Labor Union and Social Insurance*

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Abstract

This paper presents a labor market model of unions that accounts for their effects on wages and the provision of employment-based insurance benefits, and uses it to quantitatively assess the equilibrium labor market impacts of unions as well as the forces underlying the decline in the unionization rate in the United States in the past four decades. We first document that unionized firms are more likely to provide various employer-based insurance benefits. Then, we provide quasi-experimental evidence that the expansion of public insurance programs lowers unionization rates and union formation in the U.S. We then develop and estimate a frictional labor market model with endogenous union formation by workers and endogenous provision of insurance benefits by firms. The model quantitatively accounts for the relationship between a firm's union status and its provision of employer-based insurance products. Using the model, we assess the impact of social insurance, tax policies, and transfer programs on non-wage benefits and their consequences for unionization rates and the labor market. We find that these policies can have a significant impact on wage inequality through their effects on unionization. Furthermore, we quantitatively assess the relative importance of technological changes, social insurance expansion, and other regulatory changes in the decline of unionization rates in the U.S. Although technological changes account for more than half of the decline, social insurance expansions can also account for 20% of the decline.

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1 Introduction

Labor unions in the United States have seen a steady decline over the past few decades. In 1960, approximately 33% of workers were part of unions, but today that number has decreased to less than 10%. This long-term trend has spurred the interest of economists and policymakers about its consequences on labor market outcomes and welfare. As discussed by Freeman and Medoff (1984), unions can influence various aspects, such as increasing average wages, reducing wage inequality, and expanding employer-provided benefits such as health insurance and pensions. Building on these ideas, the Biden administration issued an executive order on April 26, 2021 (E.O. 14025) to promote unions and collective bargaining, emphasizing their impact on wages, benefits, and job security. However, there are also substantial concerns that unions might negatively affect labor productivity, as emphasized by Holmes (1998) and Alder et al. (2023).

When assessing the benefits and costs of unions and possible policy interventions in the U.S. context, it is essential to understand why union membership has declined. Several hypotheses can explain this phenomenon. Firstly, technological changes and globalization have shifted labor demand away from low-skilled workers, who tend to favor unionization, as discussed by Acemoglu et al. (2001), Açıkgöz and Kaymak (2014) and Dinlersoz and Greenwood (2016). Secondly, state governments have increasingly adopted right-to-work laws, preventing workers from being obligated to pay union membership fees and making it challenging for unions to sustain themselves (Farber, 2005). A third, and hitherto under-explored hypothesis is that the substantial expansion of U.S. social insurance programs may also contribute to the decline in unions. If union-provided insurance benefits are a primary reason workers join unions, the availability of affordable insurance options outside unions, either through the government or other sources, can reduce the attractiveness of union membership. Such dependence is especially relevant in the United States, where the labor market plays an important role in providing access to various essential insurance benefits compared with other European countries.[1]

Most existing studies evaluating the economic impact of unions focus on wages but do not consider insurance provisions.[2] Furthermore, there are few papers that quantify the relative importance of the aforementioned factors that may contribute to the decline in unions. Consequently, there is almost no systematic analysis of the implications of unions on the design of social insurance, tax, and transfer systems.

The goal of this paper is to develop a labor market model of unions that accounts for their

[1]For example, most European countries have universal health insurance systems, which likely eliminates union's role of insurance provisions from the beginning.

[2]See Cahuc et al. (2014) for an overview of recent labor market models of unions.

effects on wages and the provision of employer-based insurance benefits and use it to *jointly* understand union's equilibrium impacts and their declines. We begin by providing suggestive evidence that union firms are more likely to offer employer-based insurance benefits and that social insurance expansions affect the unionization rate. Then, we develop an equilibrium labor search model that features endogenous union formation and employer-based insurance provisions. We estimate our model and use simulations of the estimated model to quanitatively assess how government interventions in social insurance and employer-sponsored insurance benefits affect unionization and labor market equilibrium. Then, we explore which factors account for the decline in unions and discuss their implications.

To motivate our focus on union's role in insurance provisions, we first document the descriptive evidence that union firms tend to provide employer-sponsored health insurance (ESHI) and provide more job security. Then, we exploit variations in social insurance policies to examine their effects on unionization. We first examine the effect of the introduction of Medicare and Medicare in the 1960s and 1970s. By building on identification approaches in Finkelstein (2007) and difference-in-differences, we find that the introduction of Medicare and Medicaid lower the unionization rate and the number of union elections. Moreover, by focusing on changes in social insurance programs in recent years, such as the expansion of Medicaid under the Affordable Care Act (ACA) and unemployment insurance (UI), we find that the expansion of social insurance programs tend to lower the unionization rate, especially for low-skilled workers, underscoring the importance of considering the distributional impact of social insurance policies on the labor market.

Our equilibrium model builds on the standard search and matching model (Diamond-Mortensen-Pissarides framework, Pissarides, 2000), which naturally deviates from the competitive labor market and thus produces a firm's monopsony power in the labor market. The novel feature of our model is that it jointly incorporates the following two ingredients. First, following Taschereau-Dumouchel (2020), we incorporate endogenous firm size and union formation where firms decide on unionization based on employees' preferences for unions. Second, non-wage benefits and job security are endogenously determined in the model. Following Aizawa and Fang (2020), we postulate that a firm needs to incur a fixed cost (e.g., administrative costs) and per-employee marginal cost (e.g., medical expenses for health insurance) in order to provide the non-wage benefits to its workers.

A novel feature of our model is that employer's provisions of insurance benefits, firm's union status, firm size and skill composition, and wage inequality are all endogenously determined in equilibrium. In the model, union firms have more incentive to provide non-wage benefits than nonunion firms because nonunion firms are more likely to suffer from hold-up problems. In a union firm, compensations are determined in collective bargaining where the preferences of its workers are aggregated. A firm and its workers split all the fixed costs of providing non-wage benefits according to the bargaining power. In contrast, in a nonunion firm, compensations are determined by individual bargaining between the firm and each worker. Each worker only bears the marginal cost of non-wage benefits. As a result, nonunion firms need to incur all the fixed costs, and therefore they are less willing to provide insurance than union firms.

We structurally estimate our equilibrium model. We use micro-level data from the Current Population Survey (CPS), the Survey of Income and Program Participation (SIPP), and the Health and Retirement Study (HRS) that have detailed information on individual union status, labor market outcomes, demographics, and the menu of non-wage benefits. We consider health insurance as the main non-wage benefits in our empirical specification and significantly extend our model by adding rich heterogeneity. The estimated model successfully accounts for the relationship among the union status, insurance provisions, skill premiums, and firm sizes.

Using our equilibrium model, we first examine how social insurance policies, as well as tax and transfers to insurance provisions, affect unionization and labor market outcomes. Through a series of counterfactual experiments, our findings reveal that social insurance policies can substantially influence equilibrium labor market outcomes by altering unionization rates. Specifically, we demonstrate that a uniform social insurance approach, which replaces the existing Employer-Sponsored Health Insurance (ESHI) system with tax-funded universal health coverage, reduces the union membership density by 0.5 percentage points (p.p.). This decline in unions is associated with a 2% lower average wage and an increase in wage inequality, measured by the wage gap between the high-skilled and low-skilled workers, by 2.9 log points.

We further show that the impact of social insurance policies on the labor market is contingent on their targeting strategy. Expanding social insurance to low-skilled workers only (e.g., significant expansion of Medicaid) will lower the unionization rate by 2.1 p.p., but it will increase the average wage by 0.4%, and decrease wage inequality by 2.3 log points, highlighting the importance of the targeting of social insurance policies. However, this decline in unions also reduces access to insurance coverage for the high-skilled, suggesting a possible welfare loss to the high-skilled.

Furthermore, we find that the current structure of tax and transfer systems on non-wage benefits has a significant implication for the unionization rate. Subsidies provided for non-wage benefits, such as tax incentives for ESHI, lead to a decrease in the unionization rate. Quantitatively, subsidizing firms for 20% of the insurance fixed costs results in a 0.9 p.p. decline in the union density. This occurs as non-unionized firms increase their insurance provisions, while unionized firms lose their competitive edge in attracting workers through insurance coverage. Notably, this change also contributes to an increase in wage inequality of 0.7 log points due to the union decline. Consequently, the current structure of employer-sponsored health insurance becomes an additional source of wage inequality due to its influence on the unionization rate.

We also examine the effect of subsidizing unions, a policy frequently discussed in policy debates. Although such a policy raises the unionization rate, it has a limited effect on wage inequality, primarily because it also affects the provision of non-wage benefits. Subsidizing firms for 20% of the fixed cost of unionization increases the union density by 6.8 p.p. but reduces the skill wage gap by 0.1 log points. As long as the provision of non-wage benefits is uniform across workers within a firm, a feature that emerges due to the regulatory restriction, the expansion of unions does not significantly mitigate wage inequality.

Finally, we use our model to quantitatively assess the factors that lead to the decline in the unionization rate over time. For this purpose, we re-estimate our model to fit to the key statistics in 1962 in the U.S. and then simulate the effects of technological changes and policies. We find that technological change alone can account for more than half of the decline in unions. Interestingly, we also find that the expansion of social insurance, measured by the introduction and expansion of Medicaid, can account for up to 20% of the decline in unionization.

This paper contributes to two strands of the literature. First, it is related to the literature on unions and labor markets. Our study is most related to a growing number of macro labor studies that assess the impact of unions on labor market equilibrium. Acemoglu et al. (2001) argue that skill-biased technological change leads to a decline in the unionization rate and the decline in unions amplifies the effect of technological change on wage inequality. Subsequently, there are a few studies evaluating unions in quantitative general equilibrium models: Açıkgöz and Kaymak (2014), Dinlersoz and Greenwood (2016), Krusell and Rudanko (2016), Taschereau-Dumouchel (2020), and Alder et al. (2023). Taschereau-Dumouchel (2020) argues that unions have general equilibrium effects through the possibility of union threat by affecting firms' hiring decisions regarding the skill compositions of their workforce. There are also many empirical studies that investigate the effect of unions on wages and wage inequality. Among others, DiNardo et al. (1996), Card (2001) and Farber et al. (2021) show that unions significantly reduce wage inequality. In this vein, several empirical studies show the positive effect of unions on the level of non-wage benefits (e.g., Freeman and Medoff, 1984, Buchmueller et al., 2002, Knepper, 2020, and Lagos, 2021). We contribute to this literature in several ways. First, we develop a new framework incorporating the endogenous provision of insurance benefits in an equilibrium labor market model with unions. Second, using such framework, together with exploiting various quasi-experimental variation, we show how unions interact with social insurance programs and their implications to wage inequality. Third, we quantitatively show the relative importance of various factors contributing to the decline in unions.

Second, our paper also contributes to the literature that studies the welfare impact of social insurance provisions. First, a growing number of studies evaluate the welfare impacts of social insurance programs in structural life-cycle models (e.g., French and Jones, 2011, De Nardi et al., 2010, and Low and Pistaferri, 2015). In a similar vein, several studies evaluate various social insurance programs using equilibrium labor market models. Dey and Flinn (2005), Aizawa (2019), and Aizawa and Fang (2020) develop an equilibrium labor search model with health insurance. Mitman and Rabinovich (2015) and Chodorow-Reich et al. (2019) evaluate the general equilibrium effects of unemployment insurance programs. Cole et al. (2019) and Aizawa et al. (2024) study the design of disability policies. We contribute to this literature by studying endogenous insurance provisions through the labor market institution and its interaction with social insurance.

The rest of the paper is organized as follows. Section 2 describes institutional setting and background. Section 3 provides evidences about the relationship among unions, insurance provisions, and social insurance programs. Section 4 lays out our model, and Section 5 explains our estimation strategy and presents estimates. Section 6 describes the counterfactual experiments, and Section 7 presents our accounting exercises regarding the factors that contributed to the decline in labor unions. Section 8 concludes.

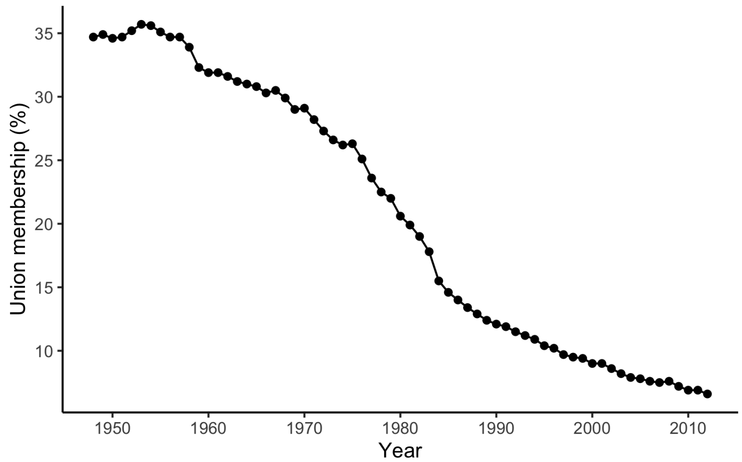
2 Background

In this section, we document several data patterns about union membership, individual insurance coverage, and social insurance. We start by showing that the union density in the U.S. declined over the last four decades while the government spending on social insurance programs kept increasing during the same time period. We then investigate how union status is related to various fringe benefits, focusing especially on employer-sponsored insurance.

2.1 Union Formation

In the U.S., workers can form a union to collectively bargain with their employers over compensation and benefits under the National Labor Relations Act (NLRA). To organize a union, workers first need to gather union authorization cards or petitions from at least 30% of their co-workers to show support for forming a union. Then, the workers can file a petition for a union election with the National Labor Relations Board (NLRB), and a union

Figure 1: National Trend in the Union Membership Density



Note: Data is from Farber et al. (2021). The union density before 1983 are based on the survey conducted by the BLS while the data from 1983 onward is from the CPS. See Farber et al. (2021) for more detail.

is formed if more than 50% of workers are in favor of unionization.[3]

Once a union is formed, collective bargaining covers all workers in a bargaining unit. The NLRA stipulates that an appropriate unit of bargaining is a group of two or more employees who share a community of interest, and the determination of a bargaining unit is left to the discretion of the NLRB. In practice, most of the bargaining takes place at the enterprise level.[4] Once a union is organized, all workers at the same workplace are covered by collective bargaining even if they are not union members. Operating a union incurs costs, and typically, union dues are automatically withheld from the payrolls of all covered workers. However, some states have approved Right-to-Work (RTW) laws, allowing non-members to avoid paying union dues while still being covered by collective bargaining agreements.

2.2 Decline in Unions and Potential Causes

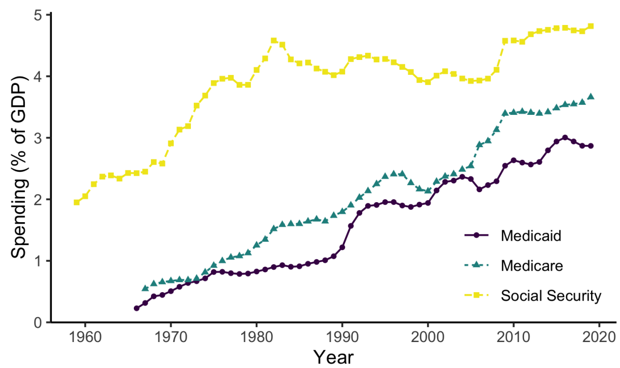
Figure 1 displays the national union membership density from 1948 onward, as taken from Farber et al. (2021). The union density was around 35% during the 1950s, and it began to decrease around 1960. A sharp decline was observed in the late 1970s and early 1980s when it reached half of its peak value. Recently, the density has dropped to less than 10%, and it continues to decrease.

There are several potential explanations for the decline in unions. First, skill-biased

[3]For more details, see a NLRB web page https://www.nlrb.gov/about-nlrb/rights-we-protect/the-law/employees/your-right-to-form-a-union

[4]According to the OECD/AIAS ICTWSS database, collective bargaining in the U.S. occurs at the company or enterprise level for more than two-thirds of union coverage.

Figure 2: Trend in Spending on Medicaid, Medicare, and Social Security



Note: Data on the government spending on each social insurance program is from Federal Reserve Economic Data (FRED).

technological change and the rise of the Chinese economy may affect unionization through their influences on a firm's production structure and labor demand. Skill-biased technological change increases the labor demand of high-skilled workers who may benefit less from joining unions (Acemoglu et al., 2001). Moreover, Charles et al. (2021) argue that trade competition with China has reduced union wage premiums by eroding profitability, resulting in union declines.

Second, the passage of state-based Right-to-Work (RTW) laws could have also contributed to the decline in unions. Most of the RTW laws were passed either in the 1940s and 1950s, or after 2000. These laws allow workers who are not union members to be also covered by collective bargaining. An immediate implication of the RTW laws is that it induces the free-riding problem, and thus fewer workers will pay union due, making it difficult to sustain unions. Recently, Fortin et al. (2022) exploit the recent new approval of RTW laws in several states to find that RTW laws reduce union membership by about two percentage points.

