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

Sara Spaziani

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**Abstract**

Unemployment insurance provides crucial support for unemployed workers but comes with substantial costs. This paper studies the optimal approach to financing unemployment benefits, focusing on how to assign unemployment tax rates to employers. While in the United States employers are assigned individualized tax rates based on the unemployment benefit cost resulting from their layoffs (experience rating), all other countries assign a common tax rate to all employers irrespective of individual costs. This insures employers against steep tax increases following negative shocks (coinsurance). I derive a formula defining the optimal financing policy through a tradeoff between the marginal value of this coinsurance and two marginal costs. The first cost is a moral hazard from reducing the private cost of layoffs for employers, which imposes a fiscal externality on the government budget through more frequent layoffs and a higher benefit cost. The second cost comes from the subsidization of high-unemployment risk industries, which leads to the reallocation of labor towards those industries. This both results in the misallocation of productive skills and imposes a fiscal externality through a higher benefit cost, as more workers are subject to a high-unemployment risk. 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 is the primary cost of coinsurance, as it is at least as costly as employer moral hazard. Additionally, the combined cost of moral hazard and labor reallocation exceeds the value of insurance, suggesting 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, helping unemployed workers maintain their consumption levels following job losses. The provision of unemployment benefits, however, comes with a substantial cost, ranging between 0.12% and 2.8% of GDP in western economies and fluctuating over economic cycles (OECD 2023). For perspective, the United States spends approximately 35 billion dollars annually in unemployment benefits during regular years, representing 0.18% of the country's GDP and 0.6% of 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 governments' ability to secure resources and promptly allocate them to workers as needed, understanding how to best finance the program is of paramount importance.

This paper investigates theoretically and empirically the optimal approach to finance unemployment insurance. Typically, unemployment benefits are funded through payroll taxes levied on employers and employees.[1] My specific focus revolves around employer-specific unemployment tax rates and the two alternative methods for assigning these rates to employers. In the United States, employers are assigned personalized and dynamic tax rates, designed to reflect the costs of unemployment benefits resulting from their layoffs. This financing method, known as *"experience rating"*, holds employers responsible for their layoffs, and ensures that they repay the costs they generated. Conversely, in Europe and Canada employers are assigned a common unemployment tax rate regardless of their individual usage of the system. This system is known as *"coinsurance"* and limits employers' tax liabilities following negative shocks.

Which of these two approaches is preferable remains unclear. 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 internalized by employers, leading to more frequent layoffs.[2] This imposes a fiscal externality on the government budget through a higher benefit cost that must be funded with increased taxation (Fath et al. 2005). Second, coinsurance reduces the labor costs of high-unemployment risk industries by distributing their benefit costs across the broader community of employers, favoring their undue expansion. The reallocation of workers towards high-risk industries results in the misallocation of productive skills and imposes a fiscal externality through a higher benefit cost, as more workers are subject to a high-unemployment risk.[3] Thirdly, critics of experience rating argue that imposing higher unemployment tax rates on employers in economic distress may reduce their labor demand, potentially leading to increased unemployment in the long run. This concern becomes particularly pronounced during recessions, when layoffs are widespread and higher

[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] It has been shown that 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 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 (1993), and Leombruni et al. (2003) document that high-unemployment industries systematically receive many more dollars in unemployment benefits than they pay in unemployment taxes. This benefit cost is covered by low-unemployment risk industries, which lay off workers less frequently but are still required to pay unemployment taxes. Topel et al. (1980), Deere (1991), and Anderson et al. (1993a) further demonstrate that the subsidization of high-unemployment risk industries leads to the reallocation of labor towards those industries and discuss the welfare implications of this reallocation.

unemployment taxes may slow down economic recovery, accentuating the business cycle.[4] In contrast, uniform tax rates act as a safeguard for employers, insuring them against large tax increases and a further deterioration of their net worth following negative shocks.

Until now, these three factors have been studied separately, offering policymakers limited guidance when deciding between experience rating and coinsurance.[5] This paper brings them together within a unified theoretical framework which recognizes them as the central forces shaping the optimal design of unemployment insurance financing policies, and empirically investigates their relative importance to inform the policy debate.

My analysis develops in three parts. The first part of the paper derives 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, which occur with different probabilities across different industries. The government levies taxes on employers to fund unemployment benefits for 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 own benefit costs that employers repay in unemployment taxes, and indicates the extent to which the financing of the program departs from pure coinsurance (where all employers pay taxes equally) and from complete experience rating (where each employer repays their full benefit costs). Consequently, it does not affect total tax revenue but rather influences how the tax burden is distributed between employers laying off workers and the broader community of employers.

The formula for the optimal degree of experience rating encapsulates estimable sufficient statistics representing the three forces identified by the experience rating literature and highlights key tradeoffs between them. On the one hand, decreasing the degree of experience rating insures employers against significant increases in their tax liabilities and a further deterioration of their net worth following negative shocks. The sufficient statistic representing the marginal value of this insurance is the loss per dollar of tax increase, which includes factors such as elevated borrowing costs for employers facing economic hardship. Every dollar of insurance provided to employers through coinsurance reduces these losses and closes the marginal profit gap between the good and the bad state of the world. On the other hand, this insurance comes with two costs. First, by reducing the labor costs for high-unemployment risk industries, coinsurance favors their expansion. The reallocation of labor towards high-risk industries results in the misallocation of productive skills and imposes a fiscal externality on the government budget through a higher benefit shock. The sufficient statistic representing these inefficiencies is the labor demand elasticity with respect to the unemployment tax per worker in high-unemployment risk industries. Intuitively, the more elastic employers are in these industries, the more workers will move into or out of them as unemployment taxes change. Second, coinsurance reduces the tax cost of

[4] This theory, advanced by 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) commented 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 UI 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."*

layoffs, leading to more frequent layoffs and to a fiscal eternality through a higher benefit cost. The sufficient statistic representing employer moral hazard is the elasticity of layoffs with respect to the degree of experience rating. 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, defined by the tradeoff between the marginal benefit and cost of providing insurance to *workers* (Baily 1978). In this sense, 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 costs associated with labor reallocation and employer moral hazard. Since the cost of moral hazard has already been extensively studied, this paper concentrates on the relatively overlooked cost of labor reallocation.

To estimate the labor demand elasticity with respect to the unemployment tax per worker for employers in high-risk industries, I obtained access to restricted unemployment tax filing data covering the universe of employers in South Carolina and Colorado and leverage state-level reforms of experience rating policies as novel sources of quasi-experimental variation in the tax per worker. The paper primarily focuses on South Carolina and provides additional consistent evidence from Colorado. Like in the rest of the country, in South Carolina employers are "experience-rated:" their experience with unemployment is assessed each year, and higher tax rates are assigned to employers with higher experience. In 2011, the government of South Carolina changed the measure of employers' experiences with unemployment used for tax rates assignment. Before the reform, tax rates were assigned based on employers' *reserve ratios*. The reserve ratio is calculated as the normalized difference between the value of the unemployment benefits ever claimed by the workers laid off by an employer and the value of all the unemployment tax payments ever made by the employer. It thus measures the employer's net position relative to the unemployment insurance system. Following the reform, unemployment tax rates became an increasing function of 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. With the reform, unemployment tax payments and benefit charges occurred beyond this seven-year lookback period were no longer relevant for the assessment of employers' experience, leading to sudden changes in employers' experiences and unemployment tax rates.

With 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: the *"recent past,"* coinciding with the reform pre-period. Nevertheless, these employers were subject to different unemployment tax rates due to the different composition of their *"distant past"* reserves. As the benefit ratio replaced the reserve ratio, unemployment tax rates were equalized, impacting these two groups differently. Employers with negative reserve ratios saw their tax rates increase because the reform focused on recent benefit charges and "forgot" their historical tax payments. In contrast, employers with positive reserve ratios experienced a decrease in their tax rates as their distant past benefit charges were discounted by the reform.

Conditional on the benefit ratio, I find that the reform increased the unemployment tax per worker of negative reserve ratio employers by \$197 per year (equivalent to 42% of the level in 2010) relative to positive reserve ratio employers. Between 2011 and 2014, negative reserve ratio employers reduced their workforce by 0.37-

0.9 employees, or 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. Due to 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, as 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 high- and low- 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 high-risk industries (high-standard deviation industries), despite employers in low- and high-risk industries experience the same increase in the unemployment tax per worker. Consequently, the labor demand elasticity is estimated to be 0.05 in low-risk industries and -0.26 in high-risk industries. This -0.26 is the sufficient statistic representing the marginal cost of labor reallocation.

The analysis based on the Colorado data yields consistent results. I leverage the elimination of a surcharge as source of variation in unemployment taxes and I identify the causal effect of unemployment taxes on labor demand by comparing different cohorts of employers, of which only one 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 $136 (19%) for affected employers, increased employment by 0.57-1.3 employees (4-10%), and increased wages by $9,000 and $35,000 (4.3-17%), with no effect on the average wage. These effects are primarily driven by employers in high-unemployment risk industries, whose elasticity of labor demand with respect to unemployment insurance taxes is estimated to be -1.06.

In the final part of the paper, I use these estimated elasticities to evaluate the optimal degree of experience rating. Completing my formula with various moments in the unemployment tax filing data, in the Quarterly Census of Employment and Wages and in the Employment and Training 394 Report data, I find that the misallocation of productive skills and the fiscal externality associated with labor reallocation have a total marginal cost of 2.93. The interpretation of this number that for every dollar of insurance offered to employers, $2.93 dollars are lost due to labor reallocation. I then calibrate the cost of moral hazard using an estimate for the layoff elasticity from Topel (1984) and find that the associated fiscal externality has a total marginal cost of 1.97. This number implies that for every dollar of insurance offered to employers, $1.97 dollars are lost because of employer moral hazard. These results indicate that labor reallocation is 49% costlier than moral hazard. Intuitively, this occurs because, based on my calibration, the fiscal externality associated with a marginal worker in the high-unemployment risk industry is larger than the one associated with reduced effort. Moreover, skill misallocation exacerbates the cost of labor reallocation. Labor reallocation remains at least as costly as employer moral hazard even when using alternative layoff elasticities, suggesting that it is the predominant source of inefficiency resulting from coinsurance.

