# Optimal Unemployment Insurance Financing: Theory and Evidence from Two US States*

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**Abstract**

Unemployment insurance provides crucial support for unemployed workers but comes with substantial costs. I study the optimal approach to financing unemployment benefits, comparing two alternative approaches to assign unemployment tax rates to employers. While employers in the United States are assigned individualized tax rates based on the unemployment benefit spending resulting from their layoffs (experience rating), in all other countries, all employers are assigned the same tax rate irrespective of their individual contributions to unemployment (coinsurance). I derive a formula that defines the optimal financing policy through a tradeoff between the marginal benefit and two marginal costs of coinsurance. The marginal benefit refers to the value of insurance for employers, as coinsurance protects them against the risk of steep tax increases and further financial deterioration following a negative shock. The first marginal cost is a moral hazard from reducing the private cost of layoffs for employers, which imposes a fiscal externality on government budgets in the form of more frequent layoffs and increased spending on benefits. The second marginal cost emerges from the subsidization of high-unemployment risk industries and the resulting reallocation of labor towards these industries. This results in the misallocation of productive skills and generates a further fiscal externality in the form of increased spending on benefits as more workers are subject to a high risk of unemployment. I express the formula for the optimal policy in terms of estimable sufficient statistics for welfare. I then use unemployment tax filing data from two US states and quasi-experimental variation in unemployment taxes from state-level reforms of experience rating policies to estimate the cost of labor reallocation. My results suggest that labor reallocation, an overlooked channel in the literature, is the primary source of inefficiency from coinsurance. Additionally, my finding that the combined marginal cost of moral hazard and labor reallocation exceeds the marginal benefit of coinsurance suggests that, in these states, the current degree of experience rating may be suboptimal.

JEL Codes: D22, H21, H22, H23, H25, H32, H53, J65

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# 1 Introduction

Unemployment insurance is a fundamental welfare program that helps unemployed workers maintain their consumption levels following job losses. The provision of unemployment benefits, however, comes at a substantial cost, ranging from 0.12% to 2.8% of GDP in Western economies and fluctuating over economic cycles (OECD 2023). For perspective, the United States normally spends approximately 35 billion dollars annually on unemployment benefits, an amount representing 0.18% of its GDP and 0.6% of its total public spending. During the COVID-19 pandemic, unemployment insurance spending reached 160 billion dollars, or 0.8% of GDP and 1.8% of public spending. Since the effectiveness and sustainability of unemployment insurance depend on the ability of governments to secure resources and promptly allocate them to workers as needed, understanding how best to finance the program is of paramount importance.

Typically, unemployment benefits are funded through payroll taxes levied on employers and employees.[1] In this paper, I focus on employer-specific unemployment tax rates and compare the two prevailing approaches to assign these rates to employers. In the United States, employers are assigned personalized and dynamic tax rates, designed to reflect the costs of the unemployment benefits resulting from their layoffs. This financing method, known as *"experience rating"*, holds employers financially responsible for their layoffs. In Europe and Canada, conversely, employers are assigned the same unemployment tax rate regardless of their individual contributions to unemployment. This system, known as *"coinsurance"*, limits employers' tax liabilities following negative shocks.

It remains unclear which of these two approaches is preferable. The literature highlights three key factors for this evaluation, two against and one in favor of coinsurance. First, coinsurance reduces the private cost of layoffs that employers internalize and, in turn, increases the frequency of layoffs.[2] The more frequent layoffs then impose a fiscal externality on government budgets in the form of increased spending on unemployment benefits, which must be funded with increased taxation (Fath et al. 2005). Second, coinsurance requires the equal participation of all employers to the financing of the system, even though layoffs are concentrated in specific industries with a high risk of unemployment. As a result, coinsurance redistributes the cost of the unemployment benefits generated by employers in high-unemployment risk industries to employers in low-unemployment risk industries. This phenomenon of cross-subsidization, where premiums paid by all insured parties cover the costs for those experiencing a shock, is a typical aspect of any insurance system. However, a concern emerges because specific industries consistently act as subsidizers or are consistently subsidized over time. Importantly, coinsurance does not simply obligate low-risk industries to financially support high-risk ones. It also reduces labor costs and consequently increases labor demand in high-risk industries, leading to the reallocation of workers towards these industries. This labor reallocation results in the misallocation of productive skills and imposes a further fiscal externality in the form of a higher benefit spending since more workers are subject to a high risk of unemployment.[3] Third, critics of experience rating argue that the

[1] In the United States, unemployment taxes are primarily levied on employers, with only three states levying taxes on employees as well. All other countries levy taxes on both employers and employees.

[2] Experience rating reduces layoffs (Feldstein 1976, Brechling 1977, Topel 1977, Topel 1983, Topel 1984, Kaiser 1986, Burgess et al. 1992, Anderson et al. 1994, Card et al. 1994, Blanchard et al. 2008) and stabilizes employment both within the year (Halpin 1979, Card et al. 1994, Anderson 1993, Katz et al. 1998) and over the business cycle (Kaiser 1986, Card et al. 1994, Duggan et al. 2022).

[3] Becker (1972), Munts et al. (1980), Mortensen (1983), Topel (1984), Anderson et al. (1993a), Anderson et al. (1993b), Laurence

imposition of higher unemployment tax rates on employers in economic distress may reduce their labor demand and, potentially, increase unemployment in the long run. This concern becomes particularly pronounced during recessions, when layoffs are widespread and higher unemployment taxes may slow down economic recovery, thereby accentuating the business cycle.[4] By contrast, uniform tax rates act as a safeguard for employers, insuring them against large tax increases and the further deterioration of their net worth following negative shocks.

Until now, these three factors—coinsurance reducing the private cost of layoffs, coinsurance redistributing the cost of the unemployment benefits from high-risk to low-risk industries, and the imposition of higher unemployment tax rates on employers in economic distress— have been studied separately, offering policymakers limited guidance when deciding between experience rating and coinsurance.[5] In this study, I bring these factors together within a unified theoretical framework, recognize them as the central forces shaping the optimal design of unemployment insurance financing policies, and empirically investigate their relative importance in order to inform the policy debate.

I develop my analysis in three stages. In the first, I derive a formula for the optimal unemployment insurance financing scheme as a function of estimable sufficient statistics. I present a theoretical framework in which employers hire workers and exert costly effort to avoid negative shocks, the probability of which varies across industries. The government levies taxes on employers to fund unemployment benefits for the workers laid off after these shocks. The key choice of the government is the "degree" of experience rating of the unemployment insurance system that maximizes welfare. The degree of experience rating is the share of their benefit costs that employers repay in unemployment taxes, and it indicates the extent to which the financing of the program departs from pure coinsurance (in which all employers pay taxes equally) and from complete experience rating (in which each employer repays its full benefit costs). Consequently, the degree of experience rating does not affect total tax revenue, but, rather, influences the distribution of the tax burden between high- and low-unemployment risk industries.

The formula for the optimal degree of experience rating highlights the key tradeoffs between the sufficient statistics representing the marginal benefits and the marginal costs of coinsurance identified by the literature. On the one hand, decreasing the degree of experience rating insures employers against significant increases in their tax liabilities and further financial deterioration following a negative shock. The sufficient statistic representing the marginal value of this insurance is the loss associated with each dollar of tax increase, which includes factors such as elevated borrowing costs for employers facing economic hardship. This loss, equivalent

(1993), and Leombruni et al. (2003) show that high-unemployment risk industries systematically receive many more dollars in unemployment benefits than they pay in unemployment taxes, with low-unemployment risk industries covering the balance. Topel et al. (1980), Deere (1991), and Anderson et al. (1993a) further demonstrate that the subsidization of high-unemployment risk industries leads to their expansion and discuss the welfare implications of this labor reallocation.

[4] This theory, advanced in the work of Lester et al. (1939), Burdett et al. (1989), and Johnston (2021), finds further support in the literatures on the incidence of payroll taxes and adjustment costs.

[5] In a review of Becker (1972), one of the earliest studies contrasting experience rating and coinsurance, McCaffree (1975) comments that *"decision makers are not provided with a clear-cut basis for determining trade-offs and making relevant choices."* Additionally, after establishing that experience rating reduces layoffs, Topel (1984) observes: *"It is tempting to conclude from these findings that subsidies to unemployment should be eliminated via complete experience rating of UI taxes. My analysis does not justify that conclusion, however, since very little is known about the optimal structure of the unemployment insurance financing system."* Several decades later, this question remains underinvestigated. Guo et al. (2021) stress that *"if the benefits of experience rating are substantial, much of the world would benefit from clear evidence. If its costs outweigh, millions of workers in the U.S. could be spared the consequences"*, and that *"empirical and theoretical work to trace out the implications of these varied costs (. . . ) would be helpful for assessing the tradeoffs of greater experience rating."*

to the marginal profit gap between the states of the world with and without shock, indicates employers' willingness to pay for one dollar of insurance against such shock. On the other hand, decreasing the degree of experience rating introduces two costs. First, doing so transfers the financial burden of the unemployment benefits generated by high-unemployment risk industries to low-risk industries, thereby reducing the labor costs in high-risk industries and increasing their labor demand. The labor demand elasticity with respect to the unemployment tax per worker in high-risk industries is the sufficient statistic representing the marginal cost of this reallocation of labor towards high-risk industries. Intuitively, the more elastic are employers in these industries, the more workers will move into them as unemployment taxes decline. This labor reallocation is inefficient because it results in the misallocation of productive skills and imposes a fiscal externality on government budgets in the form of higher spending on benefits since more workers are exposed to a high risk of unemployment. Second, decreasing the degree of experience rating reduces the private cost of a layoff for employers, thereby leading to more frequent layoffs and imposing a further fiscal externality on government budgets in the form of increased spending on benefits. The sufficient statistic representing this employer moral hazard is the elasticity of layoffs with respect to the degree of experience rating. In summary, the formula for the optimal degree of experience rating compares the marginal benefit of providing insurance to *employers* and the marginal costs from labor reallocation and employer moral hazard. As it mirrors the formula for the optimal unemployment benefit level, comparing the marginal benefit and cost of providing insurance to *workers* (Baily 1978), it can be considered as an employer-Baily-type formula.

In the second part of the paper, I bring the theoretical framework to the data and quantify the cost associated with labor reallocation, which received limited attention compared to employer moral hazard in the existing literature. To estimate the labor demand elasticity with respect to the unemployment tax per worker for employers in high-risk industries, I use restricted unemployment tax filing data covering the universe of employers in South Carolina and Colorado and leverage the quasi-experimental variation in the tax per worker generated by state-level reforms of experience rating policies. My primary focus is on South Carolina, but I provide additional consistent evidence from Colorado. Like those in the rest of the country, employers in South Carolina are "experience-rated," that is, their experience with unemployment is assessed each year, and higher tax rates are assigned to those with higher experience. In 2011, the state government changed the *measure* of employers' experiences with unemployment used to assign tax rates, resulting in a sudden change in employers' measured experiences with unemployment and unemployment tax rates. Before the reform, the tax rates were assigned based on employers' *reserve ratios*. The reserve ratio is calculated as the normalized difference between the value of all of the unemployment benefits claimed by the workers whom an employer has laid off and the value of all of the unemployment tax payments that the employer has made since the date of establishment. This ratio thus measures the employer's net position relative to the unemployment insurance system. Following the reform, the unemployment tax rates were determined based on employers' *benefit ratios*, calculated as the normalized value of the benefits charged to an employer over the rolling seven-year lookback period preceding the calculation date. Consequently, the reform made the unemployment tax payments and the benefits charged to employers beyond this seven-year lookback period irrelevant to the assessment of employers' experience.

Using a differences-in-differences approach, I compare employers with the same benefit ratios post-reform but different reserve ratios pre-reform. Because of their similar benefit ratios, these employers were on the same track during the seven-year lookback period used to calculate the benefit ratio, that is, the *"recent past,"* coinciding with the reform pre-period. Nevertheless, these employers had different unemployment tax rates because of the different composition of their *"distant past"* reserves. As the benefit ratio replaced the reserve ratio, the unemployment tax rates were equalized, impacting these two groups differently. The employers with negative reserve ratios saw their tax rates increase because the reform "forgot" their historical tax payments. By contrast, the employers with positive reserve ratios experienced a decrease in their tax rates because the reform "forgot" their distant past benefit charges.

I find that, conditional on the benefit ratio, the reform increased the unemployment tax per worker of the negative reserve ratio employers by $197 per year relative to the positive reserve ratio employers between 2011 and 2014 (equivalent to 144% of the level in 2010). Additionally, the negative reserve ratio employers reduced their workforce by 0.37-0.9 employees (5-11%), and total wages by $19,000-43,000 (6-14%) per year. Since the average wage didn't change, the reduction in total wages was entirely driven by the lower employment. The magnitude of the effect is consistent with the missing employees being average-wage employees. Because of the decline in employment, taxable wages and unemployment taxes grew by 20-80% less than they would have without employment responses. These effects are robust to several alternative specifications, including scaling outcomes by their pre-reform level, using alternative definitions of benefit ratio groups to guarantee the comparison of similar employers during the recent past, and using a continuous version of the treatment. Crucially for my ability to back up a labor demand elasticity, these effects are likely driven by fewer hirings since the reform occurred in the aftermath of the Great Recession, when most separations had already taken place.

These reduced form effects imply a full sample elasticity of labor demand with respect to unemployment taxes of -0.1. When I re-estimate the elasticities in the subsamples of employers in low- and high- unemployment risk industries, defined based on their employment standard deviation within the year, I find that the reduction in employment and wages is concentrated in the high-risk industries (high-standard deviation industries), despite the fact that employers in the low- and high-risk industries experience the same increase in the unemployment tax per worker. This result is robust to defining high-risk industries as industries with high average unemployment tax rate. Additionally, the effect is concentrated in high-unemployment tax rate industries even within high-standard deviation industries. This evidence suggests that the largest labor demand responses to unemployment taxes are observed in industries where layoffs result in unemployment benefit claims charged to employers (e.g., construction and food services) rather than in industries with high turnover but short unemployment spells (healthcare). These results imply a labor demand elasticity of -0.26 in high-employment standard deviation industries. This -0.26 is the estimated sufficient statistic representing the marginal cost of labor reallocation.

The analysis based on the Colorado data yields results consistent with those from South Carolina. I leverage the elimination of a surcharge as the source of variation in the unemployment tax per worker and I identify its causal effect on labor demand by comparing various cohorts of employers, only one of which benefitted from the elimination of the surcharge. Using a differences-in-differences approach, I find that the reform reduced the unemployment tax per worker by $137 (16%) for affected employers, increased employment by

0.46-0.84 employees (3.7-6.7%), and increased wages by $13,000 and $23,000 (5.9-10.6%), with no effect on the average wage. These effects are, once again, driven primarily by the employers in the high-unemployment risk industries.

In the final part of the paper, I use the estimated labor demand elasticity to evaluate the optimal degree of experience rating. Completing my formula with various moments in the unemployment tax filing data, the Quarterly Census of Employment and Wages, and the Employment and Training 394 Report data, I find that the marginal cost of labor reallocation is 3.86. This number indicates that, for every dollar of insurance offered to employers, $3.86 is lost because of labor reallocation. I then calibrate the marginal cost of moral hazard using an estimate for the layoff elasticity from Topel (1984) and several moments from the data. The resulting marginal cost of 1.97 means that, for every dollar of insurance offered to employers, $1.97 is lost because of employer moral hazard. The total marginal cost of insurance for employers, calculated by summing the costs from labor reallocation and employer moral hazard, is 5.83. Labor reallocation, accounting for 66% of the total cost, emerges as the primary driver of the inefficiency from incomplete experience rating in South Carolina. The result is robust to alternative estimates for the layoff elasticity and occurs because the fiscal externality associated with a marginal worker in a high-unemployment risk industry is greater than that associated with increased frequency of layoffs. Skill misallocation further increases the cost of labor reallocation. This finding is important both conceptually, given the limited attention that the inefficiencies from labor reallocation receive relative to those from employer moral hazard in the existing literature, and for its policy implications. Acknowledging the costs of labor reallocation implies recognizing the fact that coinsurance remains inefficient even in even those contexts in which employer moral hazard is limited. Such settings include European countries, where layoffs are limited by strong employment protection policies (Saez et al. 2023), and seasonal industries, compelled to downsize their workforces during the low season.

I then indirectly calibrate the marginal value of insurance using two alternative approaches. First, I assume that workers value their employers' survival because a shock to their employers could result in their unemployment. This allows me to calibrate the value of insurance for employers with the value of insurance for workers from the literature (Gruber 1997a, Hendren 2017 Landais et al. 2021). Second, I assume that the provision of insurance to employers that cannot optimally adjust following a shock is valuable in itself in the presence of liquidity constraints or wage rigidities. I thus calibrate the value of insurance for employers with the elasticity of employment with respect to the number of hours subsidized with short-time work for illiquid employers from Giupponi et al. (2022). The upper value for the marginal value of insurance of 3.13 indicates that employers are willing to pay up to $3.13 to shift one dollar from the good to the bad state.

In summary, I find that the calibrated marginal value of insurance for employers, equal to 3.13, is smaller than the combined marginal cost of labor reallocation and employer moral hazard, equal to 5.83. This observation suggests that in South Carolina employers were overinsured and the degree of experience rating was suboptimal. Increasing the degree of experience rating would not only enhance welfare but also reduce unemployment without sacrificing the generosity of unemployment benefits for workers. These conclusions, however, should be interpreted with caution. The current calibrations of the value of insurance for employers, based on estimates from other countries and historical periods, may not fully capture the magnified value of insurance for employers during the Great Recession. Therefore, refining the characterization of the value of insurance for employers and understanding its variations over economic cycles is essential before making definitive policy recommendations. A potential metric for assessing the value of insurance for employers is an employer's share of temporary layoffs, serving as a proxy for an employer's forecast regarding the future of the business (Nekoei et al. 2020). Depending on the findings, the optimal policy may involve less experience rating during recessions and more experience rating during periods of economic stability, reflecting changes in the underlying value of insurance for employers.

This paper contributes to four strands of literature. First, within the literature on the optimal design of social insurance programs, it complements research on the optimal provision of unemployment benefits (Baily 1978, Kiley 2003, Shimer et al. 2007, Gruber 1997a, Chetty 2006, and Schmieder et al. 2016) by providing a framework for characterizing the optimal approach to funding the targeted benefit level. The optimal design of unemployment insurance taxes had previously been analyzed by Fath et al. (2005) and Blanchard et al. (2008), respectively contending that experience rating eliminates fiscal externalities and achieves productive efficiency by minimizing layoffs. Blanchard et al. (2008) further acknowledges the existence of a tradeoff between the goals of reducing layoffs and of limiting tax payments following layoffs for "risk-averse" or liquidity-constrained firms. I build on this research by formalizing in a unified sufficient statistics framework the joint contribution of employer moral hazard, labor reallocation, and the value of insurance for employers to the determination of the optimal policy, and by providing its first empirical assessment. Additionally, while numerous studies have estimated the costs of moral hazard, the only estimate of the costs of labor reallocation is that by Anderson et al. (1993a). My estimate differs from that estimate in two ways. First, my model suggests that the relevant parameter to estimate is the labor demand elasticity for employers in high-unemployment risk industries. My finding of heterogeneous labor demand elasticities by unemployment risk suggests that generic labor demand elasticities underestimate the cost of labor reallocation. Additionally, my estimates capture both the fiscal externality and the skill misallocation induced by labor reallocation.

Second, this paper contributes to the literature on experience rating. Most studies focus on the effect of the presence of minimum and maximum tax rates on the degree of experience rating in a state. I highlight here a critical but underexplored policy parameter: the measure of "experience with unemployment" used for tax rate assignments. Twenty-eight US states employ the reserve ratio, and nineteen employ the benefit ratio, with infrequent transitions between the two. South Carolina's shift from a reserve ratio to a benefit ratio system offers, along with access to new data on employers' unemployment insurance accounts, a unique opportunity to evaluate this policy and shed light on the different distribution of the tax burden among employers under the two systems. This analysis complements existing studies of the velocity of tax collection (Lachowska et al. 2020) and employers' incentives (Miller et al. 2019) implied by the two measures. Moreover, the policy change represents a novel source of variation in labor costs and has many potential applications within the field.

Third, this paper contributes to the literature on the incidence of payroll and other employment taxes. While earlier studies found at least partial pass-through of payroll taxes on employers through reduced wages (Gruber 1997b, Anderson et al. 1997, Anderson et al. 2000), recent research supports the notion that the incidence of payroll taxes is on employers, with impacts on employment (Behaghel et al. 2008, Saez et al. 2019, Benzarti et al. 2021a, Benzarti et al. 2021b, Johnston 2021, and Guo 2023) and location decisions (Guo 2021). The same conclusions have been drawn based on analyses of other business taxes, such as corporate taxes and depreciation bonuses (Suárez Serrato et al. 2016, Mark et al. 2021). The findings presented here are consistent with this recent strand of this literature, demonstrating that employers are unable to shift the burden of payroll taxes onto their employees, and shed light on potential explanations. Due to their limited influence in the United States, labor unions are unlikely the cause of wage rigidities. The finding that the missing employees earn average wages suggests that minimum wages are not driving these patterns either. Consequently, the present study provides additional support for the hypothesis that the variability of unemployment taxes across employers and over time limits employers' ability to pay significantly higher or lower wages in competitive markets (Lester 1960, Brechling 1977, Anderson et al. 1997). This paper also contributes to this literature by showing that employers' responses to unemployment taxes vary with the unemployment risk in their industries. In high-risk industries, where turnover is common and employers may have greater familiarity with the unemployment insurance system because of the higher taxes, it may be easier to adapt to a new tax environment than is the case in low-risk industries. The stronger impact observed for employers in high-tax rate industries compared to low-tax rate industries with the same standard deviation of employment within the year suggests that familiarity with the unemployment insurance system may play a more significant role in driving adjustments than merely experiencing high turnover.

Lastly, this paper contributes to the literature on adjustment costs. While Bentolila et al. (1990) argue that these costs do not have significant effects on hiring decisions, Hopenhayn et al. (1993) and Anderson (1993) find that they can result in more unemployment in the long-run as a result of reduced hiring. The results presented here indicate that unemployment taxes affect hiring decisions, with industry-specific factors determining the extent of the impact.

The remainder of the paper is organized as follows. In the next section, I present the theoretical framework for characterizing the optimal degree of experience rating. In section 3, I describes the data, the sample, and the empirical strategy for estimating the marginal cost of labor reallocation, captured by the labor demand elasticity in high-risk industries, and presents the findings. In section 4, I calibrate the residual parameters of the formula and discuss the implications for the optimal degree of experience rating. I present my conclusions in section 5.

## 2 Model of Optimal Unemployment Insurance Financing

In this section, I present the theoretical framework used to explore the welfare implications of funding a predetermined unemployment benefit level using either coinsurance or experience rating. The framework yields a formula for defining the optimal financing policy as a function of the estimable sufficient statistics representing the three forces identified in the literature, namely, the marginal value of coinsurance and the two marginal costs from labor reallocation and employer moral hazard.

The model has three key features to incorporate the forces identified in the literature. First, employers face demand shocks that halt production and lead to worker layoffs. With experience rating, the shock triggers an increase in unemployment taxes, further deteriorating employers' net worth and leading to such additional losses as increased borrowing costs. The marginal value of coinsurance consists of the progressive decrease in these losses. Second, the probability of experience a shock is larger in some industries than in others.

Industries with a high exposure to shocks disproportionately contribute to overall unemployment. Coinsurance redistributes the cost of unemployment benefits from high-risk industries to the broader community of employers, ultimately reducing labor costs in high-risk industries and increasing their labor demand. The sensitivity of labor demand in high-risk industries to labor costs plays a pivotal role in determining the extent of interindustry labor reallocation following changes in the degree of experience rating and, in turn, the significance of the inefficiencies associated with labor reallocation. Third, employers can reduce their exposure to shocks by exerting effort, but coinsurance, by making layoffs less costly, reduces employers' incentives to exert effort, thereby introducing an employer moral hazard.

In the remainder of this section, I introduce the agents in the model, derive the formula for the optimal degree of experience rating, and discuss its interpretation.

## 2.1 Four Agents: Employers, Government, Workers, and Capitalists

**Employers.** I assume the existence of two employers exposed to product demand shocks. In the *good* state of the world, these employers face positive output prices, which I normalize to one. In the *bad* state, a shock occurs that lowers output prices to zero, making it unprofitable for the employers to operate. The two employers belong to two distinct industries, characterized by different exposure to shocks. While the employer in the high-risk industry experiences a shock with probability $r_H \in (0, 1)$, the employer in the low-risk industry faces a stable product demand and no risk $r_L = 0$. Since the low-risk employer faces no shock, the high-risk employer is accountable for all of the unemployment in the economy. [6] The unemployment risk of the high-risk employer, $r_H$, can be decomposed into the sum of an exogenous strictly positive component, $p_H$, and a component that the employer can reduce by exerting effort, $m$: $r_H = p_H + \frac{1}{m}$. The employers' expected profits are given by:

$$\Pi_x = (1 - r_x)\Pi_x^{good} + r_x\Pi_x^{bad}, \qquad x \in L, H \tag{1}$$

In the good state of the world, employers produce output using labor and capital, taking wages $w_L$ and $w_H$ as fixed and hiring workers from the most to the least productive available.[7] Workers, denoted by $i$, are distributed uniformly over the unit interval and differ by their productivity in the two industries. For example, given the production functions in the two industries, $f_L$ and $f_H$, worker $i$ would produce $f_L(i, k)$ in the low risk industry and $f_H(i, k)$ in the high-risk industry when combined with capital $k$. To model the existence of industry-specific skills, I assume that productivity in the low-risk industry increases linearly over the unit interval, while productivity in the high-risk industry declines linearly over the same interval.[8] Consequently,

[6] I model a product demand shock following Feldstein (1976), Topel (1984) and Card et al. (1994), but productivity shocks or other shocks causing involuntary unemployment could be equivalently used. The exposure to shocks is assumed to be a fixed property of the industry, rather than a temporary characteristic of the employer. An equivalent interpretation is that the low-risk industry operates throughout the year, while the high-risk industry operates only during the high season, lasting a fraction $1 - r_H$ of the year.

[7] Wages could be fixed either because their labor supply is perfectly elastic or because of wage rigidities introduced by collective bargaining, wage floors, or equity concerns within the firm. The welfare analysis does not depend on the specific reason why wages are fixed. Section B.5 presents a version of the model with flexible wages that preserves all of the results of the basic model.

[8] The two diagonal lines in Figure 1 illustrate an example of workers' productivity in the two industries. This assumption is grounded in the idea that, at a specific skill level, an individual's productivity correlates positively with the productivity in similar industries, but not necessarily with the productivity in different industries. For instance, a worker may excel as a bank clerk but perform poorly as a waiter. Therefore, the assumption requires that high- and low-risk industries demand distinct skill

the high-risk employer hires the worker $i = 0$ first, and then proceeds with workers with higher $i$. $l_H \in (0, 1)$ represents both the last worker hired by the high-risk industry and the share of workers employed in the high-risk industry. The remaining $1 - l_H$ workers are employed in the low-risk industry. Additionally, employers pay $j$, determined exogenously, for each unit of capital that they employ, and an unemployment tax ($\tau_L$ and $\tau_H$, depending on the industry) for each worker hired. This tax serves to finance the provision of benefits $b$ for the workers who become unemployed following a demand shock. Employers' profits in the good scenario are thus given by:

$$\Pi_H^{good} = \int_0^{l_H} f(i,k)\,di - w_H l_H - \tau_H l_H - jk \quad \text{and} \quad \Pi_L^{good} = \int_{l_H}^1 f(i,k)\,di - w_L l_L - \tau_L l_L - jk \tag{2}$$

In the bad state of the world, a product demand shock occurs that reduces output prices to zero in the high-risk industry, making production unsustainable and leading to the dismissal of all of the workers. Following a shock, the high-risk employer is still required to pay unemployment taxes[9] However, the tax cost that the high-risk employer faces increases by q%, with $q$ being strictly positive and exogenous and representing the loss associated with each dollar of tax. This loss reflects the costs associated with the further deterioration of employers' net worth as a result of increased unemployment taxes following a shock, such as higher borrowing costs. Moreover, the high-risk employer incurs the cost of having, in vain, exerted effort to prevent the shock, represented as $(1 - 1_{e=1})\psi(m)$, where $\psi$ is strictly convex and differentiable $m$. This cost disappears when $e$, the degree of experience rating of the unemployment insurance system set by the government, is equal to one. This functional form guarantees that when $e = 1$ and experience rating is complete, the high-risk employer exerts infinite effort to avoid shocks. The employers' profits in the bad state are given by:

$$\Pi_H^{bad} = -\tau_H l_H (1 + q) - \psi(m)(1 - 1_{e=1}) \tag{3}$$

**Government Budget Constraint and the Degree of Experience Rating.** The government levies taxes on the employers to finance the unemployment benefit spending and maintain a balanced budget in expectation. Equation 4 shows that the combined taxes paid by the two employers must match the expected total benefit spending $B$, which depends on the exogenous benefit level $b$, the unemployment risk in the high-risk industry $p_H + \frac{1}{m}$, and the fraction of workers who are employed in the industry and, hence, exposed to a high risk of unemployment, $l_H$.

$$\underbrace{\tau_L l_L}_{\text{Taxes paid by low-risk employer}} + \underbrace{\tau_H l_H}_{\text{Taxes paid by high-risk employer}} = \underbrace{b l_H \left(p_H + \frac{1}{m}\right) = B}_{\text{Expected total benefit cost}} \tag{4}$$

Instead of directly determining employers' tax rates, the government chooses the degree of experience rating for the unemployment insurance system, $e \in [0, 1]$. $e$ is the fraction of total benefit spending that the high-risk

sets.

[9] The modeling of unemployment taxes as head taxes paid in both states of the world is consistent with unemployment insurance financing policies in the United States. There, employers contribute unemployment taxes on the wages paid to a worker up to a threshold, known as the taxable wage base. Since most workers earn yearly wages exceeding the threshold, employers pay the lion's share of the unemployment taxes owed for the year during the first quarter. Whether a worker is retained for longer is thus irrelevant for the purpose of determining unemployment tax liabilities.

employer repays in unemployment taxes.[10] The low-risk employer pays the residual share $1-e$. $\tau_H$ and $\tau_L$ are set accordingly.

$$\underbrace{\tau_H l_H}_{\text{Total tax paid by high-risk employer}} = \underbrace{eB = ebl_H\left(p_H + \frac{1}{m}\right)}_{\text{Fraction } e \text{ of total benefit cost}} \tag{5}$$

$$\underbrace{\tau_L l_L}_{\text{Total tax paid by low-risk employer}} = \underbrace{(1-e)B = (1-e)bl_H\left(p_H + \frac{1}{m}\right)}_{\text{Fraction } 1-e \text{ of total benefit cost}} \tag{6}$$

The case of $e = 1$ corresponds to the scenario of complete experience rating, in which the high-risk employer repays the full cost of the unemployment benefit spending resulting from its layoffs, while low-risk employer, which does not lay off workers, is exempt from paying unemployment taxes. When $e < 1$, the coinsurance between the two employers comes into play since a fraction $1-e$ of the benefit cost generated by the high-risk employer is transferred to the low-risk employer. Notably, when $e = 0.5$, the two employers contribute the same amount of tax. Consequently, changes in the degree of experience rating $e$ affect the distribution of the unemployment tax burden between the employers.

**Workers.** Workers, denoted by $i$, are distributed uniformly over the unit interval and differ in terms of their productivity in the two industries. This disparity in productivity influences the probability of workers being employed in either of the industries. However, because wages are uniform for all of the workers within the same industry, they do not impact the utility that workers derive from their jobs. The workers employed in the low-risk industry derive utility from consuming their wages, represented as $U_L = u(w_L)$, where $u(c)$ is a strictly concave utility function defined over consumption $c$. The workers hired in the high-risk industry consume their wages in the good state and consume the unemployment benefit $b$ and enjoy leisure $L > 0$ in the bad state. Their expected utility is thus $U_H = u(w_H)(1-r_H) + r_H(u(b) + L)$. To focus on the key forces of the model, I make two assumptions. First, I assume that the workers derive the same utility from the low-risk and the high-risk jobs.[11] Second, I assume that workers are indifferent between consuming the high-risk wage and the combination of consuming the unemployment benefit and enjoying leisure.[12] Crucially, since a gap remains in workers' marginal utilities between the good state of the world, in which they are employed, and the bad state of the world, in which they are unemployed, $u'(b) > u'(w_H)$, unemployment insurance is still valuable for them.[13]

**Capitalists.** There is a continuum of capitalists owning capital $2k$, which assumed to be split identically between the employers for production. The capitalists consume the return from their investment: $U_C =$

[10] Consistent with Feldstein (1976) and Topel (1984), $e$ represents the tax cost per dollar of benefit spending for the high-risk employer.

[11] Section B.6 shows that, when I relax this assumption and assume that workers have heterogeneous preferences for the two industries, a new source of inefficiency is associated with labor reallocation that is equal to the utility gap experienced by the marginal worker transferred from one industry to another, $U_L - U_H$. I discuss potential approaches to calibrating this parameter and suggests that the marginal worker would have preferred the low-risk job ($U_L > U_H$). Introducing heterogeneous preferences would thus increase the total inefficiency resulting from labor reallocation, indicating that the estimates from this simplified version of the model represent a lower bound for the true cost of reallocation and reinforcing the case for a higher degree of experience rating.

[12] This assumption is not entirely unrealistic, and may explain the existence of seasonal jobs despite their typically low wages. Nevertheless, I relax it in Section B.6, eliminating leisure and allowing workers to experience lower utility when they are unemployed. The cost of moral hazard increases to reflect this utility loss. The simplified model thus provides a lower bound for the cost of moral hazard, reinforcing the case for a higher degree of experience rating.

[13] Chetty (2006) consistently discusses that when workers value leisure, they are willing to sacrifice more consumption to take time off, which results in a larger consumption drop and a greater value of unemployment insurance.

$2k[j + \gamma(\Pi_L + \Pi_H) - 1]$. For each unit of capital invested, their return consists of the exogenous price of capital, $j$, and in the exogenous fraction $\gamma \in (0, 1)$ of the employers' net worth, $\Pi_L + \Pi_H$. In the presence of asymmetric information between the lenders (capitalists) and the borrowers (employers), the former audit their investment and incur agency costs that result in the loss of a portion of their returns. A higher net worth increases the capitalists' return by reducing these agency costs (Bernanke et al. 1989).

## 2.2 Model Solution

Figure 2 illustrates the timeline for the model. First, the government chooses the degree of experience rating, $e$, that maximizes welfare. Next, the high-risk employer observes $e$ and sets effort $m$ and labor demand $l_H$ optimally. The high-risk employer hires a corresponding fraction $l_H$ of the workers, and the low-risk employer hires the rest. Last, with probability $r_H$, the shock occurs and the workers in the high-risk industry become unemployed.

I solve the model by backward induction. To begin, I derive the high-risk employer's optimal responses to the government's choice of experience rating. The variation in the high-risk employer's behavior in response to the changes in the degree of experience rating is what causes the inefficiencies associated with coinsurance. From the optimal level of effort, I obtain the elasticity of effort with respect to the degree of experience rating, which serves as the sufficient statistic capturing the extent of moral hazard. From the optimal labor demand, I obtain the elasticity of labor demand with respect to the degree of experience rating, which serves as the sufficient statistic capturing the extent of labor reallocation. I then calculate the government's optimal choice of experience rating considering employers' responses as given. The optimal policy balances the inefficiencies resulting from the high-risk employer's behavioral responses against the value of providing insurance to employers exposed to shocks.