Third, if one of the union's main roles was to provide insurance benefits to workers, the introduction and expansion of social insurance programs could have also contributed to the decline in unions by replacing their roles. Figure 2 shows the government spending on the three major social insurance programs: Medicaid, Medicare, and Social Security, with the spending presented as a percentage of GDP. In contrast to the trend in union density, the government spending on social insurance programs has constantly increased over the same time periods. Before 1965, neither Medicare nor Medicaid existed; however, spending on each program has escalated to around three percent of GDP in recent years. Of course, these aggregate patterns alone cannot provide causal evidence.[5] In the next section, we

[5]There are a few early studies documenting the time series association between the aggregate government welfare and social program expenditures and the union density (e.g., Neumann and Rissman, 1984 and Moore et al., 1989). These studies conclude that additional government welfare and social program expenditure is

exploit plausibly exogenous variations in social insurance programs to identify the causal impacts of those social insurance programs on unionization.

3 Empirical Evidence on Effects of Social Insurance on Labor Unions

This section provides new evidence of the effects of social insurance on unions. We first document the fact that unionized firms are more likely to provide a variety of employer-based insurance benefits. Then, by exploiting changes in various social insurance programs, we examine whether the expansions of social insurance programs lower union formation and unionization rates, possibly by diluting the unions' role in insurance provisions.

3.1 Unionization and Insurance Provisions by Employers

3.1.1 Data and Sample Selection

We mainly use household survey data from the Current Population Survey (CPS), the Health and Retirement Study (HRS), and the Survey of Income and Program Participation (SIPP). We also rely on multiple other papers to obtain additional data. Specifically, we use data on the state-level union density produced by Hirsch et al. (2001), and we obtain the NLRB union election data from Sojourner and Yang (2022).[6] We also use information on state-level political environments. We obtain the data on state partisan balance from KlarnerPolitics and the National Conference of State Legislatures.[7] The CPS provides cross-sectional information on union membership and basic demographic information for a large number of households over long periods of time. On the other hand, the HRS covers a smaller number of households over shorter periods of time compared to the CPS, but it provides detailed information on insurance coverage in addition to union status, which allows us to study the relationship between union membership and insurance coverage at the individual level. In some analyses, we need data on the union density prior to years covered by the CPS, and, in that case, we use data produced by Hirsch et al. (2001) which provides the estimates of the state-level union density from the year 1964. In addition, we also use aggregate time-series data on the government spending on various social insurance programs such as Medicare,

associated with lower union density in the late 20th century.

[6] Hirsch et al. (2001) provide the database at https://www.unionstats.com/MonthlyLaborReviewArticle.htm. (last accessed March 11, 2024)

[7] We obtained data on partisan balance in early years at https://www.klarnerpolitics.org/datasets-1 (Last accessed March 11, 2024) which is based on Klarner (2003) while we obtain data in recent years from the National Conference of State Legislatures.

Table 1: Union Membership and Insurance Coverage

	HI	ESHI	Pension	Life Insurance	LTC Insurance
	(1)	(2)	(3)	(4)	(5)
Union	0.020*	0.055***	0.186***	0.039***	0.007
	(0.011)	(0.018)	(0.018)	(0.013)	(0.015)
Mean outcome	0.908	0.719	0.678	0.838	0.102
Observations	33,000	32,787	32,950	32,907	32,439
R^2	0.7044	0.7635	0.7626	0.7022	0.593

Note: This table reports the estimation result of equation (1). The sample consists of workers aged 65 or younger in the HRS 1992-2019. The covariates include dummies for age, occupations, industries, four census regions, the log of the number of people in the same workplace, and the log of earnings. Year fixed effects and individual fixed effects are also controlled. Person-level analysis weights are used. Standard errors are clustered at the individual level. $^{*}p < 0.1;^{**} p < 0.05;^{***} p < 0.01$.

Medicaid, and Social Security from Federal Reserve Economic Data (FRED) to show the aggregate time trends of the spending on social insurance programs.

We use the CPS sample spanning the years 1983-2019. We restrict our sample to respondents aged 18-65 who reported their union status. In addition to union status, the CPS has information on basic demographics such as gender, education, earnings, occupations, etc. The CPS sample we use does not cover information about union status for years before 1983 while we need information on the union density before 1983 in some analyses. To deal with this issue, we use estimates of the state-level union density produced by Hirsch et al. (2001) in some analyses. They used data from the CPS and the discontinued BLS publication Directory of National Unions and Employee Associations to produce the estimates of state-level union density from the year 1964.

The HRS sample span the years 1992-2019. The HRS is a panel survey of individuals aged 50 or over and their spouses regardless of their age. The HRS has information on union status and, importantly, has detailed information on insurance coverage. As in the CPS, we restrict our sample to individuals aged 65 or under who report their union status.

For the SIPP sample, we use the SIPP panels 1996, 2001, 2004, and 2008. The SIPP is a panel survey of households in the U.S. As in the other samples, we restrict the SIPP sample to individuals aged 18-65 who reported their union status.

3.1.2 Employer-based Insurance Benefits

In this subsection, we describe how union workers are different from nonunion workers in terms of insurance coverage. We use the HRS sample to regress indicators for various insurance coverage on the worker's union status and various demographic variables. Specifically,

Table 2: Union Membership and Job Losing

	Job Losing			
	Pooled		High school	College
	(1)	(2)	(3)	(4)
Union	-0.0020***	-0.0020***	-0.0028***	-0.0012***
	(0.0001)	(0.0001)	(0.0002)	(0.0002)
Demographics		X	X	X
Mean outcome	0.007	0.007	0.008	0.006
Observations	4,549,537	4,549,537	1,721,606	2,827,931
R^2	5e-04	0.0019	0.0025	0.0012

Note: Data is the SIPP panels 1996, 2001, 2004, and 2008. Demographic controls include dummies for age, sex, race, and education. Person-level weights are used. State and year fixed effects are controlled in all specifications. Robust standard errors are reported. $^{*}p < 0.1;^{**} p < 0.05;^{***} p < 0.01$.

we take a look at (i) private health insurance (HI) coverage, (ii) employer-sponsored health insurance (ESHI) coverage, (iii) pension from the current job, (iv) life insurance coverage, and (v) long-term care (LTC) insurance coverage. We estimate the following regression equation:

$$y_{it} = \beta \cdot Union_{it} + x_{it}'\gamma + \eta_i + \mu_t + \varepsilon_{it}, \tag{1}$$

where i is the individual, t is the year, y_{it} is an indicator for insurance coverage for i at t, Union_{it} is an indicator that takes 1 if i is a union member at t, x_{it} is a vector of time-variant covariates, η_i is individual fixed effects, μ_t is time fixed effects, and ε_{it} is an error term. The coefficient β represents how much insurance coverage is related to union status. Since we control for the individual fixed effects, we exploit changes in union membership of the same individuals over time.

Table 1 shows that union membership is associated with a better access to health insurance, pension, and life insurance. Specifically, a union member is 2.0 p.p. more likely to have access to health insurance, 5.5 p.p. more likely to be covered by employer-sponsored health insurance, 18.6 p.p. more likely to have a pension plan, and 3.9 p.p. more likely to have life insurance. Access to LTC insurance is weakly correlated with a union membership although the coefficient is not statistically significant.

3.1.3 Job Security

In addition to access to various types of insurance such as health insurance and pension, unions can also provide insurance to workers as a form of better protection against layoff. We investigate how union membership of a worker is related to subsequent job loss by using the sample of employed workers from the SIPP. We estimate the following regression equation:

$$Job\ loss_{it} = \beta \cdot Union_{it} + x_{it}'\gamma + \eta_{s(i)} + \mu_t + \epsilon_{it}, \tag{2}$$

where the outcome variable $Job\ loss_{it}$ is an indicator for losing a job that takes 1 if a worker loses a job from month t to month $t+1$. We are interested in the coefficient β of $Union_{it}$ that is an indicator for union membership. Although we observe employment status in each month, union membership is asked only once at the end of each wage that consists of 4 months. A worker reports union status in a firm for which the worker worked for the longest hours during a wave. We control for demographic variables such as age, sex, race, and education. We also control for state fixed effects $\eta_{s(i)}$ and time fixed effects μ_t. ϵ_{it} is an error term.

Table 2 reports the estimated coefficients. In the first two columns, we report the results based on the pooled sample in which we do not make a distinction between high-skill workers and low-skill workers. The estimated coefficient is -0.002 with and without controls, suggesting the monthly job losing probability is smaller for union workers by 0.2 p.p., which is sizable given the overall monthly job-losing probability of 0.7%. Columns (3) and (4) demonstrate that the impact is larger for low-skill workers. Specifically, the probability of job loss is smaller by 0.28 p.p. for low-skill union workers, and 0.12 p.p. for high-skill union workers.

3.2 Effects of Social Insurance Expansions on Unionization

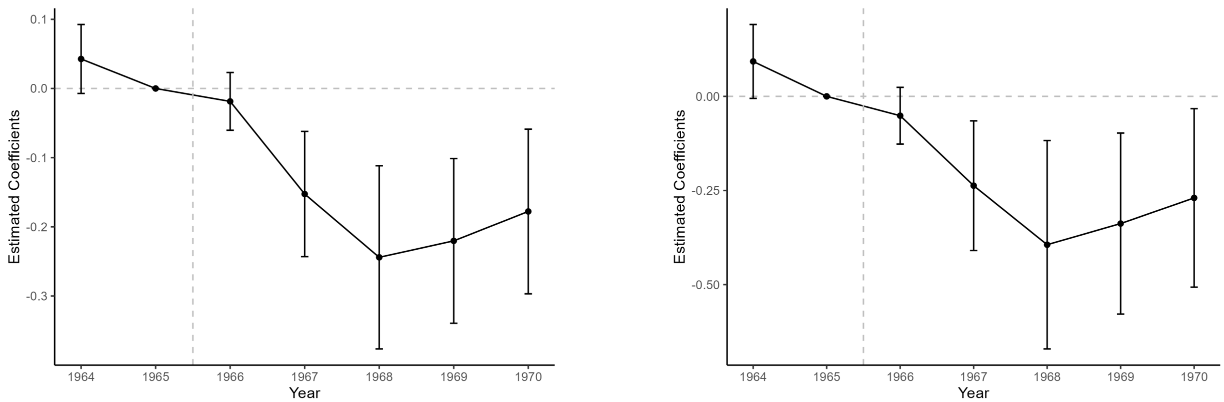
In this subsection, we investigate the impact of social insurance programs on unions. We first look into the introductions of two of the largest social insurance programs in the U.S.: Medicare and Medicaid during the 1960s. We then also study more recent policy changes including the Medicaid expansion under the ACA and state-level changes in unemployment insurance generosity.

3.2.1 Introduction of Medicare

Medicare, which was enacted into law on July 1, 1965 and implemented from July 1, 1966, is another large public social insurance program that provided almost universal health insurance coverage mainly for elderly Americans who were 65 or older and whom in many cases did not have meaningful private health insurance prior to Medicare (Finkelstein, 2007). We study the impact of the introduction of Medicare on union membership.

We follow the empirical strategy of Finkelstein (2007). Prior to the introduction of Medicare, the private health insurance coverage rates of the elderly differed across regions,

Figure 3: Estimated Impact of Medicare Introduction on Unions



(a) Blue Cross Coverage

(b) Any Insurance Coverage

Note: This figure displays the estimated coefficients of equation (3). The error bars represent the 95% confidence intervals based on standard errors clustered at the state level.

and the introduction of Medicare increased the coverage to, almost uniformly, 100 percent. In our context, given the role of unions in providing retiree insurance coverage, regions that had larger retiree private insurance coverage prior to Medicare would be associated with a larger decline in the union density after the introduction of Medicare because the role of unions in providing retiree insurance would be partly replaced by Medicare.[8]

We now investigate how the changes in the union density in each state after the introduction of Medicare is related to the fraction of elderly in the state with private retiree insurance prior to Medicare introduction. We estimate the following difference-in-difference spe cification:

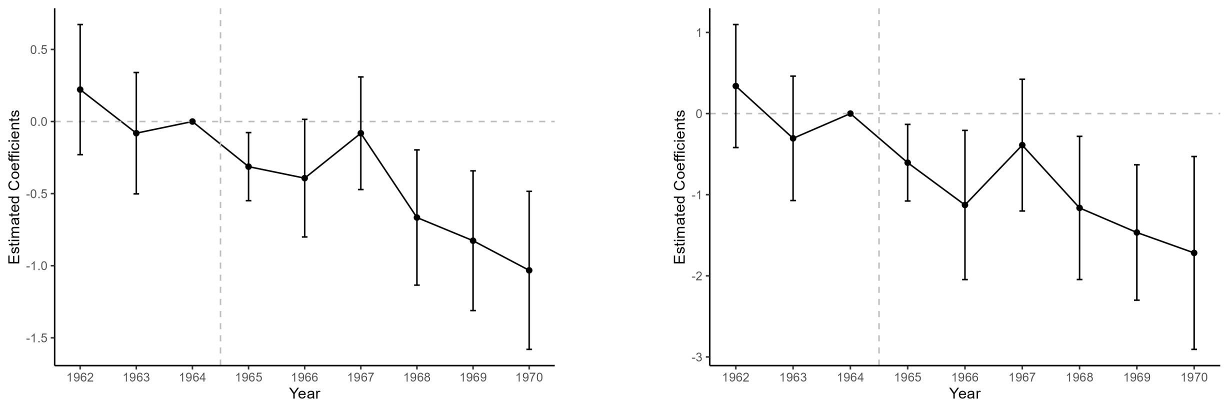
$$y_{st} = \sum_{\tau=-1,\tau\neq 0}^{5} \beta_\tau \times (Coverage_{s,1963}) \times \mathbb{1}\{t = \tau + 1965\} + x'_{st}\gamma + \alpha_s + \lambda_t + \epsilon_{st} \tag{3}$$

where the outcome variable y_{st} is the log of union membership density in our baseline analysis, and the treatment variable $Coverage_s$ is the fraction of the elderly in state s covered by private retiree insurance in 1963. x_{st} is a vector of time-varying state-level covariates. α_s and λ_t are the state and year fixed effects. We impose a normalization by excluding $\mathbb{1}\{t = 1965\}$.

We control for differential changes in state political environments. Specifically, we control for an indicator for a Democratic governor, the third-order polynomials of the proportion of state legislative seats held by the Democratic Party, separately for the state Senate and

[8]We confirm that unions indeed provided old individuals with access to insurance before the introduction of Medicare. Figures 8 and 9 in Appendix show a positive correlation between union density and the fraction of the insured elderly across states prior to the introduction of Medicare.

Figure 4: Impact of Medicare Introduction on Union Elections



(a) Blue Cross Coverage

(b) Any Insurance Coverage

Note: This figure displays the estimated coefficients of equation (3) where the outcome is the log number of elections. The error bars represent the 95% confidence intervals based on standard errors clustered at the state level.

House. Medicaid was also enacted in 1965 while its implementation was different across states, ranging from 1966 to 1972 except for Arizona. We also include four indicators for the number of years before/after the implementation of Medicaid in each state.[9] We use state population in 1960 as weights. Standard errors are clustered at the state level. We follow Finkelstein (2007) in making a distinction between Blue Cross insurance coverage, which had more comprehensive coverage than most others, and any insurance coverage.

Figure 3 graphically displays the estimates of equation (3). The coefficient is normalized to 0 in the year 1965. In line with our expectations, the estimated coefficients after the year 1965 suggest that regions with larger insurance coverage prior to Medicare, where unions would have played an important role in providing insurance, experienced declines in union density compared to regions with smaller insurance coverage during the first five years after the introduction. Although we can check the pre-trend only for one year due to the lack of data, we confirm that there is no significant pre-trend.

We provide additional evidence on the Medicare impact using the data on NLRB elections. We use the same specification as equation (3) but use the log of the number of elections as an outcome variable y_{st}. The election data is available from 1962. Since there are multiple periods available before 1965, we normalize the impact in 1964 to zero so that we can capture the impact in the same year of the Medicare introduction.

Figure 4 displays the estimated coefficients of equation (3) where the outcome variable is the log of the number of elections. Panel (a) shows the results where the treatment is Blue

[9]See Table 11 for the timing of the implementation of Medicaid, which is based on Table 1.1 of Gruber (2003).

Cross coverage while panel (b) is the case where the treatment is any insurance coverage. The figure confirms the previous result that regions with larger insurance coverage prior to Medicare introduction experienced decline in union elections compared to regions with smaller insurance coverage. We do not find significant pre-trends detected in both cases.

3.2.2 Introduction of Medicaid

In the previous analysis of Medicare introduction, we controlled for the varying timing of Medicaid implementation. We can also leverage this variation to estimate the impact of Medicaid implementation on unionization. Specifically, although Medicaid was signed into law in July, 1965, the timing of the implementation was up to each individual state. As a result, some states implemented the program earlier than other states. Table 11 lists the timing of the implementation by each state.

One complication here is staggered treatment timing that makes the standard difference-in-differences estimates hard to interpret. Furthermore, most states quickly implemented the program within a few years, and there is only a small group of states belonging to "not-yet-treated" states if we aim to estimate dynamic effects for a long period of time. As a compromise, we take a short time window.