I then indirectly calibrate the marginal value of insurance using two alternative approaches from the literature. First, I proxy the value of insurance for employers with the value of insurance for workers from the literature (Gruber 1997a, Hendren 2017 Landais et al. 2021), assuming that workers value the survival of employers due to the risk of unemployment that is associated with negative shocks to employers. Second, I employ the value of insurance for employers who cannot optimally adjust following a shock because of liquidity constraints or wage rigidities (Giupponi et al. 2022). The upper value for the marginal value of insurance is 3.13. This indicates that employers are willing to pay up to \$3.13 to shift a dollar from the good to the bad state.

Combined, labor reallocation and moral hazard amount to a total marginal cost of insurance of 4.89. This cost exceeds the marginal value of insurance, suggesting that employers in South Carolina and Colorado are overinsured, and that experience rating should be increased to enhance welfare.

This paper contributes to four strands of literature. First, I contribute to the literature on the optimal design of social insurance programs. The paper complements the literature on the optimal provision of unemployment benefits (Baily 1978, Gruber 1997a, Chetty 2006, and Schmieder et al. 2016) by providing a framework to characterize the optimal approach to fund 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 attains 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" firms or firms with liquidity constraints. This paper builds upon this research by formalizing the joint contribution of employer moral hazard, labor reallocation, and the value of insurance to determining the optimal policy, by identifying estimable parameters for each of these forces, and by providing their first empirical assessment to inform policymaking. While numerous studies have estimated the costs of moral hazard, the only estimate of the costs of labor reallocation comes from Anderson et al. (1993a). My estimate differs from theirs in two ways. To begin, my model indicates that the relevant parameter to estimate is the labor demand elasticity with respect to the degree of experience rating 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. Moreover, 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 how the presence of minimum and maximum tax rates affect the degree of experience rating in a state. This paper highlights 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, along with access to new data on employers' unemployment insurance accounts, offers a unique opportunity to evaluate this policy and shed light on the different distribution of the tax burden among employers under the two systems. Moreover, the policy represents a novel source of variation in labor costs with many potential applications within the field. This analysis complements existing studies on the velocity of tax collection (Lachowska et al. 2020) and employers' incentives (Miller et al. 2019) implied by the two measures.

Third, the 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 were drawn when analyzing other business taxes, like corporate taxes or depreciation bonuses (Suárez Serrato et al. 2016, Mark et al. 2021). The findings of this paper align with this recent strand of this literature, demonstrating that employers are unable to shift the burden of payroll taxes onto their employees and shedding light on potential explanations. To begin, discovering these effects in the United States suggests that labor unions, a potential source of wage rigidities, may not be the primary cause. Moreover, the finding that the missing employees are average-wage employees suggests that minimum wages are not driving these patterns either. One notable aspect of the institutional context in the United States that may explain the limited pass-through of unemployment taxes onto wages is the variability of these taxes across employers and over time, which restricts employers' ability to set different wages in a competitive market. This hypothesis, proposed by Lester (1960), Brechling (1977) and Anderson et al. (1997), finds additional support in my study. Furthermore, my paper contributes to this literature by revealing that employers' responses to unemployment taxes vary by 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 due to higher taxes, it may be easier to adjust to a new tax environment than in low-risk industries.

Lastly, the paper contributes to the literature on adjustment costs. While Bentolila et al. (1990) argue that they do not have large effects on hiring decisions, Hopenhayn et al. (1993) and Anderson (1993) find that they can result in more unemployment in the long-run due to reduced hiring. My results 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. The next section presents the theoretical framework characterizing the optimal degree of experience rating and describes the roadmap to empirically implement the formula for optimality. Section 3 describes the data, the sample, and the empirical strategy to estimate the costs of labor reallocation, captured by the labor demand elasticity for high-risk employers, and presents the findings. Section 4 calibrates the residual parameters in the formula and discusses the implications for the optimal degree of experience rating. Section 5 concludes.

# 2 Model of Optimal Unemployment Insurance Financing

In this section, I present a theoretical framework exploring the welfare implications of levying taxes on employers with either coinsurance or experience rating to fund a predetermined unemployment benefit level. This framework yields a formula defining the optimal unemployment insurance financing policy as a function of estimable sufficient statistics. These statistics represent the key factors identified in the experience rating literature: the value of insurance for employers, the cost of employer moral hazard, and the cost of interindustry labor reallocation.

To incorporate these three factors, the model has three key features. First, employers are exposed to demand shocks resulting in worker layoffs. When employers are subject to higher unemployment taxes, their net worth decreases, and their losses from a shock (for example, borrowing costs) increase. Coinsurance is valuable for workers as it alleviates the tax burden, thereby reducing these losses. Second, employers in different industries experience shocks with different probabilities. Coinsurance spreads the cost of unemployment benefits generated by high-unemployment risk industries across the broader community of employers, ultimately reducing labor costs for these industries and facilitating their expansion. This reallocation of workers towards high-risk industries is costly because it results in the misallocation of productive skills and imposes a fiscal externality on the government budget through a higher benefit cost. Third, employers exert effort to reduce their exposure to shocks. Coinsurance makes layoffs less costly resulting in reduced effort and more frequent layoffs. This employer moral hazard is costly because it imposes a fiscal externality on the government budget through a higher benefit cost. These value of insurance and the costs from labor reallocation and employer moral enter the formula for the optimal policy as estimable sufficient statistics for welfare.

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

**Employers.** I assume the existence of two employers exposed to product demand shocks. In the *good* state of the world, employers face positive output prices, which I normalize to one. In the *bad* state, a shock occurs and lowers output prices to zero, making it unprofitable for 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 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, $m$: $r_H = p_H + \frac{1}{m}$. Equation 1 presents employers' expected profits:

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

In the good state of the world, employers produce output using labor $l$ and capital $k$. Employers take wages $w_L$ and $w_H$ as fixed[7] and hire workers from the most to the least productive available. 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. 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. The two diagonal lines in Figure 1 illustrates

[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. 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 labor supply is perfectly elastic or because of wage rigidities, such as collective bargaining, wage floors, equity concerns within the firm, etc. 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, which preserves all the results of the basic model.

an example of workers' productivity in the two industries. This structure implies that 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 they employ, and an unemployment tax ($\tau_L$ and $\tau_H$, depending on the industry) for each worker they hire. The tax is used to finance the provision of benefits $b$ for workers who become unemployed following a demand shock. Equation 2 illustrates employers' profits in the good scenario:

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

In the bad state of the world, a product demand shock occurs and reduces output prices to zero in the high-risk industry, making production unsustainable and leading to the dismissal of all the workers. Following a shock, the high-risk employer is still required to pay unemployment taxes[8]. However, the tax cost faced by the high-risk employer increases by q%, where $q$ is strictly positive and exogenous. $q$ represents the loss associated with each dollar of tax and can be attributed to various factors, such as increased borrowing costs following a shock. Moreover, the high-risk employer also incurs the cost of having, in vain, exerted effort to prevent the shock: $(1 - 1_{e=1})\psi(m)$, 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 guarantees that under this scenario of complete experience rating the high-risk employer exerts infinite effort to avoid shocks. Equation 3 illustrates the profit of the high-risk employer in the bad state:

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

**Government Budget Constraint and the Degree of Experience Rating.** The government estimates unemployment benefit claims and sets unemployment taxes on employers to ensure a balanced budget in expectation. Equation 4 shows that the combined taxes paid by the two employers have to match the expected total benefit cost $B$. This cost is calculated as the product between the benefit level $b$ and the expected unemployment rate, which depends on the employment share in high-risk industries and the industry's unemployment risk.

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

The government does not set $\tau_H$ and $\tau_L$ directly. Rather, it selects the degree of experience rating of the unemployment insurance system $e \in [0, 1]$, modeled as the share of own benefit costs that the high-risk employer pays in unemployment taxes.[9] Equations 5 and 6 show that $\tau_H$ and $\tau_L$ are set so that the high-risk

[8] Modeling 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 pay 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 unemployment taxes due for the year during the first quarter. Whether a worker is retained for longer is thus irrelevant for determining unemployment tax liabilities.

[9] Equivalently, the degree of experience rating can be interpreted as the tax cost per dollar of unemployment benefit, consistent with the approach of Feldstein (1976) and Topel (1984).

employer pays a fraction $e$ of the total benefit cost $B$. The low-risk employer pays the residual fraction $1-e$.

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

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

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 claims resulting from their layoffs $\tau_H^{*ER} l_H^{*ER} = B$ and the low-risk employer is exempt from paying unemployment taxes. When $e < 1$, coinsurance between the two employers comes into play, as 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 contribute the same amount of tax. Changes in the degree of experience rating $e$ affect the distribution of the unemployment tax burden between employers, with consequences on their insurance status, choice of effort and labor demand, discussed in detail when solving the model in Section 2.2.

**Workers.** Workers, denoted by $i$, are distributed uniformly over the unit interval and differ by their productivity in the two industries. Since all workers within the same industry earn identical wages, these differences in productivities influence the likelihood of workers being employed in either of the two industries, but do not affect the utility they experience in each industry. When employed in the low-risk industry, workers derive utility from consuming their wage. The utility associated with the low-risk job is $U_L = u(w_L)$, where $u(c)$ are identical strictly concave utility functions defined over consumption $c$. The utility associated with the high-risk job is the weighted average of the utilities from employment and unemployment, weighted by the probabilities of the good and bad states of the world respectively: $U_H = u(w_H)(1-r_H) + r_H(u(b)+L)$. When employed in the high-risk industry, workers derive utility from consuming their wages. When unemployed, they derive utility from consuming the unemployment benefit and enjoy strictly positive leisure $L$. I make two simplifying assumptions. First, that workers derive equal utilities from the two jobs: $U_L = U_H$. This assumption justifies the existence of both jobs in an economy with fixed wages and guarantees that, when workers are reallocated across industries, there are no inefficiencies due to workers' tastes.[10] Second, I assume that workers are indifferent between consuming the high-risk wage and the combination of consuming the unemployment benefit and enjoying leisure. This assumption may explain the existence of seasonal jobs despite their typically low wages.[11] Crucially, since the gap in workers' marginal utility from consumption persists,

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

[11]I relax this assumption in Section B.6, where I eliminate leisure and allow workers to experience higher utility from consuming the high-risk wages than from consuming the unemployment benefit, since $w_H > b$ and $u(c)$ is increasing in $c$. In this case, the total inefficiency associated to employer moral hazard, which increases the likelihood unemployment, increases to reflect workers' distaste for unemployment. Consequently, the estimates from this simplified version of the model represents a lower bound for the true cost of moral hazard, reinforcing the case for a higher degree of experience rating.