**Labor Demand and Experience Rating.** In Section B.2, I derive the privately optimal labor demand of the high-risk employer by maximizing its expected profit with respect to the number of employees, $l_H$, and setting the first-order condition to zero. The high-risk employer stops hiring workers when the productivity of the marginal worker equals the marginal cost, given by the wage and the increased unemployment tax. The latter coincides with the fraction $e$ of the unemployment benefit level $b$ that the high-risk employer internalizes through taxation, scaled by the relative probability that the marginal worker becomes unemployed.

$$\underbrace{\overbrace{f_H(l_H, k)}^{\text{Marginal worker productivity}}}_{\substack{\text{Marginal product of one} \\ \text{extra unit of labor}}} = \underbrace{\left[ \overbrace{\frac{eb\left(p_H + \frac{1}{m}\right)}{1 - p_H - \frac{1}{m}}}^{\text{Extra tax}} + \overbrace{w_H}^{\text{Extra wage}} \right]}_{\substack{\text{Marginal cost of one} \\ \text{extra unit of labor}}} \tag{7}$$

From this equation, it emerges that the labor demand of the high-risk employer declines with the degree of experience rating, $\frac{\partial l_H}{\partial e} < 0$. Intuitively, a higher degree of experience rating increases the labor costs faced by the high-risk employer and reduces its labor demand. In the model, this occurs because, when experience rating increases, the productivity of the marginal worker must increase to match the higher marginal cost. Since productivity declines along the unit interval over which workers are distributed, the high-risk employer stops hiring workers earlier along the interval, at a lower level of $l_H$ which corresponds to a marginal worker with a higher productivity.[14] Figure 1 illustrates this dynamic. In the figure, workers $i$ are distributed over the unit interval on the x-axis, and their productivities in the two industries, $f_H(i,k)$ and $f_L(i,k)$, is shown on the y-axis. The high-risk employer hires workers along the x-axis starting from the most productive worker with $i=0$. With complete experience rating, the employer stops hiring when the productivity of the marginal worker is equal to labor costs, given by the wage and the total tax increase, $f_H(l_H,k) = w_H + \frac{br_H}{1-r_H}$. This condition is satisfied by point A, which identifies $l_H^{*ER}$ as the marginal worker and the prevailing employment share with complete experience rating. Decreasing the degree of experience rating reduces labor costs to $w_H + \frac{ebr_H}{1-r_H}$. Point C, where productivity matches these lower labor costs, identifies a marginal worker positioned beyond the former along the unit interval, and a higher employment share in the high-risk industry $l'_H > l_H^{*ER}$. In summary, complete experience rating minimizes the labor demand of the high-risk employer.

Once the labor demand of the high-risk employer, $l_H(e)$, is established, low-risk employment is determined residually as $l_L = 1 - l_H(e)$. Therefore, a lower degree of experience rating increases the labor demand of the high-risk employer and, in turn, reduces the employment share of the low-risk employer. This effect occurs because part of the tax burden, $\frac{(1-e)br_H}{1-r_H}$, is transferred from the high-risk employer to the low-risk employer, resulting in increased labor costs and reduced labor demand for the latter. This phenomenon of cross-subsidization, where premiums paid by all insured parties cover the costs for those experiencing a shock, is a typical aspect of any insurance system. However, a concern arises as certain employers consistently subsidize or are subsidized over time. This issue is exposed in Section B.1. If the two employers were equally exposed to shocks, their benefit spending and tax payments would balance out over time, and the allocation of workers between them would remain unaffected in the long run. However, since unemployment risk is a permanent trait, the high-risk employer consistently generates disproportionate benefit spending from one period to the next, and the cost of this spending is consistently transferred to the low-risk employer through coinsurance. Essentially, the continual subsidization of the high-risk employer at the expense of the low risk one fosters the growth of the former while diminishing the latter. This impact is not simply financial but also influences labor demand through the effect of unemployment taxes, resulting in labor reallocation. Since these patterns are generated by different unemployment risk across different industries, this model is showing that decreasing experience rating induces the reallocation of labor from the low-risk industry to the high-risk industry.

The extent of this reallocation is captured by the labor demand elasticity of the high-risk employer with respect of the degree of experience rating: $\epsilon_{l_H,e} = \frac{\partial l_H}{\partial e}\frac{e}{l_H} < 0$. Intuitively, a higher elasticity implies more movement of workers into or out of the high-risk industry as unemployment taxes change.

**Effort to Prevent Shocks and Experience Rating.** In Section B.3, I derive the high-risk employer's privately optimal effort to avoid the negative shock by maximizing its expected profit with respect to the level effort, $m$, and setting the first-order condition to zero. The optimal level is reached when the marginal benefit of additional effort equals the marginal cost. Increasing effort is associated with two marginal benefits. First, the likelihood increases that the good state of the world occurs and that the high-risk employer earns the good-state profits rather than the bad-state profits. Second, greater effort reduces the unemployment

[14] This result could be equivalently obtained with a Cobb-Douglas production function with decreasing returns from labor.

risk and, in turn, the expected benefit spending and the unemployment taxes paid by the high-risk employer. At the same time, since $\psi(m)$ is a convex function, increasing effort is associated with progressively higher monetary costs. The optimal effort balances the two marginal benefits with this marginal cost.

$$\underbrace{\frac{1}{m^2}(\overbrace{\Pi_H^{good} - \Pi_H^{bad}}^{\Delta \text{ profits between states}}) + \overbrace{\frac{ebl_H}{m^2}}^{\text{Lower tax}}}_{\substack{\text{Private marginal benefit}\\ \text{of higher effort}}} = \underbrace{\left(p_H + \frac{1}{m}\right)\psi'(m)(1 - 1_{e=1})}_{\substack{\text{Private marginal cost}\\ \text{of higher effort}}} \tag{8}$$

This equation shows how the optimal level of effort changes as a function of the degree of experience rating. With complete experience rating, when $e = 1$, this marginal cost of effort is nullified, and the employer finds it optimal to exert infinite effort. Consequently, the unemployment risk reaches its minimum, $\lim_{m\to\infty} r_H = \lim_{m\to\infty} p_H + \frac{1}{m} = p_H$. With coinsurance, when $e < 1$, the employer faces a positive and increasing marginal cost of effort that leads to a finite optimal effort and above-minimum layoffs. I show that, in this case, the optimal level of effort increases with the degree of experience rating, $\frac{\partial m}{\partial e} > 0$. These results mirror the notion that experience rating reduces employers' moral hazard and layoffs. The elasticity of effort with the degree of experience rating, $\epsilon_{m,e} = \frac{\partial m}{\partial e}\frac{e}{m} > 0$, is thus the model parameter that captures the extent of employer moral hazard.

**Optimal Degree of Experience Rating.** The government chooses the degree of experience rating $e$ that maximizes a utilitarian social welfare function, which is obtained by summing the utilities of the workers and capitalists, subject to the rules for allocating the tax burden between the employers, the high-risk employer's optimal labor demand and effort, labor market clearing, and workers' indifference conditions.

$$SWF = \underbrace{(1 - l_H)u(w_L)}_{\text{Utility of workers in low-risk job}} + l_H \underbrace{\left[\left(1 - p_H - \frac{1}{m}\right)u(w_H) + \left(p_H + \frac{1}{m}\right)u(b)\right]}_{\text{Utility of workers in high-risk job}} \underbrace{k[\gamma(\Pi_L + \Pi_H) - 1]}_{\text{Utility of capitalists}} \tag{9}$$

In Section B.4, I solve this maximization problem by taking the derivative of the social welfare function with respect to $e$ and setting it to zero. The derivative represents the welfare effects induced by a small change in the degree of experience rating. To provide a clearer interpretation, I scale this derivative by total benefit spending to obtain an equation representing the welfare effects of a small change in the unemployment tax paid by the high-risk employer. The optimal degree of experience rating, defined in Equation 10, balances the marginal benefit of this tax change with the marginal cost. To fix ideas, I consider the case of a one dollar decline in the tax paid by the high-risk employer.

$$\underbrace{\frac{\Pi_H'^{good} - \Pi_H'^{bad}}{\Pi_H'^{good}}}_{\text{Value of insurance for employers}} = \underbrace{\overbrace{-\lambda\epsilon_{l_H,\alpha}}^{\text{Cost of labor reallocation}} + \overbrace{\mu\epsilon_{m,\alpha}}^{\text{Cost of employer moral hazard}}}_{\text{Cost of insurance for employers}} \tag{10}$$

The left side of Equation 10 represents the marginal benefit of reducing by one dollar the unemployment tax paid by the high-risk employer. The sufficient statistic that represents this marginal benefit is the loss associated with each dollar of tax increase following a negative shock, $q$, capturing additional losses, such as higher borrowing costs, deriving from the employer's financial deterioration. This parameter indicates that, for every dollar reduction in unemployment taxes, the employer's profit increases by \$q. As $q$ can be equivalently written as the normalized gap in the high-risk employer's marginal profits between the good and the bad states of the world, it can also be interpreted as the value of insurance against financial deterioration for the high-risk employer, or the amount that the employer is willing to give up in order to shift one dollar from the good to the bad state.

The right side of 10 represents the marginal cost of reducing by one dollar the unemployment taxes paid by the high-risk employer. The total cost can be decomposed into the cost of interindustry labor reallocation and the cost of employer moral hazard. The sufficient statistic capturing the cost of labor reallocation is the elasticity of the high-risk employer's labor demand with respect to the degree of experience rating, $\epsilon_{l_H,e} < 0$. Shifting unemployment taxes from the high- to the low-risk employer reduces labor costs for the high-risk employer and increases its labor demand. As a result, the employment share in the high-risk industry increases. This reallocation of workers towards the high-risk industry is costly for two reasons, which the parameters within the scaling factor $\lambda$ express.

$$\lambda = \frac{1}{ebr_H^2}\left[\underbrace{f_L(l_H,k) - w_L}_{\text{Misallocation of productive skills}} + \underbrace{(1-e)br_H}_{\text{Fiscal externality due to higher benefit cost}}\right] \tag{11}$$

First, the expansion of the high-risk industry results in the misallocation of productive skills. The net productivity in the low-risk industry of the marginal worker employed in the high-risk industry, $f_L(l_H,k) - w_L$, captures this effect. Intuitively, the inefficiency emerges because the marginal worker hired in the high-risk industry, who, by definition, has net productivity equal to zero in that industry, would have had a positive net productivity if employed in the low-risk industry. Figure 1 illustrates this point. As discussed, a shift from complete ($e = 1$) to incomplete ($e < 1$) experience rating reduces labor costs for the high risk employer and increases its labor demand from $l_H^{*ER}$ to $l'_H$. $l'_H$ is the marginal worker hired by the high-risk employer when experience rating is incomplete, and, by definition, her productivity in the high-risk industry is equal to labor costs (and the net productivity is equal to zero). The inefficiency emerges because, when employed in the low-risk industry, this worker had a positive net productivity, equal to the difference between the productivity in the low-industry $f_L(l'_H,k)$, measured by the point D on the y-axis, and the low-risk wage $w_L$, measured by point E on the y-axis. The figure shows that all of the workers between $l_H^{*ER}$ and $l'_H$ would have been more productively employed in the low-risk industry. However, only the net productivity of the marginal worker is relevant to welfare. A simulation reveals that, for every \$10 of net productivity loss, the marginal cost of insurance increases by 55 cents. Intuitively, a larger disparity in skill requirements between industries implies a larger productivity loss from labor reallocation. Second, the reallocation of workers towards the high-risk industry imposes a fiscal externality on the government budget. As more workers are exposed to a high risk of unemployment, layoffs increase, along with spending on unemployment benefits that must be financed through taxes. Therefore, $\lambda\epsilon_{l_H,e}$ measures the amount lost as a result of skill misallocation as well as the fiscal externality for each dollar of insurance offered to the high-risk employer.

The sufficient statistic representing employer moral hazard is the elasticity of effort with respect to the degree of experience rating, $\epsilon_{m,e} > 0$. Lowering the unemployment tax paid by the high-risk employer decreases the cost associated with a shock. Consequently, the high-risk employer exerts less effort to prevent such shocks and, as a result, layoffs increase along with the benefit spending that the government must cover with higher taxes. For this reason, employer moral hazard constitutes a second source of fiscal externality. This externality is represented by the parameters within the scaling factor $mu$. Therefore, $\mu\epsilon_{m,e}$ measures the amount lost due to employer moral hazard for every dollar of insurance offered to the high-risk employer.

$$\mu = \underbrace{\frac{(1-e)}{emr_H^2}}_{\text{Fiscal externality due to higher benefit cost}} \tag{12}$$

The optimal degree of experience rating, then, balances the value of an additional dollar of insurance for employers with the costs of labor reallocation and employer moral hazard. By comparing the marginal benefit and costs of providing insurance to *employers*, this formula for the optimal degree of experience rating mirrors the formula for the optimal unemployment benefit level, which is defined by the tradeoff between the marginal benefit and the marginal cost of providing insurance to *workers* (Baily 1978). In this sense, the formula can be considered as an employer-Baily-type formula. Its primary application involves assessing the magnitude of its parameters within a specific context, comparing the marginal benefit and cost of insurance, and evaluating whether the degree of experience rating in that context should be reduced, as is the case when the benefit exceeds the cost, or increased, as is the case when the cost exceeds the benefits, in order to enhance welfare. The empirical section of this paper presents this evaluation.

## 2.3 Discussion

The model is based on a set of simplifying assumptions that increase its tractability but can be relaxed without altering the key insights that it provides. When I extend the model to encompass various realistic features, I consistently find that this simplified version of the model provides a lower bound for the costs of reallocation under coinsurance.[15] In Section B.5, I explore a version of the model that incorporates flexible wages. The key distinction is that the reallocation of workers across industries affects the wages offered in these industries. The formula for the optimal degree of experience rating as workers consume their wages contains two additional sufficient statistics, namely, the elasticities of wages in the two industries with respect to the degree of experience rating. Nonetheless, as Table 2 shows, these elasticities are estimated to be zero, effectively leading back to the scenario with fixed wages. In Section B.6, I present a version of the model in which workers are no longer indifferent between industries. Introducing individual preferences for a specific industry increases the cost of labor reallocation because the reallocation of the marginal worker to the high-risk industry is associated with a utility loss. Similarly, when workers are no longer indifferent between employment and the combination of unemployment and leisure, the cost of moral hazard increases because unemployment involves a utility loss. Lastly, in Section B.7, I discuss the implications of allowing the low-risk employer to have a strictly positive unemployment risk: $r_L = p_L + \frac{1}{m}$. Given that the crucial factor determining cross-subsidization is the relative exposure to risk of the two industries, I normalize $p_L$ to zero and interpret $p_H$ as the *differential* risk between them. In essence, I link the unemployment risk of the low-risk industry to the

[15] I do not incorporate the positive externalities that may arise from increased layoffs and unemployment, such as the benefit of a layoff for the workers who accepted jobs with excessive mobility costs (Diamond 1981). Any such externalities would diminish the cost of coinsurance and the optimal degree of experience rating.

effort of the low-risk employer. In this scenario, moral hazard becomes more costly because both employers contribute to it. If anything, the following considerations strengthen the case for a higher optimal degree of experience rating.

A limitation of this static model is its inability to explicitly account for economic cycles, for most unemployment benefits are distributed during recessions. However, the various parameters in the formula should not be considered as static. The evaluation of the optimal policy requires understanding how they vary with the underlying unemployment risk. This consideration prompts a discussion of the nature of unemployment risk in the model. Here, $p_H$ represents the differential unemployment risk between the two industries. If $p_H = 0$ and both industries were equally exposed to risk, then labor reallocation would not be a concern, and moral hazard would be the sole source of inefficiency associated with coinsurance. In cases in which $p_H$ is positive, it may assume different connotations. $p_H$ could represent the consistently high layoff rates in seasonal industries, in which unemployment is a recurring and predictable phenomenon so insurance unnecessary. If $p_H$ represented exposure to unforeseen shocks, insurance against these shocks would indeed be valuable, and changes in $p_H$ across economic cycles would, consequently, alter the value of insurance for employers over time. In line with this hypothesis, East et al. (2015) suggest that the value of insurance for workers might be higher during recessions than during periods of economic stability. The significance of employer moral hazard could also fluctuate over economic cycles, with layoffs occurring regardless of their costs during recessions. Similar patterns are observed among workers, where inefficiencies decline during economic downturns (Schmieder et al. 2012). Therefore, it is crucial to bear in mind that the value and costs of coinsurance may vary across different contexts and over time, influenced by factors such as the predictability of unemployment, the magnitude of shocks, and the relative exposure of various industries to these shocks. Similar to the arguments for countercyclical generosity in unemployment benefits, which offers increased support to workers during recessions (Kiley 2003, Schmieder et al. 2012), the optimal financing policy may also fluctuate over business cycles, involving more experience rating during periods of economic stability and less during recessions.

A final consideration is the distinction between employers and industries, which, in this model, coincide. The formula for the optimal degree of experience rating can be interpreted both at the industry and at the employer levels. The cost of labor reallocation is more pronounced when it occurs across different industries than when it occurs across employers within the same industry, which have similar unemployment risk and skill requirements. Conversely, moral hazard is more significant at the employer level and diluted within an industry. Lastly, the value of insuring specific industries may exceed the value of potentially inefficient insurance of specific employers, as Giupponi et al. (2022) discuss.

# 3 Estimating the Cost of Interindustry Labor Reallocation

In this section, I estimate the sufficient statistic representing the marginal cost of labor reallocation, that is, the labor demand elasticity with respect to the degree of experience rating for the high-risk employer. There is no readily available estimate for this parameter in the literature, and relying on a generic labor demand elasticity may underestimate the cost of labor reallocation.

The idea that labor demand may be more elastic for employers in high-risk industries has long been contemplated. For instance, Lester (1960) argued that employers with low layoff rates employers are more resilient to shocks than employers with high-layoff rates. Moreover, employers in high-risk industries may find it easier to adjust their employment levels in response to tax changes, possibly because of their familiarity with fluctuations in workforce size or a deeper understanding of unemployment insurance financing policies as a result of their greater exposure to both high tax rates and larger variations in their tax rates.[16]

Since, in the model, an increase in the degree of experience rating results in a higher unemployment tax per worker for the high-risk employer, I can equivalently estimate a labor demand elasticity with respect to the unemployment tax per worker, $\epsilon_{l_H,\tau}$ instead of $\epsilon_{l_H,e}$. This estimation is facilitated by the existence of numerous sources of quasi-experimental variation in the unemployment tax per worker in the United States, where experience rating policies involve several discontinuities and are subject to frequent changes. I leverage novel quasi-experimental variation in the tax per worker from state-level reforms of experience rating policies in South Carolina and Colorado to estimate the reduced form causal effect of the tax per worker on labor demand for employers in high-risk industries. This section focuses on the reform in South Carolina, with the results based on the reform in Colorado being summarized here and presented in detail in Appendix A.

### 3.1 Institutional Framework

The Unemployment Compensation Program established in response to the Great Depression with the 1935 Social Security Act of 1935 provides temporary and partial wage replacement to workers who are involuntarily laid off to ensure they can afford the necessities while unemployed. The program operates as a federal-state partnership, allowing states to design and manage state-level unemployment insurance programs consistent with the relevant federal guidelines. Consequently, states vary widely in terms of workers' eligibility criteria, the generosity of the benefits that workers receive, and the financing methods employed. Each state maintains an individual Unemployment Trust Fund into which the unemployment taxes levied on employers are deposited and from which funds are drawn to provide benefits to unemployed workers. States are responsible for the solvency of their funds through the different economic cycles and regularly adjust their unemployment tax rates based on the prevailing conditions. When trust fund levels decrease because of strong demand for benefits, states increase the unemployment tax rates on employers. Then, once the funds are replenished, the tax rates are lowered.[17] This variation in the unemployment tax rates over time is a distinctive feature of unemployment insurance financing in the United States.

A second distinctive feature is that the unemployment tax rates vary across employers and for individual

[16]Since, in the United States, employers with high layoff rates face higher unemployment tax rates, unemployment taxes are more significant for them. These higher tax rates also render them more responsive to policy changes. For instance, the impact of increases in the taxable wage base, which represents the portion of workers' annual wage to which the tax rate is applied to calculate the tax liability, is magnified for employers with high tax rates. Furthermore, changes in the tax rate schedule within a state often lead to substantial variability in the tax rates paid by high-layoff rate employers, while causing smaller fluctuations in the tax rates of low-layoff rate employers.

[17]Typically, tax rates automatically adjust, either increasing or decreasing, when specific fund thresholds are reached. Historically, some governments have deviated from these pre-determined rules, keeping tax rates high to strengthen a fund's solvency or low to ease the tax burden on employers. As a result of the variation in financing rules and compliance, the states varied widely in their ability to cope with the recent economic shocks. Panel (a) in Figure A1 displays the trends in unemployment benefits, unemployment taxes, federal loans, and trust fund reserves in the United States between 1999 and 2021. The high demand for benefits during the Great Recession and the COVID-19 pandemic resulted in the depletion of states' trust funds. Thus, thirty-three states became insolvent during the Great Recession, and eighteen during the pandemic, borrowing nearly 50 billion dollars from the federal government to cover the cost of the benefits. In the aftermath of these recessions, many states raised the unemployment taxes paid by employers to settle their debts and restore their financial reserves.

employers over time to reflect their experiences with unemployment. This system for assigning individualized and dynamic unemployment tax rates to employers is known as *"experience rating."* Since my identification strategy is based on a reform of experience rating policies, it is useful to examine the assignment process in greater detail. This assignment is implemented in three steps. First, the states calculate an updated measure of each employer's experience with unemployment annually. Twenty-eight states employ a measure of experience known as the *"reserve ratio,"* which is calculated as the ratio between the net reserves in an employer's individual account and the sum (or the average of) recently paid taxable wages. Net reserves are calculated as the difference between the sum of all of the unemployment benefits ever claimed by the employees laid off by the employer and the sum of all of the unemployment tax payments ever made by the employer since its establishment or that of the unemployment insurance system for the oldest employers. This measure thus represents the employers' net position with respect to the unemployment insurance system. Depending on whether benefit charges exceed tax payments, the reserve ratio may be positive or negative. Higher values for the reserve ratio indicate greater experience with unemployment since the dollar amount of benefit charges increases relative to tax payments.[18]

$$\text{Reserve Ratio}_{it} = \frac{\sum_{j=-\infty}^{t-1} \text{Unemployment Benefits}_{ij} - \sum_{j=-\infty}^{t-1} \text{Unemployment Taxes}_{ij}}{\sum_{j=x}^{t-1} \text{Taxable Wages}_{ij}} \tag{13}$$

Nineteen states measure employers' experience with unemployment using the *"benefit ratio,"* which is calculated as the ratio of the benefits charged to the employer to the sum of the taxable wages paid by the employer during the most recent $x$ years, with $x$ typically ranging between three and seven across the states. The benefit ratio only assumes non-negative values. Higher values of the benefit ratio indicate greater experience with unemployment, as the recent benefit charges increase.[19]

$$\text{Benefit Ratio}_{it} = \frac{\sum_{j=x}^{t-1} \text{Unemployment Benefits}_{ij}}{\sum_{j=x}^{t-1} \text{Taxable Wages}_{ij}} \tag{14}$$

Second, states assign higher unemployment tax rates to employers with higher measured experience with unemployment. To do so, they use tax rate schedules, which are functions specifying the unemployment tax rate corresponding to each level of reserve ratio or benefit ratio. These schedules are regularly adjusted to increase or decrease the overall tax burden. Every year, employers' tax rates are recalculated to reflect employers' updated experiences with unemployment as well as changes in the tax rate schedules. Employers receive a notification of their unemployment tax rate valid for the upcoming year between the end of the previous year and early into the new year.

Third, the unemployment tax rate is multiplied by the employers' taxable wages in each quarter to determine their quarterly tax liability. Workers' wages are subject to taxes up to a threshold, known as the *"taxable*

[18] In this study, I have inverted the sign of the reserve ratio to guarantee that the tax rates increase with all of the measures of unemployment risk. In fact, employers' net reserves are calculated as the difference between their total tax payments and total benefit charges, with a higher reserve ratio indicating a lower experience with unemployment.

[19] The remaining three states employ similar measures of employers' experience, namely, the "average benefit cost rate" in Alaska and the "benefit-wage ratio" in Delaware and Oklahoma. Figure A2 illustrates the geographical distribution of the states that employ the reserve ratio, the benefit ratio, and other measures. The map suggests that there is no systematic adoption of a specific measure based on regional characteristics since the states employing these measures are distributed evenly throughout the country. The map also shows the states that switched from reserve ratio to benefit ratio, South Carolina in 2011 and New Mexico in 2016.

*wage base"*, that is the same for all the employers in a state. For instance, when a worker earns $10,000 per quarter in a state with a $15,000 taxable wage base, the employer only pays taxes on all the $10,000 paid in the first quarter and on the first $5,000 paid in the second quarter.

The cross-sectional and temporal variations in the unemployment tax rates are designed to hold employers accountable for their unemployment benefit costs. Nevertheless, some benefit costs cannot be assigned to individual employers and are repaid collectively.[20] The presence of some degree of coinsurance implies that employer moral hazard and labor reallocation remain pertinent concerns, even in the United States, where experience rating policies are in place.

## 3.2 Data and Sample

The main variables in the analysis are obtained from the unemployment tax filing data provided by South Carolina Department of Employment and Workforce (SC DEW). The data cover the near-universe of employers in in the state and include the information used by SC DEW to assign unemployment tax rates to employers, including their number of employees, total wages, the unemployment tax rate, the reserve and the benefit ratios, taxable wages, unemployment benefit charges, the establishment date, and the four-digit NAICS industry code.[21] I also access analogous data from the Colorado Department of Labor and Employment (CO DLE) covering the universe of employers in the state. To identify the state-level reforms of unemployment insurance financing policies, which I leverage to obtain quasi-experimental variation in unemployment taxes, I digitized information on the unemployment tax rate schedules in place over the recent decades in each US state. Lastly, I obtain information about employment and wages at the state-industry-year-quarter level from the Quarterly Census of Employment and Wages (QCEW) and use state-year level data on unemployment benefit and tax payments, the taxable wage base, and unemployment trust fund solvency from the ET Financial Handbook 394 (ET 394).

The sample used for the analysis is a subset of the SC DEW data. To focus on the employers affected by the unemployment financing reforms, I restrict the SC DEW data to private-sector employers, the unemployment tax rate of which is determined based on their experience with unemployment. I thus exclude two categories of non-experience-rated employers, specifically, new employers, which are subject to a common tax rate of 3.4% for the first two years of liability, while building their own experience, and employers with a delinquent contribution report or unpaid unemployment taxes, which are subject to a delinquent tax rate of 3.4%. To avoid compositional changes around the time of the reform, I further restrict the sample to the employers observed continuously and with complete employee data between 2005 and 2014, thus spanning a ten-year period surrounding the 2011 reform that I leverage for identification.

[20] There are three categories of benefit costs that are not charged to specific employers. First, "ineffective charges" result from employers reaching the maximum unemployment tax rate and laying off workers without incurring additional tax liabilities. Second, certain benefits are "non-charged" to specific employers, such as the benefits claimed by workers who quit voluntarily or discharged for cause under specific circumstances, allowances for dependents, or the states' shares of the benefits paid under the Extended Benefit Program. Third, "inactive charges" are claimed by workers laid off when their employers went out of business.

[21] The SC DEW data, excluding the top 1% largest employers to ensure confidentiality and prevent identification, represents 76% of the total employment in the state. Table A1 reveals the closely aligned distribution of employers and employees across industries between the SC DEW data and the fully representative Quarterly Census of Employment and Wages data. This alignment indicates that excluding the largest employers does not significantly impact the representation of specific industries in the SC DEW data.

Table 1 shows the summary statistics for the sample in 2009, which consists mainly of small employers but also includes large ones, with a median of five employees and an average of twelve. The median employer offered an average wage of $30,000 and was established in 1995, indicating sixteen years of operation at the time of the 2011 reform. Regarding sector distribution, the primary sector employers make up 1.6% of the sample, construction 12%, manufacturing 6%, trade 22%, transportation 2.5%, and services 56%. The employers exhibit significant variation in their reserve ratios, ranging from -158 to 963 and with an average of -.05 and a median of -.14. These negative values indicate that the unemployment tax payments exceed the benefit charges for most employers. This variation in reserve ratios induces large variation in unemployment tax rates, from 1.3 to 6.1%, and in the unemployment tax per worker, which is calculated by multiplying the tax rate by the taxable wage base of $7,000 and varies between $91 and $427.[22]

### 3.3 Identification strategy

To generate quasi-experimental variation in employers' unemployment tax per worker, I leverage the reform of unemployment financing policies that occurred in South Carolina in 2011. During the Great Recession, the extraordinary demand for unemployment benefits and insufficient reserves resulted in the depletion of the state's unemployment trust fund. To cover benefit costs, the state borrowed $1 billion in federal loans. To settle its debt and replenish the fund, the state government reformed its unemployment insurance financing policies to increase tax collection. The reform was initiated in 2010, with the tax changes impacting employers beginning in 2011. By the end of 2014, the federal loan had been repaid, and South Carolina gradually reduced the tax burden on employers.[23]

The reform introduced three main changes. First, the taxable wage base increased from $7,000 to $14,000 in five years. Second, the unemployment tax rate schedule was expanded to introduce new lower and higher tax rates. Third, South Carolina replaced the reserve ratio with the benefit ratio as the measure of employers' experience with unemployment.[24] Equation 15 presents the formulas for the reserve ratio and the benefit ratio in effect in South Carolina before and after the reform. Comparing the two measures reveals two key differences. First, they differ in the length of the lookback period, $j$, used to assess employers' experiences with unemployment. While the reserve ratio is calculated using data spanning the period from the employer's establishment date to the calculation date, the benefit ratio utilizes a rolling seven-year lookback period, discarding any earlier data. Second, while unemployment taxes factor into the calculation of the reserve ratio to determine an employer's net position within the unemployment insurance system, they are irrelevant to the

[22] Compared with the original sample, the study sample is positively selected. Table A2 shows that the selected employers have six more employees and offer average annual wages $4,000 (10%) higher than the excluded employers. Consistent with the exclusion of the new employers, selected employers have eleven additional years of operation, and, consistent with the exclusion of new and delinquent employers, the selected employers face lower tax rates despite maintaining similar reserve ratios.

[23] Panel (b) of Figure A1 presents the trends in unemployment benefits, taxes, trust fund reserves, and federal loans in South Carolina around the time of the Great Recession.

[24] Figure A3 shows the increase in the taxable wage base. Figure A4 shows the unemployment tax rate schedules in place before and after the reform. Figure A5 plots employers by their tax per worker and reserve ratios, pre-reform (panel [a]), or benefit-ratios, post-reform (panel [b]). Changes in the tax per worker reflect both the higher taxable wage base and the expanded tax rate schedule. Visual inspection suggests that a significant increase occurred in the tax liability per worker, with the maximum rising from $427 to $879. Given the different measure for experience with unemployment on the x-axis, the figure does not represent how the tax per worker changed for the individual employers.

calculation of the benefit ratio, which is determined based solely on benefit charges.[25]

$$\text{RR}_{it} = \frac{\sum_{j=-\infty}^{t-1} \text{Unempl. Benefits}_{ij} - \sum_{j=-\infty}^{t-1} \text{Unempl. Taxes}_{ij}}{\text{Taxable Wages}_{i,t-1}} \longrightarrow \text{BR}_{it} = \frac{\sum_{j=-7}^{t-1} \text{Unempl. Benefits}_{ij}}{\sum_{j=-7}^{t-1} \text{Taxable Wages}_{ij}} \tag{15}$$

The government of South Carolina switched from the reserve ratio to the benefit ratio to expedite the replenishment of its unemployment insurance trust fund. Since most of the employers had built up substantial reserves through years of unemployment tax payments, the benefit costs charged during the Great Recession did not significantly increase their reserve ratios, and, consequently, their unemployment tax rates remained largely unaffected. By employing the benefit ratio, the government was able effectively to ignore unemployment taxes and impose elevated tax rates on the employers that faced substantial layoffs during the Great Recession. The finding of Lachowska et al. (2020) that benefit ratio systems restore fund solvency at double the rate of reserve ratio systems support the notion, also adduced in Miller et al. (2019), that the reserve ratio tends to be a "sticky" metric of experience, predominantly reflecting an employer's historical condition rather than its present condition. The reform was a notable event for the employers, many of which experienced a sharp increase in their tax rates just as the economy was beginning to bounce back.[26]

The transition from the reserve ratio to the benefit ratio, then, caused a sudden change in employers' measured experiences with unemployment and unemployment tax rates which resulted in the redistribution of the unemployment tax burden among employers in the state. Intuitively, the employers that had laid off workers in the distant past benefitted from the neglect of those charges. By contrast, the employers with substantial tax payments were penalized because unemployment taxes were disregarded in the experience calculations, with greater emphasis being placed on any benefit costs incurred during the Great Recession.

I use a differences-in-differences approach to compare employers with the same benefit ratios post-reform but different reserve ratios pre-reform. Because of their similar benefit ratios, these employers displayed comparable trends during the seven-year lookback period used to calculate the benefit ratio (the *"recent past,"*) which coincides with the reform pre-period. The different reserve ratios, shaped by the different compositions of their *"distant past"* reserves, lead to different changes in their unemployment tax rates. I illustrate this identification strategy with an example in Panel (a) of Figure 3 On the graph, the x-axis measures time, for which I distinguish the distant past, ranging from employers' establishment up to July, 2003, and the recent past, covering the seven-year lookback period of the benefit ratio. The y-axis shows the employers' layoff rates (solid lines) and tax rates (dashed lines). The figure presents two employers, one in orange and one in green, with the same benefit ratio but different reserve ratios. These employers share the same benefit ratio because they both maintained a consistently low layoff rate during the recent past. Before the reform, the orange employer had a high reserve ratio resulting from a high layoff rate in the distant past while the green employer maintained a low layoff rate in the distant past, resulting in a low reserve ratio before the reform. When the benefit ratio replaced the reserve ratio in 2011, the distant past layoffs made by the orange employer were

[25] Given that taxable wages in year $t-1$ and the sum of taxable wages between $t-7$ and $t-1$ have a correlation of 0.94 in my study sample, the difference between the denominators of the reserve ratio and the benefit ratio plays a minor role in the variation in the employers' measure of experience.

[26] In April 2011, the Greenville Business Magazine featured an employer concerned with the use of the benefit ratio: *"Two of those years, 2008 and 2009, are what I call the 'Katrina' years as far as the economy is concerned. They were devastating. I've been in business here for thirty years. Do the other twenty-three years not count for anything?"* The magazine also emphasized widespread concerns that *"the new rates will discourage companies from hiring new employees as the economy begins its uptick."*

disregarded, and its recent stability was emphasized. Consequently, this employer's measured experience with unemployment decreased significantly at the time of the reform, resulting in a lower unemployment tax rate. Because the green employer's behavior remained consistent over both the distant and recent past, the reform had no impact on its experience with unemployment or unemployment tax rate. As a result of the reform, the unemployment tax rates of these employers, which differed pre-reform because of their different distant past behavior, were equalized to reflect their similar behavior during the recent past.

Panel (b) in Figure 3 shows that the same pattern emerges in my study sample. The figure presents the average tax rate for the subset of employers with predicted benefit ratios equal to zero and, hence, with no layoffs during the recent past, and either a positive (orange) or a negative (green) reserve ratio in 2009.[27] Despite the parallel trends, the orange employers' tax rates were substantially greater than the green employers' tax rates pre-reform. With the 2011 reform, the orange employers' tax rates suddenly decreased by 3.9 percentage points, reaching the same level as those of the green employers. Owing to the availability of new lower tax rates, the tax rates of the green employers declined by one percentage point as well. Nevertheless, it is evident that the reform favored the orange employers by neglecting their numerous distant past layoffs.

This example focuses on employers with no layoffs during the recent past and a predicted benefit ratio equal to zero. In practice, because of the influence of the Great Recession and the variation in employers' reserve ratio pre-reform, I observe substantial variation in the predicted benefit ratios. Within each benefit-ratio group, I compare employers that had negative reserve ratios (treatment group), which were penalized by the exclusion of unemployment taxes from their experience with unemployment, with employers that had positive reserve ratios (control group), which benefitted from the exclusion of distant past benefit charges. I display the full variation in the employers' reserve ratios pre-reform and benefit ratios post-reform in Panel (a) of Figure 4. The figure presents employers by their recent benefits (the numerator of the benefit ratio) in 2011 and total reserves (the numerator of the reserve ratio) in 2010, both scaled by recent taxable wages, to emphasize the differences driven by the numerators. I observe a positive correlation, but substantial variation between these two measures remains. As a result, the employers that were previously categorized similarly and assigned the same unemployment tax rate under the old system were categorized differently and subject to different treatment under the new system. For my identification strategy, I compare the employers with the same benefit ratio on the y-axis (i.e.,horizontally). These are employers that, despite their different reserve ratios, behaved similarly in the pre-period. Comparing the employers with the same reserve ratios on the x-axis (i.e. vertically), involves comparing those with the same net position but, potentially, very different historical trends.