We begin with the following standard event study specification

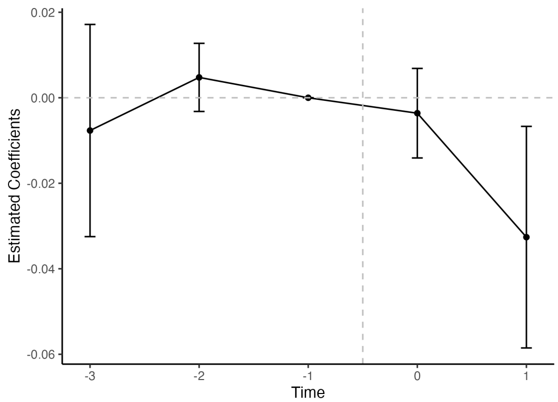
$$y_{st} = \sum_{\tau=-4,\tau\neq-1}^{1} \beta_t \mathbb{1}\{t - E_s = \tau\} + \beta_{-5}\mathbb{1}\{t - E_s \leq 5\} + x'_{st}\gamma + \alpha_s + \lambda_t + \epsilon_{st} \tag{4}$$

using the sample until $t = 1967$. The outcome of interest is either the log of union density or the log of the number of elections. E_s is the year when state s implements the Medicaid. x_{st} is a vector of time-variant covariates. α_s and λ_t are the state and year fixed effects. We control for the same set of variables representing the state political environments as in the previous regression equation (3) for Medicare. We use state population in 1960 as weights. We cluster standard errors at the state level.

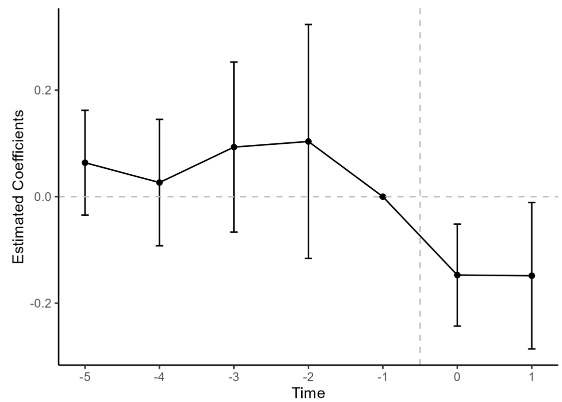
Figure 5 displays the estimated coefficients of equation (4). Panel (a) shows the impact of the Medicaid Implementation on union density. One year after the implementation, the estimate suggests union density is reduced by 3%. Panel (b) shows the impact on the number of elections. It shows the number of union elections gets more than 10% lower due to the implementation of Medicaid. In both of those cases, we do not detect significant pre-trends.

One caveat is that with treatment effect heterogeneity across states with different treatment timing, the estimated coefficients of equation (4) are harder to interpret, and testing β_τ for $\tau < -1$ does not provide a valid test for pre-trends. As a robustness check, Figure 6 report the interaction-weighted estimates proposed by Sun and Abraham (2021) and we

Figure 5: Estimated Impact of Medicaid Implementation on Union



(a) Log Union Membership Density



(b) Log Elections

Note: This figure displays the estimated coefficients of equation (4). The error bars represent the 95% confidence intervals based on standard errors clustered at the state level.

find similar patterns as in Figure 5.

3.2.3 Expansions of Social Insurance Programs in Recent Years

So far, we have documented that the introduction of large-scale social insurance programs such as Medicare and Medicaid lowered both unionization and union formation in the U.S. in the past. Next, we examine whether the expansion of social insurance programs still lowers the unionization rate in the recent time period.

Here, we summarize the main analysis and findings and relegate all the details in Appendix A. We consider policy changes in health insurance and unemployment insurance (UI) First, we examine the effect of insurance expansions under the 2010 Affordable Care Act (ACA). One of the key provisions of the ACA is a state-based expansion of Medicaid. which provides Medicaid coverage to anyone whose income is below 138% of FPL. To utilize the variation in the ACA Medicaid expansion across states, we employ a difference-in-differences approach and estimate the impact of the expansion on union membership. Our empirical speficaitions explicitly control for other factors affecting changes in the unionization rate, such as changes in RTW laws in some states. We find that the ACA Medicaid expansion slightly lowers the union membership on average; but it lowers the unionization rate much more significantly for low-educated workers.

Second, we consider the effect of more generous UI benefits. The UI provides temporary benefits to individuals who lost their jobs, which possibly substitute the union's role of job protection. Importantly, each state can adjust the UI generosity including the amount of benefits and the maximum duration. We use variations in UI generosity across states and over time to estimate the impact of UI generosity on union membership. We find that more generous UI raplacement lowers the individual unionization rate; however, higher miximum amount of UI has little effects on unionization rate, suggesting how the UI targets to workers with different income may matter in affecting worker's incentive to work at the unionized job.

Summary of findings. Overall, these patterns suggest that more generous social insurance reduces the unionization rate and union formation. Since union firms tend to offer employer-based insurance benefits, the evidence in this section as a whole suggests that the prevalence of unions in the economy depends on the social insurance system. In the next section, we formulate an equilibrium labor market model to understand the underlying mechanisms that relate labor unionization and social insurance.

4 The Model

In this section, we formulate an equilibrium labor market model to understand the underlying mechanisms that relate labor unionization and social insurance. Our previous section documents the relationship among union status, the provision of employer-based insurance benefits, and social insurance programs. Thus, we first consider that both union formation and insurance provisions are endogenously determined in the labor market and then analyze the effects of social insurance programs.

4.1 Environment

We consider a discrete time, infinite horizon model. There is a unit mass of risk-averse workers with heterogeneous skill types indexed by $x \in \mathcal{X} \equiv \{1, \ldots, X\}$. The fraction of workers of each skill type x is denoted by N_x. Workers' utility function depends on wage $w > 0$ and non-wage amenity or benefits $a \in \mathcal{A}$, where $\mathcal{A}$ is a finite set. Each element of $\mathcal{A}$ represents a particular bundle of non-wage amenities or benefits; in particular, $a = 0$ denotes no benefits. Firms are risk-neutral and are heterogeneous in their production technologies, which is indexed by $y \in \mathcal{Y} \equiv \{1, \ldots, Y\}$. Each firm uses only labor inputs $\boldsymbol{g} = (g_1, \ldots, g_X)$, where g_x denotes the measure of type-x workers it hires, to produce consumption goods according to a production function $F_y(\boldsymbol{g})$ which depends on the firm's production technology type y [see Eq. (15) for details]. The measure of type y firms is given by M_y and the total measure of firms is $M = \sum_{y \in \mathcal{Y}} M_y$. Both workers and firms discount future value at a rate $\gamma \in (0, 1)$. For simplicity, we assume that workers cannot save or borrow.

4.2 Labor Markets

There is a frictional labor market for each skill type x. Firms can post multiple vacancies. In each sub-market for skill type x, matches are created according to matching function $m(s_x, v_x)$ where s_x is the measure of unemployed job seekers of type x, and v_x is the measure of vacancies for workers of type x. We assume that $m(\cdot, \cdot)$ is strictly concave and strictly increasing in each argument, and homogeneous of degree one. We define the labor market tightness as $\theta_x = \frac{v_x}{s_x}$. Since $m(\cdot, \cdot)$ is homogeneous of degree one, the vacancy-filling probability is given by $q(\theta_x) = \frac{m(s_x, v_x)}{v_x} = m\left(\frac{1}{\theta_x}, 1\right)$, and the job-finding probability is given by $p(\theta_x) = \frac{m(s_x, v_x)}{s_x} = m(1, \theta_x)$. Matches are destroyed at the end of each period with probability $\delta_{x,k}$, which depends on worker skill type $x \in \mathcal{X}$ and firm union status $k \in \{u, n\}$. There is no on-the-job search.

4.3 Timing

The timing of events in each period is as follows. (i) Firms decide how many vacancies to post in each market and decide on amenity provisions. (ii) Vacancies and unemployed individuals are randomly matched in each labor market. (iii) Union voting takes place in which workers take into account the impact of the union voting outcome on wages. (iv) Production takes place, and wages and amenities are provided. (v) A fraction $\delta_{x,k}$ of jobs are destroyed for each x depending on the union status.

4.4 Workers

Preferences. If a worker of type x gets wage w and amenity a, then the worker gets utility $u_x(w, a)$ where we allow preferences to depend on type x. We assume that an unemployed individual gets $u_x(b_x, 0)$ where b_x is unemployment benefits (and/or home production).

Value functions. The value for a worker of skill type x when employed by a firm of type y with union status $k \in \{u, n\}$ that offers compensation package (w, a) this period is given by

$$V^E_{x,y,k}(w, a) = u_x(w, a) + \gamma\Big[\delta_{x,k} V^U_x + (1 - \delta_{x,k}) V^E_{x,y,k}(w_{x,y,k}, a_{x,y,k})\Big]. \quad (5)$$

The first term on the right hand side is the current period utility while the second term is the expected future value discounted by γ: with probability $\delta_{x,k}$, the job is destroyed and the worker gets the unemployment value V^U_x which is described below; with the remaining probability $1 - \delta_{x,k}$, the worker continues with the same firm with the same union status k that provides the equilibrium wage and amenity $(w_{x,y,k}, a_{x,y,k})$ in the next period. Firms and workers take $(w_{x,y,k}, a_{x,y,k})$ as given when determining wages in the bargaining problem for the current period.

V_x^U is the value of a type-x worker from being unemployed at the beginning of a period and is given by

$$V_x^U = p(\theta_x)V_x^M + (1 - p(\theta_x))[u_x(b_x, 0) + \gamma V_x^U], \tag{6}$$

where with probability $1-p(\theta_x)$, the worker remains unmatched, and with probability $p(\theta_x)$, the worker meets a firm and gets the value V_x^M, which denotes the expected value of a match where the expectation is taken over the distribution of firms in sub-market x. Specifically, let $v_{x,y}$ denote the measure of vacancies for type x workers posted by each type-y firm, then the value of meeting a vacancy is given by

$$\begin{aligned} V_x^M = \sum_{y=1}^{Y} \Omega_{x,y} \sum_{a \in \mathcal{A}} \Big[& \mathcal{Q}_y P_{y,u}(a) \max\{V_{x,y,u}^E(w_{x,y,u}, a), V_x^U\} \\ & + (1 - \mathcal{Q}_y) P_{y,n}(a) \max\{V_{x,y,n}^E(w_{x,y,n}, a), V_x^U\} \Big], \end{aligned} \tag{7}$$

where

$$\Omega_{x,y} = \frac{\nu_{x,y} M_y}{\sum_{y'=1}^{Y} v_{x,y'} M_{y'}} \tag{8}$$

denotes the fraction of vacancies in sub-market x posted by type-y firms. In Eq. (7), a worker of type x meets a vacancy posted by a firm of type y with probability $\Omega_{x,y}$; and among type-y firms, a fraction $\mathcal{Q}_y$ is unionized while the remainder $1 - \mathcal{Q}_y$ is not unionized.

4.5 Cost of Unionization and Union Prevention

While, in theory, a firm is expected to unionize if a majority of workers favor it, the reality is more nuanced. Firms often resort to various strategies to prevent unionization (Dickens 1983, Freeman and Kleiner 1990, Bronfenbrenner 1994). To more comprehensively capture both the costs associated with unionization and those of preventing union formation, we assume that firms determine unionization but the costs they incur in this process are influenced by the collective preferences of their workers. Consequently, while the option to remain non-unionized always exists for a firm, it is infeasible to profitably prevent unionization if workers exhibit a strong collective preference for it.

Let $w_{x,y,u}(\boldsymbol{g}, a)$ and $w_{x,y,n}(\boldsymbol{g}, a)$ be the wage schedule that a type-y firm pays to type-x workers when it is unionized ($k = u$) and nonunionized ($k = n$), respectively. These wage schedules, which will be elaborated on later, are influenced by both labor input $\boldsymbol{g}$ and the firm's chosen amenity a since these variables determine the surplus created in the firm over which the parties (workers and firm) will bargain.

We define each worker's *willingness to pay for unionization* as follows. Let $\mathcal{W}_{x,y,n}(\boldsymbol{g}, a)$ denote the willingness of a type-x worker in a type-y nonunion firm with amenity a to pay for unionization, and it is implicitly determined by

$$V^E_{x,y,u}(w_{x,y,u}(\boldsymbol{g}), a) = V^E_{x,y,n}(w_{x,y,n}(\boldsymbol{g}) + \mathcal{W}_{x,y,n}(\boldsymbol{g}, a), a), \tag{9}$$

where $V^E_{x,y,u}(\cdot)$ is defined in (5). That is, $\mathcal{W}_{x,y,n}(\boldsymbol{g}, a)$ gives a dollar amount a type-x worker needs to be compensated for staying nonunionized in type-y firm that provides amenity a. Note that $\mathcal{W}_{x,y,n}(\boldsymbol{g}, a)$ can be either positive or negative. The willingness to pay for unionization tends to be positive for low-skill workers and be negative for high-skill workers. As detailed later, this discrepancy arises because collective bargaining in union firms redistributes surplus from high-skill to low-skill workers.

The firm-level aggregate willingness to pay for union in a nonunion firm of type y is given by

$$\mathcal{W}_{y,n}(\boldsymbol{g}, a) = \sum_x \mathcal{W}_{x,y,n}(\boldsymbol{g}, a) \times g_x. \tag{10}$$

Finally, we use the willingness to pay measure defined above to construct a firm's cost of nonunionized as follows.

$$C_{y,n}(\boldsymbol{g}, a) = \begin{cases} c_{0,n}\mathcal{W}_{y,n}(\boldsymbol{g}, a) & \text{if } \mathcal{W}_{y,n}(\boldsymbol{g}, a) \geq 0 \\ 0 & \text{otherwise,} \end{cases} \tag{11}$$

where $c_{0,n} > 0$ reflects the marginal cost of the various ways that a firm may deploy to counteract unionization, which we term the *union threat cost*. Eq. (11) captures the idea that, if the employees' aggregate willingness to pay for unionization is positive, a firm needs to incur the cost to suppress unionization, and the more eager workers are to form a union, the more costly is for the firms to prevent unionization. The union threat cost implies that if different types of workers have different willingness to pay for unionization, firms have an incentive to distort composition of workers to reduce the union threat cost. Eq. (9) also makes it clear that a non-unionized firm can also modify its wage offerings $w_{x,y,n}(\boldsymbol{g})$ to affect the union threat cost.

We define similar cost function when a firm prefers unionization but its workers oppose it.[10] Let $\mathcal{W}_{x,y,u}(\boldsymbol{g}, a)$ denote the dollar amount a type-x worker in a type-y unionized firm that provides amenity a needs to be compensated to disband the union, which we refer to

[10]Although workers are likely to prefer union on average in a quantitative model we use later, we define the cost function of union firms in order to be complete.

as the *willingness to accept de-unionization*. It is defined explicitly by:

$$V_{x,y,u}^E(w_{x,y,u}(\boldsymbol{g}) + \mathcal{W}_{x,y,u}(\boldsymbol{g}, a), a) = V_{x,y,n}^E(w_{x,y,n}(\boldsymbol{g}), a). \tag{12}$$

$\mathcal{W}_{x,y,u}(\boldsymbol{g}, a)$ can be positive or negative. As before, define the firm-level aggregate willingness to accept de-unionization for all the workers in a unionized firm of type y that provides amenity a as:

$$\mathcal{W}_{y,u}(\boldsymbol{g}, a) = \sum_x \mathcal{W}_{x,y,u}(\boldsymbol{g}, a) \times g_x. \tag{13}$$

Finally, the total cost of a type-y union firm to maintain unionization of all of its workers $\boldsymbol{g}$ is given by:

$$C_{y,u}(\boldsymbol{g}, a) = \begin{cases} F_{union} + c_{0,u}\mathcal{W}_{y,u}(\boldsymbol{g}, a) & \text{if } \mathcal{W}_{y,u}(\boldsymbol{g}, a) \geq 0 \\ F_{union} & \text{if } \mathcal{W}_{y,u} < 0, \end{cases} \tag{14}$$

where F_{union} is the fixed cost of union that a firm needs to pay regardless of whether workers agree on unionization, and $c_{0,u} > 0$ reflects the marginal cost of the various ways that a firm may deploy to counteract de-unionization.

4.6 Firms

Firms produce consumption goods using only labor inputs. Firms are distinguished by their type $y \in \mathcal{Y}$. The production function of a type-y firm is a function of worker composition $\boldsymbol{g} = (g_1, \ldots, g_X)$ and is given by

$$F_y(\boldsymbol{g}) = A_y \left(\sum_{x=1}^{X} z_x g_x^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}\alpha_y}, \tag{15}$$

where A_y is the firm-specific total factor productivity (TFP), α_y is the returns to scale, σ is the elasticity of substitution between different skills, z_x is the relative skill intensity satisfying $\sum_{x=1}^{X} z_x = 1$. We assume decreasing returns to scale $\alpha_y < 1$ for all firms. Notice that in the production function specified in (15), firms of different types y differ in two aspects: their TFP A_y and their returns to scale α_y.

Firms pay wages and provide amenities to their workers. The current-period profit function of a type-y firm with union status $k \in \{u, n\}$is given by

$$\pi_{y,k}(\boldsymbol{g}, a) = F_y(\boldsymbol{g}) - \sum_{x=1}^{X} \left[w_{x,y,k}(\boldsymbol{g}, a) + c_x(a) \right] g_x - F_a(a), \tag{16}$$

where the first term is revenue from the output. The second term is the compensation costs of hiring its workers: $w_{x,y,k}(\boldsymbol{g}, a)$ is a wage schedule which depends on union status k, and $c_x(a)$ is the per-worker expected cost of providing amenity a to a worker of type x. $F_a(a)$ represents the fixed cost of providing amenity level a, and $F_a(a) > 0$ if $a > 0$ and $F_a(0) = 0$.