$u'(b) > u'(w_H)$, unemployment insurance is still valuable for workers.[12]

**Capitalists.** There is a continuum of capitalists owning capital $2k$, assumed to be split identically between the employers for production. Capitalists consume the return from their investment: $U_C = 2k[j+\gamma(\Pi_L+\Pi_H)-1]$. For each unit of capital invested, they receive a return consisting of the exogenous price of capital, $j$, and an exogenous fraction $\gamma \in (0,1)$ of employers' net worth, $\Pi_L + \Pi_H$. A higher net worth increases returns by reducing agency costs. Indeed, in presence of asymmetric information between lenders (capitalists) and borrowers (employers), lenders audit their investment and lose part of their return in agency costs. (Bernanke et al. 1989).

## 2.2 Model Solution

Figure 2 illustrates the model's development. First, the government selects the degree of experience rating $e$ of the unemployment insurance system to maximizing welfare. Second, the high-risk employer observes $e$ and sets labor demand and effort optimally. Employment in the low-risk industry is residually determined. Third, the shock occurs and some workers in the high-risk industry become unemployed. I solve the model by backward induction. I first derive employers' optimal responses to the government's choice of experience rating, and then calculate the government's optimal choice of experience rating considering employers' responses as given.

**Labor demand as function of experience rating.** Using Equation 5, I express the profits of the high-risk employer as function of the degree of experience rating $e$. The employer treats $e$ as a fixed parameter and chooses labor demand to maximize expected profits. Equation 7 presents the privately optimal labor demand of the high-risk employer as function of the degree of experience rating, calculated in Section B.2 by setting to zero de derivative of profits with respect to $l_H$. The privately optimal labor demand function equalizes the marginal product and the marginal cost of an additional worker. The former is equal to the productivity of the newly hired marginal worker in the high-risk industry. The latter is equal to the sum of the wage and unemployment tax that the employer pays on the new hire. Since $f(i,k)$ is decreasing in $i$, the labor demand of the high-risk employer declines with the degree of experience rating: $\frac{\partial l_H}{\partial e} < 0$. Given its key role in the model solution, I also define the elasticity of labor demand for the high-risk employer with respect to the degree of experience rating: $\epsilon_{l_H,e} = \frac{\partial l_H}{\partial e}\frac{e}{l_H} < 0$, measuring the percentage reduction in labor demand after a one percent increase in the degree of experience rating.

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

Once the labor demand of the high-risk employer, $l_H(e)$, is established, low-risk employment is determined residually: $l_L = 1 - l_H(e)$. Therefore, experience rating affects not only the labor demand of the high-risk employer, but the final allocation of workers between the two industries.

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

The key reason why the degree of experience rating affects both industries is that it determines the presence and the extent of interindustry cross-subsidization. When $e = 1$ and experience rating is complete, the high-risk employer bears the entire benefit cost resulting from their layoffs, effectively eliminating cross-subsidization. When $e < 1$, part of the benefit cost generated by the high-risk employer is transferred to the low-risk employer through coinsurance. Section B.1 shows that, given the permanent nature of employers' unemployment risk, the same asymmetry in unemployment usage and financing between the two employers would emerge period after period, leading to the systematic subsidization of the high-risk employer. Shifting part of the tax cost from the high- to the low-risk employer reduces labor costs and increases labor demand for the former, while increasing labor costs and reducing labor demand for the latter. These simultaneous effects generate interindustry labor reallocation.[13]

Figure 1 depicts the allocation of workers between the two industries under two illustrative scenarios. With complete experience rating and no cross-subsidization, the high-risk employer faces the highest possible unemployment tax per worker and minimizes labor demand. Along the unit interval, the high-risk employer stops hiring workers when the net productivity of the marginal worker, calculated as the difference between productivity and labor costs, is zero. This condition is satisfied by point A Figure 1, where $f_H(l_H*, k) = w_H + B$ and $l_H^{*ER}$ is the marginal worker hired by the high-risk employer. $l_H^{*ER}$ is also the prevailing employment share in the high-risk industry with complete experience rating. With coinsurance, the high-risk employer hires workers until the productivity of the marginal worker equals the reduced labor costs. Point C in the figure satisfies this condition and identifies $l'_H$ as marginal employer satisfying $f(l'_H, k) = w_H + eB$. Crucially, the lower is the degree of experience rating, the larger is the employment share of high-risk industries $l'_H$ relative to experience rating $l_H^{*ER}$.

**Effort as function of experience rating.** After observing the government's choice of the degree of experience rating $e$, the high-risk employer also chooses the level of effort $m$ to avoid shocks that maximizes expected profits. Equation 8, derived in Section B.3 shows that this optimal level of effort equalizes the marginal benefit and cost of an additional unit of effort. Increasing effort has two marginal benefits. First, it increases the probability of the good state of the world, making it more likely that the employer earns the good-state profits rather than the bad-state profits. Second, the lower unemployment risk reduces total benefit costs and hence unemployment taxes. However, since $\psi(m)$ is a convex function, increasing effort is associated to progressively higher monetary costs. 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, with complete experience rating the unemployment risk reaches its minimum: $\lim_{m\to\infty} r_H = \lim_{m\to\infty} p_H + \frac{1}{m} = p_H$. This reflects the idea that complete experience rating eliminates employer moral hazard and minimizes layoffs. With risk pooling, when $e < 1$, the marginal cost of effort is positive, the optimal level of effort is finite and increasing in the degree of experience rating: $\frac{\partial m}{\partial e} > 0$. Given its importance in the model solution, I also define the elasticity of effort

[13] Shifting part of the tax burden to the low-risk employer is key to induce interindustry labor reallocation. In this simplified model where all the workers are employed before the shock, the expansion of the high-risk industry automatically implies the contraction of the low-risk industry, but things change in a more complex scenario with unemployment. Suppose that the portion of the benefit cost not paid by the high-risk employer was paid with government spending. Then, the low-risk industry would remain unaffected, while the high-risk industry could expand, relative to the scenario of complete experience rating, hiring from the pool of unemployed workers. As both employment in the high-risk industry and total employment would increase, the effect on the employment share in the high-risk industry is ambiguous. Conversely, shifting taxes from the high- to the low-risk industry increases labor cost for the former while increasing it for the latter, unambiguously resulting in interindustry labor reallocation.

with respect to the degree of experience rating, $\epsilon_{m,e} = \frac{\partial m}{\partial e}\frac{e}{m} > 0$, measuring the percentage increase in effort after a one percent increase in the degree of experience rating.

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

**Optimal degree of experience rating.** The government chooses the degree of experience rating $e$ to maximize the utilitarian social welfare function in Equation 9, obtained by summing workers' s and capitalists' utilities, subject to the tax burden allocation rules in Equations 5 and 6, the high-risk employer's labor demand function in Equation 7, labor market clearing, and the high-risk employer's effort in Equation 8.

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

To solve this optimization problem, in Section B.4 I take the derivative of the social welfare function with respect to the degree of experience rating and set it to zero. This derivative illustrates how welfare changes when marginally decreasing the degree of experience rating or, equivalently, when marginally increasing insurance for employers. The optimal degree of experience rating is the value of $e$ that equalizes the marginal benefit and the marginal cost of increasing insurance to employers. For this reason, it can be considered an employer-Baily-type formula.

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

The left-hand side of Equation 10 presents the marginal benefit of insurance for employers, represented by the gap in the marginal profits of the high-risk employer between the bad and the good state of the world. By reducing the degree of experience rating, the government shifts a greater part of the tax cost from the high-to the low-risk employer, limiting the tax liability of the high-risk employer if a negative shock occurs. The sufficient statistic representing the marginal benefit of insurance is the gap in the marginal profits of the high-risk employer between states of the world. Equation 11 shows that the marginal profit gap is equal to $q$, which is the loss associated with each additional dollar of tax in the bad state of the world. Consequently, the left-hand side of Equation 10 can be interpreted as the price that employers are willing to pay to shift one dollar from the good to the bad state of the world This result is analogous to Baily (1978) and Chetty (2006), who find that the gap in marginal utility of consumption between the bad and the good states of the world is the sufficient statistic representing the value of insurance for workers and interpret it as the consumption given-up to shift a dollar from the employed to the unemployment state.

$$\frac{\Pi_H^{\prime good} - \Pi_H^{\prime bad}}{\Pi_H^{\prime good}} = \underbrace{q}_{\text{Loss per dollar of tax increase}} \tag{11}$$

The right-hand side of 10 presents the marginal cost of insurance. The total cost can be decomposed into the cost from interindustry labor reallocation and the cost from employer moral hazard. The elasticity of labor demand of the high-risk employer with respect to the degree of experience rating, $\epsilon_{l_H,e} < 0$, is the sufficient statistic capturing the inefficiencies due to interindustry labor reallocation. Decreasing the degree of experience rating shifts labor costs from the high- to the low-risk industry, leading to a reallocation of workers from the latter to the former. This reallocation is inefficient for two reasons, represented by the elements within the parameter $\lambda$, expressed explicitly in Equation 12. Firstly, the expansion of high-risk industries results in the misallocation of productive skills in the labor market. This effect is captured by the net productivity of the marginal worker in the high-risk industry, $f_L(l_H, k) - w_L$. This difference, corresponding to the DE segment in Figure 1 assuming that the marginal worker is the $l'_H$ represented in the graph, is positive, meaning that the worker identified by $l'_H$ would have been employed productively in the low-risk sector. However, $l'_H$ is employed in the high-risk industry, where their net productivity, equal to the difference between productivity and the wage and full tax cost, is negative: $f(l'_H, k) < w_H + B$. Intuitively, the specific allocation of workers across industries achieved with experience rating coincides with the efficient allocation of productive skills in the labor market. Efficiency is achieved because workers are placed in the industry in which their net productivity, calculated as the difference between their productivity and true labor costs, is positive. Formally this requires that the marginal worker employed in the high-risk industry possesses equal net productivity, normalized to zero, in both industries: $f_L(l_H*, k) = w_L$ and $f_H(l_H*, k) = w_H + B$. This condition identify points A and B in Figure 1, and the optimal industry size for the low-risk employer, $l_H*$. The lower the degree of experience rating, the larger the inclusion in the high-risk industry of workers who would have been more productive in the low-risk industry. Points C and D correspond to the privately optimal allocation of workers between the two industries with coinsurance. Moving from A and B from C to D implies that the low-risk employer experiences a revenue loss equivalent the light-blue area between points BFGD, while the high-risk employer gains revenue equivalent to the yellow area between points AHIC. Since the revenue loss (blue area) is greater than the revenue gain (yellow area), there is a total loss of welfare from the misallocation of productive skills. The difference between these two areas is equal to the pink area identified by points JFKG, and is proportional to the share of benefit cost transferred to the low risk employer, $(1 - e)B$. Figure A1 shows that for every \$100 of net productivity loss, $f_L(l_H, k - w_L)$, the marginal cost of insurance increases by 20 cents. Intuitively, the greater the disparity in skill requirements between industries, the larger the gap becomes.