Equation 16 shows my preferred specification. $Y_{i,t}$ is the outcome for employer $i$ in year $t$, $\alpha_i$ are employer fixed effects, $Treat_i$ is an indicator for employers with negative reserve ratios, $b_i$ are predicted benefit ratio-groups sized 0.000001, $\alpha_{b(i),t}$ are group-year fixed effects; and $\epsilon_{i,t}$ is an error term. I cluster the standard errors at the employer level. $\beta_{2010}$ is normalized to zero. I multiply the predicted benefit ratio bins by the

[27]The 2010 predicted benefit ratio is the benefit ratio that the employers would have had if the reform had taken place one year earlier, in 2010 instead of 2011. Figure A7 shows that the 2011 benefit ratio and the 2010 predicted benefit ratio are highly positively correlated, a result that supports the use of the latter for my analysis. The 2009 reserve ratio and the 2010 predicted benefit ratio are based entirely on employers' behavior before 2010, the year in which the details of the reform were defined, and are thus unaffected by employers' behavioral responses in anticipation of the reform.

year fixed effects because I expect that employers with different predicted benefit ratios display different layoff and employment trends over the pre-period. For example, employers with a predicted benefit ratio of zero (i.e., with no layoffs in the recent past) likely maintained a much more stable employment than the employers with positive predicted benefit ratios (i.e., with layoffs during the recent past).

$$Y_{i,t} = \alpha_i + \sum_{y=2005}^{2014} \beta_y 1_{y=t} Treat_i + \alpha_{b(i),t} + \epsilon_{i,t} \tag{16}$$

For the $\beta$ coefficients to identify the average treatment effect on the treated employers, the parallel trend assumption and the no-anticipation assumption need to be satisfied. The parallel trend assumption requires that the negative reserve ratio employers would have evolved in the same way as the positive reserve ratio employers within the same benefit ratio bins in the absence of the reform. My first approach for establishing the credibility of this assumption involves a direct examination of parallel trends in the employers' outcomes. The second approach involves showing that the reserve ratio primarily reflects the employers' distant past behavior. If this is, indeed, the case, the reserve ratio should not correlate with current outcomes, especially after accounting for recent trends through the benefit ratio.

To this end, I decompose the numerator of the reserve ratio, the employer's *total reserves*, into three components, specifically, the *recent benefits*, which correspond to the numerator of the benefit ratio, the *distant past reserves*, which are calculated as the difference between the benefits charged to the employer and the unemployment taxes paid by the employer from its establishment to seven years before the calculation date, and the *recent taxes* paid by the employer. The variation in the distant past reserves and recent taxes generates variation in the reserve ratios of employers with the same benefit ratio. To isolate the contribution of the distant past reserves to this variation, in panel (b) of Figure 4 I plot the employers by their benefit ratios and the residualized reserve ratios obtained from a regression of the reserve ratios on recent taxes. The figure shows the exclusion of distant past reserves from the calculation of experience when keeping recent taxes fixed, which reflects the reduced *memory* of the unemployment insurance system, contributes significantly to the variation. In panel (c), I isolate the role of recent taxes by focusing on employers "without memory", that is, those established in 2003 or later and for which the total reserves coincide with their recent reserves. The amount of taxes that the employers pay during the recent past is determined by their reserve ratios. After the removal of the variation from the distant past reserves, the recent taxes *matching* recent benefits in various ways to determine the same reserve ratio contributed much less to the total variation. These findings support the notion that the treatment is uncorrelated with current outcomes conditional on the benefit ratio and reinforce the credibility of the parallel trend assumption.

$$\underbrace{\sum_{-\infty}^{0} \text{Benefits}_i - \sum_{-\infty}^{0} \text{Taxes}_i}_{\text{RR num= Tot. reserves}} = \underbrace{\sum_{-7}^{0} \text{Benefits}_i}_{\substack{\text{BR num.=}\\ \text{recent benefits}}} + \underbrace{\left( \sum_{\infty}^{-7} \text{Benefits}_i - \sum_{\infty}^{-7} \text{Taxes}_i \right)}_{\substack{\text{Distant past reserves}\\ \text{MEMORY}}} - \underbrace{\sum_{-7}^{0} \text{Taxes}_i}_{\substack{\text{Recent Taxes}\\ \text{MATCH}}} \tag{17}$$

Second, identification hinges on the non-anticipation assumption. For several reasons, it is unlikely that the reform influenced employers before its actual implementation in 2011. In the first place, the steady depletion of the unemployment trust fund was largely ignored until December 2008, when South Carolina became insolvent and the need to increase its unemployment tax rates became evident.[28] Secondly, employers had no means to anticipate the broad impact of the reform until spring 2010, when it was approved, and were unable to anticipate the individual effects until late November 2010, when they were notified their unemployment tax rates for 2011. Anticipating the 2011 tax rates was unfeasible because of the extensive data required for calculating benefit ratios, because the new system assigned tax rates based on employer ranking by experience rather than the absolute value of their experience, and because the reform stipulated a ten-year lookback period for the calculation of the benefit ratio, but SC DEW only had seven years of data available, which introduced a discrepancy between the law and its implementation.[29] When the tax rates were announced to employers, *"after most companies began their fiscal years with budgets already in place"*, it was too late for adjustments, leaving employers *"blindsided"* with *"tens of thousands of dollars in unplanned expenses"* (The Greenville Business Magazine, April 2011). To reduce the risk of anticipation effects further, I classify employers as treated or control based on their 2009 reserve ratios, and use the 2010 predicted benefit ratio instead of the true 2011 benefit ratios to create benefit-ratio bins. These two variables rely on pre-reform-announcement data and are thus unaffected by any anticipation effects.

I estimate Equation 16 for the full study sample and separately for the employers in low- and high-risk industries. The SC DEW data include employers' four-digit NAICS codes, which I use to define 305 industries. I categorize these industries as either low- or high-risk depending on their average within-year standard deviation of employment between 2001 and 2006 using the QCEW data. This measure serves to identify industries with a high degree of seasonality, in which most layoffs result from the nature of the industry rather than individual employers' choices or aggregate shocks. To this end, I use data prior to the Great Recession.[30] I then define the cutoff value for considering industries as high-risk. Based on the distribution of industries' average employment within-year standard deviation illustrated in Figure A9, a value of 250 identifies industries with exceptionally large variation in employment within the year. The results are robust to alternative cutoff values. Table A3 lists the forty-nine industries (16%) classified as high-risk by this definition. As panel (a) in Figure A10 shows, these industries are distributed across the primary, secondary and tertiary sectors, with notable concentration in construction, manufacturing, retail, professional and technical services, and hospitality. To accurately capture unemployment risk, I also classify industries as either low- or high-risk based on their average unemployment tax rate between 2001 and 2006 based on the QCEW data. I use the average industry tax rate in the sample, 0.0059, as the cutoff to identify high-tax rate industries. This alternative classification enables me to to distinguish industries where layoffs result in unemployment (agriculture, construction, textile, retail, accommodation, food services, and recreation, as shown in Table A3) from industries with high turnover but no unemployment (healthcare and other manufacturing).

[28] On March 19, 2010, The Sun News reported that, despite warnings raised by the South Carolina Chamber of Commerce since 2005, the General Assembly had overlooked the steady depletion of the fund until, in March 2008, it became evident insolvency was inevitable. Additionally, the reform process started in 2009 and was only approved in spring 2010, a delay attributed to legislators, who, seeking re-election at that time, *"said nothing. None publicly told his colleagues what he had heard. Not one alerted the media nor, as far as I can tell, anyone else. Another option would have been simply to tell someone - the press, the colleagues, anyone, and begin working on a solution in April 2008"*.

[29] See the notes to Figure A4 for details about tax rate assignment after the reform.

[30] The correlation of 0.99 between industries' median and average within-year employment standard deviation shown in Figure A8 suggests that the average is not influenced by years with exceptionally low or high standard deviations but is instead a persistent characteristic of the industries.

The last step in the analysis involves mapping the reduced form effects from Equation 16 onto the elasticity estimates. To calculate a labor demand elasticity with respect to the unemployment tax per worker, I divide the reduced form effect on employment by the reduced form effect on the tax per worker, and scale this ratio by the ratio of the average tax per worker and employment in the last pre-reform year, 2010, for the treatment group. I calculate the elasticity for the full sample and the subsamples of the employers in the low- and high-unemployment risk industries. The labor demand elasticity estimated for employers in high-risk industries is the parameter representing the marginal cost of labor reallocation in the formula for the optimal degree of experience rating. Using a similar approach, I also estimate the corresponding wage elasticities with respect to the unemployment tax per worker.

$$\epsilon_{l_x,\tau_x} = \frac{\beta_{l_x}}{\beta_{\tau_x}} \frac{\tau_{x,2010,Treat}}{l_{x,2010,Treat}} \tag{18}$$

### 3.4 Results

**Full Sample Effects and the Incidence of Unemployment Taxes.** Figure 5 presents the estimated $\beta_y$ coefficients from Equation 16 for the South Carolina employers in the study sample. To reduce the noise introduced by the largest employers, I focus on the employers with quarterly workforces ranging from one to fifty in 2010, with fifty representing the $95^{th}$ percentile of the distribution. These estimates represent the reduced form causal effects of the transition from a reserve ratio to a benefit ratio system on the employers' outcomes. First, the reform increased the unemployment tax per worker of the treated employers by \$197 in 2011 relative to the control employers, or by 144% relative to the average tax per worker in 2010. This effect continued in subsequent years, when the benefit ratio was recalculated using a lookback period shifted by one year each year, the result being similar tax rate assignments for the employers. Second, the reform decreased the average number of employees of the treated employers by 0.37-0.9, equivalent to 4.6-11.1% of their workforces in 2010. The decline in employment began in 2011 and continued in 2012 and 2013, with employment starting to recover in 2014. This progressively larger effect is consistent with employers' gradual adjustment to the unplanned expenses. Third, the reform resulted in a reduction in the total wages paid by the treated employers by \$19,500-43,000, or 6.2-13.6% of the 2010 wage level. However, the fact that I find no evidence of effects on the average wage indicates that the decrease in wages was driven solely by the reduction in the number of employees. Scaling the effect on wages by the effect on employment allows for the estimation of the yearly wages of the missing employees in the treated group. For example, these wages are \$52,700 in 2011 (the ratio of \$19,500 and 0.37) and \$55,136 in 2012 (the ratio of \$38,320 and 0.695), being 1.2 and 1.4 larger than the mean average wage in 2010 respectively. Fourth, the absence of an effect on taxable wages suggests that the reduced number of employees exactly compensates for the higher taxable wage base. The increase in the taxable wages based on the 2010 payroll, which represents an estimate of employers' taxable wages if they did not reduce their workforces at the time of the reform, confirms this hypothesis. The gap between the true taxable wages and those based on the pre-reform payroll, sized \$10,000, coincides exactly with the taxable wages that the negative reserve ratio employers would have paid had they hired the missing worker at the estimated wage, which is higher than the taxable wage base of \$10,000 in 2011. Lastly, the unemployment taxes paid by treated employers increased by \$839 (or 59%) in 2011. The tax increase was more limited in 2012 and 2013 owing to a combination of a lower tax per worker and fewer employees. The comparison with the total taxes based on the 2010 payroll indicates that, if the treated employers had not reduced their workforces, they would have paid \$213 more in unemployment taxes in 2012, \$506 more in 2013, and \$264 more in 2014.

These findings suggest that the incidence of unemployment taxes is on employers, who do not pass the tax back to their workers in the form of lower wages. Since the missing employee earned an average wage, this effect is not explained by wage rigidities introduced by minimum wage regulations. Additionally, these findings indicate that the reform effectively increased the employers' unemployment taxes and achieved the goal of replenishing the South Carolina's unemployment trust fund. However, the employers' responses to the tax increase diminished the revenue collected.

**Robustness.** I test the stability of my findings in several ways. First, I expand the sample to include the employers with more than fifty employees in 2010. Given the large variability introduced by large employers, I rescale the outcomes by their level in 2010. Figure A11 presents the $\beta$ coefficients from Equation 16 estimated for the sample of the employers with an year-average number of employees greater than one. The results remain consistent. The negative reserve ratio employers experienced a 60% increase in their unemployment tax per worker relative to positive reserve ratio employers. In response, they reduced their employees by 4-21% and their total wages by 3-13%, without changing the average wage offered to their employees. I also find that taxable wages declined by 5-33%, so the decline in employment more than compensated for the increase in the taxable wage base. Unemployment taxes grew by 64% in 2011 and by approximately 30% in 2012 and 2013. These results not only confirm the validity of the initial findings for the large employers but also demonstrate that the observed patterns are not driven by outliers when measuring the outcomes in level.

Second, my findings are robust to the use of a different definition of benefit ratio groups. My original approach involves creating very small bins (sized 0.000001) of the predicted benefit ratio and including the fixed effects for each of these bins. Alternatively, I calculate the employers' yearly benefit ratios based on the benefits charged and the taxable wages paid in each year of the seven-year lookback period of the 2011 benefit ratio. I then create bins of the yearly benefit ratios (sized 0.1) and of the predicted benefit ratio (sized 0.001) and create groups of employers falling into these bins. The bins are larger than before to guarantee the presence of enough employers sharing the same history. This approach allows me to compare employers with both the same overall layoff rate during the pre-period and the same distribution of layoffs over the seven years. Figure A12 presents the reduced form effects using this alternative set of fixed effects. The negative reserve ratio employers experienced an increase in their unemployment tax per worker of \$245 in 2011 and \$140 thereafter relative to the positive reserve ratio employers. In response, these employers reduced their employees by 0.37-0.65 and their total wages by \$20,000-26,000, without changing the average wage offered to their employees. These effects emerged only in 2012. I also find that taxable wages were unaffected, but would have increased by \$6,400-11,000 per year had the employers not decreased their workforces. As a result, their total taxes increased by \$1,800 in the first year and \$600 thereafter, but they would have increased by \$1,900 and \$900 per year, respectively, in the absence of behavioral responses.

Lastly, I present an alternative version of these findings using a continuous treatment measuring the employers' account reserves in 2009. This approach demonstrates that my results are not contingent on the specific zero-reserve ratio cutoff that I use to distinguish the treated and the control employers. An increase in account reserves by $1,000 leads to a 0.002% increase in taxes per worker, a 0.001% reduction in the number of employees, a 0.002-0.0025% decrease in wages, a 0.002% decline in taxable wages, and a 0.001% increase in taxes –0.001% less than the absence of behavioral responses – with no impact on the average wage.

**Additional Findings.** I present here a set of additional considerations. First, since the SC DEW conducts routine annual audits of 1,000-1,500 employers to verify the accuracy of the information that employers provide and imposes elevated "delinquent" tax rates to employers found misreporting, it is unlikely that the observed effects result from employers manipulating their data to lower their tax liabilities. Second, to obtain a labor demand elasticity, the reduced form effects on employment must be predominantly due to reduced hiring rather than increased separations or labor supply responses. The lack of effects on the average wage rules out any shifts in labor supply. Additionally, while my data lacks explicit information regarding hirings and separations, several factors point to reduced hirings as the key driver of the observed effects. First, if the decline in employment was driven by increased separations, I would not observe a gap between true taxable wages and taxable wages based on the 2010 payroll in 2011 because employers pay taxes on the wages paid to employees whom they lay off during the year. Further, the reform took place in the aftermath of the Great Recession, when most separations had already occurred and employers' primary decision-making margin was related to hiring.[31]. Furthermore, Guo (2023) uses data on hirings and separations to show that increasing unemployment taxes after the Great Recession reduced employment by discouraging hiring in several U.S. states, including South Carolina. Third, I explore the existence of heterogeneous effects of the reform by firm size, age, and productivity, with productivity being proxied by the average wage in the firm. Figure A14 reveals that the impact is more pronounced for the larger and the younger firms, with no notable variations by productivity. I use these findings to determine whether liquidity or price effects drive the observed effects. The rise in the tax per worker could deter hiring because either the increased financial burden on current employees creates liquidity constraints for employers or new hirings become costlier. To determine the relative importance of these effects, I follow the approach in Saez et al. (2019) and evaluate whether the impact of the reform on employment is more significant for the smaller and the younger firms, which may face liquidity constraints. While the larger declines in the younger firms are consistent with the presence of liquidity effects, those in larger firms are not. Fourth, I examine whether the reform increased the probability of an employer going out of business. I expand my sample to include employers that entered or exited the data between 2005 and 2014 and estimate Equation 16 using as outcome an indicator equal to one in the last year of observation for each employer. The results, presented in Figure A15, do not offer substantial evidence of differential employer exit rates, either in the full sample or in the subsamples of the younger and the smaller employers.

**Heterogeneous Effects by Industries' Unemployment Risk**. Figure 6 presents the estimated $\beta_y$ coefficients from Equation 16 separately for the employers in low- and high-employment standard deviation industries. Despite facing similar increases in their unemployment taxes per worker, the employers in low- and high-standard deviation industries display markedly different responses.[32] The declines in the number

[31] This sentiment is echoed in reports in Greenville Business Magazine, which, in April 2011, suggested that *"the new rates will discourage companies from hiring new employees as the economy begins its uptick."* and voiced employers' concerns that *"no employer should feel safe. This structure will keep South Carolina in a recession and make sure (employers) will not recover."*

[32] Figure A16 shows a similar distribution of the change in the unemployment tax per worker from 2010 to 2011 between low- and high-employment standard deviation industries. The tax per worker changed similarly across industries both before (panel

of employees and in total wages documented in the full sample are entirely driven by the employers in high-employment standard deviation industries, which experienced a reduction in the number of employees by 0.8-2.4 and a decline in wages by \$40,000-\$117,000. By contrast, employers in low-standard deviation industries experienced an increase in the number of employees by 0.3-0.8 over the period, though this increase appears to be a result of a positive trend that began in the pre-period. The average wages remained unaffected for employers in both types of industries. Consistent with their stable payrolls, employers in low-standard deviation industries experienced sharp increases in their taxable wages driven by their higher tax rates and a progressively higher taxable wage base. By contrast, the taxable wages of employers in high-standard deviation industries remained unaffected, or even declined (though the estimates are insignificant) because of their smaller workforces. Consequently, taxes increased for both sets of employers in 2011 and then diverged, with employers in low-standard deviation industries still facing higher taxes by \$800 per year and employers in high-standard deviation industries drastically reducing their tax burden. Figure A17 shows that the same patterns emerge when comparing employers in low- and high-unemployment tax rate industries, highlighting the role of unemployment risk over labor turnover in driving these heterogeneities. Additionally, in Figure A18 I restrict the sample to high-employment standard deviation industries, and test for heterogeneous effects between low- and high-tax rate industries. The stronger impact observed in high-tax rate industries suggests that these industries leverage their deeper understanding of the unemployment insurance financing policies to adjust their workforce sizes and counterbalance the increased taxes. The flexibility afforded by high labor turnover is insufficient for achieving such adjustments without the insights gained from exposure to the system.

**Elasticities calculation.** Table 2 presents the labor demand elasticities with respect to the unemployment tax per worker for the full sample of South Carolina employers and the subsamples of the employers in low- and high-employment standard deviation industries. For the calculation, I use the $\beta_{2013}$ coefficients from Equation 16, which are selected to best represent the impact of the reform after allowing time for the adjustments to take place. I estimate a labor demand elasticity of -0.1 for the full sample, of 0.047 for employers in low-employment standard deviation industries, and of -0.26 for employers in high-employment standard deviation industries. The distinct elasticities across industries are due to different employment responses to similar increases in the unemployment tax per worker. The table also presents the estimated wage elasticities with respect to the unemployment tax per worker, which, because of the limited reduced form effects on average wages, are small and statistically insignificant. The key finding is the value of the labor demand elasticity with respect to the tax per worker for employers in high-standard deviation industry, equal to -0.26. This is the estimated value of the sufficient statistic representing the marginal cost of labor reallocation.

**The Colorado Experiment.** I estimate the same set of labor demand elasticities using the employer-level data from CO DLE and leveraging the elimination of a surcharge in Colorado as quasi-experimental source of variation in the unemployment tax per worker. In 2018, the state government, having replenished its unemployment trust fund after its depletion during the Great Recession, discontinued the surcharge. This change primarily benefited the employers with positive reserve ratios. I compare the evolution of firm outcomes for various cohorts of employers with a positive reserve ratio at several points in time. Specifically, only the cohort with positive reserve ratio in 2017 (the treatment group) benefitted from a reduction in the tax per

[a]) and around the reform (panel [b]).

worker in 2018. I find that reducing the tax per worker increased the employment and wages of the treated employers and had no impact on average wages. The implied labor demand elasticity with respect to the unemployment tax is -0.66. Notably, the effects are more pronounced in high-employment standard deviation industries, where the elasticity is -1.06, compared with -0.28 in low-employment standard deviation industries. This analysis, detailed in Section A, provides additional robustness to the evidence from South Carolina.

# 4 Optimal Unemployment Insurance Financing Policy

In this section, I use the estimated sufficient statistic representing the cost of interindustry labor reallocation to evaluate the optimal unemployment insurance financing policy. I finalize the calibration of the various parameters in the formula for the optimal degree of experience rating using various moments from the data and estimates from the literature and then present and discuss the findings.

## 4.1 Calibrating the Marginal Cost of Labor Reallocation

As Equation 10 shows, the marginal cost of labor reallocation is calculated by multiplying the labor demand elasticity for the high-risk employer, $\epsilon_{l_H,e}$, by the scaling factor $\lambda$. This scaling factor, defined in Equation 11, captures the fiscal externality and the loss from the misallocation of productive skills induced by labor reallocation. Table 3 presents the calibrated values for the parameters in $\lambda$, namely, $e$, $b$, $r_H$, $w_L$, and $f_L(l_H, k)$.

To calibrate the degree of experience rating, $e$, which represents the tax cost per dollar of unemployment benefit claimed by laid off workers, I leverage the rich information on employers' unemployment benefit charges and tax payments available in the SC DEW data. I focus on the employers with positive benefit charges between July 2005 and July 2006 (the base period) and no other charges in the surrounding years. For each employer, I calculate the cumulative unemployment taxes paid in each year from 2007 to 2010 and divide them by the base charges. In this way, I track the evolution of the tax cost per dollar of benefit charge over time. As Figure 7 shows, the median tax cost was 0.29 in 2007, indicating that the median employer paid 29 cents in unemployment taxes for every dollar of benefit charged during the base period. The total cost had increased to 61 cents by 2008, 94 cents by 2009, and \$1.15 by 2010. Reflecting the gradual increase in unemployment taxes under a reserve ratio system, the median employer repaid the cost of the base charges over the following four years. I use the average of these median tax costs, 75 cents, to represent the pre-reform short-term cost of a dollar of benefit charge for an employer in South Carolina, and calibrate $e = 0.75$. This value is consistent with other estimates in the literature, which range from 75 to 87 cents (Topel 1984, Johnston 2021).

I then calibrate the unemployment benefit level, $b$, with the average unemployment benefit claimed in South Carolina. I select the value for 2006 in order to avoid the influence of the Great Recession. The average benefit is calculated by multiplying the average benefit duration in weeks by the average weekly benefit amount from the ET 394 data. I find that the average claimant in South Carolina received $b = \$2,986$.

To calibrate the unemployment risk in the high-risk industry, $r_H$, I use the ratio between the trough and the peak quarterly employment in high-risk industries in South Carolina in 2006 based on the QCEW data. Using the definition of high-unemployment risk industries based on the standard deviation of employment within the year, I find that $r_H = 0.046$, indicating that employment in high-risk industries was 4.6% lower in the trough quarter than in the peak quarter. For reference, the unemployment risk in low-risk industries was one-third the size, $r_L = 0.016$. I then calibrate $w_L$ with the average annual wage offered in low-risk industries in South Carolina, calculated as the ratio between total wages and average employment in 2006 from the QCEW data. I find that $w_L = \$37,274$.

Lastly, the marginal productivity in the low-risk industry of the marginal worker employed in the high-risk industry, $f_L(l_H, k)$, coincides with the measure of point D on the y-axis in Figure 1. I thus calibrate it with the labor costs in the low-risk industry with incomplete experience rating, $f_L(l_H, k) = w_L + \frac{(1-e)br_H}{1-r_H}$. I use the values for $w_L$, $r_H$, $e$, and $b$ just derived to obtain $f_L(l_H, k) = \$37,310$. Comparing the marginal productivity with the wage in the low-risk industry implies a net productivity loss of \$36.

I find that the reallocation of an additional worker in the high-risk industry induces a fiscal externality of -7.25 and a loss from skill misallocation of -7.6. Combined, these parameters give a total value of $\lambda$ of -14.85. Multiplying the estimate for $\lambda$ by the estimate for the high-risk labor demand, $\epsilon_{l_H,e}$, gives a total cost of labor reallocation of 3.86. This value indicates that for every dollar of insurance offered to employers, \$3.86 are lost because of the skill misallocation and fiscal externality associated with the reallocation of workers towards high-unemployment risk industries.

## 4.2 Calibrating the Marginal Cost of Employer Moral Hazard

As Equation 10 shows, the marginal cost of employer moral hazard is calculated by multiplying the elasticity of effort to prevent negative shocks with respect to the degree of experience rating, $\epsilon_{m,e}$, by the scaling factor $\mu$. This scaling factor, defined in Equation 12, captures the fiscal externality associated with employers' reduced effort to avoid layoffs. Table 4 presents the calibrated values for $\epsilon_{m,e}$ and the parameters within $\mu$, namely, $r_H$, $m$, and $e$.

To calibrate the effort elasticity, I leverage the relationship in the model between effort, $m$, and unemployment risk in the high-risk industry, $r_H = p_H + \frac{1}{m}$. In Section B.8, I show that the effort elasticity is a transformation of the elasticity of the unemployment risk in the high-risk industry with respect to the degree of experience rating, $\epsilon_{e,m} = -r_H m(\epsilon_{r_H,e})$. This transformation is convenient because I can calibrate $\epsilon_{r_H,e}$ using an estimate of the layoff elasticity with respect to the degree of experience rating drawn from the literature on employer moral hazard. Table A6 presents the various estimates from this literature, which range from -0.43 to 0. I selected -0.27 from Topel (1984), lying in the middle of the range, as the preferred estimate, and explore the implications of using alternative estimates.[33]

To calibrate the effort exerted to avoid negative shocks, $m = \frac{1}{r_H - p_H}$, it is necessary to quantify $p_H$, the exogenous part of unemployment risk in the high-risk industry. To do so, I assume that the unemployment risk structure in the low-risk industry resembles that in the high-risk industry, $r_L = p_L + \frac{1}{m}$, with the exception that there is no exogenous risk, $p_L = 0$, and further assume that employers in low- and high-risk industries

[33] In particular, the estimate of zero from Johnston (2021) would minimize the marginal cost of insurance by setting the marginal cost of moral hazard to zero. Notably, however, this estimate is derived from a sample of employers in Florida that were assigned the maximum unemployment tax rate and are likely either to have already laid off workers or have a consistently high layoff rate regardless of the cost associated with the layoffs. As a result, the estimated layoff elasticity of zero for this sample of employers in Florida likely represents a lower bound for the layoff elasticity in the state.

exert the same level of effort $m$. In this way, I am able to calculate $p_H$ as the difference in the unemployment risk between high- and the low- risk industries, $p_H = r_H - r_L$. Using the calibrations for $r_H$ and $r_L$ previously described, I find that $p_H = 0.03$, and, thus, that $m = 62.5$. These values yield an elasticity of effort with respect to the degree of experience rating, $\epsilon_{m,e} = 0.78$.

I find that $\mu = 2.52$. Multiplying this value by the effort elasticity gives a marginal cost of employer moral hazard of 1.97. This result indicates that for every dollar of insurance offered to employers, \$1.97 are lost because of the fiscal externality generated by increased layoffs.

### 4.3 Calibrating the Marginal Value of Insurance for Employers

In Equation 10, the sufficient statistic that embodies the marginal value of insurance for employers is the normalized gap in marginal profits between the good and the bad states of the world for the high-risk employer. The marginal profit gap is equivalent to the parameter $q$, which measures the further financial deterioration, such as higher borrowing costs, associated with each dollar of unemployment tax increase.

In the model, these losses affect welfare because profits enter the social welfare function through capitalists' utilities. A lower degree of experience rating increases employers' net worth, consequently increasing the return from capital investment consumed by capitalists. However, the value of insurance for employers does not depend on this specific modeling choice. Here, I explore two alternative modeling approaches that have equivalent implications for optimal policy and offer additional insights into the calibration of the marginal value of insurance for employers.

The first approach incorporates profits in the social welfare function through workers', instead of capitalists', utilities. Workers may value the continuity and survival of their employers either because they supply capital and consume the return from their investments or because shocks to their employers result in layoffs and unemployment for them, creating a gap in their marginal utility of consumption between states of the world. Consequently, the value of insurance for workers can proxy the value of insurance for employers. Table A7 illustrates various estimates for the value of insurance for workers from the literature. The upper bound of these estimates, from Landais et al. (2021), is 3.13. Interpreted as the value of insurance for employers, this estimate indicates that employers are willing to pay \$3.13 to shift a dollar from the good to the bad state of the world.

The second approach incorporates profits directly as a factor in social welfare. One possible justification for this step is the existence of liquidity constraints or wage rigidities that prevent employers from adjusting optimally following a shock. Giupponi et al. (2022) find that subsidizing jobs with short time work policies increases employment and the probability of survival, especially for liquidity-constrained employers. This finding suggests that these inefficiencies may be in place. Therefore, the value of insurance for employers could be calibrated using their estimated elasticity of employment with respect to the number of hours subsidized through short-time work. The estimate of 2.53 indicates that employers would be willing to pay \$2.53 to shift a dollar from the good to the bad state.

## 4.4 Optimal Degree of Experience Rating

The calibration of the various parameters in Equation 10 enables me to quantify the marginal benefit and the marginal cost of insurance for employers. Comparing these values provides insights into the optimal unemployment insurance financing policy. When the marginal benefit exceeds the marginal cost, reducing the degree of experience rating is welfare-improving. Conversely, when the marginal cost exceeds the benefit, experience rating should be increased to achieve greater welfare.

Accordingly, I first calculate the total marginal cost of insurance for the South Carolina employers by summing the costs of labor reallocation (3.86) and employer moral hazard (1.97). The resulting total marginal cost is 5.83. Labor reallocation, accounting for 66% of the total cost, emerges as the primary driver of the inefficiency from incomplete experience rating in South Carolina. As panel (a) in Figure 8 shows, the cost of employer moral hazard ranges from zero to 3.12 depending on the estimate for the layoff elasticity used. Across these scenarios, labor reallocation remains the primary determinant of the marginal cost of insurance. This finding is important both conceptually, given the limited attention that the inefficiencies from labor reallocation have received in the existing literature compared with the inefficiencies from employer moral hazard, and for its policy implications. Acknowledging the inefficiencies from labor reallocation implies recognizing that coinsurance remains inefficient even in even those contexts in which employer moral hazard is limited. Such settings include European countries, where layoffs are reduced by strong employment protection policies, and seasonal industries, compelled to downsize their workforce during the low season.

Next, I compare the marginal cost of insurance, 5.83, with the two calibrations for the marginal value, 3.13 and 2.58. These figures indicate that, for every dollar of insurance offered to employers, up to $3.13 is gained in insurance value, but $5.83 is lost because of labor reallocation and employer moral hazard. The finding that the marginal cost of insurance exceeds the marginal value suggests that, pre-reform, the employers in South Carolina were overinsured and the degree of experience rating in the state was suboptimal. Confirming this interpretation, I find that the marginal value of insurance remains smaller than the marginal cost even in the absence of employer moral hazard, as panel (b) in Figure 8. Additionally, as I discuss in Section 2.3, the marginal cost of insurance increases further in several model extensions.

Caution is required in interpreting these conclusions. First, the current calibrations of the value of insurance for employers, being based on estimates from other countries and historical periods, may not capture fully the magnified value of insurance for employers during the Great Recession. Further research on the value of insurance for employers and its variations over economic cycles is essential before making definitive policy recommendations. Depending on the findings, the optimal policy may involve less experience rating during recessions and more experience rating during periods of economic stability, so as to reflect changes in the underlying value of insurance for employers. A potential starting point for exploration in this area involves analyzing the fluctuations across business cycles in the proportion of temporary layoffs, known as a proxy for an employer's perspective on the future of the business (Nekoei et al. 2020).

Additionally, this evaluation is based on local estimates and applies to the specific context from which these estimates were derived, namely, South Carolina. The broader relevance of these results to other US states depends on how closely they resemble South Carolina in terms of their labor markets and experience rating policies. The substantial differences in labor market institutions between the United States and European countries or Canada further limit the generalizability of these findings to those areas. The theoretical and empirical foundations presented in this paper provide a basis for further research to assess the desirability of experience rating across various economic stages and global regions.

# 5 Conclusions

Unemployment insurance provides crucial support for unemployed workers but entails significant costs, ranging from 0.12% to 2.8% of the GDP in Western economies. A substantial portion of the funding for unemployment benefits is derived from the unemployment payroll taxes imposed on employers. However, there is significant cross-country variation in the methods that governments use to determine and allocate unemployment tax rates to employers. While, in the United States, employers are assigned individualized unemployment tax rates based on the benefit cost of their layoffs (experience rating), all other countries assign the same tax rate to all employers irrespective of their individual contribution to unemployment (coinsurance). Each approach introduces distinct labor market distortions. However, the existing literature lacks a comprehensive framework for comparing these distortions, leaving policymakers without clear guidance for making informed choices in this area.

In this paper, I investigate theoretically and empirically the optimal design of unemployment insurance financing policies. First, I derive an employer-Baily-type sufficient statistic formula specifying that the optimal financing scheme balances the marginal value and the marginal cost of insuring employers through coinsurance. Coinsurance acts as a safeguard for employers, insuring them against steep increases in unemployment taxes in case of negative shocks, but it comes with two costs. First, it reduces the private cost of layoffs internalized by employers and, thereby, increases the frequency of layoffs. This employer moral hazard imposes a fiscal externality on government budgets through a higher benefit spending. Second, coinsurance subsidizes the expansion of high-unemployment risk industries, leading to the reallocation of workers towards them. This labor reallocation both results in the misallocation of productive skills and imposes a further fiscal externality through a higher benefit spending, as more workers are exposed to a high risk of unemployment.

Next, I put the formula into practice by assessing the magnitude of the sufficient statistics representing the marginal benefit and cost of coinsurance. I estimate the marginal cost of labor reallocation using unemployment tax filing data from South Carolina and Colorado and leveraging quasi-experimental variation in unemployment taxes from two state-level reforms of experience rating policies. I then calibrate the marginal cost from employer moral hazard and the marginal value of insurance for employers using various moments from the data and estimates from the literature.

My results suggest that labor reallocation is the predominant source of inefficiency arising from incomplete experience rating in South Carolina. This finding emphasizes the crucial role of this channel, which has received relatively less attention in the literature compared to employer moral hazard. Additionally, this result underscores the existence of inefficiencies from coinsurance even in settings with limited moral hazard, such as European countries, where layoffs are reduced by robust employment protection policies, and seasonal industries, compelled to reduce their workforce during the low season irrespective of the associated layoff costs.

I also find that the combined marginal cost of moral hazard and labor reallocation is larger than the marginal value of insurance, suggesting that, in South Carolina, the degree of experience rating was suboptimal. However, further research that deepens the understanding of the value of insurance for employers and its variations over economic cycles is needed before making definite policy recommendations. Depending on the findings, the optimal policy may entail reducing experience rating during recessions, when the marginal value of insurance is at its peak, and increasing it during periods of economic stability. The theoretical and empirical foundations presented in this paper provide a basis for further research evaluating experience rating policies across US states and exploring the implications of adopting of experience rating in countries where it is not currently implemented. Such research is particularly needed in the European Union, where the recent introduction of layoff taxes in some countries and the ongoing discussion regarding the design of the European Unemployment Benefit Scheme have sparked interest in the possibility of moving closer to the experience rating model used in the United States (Fuest et al. 2005, Simonetta 2017).

While I primarily explore the design of unemployment tax rates for employers, this policy choice is entwined with the design of worker tax rates and the generosity of unemployment benefits. Future research can, accordingly, explore the implications of experience rating for workers and investigate the optimal joint design of unemployment benefits and taxes in order to provide a more comprehensive understanding of the unemployment insurance system and more informed policy recommendations.

The evaluation of the policy reforms in South Carolina and Colorado lead me to two further conclusions. First, South Carolina's switch from a reserve ratio system to a benefit ratio system provides insights into the labor market effects of alternative designs of experience rating policies. The choice between these two systems, which have different lookback periods and use different factors to assess experience, significantly affects the distribution of unemployment tax burdens among employers.