The fixed cost $F_a(a)$ encapsulates various costs tied to amenity provisions that remain invariant with respect to the firm size. For instance, a firm might establish and run a benefits office to offer amenities to its employees. This can also encompass the transaction costs arising from making contracts with insurance providers. Also, in the case of health insurance, insurance companies often impose an administrative service over the anticipated claims costs. As noted by Karaca-Mandic et al. (2011), smaller establishments tend to bear considerably higher loading fees compared to their larger counterparts. A portion of this discrepancy can be attributed to the fixed cost in our model.[11] The fixed cost of providing amenities give union firms the cost advantage in providing amenities to their workers, which we discuss in Section 4.9.

A firm pays a cost $\kappa > 0$ for each vacancy. Given $\boldsymbol{g}$ and a, type-y firms choose the number of vacancies to post in each sub-market for skill type $x \in \mathcal{X}$, denoted by $\nu_{x,y}$, to maximize the discounted sum of profits:

$$J_{y,k}(\boldsymbol{g}, a) = \max_{\{\nu_{1,y},\ldots,\nu_{X,y}\}} \left\{ \pi_{y,k}(\boldsymbol{g}', a) - C_{y,k}(\boldsymbol{g}, a) - \kappa \sum_{x=1}^{X} \nu_{x,y} + \gamma J_{y,k}(\boldsymbol{g}', a) \right\}, \tag{17}$$

subject to the law of motion

$$g'_x = (1 - \delta_{x,k}) g_x + \nu_{x,y} q(\theta_x) e_{x,y,k,a}, \quad x = 1, \ldots, X, \tag{18}$$

where $q(\theta_x)$ is defined in Subsection 4.2 and $e_{x,y,k,a}$ is worker's decision of accepting a job from this firm.[12] Notice that the objective function (17) incorporates the union threat cost $C_{y,n}(\boldsymbol{g}, a)$, or the union maintenance cost $C_{y,u}(\boldsymbol{g}, a)$, as defined by (11) and (14) respectively. The first term in the law of motion (18) is the number of workers who are not hit with the exogenous separation shock from the firm, while the second term is the number of new hires.[13] Notice that the separation rate $\delta_{x,k}$ is allowed to differ by x and k, which can capture two relevant forces: first, workers of different skills can subject to different rates of job separation, and second, unions can affect job security and the impact can potentially

[11]This type of cost is quantitatively important too. Karaca-Mandic et al. (2011) report firms of up to 100 employees face loading fees of about 34%. The number is 4% for firms with more than 10,000 employees.

[12]Recall that $\theta_x = \nu_x / s_x = \sum_{y' \in \mathcal{Y}} \nu_{x,y'} / s_x$. We assume that each type-y firm is infinitesimally small so its choice of $\nu_{x,y}$ does not impact θ_x.

[13]Although each vacancy is filled randomly, due to the law of large numbers, the number of new hires is deterministic.

differ by workers' skill type.

In a steady state, the objective function for firms of type y can be rewritten as follows.[14]

$$\pi_{y,k}(\boldsymbol{g}, a) - C_{y,k}(\boldsymbol{g}, a) - \psi_{y,k}(\boldsymbol{g}, a), \tag{19}$$

where

$$\psi_{y,k}(\boldsymbol{g}, a) = \kappa \sum_{x=1}^{X} \frac{g_x}{q(\theta_x)} - \kappa\gamma \sum_{x=1}^{X} (1 - \delta_{x,k}) \frac{g_x}{q(\theta_x)}. \tag{20}$$

The first term in (19) is the current-period profit; the second term is the union threat cost $C_{y,n}(\boldsymbol{g}, a)$, or the union maintenance cost $C_{y,u}(\boldsymbol{g}, a)$, as defined by (11) and (14) respectively; and the third term $\psi_{y,k}(\boldsymbol{g}, a)$ is the cost of posting a vacancy and the gain from lowering the future hiring costs. Although the total cost of vacancy posting is linear in the number of workers, the firm's problem has a solution since the production function exhibits decreasing returns to scale.

Hiring and amenity provision. We now describe the optimal choice of $\boldsymbol{g}$ and a. We introduce firms' taste shocks for amenity provision $\{\epsilon_a\}_{a\in\boldsymbol{\mathcal{A}}}$ and for union formation $\{\epsilon_k\}_{k\in\{u,n\}}$ that follows Type-I extreme value distributions with scale parameters σ_a and σ_k respectively, and these shocks are assumed to be independently across firms but are fixed over time each firm. Since shocks are fixed over time for each firm, each firm has the same union status and amenity-provision status over time in a steady state. We assume that these shocks are unobservable to workers and cannot be bargained over in either individual bargaining or collective bargaining that we describe in the next subsection. As a result, these shocks do not affect wage functions.

To compute the probability of providing insurance and unionization, we first consider a firm's hiring problem given a and union status k. Given a and union status $k \in \{u, n\}$, a firm maximizes the steady state objective function (19):

$$\boldsymbol{g}_{y,k}(a) = \arg\max_{\boldsymbol{g}} \left\{\pi_{y,k}(\boldsymbol{g}, a) - C_{y,k}(\boldsymbol{g}, a) - \psi_{y,k}(\boldsymbol{g}, a)\right\}. \tag{21}$$

Given the optimal hiring choices above, a firm's value of choosing a is given by the discounted sum of profits:

$$\hat{J}_{y,k}(a) = \frac{1}{1-\gamma}\left[\pi_{y,k}(\boldsymbol{g}_{y,k}(a), a) - C_{y,k}(\boldsymbol{g}, a) - \kappa \sum_{x=1}^{X} \frac{\delta_x g_{x,y,k}(a)}{q(\theta_x)}\right]. \tag{22}$$

[14]See Lemma 1 of Taschereau-Dumouchel (2020).

For each $k \in \{u, n\}$, a firm's amenity choice problem is given by

$$J_{y,k}(\{\epsilon_a\}_{a\in\mathcal{A}}) = \max_{a\in\boldsymbol{\mathcal{A}}} \left\{\hat{J}_{y,k}(a) + \epsilon_a\right\}. \tag{23}$$

Given that ϵ_a is assumed to have extreme value Type-I distribution with scale parameter σ_a (and location parameter 0), the probability that a firm provides amenity a conditional on union status $k \in \{u, n\}$ is then given by

$$P_{y,k}(a) = \frac{\exp\left(\hat{J}_{y,k}(a)/\sigma_a\right)}{\sum_{a'\in\boldsymbol{\mathcal{A}}} \exp\left(\hat{J}_{y,k}(a')/\sigma_a\right)}. \tag{24}$$

Unionization. A firm solves the hiring problem (21) for both $k = u$ and $k = n$, and it chooses a union status that gives a higher value. Specifically, a firm of type y unionizes if and only if $J_{y,u}(\{\epsilon_a\}_{a\in\boldsymbol{\mathcal{A}}}) + \epsilon_u \geq J_{y,n}(\{\epsilon_a\}_{a\in\boldsymbol{\mathcal{A}}}) + \epsilon_n$, where ϵ_u and ϵ_u are respectively the independently shocks independently drawn from Type-I extreme value distribution with scale parameter σ_k as described previously. Thus the fraction of union firms among type y firms is given by

$$\mathcal{Q}_y = \mathbb{E}\left[\frac{\exp\left(J_{y,u}(\{\epsilon_a\}_{a\in\boldsymbol{\mathcal{A}}})/\sigma_k\right)}{\exp\left(J_{y,u}(\{\epsilon_a\}_{a\in\boldsymbol{\mathcal{A}}})/\sigma_k\right) + \exp\left(J_{y,n}(\{\epsilon_a\}_{a\in\boldsymbol{\mathcal{A}}})/\sigma_k\right)}\right], \tag{25}$$

where the expectation is taken over the joint distribution of a firm's taste shocks for amenity provision $\{\epsilon_a\}_{a\in\boldsymbol{\mathcal{A}}}$. Notice $\mathcal{Q}_y$ as derived in (25) appears in the workers' value function (7).

Remark 1. *In our model we conceptualize that it is up to the firms to decide whether or not their workers will be unionized, the firms cannot ignore workers' preferences. The reduced-form union threat cost $C_{y,n}(\boldsymbol{g}, a)$ as defined by (11) implies that if workers have strong preferences for unionization, firms cannot profitably prevent unionization and therefore likely end up with unionized workers; likewise, the union maintenance cost $C_{y,u}(\boldsymbol{g}, a)$, as defined by (14), implies that if workers have strong preferences for non-unionization, firms cannot profitably unionize the workers and therefore likely end up with non-unionized workers.*

4.7 Wage Bargaining

Wages are determined by Nash bargaining between an employer and its workers. In a union firm, *collective bargaining* takes place between the workers' union and the employer where they split the total surplus of the match. We specify the collective bargaining problem as an n-player Nash bargaining problem. In a nonunion firm, *individual bargaining* takes place between each individual worker and the employer where they split only the surplus generated by the focal worker joining the production. These bargaining problems are solved given the hiring profile $\boldsymbol{g} = (g_1, \ldots, g_x)$ and amenity provision a.

Note that a surplus generated from employment for a worker of type x is given by

$$V^E_{x,y,k}(w, a) - u_x(b_x, 0) - \gamma V^U_x = u_x(w, a) - \upsilon_{x,y,k}, \tag{26}$$

where $\upsilon_{x,y,k}$ is the net value of unemployment which is given by

$$\upsilon_{x,y,k} = u_x(b_x, 0) + \gamma(1 - \delta_{x,k})\frac{(1-\gamma)V^U_x - u_x(w_{x,y,k}, a_{x,y,k})}{1 - \gamma(1 - \delta_{x,k})}. \tag{27}$$

Since we assume that wage bargaining takes places in each period without commitment, $\upsilon_{x,y,k}$ is taken as given in the current-period bargaining because the term is determined in future bargaining.

Individual bargaining. In an individual bargaining problem, the firm bargains with each worker separately. Due to the decreasing returns to scale of the production function, the surplus depends on whether a worker is treated as a marginal worker or an infra-marginal worker. We take the approach by Stole and Zwiebel (1996) where every worker is treated as a marginal worker.[15] Because of the decreasing returns to scale technology, adding each marginal worker's contribution to output does not add up to the total production.

Note that the bargaining takes place after the hiring decision and therefore the bargaining does not take into account the impact of an extra worker on the vacancy posting cost that was needed to hire the worker. Accordingly, the marginal gain from an extra worker of type x considered in the bargaining is obtained by differentiating equation (19) ignoring the first term of (20), and it is given by:

$$\Delta_{x,y,n}(\boldsymbol{w}, a) = \frac{\partial F_y(\boldsymbol{g})}{\partial g_x} - w_{x,y,n}(\boldsymbol{g}, a) - c_x(a) - \sum_{x'=1}^{X} \frac{\partial w_{y,x',n}(\boldsymbol{g})}{\partial g_x} g_{x'} + \frac{\gamma\kappa(1-\delta_{x,n})}{q(\theta_x)}. \tag{28}$$

The individual bargaining problem is then given by, for each $x \in \mathcal{X}$:

$$\max_{w_x} \quad [u_x(w_{x,y,n}(\boldsymbol{g}), a) - \upsilon_{x,y,n}]^{\beta_n} \left[\Delta^n_{x,y,n}(\boldsymbol{w}, a)\right]^{(1-\beta_n)}, \tag{29}$$

where $\beta_n \in (0, 1)$ is the bargaining power of a nonunion worker. Note that the bargaining problems in (29) for all $x \in \mathcal{X}$ need to be solved simultaneously.

[15]The same approach is taken by, for example, Acemoglu and Autor (2011), Elsby and Michaels (2013), and Taschereau-Dumouchel (2020).

Collective bargaining. We consider a collective bargaining problem as a n-player Nash bargaining problem between a firm and all its workers represened by their union, following Taschereau-Dumouchel (2020). The collective bargaining problem is given by

$$\max_{\boldsymbol{w}} \left[\prod_x (u_x(w_{x,y,u}(\boldsymbol{g}), a) - \upsilon_{x,y,u})^{\frac{g_x}{n_y}} \right]^{\beta_u} \times \left[F_y(\boldsymbol{g}) - \sum_{x=1}^{X} (w_{x,y,u}(\boldsymbol{g}) + c_x(a)) g_x - F_a(a) + \kappa\gamma \sum_{x=1}^{X} \frac{(1-\delta_x) g_x}{q(\theta_x)} \right]^{(1-\beta_u)}, \tag{30}$$

where $n_y = \sum_{x=1}^{X} g_x$ is the total size of type-y firm, and β_u is the workers' common bargaining power. Importantly, the fixed cost of amenity F_a shows up in the collective bargaining problem since it is part of the firm's *overall* profit while it does not show up in the individual bargaining since it is not a part of each worker's *marginal* contribution.

4.8 Equilibrium

We focus on a steady-state equilibrium. Market tightness vector for all X sub-markets, denoted by $\theta = (\theta_1, \cdots, \theta_X)$, is determined by two steady-state relationships between the mass of the unemployed and market tightness. First, on the firm side, given market tightness θ, the mass of the unemployed for each skill type x is determined by the hiring decision of firms. Second, on the worker side, given market tightness θ, the mass of the unemployed for each skill type x is determined by the flow into and out of unemployment that are dictated by the exogenous matching function and job destruction.

Given tightness θ_x, firms decide on the optimal hiring which leads to the following total mass of workers hired by firms:

$$\bar{g}_x(\theta) = \sum_{y=1}^{Y} M_y \sum_{a \in \boldsymbol{\mathcal{A}}} \left[\mathcal{Q}_y P_{y,u}(a) g_{x,y,u}(a;\theta) + (1-\mathcal{Q}_y) P_{y,n}(a) g_{x,y,n}(a;\theta) \right], \tag{31}$$

where we let $g^k_{x,y,k}$ for $k \in \{u, n\}$ explicitly depend on θ. Recall that a mass of workers of each skill in the economy is $\{N_x\}_{x=1}^{X}$. The optimal hiring decisions of firms give us a relationship between a mass of unemployed workers and market tightness:

$$\mathcal{U}_x^{JC}(\theta) = N_x - \bar{g}_x(\theta) \tag{32}$$

for each $x = 1, \ldots, X$. We use the superscript JC to emphasize that this is the mass of unemployed workers of each skill type implied by the optimal job creation decisions on the labor demand side.

On the labor supply side, let $s_x(\theta)$ be the steady-state mass of type-x job seekers at the beginning of a period. For each $x \in \mathcal{X}$, we have

$$\sum_{k=u,n} \delta_{x,k}\bar{g}_{x,k}(\theta) = s_x(\theta)p(\theta_x), \tag{33}$$

where the left-hand side is the flow into unemployment and the right-hand side is the flow-out of unemployment.[16] $\bar{g}_{x,k}$ is a mass of workers hired by firms with union status $k \in u, n$ and they are given by

$$\begin{aligned} \bar{g}_{x,u}(\theta) &= \sum_{y=1}^{Y} M_y \mathcal{Q}_y \sum_{a\in\boldsymbol{\mathcal{A}}} P_{y,u}(a) g_{x,y,u}(a;\theta), & (34)\\ \bar{g}_{x,n}(\theta) &= \sum_{y=1}^{Y} M_y (1-\mathcal{Q}_y) \sum_{a\in\boldsymbol{\mathcal{A}}} P_{y,n}(a) g_{x,y,n}(a;\theta). & (35) \end{aligned}$$

Given $s_x(\theta)$, we obtain the mass of unemployed workers (after firms make their hiring)

$$\begin{aligned} \mathcal{U}_x^{BC}(\theta) &= (1-p(\theta_x))s_x(\theta) \\ &= \frac{1-p(\theta_x)}{p(\theta_x)} \sum_{k=u,n} \delta_{x,k}\bar{g}_{x,k}(\theta), \end{aligned} \tag{36}$$

where the second line following from plugging in (33). The function $\mathcal{U}_x^{BC}(\theta)$ represents the mass of unemployed workers of skill x that equalizes flows into and out of unemployment given tightness θ, and BC represents the Beverage curve. Note that both $\mathcal{U}_x^{JC}(\theta)$ and $\mathcal{U}_x^{BC}(\theta)$ are the mass of unemployed workers after matches are formed in the frictional labor markets and before jobs are destructed at the end of a period. Equilibrium market tightness is pinned down by

$$\mathcal{U}_x^{BC}(\theta) = \mathcal{U}_x^{JC}(\theta) \quad x \in \mathcal{X}. \tag{37}$$

Note that our characterization of equilibrium is much richer than existing ones. For example, firms not only decide the union status and the number of vacancies in each sub-market, but they also decide on insurance provisions. Moreover, we allow more worker and firm heterogeneity that may affect these choices. This creates rich predictions among union status, firm size, wages, and insurance coverage. For worker side, we allow that workers may selectively accept job offers based on the union and insurance status of the firm. Such a feature is important in accounting for two-sided sorting in this context.

The cost of our approach is that we lose analytically tractability. For example, by in-

[16] One can get this by imposing the steady state condition on $s'_x = (1-p(\theta))s_x + \sum_k \delta_{x,k}\bar{g}_{x,k}(\theta)$ where s'_x is the mass of job seekers in the next period.

corporating risk averse workers, we cannot obtain a closed-form solution for wage functions $w^k_{x,y}(\boldsymbol{g}, a)$ unlike Taschereau-Dumouchel (2020). However, our model is still numerically tractable. We develop a robust numerical algorithm to solve an equilibrium. Appendix B provides the numerical algorithm we use to solve for equilibrium. Through extensive searches across parameters, our numerical algorithm allows us to find an equilibrium quickly and leads to a unique equilibrium.

