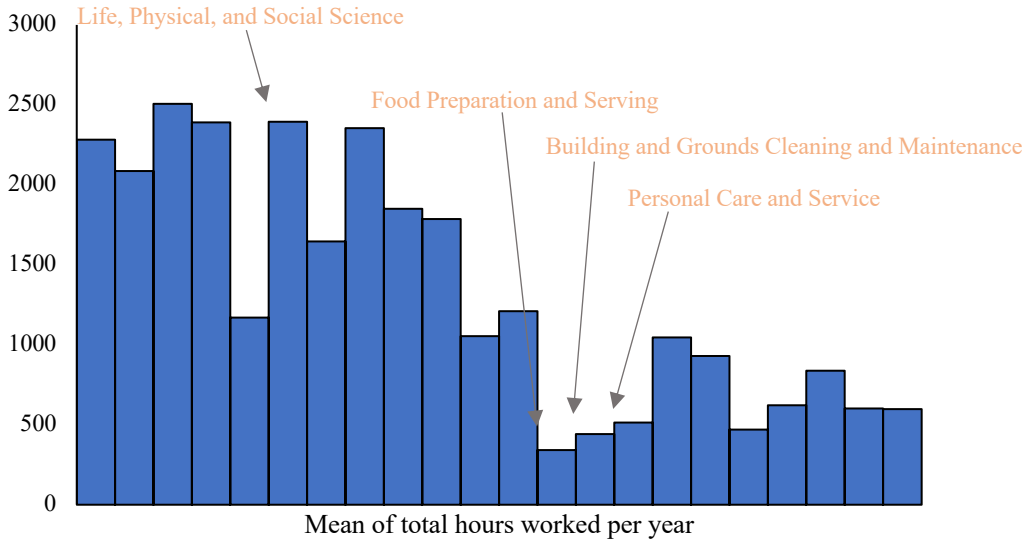


Figure 5. Labor Market Outcomes-Licensing Comparison Between Sectors

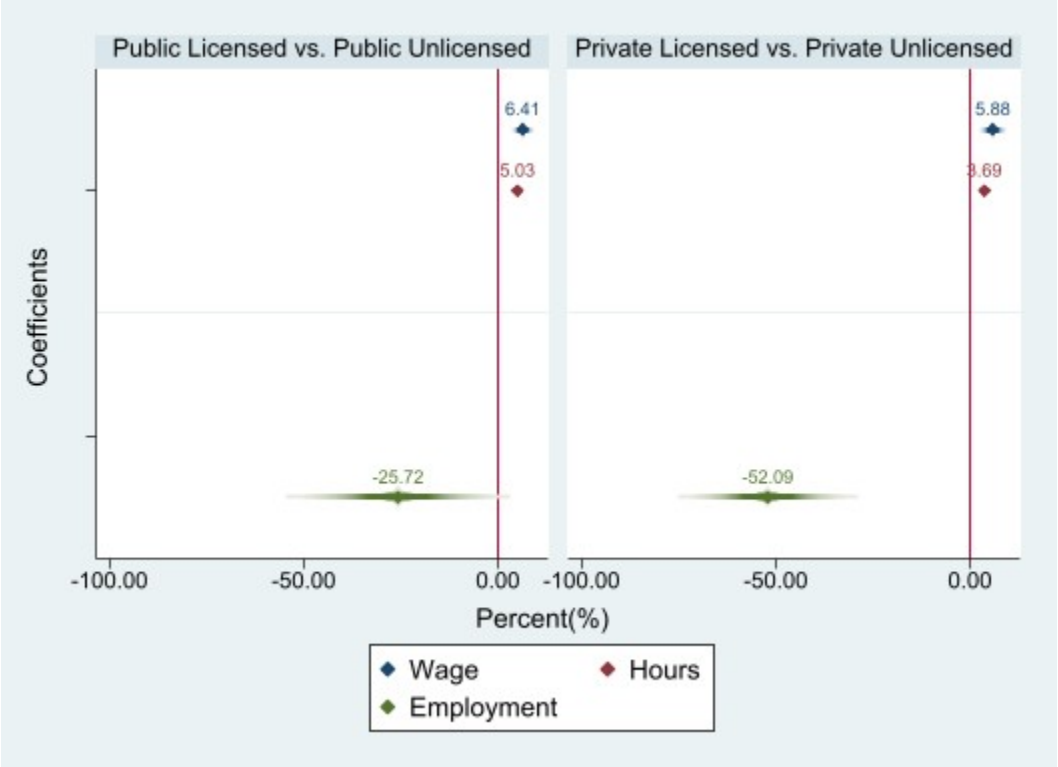


Figure 6. Labor Market Outcomes-Sector Comparison Between Licensing

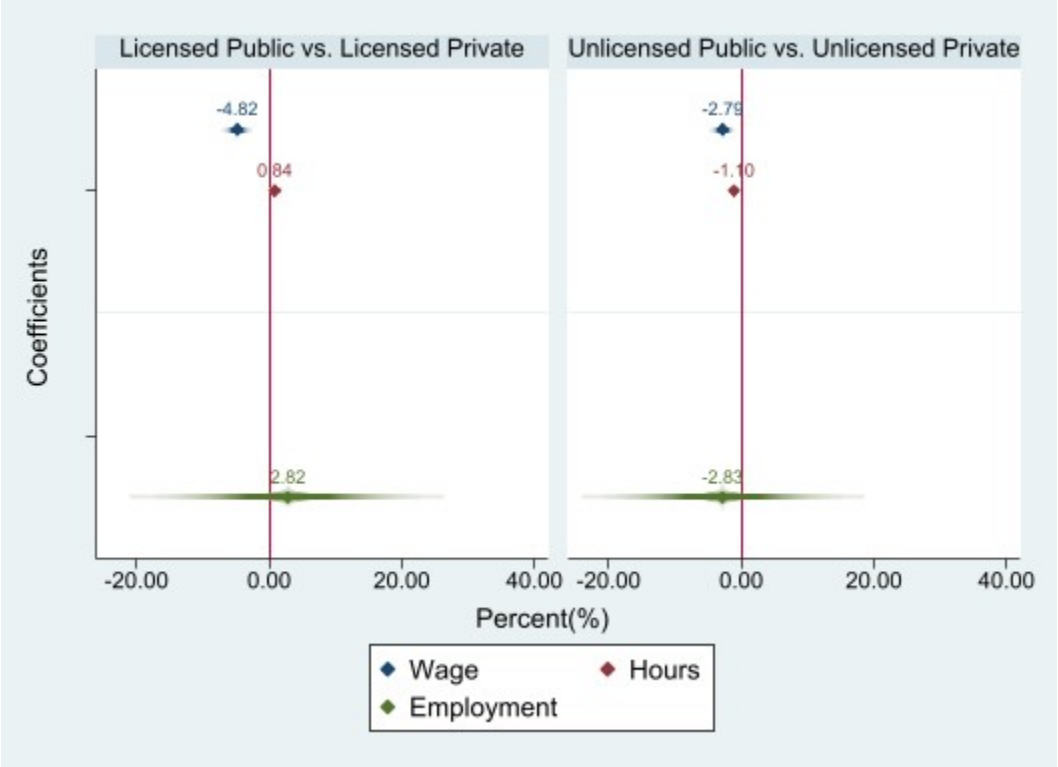


Figure 7. Labor Market Outcomes-Interactor Groups Comparison