Lastly, governments should consider employers' reactions to increased taxes, which can significantly affect the tax revenue that they can collect. These considerations are particularly relevant to the ongoing debate about the generosity of unemployment benefits in the United States. After substantial reductions in these benefits following the Great Recession, there has been a proposal to increase them with higher unemployment taxes (Wandner 2023). Higher unemployment taxes, however, may reduce employment high-tax rate industries, potentially increasing unemployment in the short term.

# Main Tables

Table 1: Summary Statistics for South Carolina Employers in 2009

| | **N** | **Mean** | **Std. dev.** | **Min** | **Median** | **Max** |
|---|---|---|---|---|---|---|
| *Panel A: Main Outcomes* | | | | | | |
| Tax per worker | 31,878 | 128.258 | 79.020 | 91 | 91 | 427 |
| Number of employees | 31,878 | 11.980 | 20.422 | 0 | 5 | 480 |
| Total wages | 31,878 | 451,578.079 | 953,671.469 | 0 | 155,714.133 | 26,304,760 |
| Average wage | 31,583 | 40,225.009 | 59,957.251 | 0 | 30,000 | 6,212,177.500 |
| Taxable wages | 31,878 | 97,559.060 | 168,956.792 | 0 | 39,899.460 | 3,459,624.406 |
| Total taxes | 31,878 | 1,890.495 | 4,151.008 | 0 | 637 | 117,627.234 |
| *Panel B: Other Characteristics* | | | | | | |
| Year of establishment | 31,878 | 1,991.553 | 10.978 | 1930 | 1995 | 2004 |
| Primary | 31,767 | 0.016 | 0.126 | 0.000 | 0.000 | 1.000 |
| Construction | 31,767 | 0.121 | 0.326 | 0 | 0 | 1 |
| Manufacturing | 31,767 | 0.060 | 0.238 | 0 | 0 | 1 |
| Trade | 31,767 | 0.221 | 0.415 | 0 | 0 | 1 |
| Transport | 31,767 | 0.024 | 0.152 | 0 | 0 | 1 |
| Services | 31,767 | 0.557 | 0.497 | 0 | 1 | 1 |
| Reserve ratio | 31,855 | -0.051 | 6.629 | -157.819 | -0.144 | 962.185 |

*Notes:* This table shows summary statistics for South Carolina employers in the study sample in 2009. The tax per worker is obtained by multiplying employers' individual tax rates by the taxable wage base ($7,000). The number of employees is the average across the four quarters of the year. The quarterly number of employees is the average across the three months in the quarter. Each month, employers are asked to count the number of employees on payroll for the week containing the 12th of the month. Total wages are the sum of the yearly wages of all the employees. The average wage is obtained by dividing total wages by the number of employees. Taxable wages are the part of workers' yearly wages subject to taxes. Total taxes are obtained by multiplying employers' individual tax rate by the taxable wages. The reserve ratio is calculated as in Equation 13.

Table 2: Employment and Wage Elasticities with respect to the Unemployment Tax Per Worker

| | **Full Sample** | **Low Risk** | **High Risk** |
|---|---|---|---|
| *Panel A: Number of Employees* | | | |
| Treated $\times$ 2013: $\beta$ | -0.895** | 0.384** | -2.415** |
| Treated $\times$ 2013: $se$ | (0.387) | (0.183) | (0.994) |
| Mean 2010 Treated | 6.060 | 5.104 | 6.054 |
| *Panel B: Average Wage* | | | |
| Treated $\times$ 2013: $\beta$ | 1532.841 | -879.258 | 3408.994 |
| Treated $\times$ 2013: $se$ | (1938.173) | (2257.449) | (3648.855) |
| Mean 2010 Treated | 40948.286 | 41466.840 | 40584.313 |
| *Panel C: Tax Per Worker* | | | |
| Treated $\times$ 2013: $\beta$ | 143.267*** | 154.368*** | 148.038*** |
| Treated $\times$ 2013: $se$ | (14.116) | (19.707) | (24.756) |
| Mean 2010 Treated | 98.185 | 96.678 | 96.269 |
| *Panel D: Elasticities* | | | |
| Employment elasticity w.r.t. tax per worker | -0.101 | 0.047 | -0.259 |
| Wage elasticity w.r.t. tax per worker | 0.026 | -0.013 | 0.055 |

*Notes:* This table illustrates the elasticities of employment and wages with respect to the unemployment tax per worker and the components that contribute to their calculation for South Carolina employers with with 1-50 quarterly employees in 2010. Elasticities are calculated using Equation 18. The $Treated \times 2013$ coefficients and standard errors are estimated from Equation 16. The elasticities and their determinants are reported for the full sample and the subsamples of employers in low- and high-unemployment risk industries. High-unemployment risk industries have a median within-year standard deviation in employment between 1998 and 2006 greater than 250 according to the Quarterly Census of Employment and Wages data for South Carolina. Industries are defined using the NAICS-4 digits code.

Table 3: Marginal Cost of Interindustry Labor Reallocation: Parameters' Estimated and Calibrated Values

| Parameter | Description | Approach | Data | Value |
|---|---|---|---|---|
| $e$ | Degree of experience rating of the unemployment insurance system | Average value, calculated between 2007 and 2010, of the median tax cost per dollar of unemployment benefit charged to South Carolina employers between July 2005 and July 2006 | SC DEW | .75 |
| $b$ | Unemployment benefit level | Average unemployment benefit in South Carolina in 2006 | ET 394 | $2,986 |
| $r_H$ | Unemployment risk in the high-risk industry | Trough-to-peak employment in high-risk industries in South Carolina in 2006 | QCEW | .046 |
| $w_L$ | Wage in the low-risk industry | Average yearly wage in low-risk industries in South Carolina in 2006 | QCEW | $37,274 |
| $f_L(l_H, k)$ | Productivity of the marginal worker in the low-risk industry | $w_L + \frac{(1-e)br_H}{1-r_H}$, using the measure of point D on the y-axis in Figure 1 | - | $37,310 |
| $\frac{f_L(l_H,k)-w_L}{ebr_H^2}$ | Skill misallocation | Equation 11 | - | -7.60 |
| $\frac{(1-e)}{er_H}$ | Fiscal externality | Equation 11 | - | -7.25 |
| $\lambda$ | Skill misallocation + fiscal externality | Equation 11 | - | -14.85 |
| $\epsilon_{l_H,e}$ | Labor demand elasticity w.r.t. degree of experience rating for high-risk employer | Estimated labor demand elasticity w.r.t. unemployment tax per worker for employers in high-risk industries | SC DEW | -.26 |
| $\lambda\epsilon_{l_H,e}$ | **Marginal cost of labor reallocation** | - | - | **3.86** |

*Notes:* This table reports the approach and data source used to estimate or calibrate the parameters determining the marginal cost of labor reallocation, together with their values.

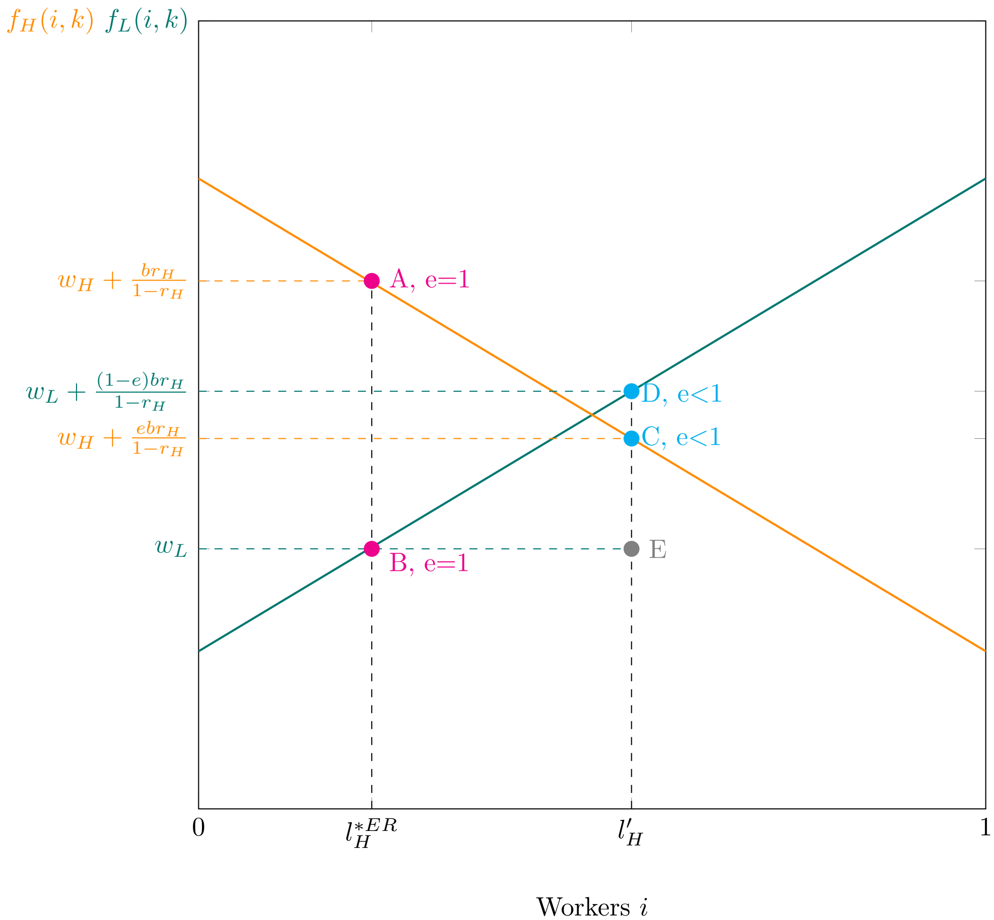
Table 4: Marginal Cost of Employer Moral Hazard: Parameters' Calibrated Values

| Parameter | Description | Approach | Data | Value |
|---|---|---|---|---|
| $\epsilon_{r_H,e}$ | Elasticity of unemployment risk w.r.t. degree of experience rating | Elasticity of temporary layoffs w.r.t. experience rating | Topel (1984) | -0.27 |
| $r_H$ | Unemployment risk in the high-risk industry | Trough-to-peak employment in high-risk industries in South Carolina in 2006 | QCEW | .046 |
| $r_L$ | Unemployment risk in the low-risk industry | Trough-to-peak employment in low-risk industries in South Carolina in 2006 | QCEW | .016 |
| $p_H$ | Exogenous component of unemployment risk in the high-risk industry | $r_H - r_L$, assumption | - | .03 |
| $m$ | Effort to avoid shock | $\frac{1}{r_H - p_H}$ from definition of $r_H$ | - | 62.5 |
| $e$ | Degree of experience rating of the unemployment insurance system | Average value, calculated between 2007 and 2010, of the median tax cost per dollar of unemployment benefit charged to South Carolina employers between July 2005 and July 2006 | SC DEW | .75 |
| $\mu$ | Fiscal externality | Equation 12 | - | 2.52 |
| $\epsilon_{m,e}$ | Elasticity of effort to avoid shocks w.r.t. degree of experience rating | $-r_H m(\epsilon r_H, e)$ | - | .78 |
| $\mu\epsilon_{m,e}$ | **Marginal cost of insurance due to employer moral hazard** | - | - | **1.97** |

*Notes:* This table reports the approach and data source used to estimate or calibrate the parameters determining the marginal cost of employer moral hazard, together with their values.

# Main Figures

Figure 1: Experience Rating and the Misallocation of Productive Skills in the Economy




*Notes:* This graph illustrates the productivity in the low-risk industry, $f_L(i,k)$ and in the high-risk industry, $f_H(i,k)$ for each worker $i \in [0,1]$ on the x-axis. Points A and B specify the allocation of workers between industries with complete experience rating ($e = 1$); points C and D with a coinsurance ($e < 1$). $l_H^{*ER}$ is the prevailing employment share in the high-risk industry and the marginal worker hired in the high-risk industry with complete experience rating. $l'_H$ with coinsurance.

Figure 2: Model Timeline

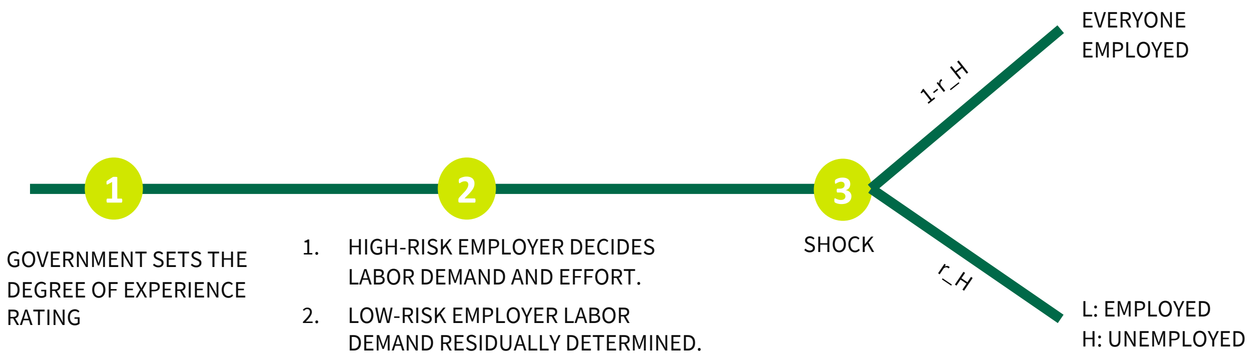
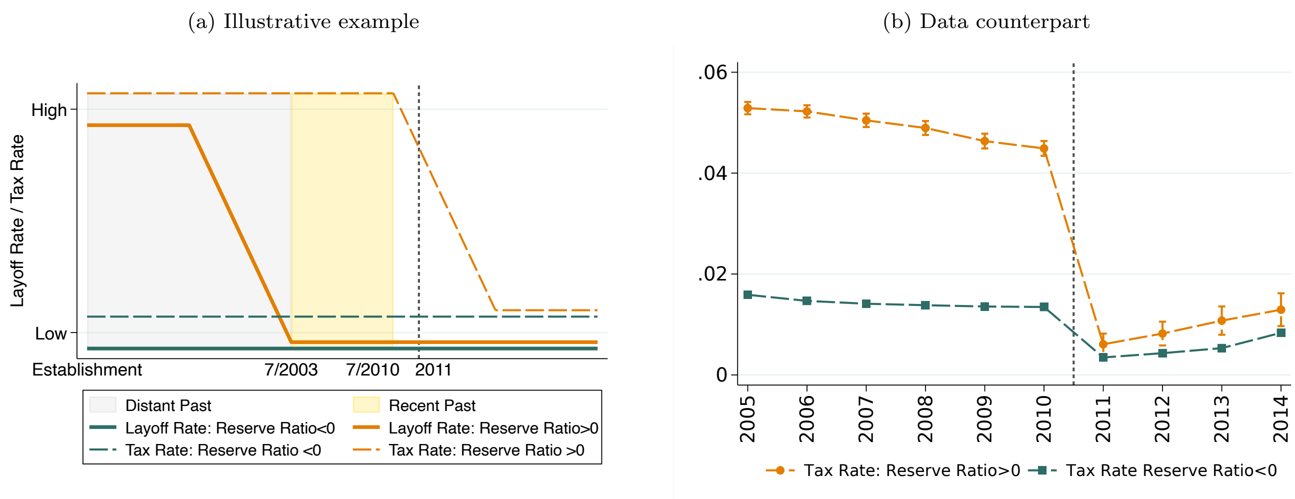


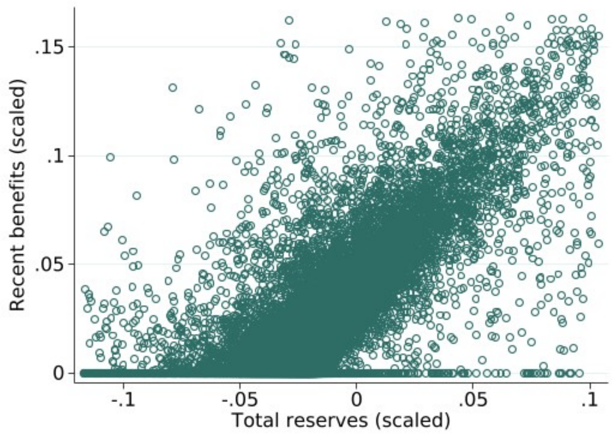

Figure 3: Variation in Unemployment Tax Rates by Reserve Ratio Conditioning on the Benefit Ratio



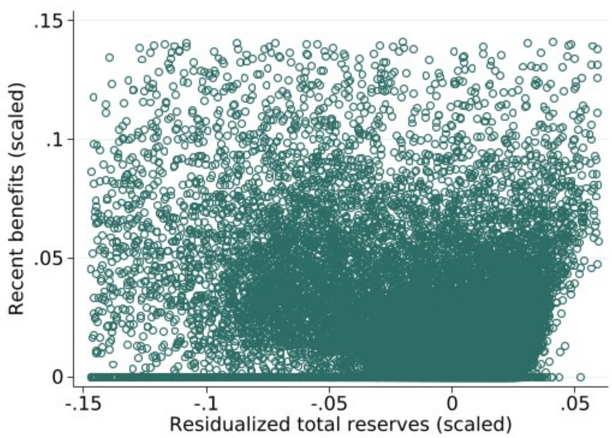

*Notes:* Panel (a) illustrates the layoff rates (solid lines) and tax rates (dashed lines) of two representative employers with equal benefit ratio but different reserve ratio (positive: orange; negative: green) over time. Time is split into the distant past, ranging between the employers' establishment date and seven years before the 2011 reform, and the recent past, covering the seven years before the reform. Panel (b) plots the average tax rate for South Carolina employers with positive (orange) or negative (green) reserve ratio and a predicted benefit ratio equal to zero. 95% confidence intervals are reported.

Figure 4: Variation between South Carolina Employers' Reserve Ratios and Benefit Ratios

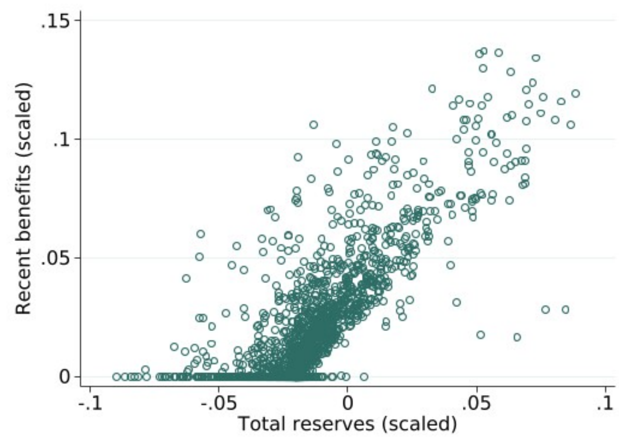
(a) Total Variation




(b) Variation due to Memory

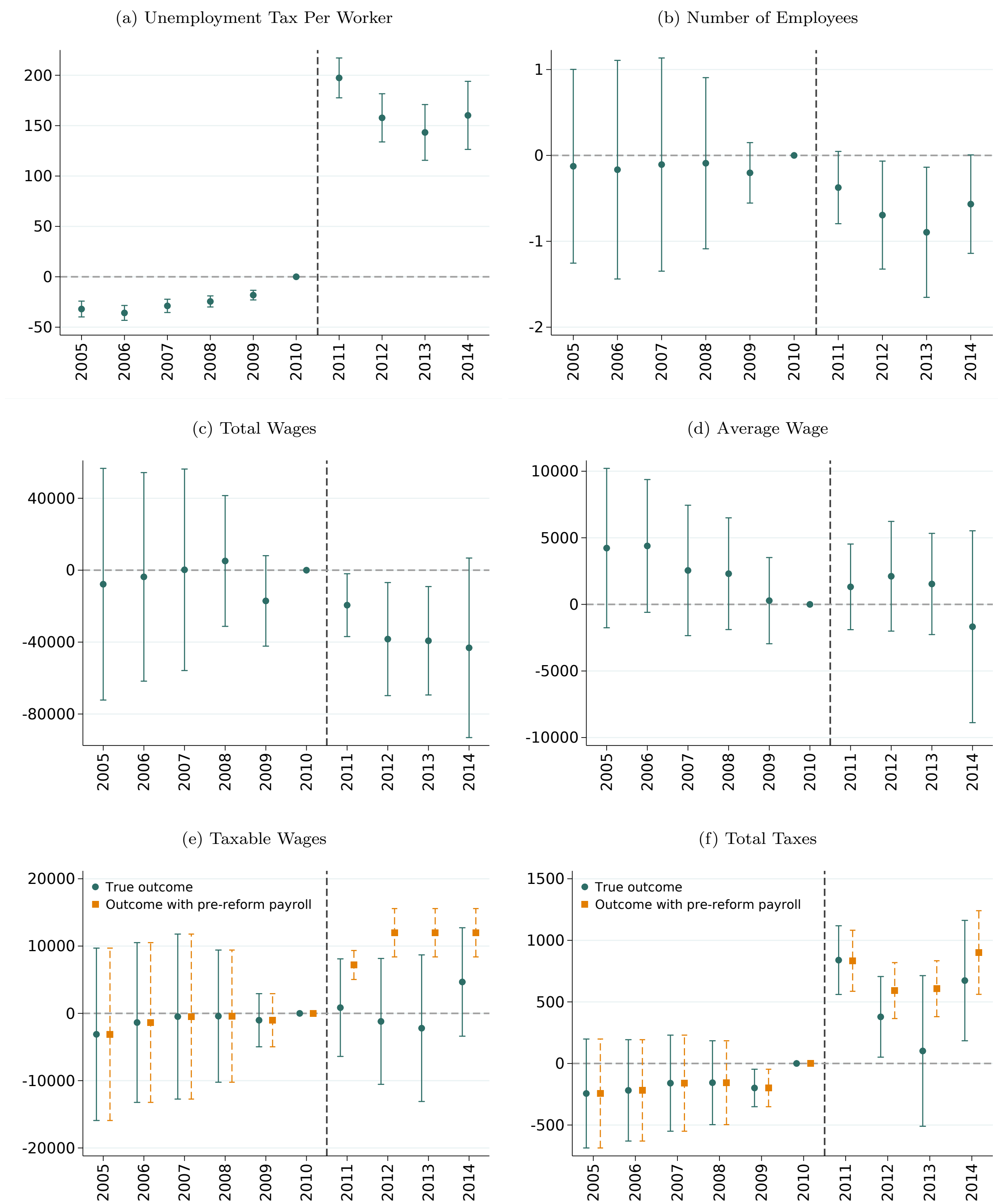



(c) Variation due to Match



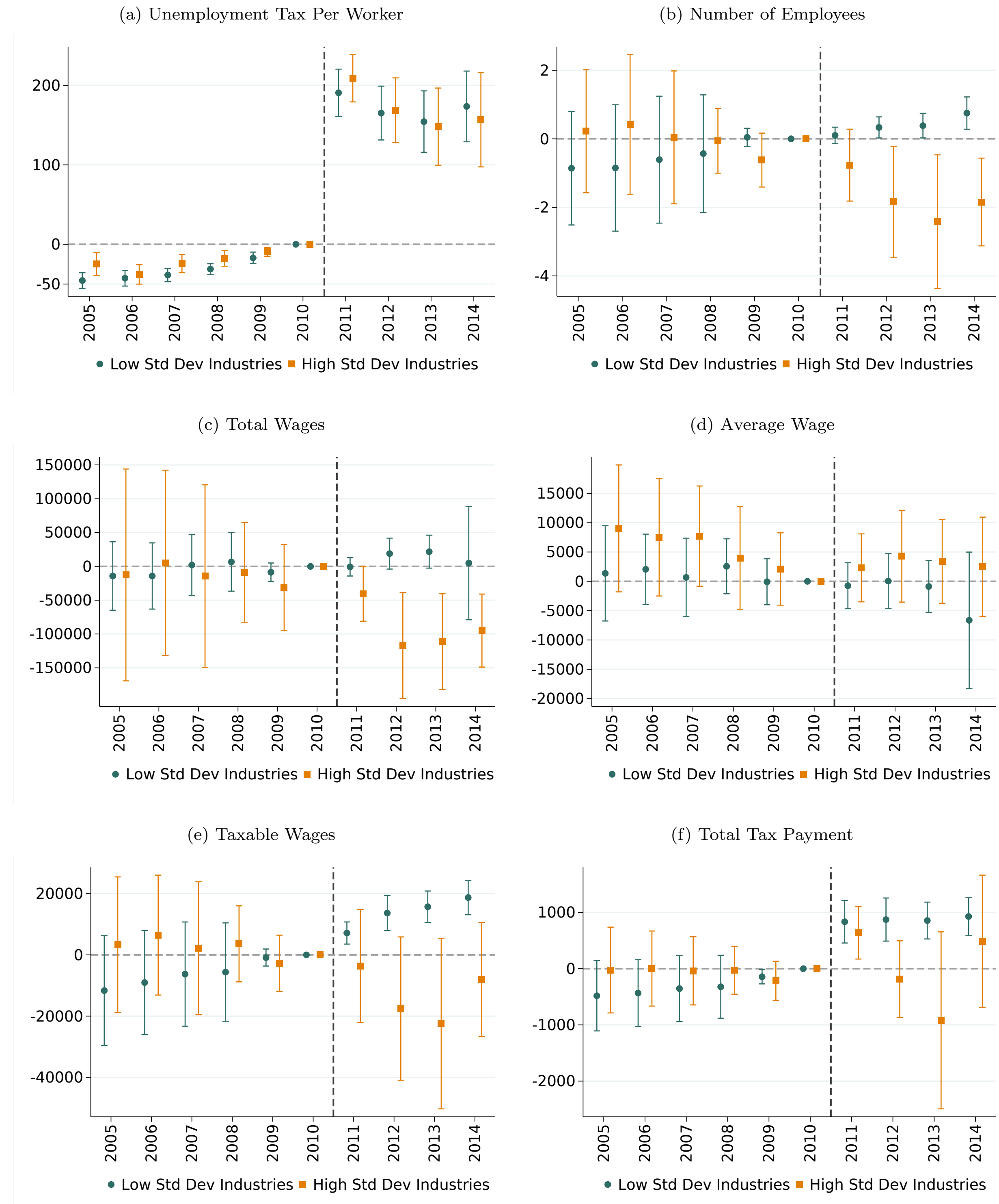

*Notes:* This figure illustrates the variation between South Carolina employers' reserve ratios and benefit ratios and the drivers of this variation. Panel (a) plots employers by their 2011 recent benefits and 2010 total reserves, both scaled by recent taxable wages. Scaled recent benefits thus coincide with the benefit ratio, while scaled total reserves are a modified version of the reserve ratio maintaining the original numerator but using the benefit ratio's denominator. This allows me to isolate the variation between the reserve ratios' and benefit ratios' numerators. Equation 17 shows that the variation between the numerators of the reserve ratio and the benefit ratio is driven by the distant past balance and recent taxes. Panels (b) and (c) aim at understanding the relative contribution of these two factors to the total variation. Panel (b) plots employers by their scaled recent benefits and residualized scaled total reserves. The latter are obtained from a regression of scaled total reserves on scaled recent taxes. This allows me to isolate the variation driven by the distant past balance and observe the role of *"memory."* Panel (c) plots scaled recent benefits against scaled total reserves for employers "without memory", namely, employers established in 2003 or later, whose total reserves coincide with their recent reserves. This allows me to focus on the role of *"match"*. All these variables have been trimmed at the first and ninety-ninth percentile.

Figure 5: Full Sample Reduced Form Effects on Employer Outcomes



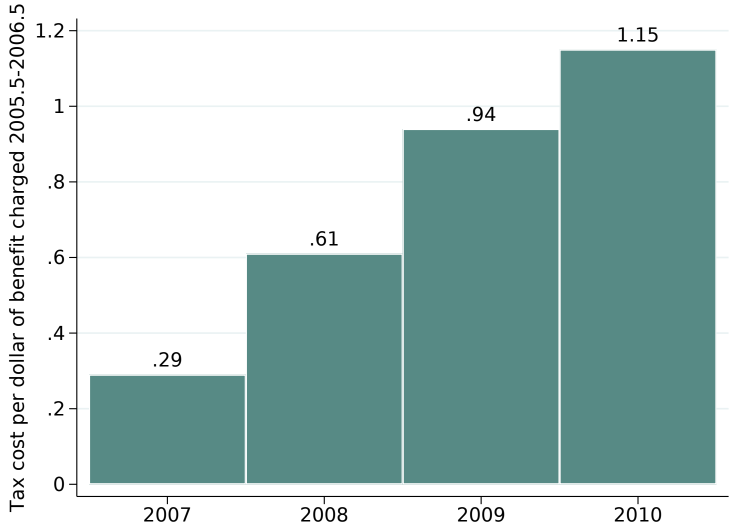

*Notes:* This figure illustrates the estimated $\beta_y$ coefficients from Equation 16 for South Carolina employers with 1-50 quarterly employees in 2010. Refer to the Table 1 notes for information on the main outcomes. The taxable wages based on the 2010 payroll in panel (e) are equal to true taxable wages until 2010. In each year from 2011 on, they are equal to the taxable wages in 2010 scaled by the relative increase in the taxable wage base between that year and 2010. Total taxes based on the 2010 payroll in panel (f) are calculated by multiplying employers' unemployment tax rates by the taxable wages based on the 2010 payroll. 95% confidence intervals are reported. Coefficients and standard errors are reported in Table A4.

Figure 6: Heterogeneous Reduced Form Effects by Industry-Within Year Employment Standard Deviation



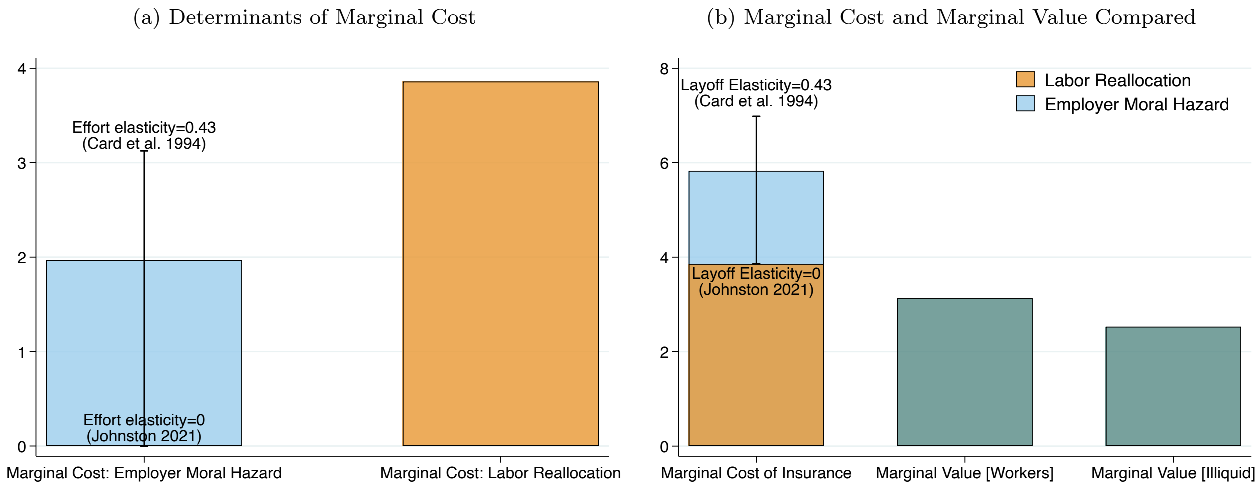

*Notes:* This figure illustrates the estimated $\beta_y$ coefficients from Equation 16 for South Carolina employers with 1-50 quarterly employees in 2010 in industries with low- and high-within year employment standard deviation. High-standard deviation industries have average within-year standard deviation of employment between 2001 and 2006 greater than or equal to 250 based on the QCEW data for South Carolina. Refer to the Table 1 notes for information on the main outcomes. 95% confidence intervals are reported. Coefficients and standard errors are reported in Table A5.

Figure 7: The Degree of Experience Rating in South Carolina, 2005-2010




*Notes:* This figure illustrates the median cumulated tax cost per dollar of unemployment benefit charged to South Carolina employers between July 2005 and July 2006. The tax cost in each year represents the cumulated tax cost between 2007 and that year. These values are calculated for South Carolina employers observed continuously between 2007 and 2010 and with no other benefit charges between July 2003 and July 2011 than the ones charged between July 2005 and July 2006. The value of $e$ in Tables 3 and 4 is calculated as the average of these median tax costs per dollar of benefit charge.

Figure 8: Marginal Cost and Marginal Value of Insurance for Employers in South Carolina




*Notes:* Panel (a) compares the two components of the marginal cost of insurance for employers in South Carolina: the cost from labor reallocation, calculated in Table 3, and the cost from employer moral hazard, calculated in Table 4. The marginal cost of moral hazard is based on an estimate for the layoff elasticity with respect to the degree of experience rating from Topel (1984). The dashed line shows how this cost would change with alternative estimates for the layoff elasticity from Table A6. The cost ranges from zero, when using the null layoff elasticity from Johnston (2021), to 3.12, when using the layoff elasticity of -0.43 from Card et al. (1994). Panel (b) compares the marginal cost of insurance for employers, obtained by summing the costs from labor reallocation and employer moral hazard, with the marginal value of insurance for employers. The marginal value is calibrated either using the value of insurance for workers from Landais et al. (2021), or with the employment elasticity with respect to the number of hours subsidized with short-term work for employers with liquidity constraints from Giupponi et al. (2022). The dashed line shows that the marginal cost of insurance ranges between 3.86 and 6.98 depending on the estimated layoff elasticity used in the calculation of the cost of employer moral hazard.

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## Supplementary Tables and Figures

Table A1: Representativeness of the SC DEW Dataset

| | ***% Employers*** | | ***% Employees*** | | ***Average yearly wage*** | |
|---|---|---|---|---|---|---|
| | SC DEW | QCEW | SC DEW | QCEW | SC DEW | QCEW |
| Primary | .011 | .011 | .014 | .010 | $31,016 | $29,601 |
| Construction | .141 | .118 | .094 | .067 | $32,900 | $40,264 |
| Manufacturing | .043 | .046 | .098 | .112 | $39,828 | $43,815 |
| Trade | .199 | .234 | .178 | .199 | $41,602 | $31,724 |
| Transport | .028 | .025 | .030 | .034 | $39,806 | $36,357 |
| Services | .578 | .567 | .586 | .579 | $36,546 | $33,127 |

*Notes:* This table compares the distribution of the share of employers, the share of employees, and the average wage across broad economic sectors between the SC DEW data, excluding the top 1% largest employers, and the QCEW data, covering all private sector employers in South Carolina in 2009.

Table A2: South Carolina Study Sample and Excluded Employers: Summary Statistics and Balance Tests

| | ***Study Sample (SC DEW)*** | | | ***Excluded Employers (SC DEW)*** | | | | |
|---|---|---|---|---|---|---|---|---|
| | N | Mean | Std. dev. | N | Mean | Std. dev. | Difference | P-value |
| *Panel A: Main Outcomes* | | | | | | | | |
| Tax per worker | 31878 | 128.258 | 79.020 | 82120 | 179.759 | 82.704 | -51.501 | 0.000 |
| Number of employees | 31878 | 11.980 | 20.422 | 71978 | 5.686 | 18.705 | 6.293 | 0.000 |
| Total wages | 31878 | 451578.079 | 953671.469 | 71975 | 172348.859 | 647988.999 | 279229.220 | 0.000 |
| Average wage | 31583 | 40225.009 | 59957.251 | 62052 | 35983.206 | 92069.699 | 4241.803 | 0.000 |
| Taxable wages | 31878 | 97559.060 | 168956.792 | 82120 | 41571.602 | 133931.239 | 55987.458 | 0.000 |
| Total taxes | 31878 | 1890.495 | 4151.008 | 82120 | 1020.303 | 3694.009 | 870.191 | 0.000 |
| *Panel B: Other Characteristics* | | | | | | | | |
| Year of establishment | 31878 | 1991.553 | 10.978 | 81893 | 2002.622 | 8.160 | -11.069 | 0.000 |
| Primary | 31767 | 0.016 | 0.126 | 81668 | 0.009 | 0.096 | 0.007 | 0.000 |
| Construction | 31767 | 0.121 | 0.326 | 81668 | 0.149 | 0.356 | -0.029 | 0.000 |
| Manufacturing | 31767 | 0.060 | 0.238 | 81668 | 0.037 | 0.188 | 0.024 | 0.000 |
| Trade | 31767 | 0.221 | 0.415 | 81668 | 0.190 | 0.393 | 0.031 | 0.000 |
| Transport | 31767 | 0.024 | 0.152 | 81668 | 0.029 | 0.168 | -0.005 | 0.000 |
| Services | 31767 | 0.557 | 0.497 | 81668 | 0.585 | 0.493 | -0.028 | 0.000 |
| Reserve ratio | 31855 | -0.051 | 6.629 | 79671 | -5.068 | 895.472 | 5.018 | 0.317 |

*Notes:* This table presents summary statistics for a set employer characteristics in 2009 and tests for difference in means between the group of South Carolina employers satisfying the criteria to enter the study sample and the remaining employers. See Section 3.2 for details on the study sample.