4.9 Mechanisms: Incentive to Unionize and Provide Amenity

The main difference between individual bargaining and collective bargaining is that workers in individual bargaining receive their *marginal* contribution to production while workers in collective bargaining receive the *average* contribution to production. Since every worker in a nonunion firm is treated as a marginal worker, the decreasing returns to scale production technology imply that adding up each worker's contribution to the output is smaller than the total output. As a result, a firm can extract more surplus in individual bargaining than in collective bargaining even with the same bargaining power $\beta_u = \beta_n$. In a simple case with risk-neutral workers without amenities, one can analytically show that, if firms can ignore union voting, firms always choose not to be unionized regardless of α as long as $\alpha < 1$ (Taschereau-Dumouchel, 2020).

Worker preferences affect a firm's decision on unionization through the union threat cost (11) for nonunionized firms and the union maintenance cost (14) for unionized firms. Low-skill workers tend to prefer unionization since they benefit from high-skill workers' contributions to production in collective bargaining. To the extent that more workers prefer unionization, nonunion firms have to pay the cost to stay nonunionized. Nonunion firms adjust the skill profile of their workforce to reduce the union threat cost, which implies that they move away from an efficient mix of worker skill composition. If α is small enough, then a firm's gain from individual bargaining is large enough to compensate for production loss associated with the hiring adjustment. But if α is close to 1, the gain from individual bargaining is not sufficiently large and the firm may optimally choose unionization. Therefore, in our model firms with higher α tend to be unionized. Since firms with higher α also tends to be larger (because they are less subject to decreasing returns to scale), our model thus can also explain the empirical observation that larger firms are more likely to be unionized.

Amenity provision also provides incentives to unionize. Amenity provision generates a surplus that firms can extract *only* in collective wage bargaining. Without the fixed cost of amenity provisions, firms' incentives to provide insurance would be independent of the union status; however, with the positive fixed cost of amenity provisions, unionized firms can provide insurance with smaller costs since union firms can pass a part of the fixed cost onto the worker side in collective bargaining. This generates an additional incentive for firms to unionize.

5 Estimation

5.1 Empirical Specification

In order to estimate our model, we will make additional assumptions. First, although our model describes non-wage benefits generally enough, we focus on health insurance in our quantitative applications. a is now a binary variable. A worker with $a = 1$ is insured while a worker with $a = 0$ is not. Second, we specify the direct utility function as follows.

$$u_x(w, a) = \int \frac{C(w, a)^{1-\zeta_x}}{1 - \zeta_x} dH_x(m) \tag{38}$$

where $C(w, a)$ is the level of consumption given wage w and insurance a provided by the firm, ζ_x is the relative risk-aversion parameter, and H_x is the distribution of medical expenditure for type-x workers. For the current specification, we assume that the utility from consumption is $u_x(C(w, a)) = \log C(w, a)$ for all x; i.e., $\zeta_x = 1$ for all x. Consumption level $C(w, a)$ is given by

$$C(w, a) = \max\{w - OOP(m_x; a), \underline{c}\}, \tag{39}$$

where $\underline{c}$ is the consumption floor, and $OOP(m_x; a)$ is an out-of-pocket medical expenditure that depends on a worker's health insurance status.

5.2 Externally Set Parameters

In this section, we estimate the model parameters using U.S. data. We calibrate the model to the economy in 2007. We mainly use the data from the CPS. We also use the firm size information in the Census Business Dynamics Statistics (BDS).

We first take several parameters directly from the literature. First, we set the number of skill types to be $X = 2$. We identify low-skill workers ($x = 1$) as those who are high school graduates or have less education, and high-skill workers ($x = 2$) as those with at least some college education, which is a standard approximation in the literature (Acemoglu and Autor, 2011). Each period of the model is one quarter. The discount rate is set to $\gamma = \frac{1}{1+r}$ where $r = 1.05^{1/4} - 1$ to reflect an annual interest rate of 5%. The elasticity of substitution between skill types is set to $\sigma = 1.5$ (Johnson, 1997). We set the consumption floor $\underline{c}$ to \$1,000. We specify the matching function as $m(s, v) = \mu \frac{sv}{s+v}$ following Den Haan et al.

(2000) where μ is the matching efficiency parameter.[17] The matching efficiency parameter μ and the vacancy creation cost κ are not separately identified from the unemployment rate. We normalize $\mu = 1$ and internally estimate κ. We calibrate b_x so that it includes both unemployment insurance benefits and other sources of non-labor income. Following Hall (2009) and Taschereau-Dumouchel (2020), we set b_x to 85% of the average wage for each skill type. We set the bargaining powers for union workers and nonunion workers to $\beta_u = \beta_n = 0.5$.

5.3 Externally Estimated Parameters

The job destruction rates are allowed to depend both on the skill type and union status. Unfortunately, union status in the CPS is available only in the Outgoing Rotation Samples, which makes it impossible to infer the relationship between union membership and subsequent job loss. To deal with that, we estimate the impact of union status on subsequent job-losing probability in the SIPP and use the estimation result to adjust the job-losing probability in the CPS. For union workers, we set the job destruction rates for $\delta_{1,u} = 0.0549$ and $\delta_{2,u} = 0.0276$ while for nonunion workers, $\delta_{1,n} = 0.0639$, and $\delta_{2,n} = 0.0313$.

The distribution of medical expenditure $H_x(m)$ is parameterized by a log-normal distribution with a mass point at zero. We estimate the parameters of the log-normal distribution and the fraction of individuals with zero expenditure for each skill type in the 2007 Medical Expenditure Panel Survey (MEPS).[18] Note that $OOP(m_x; a)$ depends on the characteristics of an insurance contract. Following Aizawa (2019), we refer to the characteristics of representative employer-sponsored plans reported by Sommers and Crimmel (2008) and assume the annual deductible is \$714 and the coinsurance rate is 18%. Since \$714 is in the 2006 dollar values, we deflate it using the CPI for medical expenditure. We also calculate the average insurance costs for a firm c_x using the estimated medical expenditure distribution $H_x(m)$ and these contract characteristics.

5.4 Internally Estimated Parameters

Identification. We identify and estimate the rest of the parameters within the model. To do so, we first assume that there is a finite set of firm types $y = 1, \ldots, Y$. We set the number of firm types to $Y = 100$. We assume that firms can be different in terms of the returns to scale α_y but the same in terms of TFP A. The heterogeneity in α_y endogenously generates a pattern that larger firms tend to be unionized even without TFP heterogeneity.

[17] This functional form is common in the literature. For example, see Krusell and Rudanko (2016) and Taschereau-Dumouchel (2020).

[18] See https://meps.ahrq.gov/mepsweb/data_stats/.

Table 3: List of Externally Set Parameters

Parameter	Description	Value	Target
γ	Discount rate	0.984	5% annual interest rate
σ	Elasticity of substitution between skills	1.5	Johnson (1997)
μ	Match efficiency	1.0	Normalization
ζ	CRRA parameter	1.0	
$\underline{c}$	Consumption floor ($1K)	0.1	
β_u	Bargaining power of union workers	0.5	
β_n	Bargaining power of nonunion workers	0.5	
N_x	Measure of workers of each type	0.44, 0.56	Fraction of each skill group
$\delta_{u,x}$	Job destruction rate (union)	0.05, 0.03	See text
$\delta_{n,x}$	Job destruction rate (nonunion)	0.06, 0.03	See text
b_x	Consumption during unemp. ($1K)	6.63, 12.00	85% of average wages for each skill
c_x	Variable insurance cost ($1K)	0.78, 0.71	Expected insurer's cost
$H_x(m)$	Distribution of medical expenditure	See text	Medical expenditure distribution for each skill

Note: Monetary values are in $1,000 in year 2007. For the "Value" column with two numbers, the first number corresponds to the value for $s = 1$, and the second for $s = 2$.

We discuss the identification of the key parameters: the measure of firms M, the firm's production technology A and α_y, the cost associated with unions F_{union}, c_0^k, the fixed cost of insurance F_a, and the scale parameters for the choice-specific Type-I extreme value shocks for amenities, σ_a, and for union status σ_k.

The first set of key parameters is the parameters associated with unionization. Regarding the union cost, c_0^n determines the degree of union threats. As we discussed in Section 4.9, if there is no union threat and no benefit to share the fixed cost of insurance provision with the worker union, then no firms have the incentive to unionize. With $c_0^n > 0$, some firms optimally unionize to avoid incurring the cost $C^n(\boldsymbol{g}, a)$. Since this cost is increasing in the firm size, this parameter helps the model account for the unionization rate of large firms. Union firms are "better" at providing insurance; however, the incentives for small firms to unionize depends on the fixed cost of unionization F_{union}, which is the key to determine the unionization rate among small firms. Finally, the parameter σ_k smooths the relationship among firm size, insurance provisions, and unionization rate. We use the union density, the union workers' employment share by firms of size 10+, and the same share by firms of size 100+, in our estimation. Recall that in the model section, we allowed c_0^k to depend on the union status $k \in \{u, n\}$. In the estimation, we assume $c_0^u = c_0^n$. In our model, union firms rarely encounter a situation where a majority of workers are against unions, and hence c_0^u does not affect union firms' decisions, which makes it hard to identify from the data.

The second set of key parameters is the parameters related to insurance provision. The fixed cost of insurance F_a is identified by the overall insurance rate. The model predicts that union firms are more likely to provide insurance for two reasons. First, given the firm size,

Table 4: List of Internally Estimated Parameters

Parameter	Description	Value	Target
M	Measure of total firms	0.04	Average firm size
A	TFP	432.6	Average wage
$\alpha \sim Beta(a, b)$	Production curvature distribution	0.81, 0.75	Firm size distribution
z_1	Low-skill worker relative productivity	0.31	Log wage difference between skill groups
F_a	Fixed cost of insurance provision	12.36	ESHI coverage rate of union and nonunion workers
σ_a	Std. dev. of insurance cost shock	2.24	ESHI coverage rate of union and nonunion workers
F_{union}	Fixed cost of unionization	18.26	Union membership density
σ_k	Std. dev. of union cost shock	5.18	Empl. share of 10+ firms: conditional on union
c_0	Cost of union threat	0.15	Empl. share of 100+ firms: conditional on union
κ	Vacancy posting cost	2.94	Unmpeloyment rate

Note: Monetary values are in $1,000 in year 2007.

union firms are more likely to provide insurance because they can pass part of the fixed cost of insurance to the worker side in collective bargaining. Second, union firms tend to be larger, and the fixed cost of insurance is less damaging for these large firms. A larger taste shock size for insurance σ_a attenuates these effects. More specifically, a larger shock size shrinks the difference between the insured rate of union workers and that of nonunion workers. Hence, the overall insured rate identifies F_a while the relative insured rates conditional on union status provide information on σ_a.

We now discuss the identification of the remaining parameters. The total measure of firms M is chosen to match the average firm size. Firms of different types have different returns to scale α_y. We assume that α_y follows a Beta distribution $Beta(a, b)$ on the support $[0.5, 0.9]$. The distribution of firm sizes is informative about the parameters a and b. If the distribution has a larger density at the upper end of the distribution, large firms have a larger share of employment. For this, we use the employment share by firms of size 10+ and the share by firms of size 100+. TFP A is informed by the average wage. Skill-specific productivity z_1 and z_2 are normalized so that they add up to one. They are informed by the ratio of high-skill wages and low-skill wages. Finally, we identify the match efficiency κ by matching the unemployment rate.

Estimation. Motivated by the above identification arguments, we estimate these parameters via the GMM: especially, we minimize the objective function

$$Q(\vartheta) = [\log \hat{\boldsymbol{m}} - \log \boldsymbol{m}(\vartheta)]' \boldsymbol{W} [\log \hat{\boldsymbol{m}} - \log \boldsymbol{m}(\vartheta)] \tag{40}$$

where $\vartheta = (M, a, b, A, z_1, F_a, \sigma_a, c_0^n, F_{union}, \sigma_k, \kappa)$ is a vector of parameters to be estimated, $\boldsymbol{m}(\vartheta)$ is a vector of model moments based on ϑ, and $\hat{\boldsymbol{m}}$ is a vector of empirical moments. $\boldsymbol{W}$ is a weighting matrix. We set $\boldsymbol{W}$ to an identity matrix.

Table 5: Model Fit

Moments	Data	Model
Union density	0.08	0.08
ESHI coverage: union	0.82	0.77
ESHI coverage: nonunion	0.55	0.62
ESHI coverage: low skill	0.47	0.61
ESHI coverage: high skill	0.62	0.64
Unemployment rate	0.05	0.05
Average quarterly wage ($1K)	11.45	12.53
Skill wage gap (in log)	0.59	0.62
Average firm size	22.56	23.45
Empl. share of 10+ firms	0.88	0.89
Empl. share of 100+ firms	0.64	0.55
Union empl. share of 10+ firms	0.94	0.95
Union empl. share of 100+ firms	0.80	0.71

Table 4 reports estimated parameters together with other parameters and targeted moments. The measure of total firms is estimated to be 0.04. The estimated TFP is 432.6. The parameters of the Beta distribution of α_y are 0.81 and 0.75. This translates to the average returns to scale of around 0.7, which is in line with the estimated values in the literature (e.g. Elsby and Michaels 2013, Cooper et al. 2015) although they estimate it in a different model using other moments. The fixed cost of insurance FC_a is $12,360 per quarter while the S.D. of the cost shock is $2,240. The fixed cost of unionization FC_{union} is about $18,260 per quarter and the S.D. of the cost shock is $5,180. The cost of union threat is estimated to be $c_0^n = 0.15$. The vacancy posting cost is estimated to be $\kappa = 2.94$.

5.5 Model Fit

Table 5 shows the fit of the estimated model. The model succeeds in fitting most moments very well. In particular, union workers are more likely to be covered by ESHI than nonunion workers both in the model and in the data. The model slightly misses the moments related to insurance coverage for each skill although the model still predicts that high-skill workers are more likely to be covered.

Although we do not directly target a union wage premium in the estimation, it would be worth discussing whether the model generates a reasonable one. Just comparing the average wage of unionized firms with that of non-unionized firms masks the direct impact of unionization on average wages and the differences in worker-type compositions between the two. To isolate the direct impact of unionization, we compare the average wage of union firms

Table 6: Counterfactual Policy Simulation: Insurance, Partial Equilibrium (Fixed θ)

	(1)	(2)	(3)	(4)
	Baseline	SI for all	SI for low-skill unemp	Mandatory
Union density (%)	8.0	4.7	6.5	8.0
ESHI coverage (%)				
Overall	63.1	0.0	55.4	100.0
Union	76.8	0.0	65.5	100.0
Nonunion	61.9	0.0	54.7	100.0
Low skill	61.4	0.0	53.3	100.0
High skill	64.3	0.0	56.8	100.0
Output per capita (% change)	0.0	-37.2	-18.4	9.4
Average wage (% change)	0.0	0.9	3.1	-2.8
Skill wage gap (log points)	62.5	63.7	58.4	64.1
Average firm size				
Overall	23.4	13.4	18.2	25.9
Union	45.0	17.9	29.0	49.2
Nonuion	22.5	13.3	17.8	24.8

Note: This table reports the partial equilibrium impacts of each policy change where tightness is fixed at the baseline level. In partial equilibrium, market tightness is fixed at the baseline level. In general equilibrium, tightness is adjusted to satisfy equation (37).

with the average wage of nonunion firms, evaluated based on the hiring decisions of union firms. In our model, the average union wage is only 0.43% higher than the average non-union wage when evaluated with the same hiring composition as in union firms. This small union wage premium in the model is consistent with papers using regression discontinuities in union elections to estimate the causal effect of unionization on firm-level outcomes (DiNardo and Lee, 2004, Frandsen, 2021) although estimated union wage premiums tend to be larger in papers using individual-level data (Card, 1996, Farber et al., 2021).

6 Counterfactual Policy Experiments

In this section, we conduct various counterfactual experiments to understand the equilibrium impacts of union's influence on insurance provisions and labor market outcomes. We first examine the equilibrium impacts of social insurance policies. Second, we examine the effect of subsidizing union firms. Finally, we examine what happens if the labor union loses comparative advantage in providing insurance.

Table 7: Counterfactual Policy Simulation: Insurance, General Equilibrium

	(1)	(2)	(3)	(4)
	Baseline	SI for all	SI for low-skill unemp	Mandatory
Union density (%)	8.0	7.5	5.9	4.8
ESHI coverage (%)				
Overall	63.1	0.0	59.0	100.0
Union	76.8	0.0	65.3	100.0
Nonunion	61.9	0.0	58.6	100.0
Low skill	61.4	0.0	57.0	100.0
High skill	64.3	0.0	60.4	100.0
Unemployment rate (%)				
Overall	5.4	7.9	6.9	5.7
Low skill	9.8	14.6	13.1	10.6
High skill	1.9	2.5	2.0	1.8
Output per capita (% change)	0.0	-1.7	-1.0	-0.1
Average wage (% change)	0.0	-2.0	0.4	-2.8
Skill wage gap (log points)	62.5	65.4	60.2	67.2
Average firm size				
Overall	23.4	22.8	23.1	23.4
Union	45.0	44.0	35.0	31.1
Nonuion	22.5	22.0	22.6	23.1

Note: This table reports the general equilibrium impacts of each policy change.