Secondly, the expansion of the high-risk industry has a fiscal externality on the government budget. Increasing the employment share of high-risk industries implies expanding the pool of workers subject to a high unemployment risk and the expected total cost of benefit $B$, which the government needs to finance through higher taxes.

$$\lambda = \frac{1}{ebr_H^2}\left[\underbrace{f_L(l_H,k) - w_L}_{\text{Misallocation of productive skills}} + \underbrace{(1-e)br_H}_{\text{Fiscal externality due to higher benefit cost}}\right] \tag{12}$$

The elasticity of effort with respect to the degree of experience rating, $\epsilon_{m,e} > 0$, is the sufficient statistic capturing the inefficiencies due to employer moral hazard. Decreasing the degree of experience rating reduces the cost of a shock, reducing employers' incentives to exert effort. With lower effort, more layoffs occur, increasing the expected total benefit cost $B$ that the government needs to finance through general taxation. Hence, employer moral hazard imposes a fiscal externality on the government budget.[14]

$$\mu = \underbrace{\frac{(1-e)}{emr_H^2}}_{\text{Fiscal externality due to higher benefit cost}} \tag{13}$$

In summary, offering insurance to employers is valuable for economic agents who benefit from employers' continuity and survival but is costly for society due to the skill misallocation and fiscal externality driven by interindustry labor reallocation and due to the fiscal externality from employer moral hazard. The optimal degree of experience rating equates these three forces.

### 2.3 Empirical implementation

The primary application of Equation 10 consists in assessing the relative magnitude of the benefit and the costs of insurance within a given context and evaluate whether the degree of experience rating in that context is optimal, too low (if marginal benefits exceed marginal costs), or too high (if marginal costs exceed marginal benefits). This evaluation is the objective of the empirical section of this paper. Before proceeding to the implementation, some considerations are needed.

First, the notion that employers in low- and high- unemployment risk industries react differently to changes in unemployment insurance financing policies has long been contemplated. For instance, Lester (1960) argued that employers with low- layoff rates exhibit greater resilience to shocks compared to high-layoff rate employers. Moreover, employers in high-risk industries may find it more feasible to adjust their employment levels in response to tax changes compared to low-risk employers. This adaptability could stem from their familiarity with fluctuations in workforce size or a deeper understanding of unemployment insurance financing policies, given their greater exposure to tax variations.[15] This justifies the estimation of a labor demand elasticity specifically for employers in high-risk industries, as opposed to relying on a generic labor demand elasticity.

[14] This model does not account for positive externalities that may arise from increased layoffs and unemployment, which could reduce the cost of insurance and, thus, provide a stronger argument for a lower degree of experience rating. For instance, workers might accept jobs with excessive mobility costs (Diamond 1981).

[15] In the United States, most policy changes in unemployment insurance financing disproportionately impact employers with high layoff rates. First, high-layoff rate employers are assigned higher unemployment tax rates. By itself, this makes unemployment taxes more relevant for these employers. Additionally, the higher tax rates for high-layoff rate employers amplify the consequences of any adjustments in the taxable wage base, which denotes the portion of a worker's annual wage over which the tax rate is applied. Moreover, states often adjust their unemployment tax rate schedules, raising unemployment tax rates when they aim to collect more unemployment taxes and reducing them to alleviate the tax burden on employers. These rate schedules are typically designed to induce substantial variability in the tax rates paid by high-layoff rate employers, with substantially smaller variation in the tax rates of low-layoff rate employers.

Therefore, the primary focus of the empirical section of this paper is to estimate this parameter, for which there is no available estimate from the literature. 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 $\epsilon_{l_H,e}$. The estimation is facilitated by the existence of numerous sources of quasi-experimental variation in the unemployment tax per worker in the United States, where state-level reforms of unemployment insurance financing policies are frequent and policies involve several kinks and discontinuities. Johnston (2021) and Guo (2023) have used this type of variation. This paper leverages novel quasi-experimental variation in the tax per worker from two reforms of unemployment financing 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. The use of reduced form effects is particularly appropriate as they encapsulate all behavioral responses to changes in the tax per worker that ultimately influence labor demand, mirroring the total derivative in the labor demand elasticity.

The paper then proceeds with the calibration of the other parameters in the cost-side of Equation 10. Since the elasticity of effort with respect to the degree of experience rating, $\epsilon_{m,e}$, is equal to the negative of the elasticity of layoffs with respect to the degree of experience rating, $\epsilon_{r_H,e}$, I borrow an estimate of the layoff elasticity from the existing literature on employers' moral hazard. Then, I calibrate there are various parameters in $\lambda$ and $\mu$ using several moments in the data. To maintain consistency and make sensible comparisons, the the calibrations of the parameters stem from the same context in which the labor demand elasticity was estimated. The use of local estimates further implies that the policy considerations only hold policy relevance for the specific context in which the formula has been implemented – in this paper, South Carolina and Colorado. I will then discuss the generalizability of the findings to other US states and European countries.

Notably, the model is based on a set of simplifying assumption that increase its tractability but can be relaxed without altering its key intuition. I show that Equation 10 could be augmented with additional features making the model closer to the real world, whose impact is to increase the cost-side of the equation. This suggests that implementing this simpler version of the model provides a lower bound for the cost of insurance, if anything strengthening the case of a higher optimal degree of experience rating. Section B.5 discusses a version of the model with flexible wages. The key distinction is that the reallocation of workers across industries affects the wages offered in these industries. Since workers consume their wages, the formula for the optimal degree of experience rating contains two additional sufficient statistics: the elasticities of wages in the two industries with respect to the degree of experience rating. Table 4 shows that these elasticities are estimated to be zero, leading us back to the scenario with fixed wages. Section B.6 presents a version of the model in which workers are not indifferent between jobs and without leisure. Introducing individual tastes increases the costs of reallocation and of employer moral hazard, strengthening the case of a higher optimal degree of experience rating. Section B.7 discusses the implications of allowing the low-risk employer having a strictly positive unemployment risk. While both employers now contribute negatively with moral hazard, so long as the risk of the low-risk employer is smaller than that of the high-risk employer all the considerations around labor reallocation remain the same.

One last note concerns the value of insurance for employers. While the reason to insure workers – the existence of a gap in the marginal utility of consumption between the employed and the unemployed states – seems obvious, the justification for insuring employers is less straightforward. This paper does not take a unique view of why offering insurance to employers is valuable for society. In the model, I introduce a generic loss associated with the bad state of the world, and this loss reduces welfare by decreasing the returns consumed by capitalists, whose utility enters the social welfare function, in presence of information asymmetries and agency costs. There are, however, alternative approaches with equivalent implications on the formula for the optimal degree of experience rating. One approach consists in assuming that workers themselves, rather than capitalists, value the continuity and survival of the employers, either because they are the ones supplying capital, or because the long-term survival of employers means maintaining the ability to consume wages. In this case, employers' profits would enter the social welfare function through workers' utilities, and the presence of a shock would create a gap in the marginal utility of consumption between states. Consequently, the value of providing insurance to workers – the reason why unemployment insurance exists in the first place – provides an upper bound for the value of providing insurance for employers. I thus use estimates of the value of insurance for workers from Landais et al. (2021) as a benchmark for the value of insurance for employers. A second approach consists in considering employers as economic agents just like workers and capitalists whose wellbeing must be maximize, and to include profits directly in the social welfare function. One possible justification is the existence of liquidity constraints or wage rigidities that prevent employers from optimally adjusting when facing a shock. Giupponi et al. (2022) finds that subsidizing jobs with short time work policies and finds increases employment and the probability of survival especially for liquidity constrained employers, suggesting these inefficiencies may be in place. Their estimate of the elasticity of employment with respect to the number of subsidized hours provides an additional measure for the value of insurance for employers.

In the next section, I focus on estimating the labor demand elasticity with respect to the unemployment tax per worker for employers in high-unemployment risk industries separately for South Carolina and Colorado. Then, I will calibrate the other parameters in the cost-side of Equation 10 and calculate an estimate for the total cost of insurance for employers for these settings. Lastly, I will compare this cost with the alternative measures of the value of insurance for employers just discussed and draw implications for the optimal degree of experience rating in these two states.

# 3 Estimating the cost of interindustry labor reallocation

This section presents my approach to estimate the labor demand elasticity with respect to the unemployment tax per worker for employers in high-unemployment risk industries. The estimation relies on quasi-experimental variation in the unemployment tax per worker generated by a reform of experience rating policies in South Carolina. The results based on the reform in Colorado, briefly presented in this section, are derived 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, ensuring they can meet necessities while unemployed. The program operates as a federal-state partnership, allowing states to design and manage their own unemployment insurance program within federal guidelines. Consequently, states vary widely in terms of workers' eligibility criteria, the generosity of benefits, and the financing methods employed. Each state maintains an individual Unemployment Trust Fund, where 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 due to high benefit demand, states increase unemployment tax rates on employers; once the fund is replenished, tax rates are lowered.[16] This variation in unemployment tax rates over time is the first distinctive feature of unemployment insurance financing in the United States.