Table A3: South Carolina Industries with High-Standard Deviation: Turnover and Unemployment Risk

| **NAICS** | **Denomination** | High Std Dev | High Tax Rate |
|---|---|---|---|
| 1113 | Fruit and Tree Nut Farming | ✓ | ✓ |
| 1119 | Other Crop Farming | ✓ | ✓ |
| 2111 | Oil and Gas Extraction | | ✓ |
| 2211 | Electric Power Generation, Transmission and Distribution | ✓ | |
| 2361 | Residential Building Construction | ✓ | ✓ |
| 2362 | Nonresidential Building Construction | ✓ | ✓ |
| 2381 | Foundation, Structure, and Building Exterior Contractors | ✓ | ✓ |
| 2382 | Building Equipment Contractors | ✓ | ✓ |
| 2383 | Building Finishing Contractors | ✓ | ✓ |
| 2389 | Other Specialty Trade Contractors | ✓ | ✓ |
| 3131 | Fiber, Yarn, and Thread Mills | ✓ | |
| 3132 | Fabric Mills | ✓ | ✓ |
| 3133 | Textile and Fabric Finishing and Fabric Coating Mills | ✓ | ✓ |
| 3141 | Textile Furnishings Mills | ✓ | ✓ |
| 3222 | Converted Paper Product Manufacturing | ✓ | |
| 3252 | Resin, Synthetic Rubber ... | ✓ | |
| 3261 | Plastics Product Manufacturing | ✓ | |
| 3359 | Other Electrical Equipment and Component Manufacturing | ✓ | |
| 3363 | Motor Vehicle Parts Manufacturing | ✓ | |
| 4235 | Metal and Mineral (except Petroleum) Merchant Wholesalers | ✓ | |
| 4431 | Electronics and Appliance Stores. | ✓ | |
| 4441 | Building Material and Supplies Dealers | ✓ | |
| 4451 | Grocery Stores | ✓ | ✓ |
| 4461 | Health and Personal Care Stores | | |
| 4471 | Gasoline Stations | ✓ | ✓ |
| 4481 | Clothing Stores | ✓ | ✓ |
| 4511 | Sporting Goods, Hobby, and Musical Instrument Stores | ✓ | ✓ |
| 4521 | Department Stores | ✓ | ✓ |
| 4921 | Couriers | ✓ | |
| 5121 | Motion Picture and Video Industries | ✓ | ✓ |
| 5221 | Depository Credit Intermediation | ✓ | |
| 5222 | Nondepository Credit Intermediation | ✓ | |
| 5312 | Offices of Real Estate Agents and Brokers | ✓ | |
| 5411 | Legal Services | ✓ | |
| 5412 | Accounting, Tax Preparation, Bookkeeping, and Payroll Services | ✓ | ✓ |
| 5413 | Architectural, Engineering, and Related Services | ✓ | ✓ |
| 5416 | Management, Scientific, and Technical Consulting Services | ✓ | |
| 5613 | Employment Services | ✓ | ✓ |
| 5616 | Investigation and Security Services | ✓ | |
| 5617 | Services to Buildings and Dwellings | ✓ | ✓ |
| 6211 | Offices of Physicians | ✓ | |
| 6216 | Home Health Care Services | ✓ | |
| 6221 | General Medical and Surgical Hospitals | ✓ | |
| 7112 | Spectator Sports | ✓ | ✓ |
| 7131 | Amusement Parks and Arcades | ✓ | ✓ |
| 7139 | Other Amusement and Recreation Industries | ✓ | ✓ |
| 7211 | Traveler Accommodation | ✓ | ✓ |
| 7221 | Full-Service Restaurants | ✓ | ✓ |
| 7222 | Limited-Service Eating Places | ✓ | ✓ |
| 7223 | Special Food Services | ✓ | ✓ |

*Notes:* This table reports the NAICS four-digits code and the denomination of high-employment standard deviation industries in South Carolina. The table also indicates which, among these industries, also have high-average unemployment tax rate. High-unemployment risk industries have average within-year standard deviation of employment greater or equal to 250 according to the Quarterly Census of Employment and Wages data for South Carolina and Colorado between 2001 and 2006. High-unemployment tax rate industries have an average unemployment tax rate between 2001 and 2006 larger than 0.0059 (the study sample mean) based on the QCEW data for South Carolina.

Table A4: Full Sample Reduced Form Effects on Employer Outcomes

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| Outcome: | Tax per worker | Employees | Total wages | Average wage | Taxable wages | Taxable wages (2010 payroll) | Total taxes | Total taxws (2010 payroll) |
| Treated × 2005 | -31.999*** | -0.126 | -7,797.990 | 4,228.489 | -3,109.353 | -3,109.353 | -243.931 | -243.931 |
| | (4.003) | (0.576) | (32,870.817) | (3,053.160) | (6,534.490) | (6,534.490) | (225.698) | (225.698) |
| Treated × 2006 | -35.865*** | -0.166 | -3,713.626 | 4,389.001* | -1,357.292 | -1,357.292 | -218.614 | -218.614 |
| | (3.763) | (0.649) | (29,593.515) | (2,543.692) | (6,055.655) | (6,055.655) | (210.029) | (210.029) |
| Treated × 2007 | -28.877*** | -0.107 | 220.419 | 2,549.163 | -477.089 | -477.089 | -160.087 | -160.087 |
| | (3.367) | (0.633) | (28,594.757) | (2,497.509) | (6,254.873) | (6,254.873) | (199.126) | (199.126) |
| Treated × 2008 | -24.484*** | -0.091 | 5,123.444 | 2,304.777 | -409.987 | -409.987 | -156.198 | -156.198 |
| | (2.803) | (0.509) | (18,555.025) | (2,139.768) | (5,010.487) | (5,010.487) | (173.741) | (173.741) |
| Treated × 2009 | -18.204*** | -0.203 | -17,086.746 | 281.240 | -1,019.697 | -1,019.697 | -198.974** | -198.974** |
| | (2.441) | (0.180) | (12,837.579) | (1,651.322) | (2,014.504) | (2,014.504) | (77.630) | (77.630) |
| Treated × 2011 | 197.396*** | -0.374* | -19,447.029** | 1,316.513 | 850.952 | 7,189.328*** | 839.321*** | 834.164*** |
| | (10.086) | (0.215) | (8,914.287) | (1,640.092) | (3,698.944) | (1,099.152) | (142.305) | (126.471) |
| Treated × 2012 | 157.744*** | -0.695** | -38,320.585** | 2,111.847 | -1,192.993 | 11,982.213*** | 378.604** | 591.968*** |
| | (12.200) | (0.321) | (16,045.541) | (2,101.428) | (4,771.922) | (1,831.920) | (167.081) | (115.900) |
| Treated × 2013 | 143.267*** | -0.895** | -39,252.149** | 1,532.841 | -2,201.282 | 11,982.213*** | 101.648 | 607.170*** |
| | (14.116) | (0.387) | (15,382.852) | (1,938.173) | (5,557.137) | (1,831.920) | (312.096) | (115.905) |
| Treated × 2014 | 160.190*** | -0.567* | -43,169.141* | -1,677.546 | 4,665.711 | 11,982.213*** | 673.278*** | 901.010*** |
| | (17.231) | (0.292) | (25,472.853) | (3,675.095) | (4,110.560) | (1,831.920) | (249.413) | (173.229) |
| Observations | 184,610 | 184,610 | 184,610 | 182,663 | 184,610 | 184,610 | 184,610 | 184,610 |
| R-squared | 0.555 | 0.916 | 0.921 | 0.670 | 0.887 | 0.922 | 0.785 | 0.797 |
| Mean outcome 2010 | 139.1 | 8.126 | 315906 | 40674 | 66509 | 66509 | 1417 | 1417 |
| P-value post | 0 | 0.241 | 0.103 | 0.691 | 0.0370 | 0 | 0 | 0 |
| P-value pre | 0 | 0.825 | 0.307 | 0.670 | 0.740 | 0.740 | 0.173 | 0.173 |

*Notes:* This table reports the estimated $\beta_y$ coefficients from Equation 16 for South Carolina employers with 1-50 quarterly employees in 2010. The table reports the p-values from the tests that the post-reform coefficients (2011-2014) and the pre-reform coefficients (2005-2009) are jointly significant. Refer to the Table 1 notes for information on the main outcomes. The taxable wages based on the 2010 payroll in column (6) are equal to true taxable wages until 2010. In each year from 2011 on, they are equal to the taxable wages in 2010 scaled by the relative increase in the taxable wage base between that year and 2010. Total taxes based on the 2010 payroll in column (8) are calculated by multiplying employers' unemployment tax rates by the taxable wages based on the 2010 payroll. *** p<0.01, ** p<0.05, * p<0.1.

Table A5: Heterogeneous Reduced Form Effects on Employer Outcomes by Industry-Unemployment Risk

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tax per worker | | Employees | | Total wages | | Average wage | | Taxable wages | | Total taxes | |
| Industry Std Dev: | *Low* | *High* | *Low* | *High* | *Low* | *High* | *Low* | *High* | *Low* | *High* | *Low* | *High* |
| Treat × 2005 | -45.560*** | -24.789*** | -0.856 | 0.222 | -14,250.890 | -12,661.847 | 1,358.923 | 9,028.679 | -11,656.399 | 3,303.906 | -480.804 | -24.114 |
| | (5.020) | (7.258) | (0.846) | (0.915) | (25,850.679) | (79,897.823) | (4,147.385) | (5,521.515) | (9,155.613) | (11,303.263) | (319.278) | (389.099) |
| Treat × 2006 | -42.699*** | -37.867*** | -0.850 | 0.418 | -14,235.774 | 5,202.093 | 2,037.770 | 7,507.791 | -9,041.350 | 6,450.197 | -434.044 | 2.774 |
| | (5.039) | (6.247) | (0.941) | (1.039) | (24,962.774) | (69,872.337) | (3,060.986) | (5,107.744) | (8,671.797) | (9,985.209) | (303.795) | (340.871) |
| Treat × 2007 | -38.684*** | -24.214*** | -0.609 | 0.042 | 2,047.508 | -14,345.965 | 657.935 | 7,690.872* | -6,283.966 | 2,176.472 | -354.345 | -37.234 |
| | (4.259) | (5.824) | (0.945) | (0.989) | (23,067.460) | (68,858.868) | (3,412.869) | (4,363.426) | (8,682.084) | (11,071.737) | (299.976) | (309.720) |
| Treat × 2008 | -31.128*** | -17.803*** | -0.432 | -0.059 | 6,593.939 | -8,987.301 | 2,564.390 | 3,982.117 | -5,626.820 | 3,609.465 | -321.938 | -28.251 |
| | (3.411) | (5.026) | (0.875) | (0.482) | (22,081.521) | (37,558.624) | (2,389.372) | (4,464.233) | (8,197.852) | (6,330.474) | (285.600) | (217.298) |
| Treat × 2009 | -17.028*** | -9.601*** | 0.044 | -0.621 | -8,777.727 | -31,031.428 | -68.559 | 2,099.945 | -870.793 | -2,749.813 | -142.379** | -215.762 |
| | (3.685) | (2.779) | (0.135) | (0.401) | (7,027.705) | (32,449.815) | (2,003.066) | (3,149.207) | (1,420.345) | (4,679.612) | (65.212) | (177.446) |
| Treat × 2011 | 190.600*** | 208.869*** | 0.099 | -0.768 | -654.158 | -40,477.216* | -743.843 | 2,292.339 | 7,134.948*** | -3,635.398 | 835.116*** | 637.599*** |
| | (15.183) | (15.158) | (0.123) | (0.535) | (6,929.547) | (20,730.810) | (1,998.971) | (2,958.278) | (1,843.887) | (9,413.994) | (192.910) | (237.769) |
| Treat × 2012 | 165.132*** | 168.663*** | 0.332** | -1.839** | 18,860.967 | -117,087.278*** | 41.072 | 4,280.126 | 13,653.276*** | -17,537.650 | 873.949*** | -186.252 |
| | (17.263) | (20.776) | (0.157) | (0.825) | (11,661.894) | (39,986.545) | (2,386.749) | (3,991.172) | (2,934.013) | (11,937.507) | (195.633) | (348.062) |
| Treat × 2013 | 154.368*** | 148.038*** | 0.384** | -2.415** | 21,742.379* | -111,160.953*** | -879.214 | 3,409.050 | 15,707.891*** | -22,432.566 | 856.606*** | -918.472 |
| | (19.707) | (24.756) | (0.183) | (0.994) | (12,420.317) | (36,080.743) | (2,257.448) | (3,648.855) | (2,623.257) | (14,202.658) | (166.975) | (803.190) |
| Treat × 2014 | 173.492*** | 156.827*** | 0.751*** | -1.843*** | 4,862.005 | -94,926.631*** | -6,651.810 | 2,487.624 | 18,722.628*** | -8,061.617 | 928.585*** | 487.653 |
| | (22.679) | (30.317) | (0.241) | (0.653) | (42,721.812) | (27,529.836) | (5,935.416) | (4,313.896) | (2,864.794) | (9,505.419) | (173.952) | (599.927) |
| Observations | 100,680 | 70,460 | 100,680 | 70,460 | 100,680 | 70,460 | 99,644 | 69,630 | 100,680 | 70,460 | 100,680 | 70,460 |
| R-squared | 0.504 | 0.473 | 0.911 | 0.908 | 0.887 | 0.926 | 0.662 | 0.670 | 0.877 | 0.874 | 0.780 | 0.732 |
| Mean Outcome 2010 | 135.7 | 143.5 | 7.785 | 8.569 | 314279 | 318105 | 41960 | 39019 | 63345 | 70624 | 1330 | 1530 |

*Notes:* The table reports the estimated $\beta_y$ coefficients from Equation 16 for South Carolina employers with 1-50 quarterly employees in 2010 in low- and high-unemployment risk industries. High-unemployment risk industries have average within-year standard deviation of employment between 2001 and 2006 greater than or equal to 250 based on the QCEW data for South Carolina. Refer to the Table 1 notes for information on the main outcomes. *** p<0.01, ** p<0.05, * p<0.1

Table A6: Estimates for the Elasticity of Layoffs w.r.t the Degree of Experience Rating from the Literature

| **Study** | **Estimated value** | **Parameter** |
|---|---|---|
| Topel (1984) | -0.27 | Elasticity of temporary layoffs w.r.t. experience rating |
| Card et al. (1994) | -0.43 | Elasticity of temporary layoffs w.r.t. experience rating |
| Card et al. (1994) | -0.1 | Elasticity of permanent layoffs w.r.t. experience rating |
| Anderson et al. (1994) | -0.15 – -0.33 | Elasticity of temporary layoffs w.r.t. experience rating |
| Johnston (2021) | 0 | Elasticity of layoffs w.r.t. unemployment tax rate |

*Notes:* This table lists various estimates for the elasticity of layoffs with respect to the degree of experience rating. The value of -0.27 for Topel (1984) is backed up from the conclusions of the paper. The values of -0.43 and -0.1 for Card et al. (1994) are taken from Table 2. Anderson et al. (1994) reports various estimates ranging between -0.15 and -0.33 in Section 5. The value of zero for Johnston (2021) is taken from Table 2.

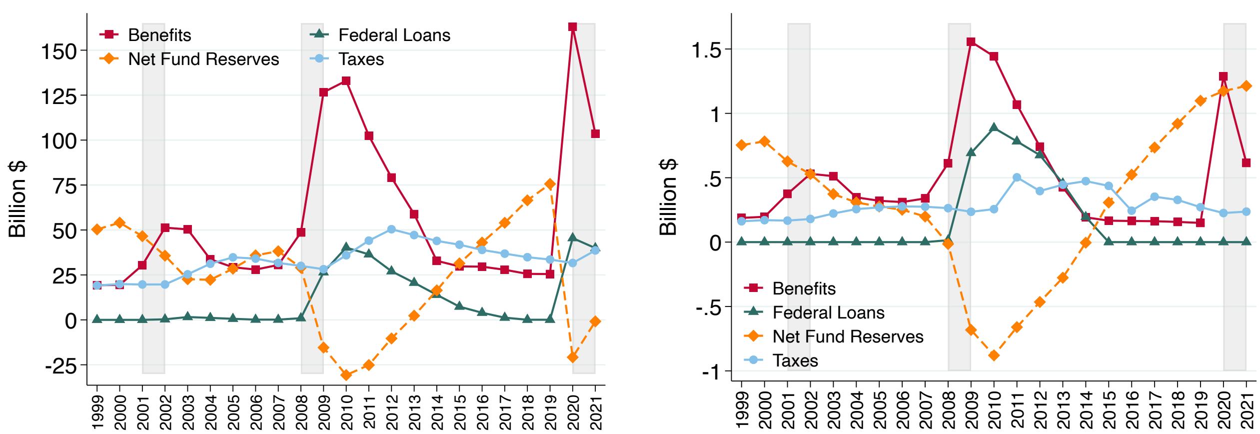
Table A7: Estimated Value of Insurance for Workers from the Literature

| **Study** | **Estimated value** | **Approach** |
|---|---|---|
| Gruber (1997a) | 0.89 | Consumption drop |
| Hendren (2017) | 1.32 | Consumption drop |
| Hendren (2017) | 1.87 | Ex-ante consumption drop |
| Landais et al. (2021) | 1.52 | Consumption drop |
| Landais et al. (2021) | 1.59 | Marginal propensity to consume |
| Landais et al. (2021) | 3.13 | Revealed preference |

*Notes:* This table lists various estimates for the value of insurance for workers. The value of 0.89 for Gruber (1997a) is obtained by multiplying the percentage drop in consumption at layoff, 22.2% in their Table 1 by the highest value of risk aversion cosidered, 4. The value of 1.32 for Hendren (2017) comes from column 1 of their Table 5. Hendren (2017) comes from column 1 of their Table 6. The value of 1.52 for Landais et al. (2021) is the highest estimate in their Figure 1. The value of 1.59 for Landais et al. (2021) comes from column 1 of their Table 2. The value of 3.13 for Landais et al. (2021) comes from column 1 of their Table 3.

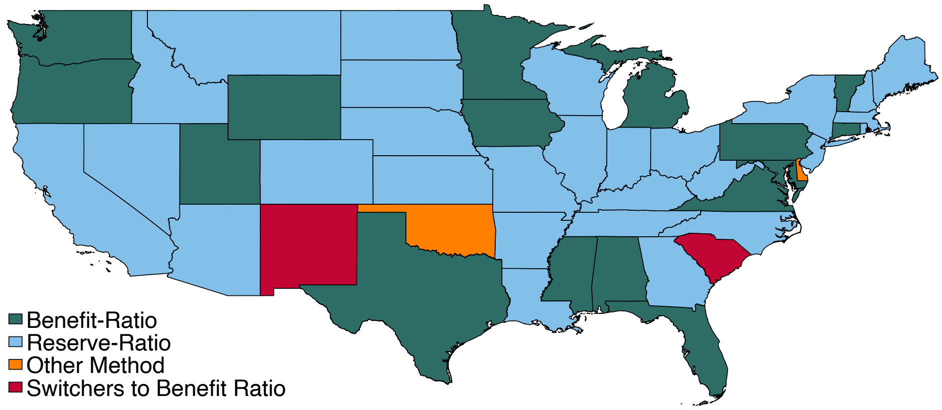
Figure A1: Recent Trends in Unemployment Benefits, Taxes, and Unemployment Trust Fund Solvency

(a) United States (b) South Carolina



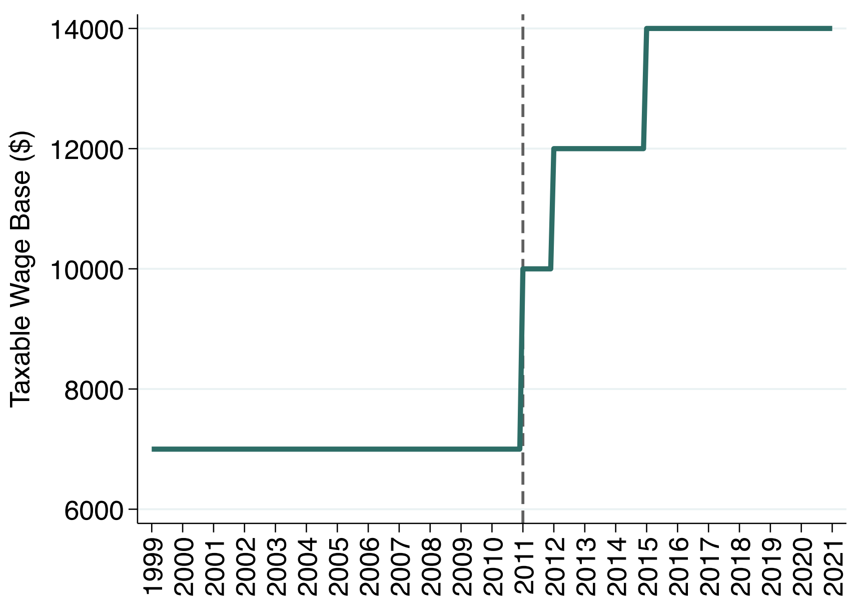

*Notes:* This figure illustrates the change in the total amount of unemployment benefits paid out to workers (including regular, extended, and emergency benefits), federal government loans, reserves in the Unemployment Trust Fund net of federal loans, and unemployment taxes collected in the United States (panel [a]) and in South Carolina (panel [b]). The cumulative figures in panel [a] are derived by aggregating the values from all states. Gray areas correspond to economic recessions. Data sources: ET 394 and US Business Cycle Expansions and Contractions from the NBER.

Figure A2: States' Measure of Unemployment Risk for Tax Rate Assessment




*Notes:* This figure illustrates the states currently using the benefit ratio, the reserve ratio, and other measures of experience with unemployment to assign unemployment tax rates to employers. The figure also shows the states that switched from a reserve ratio to a benefit ratio system: South Carolina in 2011, and New Mexico in 2015.

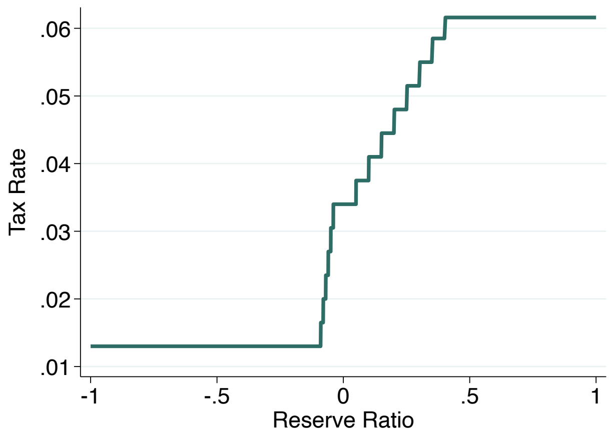
Figure A3: Taxable Wage Base in South Carolina



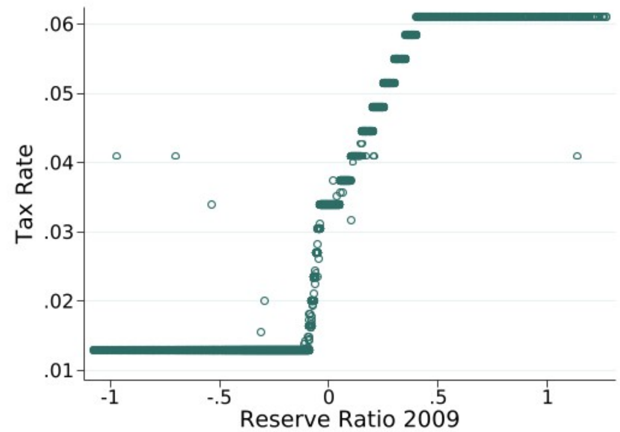

*Notes:* This figure illustrates the change the taxable wage base in South Carolina between 1999 and 2021. Data source: ET 394.

Figure A4: Pre- and Post-Reform Unemployment Tax Rate Schedules in South Carolina

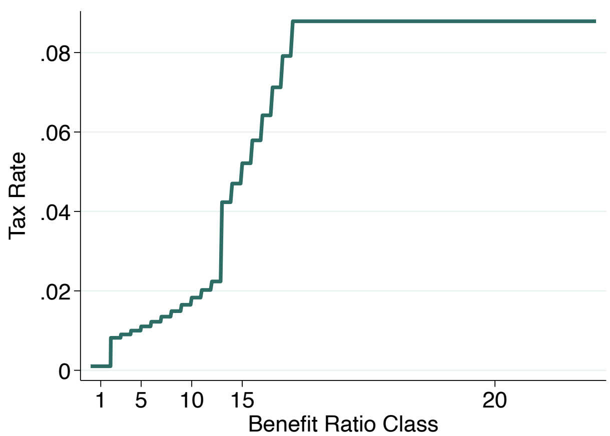
(a) Tax Rate Schedule Pre-Reform



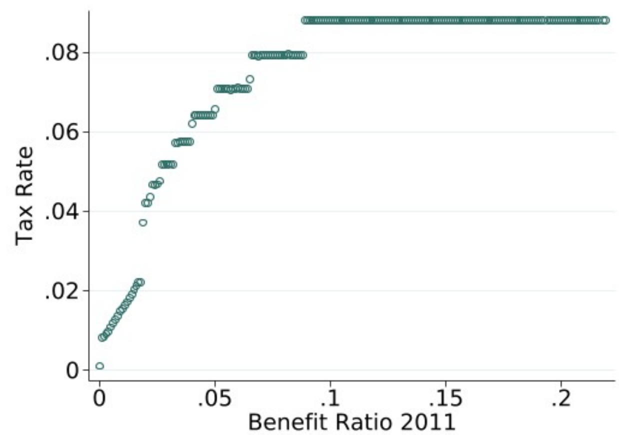

(b) Binscatter of Employers by Tax Rate and Reserve Ratio




(c) Tax Rate Schedule Post-Reform




(d) Binscatter of Employers by Tax Rate and Benefit Ratio

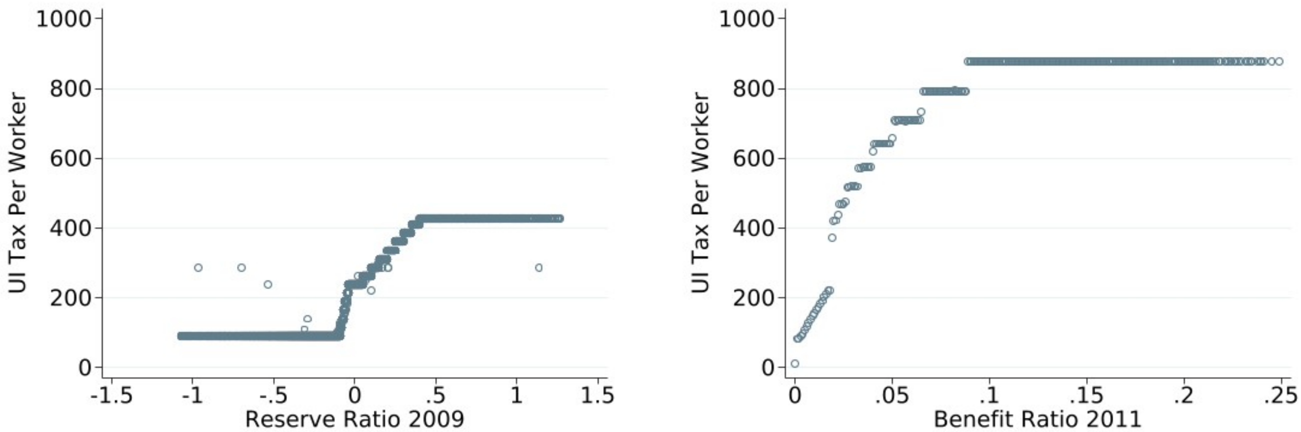



*Notes:* Panel (a) illustrates the unemployment tax rate schedule in effect in South Carolina between 2004 and 2010 from the US Unemployment Insurance Financing Policy Database. The schedule specifies the unemployment tax rates, ranging from 1.3 to 6.1%, associated each level of reserve ratio. Panel (b) is a binscatter of South Carolina employers, plotted by their unemployment tax rates and reserve ratios in 2009. Each marker corresponds to the average tax rate in a bin of reserve ratio sized 0.0001. The reserve ratio is trimmed to the first and ninety-ninth percentile. Panel (c) illustrates the unemployment tax rate schedule in effect in South Carolina in 2011 from the US Unemployment Insurance Financing Policy Database. Employers are ranked based on their benefit ratios and divided into twenty classes, each including approximately five percent of the state's taxable wages. All the employers within a class are assigned the same tax rate. Tax rates range between from 0.103% for bottom class employers to 8.789% for top class employers. Panel (d) is a binscatter of South Carolina employers, plotted by their unemployment tax rates and benefit ratios in 2011. Each marker indicates the average tax rate in a bin of benefit ratio sized 0.001. The benefit ratio is trimmed at the ninety-ninth percentile. Both before and after the reform, the binscatters match the schedules, confirming compliance with unemployment financing policies.

Figure A5: Pre- and Post- Reform Unemployment Tax Per Worker by Experience with Unemployment in South Carolina

(a) Unemployment Tax Per Worker by Reserve Ratio in 2009

(b) Unemployment Tax Per Worker by Benefit Ratio in 2011

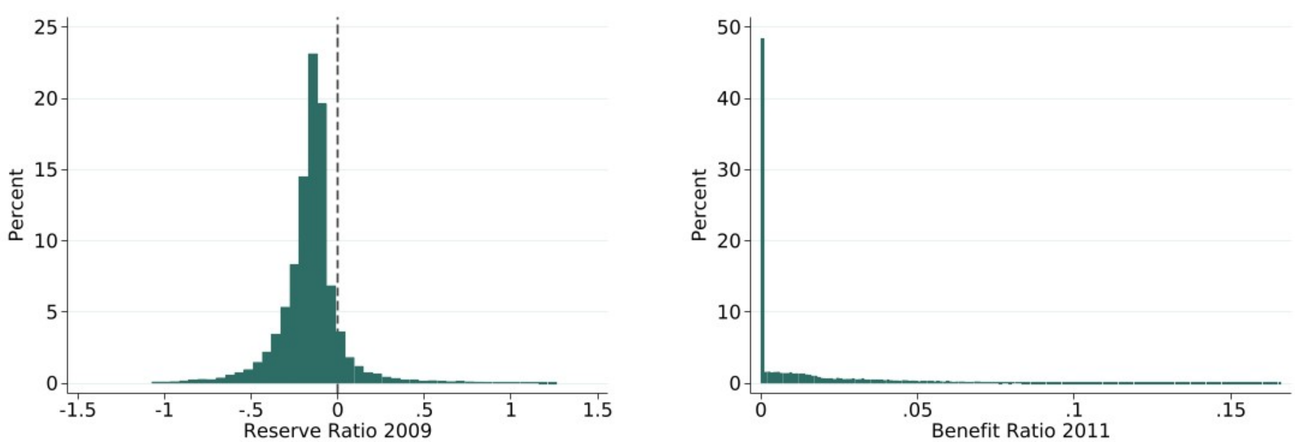



*Notes:* This figure plots South Carolina employers by their unemployment tax per workers and reserve ratios in 2009 (panel [a]) and by their unemployment tax per workers and benefit ratios in 2011 (panel [b]). The tax per worker is obtained by multiplying the taxable wage base, common to all employers in the state in a given year, by employers' individual unemployment tax rates.

Figure A6: Distribution of Reserve Ratio Pre-Reform and Benefit Ratio Post-Reform in South Carolina

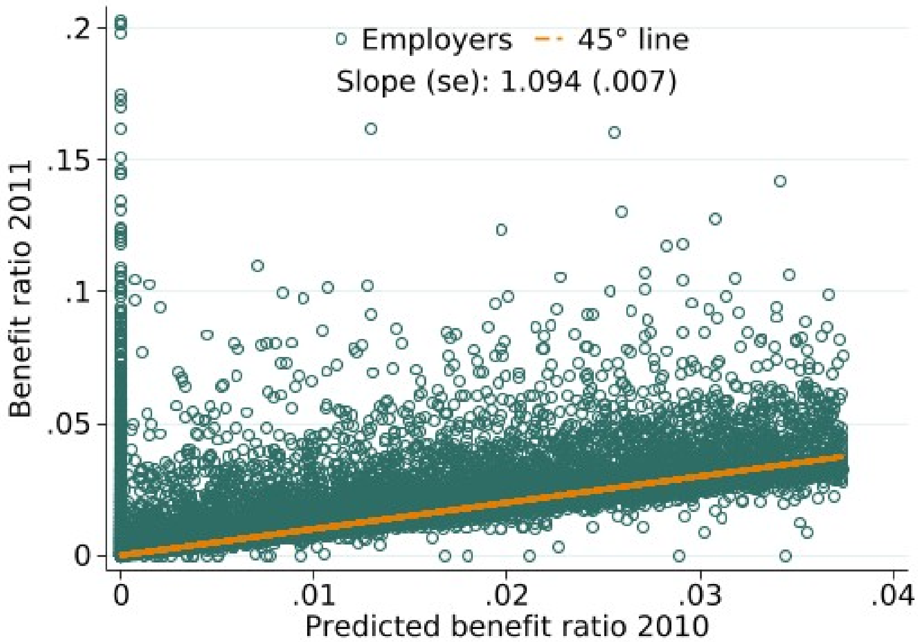
(a) Distribution of Reserve Ratio in 2009

(b) Distribution of Benefit Ratio in 2011



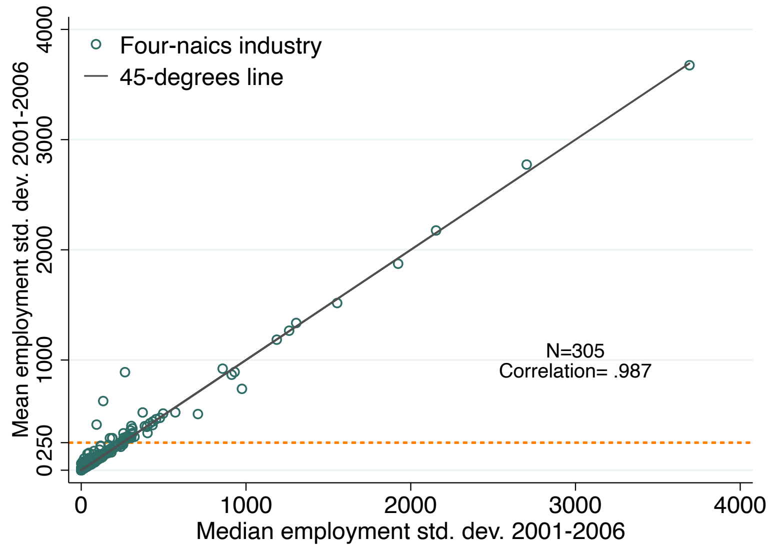

*Notes:* This figure illustrates the distribution of South Carolina employers' reserve ratios in 2009 (panel [a]) and benefit ratios in 2011 (panel [b]). The reserve ratio and the benefit ratio are trimmed at the first and ninety-ninth percentiles.

Figure A7: South Carolina Employers' Benefit Ratio in 2011 and Predicted Benefit Ratios in 2010



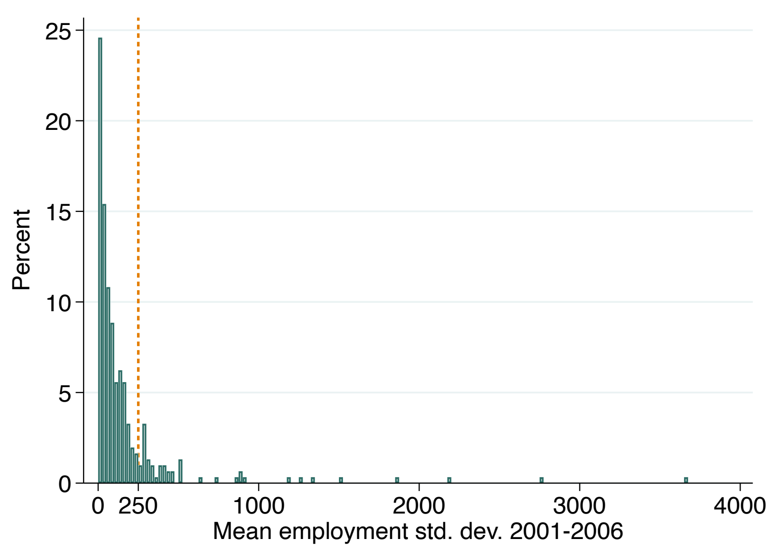

*Notes:* This figure plots South Carolina employers by their benefit ratio in 2011 and their predicted benefit ratios in 2010. The latter is the benefit ratio that employers would have had if the reform took place in 2010 instead of 2011. Because of data availability, it is calculated over a lookback period of six years instead of seven. This means that it is calculated as the ratio of the total benefits charged to the employer between July 1, 2003 and July 1, 2009 to the total taxable wages paid during the same period. The variables are trimmed to the ninety-fifth percentile. The figure also reports the slope and standard error of a regression of the 2011 benefit ratio on the 2010 predicted benefit ratio. The 2011 benefit ratio tends to be higher than the 2010 predicted benefit ratio, and this can be attributed to the fact that the period between July 1, 2009, and July 1, 2010, is included in the 2011 benefit ratio's lookback period but not in the 2010 predicted benefit ratio's lookback period. This specific period saw a significant amount of unemployment benefit charges.