6.1 Social Insurance

We begin by examining the implications of social insurance for all workers. Specifically, we consider a policy where the government ensures universal health insurance coverage. The associated insurance costs are borne by firms. Let $T(\boldsymbol{g})$ be the total taxes paid by a firm with labor input $\boldsymbol{g}$. $T(\boldsymbol{g})$ is given by

$$T(\boldsymbol{g}) = \sum_{x \in \mathcal{X}} \left(1 + \frac{\mathcal{U}_x}{N_x - \mathcal{U}_x}\right) c_x g_x. \tag{41}$$

Recall that c_x represents the variable cost for a firm to insure a worker of type x in the baseline model. For the policy to be a balanced budget, firms need to pay the cost of insurance for unemployed workers, which is captured by $\frac{\mathcal{U}_x}{N_x - \mathcal{U}_x} \geq 0$ where $\mathcal{U}_x$ is the measure of unemployed workers of skill x and $N_x - \mathcal{U}_x$ is the measure of employed workers of skill x. Although insurance is financed by taxes on firms, firms no longer pay fixed costs since the government provides insurance.

To isolate the direct impact of the policy change on firm behaviors from its equilibrium implications, we first look at labor market outcomes in partial equilibrium with fixed market tightness θ_x and then move on to a general equilibrium impact of the policy change.

Column (2) in Table 6 shows the policy impact under partial equilibrium maintaining market tightness at the baseline level. First of all, the policy change reduces the union density by 3.3 p.p. from 8.0% to 4.7%. This union decline arises primarily from two factors. First, every worker gets health insurance from the government, which removes the cost advantage of union firms in insurance provision. Second, the policy change increases wages by improving the workers' outside option. The higher labor cost makes firms smaller and some firms become unable to profitably cover the fixed costs of union. In general equilibrium, tightness is adjusted, bringing back firm sizes close to the baseline as displayed in Table 7. As a result, the second channel above is alleviated, and the union density is 7.5%, which is 0.5 p.p. smaller than the baseline. The unemployment rate increases by 2.5 p.p. due to the higher marginal cost of hiring, which results in the output loss of 1.7%.

The union decline of 0.5 p.p. associated with the social insurance has different implications for low-skill and high-skill workers both in terms of employment and wages. Since union firms tend to rely more on low-skill workers than nonunion firms, the policy change results in a sharp increase in the unemployment rate among low-skill workers through the union decline. Quantitatively, the unemployment rate among low-skill workers increases by 4.8 p.p. whereas the unemployment rate among high-skill workers increases by only 0.6 p.p. Furthermore, the union decline increases the wage inequality between high-skill workers and low-skill workers by 2.9 log points due to the different bargaining protocols between union firms and nonunion firms.

6.2 Public Insurance for the Low-Income Unemployed

We next examine the impact of public insurance provided to low-skill unemployed workers. Again, we consider a balanced budget policy. Let $T(\boldsymbol{g})$ be the total taxes paid by a firm with labor input $\boldsymbol{g}$. This time, $T(\boldsymbol{g})$ is given by

$$T(\boldsymbol{g}) = \frac{\mathcal{U}_1}{\sum_{x\in\mathcal{X}}(N_x - \mathcal{U}_x)} \sum_{x\in\mathcal{X}} c_1 g_x \tag{42}$$

where c_1 is the variable cost of insuring the low-skill workers of type $x = 1$. Unlike social insurance considered in the previous subsection, firms privately provide health insurance to their workers. Therefore, firms pay fixed costs of insurance if they provide insurance.

Column (3) in Table 6 shows the policy impact under partial equilibrium. The policy change reduces the union density by 1.5 p.p. from 8.0% to 6.5%. As in the previous simulation of social insurance for all, the current policy change also increases the marginal hiring cost, resulting in the union decline through the scale-down of firms. In addition, since public insurance is provided only to low-skill unemployed workers, the policy change is particularly damaging to union firms that rely more on low-skill workers than nonunion firms. As displayed in column (3) in Table 7, the union density further goes down to 5.9% in general equilibrium. The general equilibrium adjustment in tightness makes it cheaper to hire low-skill workers. This allows nonunion firms to easily prevent unionization by over-hiring low-skill workers. As with social insurance for all in the previous simulation, the higher marginal cost of hiring workers raises the unemployment rate by 1.5 p.p., which in turn reduces the output by 1.0%.

The union decline associated with the policy change is damaging to high-skill workers in terms of ESHI coverage. In the baseline, 64.3% of high-skill workers are covered by ESHI while 60.4% of high-skill workers are covered in the counterfactual, which is a 3.9% decline from the baseline. Although the ESHI coverage rate similarly declines for low-skill workers, 13% of low-skill workers are unemployed and they get free public insurance.

Finally, despite the union decline, the policy change reduces the skill wage gap by 2.3 log points. On the one hand, the union decline reduces the number of workers covered by collective bargaining, which widens wage inequality. But the policy change directly increases wages of low-skill workers by improving their outside options, which reduces wage inequality. In total, the positive impact of the union decline on wage inequality is more than offset by the direct impact of the policy change.

The results here and the ones in the previous subsection highlight the difference between the social insurance policy for all workers and the one targeted to low-skill unemployed workers. Although union density decreases in both cases, they have different impacts on the average wage and wage inequality. Social insurance for all workers reduces the average wage and increases wage inequality through the union decline. In contrast, by focusing on low-skill workers, public insurance for low-skill workers helps reduce wage inequality. Also, the impact of the union decline is not strong enough to eliminate all the wage increases. However, by not providing complete insurance coverage, the union decline leads to a lower insurance coverage rate for high-skilled workers.

6.3 Mandatory Insurance

We next study the impact of mandating insurance provisions. Unlike the previous two policies, this does not involve any government transfers.

Column (4) in Table 6 shows the partial equilibrium impact of mandating insurance provision. The policy change has no impact on the union density. There are two counteracting forces behind this. On the one hand, being forced to provide insurance, some firms unionize to reduce the burden of the fixed costs of insurance. On the other hand, firms become less profitable, being unable to cover the union cost. On net, the policy change has almost no effect in partial equilibrium. Yet, once tightness is adjusted in general equilibrium, as shown in Table 7, firms hire fewer workers and the average firm size reduces by 9.7%, which reduces the union density by 3.2 p.p.

Compared to the previous two policy changes, the insurance mandate has a smaller impact on the unemployment rate (+0.3 p.p.). The mandate does not directly affect worker outside options unlike the previous two cases, and therefore the marginal cost of hiring is not directly affected by the policy change. Because of the smaller impact on employment, the impact on output is limited.

As with social insurance for all, the policy change widens wage inequality through deunionization. Quantitatively, the skill wage gap increases by 4.7 log points. Due to the union decline, the average wage declines by 2.8%, but this also partly comes from the fact that all workers are now compensated by insurance and hence accept lower wages.

6.4 Subsidies

Insurance subsidy. In this subsection, we consider subsidies for insurance provisions or unionization. In the U.S., many employer-sponsored insurance benefits are tax deductible, which incentivize firms to provide those benefits. To examine their effects on unionization and labor market outcomes, we first study the effect of subsidies for insurance provisions We implement this policy by reducing insurance fixed costs by 20%, which amounts to about $2,500 per quarter. Column (2) in Table 8 shows the outcomes under the insurance subsidy. Recall that one key incentive for firms to unionize (or not try hard to prevent unionization) is the cost advantage in providing insurance as collective bargaining allows firms to pass through a part of insurance fixed costs to the worker side. By making insurance fixed costs less important, the insurance subsidy reduces the union density by 0.9 p.p. As a result, the insurance subsidy, intended to help workers, has unintended consequences through the union decline. First, fewer workers are covered by collective bargaining and consequently, the subsidy widens wage inequality as the skill wage gap increases by 0.7 log points. Also, the decline in the number of union firms reduces the demand for low-skill workers, pushing up the unemployment rate among low-skill workers by 0.2 p.p. while having no effect on the unemployment rate of high-skill workers.

Since insurance fixed costs matter more for nonunion firms, the subsidy increases the ESHI coverage rate of nonunion workers by 5.4 p.p. while it increases that of union workers just by 2.4 p.p. Since union workers are more likely to be covered by ESHI in baseline, the subsidy shrinks the difference in coverage between union and nonunion workers.

This finding has several interesting implications. First, policies such as the tax deductibil-

Table 8: Counterfactual Policy Simulation: Subsidies

	(1)	(2)	(3)
	Baseline	Insurance subsidy	Union subsidy
Union density (%)	8.0	7.1	14.8
ESHI coverage (%)			
Overall	63.1	68.2	63.9
Union	76.8	79.2	76.6
Nonunion	61.9	67.3	61.6
Low skill	61.4	66.6	62.4
High skill	64.3	69.3	64.9
Unemployment rate (%)			
Overall	5.4	5.5	5.4
Low skill	9.8	10.0	9.7
High skill	1.9	1.9	1.9
Output per capita (% change)	0.0	0.0	0.0
Average wage (% change)	0.0	-0.6	-0.4
Skill wage gap (log points)	62.5	63.2	62.4
Average firm size			
Overall	23.4	23.4	23.5
Union	45.0	42.1	43.3
Nonuion	22.5	22.7	21.7

Note: This table reports the general equilibrium impacts of subsidies for the fixed costs of insurance and the fixed costs of unionization.

ity of employer-sponsored insurance benefits can lower unionization. Such policies essentially weaken union's comparative advantage in providing insurance benefits. Second, subsidizing insurance provisions can also contribute to the rise of wage inequality. This result complements the existing arguments the tax deductibility of these benefits have regressive effects when income tax is progressive. Our finding suggests that even pre-tax income could be affected, leading to further consumption inequality between skilled and less skilled workers.

Union subsidy. We now examine the impact of subsidies for unions. This counterfactual simulation is motivated to evaluate current policy debates to support the unionization in the U.S. We implement this by reducing the fixed cost of union F_{union} by 20%, which amounts to $3,700 per quarter. Column (3) in Table 8 shows the result.

By reducing the cost of unionization, the subsidy directly encourage more firms to unionize, pushing up the union density by 6.8 p.p. from 8.0% to 14.8%. The rise in unions increases the overall ESHI coverage rate by 0.8 p.p. due to unions' advantage in insurance provision. The rise in unions helps low-skill workers in particular. The ESHI coverage rate increases by 1.0 p.p. for low-skill workers while the increase is 0.6 p.p. for high-skill workers. Furthermore, the unemployment rate of low-skill workers slightly decreases by 0.1 p.p.

Despite the large increase in the union density, the impact on wage inequality is limited. The limited impact partly comes from the increased ESHI access. Low-skill workers tend to value ESHI coverage more than high-skill workers and hence low-skill workers accept a larger wage decline in exchange for insurance coverage compared to high-skill workers. Interestingly, the average wage decreases due to the compensation differential mechanisms; the marginal firms that switch from non-union to union start providing insurance benefits and these benefits pass through to the reduction of average wages. Finally, despite the rise of unionization, their effect on output is negligible.

This result suggests that the comprehensive evaluation of unions' labor market impacts should look at not only wage inequality but also changes in insurance provisions, which also affect equilibrium wages.

6.5 Insurance Quality

Finally, we consider a counterfactual where nonunion firms provide better insurance. In previous exercises, we consider the case where union firms have better access to insurance provisions. However, it may be possible that non-union firms also gain better technology in providing insurance. For example, they improve their ability to negotiate with insurance companies who offer better insurance products. Indeed, certain insurance benefits, such as defined contribution pensions, are increasingly provided by non-union firms. These forces generate additional but related mechanisms leading to the decline in unions. We implement this experiment by reducing the fixed cost of insurance provision of only nonunion firms by 20 percent.

Table 9 reports the simulation result. Unionization becomes less attractive for firms and they now try harder to prevent unionization, reducing the union density by 2.3 p.p. in partial equilibrium. The firm size increases slightly because of two reasons. First, given the firm type, nonunion firms have the incentive to scale up to push down wages in individual bargaining. Second, insurance provision reduces the marginal cost of hiring, which also makes firms larger. Tightness adjustment in general equilibrium brings back firm sizes, and further pushes down the union density by 0.5 p.p. Consistent with other counterfactual simulations, deunionization here also pushes up wage inequality measured by the skill wage gap by 0.9 log points.

Nonunion firms now can provide insurance at a smaller cost, and the insured rate of nonunion workers increases by 6.6 p.p. There is an indirect effect on union firms. Since

Table 9: Counterfactual Policy Simulation: Better Insurance by Nonunion Firms

	(1)	(2)	(3)
	Baseline	PE	GE
Union density (%)	8.0	5.7	5.2
ESHI coverage (%)			
Overall	63.1	69.2	68.3
Union	76.8	71.0	68.1
Nonunion	61.9	69.1	68.3
Low skill	61.4	67.4	66.5
High skill	64.3	70.4	69.5
Unemployment rate (%)			
Overall	5.4	NA	5.5
Low skill	9.8	NA	10.1
High skill	1.9	NA	1.9
Output per capita (% change)	0.0	1.0	0.0
Average wage (% change)	0.0	-0.5	-0.7
Skill wage gap (log points)	62.5	63.0	63.4
Average firm size			
Overall	23.4	23.7	23.4
Union	45.0	35.8	33.3
Nonuion	22.5	23.2	23.0

Note: This table reports the outcomes under the counterfactual where nonunion firms become more efficient in providing insurance. Column (2) is the partial equilibrium impact where tightness is fixed at the baseline level while column (3) is the general equilibrium impact where tightness is adjusted to satisfy equation (37).

union firms offering insurance have an incentive to switch to nonunion, firms remaining unionized in the counterfactual are more likely to be not offering insurance. This selection effect reduces the insured rate of union workers by 8.7 p.p.

7 Roles of Skill-Biased Technological Changes and Social Insurance Expansions in the Union Decline

So far, we have conducted various policy experiments to see the importance of unions in assessing the labor market impacts of social insurance policies and firm subsidies, using the economy calibrated to the year 2007. Now we investigate what factors explain the large union decline over the past half-century. In particular, we study the contribution of the following two factors. The first one is skill-biased technological changes favoring high-skill workers, which is a well-documented empirical pattern over the past half-century (Acemoglu

Table 10: Deunionization by Technological Change and Social Insurance Expansion

	Model			Data
	Year 1962	Tech change	Medicaid	Year 2016
Union density (%)	31.2	10.8	24.9	6.5

Note: This table reports the impact of skill-biased technological changes (Tech change) and Medicaid expansion on the union membership density together with observed union density in 1962 and 2016.

and Autor, 2011). The second one is the introduction and expansion of social insurance programs described in Section 2.

To that end, we fit the model economy with the data in the year 1962. We discuss the detail of empirical moments and the estimated parameters in Appendix C.

Skill-biased technological changes. We start by investigating the impact of a skill-biased technological change favoring high-skill workers on unionization. While the technological change is often cited as a primary factor behind deunionization, within our framework, it sets two counteracting forces into motion: one originating from firms and the other from workers. From the perspective of firms, the technological change encourages them to be more aggressive in preventing unionization. As the relative productivity of low-skilled workers decreases, union firms that predominantly rely on low-skill workers find it too costly to be unionized, leading to a union decline. Conversely, the worker-side perspective sheds light on a shift in their demand for unionization. The technological change exacerbates the wage disparity between high-skilled and low-skilled workers, making low-skill workers more desperate for unionization. This surge in the low-skilled workers' valuation of unionization could in turn increase the costs for firms to deter unionization.

We implement this by changing the relative productivity of each skill (z_l, z_h) together with the fraction of workers of each type (N_l, N_h). Starting from the economy in 1962, we adjust (z_l, z_h) so that the model economy generates the observed skill wage gap in 2016. Specifically, the skill wage gap in the calibrated economy is 0.42, and we adjust (z_l, z_h) by targeting 0.59 which is the observed skill wage gap in the year 2016. We also change the fraction of each type to $(N_l, N_h) = (0.38, 0.62)$ to reflect the skill composition in 2016. We then ask how much this skill-biased technological change explains the observed decline in union membership.

Table 10 reports the results. In the model, the union density is originally 31.2%. The skill-biased technological change reduces the union density to 10.8%. In data, the union density decreases to 6.5%. Therefore, the skill-biased technological change alone could explain up to 80% of the deunionization over the past half-century.

Social Insurance Expansion. As we discussed in Section 2, social insurance programs have been introduced and expanded over the last half-century, which is another potential explanation for deunionization. Indeed, counterfactual policy changes in the previous section demonstrate that social insurance expansions lead to deunionization by replacing unions' role in insurance provisions. In particular, we focus on the introduction of Medicaid, which would be more relevant for the working-age population compared to other programs such as Medicare or Social Security. We implement Medicaid by providing free public insurance to low-skill unemployed workers as in Section 6.2.

Table 10 shows that the introduction of Medicaid also explains a sizable fraction of observed deunionization. Medicaid reduces the union density to 24.9%, explaining 26% of the observed union decline.