The second feature is that unemployment tax rates vary among employers and for each employer over time to reflect employers' experiences with unemployment. This system to assign individualized and dynamic unemployment tax rates to employers, known as *"experience rating"*, is implemented in three steps. Firstly, every year states calculate for each employer an updated measure of the employer's experience with unemployment. Twenty-eight states employ a measure of experience known as *"reserve ratio"*, presented in Equation 14. The reserve ratio 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 the unemployment benefits ever claimed by the employees laid off by the employer and the sum of all the unemployment tax payments ever made by the employer since the date of establishment (or since the inception 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 could be positive or negative. Higher values of reserve ratio indicate greater experience with unemployment, as the dollar amount of benefit charges raises relative to tax payments.[17]

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

Nineteen states measure employers' experience with unemployment using the *"benefit ratio"*, illustrated in Equation 15. The benefit ratio is calculated as the ratio of the benefits charged to the employer and 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 different states. The benefit ratio only assumes non-negative values. Higher values of

[16]Most states establish specific thresholds of trust fund solvency triggering tax increases or decreases. Historically, some governments have deviated from these rules, keeping tax rates high to strengthen the fund's solvency or low to ease the tax burden on employers. As a result of different financing rules and compliance, states varied widely in their ability to cope with the recent economic shocks. Panel (a) of Figure B.1 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 fund. 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 benefit costs. In the aftermath of these recessions, many states raised unemployment taxes on employers to settle their debts and restore their financial reserves.

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

benefit ratio indicate greater experience with unemployment, as recent benefit charges rise.[18]

$$\text{Benefit Ratio}_{it} = \frac{\sum_{j=x}^{t-1} \text{Unemployment Benefits}_{ij}}{\sum_{j=x}^{t-1} \text{Taxable Wages}_{ij}} \tag{15}$$

Secondly, states assign higher unemployment tax rates to employers with higher experience with unemployment. To do so, states use tax rate schedules, which are functions specifying the unemployment tax rate corresponding to each level of reserve ratio or benefit ratio. Tax rate schedules are regularly adjusted to increase or decrease the overall tax burden. Every year, employers' experience and tax rate are recalculated to reflect employers' updated experience 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.

Thirdly, the unemployment tax rate is multiplied by the employer's 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 wage base"*, common to all the employers in a state. For instance, if 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 unemployment tax rates are designed to hold employers accountable for their unemployment benefit costs However, there are three categories of benefit costs that cannot be charged to specific employers. Firstly, "ineffective charges" result from employers reaching the maximum unemployment tax rate, who lay off workers without incurring in additional tax liabilities. Secondly, certain benefits are "non-charged" to specific employers, such as 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. Thirdly, "inactive charges" are claimed by workers laid off by employers who went out of business. These costs repaid collectively, making experience rating "incomplete" even in the United States.

## 3.2 Data and sample

The main variables in the analysis are obtained from unemployment tax filing data provided by South Carolina Department of Employment and Workforce (SC DEW). The data cover the near-universe of employers in South Carolina[19] 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 ratio, taxable wages, unemployment benefit charges, the establishment date and a NAICS four-digits industry

[18] The remaining states employ similar measures of employers' experience: the "average benefit cost rate" in Alaska; the "benefit-wage ratio" in Delaware and Oklahoma. Figure A3 illustrates the geographical distribution of states employing benefit-ratio, reserve-ratio, and other measures. The map suggests that there is no systematic adoption of a specific measure based on regional characteristics, as the states employing these measures are evenly distributed 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.

[19] The SC DEW data, excluding the top 1% largest employers to ensure confidentiality and prevent identification, represents 76% of total employment in the state. Table A1 reveals a closely aligned distribution of employers and employees across industries between the SC DEW data and the QCEW data, covering the entire labor market, indicating that excluding the largest employers does not significantly impact the representation of specific industries in the SC DEW data.

code. I also obtained access to analogous data from the Colorado Department of Labor and Employment, which enables me to estimate in parallel the same labor demand elasticity using quasi-experimental variation and a sample of employers from Colorado.

To identify 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.

The sample used for the analysis is a subset of the SC DEW data. To focus on employers affected by unemployment financing reforms, I restrict the SC DEW data to private sector employers, whose unemployment tax rate is determined based on their measure of experience with unemployment. I thus exclude two categories of non-experience rated employers: new employers, 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, subject to delinquent tax rate of 3.4% until defects are fixed. To avoid compositional changes around the time of the reform, I further restrict the sample to employers observed continuously and with complete employee data between 2005 and 2014, spanning a ten-year period surrounding the 2011 reform I leverage for identification.

Table 1 shows summary statistics for the sample in 2009. The sample predominantly comprises small employers but also includes large ones, with a median of 5 employees and an average of 12. The median employer offers an average wage of $30,000 and was established in 1995, indicating sixteen years of operation by the time of the 2011 reform. Regarding sector distribution, primary sector employers make up 1.6% of the sample, construction 12%, manufacturing 6%, trade 22%, transportation 2.5%, and services 56%. Employers exhibit significant variation in their reserve ratios, spanning from -158 to 963, with an average of -.05 and a median of -.14. These negative values indicate that unemployment tax payments exceed benefit charges for most employers. This variation in reserve ratios induce large variation in unemployment tax rates, ranging between 1.3 and 6.1%, and in the tax per worker, calculated by multiplying the tax rate by the taxable wage base of $7,000, varying between $91 and $427.[20]

### 3.3 Identification strategy

To generate quasi-experimental variation in employers' unemployment tax per worker, I leverage the reform of unemployment financing policies occurred in South Carolina in 2011. During the Great Recession, the unemployment trust fund in South Carolina was depleted due to an extraordinary demand for unemployment benefits and insufficient reserves. To cover benefit costs, the state borrowed $1 billion in federal loans. To

[20] Compared to 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 excluded employers. Consistent with the exclusion of new employers, selected employers have eleven additional years of operation; and consistent with the exclusion of new and delinquent employers, selected employers face lower tax rates despite maintaining similar reserve ratios.

settle its debt and replenish the fund, South Carolina reformed its unemployment insurance financing policies to increase tax collection. The reform was initiated in 2010, with tax changes impacting employers from 2011. By the end of 2014, the federal loan was repaid, and South Carolina gradually reduced the tax burden on employers.[21]

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 measure of employers' experience with unemployment.[22] Equation 16 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 between them. First, they differ in the length of the lookback period $j$ used for assessing employers' experiences with unemployment. While the reserve ratio is calculated using data spanning from the employer's establishment date to the calculation date, the benefit ratio utilizes a rolling seven-year lookback period, discarding any data predating this period. Second, while unemployment taxes are a component in the calculation of the reserve ratio to determine an employer's net position within the unemployment insurance system, they are irrelevant for the calculation of the benefit ratio, determined solely based on benefit charges.[23]

$$\mathrm{RR}_{it} = \frac{\sum_{j=-\infty}^{t-1} \text{Unempl. Benefits}_{ij} - \sum_{j=-\infty}^{t-1} \text{Unempl. Taxes}_{ij}}{\text{Taxable Wages}_{i,t-1}} \longrightarrow \mathrm{BR}_{it} = \frac{\sum_{j=-7}^{t-1} \text{Unempl. Benefits}_{ij}}{\sum_{j=-7}^{t-1} \text{Taxable Wages}_{ij}} \tag{16}$$

The South Carolina government switched from the reserve ratio to the benefit ratio to expedite the replenishment of the unemployment insurance trust fund. As most employers had built up substantial reserves through years of unemployment tax payments, the benefit costs charged during the Great Recession did not lead to significant increases in their reserve ratios, and consequently, their unemployment tax rates remained largely unaffected. By employing the benefit ratio, the government could effectively ignore unemployment taxes and impose elevated tax rates on employers who faced substantial layoffs during the Great Recession. The findings from Lachowska et al. (2020) that benefit ratio systems restore fund solvency at double the rate of reserve ratio systems support the concept also pointed by 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 their present one. The reform was a notable event for employers, many of which experienced a sharp increase in their tax rates just as the economy was beginning to bounce back.[24]

[21] Trends in unemployment benefits, taxes, trust fund reserves and federal loans for South Carolina are presented in panel (b) of Figure B.1.

[22] Figure A4 displays the increase in the taxable wage base. Figure A5 illustrates the unemployment tax rate schedules in place before and after the reform. Figure A6 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 a significant increase in 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 allow the reader how the tax per worker changed for individual employers.

[23] 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 in the denominators of the reserve ratio and the benefit ratio plays a minor role to the variation in employers' measure of experience.

[24] 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."*

The transition from the reserve ratio to the benefit ratio caused the redistribution of the unemployment tax burden among employers in the state. By disregarding all unemployment tax payments and benefit charges occurring before the seven-year lookback period, the reform suddenly changed employers' measured experience with unemployment, resulting in substantial variations in their unemployment tax rates. Intuitively, employers who had laid off workers in the distant past benefitted from the oblivion of those charges. In contrast, employers with substantial tax payments were penalized because unemployment taxes were disregarded in experience calculations, with greater emphasis placed on any benefit costs incurred during the Great Recession.

With 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 displayed comparable trends during the seven-year lookback period used to calculate the benefit ratio (the *"recent past"*), coinciding with the reform pre-period. The different reserve ratios, shaped by 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, divided into 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 portrays employers' layoff rates (solid lines) and tax rates (dashed lines). The figure displays two employers, one in orange and one in green, with the same benefit ratio but different reserve ratios. The reason why these employers share the same benefit ratio is that 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 during the distant past; 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 disregarded and their recent stability was emphasized. Consequently, this employer's measured experience with unemployment saw a significant decrease at the time of the reform, resulting in a lower unemployment tax rate for them. Because the green employer's behavior remained consistent over both the distant and recent past, the reform had no impact on this employer's experience with unemployment or their unemployment tax rates. As a result of the reform, the unemployment tax rates of these employers, which differed pre-reform due to their different distant past behavior, were equalized to reflect their similar behavior during the recent past.

Panel (b) of Figure 3 shows that the same pattern emerges in my study sample. The figure illustrates the average tax rate for employers with predicted benefit ratio[25] equal to zero, hence with no layoffs during the recent past, and either positive (orange) or negative (green) reserve ratio in 2009. Despite the parallel trends, orange employers' tax rates were substantially than green employers' tax rates pre-reform. With the 2011 reform, orange employers' tax rates suddenly decreased by 3.9 percentage points, reaching the same level of the green employers. Due to the availability of new lower tax rates, the tax rates of green employers declined by one percentage point as well. Nevertheless, it is evident that the reform favored orange employers – the ones with numerous distant past layoffs and a positive reserve ratio pre-reform.

[25]The 2010 predicted benefit ratio is the benefit ratio that employers would have had if the reform took place one year earlier. Figure A8 shows that the 2011 benefit ratio and the 2010 predicted benefit ratio are highly positively correlated, supporting the use of the latter for my analysis. The 2009 reserve ratio and the 2010 predicted benefit ratio are entirely determined based on employers' behavior before 2010, the year in which the details of the reform were defined and are thus clean from employers' behavioral responses in anticipation of the reform.