Figure A8: Average and Median Industry Within-Year Standard Deviation in Employment in South Carolina



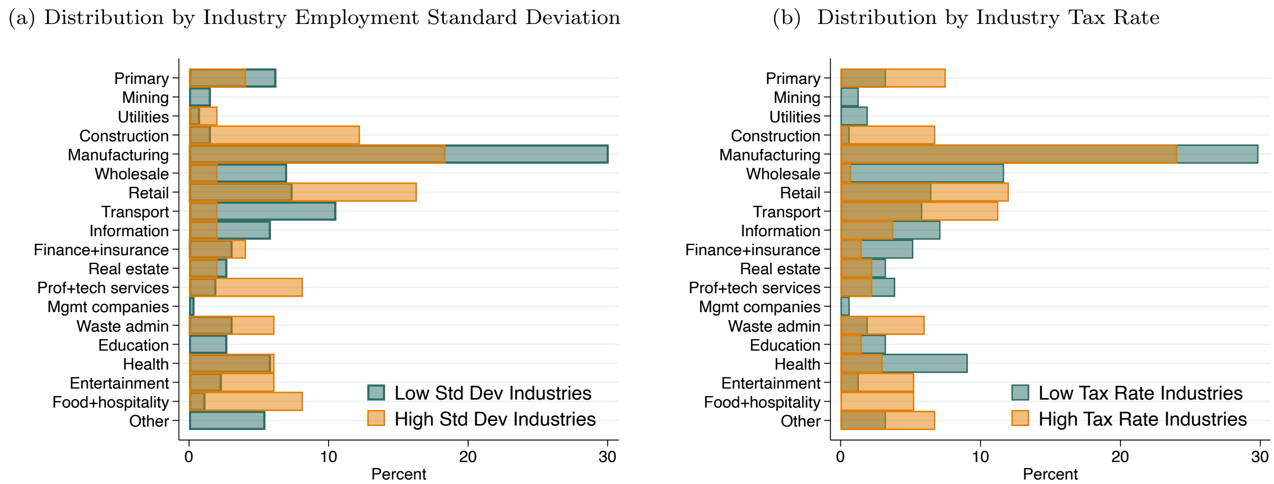

*Notes:* This figure illustrates the correlation between industries' average and median employment within-year standard deviations between 2001 and 2006 in South Carolina from the QCEW data. Each marker corresponds to a different industry identified by a NAICS four-digit code. Markers tend to be distributed along the forty-five degrees line. The figure also reports the number of industries and the correlation between the mean and the median within-year standard deviations in employment. The dashed line indicates the value of the mean distinguishing high- (above) and low- (below) unemployment risk industries.

Figure A9: Distribution of South Carolina Industries' Average Within-Year Employment Standard Deviation




*Notes:* This figure illustrates the distribution of the average within-year standard deviation of employment between 2001 and 2006 for South Carolina industries in 2006. The dashed line indicates the value of the mean distinguishing high- (above) and low- (below) unemployment risk industries. Each bar corresponds to bins of average standard deviation sized 25.

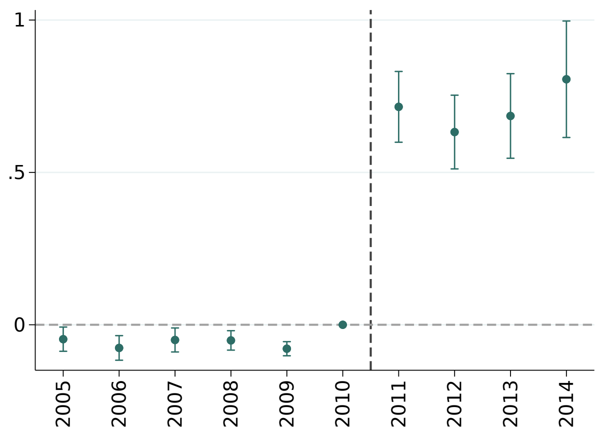
Figure A10: Broad Sectoral Distribution of Low- and High- Unemployment Risk Industries in South Carolina



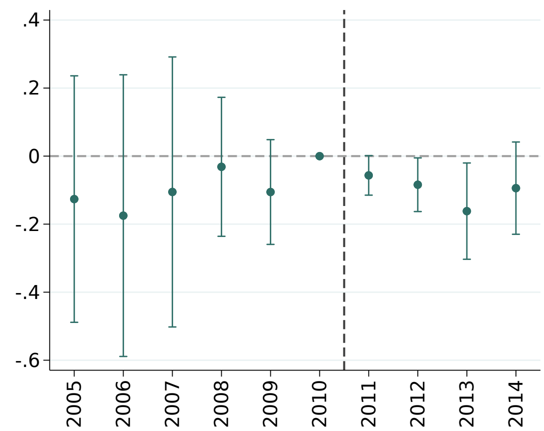

*Notes:* The figure illustrates the distribution of low- and high- unemployment risk industries in South Carolina across broad economic sectors. Unemployment risk is based on the within-year employment standard deviation in panel (a) and on the average unemployment tax rate in panel (b). Industries are defined using NAICS four-digit codes. High employment-standard deviation industries have average within-year standard deviation of employment between 2001 and 2006 greater than or equal to 250 based on the QCEW data for South Carolina. High-unemployment tax rate industries have an average unemployment tax rate between 2001 and 2006 larger than 0.0059 (the study sample mean) based on the QCEW data for South Carolina. Broad economic sectors are defined using NAICS two-digit codes.

Figure A11: Full Sample Reduced Form Effects: Large Employers and Outcomes Scaled by 2010 Level

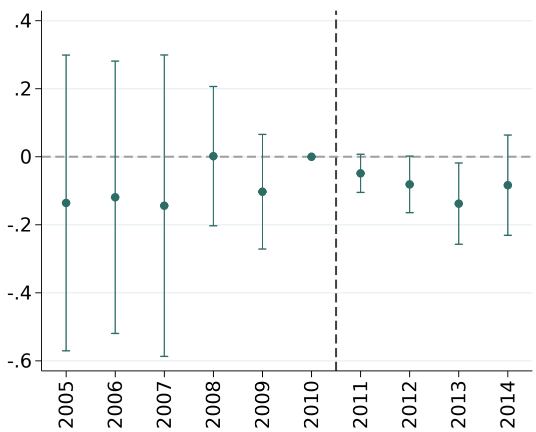
(a) Unemployment Tax Per Worker (Scaled by 2010 Level)



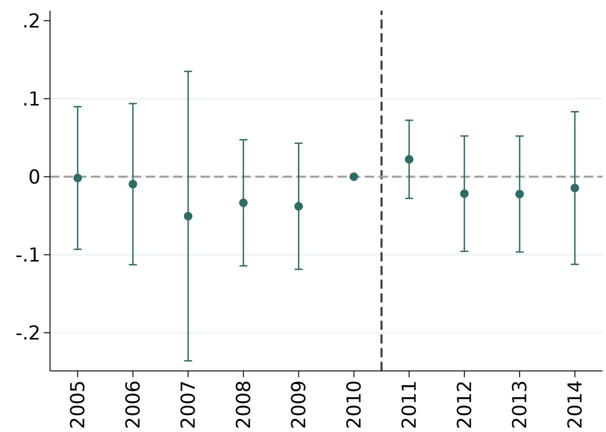

(b) Number of Employees (Scaled by 2010 Level)



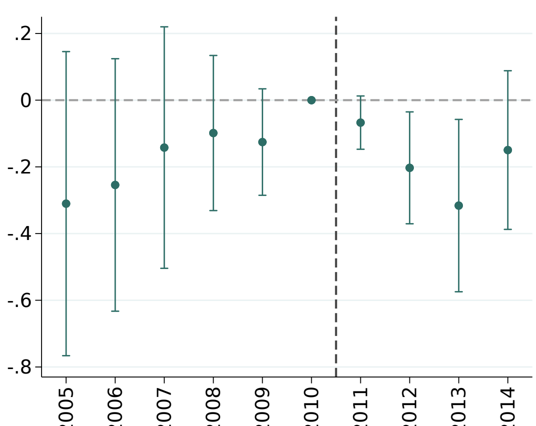

(c) Total Wages (Scaled by 2010 Level)



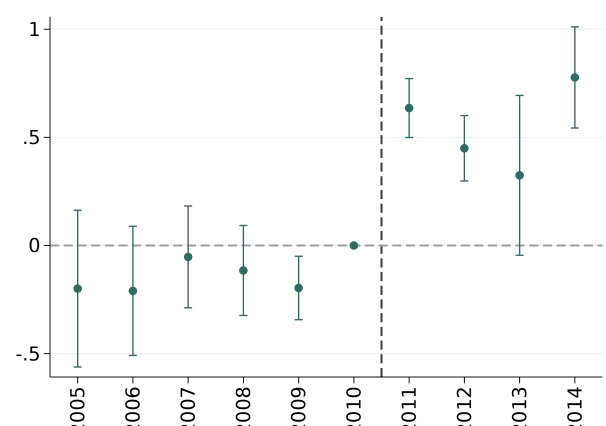

(d) Average Wage (Scaled by 2010 Level)




(e) Taxable Wages (Scaled by 2010 Level)

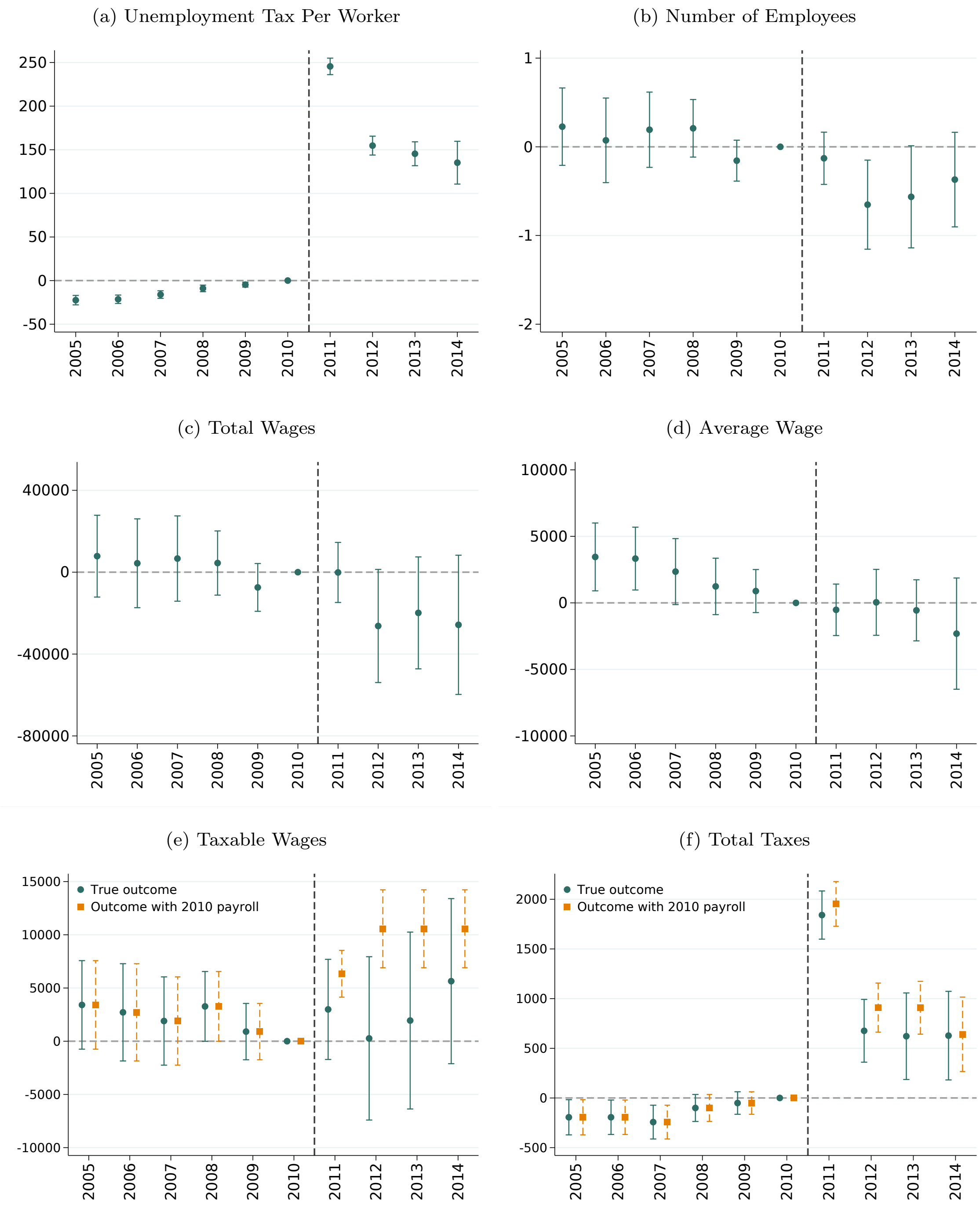



(f) Total Taxes(Scaled by 2010 Level)




*Notes:* This figure illustrates the estimated $\beta_y$ coefficients from Equation 16 for South Carolina employers with at least one employee in 2010. All the outcome variables are scaled by their 2010 level. Refer to the Table 1 notes for information on the main outcomes. 95% confidence intervals are reported.

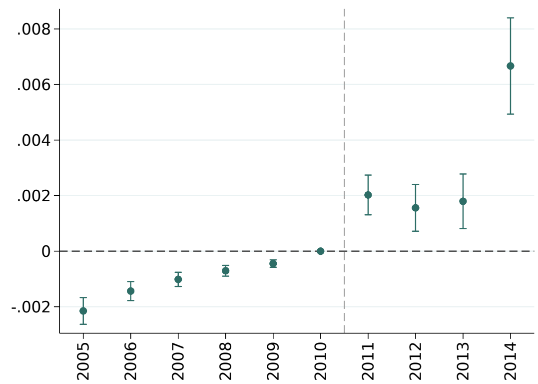
Figure A12: Full Sample Reduced Form Effects: Alternative Benefit Ratio Groups



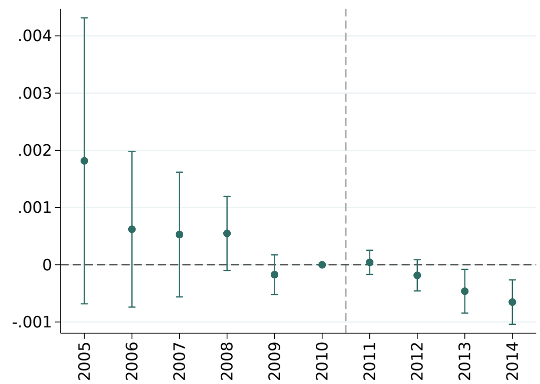

*Notes:* This figure illustrates the estimated $\beta_y$ coefficients from Equation 16 for South Carolina employers with 1-50 quarterly employees in 2010. The figure is based on a different definition of employers' benefit ratio groups. I calculated "yearly benefit ratios" for each employer based on the benefits charged and the taxable wages paid in each of the seven-year lookback period of the 2011 benefit ratio. I then created bins sized 0.1 for the yearly benefit ratios and sized 0.01 for the predicted benefit ratio, and created groups for employers falling in the same bins. These bins guarantee the presence of enough employers sharing the same history. Refer to the Table 1 notes for information on the main outcomes. The taxable wages based on the 2010 payroll in panel (e) are equal to true taxable wages until 2010. In each year from 2011 on, they are equal to the taxable wages in 2010 scaled by the relative increase in the taxable wage base between that year and 2010. Total taxes based on the 2010 payroll in panel (f) are calculated by multiplying employers' unemployment tax rates by the taxable wages based on the 2010 payroll. 95% confidence intervals are reported.

Figure A13: Full Sample Reduced Form Effects: Continuous Treatment

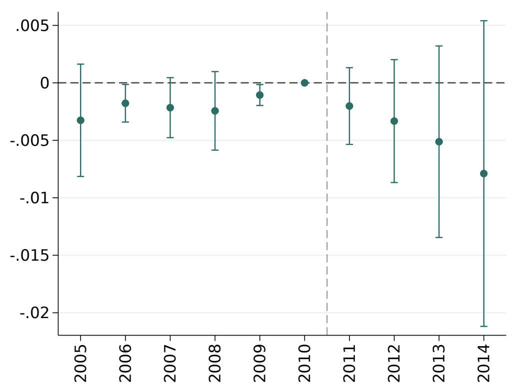
(a) Unemployment Tax Per Worker (Scaled by 2010 Level)



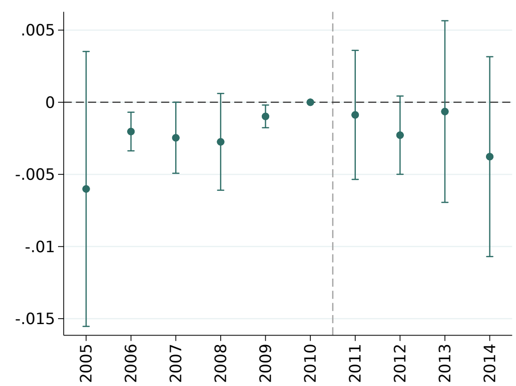
(b) Number of Employees (Scaled by 2010 Level)



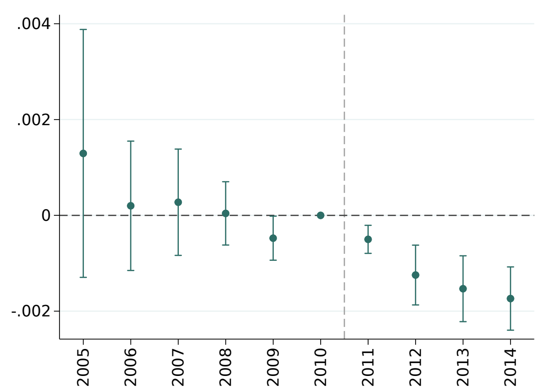
(c) Total Wages (Scaled by 2010 Level)



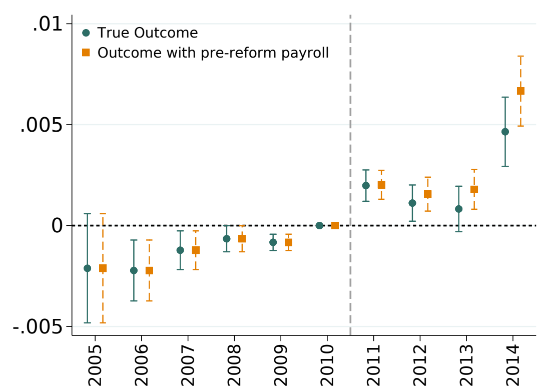
(d) Average Wage (Scaled by 2010 Level)



(e) Taxable Wages (Scaled by 2010 Level)



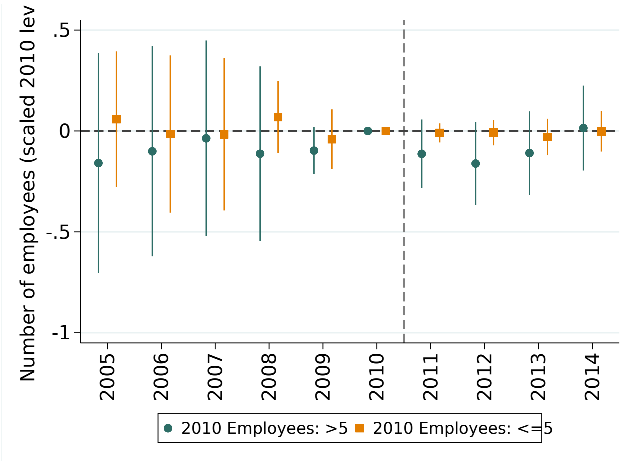
(f) Total Taxes (Scaled by 2010 Level)



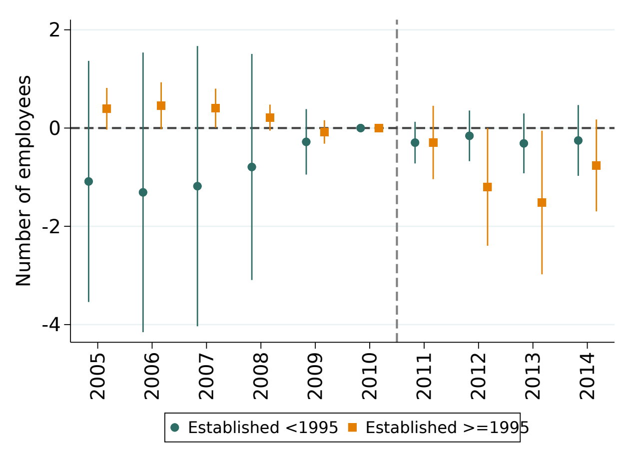

*Notes:* This figure illustrates the estimated $\beta_y$ coefficients from Equation 16 for South Carolina employers with at least one employee in 2010. Treatment is a continuous variable measuring employers' account reserves in 2009, expressed in thousand dollars. Account reserves are calculated as the difference between total benefit charges and total tax payments and represent the numerator of employers' reserve ratios. The $\beta$ coefficients thus represent the effects of \$1,000 more dollars of account reserves on the outcomes. Refer to the Table 1 notes for information on the main outcomes. The taxable wages based on the 2010 payroll are equal to true taxable wages until 2010. In each year from 2011 on, they are equal to the taxable wages in 2010 scaled by the relative increase in the taxable wage base between that year and 2010. Total taxes based on the 2010 payroll in panel (f) are calculated by multiplying employers' unemployment tax rates by the taxable wages based on the 2010 payroll. 95% confidence intervals are reported.

Figure A14: Heterogeneous Reduced Form Effect on Employment by Firm Size, Age, and Productivity

(a) Heterogeneity by Firm Size



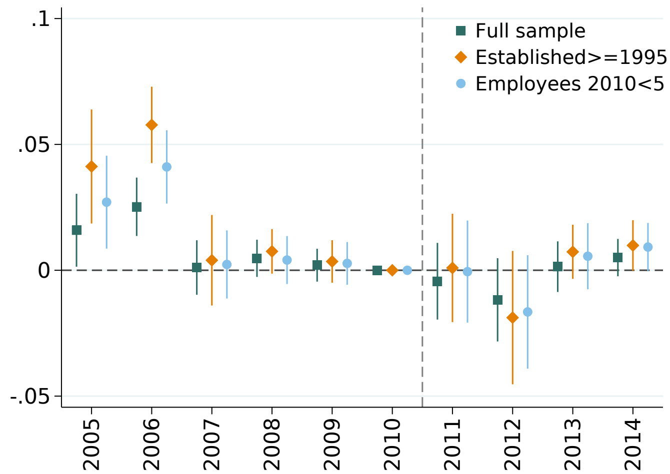

(b) Heterogeneity by Age




(c) Heterogeneity by Productivity


*Notes:* This figure illustrates the estimated $\beta_y$ coefficients from Equation 16 for South Carolina employers with fewer or more than five employees (panel [a]), established before or after 1995, the median establishment date, (panel [b]) and with average wage above or below the median in 2009 (panel [c]) The outcome is the number of employees scaled by the 2010 level in panel (a) and the number of employees in level in panels (b) and (c). 95% confidence intervals are reported.

Figure A15: The Impact of the Transition from Reserve Ratio to Benefit Ratio on Firm Exit Rate

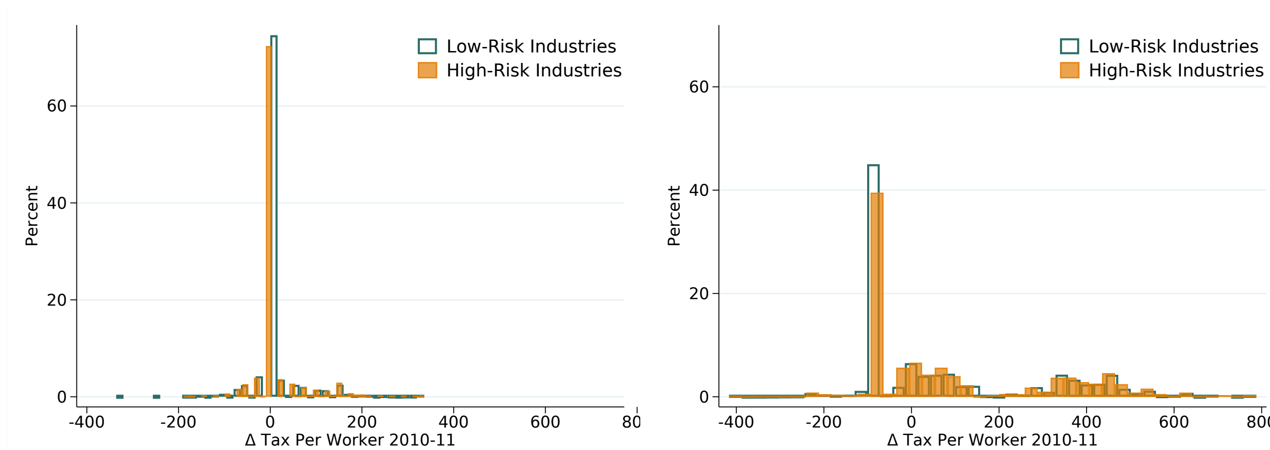



*Notes:* This figure illustrates the estimated $\beta_y$ coefficients from Equation 16 for all South Carolina employers observed between 2005 and 2014, including those that enter and exit the sample in any point of this period. The outcome is an indicator equal to one in the last year in which an employer is observed. I also perform the estimation for the subsamples of small and young firms. Small firms are firms with up to five employees. Young firms are established after 1995. 95% confidence intervals are reported.

Figure A16: Δ Tax Per Worker for Employers in Low- and High-Employment Standard Deviation Industries

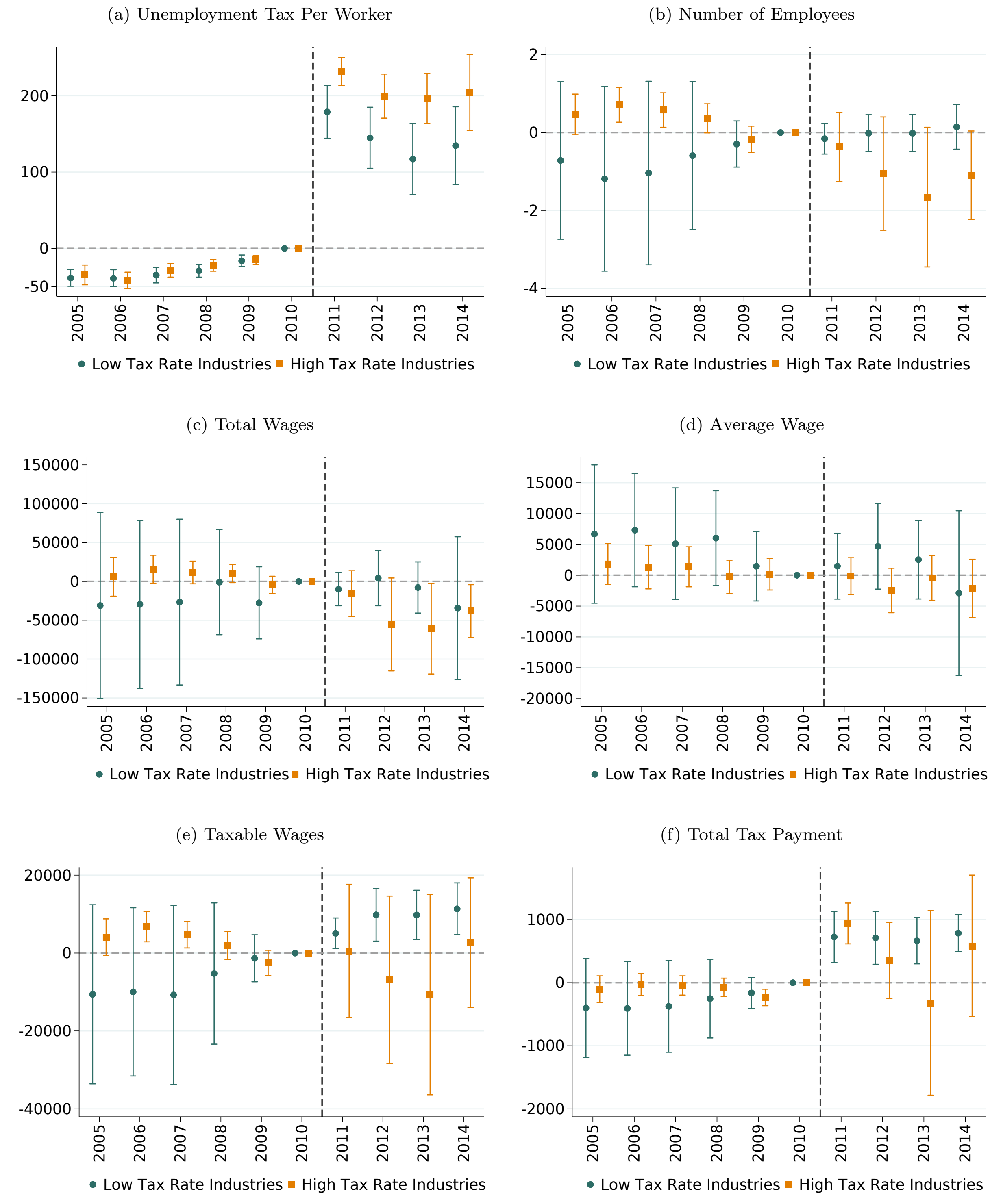
(a) 2009-2010 (Pre-Reform)

(b) 2010-2011 (Around the Reform)




*Notes:* This figure illustrates the distribution of the dollar change in the tax per worker for employers in high- and low-employment standard deviation industries pre-reform (2009-2010, panel [a]) and around the time of the reform (2010-2011, panel [b]). High employment-standard deviation industries have average within-year standard deviation of employment between 2001 and 2006 greater than or equal to 250 based on the QCEW data for South Carolina.

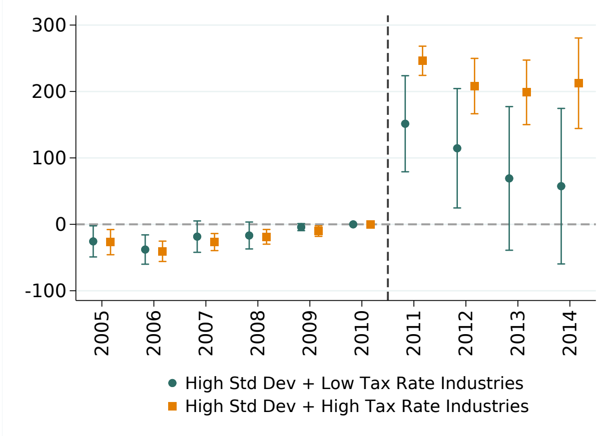
Figure A17: Heterogeneous Reduced Form Effects on Employer Outcomes by Industry Average Tax Rate



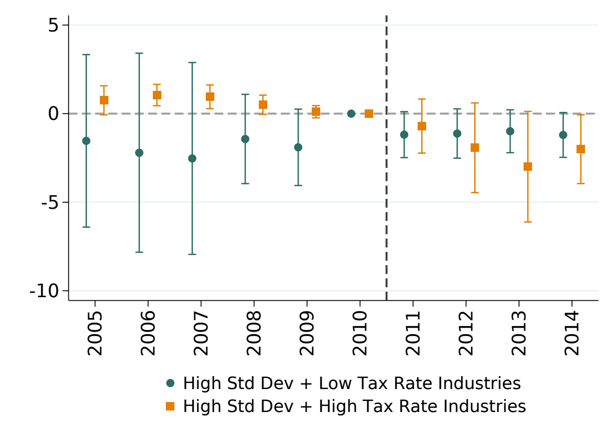

*Notes:* This figure illustrates the estimated $\beta_y$ coefficients from Equation 16 for South Carolina employers with 1-50 quarterly employees in 2010 in low- and high-average tax rate industries. High-unemployment tax rate industries have an average unemployment tax rate between 2001 and 2006 larger than 0.0059 (the study sample mean) based on the QCEW data for South Carolina. Refer to the Table 1 notes for information on the main outcomes. 95% confidence intervals are reported.

Figure A18: Distinguishing Unemployment Risk from Labor Turnover

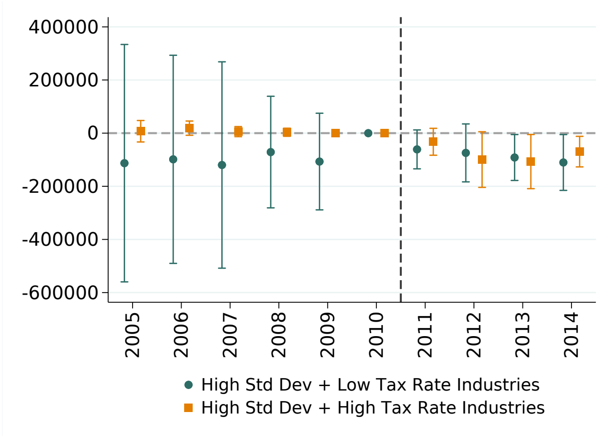
(a) Unemployment Tax Per Worker



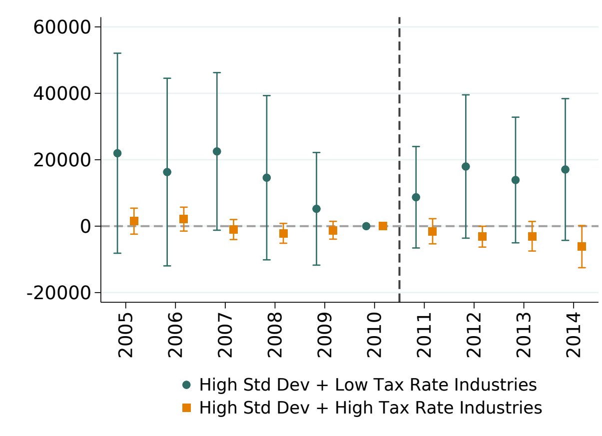

(b) Number of Employees



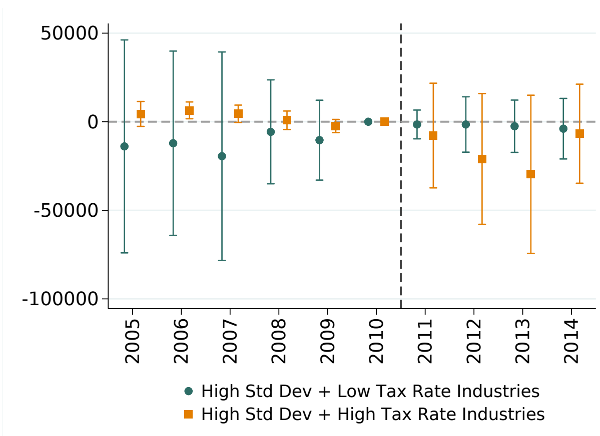

(c) Total Wages



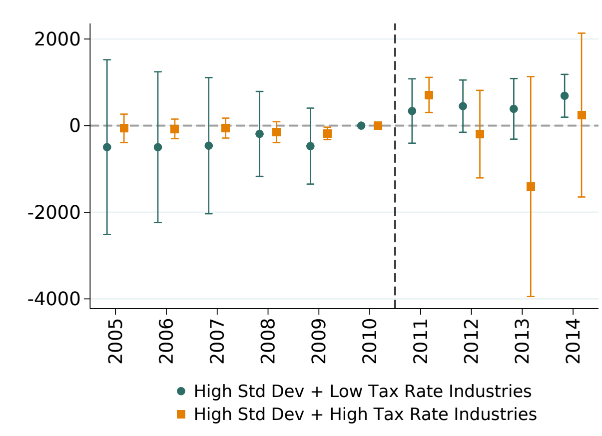

(d) Average Wage




(e) Taxable Wages




(f) Total Tax Payment




*Notes:* This figure illustrates the estimated $\beta_y$ coefficients from Equation 16 for South Carolina employers with 1-50 quarterly employees in 2010 in industries with high employment standard deviation industries and low- or high- average industry unemployment tax rate. High employment-standard deviation industries have average within-year standard deviation of employment between 2001 and 2006 greater than or equal to 250 based on the QCEW data for South Carolina. High-unemployment tax rate industries have an average unemployment tax rate between 2001 and 2006 larger than 0.0059 (the study sample mean) based on the QCEW data for South Carolina. Refer to the Table 1 notes for information on the main outcomes. 95% confidence intervals are reported.