Policy Implications. Overall, our findings suggest that both technological changes and social insurance expansions are quantitatively relevant in accounting for the decline in unions. Importantly, we find that the decline in unions caused by these two channels lowers the insurance access of the low-skilled employed workers. Even social insurance expansions do not provide insurance protections because social insurance benefits are mainly available to the non-employed. Therefore, an important policy issue is to address how to provide insurance coverage for those employed to compensate the decline in unions.

8 Conclusion

In this paper, we have studied the determinants of unionization rates and their labor market implications by focusing on the union's influence on the provision of employer-based insurance benefits. We document that union firms are more likely to provide various employer-based insurance benefits. Moreover, we provide suggestive evidence that the expansion of social insurance programs reduces unionization rates. Then, we develop and estimate a frictional labor market model that features endogenous union formation and insurance provisions by firms. The model highlights that union firms, through collective bargaining, are more likely to provide insurance benefits compared to nonunion firms. We then use our estimated model to conduct a quantitative assessment of the equilibrium labor market impacts of social insurance, tax, and transfer policies, and explore the causes of the decline in unions in the U.S that occurred over the last 60 years.

Our finding suggests that social insurance policies and tax and transfer policies for employer-based insurance products can significantly impact labor market outcomes such as wage inequality through changes in unionization. For example, we find that the expansion of social insurance can reduce the unionization rate by replacing the role of union firms in providing insurance, which in turn can increase wage inequality. Moreover, tax subsidies to employer-sponsored health insurance can also increase wage inequality through deunionization. Furthermore, we find that not only technological changes but also the expansion of social insurance programs can account for a large part of the decline in unions in the U.S.

We believe that the framework developed in this paper can be useful for studying a variety of other important issues associated with interactions between labor market institutions and social insurance policies. The model could be extended to incorporate richer heterogeneity to study the distributional consequences of these policies. Moreover, it would be interesting to incorporate the effect of unions on firms' entry decisions and technology choices. We leave these important extensions for future work.

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Online Appendix (Not for Publication)

A Additional Evidences of Effects of Social Insurance on Unionization

A.1 ACA Medicaid expansion.

Medicaid is a public social insurance program that provides health insurance to low-income households. The Affordable Care Act (ACA), which was enacted in 2010, included a provision that would significantly expand the Medicaid eligibility. Prior to the ACA expansion, Medicaid eligibility depended on income and other characteristics; specifically, children and pregnant women were likely to be eligible even if their income was larger than 138% of FPL, but disabled adults and low-income parents were eligible only if their income was much lower, and the remaining adults were not eligible in most states (Frean et al., 2017). ACA would have expanded Medicaid coverage to all people with incomes below 138% of the Federal Poverty Level (FPL). In 2012, the Supreme Court made a decision to allow each state to decide whether to adopt the Medicaid expansion, which created an exogenous variation in the Medicaid expansion across states. Specifically, twenty-six states adopted Medicaid expansion in 2014, three states in 2015, and two states year 2016, and nineteen states did not yet expand Medicaid.

We use the CPS sample and the variation in the ACA Medicaid expansion across states to estimate the impact of the expansion on union membership. We focus on states that expanded Medicaid in January 2014 or never expanded during the sample period. Our empirical specification is

$$\mathit{Union}_{ist} = \beta \cdot \mathit{(ACA\ Medicaid)}_{st} + x'_{ist}\gamma + \alpha_s + \lambda_t + \epsilon_{ist}, \tag{43}$$

where i is the individual, s is the state, t is the year, Union_{ist} is an indicator that takes 1 if individual i in state s is a union member at t, $\mathit{(ACA\ Medicaid)}_{st}$ is an indicator that takes 1 if state s has expanded Medicaid coverage in t. x_{ist} is a vector of time-variant covariates including age, education, gender, race, year-specific dummies for industries and occupations. x_{ist} also includes the same set of political variables used in the analysis of Medicare and Medicaid introduction. α_s and λ_t are the state and time fixed effects. ϵ_{ist} is an error term. Medicaid is mostly targeted at low-income households while there would be many individuals in the sample who are unlikely to be eligible for Medicaid. To focus on those who are likely to be affected by the expansion, we split the sample into individuals with low education, who are more likely to be eligible due to low income, and high education, who are less likely to be eligible. Specifically, the first sample consists of individuals who have high school or less education while the second sample consists of the remaining individuals. One concern is that there are multiple states newly passed the RTW laws during this period, which would also affect union membership (Fortin et al., 2022). We alleviate this concern by controlling for indicators for time before/after the passage of the RTW laws.

Table 13 reports the estimation result. In Column 1, we report the result where we used all individuals in the sample. 12% of individuals are union members, and the ACA Medicaid expansion decreased the union density by 0.3 percentage points, although the coefficient is not statistically significant. Column 2 shows that the expansion had a statistically significant impact on low-education individuals, decreasing union members among them by 0.5 p.p., which is about 5% decrease in the union membership given that 10% of individuals in this sample were union members. In contrast, the expansion had almost no impact on high-education individuals, as indicated by the last column. Figure 7 in Appendix shows an event study plot consistent with these results, which also shows there is no pre-trend.

A.2 Unemployment Insurance

Unemployment insurance (UI) provides temporary benefits to individuals who lost their jobs. Importantly, each state can adjust the UI generosity including the amount of benefits and the maximum duration. We use variations in UI generosity across states and over time to estimate the impact of UI generosity on union membership.

We use the CPS 2000-2019 to estimate the following specification.

$$\mathit{Union}_{ist} = \beta \cdot (\mathit{UI\ Generosity})_{ist} + \mathbf{x}'_{ist}\gamma + \eta_s + \mu_t + \varepsilon_{ist}, \tag{44}$$

where i is the individual, s is the state, t is the year, Union_{ist} is an indicator that takes 1 if individual i in state s is a union member at t, $\mathit{UI\ Generosity}_{ist}$ is a variable indicating the generosity of UI for i in s at t, $\mathbf{x}_{ist}$ is a vector of time-variant covariates, η_s is state fixed effects, μ_t is year fixed effects, and ε_{ist} is an error term.

For the variable of interest $\mathit{UI\ Generosity}_{ist}$, we use three proxy measures. First, following Hsu et al. (2018), we use *Max Benefit*, which is simply the product of the maximum weekly benefit amount and the maximum benefit duration in the state, as a proxy for the generosity of UI in the state. The second proxy is the log of *Max Benefit* in the state. Finally, we also use the individual-level replacement rate, which is calculated as the weekly benefit amount divided by the individual's weekly wage.

Table 14 reports the estimation result of equation (44). When we used *Max Benefit* or log of *Max Benefit* as proxy measure for *UI Generosity*$_{ist}$, we find no impact of UI on union membership. However, when we use the individual-level replacement rate as a proxy for *UI Generosity*$_{ist}$, we find a statistically significant impact of UI generosity on union membership. Specifically, if UI becomes generous in terms of replacement rate by 10 p.p., an individual is less likely to be a union member by 2.1 p.p. Columns (4)-(6) indicate that these patterns remain even after we control for UI maximum duration, the RTW laws, and political variables that we used for the analysis of Medicare introduction.

B Numerical Algorithm

In this section, we lay out our numerical algorithm to solve for the equilibrium.

1. Provide an initial guess of tightness θ, wages $w^k_{y,x}(a)$ for each x, y, k, a, union probability Q_y, insurance provision probability given union status P^k_y.

2. Solve for worker value functions by the value function iteration.

3. Solve firm problems for each firm type and get $(w^{k,*}_{y,x}(a), Q^*_y, P^{k*}_y, g^{k*}_{x,y}(a))$:

   a. Numerically solve the individual bargaining problem. Discretize the space of labor input $\boldsymbol{g}$ and approximate the partial derivatives by finite differences. Iterate the first-order conditions until wages converge. Obtain $w^{n,*}_{y,x}(a)$.

   b. Numerically solve the collective bargaining problem. Iterate the first-order conditions until wages converge. Obtain $w^{n,*}_{y,x}(a)$.

   c. Given the numerically solved wage functions, solve the firm hiring problem for each union status and insurance status. Obtain $g^{k*}_{x,y}(a)$.

   d. Compute insurance provision probability and union probability. Obtain (Q^*_y, P^{k*}_y).

4. Update wages, union probability, and insurance provision based on the solution in 3.

$$w^{k,new}_{y,x}(a) = \omega_w w^{k,*}_{y,x}(a) + (1-\omega_w) w^k_{y,x}(a), \tag{45}$$

$$g^{k,new}_{y,x}(a) = \omega_g g^{k,*}_{y,x}(a) + (1-\omega_g) g^k_{y,x}(a), \tag{46}$$

$$Q^{new}_y = \omega_Q Q^*_y + (1-\omega_Q) Q_y, \tag{47}$$

$$P^{k,new}_y = \omega_P P^{k,*}_y(a) + (1-\omega_P) P^k_y(a), \tag{48}$$

   where $\omega_w, \omega_g, \omega_Q, \omega_P \in (0, 1]$ are weights for facilitating convergence.

5. Compute $\mathcal{U}^{BC}_x(\theta)$ and $\mathcal{U}^{JC}_x(\theta)$ based on $(w^{k,new}_{y,x}(a), Q^{new}_y, P^{k,new}_y, g^{k,new}_{x,y}(a))$.

6. Update market tightness. Increase market tightness θ_x if $\mathcal{U}_x^{BC}(\theta) > \mathcal{U}_x^{JC}(\theta)$ while decrease market tightness θ_x if $\mathcal{U}_x^{BC}(\theta) < \mathcal{U}_x^{JC}(\theta)$. Specifically,

$$\log \theta_x^{new} = \log \theta_x + \omega_\theta(\mathcal{U}_x^{BC}(\theta) - \mathcal{U}_x^{JC}(\theta)) \tag{49}$$

where $\omega_\theta > 0$ is a pre-specified constant chosen for facilitating convergence.

Importantly, the model incorporates sufficient amount of shocks and heterogeneity, which helps our algorithm very stable across different configurations of parameters. At the same time, it helps us account for observed heterogeneity in data. Consequently, we can use it to estimate our parameters.

C Calibration Targeting the Economy in 1962

To study the contributions of skill-biased technological changes and social insurance expansions to deunionization, we calibrate the model economy to the year 1962. Although some data moments are available for the year 1962, we need extrapolation for some other moments.

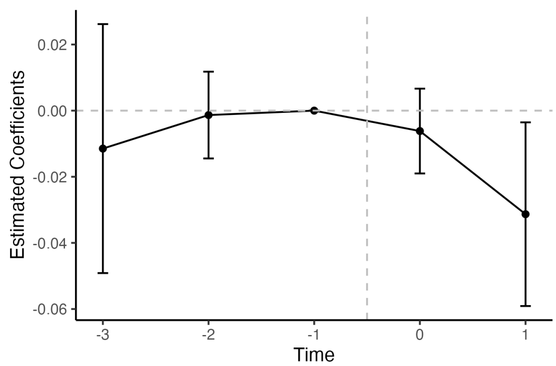
The average wage, the skill wage gap, and the unemployment rate were available in the CPS in 1962. The aggregate union density is also available in 1962, which comes from Farber et al. (2021). The following moments are not available in 1962, and we therefore rely on extrapolation to get moments in 1962. Union membership in the CPS is available from 1983, and therefore we extrapolate ESHI coverage rates conditional on union membership using the CPS sample from 1983 onward. Information on ESHI coverage is available starting from 1979 in the CPS, and therefore we extrapolate ESHI coverage rates for each skill type using the CPS sample from 1979 onward. The census BDS, which is used for calculating the average firm size and the employment share distribution, is available from 1978 onward. The firm size information in the CPS is available from 1992, and we, therefore, calculate the employment share distribution conditional on unions from 1992 onward and extrapolate it.[19] These data moments and the corresponding model moments are in Table 17. We also need extrapolation for some externally set parameters. In particular, we extrapolate job-losing rates that are available from 1976 onward in the CPS, and we extrapolate medical cost distribution available in MEPS from 1997 onward. Table 15 reports the externally set parameters while Table 16 reports the parameters internally estimated to match the extrapolated moments. The extrapolations are displayed in Figures 11-15. In the figures, the data points in the shaded areas are predicted values. Extrapolations are linear in year

[19]More precisely, firm size information in the CPS is a categorical value and is available from 1987, but there was a slight change in categorical values in 1992.

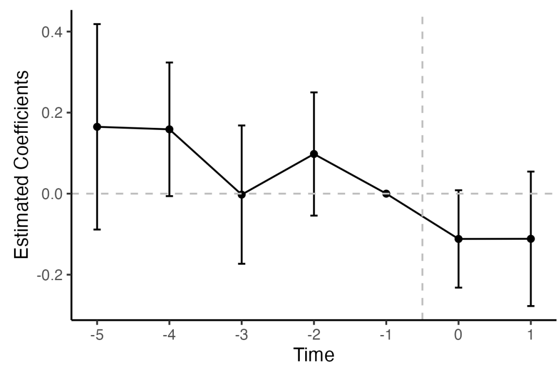
except for ESHI rates, employment shares, and the fraction of zero medical costs. In these cases, we make sure the values are between 0 and 1 by regressing $\log\left(\frac{y}{1-y}\right)$ on years where y is the variable of interest.

D Additional Figures and Tables

Figure 6: Impact of Medicaid Introduction on Union: Interaction-Weighted Estimate



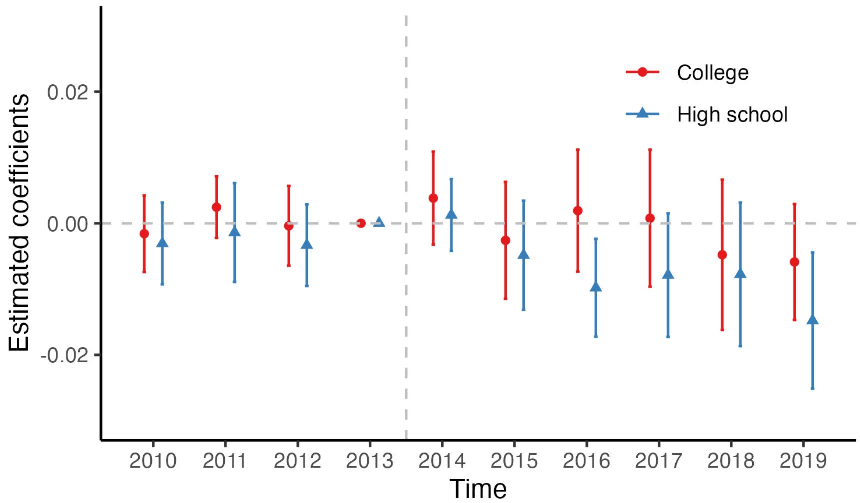
(a) Union Density



(b) Elections

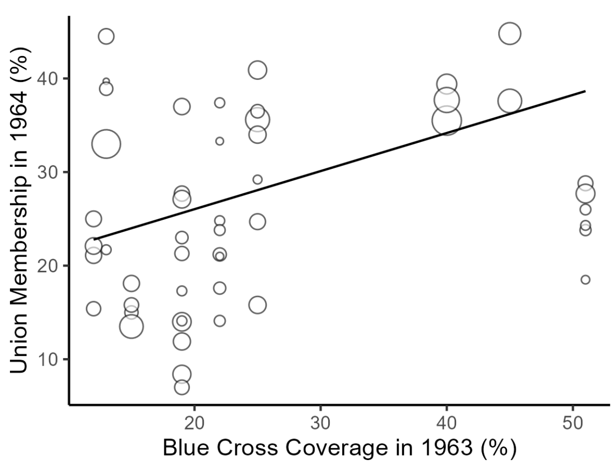
Note: This figure displays the interaction-weighted estimates by Sun and Abraham (2021). The outcome variable is the log union density in Panel (a) while it is the log number of elections in panel (b). The error bars represent the 95% confidence intervals based on standard errors clustered at the state level.

Figure 7: ACA Medicaid Expansion Impact on Union Membership



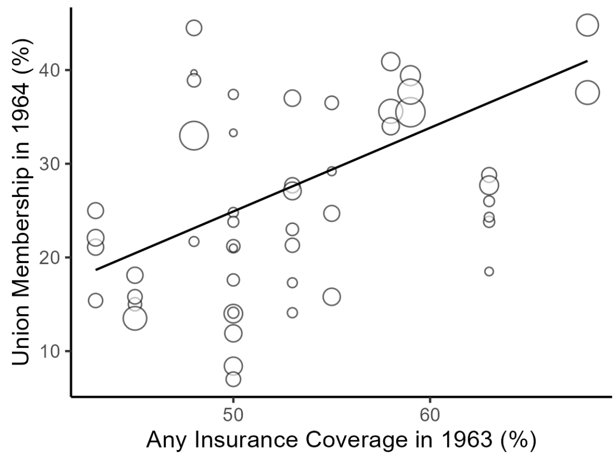
Note: This figure shows the estimated coefficients of equation $Union_{ist} = \sum_{\tau=2010,\tau\neq 2013}^{2019} \beta_\tau \times \text{ACA Medicaid}_s \times \mathbb{1}[t = \tau] + x'_{ist}\gamma + \eta_s + \mu_t + \varepsilon_{ist}$, where ACA Medicaid$_s$ is an indicator taking 1 if a state expanded Medicaid in January 2014. Data is from the CPS 2010-2019. States that expended Medicaid in other periods during 2010-2019 are excluded. Other variables are the same as in equation (43). The covariates include dummies for sex age, education, race, year-by-occupation, year-by-industry, and political controls including an indicator for a Demogratic governor and third-order polynomials of the fraction of state legislative seats held by the Democratic party each for state senate and house. Year fixed effects, month fixed effects and state fixed effects are also controlled. Person-level weights are used. Standard errors are clustered at the state level. The error bars represent 95% confidence intervals.