This example focused 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 substantial difference in employers' reserve ratio pre-reform, I observe a variety of predicted benefit ratios. Within each benefit-ratio group, I compare employers with negative reserve ratios, penalized by the disregard of unemployment taxes, and employers with positive reserve ratios, favored by the disregard of distant past benefit charges. I display the full variation in employers' reserve ratios pre-reform and benefit ratios post-reform in Panel (a) of Figure 4. The figure shows employers by their recent benefits (numerator of the benefit ratio) in 2011 and total reserves (numerator of the reserve ratio) in 2010, both scaled by recent taxable wages to emphasize differences driven by the numerators. Although there is a noticeable positive correlation, there remains substantial variation between these two measures. As a result, employers who were previously categorized similarly and assigned the same unemployment tax rate under the old system now find themselves categorized differently and subject to different treatment under the new system. I compare employers with the same benefit ratios, i.e. horizontally: these are employers that, despite their different reserve ratios, behave similarly in the pre-period. Comparing employers with the same reserve ratios, i.e. vertically, signifies comparing employers with the same net position but potentially very different historical trends.

Equation 17 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. Standard errors are robust to heteroskedasticity and clustered at the employer level. $\beta_{2010}$ is normalized to zero. I multiply the predicted benefit ratio bins by year fixed effects because employers with different levels of predicted benefit ratio are expected to display different layoff and employment trends during the pre-period. For example, employers with a predicted benefit ratio of zero (with no layoffs during the recent past) likely maintained a much more stable employment than employers with positive predicted benefit ratios (with layoffs during the recent past).

$$Y_{i,t} = \alpha_i + \sum_{y=2005}^{2014} \beta_y 1_{y=t} Treat_i + \alpha_{b(i),t} + \epsilon_{i,t} \tag{17}$$

For the $\beta$ coefficients to identify the Average Treatment Effect on the Treated, the parallel trend and the no-anticipation assumptions need to be satisfied. I begin by discussing the plausibility of the parallel trend assumption. The assumption requires that negative reserve ratio employers would have evolved in the same way as the positive reserve ratio employers within the same benefit ratio bins in absence of the reform. Formally, it requires that the reserve ratio, determining treatment status, is uncorrelated with the error term. The first approach to establish the credibility of this assumption involves the direct examination of parallel trends in employers' outcomes. The second approach consists in showing that the reserve ratio primarily reflects employers' distant past behavior. If this is the case, the reserve ratio should be uncorrelated with current outcomes in itself, and especially after accounting for recent trends through the benefit ratio.

To this goal, Equation 18 decomposes the numerator of the reserve ratio, the employer's *total reserves*, into three components: the *recent benefits*, corresponding to the numerator of the benefit ratio, the *distant past reserves*, calculated as the difference between the benefits charged to the employer and the unemployment taxes paid by the employer from the establishment to seven years before the calculation date, and the *recent taxes* paid by the employer. The variation in distant past reserves and recent taxes generates variation in the reserve ratios of employers with the same benefit ratio.

$$\underbrace{\sum_{-\infty}^{0}\text{Benefits}_i - \sum_{-\infty}^{0}\text{Taxes}_i}_{\text{RR num= Tot. reserves}} \underbrace{\sum_{-7}^{0}\text{Benefits}_i}_{\substack{\text{BR num.=}\\ \text{recent benefits}}} + \underbrace{\left(\sum_{\infty}^{-7}\text{Benefits}_i - \sum_{\infty}^{-7}\text{Taxes}_i\right)}_{\substack{\text{Distant past reserves}\\ \text{MEMORY}}} - \underbrace{\sum_{-7}^{0}\text{Taxes}_i}_{\substack{\text{Recent Taxes}\\ \text{MATCH}}} \tag{18}$$

I argue that the credibility of the parallel trend assumption increases if distant past reserves are the primary driver of the variation in employers' reserve ratios. To isolate the contribution of distant past reserves to the total variation between the two measures of experience, I plot employers by their scaled recent benefits and residualized scaled total reserves, obtained from a regression of scaled total reserves on scaled recent taxes, in Panel (b) of Figure 4. The variation between these two measures expands relative to the original variation, supporting the central role of distant past reserves, or *memory*, as driver of the variation. Many employers with negative distant past reserves, built up through regular tax payments over time, accumulated positive benefit charges during the Great Recession. Ignoring these negative distant past reserves increases the measure of experience, explaining the high recent benefits of many employers with low total reserves. Symmetrically, some employers with positive distant past reserves from past benefit charges experienced no layoffs in the recent past. Disregarding the positive reserves reduces their measure of experience, explaining the low recent benefits of many employers with high total reserves. I then isolate the contribution of recent taxes to the original variation. 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. The variation between the two variables is due to benefit charges *matching* unemployment tax payments in multiple ways to give the same total reserve balance. The amount of taxes that employers pay during the recent past is determined by the reserve ratio. Once we remove the variation from the distant past by focusing on employers without memory, match seems to have a much more limited contribution to the total variation. Overall, this analysis underscores the significance of the composition of distant past reserves as a primary factor in the variation between employers' reserve ratios and benefit ratios, supporting the plausibility of the parallel trend assumption.

Secondly, identification hinges on the non-anticipation assumption. Several factors make it unlikely that the reform influenced employers before its actual implementation in 2011. Firstly, the steady depletion of the unemployment trust fund was largely ignored until December 2008, when South Carolina became insolvent and the need to increase unemployment tax rates became evident.[26] Secondly, employers had no means to anticipate the broad impact of the reform until Spring 2010, when it was approved, and they couldn't anticipate

[26] On March 19, 2010, The Sun News reported that, despite the warnings raised by the South Carolina Chamber of Commerce since 2005, the General Assembly had overlooked the steady fund depletion until March 2008, when it became evident insolvency was inevitable. Additionally, the reform process started in 2009 and was only approved in spring 2010. This delay was 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".*

the individual effects until late November 2010, when unemployment tax rate notifications were sent out. This was not solely because of the extensive data required for calculating benefit ratios, but also because the new system assigned tax rates based on employer ranking by experience rather than the absolute value of their experience.[27] Additionally, the reform stipulates a ten-year lookback period for the calculation of the benefit ratio, but SC DEW only had seven years of data available, leading to a discrepancy between the law and its implementation. Predicting an individual ranking in the state using the new formula and the corresponding tax rate was, therefore, unfeasible. When tax rates were announced to employers, it was too late to adjust: it happened *"after most companies began their fiscal years with budgets already in place"*, leaving employers *"blindsided"* with *" tens of thousands of dollars in unplanned expenses"* (The Greenville Business Magazine, April 2011). To further reduce the risk of anticipation effects, I classify employers as treated and control based on their 2009 reserve ratios and using the 2010 predicted benefit ratio instead of the true 2011 benefit ratios to create benefit-ratio bins.

I estimate Equation 17 for the full study sample and separately for employers in low- and high- risk industries. The SC DEW data provides information on employers' NAICS-4 digits codes, which I use to define 305 industries. I categorize these industries as low- or high-risk depending on their average within-year standard deviation of employment between 2001 and 2006 using the QCEW data. This measure aims at identifying industries with a high degree of seasonality, where most layoffs result from the nature of the industry rather than individual employer choices or aggregate shocks. To this end, the selected period excludes variations in employment during the Great Recession.[28] I then define a cutoff value above which industries are considered high-risk. The distribution of industries average within-year standard deviation illustrated in Figure A10 shows that the 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 with this definition. As shown in Figure A11, these industries are spread across the primary, secondary and tertiary sectors, with notable concentration in construction, manufacturing, retail, professional and technical services, and hospitality.

The last step of the analysis is to map the reduced form effects from Equation 17 to elasticity estimates. I calculate the labor demand elasticity with respect to the unemployment tax per worker using Equation 19: 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 employers in low- and high-unemployment risk industries. With a similar approach, I also estimate the corresponding wage elasticities with respect to the unemployment tax per worker.

$$\epsilon_{l_x,\tau_x} = \frac{\beta_{l_x}}{\beta_{\tau_x}} \frac{\tau_{x,2010,Treat}}{l_{x,2010,Treat}} \tag{19}$$

[27] See the notes to Figure A5 for details about tax rate assignment after the reform.

[28] Figure A9 shows a correlation of 0.99 between industries' median and average within-year employment standard deviation. This 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.

## 3.4 Results

**Full sample effects and the incidence of payroll taxes.** Figure 5 and Table 2 present the estimated $\beta_y$ coefficients from Equation 17 for South Carolina employers in the study sample. To reduce the noise introduced by the largest employers, I focus on employers with a quarterly workforce ranging between one and 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 employers' outcomes. Firstly, the reform increased the unemployment tax per worker of treated employers by \$197 in 2011 relative to control employers, or by 42% relative to the average tax per worker in 2010. This effect endured in subsequent years, when the benefit ratio was recalculated using a lookback period shifted by one year each year, leading to similar tax rate assignments for employers. Secondly, the reform decreased the average number of employees of treated employers by 0.37-0.9, equivalent to 4.6-11.1% of their workforce in 2010. The decline in employment began in 2011 and continued in 2012 and 2013, until employment started recovering in 2014. This progressively larger effect is consistent with gradual employers' adjustment to unplanned expenses. Thirdly, the reform resulted in a reduction in the total wages paid by treated employers by \$19,500-43,000, or 6.2-13.6% of the 2010 wage level. However, there is no evidence of effects on the average wage, indicating that the decrease in wages was solely driven 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), and are 1.2 and 1.4 larger than the mean average wage in 2010 respectively. Fourthly, there is no effect on taxable wages, suggesting that the reduced number of employees exactly compensates the higher taxable wage base. This hypothesis is confirmed by the increase in the taxable wages based on the 2010 payroll, which represent an estimate of employers' taxable wages if they did not reduce their workforce at the time of the reform. The gap between true and non-behavioral taxable wages, sized \$10,000, exactly coincides with the taxable wage base of the missing worker of negative reserve ratio employers. 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, due to a combination of a lower tax per worker and more reduced number of employees. The comparison with total taxes based on the 2010 payroll indicates that if treated did not reduce their workforce, they would have paid \$213 more in 2012, \$506 more in 2013 and \$264 more in 2014 in unemployment taxes.