# ONLINE APPENDIX FOR:

Optimal Unemployment Insurance Financing:

Theory and Evidence from two US States

by Sara Spaziani

# A The Colorado Experiment

This section describes an alternative strategy to identify the elasticity of employment with respect to the unemployment tax. This approach is based on a reform of unemployment financing rules in Colorado and employer-level data covering 2013-2020 provided by the Colorado Department of Labor and Employment. I estimate the elasticity both the full sample and in the subsamples of employers in high- and low-unemployment risk industries.

## A.1 Context and source of variation

Structural changes of unemployment financing rules, like the transition of South Carolina from a Reserve Ratio to a Benefit Ratio system, are unusual. Most fluctuations in unemployment taxes are driven by either increases in the Taxable Wage Base, or transitions to lower or higher tax-rate schedules, or the institution or elimination of surcharges. Colorado used a mix of these strategies to increase unemployment taxes following the depletion of its Unemployment Trust Fund in 2009. Firstly, as Figure A.2 shows, the Taxable Wage Base was progressively increased from $10,000. Secondly, tax rate schedules were reduced from twelve to six, with new higher tax rates. Additionally, the state issued $630 million in bonds in 2012 (Post 2020). To pay the principal on those bonds, the state instituted a surcharge representing the percent amount by which the unemployment tax rates in the schedule in effect in each year had to be incremented to obtain the effective tax rates. Table A.1 shows the surcharge in effect in each year between 2013 and 2019. For example, the surcharge in 2017 was equal to 23.94%, meaning that an employer with a tax rate of $\tau$% from the schedule had to pay a final tax rate equal to $(\tau \times 1.2394)$%. Panel (c) of Figure A.1 shows the trends in unemployment benefits, taxes, and fund solvency in Colorado. The figure shows that the combinations of these measures allowed the state to collect almost half billion more unemployment taxes. After paying off the bonds' principal in May 2017, the surcharge was eliminated in 2018.

Since the surcharge was proportional to the original tax rate, employers with initially higher tax rates disproportionately benefitted from its elimination. This asymmetric effect becomes evident when comparing the unemployment tax rate schedules in effect in 2017 and 2018, presented in panel (a) of Figure A.3. While the tax rate associated to negative values of Reserve Ratio remained relatively stable, the tax rate assigned to positive Reserve Ratios decreased by up to 2 percentage points.

Panel (b) plots employers in Colorado by their tax rate in 2017 and 2018 and their Reserve Ratio, revealing a corresponding reduction in tax rates for each Reserve Ratio bin. Consistently, panel (c) shows that in 2018 the maximum Unemployment Tax Per Worker decreased by up to $250 for positive Reserve Ratio levels and remained stable for negative ones. The same patterns emerge when plotting Colorado employers by their Tax Per Worker and Reserve Ratio in 2017 and 2018 in panel (d). The variation in the Tax Per Worker induced by the elimination of the surcharge in 2018 is the variation with which I identify the causal effect of unemployment taxes on employment.

## A.2 Empirical strategy

The disproportionate reduction in unemployment taxes for Reserve Ratios just above zero seems to provide an ideal setting for a Regression Discontinuity Design. However, the very low variability in the coarsely rounded Reserve Ratio prevents its use in this approach. An alternative strategy consists in comparing outcomes for employers in a small window around the zero Reserve Ratio cutoff using a differences-in-differences strategy. Employers with negative Reserve Ratios would serve as the control group, while those with positive Reserve Ratios as the treatment group. However, given the association between past layoffs and the Reserve Ratio, positive Reserve Ratio employers are more likely to be on a recovery trend than negative Reserve Ratio ones, and may display a larger employment increase even in the absence of a tax cut. I thus compare different cohorts of employers with positive Reserve Ratio in different years. These cohorts were all on a similar recovery pattern, but only the one with positive Reserve Ratio in 2017 benefitted from the elimination of the surcharge.

Table A.2 illustrates the conditions used to classify employers into treatment and control cohorts. Treated employers have positive Reserve Ratio in 2017, the year before the reduction in the Tax Per Worker. Control employers have positive Reserve Ratio in 2015, the year before a "placebo event" in which the Tax Per Worker remains relatively stable. Additionally, there is a non-overlapping condition between the two cohorts, where treated employers must have a negative Reserve Ratio in 2015. Lastly, a similarity condition requires that control employers also have a positive Reserve Ratio three years before the placebo event, in 2013.

Figure A.5 illustrates the change in the Tax Per Worker associated to each level of Reserve Ratio around the true event (2017 vs 2018) and the placebo event (2015 vs 2016). In 2018, there is a progressively larger decline in the Tax Per Worker for higher Reserve Ratio levels, which is not observed in 2016, when the Tax Per Worker modestly increases due to a Taxable Wage Base increase from \$ 11800 to \$ 12200.

My identification strategy consists in comparing the differential evolution of firm outcomes of treated and control employers for eight quarters around the time of event (2018Q1 for the treated cohort, and 2016Q1 for the control cohort). I estimate the following differences-in-differences equation:

$$Y_{i,t} = \alpha_i + \sum_{y=-8}^{8} \beta_y Treat_i \times 1_{y=t} + \epsilon_{i,t} \tag{19}$$

In Equation 19, $Y_{i,t}$ is the outcome for employer $i$ at time t, measured in quarters relative to the time of event; $\alpha_i$ are employer fixed effects; $Treated_i$ is equal to one for the treated cohort of employers; $\epsilon_{i,t}$ is an error term. The $\beta_y$ coefficients measure the differential effect of the elimination of the surcharge on the treated cohort relative to the control cohort. $\beta_{-1}$ is normalized to zero. Standard errors are robust to heteroskedasticity and clustered at the employer level.

Table A.3 presents summary statistics for treatment and control employers along with tests for baseline differences. Treated and control employers have similar number of employees in the pre-event quarter and sectoral distribution. However, treated employers offer higher wages, resulting in a higher average wage. This difference may be attributed to the treated cohort being selected to be further away in time from the

Great Recession compared to the control cohort. Regarding tax-related metrics, treated and control employers exhibit similar average Reserve Ratios. However, treated employers have a lower tax rate but a higher Tax Per Worker. These differences likely stem from the lower surcharge in effect in 2015 compared to 2017, leading to higher effective tax rates in 2015 than in 2017. Additionally, the higher Taxable Wage Base in 2017 contributes to the higher Tax Per Worker for the same average Reserve Ratio in that year. Due to the higher wages they pay, treated employers also have higher taxable wages and pay higher unemployment taxes. However, these employers are similar in terms of the benefits they were charged.

Given the strong positive correlation between employers' Reserve Ratios over time (shown in Figure A.4), control employers may have positive Reserve Ratio in 2017 as well and also experience a reduction in their taxes. Reassuringly, 55% of the control employers have negative Reserve Ratio in 2017 and 76% of them have a lower Reserve Ratio in 2017 than in 2015, suggesting that the exposure of the control group to the elimination of the surcharge was diluted. Overall, these statistics suggest that the control cohort represents a good counterfactual for the treated cohort in absence of the tax reduction.

## A.3 Findings

### A.3.1 Reduced form effects of the elimination of the surcharge

Figure A.6 and Table A.4 present the $\beta$ coefficients obtained from Equation 19. Firstly, treated employers experienced a disproportionate reduction in their Tax Per Worker of $136 compared to control employers, equivalent to 19% of the average Tax Per Worker in the pre-reform year.

Secondly, there was a notable increase in the quarterly number of employees right at the time of the event for treated employers. The number of employees remained permanently higher for the following eight quarters. The estimated effect ranges between 0.57 and 1.3 employees, representing a 4.4-10.1% increase in the workforce in 2010Q4. Thirdly, total wages significantly increased at the time of the event for the treatment group and persistently remain higher than for the control group. The effect ranges between $9,000 and $35,000 or 4.3-17% of the pre-reform quarter. However, the average wage remained unaffected, indicating that the increase in total wages was solely driven by the increase in employment. To estimate the yearly wage of the additional workers in the treatment group, I calculate the ratio of the effect on wages to the effect on employment. For $t = 3$, the first year with a significant effect on employment, the ratio is $16,077 (the ratio of $25,402 to 1.158), which is equivalent to 92% of the average wage in the pre-reform quarter. The analysis suggests that the additional employees in the treated group were average-wage employees.

Fourthly, in the treatment group, taxable wages in quarter one significantly increase by approximately $36,000 or 83% of the taxable wages in the pre-reform quarter. However, this effect would have been smaller if taxable wages were related to quarter one, rather than quarter four, of the pre-reform year. By subtracting the taxable wages from time $t - 4$, which correspond to quarter one of the pre-reform year, we obtain a net effect of $18,000, taking into account that taxes are higher in any quarter one for the treated group. The effect on taxable wages is influenced by two components: the differential increase in the Taxable Wage Base experienced by the treated and control cohorts at the time of the event, as it occurs in different years, and the behavioral responses displayed by the treated group. The change in the Taxable Wage Base was $400 in 2016 and $100 in

2018. Consequently, if the cohort had experienced the same increase in the Taxable Wage Base, the effect on taxable wages for the treated group would have been even larger. With the Taxable Wage Base at \$12,500 in 2018, the increase in taxable wages by \$18,000 relative to quarter one of the previous year is equivalent to each existing employee's taxable wages increasing by \$100 and the addition of 1.336 new employees throughout the year, which is consistent with the observed employment increase.

Lastly, the comparison between behavioral and non-behavioral unemployment taxes reveals that treated employers would have experienced a reduction in unemployment taxes if they did not display behavioral responses. However, the increase in taxable wages compensates for the reduction in the tax rate, leading to higher or equal total unemployment taxes relative to the control group.

The findings from the Colorado experiment are highly consistent with those found for South Carolina. In this case, a reduction in unemployment taxes enables employers to expand their workforce. I now turn to investigating heterogeneities in this effect for employers in low-and high-unemployment risk industries.

#### A.3.2 Heterogeneity of employment effects by industry unemployment risk and elasticities calculation

Following the same approach used in the South Carolina experiment, I classify industries into the high- and low- unemployment risk category based on their seasonality in employment. To define industries, I utilize the NAICS 6-digits code, which is the lowest level of aggregation available in the CO DLE data. For each industry, I calculate the median within-year standard deviation in employment over the period between 1998 and 2006 using the QCEW data. This approach allows me to calculate seasonality during a period sufficiently distant from the Great Recession. High-unemployment risk industries are defined as industries with a median within-year standard deviation in employment above 250 between 1998 and 2006.The findings are robust to using alternative cutoffs.

Figure A.7 illustrates the $\beta$ coefficients obtained by estimating Equation 19 separately for the subsamples of employers in low- and high- unemployment risk industries. Despite the large confidence intervals, the figure suggests that the decline in employment and wages documented for the full sample is mostly driven by high-unemployment risk industries, which exhibit larger increases in employment and wages despite a similar decline in the Tax Per Worker compared to low-risk industries. Notably, the average wage also increases for treated employers in high-isk industries, a pattern that does not emerge for treated employers in low-risk industries.

Table A.5 reports the estimated $\gamma$ coefficients from Equation 20:

$$Y_{i,t} = \alpha_i + \sum_{y=-8}^{8} \beta_y 1_{y=t} Treat_i + \sum_{y=-8}^{8} \gamma_y 1_{y=t} Treat_i \times \text{High Risk}_i + \epsilon_{i,t} \tag{20}$$

The $\gamma$ coefficients attached to the interaction of time dummies, the indicator for treatment, and the indicator for high-risk industries, measure the heterogeneous effect of the reform on firm outcomes in low- and high-unemployment risk industries. The table shows that, despite treated employers in low- and high-risk industries experience the same reduction in their Tax Per Worker, treaded employers in high-risk industries have 1.4-3.3 more employees, pay \$26,000-50,000 more in wages, and increase their average wage by \$2,400-3,900.

Although the differential effects on employment and wages are statistically insignificant, the large increase in the magnitude of the coefficients at the time of the reform suggests that this analysis is underpowered.

Lastly, I calculate the elasticity of employment with respect to the unemployment tax per worker using the formula in Equation 18. To do this, I divide the reduced form effect of the reform on employment by the reduced form effect of the reform on the Unemployment Tax Per Worker $\tau$. Then, I multiply this ratio by the ratio of the average Tax Per Worker to the average Employment of the treatment group in 2010.

$$\epsilon_{Employment,\tau} = \frac{\beta_{Employment}}{\beta_{\tau}} \frac{\tau_{t-1,Treat=1}}{Employment_{t-1,Treat=1}} \tag{21}$$

The reduced form effects employed in the calculation of the elasticity are obtained from estimating Equation 22, which pools together all the pre-period and post-period coefficients.

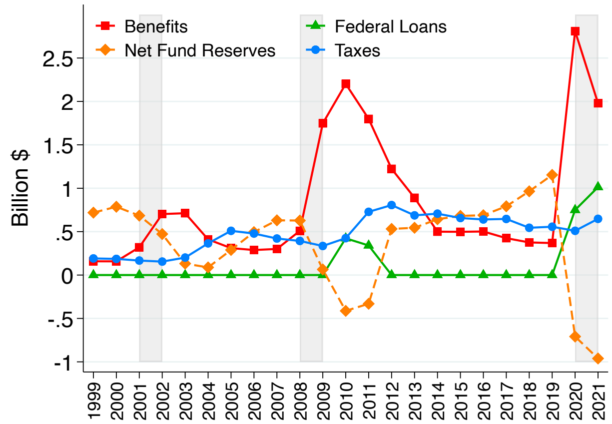
$$Y_{i,t} = \alpha_i + \beta 1_{y=t} Treat_i \times Post_t + + \epsilon_{i,t} \tag{22}$$

Table 2 presents the components that contribute to the elasticity calculation and the corresponding estimated elasticities for the full sample and the subsamples of employers in low- and high-unemployment risk industries. The table shows that the increase in employment in high-unemployment risk industries is more than twice as large as that in low-risk industries. Given the similar pre-period employment and tax per worker, and given the similar reduction in the Tax Per Worker due to the reform, I find a higher elasticity for employers in high-risk industries. The elasticity of employment with respect to the Tax Per Worker, estimated at -1.348 in the full sample, is -1.354 for employers in low-risk industries and -2.452 for high-risk industries.

The patterns observed in the Colorado experiment confirm the findings obtained in the South Carolina experiment. The evidence indicates that the elasticity of employment with respect to the unemployment tax per worker is larger in high-unemployment risk industries. This suggests that industries with higher inherent unemployment risk are more responsive to changes in the unemployment tax, resulting in greater fluctuations in employment levels in response to tax policy reforms. The consistency between the two experiments strengthens the validity of the findings.

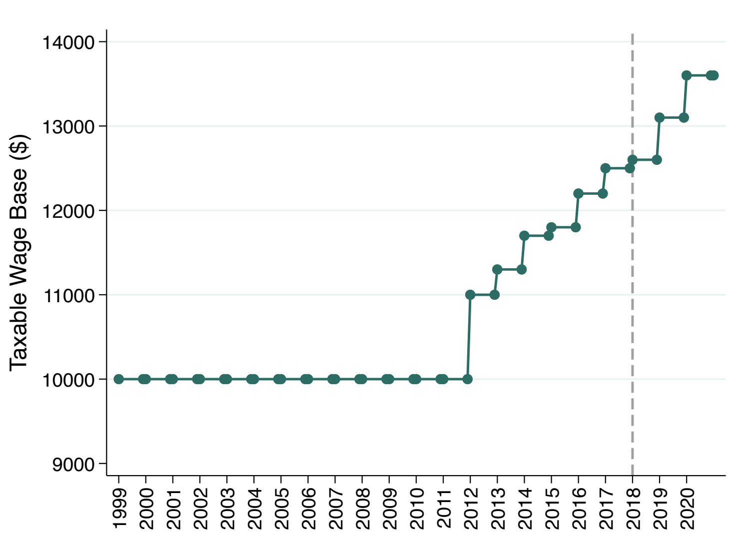
## A.4 Colorado Tables and Figures

Figure A.1: Recent Trends in Unemployment Benefits, Taxes, and Trust Fund Solvency in the United States




*Notes:* The figure illustrates the evolution over time of the total amount of unemployment benefits paid out to workers (regular, extended and emergency benefits), federal government loans, reserves in the Unemployment Trust Fund net of federal government loans, and unemployment taxes collected in Colorado (panel [c]). Gray areas correspond to economic recessions. Data sources: ET Financial Handbook 394 from the US Department of Labor and US Business Cycle Expansions and Contractions.

Figure A.2: Taxable Wage Base in Colorado.




*Notes:* The figure illustrates the evolution of the taxable wage base in Colorado between 1999 and 2021 as reported in the Unemployment Insurance Financial Data Handbook (ET Financial Handbook 394) redacted by the US Department of Labor.

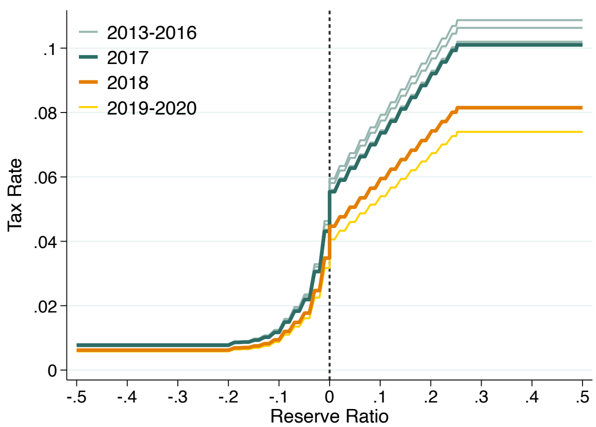
Table A.1: Surcharges in Colorado between 2013 and 2019

| **Year** | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|
| **Surcharge** | 19.39% | 22.19% | 25.20% | 24.47% | 23.94% | 0 | 0 |

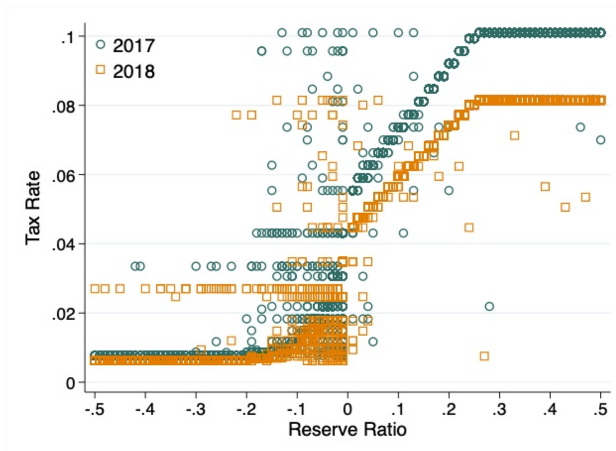
*Notes:* The table reports the surcharges in effect in Colorado between 2013 and 2019. The surcharge represents the percent amount by which the unemployment tax rates in the schedule in effect in each year had to be incremented to obtain the final effective tax rates.

Figure A.3: Unemployment Financing Rules in Colorado

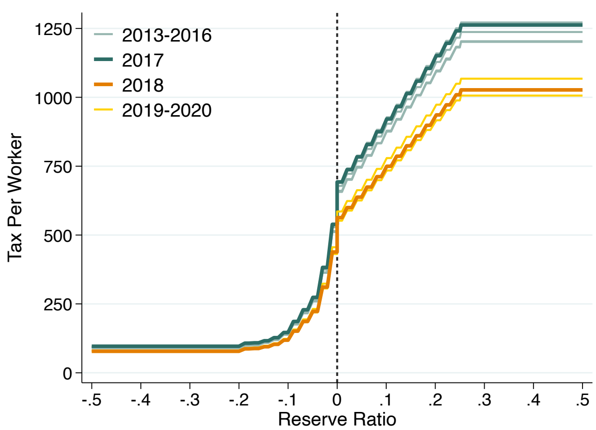
(a) Unemployment Tax Rate Schedule



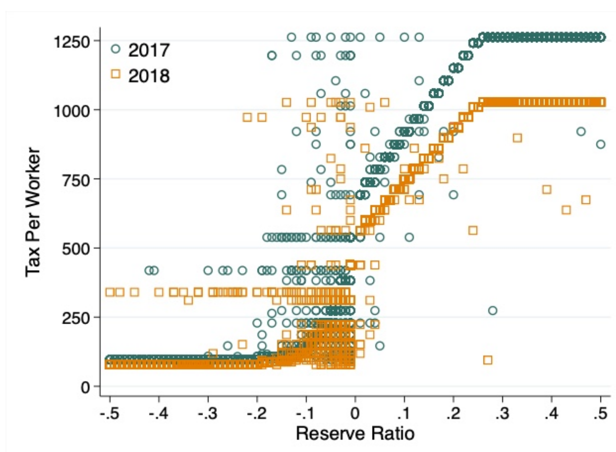

(b) Binscatter of Employers by Tax Rate and Reserve Ratio




(c) Maximum Unemployment Tax Per Worker

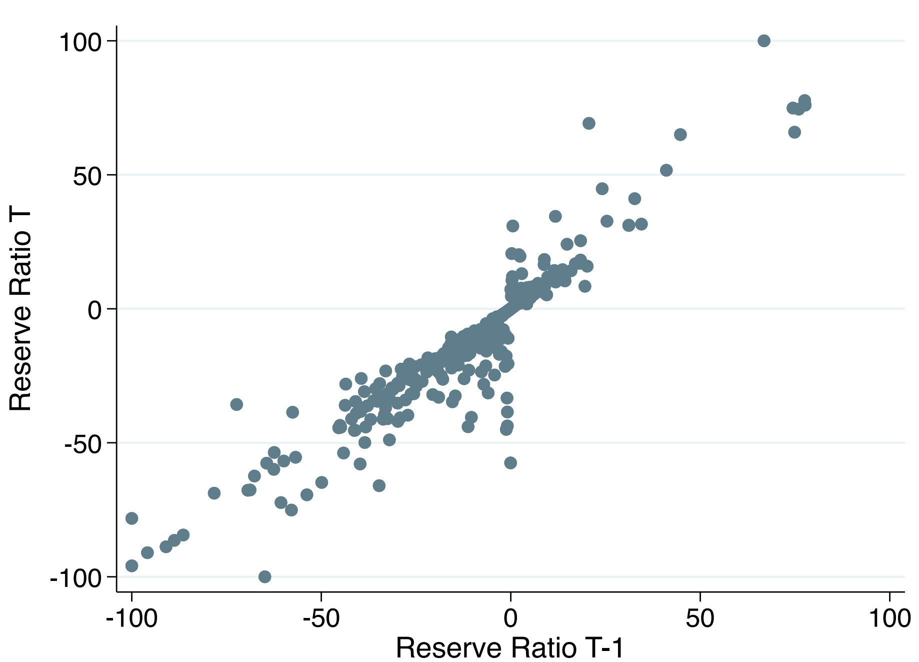



(d) Binscatter of Employers by Tax Per Worker and Reserve Ratio




*Notes:* The figure illustrates the unemployment financing rules in effect in Colorado between 2013 and 2020. Panel (a) illustrates the tax rate schedule in effect in each year, assigning tax rates to each level of Reserve Ratio. Panel (b) plots Colorado employers by their tax rates and Reserve Ratios in 2017 and 2018. Panel (c) illustrates the Maximum Unemployment Tax Per Worker associated by law to each level of Reserve Ratio in each year. The tax associated to each level of Reserve Ratio is obtained by multiplying the corresponding tax rate by the Taxable Wage Base in effect in each year. Panel (d) plots Colorado employers by their Tax Per Worker and Reserve Ratios in 2017 and 2018.

Figure A.4: Correlation in Employers' Reserve Ratio Over Time



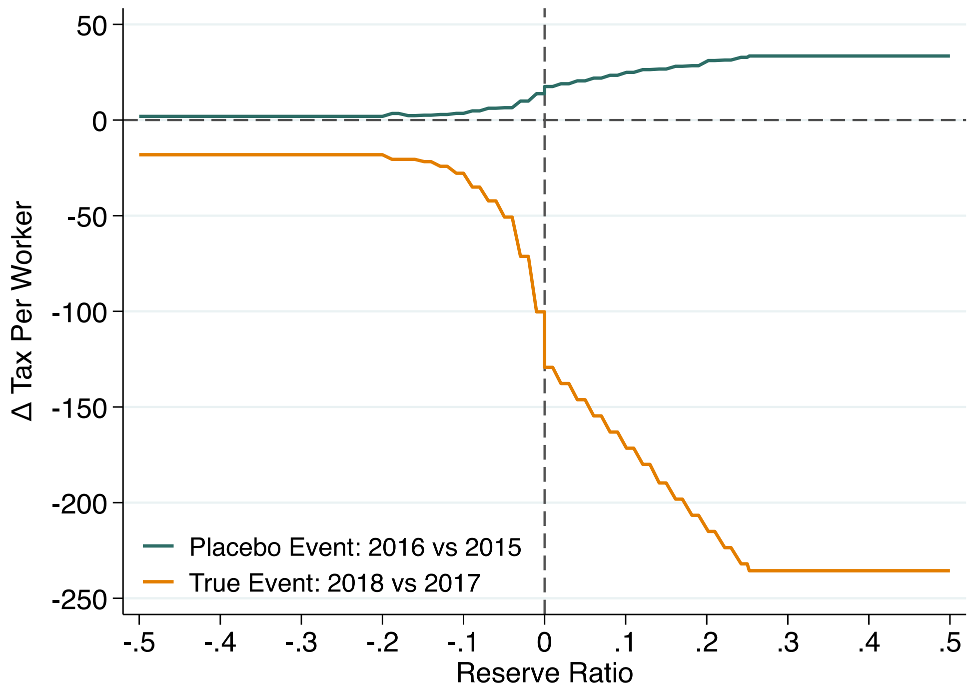

*Notes:* This figure plots Colorado employers by their Reserve Ratio in year T and Reserve Ratio in year T-1, with T=2014, 2015, 2016, 2017, 2018. The Reserve Ratio in year T has been rounded to the first decimal place. Each marker corresponds to the average of the Reserve Ratio in year T-1 for employers in that bin of Reserve Ratio in year T.

Table A.2: Classification of Colorado Employers into Treatment and Control Cohorts

| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|
| Treated cohort | | | RR $<$ 0 | | RR $>$ 0 | True Event | |
| Control cohort | RR $<$ 0 | | RR $>$ 0 | Placebo Event | | | |

*Notes:* This table illustrates the conditions I use to classify employers into treatment and control groups. Treated employers have positive Reserve Ratio in 2017, the year before the reduction in the Tax Per Worker. Control employers have positive Reserve Ratio in 2015, the year before a placebo event. The *non-overlapping condition* condition between the two cohorts requires that treated employers have negative Reserve Ratio in 2015. The *similarity condition* requires that control employers also have positive Reserve Ratio three years before the placebo-event year, in 2013.

Figure A.5: Variation in Unemployment Tax Per Worker by Reserve Ratio in True and Placebo Year



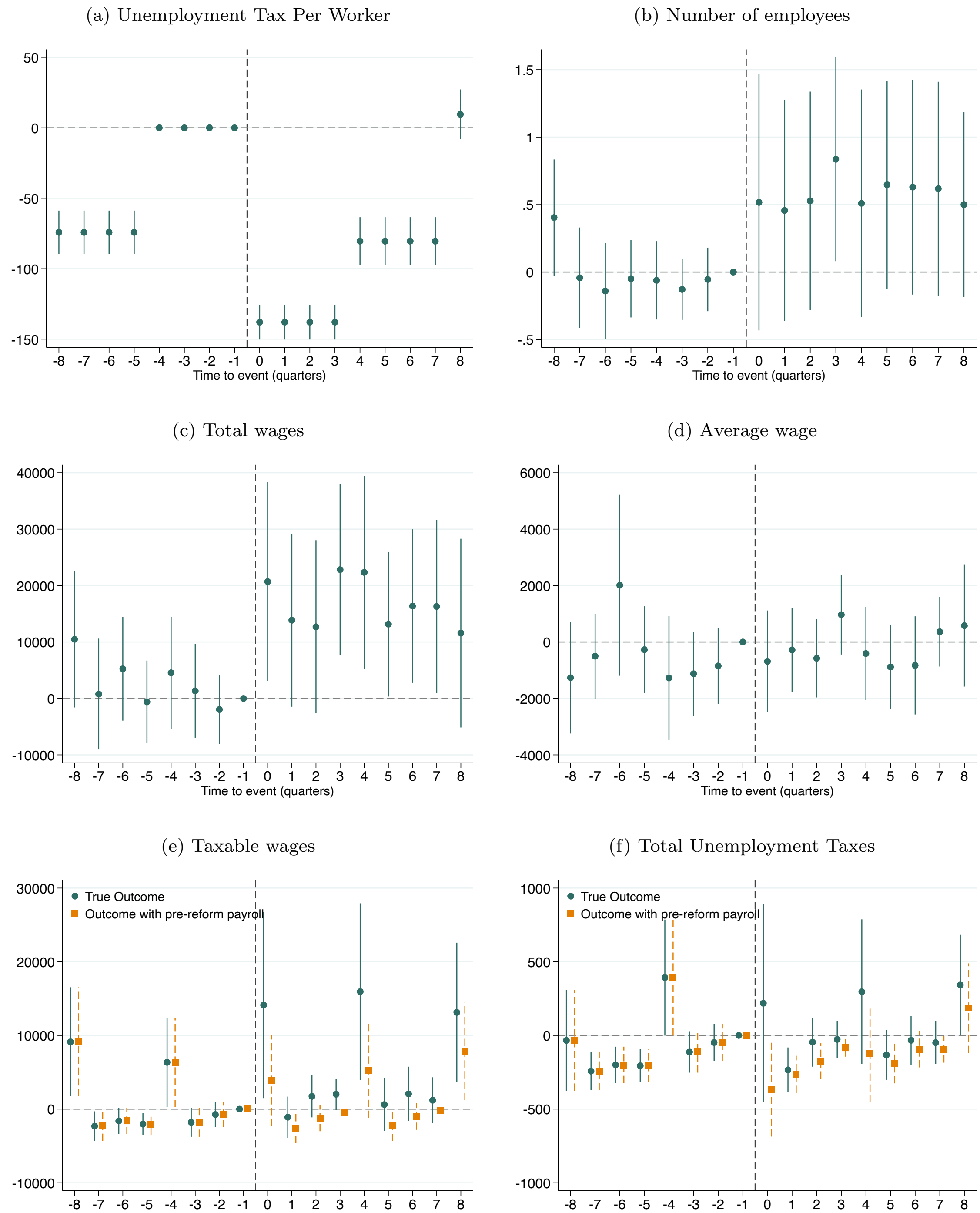

*Notes:* This figure illustrates the variation in the Unemployment Tax Per Worker associated to each level of Reserve Ratio between 2017 and 2018 (the true event year) and between 2015 and 2016 (the placebo event year).

Table A.3: Summary Statistics and Balance Tests for Colorado Treated and Control Cohorts in Pre-Period

| | *Control Cohort* | | | *Treated Cohort* | | | | |
|---|---|---|---|---|---|---|---|---|
| | N | Mean | Std. Dev. | N | Mean | Std. dev | Diff C-T | P-value |
| *Panel A: Main outcomes* | | | | | | | | |
| Tax per worker | 2435 | 848.597 | 188.540 | 1786 | 880.324 | 186.541 | -31.727*** | 0.000 |
| Employees | 2435 | 11.970 | 53.162 | 1786 | 13.486 | 51.014 | -1.517 | 0.352 |
| Total wages | 2435 | 196571.647 | 797855.771 | 1786 | 276538.280 | 1307746.230 | -79966.633** | 0.014 |
| Average wage | 2382 | 17943.359 | 19458.237 | 1742 | 20435.673 | 28746.423 | -2492.314*** | 0.001 |
| Taxable wages | 2435 | 17087.057 | 105156.599 | 1786 | 23457.222 | 127418.331 | -6370.166* | 0.076 |
| Total taxes | 2435 | 1133.960 | 8014.412 | 1786 | 1492.809 | 7632.521 | -358.849 | 0.143 |
| *Panel B: Other employer characteristics* | | | | | | | | |
| Year of establishment | 2435 | 2002.430 | 9.860 | 1786 | 2003.057 | 9.785 | -0.627** | 0.041 |
| Primary | 2435 | 0.025 | 0.155 | 1786 | 0.061 | 0.239 | -0.036*** | 0.000 |
| Construction | 2435 | 0.064 | 0.245 | 1786 | 0.066 | 0.247 | -0.001 | 0.851 |
| Manufacturing | 2435 | 0.054 | 0.226 | 1786 | 0.054 | 0.226 | 0.000 | 0.948 |
| Trade | 2435 | 0.204 | 0.403 | 1786 | 0.204 | 0.403 | -0.001 | 0.957 |
| Transport | 2435 | 0.099 | 0.299 | 1786 | 0.087 | 0.282 | 0.013 | 0.166 |
| Services | 2435 | 0.100 | 0.300 | 1786 | 0.073 | 0.260 | 0.027*** | 0.002 |
| Reserve Ratio | 2435 | 0.121 | 0.176 | 1786 | 0.114 | 0.174 | 0.007 | 0.175 |

*Notes:* This table shows summary statistics and tests for baseline differences between the treatment and control cohorts of Colorado employers in the quarter before the time of event. Time of event is set as 2018Q1 for the treated cohort, and 2016Q1 for the control cohort. Thus, these statistics refer to 2017Q4 for the treated cohort and 2015Q4 for the control cohort.

Figure A.6: Reduced Form Effects of the Elimination of the Surcharge on Firm Outcomes



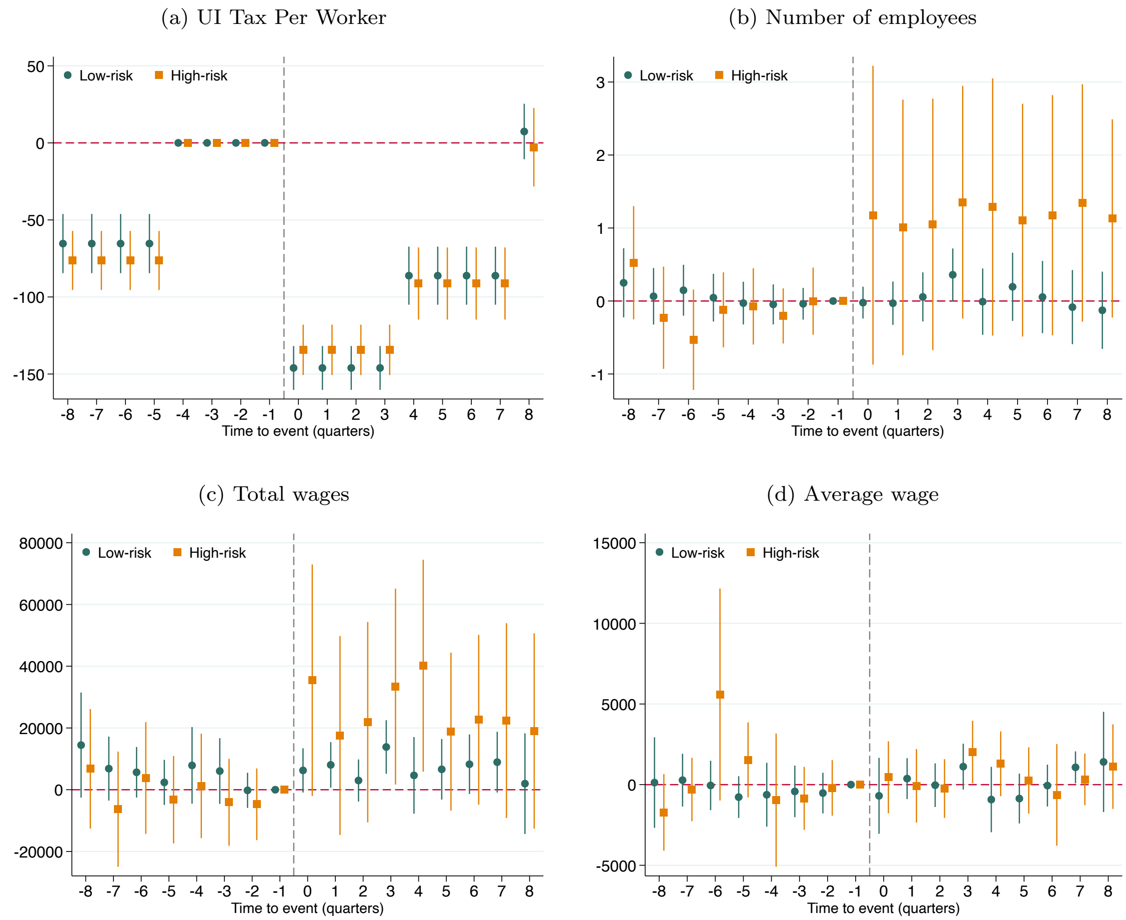

This figure illustrates the estimates of the $\beta_y$ coefficients from Equation 19 for the sample of Colorado employers with positive Reserve Ratio. The treatment group includes employers with Positive Reserve Ratio in 2017. The control group includes employers with Positive Reserve Ratio in 2015. The outcomes are the unemployment tax per worker in panel (a) the quarterly average number of employees in panel (b), total wages in panel (c), the average wage in panel (d), the quarterly taxble wages in panel (e), and total unemployment taxes in panel (f). Non-behavioral unemployment taxes are equal to true unemployment taxes until time $t-1$. From $t=0$ on, they are the obtained by multiplying the tax rate by the taxable wages of that quarter in $t-1$, rescaled by the pecent increase in the Taxable Wage Base in that year relative to the pre-reform one ($10,000). 95% robust confidence intervals are reported.