Figure 8: Private Insurance Coverage and Union Density Prior to Medicare: Blue Cross



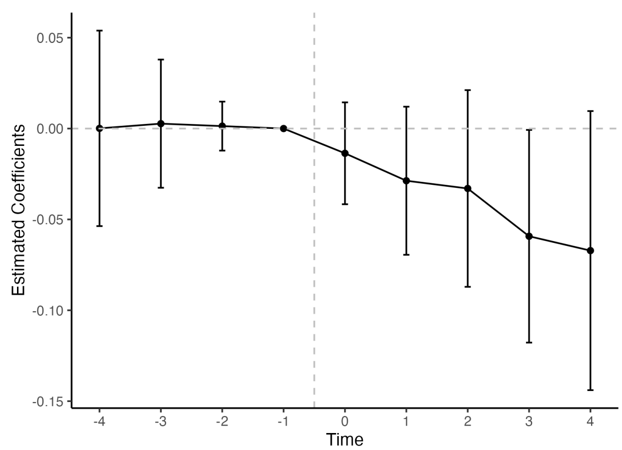
Note: Data on the fraction of the insured elderly is from Finkelstein (2007). Data on the union density is from Hirsch et al. (2001). Each circle corresponds to each state in the U.S. and the size of the circles represents the size of the state population.

Figure 9: Private Insurance Coverage and Union Density Prior to Medicare: Any Insurance



Note: Data on the fraction of the insured elderly is from Finkelstein (2007). Data on the union density is from Hirsch et al. (2001). Each circle corresponds to each state in the U.S. and the size of the circles represents the size of the state population.

Figure 10: Impact of Medicaid Introduction on Union Density



Note: This figure displays the estimated coefficients of the event-study specification $y_{st} = \sum_{\tau=-4,\tau\neq-1}^{4} \beta_\tau \mathbb{1}[t - t_s^{Medicaid} = \tau] + \beta_{-5}\mathbb{1}[t - t_s^{Medicaid} \leq 5] + \beta_{5+}\mathbb{1}[t - t_s^{Medicaid} \geq 5] + x_{st}'\gamma + \eta_s + \mu_t + \epsilon_{st}$ where x_{st} include the political controls. The outcome is the log of union density. The error bars represent the 90% confidence intervals based on standard errors clustered at the state level.

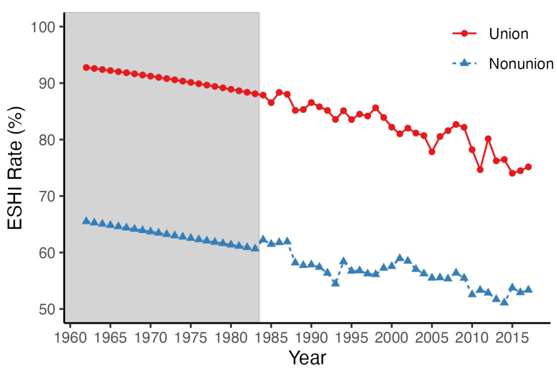
Table 11: Medicaid Introduction by State

Year	States
1966	CA, CT, DE, HI, IA, ID, IL, KY, LA, MA, MD, ME, MI, MN, ND, NE, NM, NY, OH, OK, PA, RI, UT, VT, WA, WI, WV
1967	GA, IA, KS, MO, MT, NV, NH, OR, SD, TX, WY
1968	DC, SC
1969	CO, TN, VA
1970	AL, AR, FL, IN, MS, NJ, NC
1972	AK
1982	AZ

Note: This table lists the years when each state implemented Medicaid. See Gruber (2003) for more detailed information.

Figure 11: Extrapolation: ESHI Coverage

(a) ESHI rate by union



(b) ESHI rate by skill

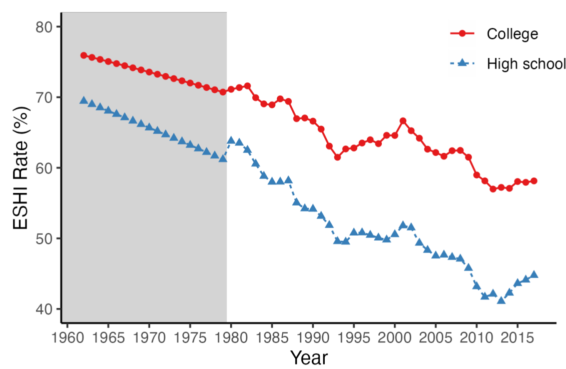


Table 12: ACA Medicaid Expansion by State

Year	Month	States
2014	1	AZ, AR, CA, CO, CT, DE, DC, HI, IL, IA, KY, MD, MA, MN, NE, NV, NJ, NM, NY, ND, OH, OR, RI, VT, WA, WV
2014	4	MI
2014	8	NH
2015	1	PA
2015	2	IN
2015	9	AK
2016	1	MT
2016	7	LA
2019	1	ME, VA
2020	1	ID, UT
2021	7	OK
2021	10	MO
2023	7	SD
2023	12	NC

Table 13: ACA Medicaid Expansion Impact on Union Membership

	Union Membership		
	All	High School	College
	(1)	(2)	(3)
ACA Medicaid	-0.003	-0.005**	-0.001
	(0.003)	(0.003)	(0.003)
Mean outcome	0.118	0.103	0.125
Observations	1,177,618	393,223	784,395
R-sq	0.24	0.19	0.27

Note: This table reports the estimation result of equation (43). Data is from the CPS 2010-2019. The first column uses the whole sample. The second column restricts the sample to individuals whose highest grade is not greater than the high-school graduate. The third column restricts the sample to individuals whose highest grade is greater than the high-school graduate. Person-level weights are used. The covariates include gender, dummies for age, and industries. Dummies for education are controlled in column (1). Year fixed effects and state fixed effects are also controlled. Standard errors are clustered at the state level. $^{*}p < 0.1$;$^{**}p < 0.05$;$^{***}p < 0.01$.

Table 14: Unemployment Insurance Impact on Union Membership based on the CPS Sample

	Union Membership					
	(1)	(2)	(3)	(4)	(5)	(6)
Max Benefit	0.003					
	(0.022)					
log(Max Benefit)		-0.002				
		(0.007)				
Replacement Rate			-0.215***	-0.215***	-0.217***	-0.218***
			(0.020)	(0.020)	(0.020)	(0.021)
UI Duration FE				X	X	X
RTW Law					X	X
Political Control						X
Observations	2,680,517	2,680,517	2,680,517	2,680,517	2,680,517	2,598,633
R-sq	0.2512	0.2512	0.2543	0.2543	0.2545	0.2548

Note: This table reports the estimation result of equation (44). Data is from CPS 2000-2019. The information on UI generosity is obtained from "Significant Provisions of State Unemployment Insurance Laws" published by the BLS. Dummies for age, gender, education, occupation, industry, year fixed effects, and state fixed effects are controlled in all specifications. Standard errors are clustered at the state level. $^{*}p < 0.1; ^{**}p < 0.05; ^{***}p < 0.01$.

Table 15: Externally Set / Externally Calibrated Parameters (year 1962)

Parameter	Description	Value	Target
γ	Discount rate	0.984	5% annual interest rate
σ	Elasticity of substitution between skills	1.5	Johnson (1997)
μ	Match efficiency	1.0	Normalization
ζ	CRRA parameter	1.0	
$\underline{c}$	Consumption floor ($1K)	1.0	
β_u	Bargaining power of union workers	0.5	
β_n	Bargaining power of nonunion workers	0.5	
N_x	Measure of workers of each type	0.82, 0.18	Fraction of each skill group
$\delta_{u,x}$	Job destruction rate (union)	0.07, 0.04	See text
$\delta_{n,x}$	Job destruction rate (nonunion)	0.08, 0.04	See text
b_x	Consumption during unemp. ($1K)	0.98, 1.53	85% of average wages for each skill
c_x	Variable insurance cost ($1K)	0.02, 0.01	Expected insurer's cost
$H_x(m)$	Distribution of medical expenditure	See text	Medical expenditure distribution for each skill

Table 16: Internally Estimated Parameters (year 1962)

Parameter	Description	Value	Target
M	Measure of total firms	0.05	Average firm size
A	TFP	4.8	Average wage
$\alpha \sim Beta(a, b)$	Production curvature distribution	0.72, 0.98	Firm size distribution
z_1	Low-skill worker relative productivity	0.64	Log wage difference between skill groups
F_a	Fixed cost of insurance provision	0.98	ESHI coverage rate of union and nonunion workers
σ_a	Std. dev. of insurance cost shock	0.30	ESHI coverage rate of union and nonunion workers
F_{union}	Fixed cost of unionization	1.52	Union membership density
σ_k	Std. dev. of union cost shock	0.53	Empl. share of 10+ firms: conditional on union
c_0	Cost of union threat	0.14	Empl. share of 100+ firms: conditional on union
κ	Vacancy posting cost	0.30	Unmpeloyment rate

Table 17: Model Fit (year 1962)

Moments	Data	Model
Union density	0.32	0.31
ESHI coverage: union	0.93	0.93
ESHI coverage: nonunion	0.65	0.65
ESHI coverage: low skill	0.69	0.75
ESHI coverage: high skill	0.76	0.69
Unemployment rate	0.07	0.07
Average quarterly wage ($1K)	1.29	1.34
Skill wage gap (in log)	0.44	0.42
Average firm size	17.43	18.23
Empl. share of 10+ firms	0.83	0.83
Empl. share of 100+ firms	0.55	0.51
Union empl. share of 10+ firms	0.97	0.96
Union empl. share of 100+ firms	0.84	0.83

Figure 12: Extrapolation: Employment Share

(a) Empl. share of firms +10 (b) Empl. share of firms +100

(c) Union empl. share of firms +10 (d) Union empl. share of firms +10

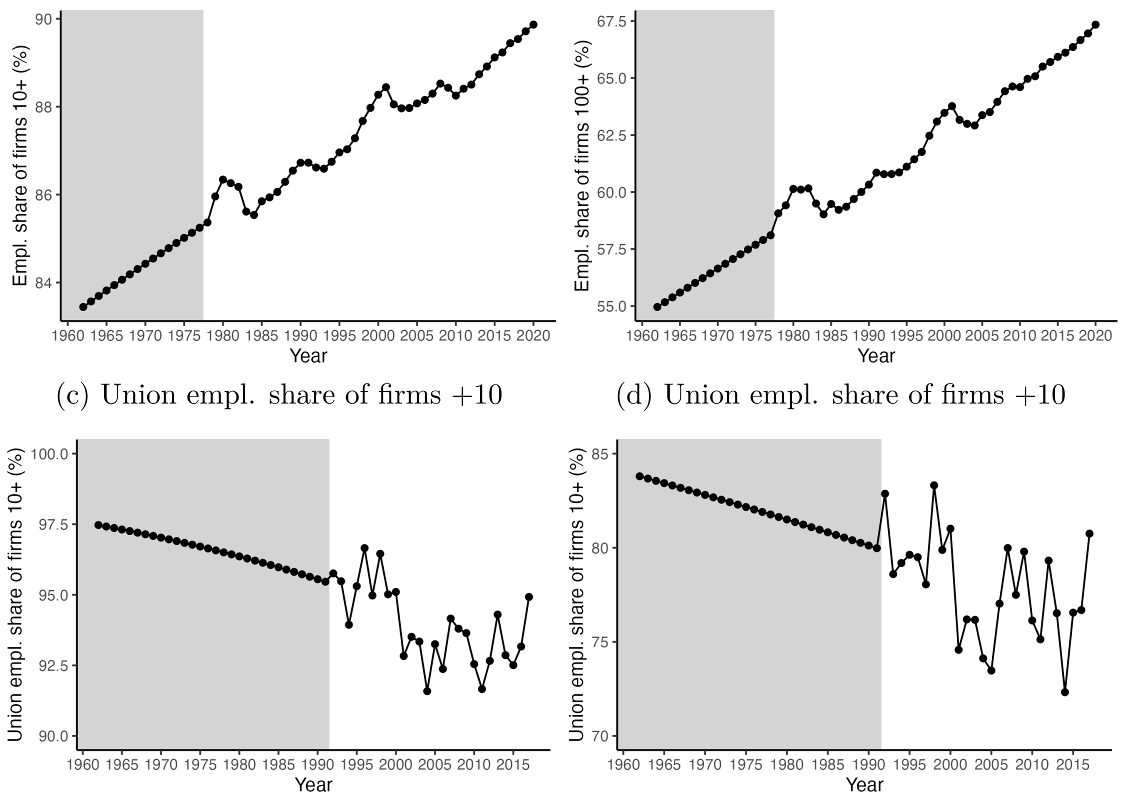


Figure 13: Extrapolation: Average firm size

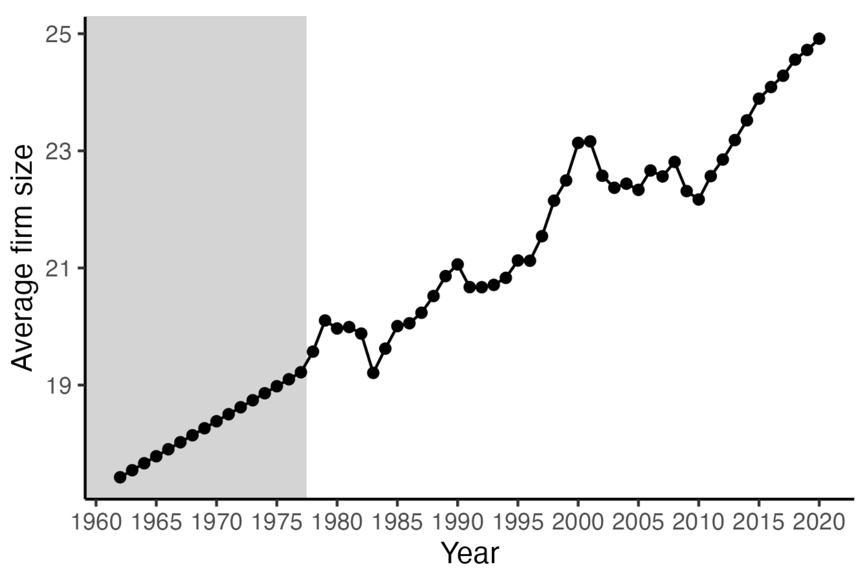


Figure 14: Extrapolation: Job Loss

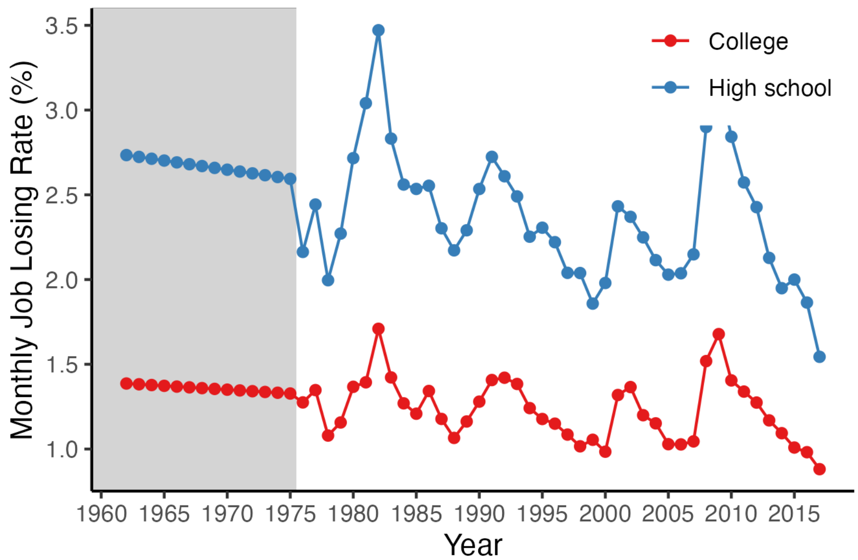
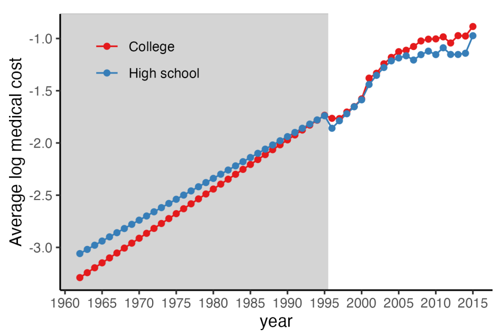
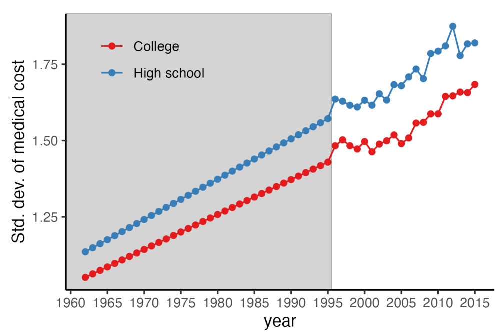


Figure 15: Extrapolation: Medical Expenditure Distribution

(a) Average



(b) Std. dev.



(c) Zero cost