In summary, the unemployment tax per worker of negative reserve ratio employers increased by \$200 per year compared to positive reserve ratio employers. In response, negative reserve ratio downsized their workforce by nearly one employee. Since the average wage remained unchanged, the reduction in wages can be attributed solely to the reduction in workforce size. These findings suggest that the incidence of unemployment taxes is on employers, who do not pass the tax backward to workers in the form of lower wages. Furthermore, since the results are consistent with the absence of a one-average wage employee, it appears that wage rigidities due to minimum wage regulations are not a driving factor in these outcomes.

Additionally, these findings indicate that the reform effectively increased employers' unemployment taxes, aligning with South Carolina's goal to replenish the unemployment trust fund. However, the revenue collected was diminished by employers' responses to the tax increase.

**Robustness.** I test the stability of my findings in several ways. First, I expand the sample to include 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 A12 presents the $\beta$ coefficients from Equation 17 estimated for the sample of employers with an year-average number of employees greater than one. Results remain consistent. 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 number of 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 decline by 5-33%, indicating that the decline in employment more than compensates the increase in the taxable wage base. Unemployment taxes grew by 64% in 2011 and by approximately 30% in 2012 and 2013. These results confirm not only the validity of the initial findings for large employers as well but also demonstrate that the observed patterns are not driven by outliers when using outcomes in level.

Second, my findings are robust to using a different definition of benefit ratio groups. My original approach consists in creating very small bins (sized 0.000001) of predicted benefit ratio and include fixed effects for each of these bins. Alternatively, I calculate employers' yearly benefit ratios 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 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 in the same bins. The bins are larger than in the original to guarantee the presence of enough employers sharing the same history. This approach allows me to compare employers with not only the same overall layoff rate during the pre-period, but also the same distribution of layoffs over the seven years. Figures A13 present the reduced form effects of the reform on firm outcomes in levels using this alternative set of fixed effects. Negative reserve ratio employers experienced an increase in their unemployment tax per worker of \$245 in 2011 and \$140 thereafter relative to positive reserve ratio employers. In response, they reduced their number of 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 are unaffected, but would have increased by \$6,400-11,000 per year if employers did not decrease the size of their workforce. As a result, total taxes increased by \$1,800 in the first year and \$600 thereafter, but would have increased by \$1,900 and \$900 per year in absence of behavioral responses.

Finally, I present an alternative version of these findings using a continuous treatment measuring employers' account reserves in 2009. This demonstrates that my results are not contingent on the specific zero-reserve ratio cutoff that I use to distinguish treated from control employers. An increase in account reserves by \$1,000,000 leads to a 2% increase in taxes per worker, a 1% reduction in the number of employees, a 2-2.5% decrease in wages, no impact on the average wage, a 2% decline in taxable wages, and a 1% increase in taxes –1% less than the absence of behavioral responses.

**Additional considerations and findings.** First, given that the South Carolina Department of Employment and Workforce (SC DEW) conducts routine audits of 1,000-1,500 employers annually to verify the accuracy and honesty of the information provided by employers, as well as the presence of penalty rates for employers found misreporting, it is improbable that the observed effects are a result of employers manipulating their data to lower their tax liabilities.

Second, my ability to back up a labor demand elasticity from the reduced form effects relies on the assumption that the decline in the number of employees among treated employers is primarily due to reduced hiring rather than increased separations. While my data lacks explicit information on hirings and separations, several factors support this assumption. Firstly, if the gradual employment reduction were driven by separations, we wouldn't observe a gap between true taxable wages and taxable wages based on the 2010 payroll in 2011, because employers pay taxes on wages paid to employees they lay off during the year. Then, the reform took place in the aftermath of the Great Recession, when most separations had already taken place and employers' primary decision-making margin was related to hiring.[29]. Furthermore, Guo (2023) shows that the rise in unemployment taxes after the Great Recession had a detrimental effect on employment in a group of U.S. states, including South Carolina. By examining data on both hirings and separations, she identified reduced hirings as the primary factor behind the decline in employment.

I then explore the existence of heterogeneous effects of the reform by firm size, age, and productivity, proxied by average wage. Figure A15 reveals that the impact is more pronounced for larger and younger firms, with no notable variations by productivity. I use these findings to discuss whether the observed effects are driven by liquidity or price effects. The rise in the tax per worker can deter hiring for two potential reasons: 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 Saez et al. (2019)'s approach and assess whether the reform's impact on employment is more significant for small and young firms, which may face liquidity constraints. The larger drops in younger firms may suggest liquidity effects, but the more substantial effects on larger firms point in the opposite direction.

Lastly, I examine whether the reform influenced firm shutdown rates. I expand my sample to include employers that entered or exited the sample between 2005 and 2014 and estimate Equation 17 using as outcome an indicator which equals one in the last year of observation for each employer. The results, presented in Figure A16, do not offer substantial evidence of differential firm exit rates, both in the full sample and in the subsamples of younger and smaller employers.

**Heterogeneous effects by industries' unemployment risk**. Table 2 and Figure 5 illustrate the estimated $\beta_y$ coefficients from Equation 17 separately for employers in low- and high-unemployment risk industries. Despite facing similar increases in their unemployment taxes per worker, employers in low- and high-risk industries display markedly different responses. Firstly, the decrease in the number of employees and wages, as observed in the full sample, is primarily driven by employers in high-risk industries. These employers see a reduction in the number of employees by 0.8-2.4 and a decline in wages by $40,000-117$,000. In contrast, employers in low-risk industries witness an increase in the number of employees by 0.3-0.8 over the period, although this increase appears to stem from a positive trend initiated in the pre-reform period. Average wages remain unaffected for employers in both types of industries. Consistent with their stable payroll, employers in low-risk industries experience a sharp increase in their taxable wages driven by their higher tax rates and the

[29]This sentiment is echoed in reports from the 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 we will not recover."*

higher taxable wage base: by $7,000 in 2011 and then by $13,000-18,000. In contrast, the taxable wages of employers in high-risk industries remain unaffected, or even decline (although the estimates are insignificant) with their lower number of employees. Consequently, taxes increase for both sets of employers in 2011 and then diverge, with low-risk employers still facing higher taxes by $800 per year and high-risk employers drastically reducing their tax burden.

These differences are consistent with employers in high-risk industries having more flexibility or a deeper understanding of the unemployment insurance system, allowing them to precisely adjust their workforce to offset the higher taxes. Meanwhile, the lack of an effect for employers in low unemployment risk industries implies that unemployment taxes curtail profits in these sectors.

**Elasticities calculation.** Table 4 presents the labor demand elasticities with respect to the unemployment tax per worker, calculated using Equation 19, for the full sample of South Carolina employers and the subsamples of employers in low- and high-unemployment risk industries. For the calculation, I use the $\beta_{2013}$ coefficients from Equation 17. These coefficients are selected to best represent the impact of the reform after allowing time for adjustments to take place. I estimate a full sample labor demand elasticity of -0.1. In line with their comparable increase in the unemployment tax per worker but differing employment responses, the labor demand elasticity varies significantly for employers in low- and high-risk industries. I observe a labor demand elasticity of 0.047 for employers in low-risk industries and -0.26 for employers in high-risk industries. The estimated value of $\epsilon_{l_H,e} = -0.26$ is the one I utilize in my formula for the optimal degree of experience rating. The table also includes the estimated wage elasticities with respect to the unemployment tax per worker. Since I do not find any reduced form effects on the average wage in either the full sample or for employers in low- and high-unemployment risk industries, these elasticities are small and statistically insignificant.

#### 3.4.1 The Colorado Experiment [TO REVIEW]

The same analysis of estimating employers' elasticity of labor demand to unemployment taxes and examining heterogeneities by industries' unemployment risk was replicated using employer-level data from CO DLE, leveraging the elimination of a surcharge in Colorado as a source of variation in unemployment taxes. All the details of this analysis are contained in Appendix C. The government eliminated a surcharge in 2018 after replenishing its Unemployment Trust Fund and repaying the federal government loan taken during the Great Recession. Since the surcharge was applied as a percentage increase to the tax rate, employers with high tax rates disproportionately benefitted from its elimination. I compare the evolution of firm outcomes for different cohorts of employers with high tax rates at different points in time. Only the cohort with high-tax rates in 2017 benefitted from the reduction in taxes in 2018. The results show that the reduction in the unemployment tax led to significantly higher employment and wages for the affected employers, with no impact on their average wage. Further investigation into the heterogeneities of this effect by industries' unemployment risk revealed larger effects for high-risk industries. Although I could not claim that the effects were statistically different due to imprecise estimates, the elasticity of labor demand in high-risk industries was estimated to be -2.5, while the elasticity for low-risk industries was -1.345. The Colorado experiment corroborates the evidence obtained from the South Carolina experiment, providing robustness and validation to the earlier findings.

# 4 Optimal Degree of Experience Rating

Equation 10 defines the optimal degree of experience rating as the level that equalizes the marginal value and the marginal cost of increasing insurance for employers. Assessing the magnitude of the parameters in the formula enables me to quantify and compare the benefit and the cost and discuss implications for the optimal policy. If the marginal benefit outweighs the marginal cost, employers are underinsured, and experience rating should be decreased to enhance welfare. If the marginal costs exceed the marginal benefits, employers are overinsured, and experience rating should be increased. After estimating the labor demand elasticity with respect to the degree of experience rating for employers in the high-risk industry in Section 3, I proceed with the calibration of the other parameters in the formula.

## 4.1 Calibrating the Cost of Labor Reallocation

Table 5 presents the parameters determining the marginal cost of insurance due to labor reallocation. For each parameter, the table summarizes the approach and data used for calibration, along with the calibrated value. I begin by quantifying the parameters within $\lambda$ – the scaling factor of the labor demand elasticity $\epsilon_{l_H} e$, explicitly expressed in Equation 12. The model parameters to calibrate are $e$, $b$, $r_H$, $w_L$, and $f_L(l_H, k)$.

I calibrate the degree of experience rating of the unemployment insurance system $e$, with the 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 (the base period), based on the SC DEW data. As shown in Figure 7, the median cumulative tax cost per dollar of benefit charged during the base period increased over time. The value of 0.29 for 2007 indicates that the median employer paid 29 cents in unemployment taxes in 2007 for every dollar of benefit charged during the base period. By 2008, the total cost had increased to 61 cents, reaching \$1.15 by 2010. This dynamic illustrates that, under a reserve ratio system, unemployment taxes increase gradually over time following benefit charges: it took four years for these employers to repay the full benefit cost and accumulate new account reserves. I calculate the average of these median tax costs between 2007 and 2010 and use this value to calibrate the degree of experience rating in South Carolina. The calibration results in $e = 0.75$, indicating that, on average, the median employer paid 75 cents between 2007 and 2011 for every dollar of unemployment benefit charged during the base period. This value aligns with other estimates from the literature, ranging between 75 and 87 cents for different states and different measures of experience with unemployment (Topel 1984, Johnston 2021).