Table A.4: Reduced Form Effects of the Elimination of the Surcharge on Firm Outcomes

| Outcome: | (1)<br>Tax per worker | (2)<br>Employees | (3)<br>Total wages | (4)<br>Avg wage | (5)<br>Tax wages | (6)<br>tTax wages (payroll -1) | (7)<br>Tot taxes | (8)<br>Tot taxes (payroll -1) |
|---|---|---|---|---|---|---|---|---|
| Treated × Time Event -7 | -74.170*** | -0.042 | 780.880 | -502.067 | -2,309.157** | -2,309.157** | -242.643*** | -242.643*** |
| | (5.553) | (0.190) | (5,010.572) | (765.625) | (1,020.746) | (1,020.746) | (65.945) | (65.945) |
| Treated × Time Event -6 | -74.170*** | -0.141 | 5,256.345 | 2,011.565 | -1,601.360* | -1,601.360* | -199.575*** | -199.575*** |
| | (5.553) | (0.181) | (4,681.723) | (1,635.617) | (907.916) | (907.916) | (62.822) | (62.822) |
| Treated × Time Event -5 | -74.170*** | -0.049 | -605.613 | -271.399 | -2,031.131*** | -2,031.131*** | -205.710*** | -205.710*** |
| | (5.553) | (0.147) | (3,730.643) | (783.724) | (743.803) | (743.803) | (56.746) | (56.746) |
| Treated × Time Event -4 | -0.000 | -0.061 | 4,551.471 | -1,272.757 | 6,348.528** | 6,348.528** | 392.535* | 392.535* |
| | (0.000) | (0.148) | (5,047.063) | (1,118.952) | (3,096.095) | (3,096.095) | (200.674) | (200.674) |
| Treated × Time Event -3 | -0.000 | -0.129 | 1,343.140 | -1,125.463 | -1,795.814* | -1,795.814* | -112.226 | -112.226 |
| | (0.000) | (0.115) | (4,229.319) | (759.795) | (999.585) | (999.585) | (71.532) | (71.532) |
| Treated × Time Event -2 | -0.000 | -0.055 | -1,959.303 | -846.689 | -736.837 | -736.837 | -48.226 | -48.226 |
| | (0.000) | (0.120) | (3,103.647) | (684.844) | (880.431) | (880.431) | (64.038) | (64.038) |
| Treated × Time Event | -137.931*** | 0.517 | 20,699.545** | -687.090 | 14,117.023** | 3,894.169 | 218.213 | -366.714** |
| | (4.441) | (0.484) | (8,979.766) | (919.934) | (6,444.497) | (3,165.377) | (342.139) | (163.002) |
| Treated × Time Event +1 | -137.931*** | 0.457 | 13,859.271* | -281.527 | -1,098.065 | -2,601.310** | -233.989*** | -263.689*** |
| | (4.441) | (0.417) | (7,816.478) | (761.756) | (1,423.879) | (1,021.194) | (77.560) | (64.245) |
| Treated × Time Event +2 | -137.931*** | 0.528 | 12,701.203 | -577.271 | 1,723.298 | -1,251.636 | -46.166 | -172.964*** |
| | (4.441) | (0.413) | (7,817.753) | (708.032) | (1,451.139) | (895.102) | (84.621) | (61.026) |
| Treated × Time Event +3 | -137.931*** | 0.836** | 22,832.893*** | 967.837 | 2,007.980* | -390.274*** | -27.148 | -84.090*** |
| | (4.441) | (0.385) | (7,755.592) | (719.854) | (1,081.326) | (20.555) | (64.344) | (30.650) |
| Treated × Time Event +4 | -80.467*** | 0.510 | 22,337.083** | -408.008 | 15,948.231*** | 5,251.370 | 296.574 | -124.635 |
| | (6.121) | (0.430) | (8,694.516) | (840.957) | (6,109.702) | (3,281.596) | (250.378) | (168.442) |
| Treated × Time Event +5 | -80.467*** | 0.647* | 13,157.465** | -884.307 | 615.319 | -2,278.433** | -132.583 | -188.393*** |
| | (6.121) | (0.393) | (6,535.986) | (764.184) | (1,837.183) | (1,052.966) | (85.930) | (69.828) |
| Treated × Time Event +6 | -80.467*** | 0.629 | 16,369.790** | -829.554 | 2,063.071 | -1,003.068 | -33.455 | -93.971 |
| | (6.121) | (0.406) | (6,937.115) | (886.859) | (1,884.058) | (920.311) | (84.275) | (62.928) |
| Treated × Time Event +7 | -80.467*** | 0.618 | 16,298.354** | 363.051 | 1,207.561 | -161.273*** | -48.963 | -95.384** |
| | (6.121) | (0.404) | (7,831.682) | (628.578) | (1,583.987) | (48.856) | (74.079) | (45.565) |
| Treated × Time Event +8 | 9.544 | 0.500 | 11,583.325 | 578.978 | 13,124.311*** | 7,847.570** | 342.508** | 185.021 |
| | (6.365) | (0.349) | (8,529.672) | (1,100.913) | (4,826.137) | (3,377.565) | (173.614) | (154.974) |
| Observations | 70,312 | 70,312 | 70,312 | 68,098 | 70,312 | 70,312 | 70,312 | 70,312 |
| R-squared | 0.605 | 0.748 | 0.757 | 0.456 | 0.466 | 0.567 | 0.441 | 0.513 |
| Mean Outcome | 862 | 12.45 | 216724 | 17544 | 49284 | 49284 | 3206 | 3206 |

This table reports the estimates of the $\beta_y$ coefficients from Equation 19 for the sample of Colorado employers. The treatment group includes employers with Positive Reserve Ratio in 2017. The control group includes employers with Positive Reserve Ratio in 2015. The outcomes are the unemployment tax per worker in column (1) the quarterly average number of employees in column (2), quarterly total wages in column (3), the average wage in column (4), the quarterly taxable wages in column (5), quarterly total unemployment taxes in column (6), and quarterly non-behavioral total unemployment taxes in column (7). Non-behavioral unemployment taxes are equal to true unemployment taxes until time $t-1$. From $t=0$ on, they are the obtained by multiplying the tax rate by the taxable wages of that quarter in $t-1$, rescaled by the pecent increase in the Taxable Wage Base in that year relative to the pre-reform one ($10,000). Standard errors are robust to heteroskedasticity and clustered at the employer level. *** p<0.01, ** p<0.05, * p<0.1

Figure A.7: Differential Reduced Form Effects in High- and Low-Unemployment Risk Industries




This figure illustrates the estimates of the $\beta_y$ coefficients from Equation 19 estimated separately for the subsample of Colorado employers in low- and high-unemployment risk industries. High-unemployment risk industries have median within-year standard deviation in employment above 250 between 1998 and 2006 according to the Quarterly Census of Employment and Wages data for Colorado. Industries are defined using the NAICS-6 digits code. The treatment group includes employers with Positive Reserve Ratio in 2017. The control group includes employers with Positive Reserve Ratio in 2015. The outcomes are the unemployment tax per worker in panel (a) the quarterly average number of employees in panel (b), total wages in panel (c), and the average wage in panel (d). 95% robust confidence intervals are reported.

Table A.5: Differential Reduced Form Effects in High- and Low-Unemployment Risk Industries

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outcome: | Tax per worker | | Employees | | Tot wages | | Avg wage | | Tax wages | | Tot taxes | |
| Industry unempl. risk: | *Low* | *High* | *Low* | *High* | *Low* | *High* | *Low* | *High* | *Low* | *High* | *Low* | *High* |
| Treated × Time Event -7 | -65.351*** | -76.328*** | 0.064 | -0.229 | 6,839.637 | -6,309.452 | 277.745 | -299.623 | -245.691 | -4,638.028*** | -106.381 | -396.429*** |
| | (8.120) | (8.106) | (0.197) | (0.357) | (5,281.841) | (9,508.846) | (834.497) | (1,001.305) | (1,322.057) | (1,736.712) | (69.411) | (124.235) |
| Treated × Time Event -6 | -65.351*** | -76.328*** | 0.148 | -0.530 | 5,650.153 | 3,796.609 | -50.489 | 5,587.315* | -439.684 | -3,161.027* | -85.657 | -341.465*** |
| | (8.120) | (8.106) | (0.178) | (0.350) | (4,174.775) | (9,221.120) | (780.031) | (3,350.178) | (855.470) | (1,787.852) | (53.734) | (126.010) |
| Treated × Time Event -5 | -65.351*** | -76.328*** | 0.046 | -0.121 | 2,371.989 | -3,215.094 | -772.553 | 1,535.215 | -1,777.459** | -2,177.790 | -136.811*** | -276.331** |
| | (8.120) | (8.106) | (0.167) | (0.262) | (3,719.523) | (7,218.785) | (659.674) | (1,184.376) | (748.920) | (1,412.965) | (49.934) | (111.732) |
| Treated × Time Event -4 | -0.000 | -0.000 | -0.029 | -0.074 | 7,876.477 | 1,228.969 | -625.313 | -961.419 | 5,080.812 | 6,429.211 | 338.898 | 365.657 |
| | (0.000) | (0.000) | (0.149) | (0.267) | (6,327.823) | (8,627.616) | (1,009.621) | (2,106.249) | (3,955.861) | (5,060.343) | (258.932) | (327.328) |
| Treated × Time Event -3 | -0.000 | -0.000 | -0.046 | -0.204 | 6,039.772 | -4,071.251 | -421.445 | -848.960 | -1,677.381 | -1,798.237 | -108.399 | -108.321 |
| | (0.000) | (0.000) | (0.140) | (0.193) | (5,425.555) | (7,174.513) | (814.592) | (995.341) | (1,185.386) | (1,791.744) | (75.658) | (134.448) |
| Treated × Time Event -2 | 0.000 | -0.000 | -0.038 | -0.003 | -203.191 | -4,713.430 | -522.524 | -202.222 | -878.889 | -454.638 | -53.888 | -38.159 |
| | (0.000) | (0.000) | (0.111) | (0.235) | (2,902.398) | (5,913.403) | (642.738) | (877.602) | (770.290) | (1,744.671) | (47.755) | (130.462) |
| Treated × Time Event | -146.066*** | -134.328*** | -0.023 | 1.175 | 6,259.152* | 35,474.547* | -692.933 | 457.463 | 6,165.334 | 21,173.022 | -193.586 | 548.575 |
| | (6.017) | (6.916) | (0.111) | (1.044) | (3,655.511) | (19,115.533) | (1,200.526) | (1,137.710) | (4,140.543) | (13,267.460) | (226.168) | (703.023) |
| Treated × Time Event +1 | -146.066*** | -134.328*** | -0.030 | 1.008 | 8,044.522** | 17,546.204 | 375.049 | -73.570 | -1,734.353 | -336.872 | -219.997*** | -268.316* |
| | (6.017) | (6.916) | (0.151) | (0.893) | (3,758.433) | (16,430.347) | (646.810) | (1,162.467) | (1,324.129) | (2,762.643) | (67.454) | (153.982) |
| Treated × Time Event +2 | -146.066*** | -134.328*** | 0.056 | 1.050 | 2,992.886 | 21,861.815 | -33.220 | -240.915 | -445.600 | 4,063.815 | -102.312* | -9.992 |
| | (6.017) | (6.916) | (0.171) | (0.879) | (3,474.201) | (16,546.956) | (689.497) | (928.407) | (970.763) | (2,992.200) | (58.134) | (174.746) |
| Treated × Time Event +3 | -146.066*** | -134.328*** | 0.359* | 1.353* | 13,839.625*** | 33,394.526** | 1,118.710 | 2,023.775** | 800.737 | 3,227.674 | -39.142 | -30.356 |
| | (6.017) | (6.916) | (0.184) | (0.813) | (4,429.307) | (16,172.578) | (725.299) | (987.723) | (823.309) | (2,195.780) | (50.150) | (130.474) |
| Treated × Time Event +4 | -86.171*** | -91.274*** | -0.009 | 1.288 | 4,645.345 | 40,167.666** | -923.358 | 1,290.937 | 7,783.993 | 22,935.838* | 143.888 | 306.037 |
| | (7.969) | (9.899) | (0.232) | (0.899) | (6,329.222) | (17,497.892) | (1,033.636) | (1,023.353) | (4,848.091) | (12,163.159) | (241.358) | (479.432) |
| Treated × Time Event +5 | -86.171*** | -91.274*** | 0.195 | 1.108 | 6,607.720 | 18,819.582 | -862.684 | 257.495 | -205.197 | 1,721.020 | -104.119 | -195.801 |
| | (7.969) | (9.899) | (0.238) | (0.813) | (5,001.746) | (13,037.911) | (787.237) | (1,046.343) | (1,482.703) | (3,685.394) | (79.804) | (166.896) |
| Treated × Time Event +6 | -86.171*** | -91.274*** | 0.054 | 1.176 | 8,251.472* | 22,666.295 | -57.967 | -633.079 | -847.528 | 5,172.709 | -46.149 | -39.000 |
| | (7.969) | (9.899) | (0.252) | (0.839) | (4,918.912) | (14,011.561) | (661.780) | (1,606.147) | (1,001.170) | (3,976.950) | (56.577) | (174.698) |
| Treated × Time Event +7 | -86.171*** | -91.274*** | -0.084 | 1.343 | 8,929.959* | 22,364.019 | 1,073.705** | 326.749 | -757.729 | 3,435.659 | -50.271 | -57.075 |
| | (7.969) | (9.899) | (0.259) | (0.829) | (5,019.833) | (16,093.049) | (504.477) | (816.461) | (771.339) | (3,361.001) | (45.573) | (154.457) |
| Treated × Time Event +8 | 7.377 | -2.808 | -0.127 | 1.131 | 1,969.492 | 19,027.445 | 1,408.415 | 1,115.727 | 7,531.834 | 16,718.145* | 373.635* | 186.107 |
| | (7.618) | (10.778) | (0.270) | (0.692) | (8,312.643) | (16,128.452) | (1,584.706) | (1,336.287) | (5,411.154) | (8,565.987) | (207.084) | (301.509) |
| Observations | 36,074 | 30,311 | 36,074 | 30,311 | 36,074 | 30,311 | 35,260 | 29,048 | 36,074 | 30,311 | 36,074 | 30,311 |
| R-squared | 0.615 | 0.597 | 0.877 | 0.685 | 0.805 | 0.733 | 0.590 | 0.344 | 0.544 | 0.433 | 0.514 | 0.407 |
| Mean Outcome | 863.4 | 870.6 | 7.815 | 8.585 | 124741 | 155857 | 16905 | 18842 | 28648 | 35323 | 1874 | 2318 |

This table reports the estimates of the $\gamma_y$ coefficients from Equation 20 estimated for the sample of Colorado employers. High-unemployment risk industries have median within-year standard deviation in employment above 250 between 1998 and 2006 according to the Quarterly Census of Employment and Wages data for Colorado. Industries are defined using the NAICS-6 digits code. The treatment group includes employers with Positive Reserve Ratio in 2017. The control group includes employers with Positive Reserve Ratio in 2015. The outcomes are the unemployment tax per worker in column (1) the quarterly average number of employees in column (2), quarterly total wages in column (3), and the average wage in column (4). Standard errors are robust to heteroskedasticity and clustered at the employer level. *** p<0.01, ** p<0.05, * p<0.1

Table A.6: Elasticities of Employment and Wages with respect to the Unemployment Tax Per Worker

| | **Full Sample** | **Low Risk** | **High Risk** |
|---|---|---|---|
| *Panel A: Employees* | | | |
| Treated × Time Event +3: $\beta$ | 0.836*** | 0.359 | 1.353** |
| Treated × Time Event +3: *se* | (0.316) | (0.238) | (0.661) |
| Mean 2010 Treated | 8.091 | 7.710 | 8.451 |
| *Panel B: Average Wage* | | | |
| Treated × Time Event +3: $\beta$ | 967.837 | 1118.710 | 2023.775 |
| Treated × Time Event +3: *se* | (901.992) | (1017.453) | (1672.155) |
| Mean 2010 Treated | 18472.681 | 17824.092 | 19613.702 |
| *Panel C: Tax Per Worker* | | | |
| Treated × Time Event +3: $\beta$ | -137.931*** | -146.066*** | -134.328*** |
| Treated × Time Event +3: *se* | (4.291) | (5.813) | (6.682) |
| Mean 2010 Treated | 882.939 | 882.152 | 888.466 |
| *Panel D: Elasticities* | | | |
| Employment Elasticity wrt Tax Per Worker | -0.661 | -0.281 | -1.059 |
| Wage Elasticity wrt Tax Per Worker | -0.335 | -0.379 | -0.682 |

*Notes:* This table illustrates the components that contribute to the calculation of the elasticity of employment with respect to the unemployment tax per worker and the corresponding estimated elasticitiy. I calculate this elasticity in the full sample of Colorado employers and in the subsamples of employers in low- and high-unemployment risk industries. High-unemployment risk industries have median within-year standard deviation in employment above 250 between 1998 and 2006 according to the Quarterly Census of Employment and Wages data for Colorado. Industries are defined using the NAICS-6 digits code. The elasticity is calculated using the formula in Equation 21. The Treated×Post coefficients are the estimated coefficients from Equation 22. The treatment group includes employers with Positive Reserve Ratio in 2017. The control group includes employers with Positive Reserve Ratio in 2015.

# B Model Derivation and Extension

In this section, I derive explicitly the results presented in Section 2.

## B.1 Experience Rating and Interindustry Cross-Subsidization

In this section, I show that coinsurance consistently places a financial burden on the low-risk employer to subsidize the high-risk employer. I calculate the subsidy received by each employer as the difference between the unemployment benefit spending that they generated with layoffs and the unemployment taxes they paid. The unemployment taxes are determined in Equations 5 and 6.

Under complete experience rating, subsidies amount to zero because the high-risk employer covers fully its positive benefit spending through taxes, while the low-risk employer, generating no benefit spending, remains exempt from paying taxes.

$$Subsidy_H^{Exp.Rating} = \underbrace{bp_H l_H}_{\text{Benefit Spending}} - \underbrace{bp_H l_H}_{\text{Tax Payment}} = 0 \tag{23}$$

$$Subsidy_L^{Exp.Rating} = \underbrace{0}_{\text{Benefit Spending}} - \underbrace{0}_{\text{Tax Payment}} = 0 \tag{24}$$

In a coinsurance system, a fraction $1 - e$ of benefit spending is transferred from the high-risk employer to the low-risk employer. The high-risk employer, producing more benefit spending than their tax contributions, receives a positive subsidy from the low-risk employer, that pays more taxes than the benefit spending they create. This imbalance, persisting from one period to the next, results in the continuous accumulation of subsidies for the high-risk employer. If the employers' unemployment risks were randomly drawn in each period and taxes were assigned in proportion of industry size, subsidies would balance out over time for each industry. Different unemployment risks across industries are, thus, key for the emergence of systematic patterns of interindustry cross-subsidization.

$$Subsidy_H^{Coinsurance} = \underbrace{bl_H\left(p_H + \frac{1}{m}\right)}_{\text{Benefit Spending}} - \underbrace{ebl_H\left(p_H + \frac{1}{m}\right)}_{\text{Tax Payment}} = (1-e)bl_H\left(p_H + \frac{1}{m}\right) > 0 \tag{25}$$

$$Subsidy_L^{Coinsurance} = \underbrace{0}_{\text{Benefit Spending}} - \underbrace{(1-e)bl_H\left(p_H + \frac{1}{m}\right)}_{\text{Tax Payment}} = -(1-e)bl_H\left(p_H + \frac{1}{m}\right) < 0 \tag{26}$$

## B.2 Labor Demand and Experience Rating

In this section, I derive the high-risk employer's privately optimal labor demand illustrated in Equation 7. The employer chooses the labor demand that maximizes its expected profit treating the degree of experience rating chosen by the government, $e$, as fixed. Substituting $\tau_H l_H$ from Equation 5 in Equation 1, I express the expected profit as a function of the degree of experience rating. I then take the derivative of the expected profit with respect to labor demand, $l_H$, set the derivative to zero, and rearrange terms to obtain Equation

7.

$$\Pi_H = \left(1 - p_H - \frac{1}{m}\right)\left[\int_0^{l_H} f(i,k)\,di - w_H l_H - ebl_H\left(p_H + \frac{1}{m}\right) - jk\right] + \left(p_H + \frac{1}{m}\right)\left[-ebl_H\left(p_H + \frac{1}{m}\right)(1+q) - (1 - 1_{e=1})\psi(m)\right] \tag{27}$$

$$\frac{\partial \Pi_H}{\partial l_H} = \left(1 - p_H - \frac{1}{m}\right)\left[f(l_H, k_H) - w_H - eb\left(p_H + \frac{1}{m}\right)\right] - \left(p_H + \frac{1}{m}\right)^2 eb = 0 \tag{28}$$

To evaluate how the optimal labor demand changes with the degree of experience rating, I leverage the fact that the first-order condition of this maximization problem is equal to zero at the optimum and use the Implicit Function Theorem to determine the derivative of labor demand with respect to experience rating, $\frac{\partial l_H}{\partial e}$. Since $f(i,k)$ is decreasing in $i$ by assumption, $f'(l_H, k_H) < 0$, and $\frac{\partial l_H}{\partial e} < 0$.

$$G(l_H, e) = \frac{\partial \Pi_H}{\partial l_H} = f_H(l_H, k) - \left[\frac{eb\left(p_H + \frac{1}{m}\right)}{\left(1 - p_H - \frac{1}{m}\right)} + w_H\right] = 0 \tag{29}$$

$$\frac{\partial l_H}{\partial e} = -\frac{\frac{\partial G(l_H,e)}{\partial e}}{\frac{\partial G(l_H,e)}{\partial l_H}} = -\frac{-\frac{b\left(p_H + \frac{1}{m}\right)}{\left(1 - p_H - \frac{1}{m}\right)}}{f'_H(l_H, k_H)} < 0 \tag{30}$$

## B.3 Effort to Prevent Shocks and Experience Rating

In this section, I derive the high-risk employer's optimal level of effort to avoid shocks illustrated in Equation 8. The employer chooses the level of effort that maximizes its expected profit treating the degree of experience rating chosen by the government, $e$, as fixed. I take the derivative of the expected profit with respect to the level of effort, $m$, set the derivative to zero, and rearrange terms to obtain Equation 8.

$$\frac{\partial \Pi_H}{\partial m} = \frac{1}{m^2}\left[\underbrace{\int_0^{l_H} f(i,k)\,di - w_H l_H + ebl_H\left(p_H + \frac{1}{m}\right)q - kj + (1 - 1_{e=1})\psi(m)}_{\Pi_H^{good} - \Pi_H^{bad}}\right] + \frac{1}{m^2}ebl_H - \left(p_H + \frac{1}{m}\right)\psi'(m)(1 - 1_{e=1}) \tag{31}$$

To assess how the optimal level of effort changes with the degree of experience rating, it is useful to distinguish two cases. When experience rating is complete and $e = 1$, the marginal cost of effort, $(1 - 1_{e=1})\psi(m)$, is nullified, and the derivative of the expected profit with respect to effort is positive. Consequently, it is optimal for the high-risk employer to exert infinite effort to avoid negative shocks, $m^{*,ER} \to \infty$. In turn, the unemployment risk in the economy is minimized, $\lim_{m\to\infty} r_H = \lim_{m\to\infty} p_H + \frac{1}{m} = p_H$.

$$\frac{\partial \Pi_H}{\partial m}|_{e=1} = \frac{1}{m^2}\left[\int_0^{l_H} f_H(i,k)\,di - w_H l_H + bl_H\left(p_H + \frac{1}{m}\right)q - kj\right] + \frac{1}{m^2}bl_H > 0 \tag{32}$$

Conversely, in the case of coinsurance and $e < 1$, the marginal cost of effort becomes non-zero. Consequently, the high-risk employer exerts a finite level of effort, leading to above-minimum unemployment risk. To evaluate how the optimal level of effort changes with the degree of experience rating in this scenario, I leverage the fact that the first-order condition of the maximization problem is equal to zero at the optimum, and use the Implicit Function Theorem to determine the derivative of effort with respect to the degree of experience rating, $\frac{\partial m}{\partial e}$. Since $\frac{\partial [G(m,e)m^2]}{\partial m} = \frac{\partial G(m,e)}{\partial m}m^2 + 2mG(m,e)$ and $G(m,e) = 0$ at the optimum, the sign of $\frac{\partial G(m,e)}{\partial m}$ and $\frac{\partial [G(m,e)m^2]}{\partial m}$ must coincide. Since $\psi$ is convex, it follows that $\psi'(m) > 0$ and $\psi''(m) > 0$ and that $\frac{\partial [G(m,e)m^2]}{\partial m} < 0$. Consequently, $\frac{\partial G(m,e)}{\partial m} < 0$ and $\frac{\partial m}{\partial e} > 0$, which implies that the optimal level of effort increases in the degree of experience rating.

$$G(m,e) = \frac{\partial \Pi_H}{\partial m}|_{e<1} = \frac{1}{m^2}\left[\int_0^{l_H} f_H(i,k)\,di - w_H l_H + ebl_H\left(p_H + \frac{1}{m}\right)q - kj + \psi(m)\right] + \frac{1}{m^2}ebl_H - \left(p_H + \frac{1}{m}\right)\psi'(m) = 0 \tag{33}$$

$$\frac{\partial m}{\partial e} = -\frac{\partial G(m,e)\partial e}{\frac{\partial G(m,e)}{\partial m}} = -\frac{bl_H\left(p_H + \frac{1}{m}\right)q}{-\frac{2}{m^3}[\int_0^{l_H} f_H(i,k)\,di - w_H l_H + ebl_H\left(p_H + \frac{1}{m}\right)q - kj + \psi(m)] - \frac{1}{m^4}ebl_H q - \frac{2}{m^3}ebl_H + \frac{2\psi'(m)}{m} - \left(p_H + \frac{1}{m}\right)\psi''(m)} \tag{34}$$

$$\frac{\partial G(m,e)m^2}{\partial m} = -\frac{1}{m}ebl_H q - p_H\psi''(m)m^2 - p_H 2m\psi'(m) - \psi''(m)m < 0 \tag{35}$$

## B.4 Optimal Degree of Experience Rating

In this section, I derive the formula for the optimal degree of experience rating illustrated in Equation 10. The government selects the degree of experience rating, $e$, that maximize the social welfare function, which is illustrated in in Equation 9 and obtained as the sum of workers' and capitalists' utilities, subject to the rules for allocating the tax burden between the employers in Equations 5 and 6, the high-risk employer's optimal labor demand and effort in Equations 7 and 8, labor market clearing, and workers' indifference conditions.

$$\max_e \quad SWF$$

$$\begin{aligned}
\text{s.t.} \quad & \tau_L l_L = (1-e)bl_H\left(p_H + \frac{1}{m}\right) && \text{[Tax Low-Risk Employer]},\\
& \tau_H l_H = ebl_H\left(p_H + \frac{1}{m}\right) && \text{[Tax High-Risk Employer]},\\
& f_H(l_H,k) = \frac{eb\left(p_H + \frac{1}{m}\right)}{1 - p_H - \frac{1}{m}} + w_H && \text{[Optimal Labor Demand]},\\
& \left(p_H + \frac{1}{m}\right)\psi'(m)(1 - 1_{e=1}) = \frac{1}{m^2}(\Pi_H^{good} - \Pi_H^{bad}) + \frac{1}{m^2}ebl_H && \text{[Optimal Effort]},\\
& l_L = 1 - l_H && \text{[Labor Market Clearing]},\\
& u(w_H)(1-r_H) + [u(b) + L]r_H = u(w_L) && \text{[Indifference between Sectors]},\\
& u(w_H) = u(b) + L && \text{[Indifference between Employment and Unemployment]}
\end{aligned}$$

To determine the optimal degree of experience rating, $e^*$, I take the derivative of the Lagrangean associated with this maximization problem with respect to the degree of experience rating, $e$, and set this derivative equal to zero. By the Envelope Theorem, the derivatives of the high-risk employer's labor demand and effort with respect to the degree of experience rating are equal to zero within the employer's expected profit because labor demand and effort are optimal responses to the selected degree of experience rating, $\frac{\partial l_H*}{\partial e} = \frac{\partial m*}{\partial e} = 0$. Consequently, when taking the derivative of the high-risk employer's expected profit with respect to $e$, I can disregard that $m$ and $l_H$ are functions of $e$. Next, I notice that $r_H bl_H q = \Pi_H^{'good} - \Pi_H^{'bad}$ and that

$\Pi_H^{'good} = bl_H r_H$, where $\Pi_H^{'good}$ and $\Pi_H^{'bad}$ are respectively the partial derivatives of the good- and the bad-states profits with respect to the degree of experience rating, $\Pi_H^{'good} = \frac{\partial \Pi_H^{good}}{\partial e}$ and $\Pi_H^{'bad} = \frac{\partial \Pi_H^{bad}}{\partial e}$. I divide the derivative of the Lagrangean by $\Pi_H^{'good}$ and use the definitions for $\lambda$ and $\mu$ in Equations 11 and 12 to obtain Equation 10.

$$\begin{aligned}\mathcal{L} =&(1-l_H)u(w_L) + l_H\left[\left(1-p_H-\frac{1}{m}\right)u(w_H) + \left(p_H+\frac{1}{m}\right)[u(b)+L]\right] + k[\gamma(\Pi_L+\Pi_H)-1]\\ =&(1-l_H)u(w_L) + l_H\left[\left(1-p_H-\frac{1}{m}\right)u(w_H) + \left(p_H+\frac{1}{m}\right)[u(b)+L]\right] + \gamma\left[\int_{l_H}^1 f_L(i,k)\,di - w_L(1-l_H) - (1-e)bl_H\left(p_H+\frac{1}{m}\right) - jk\right]\\ &+ k\gamma\left(1-p_H-\frac{1}{m}\right)\left[\int_0^{l_H} f(i,k)\,di - w_H l_H - ebl_H\left(p_H+\frac{1}{m}\right) - jk\right] + k\gamma\left(p_H+\frac{1}{m}\right)\left[-ebl_H\left(p_H+\frac{1}{m}\right)(1+q) - (1-1_{e=1})\psi(m)\right] - k\end{aligned} \tag{36}$$

$$\begin{aligned}\frac{\partial\mathcal{L}}{\partial e} =&\overbrace{\left[-u(w_L) + \left(1-p_H-\frac{1}{m}\right)u(w_H) + \left(p_H+\frac{1}{m}\right)[u(b)+L]\right]}^{=0\text{ by Indifference between Industries}}\frac{\partial l_H}{\partial e} + \frac{l_H}{m^2}\frac{\partial m}{\partial e}\overbrace{[u(w_H)-u(b)-L]}^{=0\text{ by Indifference between Empl. And Unempl.}}\\ &+ k\gamma\left[-f_L(l_H,k) + w_L - (1-e)b\left(p_H+\frac{1}{m}\right)\right]\frac{\partial l_H}{\partial e} + k\gamma bl_H\left(p_H+\frac{1}{m}\right) + k\gamma\frac{(1-e)bl_H}{m^2}\frac{\partial m}{\partial e}\\ &+ k\gamma\left(1-p_H-\frac{1}{m}\right)\left[-bl_H\left(p_H+\frac{1}{m}\right)\right] + k\gamma\left(p_H+\frac{1}{m}\right)\left(-bl_H\left(p_H+\frac{1}{m}\right)(1+q)\right)\\ =&-\epsilon_{l_H,e}\frac{l_H}{er_H}\left[f_L(l_H) - w_L + (1-e)br_H\right] + \epsilon_{m,e}\frac{(1-e)bl_H}{emr_H} - r_H bl_H q = 0\end{aligned} \tag{37}$$

## B.5 Extension: Flexible Wages

Coming soon.

## B.6 Extension: Workers' Preferences

In this section, I relax the assumptions of workers indifference between industries and, within the high-risk industry, between employment and unemployment. As illustrated in Equation 37, which shows the derivative of the Lagrangean associated with the government's maximization problem with respect to the degree of experience rating, accounting for workers' preferences introduces two additional terms in the formula for the optimal degree of experience rating through the scaling factors $\lambda$ and $\mu$. The first term is the gap in workers' utilities between the two industries. This term emerges because transferring the marginal worker from the low-risk to the high-risk industry impacts the utility that they derive. Depending on whether the utility is higher in the low-risk or high-risk industry, this reallocation could either benefit or harm the marginal workers. This welfare effect enters the formula for the optimal degree of experience rating through the scaling factor $\lambda^{Pref}$.

$$\lambda^{pref} = \frac{l_H}{er_H}\left[\underbrace{u(w_L) - \left(1-p_H-\frac{1}{m}\right)u(w_H) - \left(p_H+\frac{1}{m}\right)u(b)}_{\Delta\text{ Utility between Industries}} + \underbrace{\gamma[f_L(l_H,k)-w_L]}_{\text{Skill misallocation}} + \underbrace{\gamma\left((1-e)b\left(p_H+\frac{1}{m}\right)\right)}_{\text{Fiscal externality}}\right] \tag{38}$$

The second term is the gap in workers' utilities between being employed in the high-risk industry and being unemployed. This term emerges because, when the high-risk employer reduces the level of effort exerted to avoid negative shocks, the probability of workers experiencing unemployment increases, resulting in a utility loss. This welfare effect enters the formula for the optimal degree of experience rating through the scaling factor $\mu^{Pref}$.

$$\mu = \frac{l_H}{emr_H}[\underbrace{u(w_H) - u(b) - L}_{\Delta \text{ utility between Empl and Unempl.}} + \underbrace{\gamma(1-e)b}_{\text{Fiscal externality}}] \tag{39}$$

The implications of using these extended scaling factors on the optimal degree of experience rating depend on the values of the new parameters in the formula. I argue that $\lambda^{Pref} > \lambda$, which implies that the marginal cost of labor reallocation increases, and that $\mu^{Pref} > \mu$, which implies that the marginal cost of moral hazard increases, compared with the basic model. [...]

## B.7 Optimal degree of experience rating with non-zero risk

Coming soon.

## B.8 Effort elasticity and layoff elasticity

To calibrate the elasticity of effort with respect to the degree of experience rating, $\epsilon_{m,e}$ elasticity, I leverage the relationship between effort $m$ and the unemployment risk $r_H$ in the model. Since $r_H = p_H + \frac{1}{m}$, it is possible to express the elasticity of effort as a function of the elasticity of the unemployment risk, as shown in Equation 40:

$$\epsilon_{r_H,e} = \frac{\partial r_H}{\partial e}\frac{e}{r_H} = \frac{\partial p_H}{\partial e} + \frac{d\frac{1}{m}}{\partial e} = -\frac{1}{m^2}\frac{\partial m}{\partial e}\frac{e}{r_H} = -\frac{\epsilon_{m,e}}{mr_H} \tag{40}$$

It follows that $\epsilon_{m,e} = -mr_H\epsilon_{r_H,e}$.