I calibrate the unemployment benefit level $b$ using the average unemployment benefit claimed in South Carolina in 2006, based on ET 394 data. I use data from 2006 for the calibration to avoid the influence of the Great Recession while still representing the same period from which the other parameters are assessed. The average benefit is calculated as the product of the average benefit duration in weeks and the average weekly benefit amount. 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 total quarterly employment in high-risk industries in South Carolina in 2006, based on the QCEW data. Using the same definition of high-unemployment risk industries described in Section 3.3, based on the standard deviation of employment within the year, I find that $r_H = 0.046$. This value indicates that employment in high-risk industries is 4.6% lower in the trough quarter compared to the peak quarter. For reference, the unemployment risk in low-risk industries is $r_L = 0.016$.

To calibrate the wage offered in the low-risk industry, $w_L$, I use the average annual wage offered in low-risk industries in South Carolina from the QCEW data, calculated as the ratio between total wages and average employment in 2006. I find that $w_L = \$37.274$.

Lastly, calibrate the marginal productivity in the low-risk industry of the marginal worker employed in the high-risk industry, $f_L(l_H, k)$, I observe in Figure 1 that it coincides with the measure of point D on the y-axis. Consequently, I can back up $f_L(l_H, k) = w_L + (1 - e)B$. Here, $B$ is the total expected benefit cost in the economy, and is calculated as $B = r_H l_H b$ from Equation 4. I calibrate $l_H = 0.56$ using the employment share of high-risk industries in South Carolina in 2006 and use the values for $e$, $r_H$ and $b$ just derived to obtain $B = 77$ and $f_L(l_H, k) = \$37,293$.

Combined, these parameters give total value of $\lambda$ of -\$11.26. This number represents the loss resulting from skill misallocation and the fiscal externality associated with an additional worker in high-unemployment risk industries. 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 2.93. This value indicates that for every dollar of insurance offered to employers, \$2.93 are lost due to the misallocation of productive skills and the fiscal externality induced by the reallocation of workers towards high-unemployment risk industries.

## 4.2 Calibrating the Cost of Employer Moral Hazard

Table 6 presents the parameters determining the marginal cost of insurance due to employer moral harzard. As shown in Equation 10, the sufficient statistic representing the cost of employer moral hazard is the elasticity of effort with respect to the degree of experience rating, $\epsilon_{m,e}$. To calibrate this elasticity, I leverage the relationship between effort, $m$, and the unemployment risk, $r_H$, in the model: $r_H = p_H + \frac{1}{m}$. Section B.8 derives the effort elasticity as a transformation of the elasticity of the unemployment risk in the high-risk industry with respect to the degree of experience rating: $\epsilon_{e,m} = -r_H m(\epsilon_{r_H,e})$. Since the unemployment risk in the high-risk industry coincides with the layoff rate in the economy, I can calibrate $\epsilon_{r_H,e}$ using an estimate of the layoff elasticity from the literature on employer moral hazard. Table A4 present various estimates from this literature, ranging between -0.43 and zero. I selected -0.27 from Topel (1984), lying in the middle of the range, as preferred estimate, and explore the implications of using alternative estimates. In particular, the estimate of zero from Johnston (2021) would minimize the total cost of insurance by setting the cost of moral hazard to zero. However, it's important to note that this estimate is derived from a sample of employers in Florida who are assigned the maximum unemployment tax rate. These employers are likely to be firms that have either already laid off workers or have a consistently high layoff rate, regardless of the cost associated with layoffs. As a result, the zero layoff elasticity estimated in this sample likely represents a lower bound for the layoff elasticity in the state.

To calibrate the effort exerted to avoid negative shocks, $m = \frac{1}{r_H - p_H}$, I still need to determine the value of the exogenous factor in the high-risk industry's unemployment risk, $p_H$. To do so, I assume that employers in low- and high-risk industries exert the same level of effort, and that the unemployment risk structure in the low-risk industry resembles that of the high-risk industry, $r_L = p_L + \frac{1}{m}$, with the exception that there is no exogenous risk, $p_L = 0$. This allows me to calculate $p_H$ as the difference in the unemployment risk between the high- and the low- risk industries, $p_H = r_H - r_L$. I obtain that $p_H = 0.03$ and $m = 62.5$ Combined, these values yield an elasticity of effort with respect to the degree of experience rating $\epsilon_{m,e} = 0.78$.

Lastly, I use Equation 13 to obtain the value of $\mu$, measuring the fiscal externality associated with decreased effort to avoid negative shocks. I find that $\mu = \$2.52$. Multiplying this value by the effort elasticity gives a total cost of employer moral hazard of \$1.97. This means that for every dollar of insurance offered to employers, \$1.97 are lost due to the fiscal externality generated by increased layoffs.

## 4.3 Calibrating the Value of Insurance

In Equation 10, the sufficient statistic that embodies the marginal benefit of insurance for employers is the difference in marginal profits between the good and bad states for the high-risk employer. This difference reflects the additional losses that employers incur when facing higher unemployment taxes, which cause a further reduction in their net worth following a negative shock. One example of such loss would be higher borrowing cost. The loss per dollar of tax increase is represented by the parameter $q$. Section 2.3 discusses several alternative interpretations for these losses and the marginal profit gap. I focus here on the two interpretations enabling me to calibrate this parameter. The first approach assumes that workers value the survival of employers due to the risk of unemployment that is associated with negative shocks to employers. This enables me to proxy the value of insurance for employers with the value of insurance for workers. I borrow an estimate for the value of insurance for workers from the existing literature. The upper bound of these estimates is 3.13 from Landais et al. (2021). This estimate, when interpreted as the value of insurance for employers, indicates that employers are willing to pay up to \$3.13 to shift a dollar from the good to the bad state of the world.

The second approach assumes that the wellbeing of employers by itself matters for social welfare. Consequently, it is valuable to provide insurance to employers who cannot optimally adjust following a shock, due, for instance, to liquidity constraints or wage rigidities. I calibrate the value of insurance for employers with the estimated elasticity of employment with respect to the number of hours subsidized with short-time work from Giupponi et al. (2022). The estimate of 2.53 indicates that employers are 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 coinsurance and to compare them to discuss the implications for the optimal policy.

On the cost side, my results indicate that the cost of labor reallocation is 2.93, 49% higher than the cost of employer moral hazard, calibrated at 1.97. Intuitively, this occurs because, based on my calibration, the fiscal externality associated with a marginal worker in the high-unemployment risk industry is larger than the one associated with reduced effort. Moreover, the misallocation of productive skills in the labor market further increases the cost of labor reallocation. Figure A17 compares the cost of labor reallocation with the cost of employer moral hazard when using alternative estimates for the layoff elasticity from Table A4. The figure shows that the calibrated cost of employer moral hazard ranges between zero and 3.13, depending on the layoff elasticity used. A more conservative interpretation of the findings would be that labor reallocation is at least as important as employer moral hazard for determining the cost of coinsurance. This finding is significant given the relatively limited attention that this channel has received.

Together, labor reallocation and employer moral hazard imply a total cost of insurance of 4.9. Figure 8 compares this cost with the two calibrations for the value of insurance, 3.13 and 2.58. These numbers indicate that for every dollar of insurance offered to employers, up to $3.13 are gained in insurance value, but $4.9 are lost due to labor reallocation and employer moral hazard. Since the marginal cost of insurance exceeds the marginal value, these results suggest that before the 2011 reform of unemployment insurance financing, employers in South Carolina were overinsured, and the degree of experience rating in the state was suboptimal. Confirming this interpretation, Figure A18 shows that even when assuming that there is no cost of employer moral hazard, the cost of insurance, driven by the cost of labor reallocation, would still be as large as the value of insurance for employers proxied by the value for workers, and larger than the value of insurance for illiquid employers.

The case for a greater degree of experience rating is further supported by the fact that the calibrated cost of insurance is likely a lower bound for the true cost, while the calibrated value is likely an upper bound for the true value. Section 2.3 discussed that introducing additional features in the model, such as accounting for workers' preferences over sectors and employment status, leads to a larger cost of insurance. At the same time, it is reasonable to assume that the value of insurance for workers, which motivates the existence of the unemployment insurance system, exceeds the value of insurance for employers.

These conclusions, however, should be applied with caution. The value of insurance for employers, calibrated using estimates from other countries and periods, may have been significantly higher during the Great Recession. In support of this hypothesis, East et al. (2015) suggest that the value of insurance for workers may be higher during recessions during regular times. Further research on the value of insurance for employers and its variation over the economic cycles seems thus necessary before drawing definitive conclusions.

Additionally, this evaluation relies on local estimates that are applicable to the specific context from which they were derived, namely South Carolina. The generalizability of these findings should thus be discussed. Given the overall similarity in labor market and experience rating structure between South Carolina and other states in the US, it appears that these findings can be reasonably extended to the rest of the country. However, applying these conclusions to other countries, such as those in Europe or Canada where experience rating is not in place, is more complex. In European countries, for example, strong employment protection policies may reduce the extent of employer moral hazard, which could suggest a lower need for experience rating. However, with uniform tax rates, there may be even greater systematic subsidization of high-unemployment risk industries. Understanding the desirability of experience rating in European countries is particularly important because some of these nations have recently introduced layoff taxes, and discussions regarding the design of the European Unemployment Benefit Scheme are ongoing, with some experts advocating for it to follow the US model.

# 5 Conclusions

Unemployment insurance provides crucial support for unemployed workers. However, the program entails significant costs, ranging between 0.12 and 2.8% of the GDP in western economics. A significant portion of the funding for unemployment benefits is derived from payroll taxes imposed on employers. However, there exist substantial variations in the methods used by governments to allocate unemployment tax rates to employers across different countries. While in the United States employers are assigned individualized unemployment tax rates based on the benefit cost of their layoffs (experience rating), most other countries assign a common tax rate to all employers irrespective of individual costs. (coinsurance). Which of these two approaches is preferable is unclear, and policymakers often lack clear guidance for making informed choices in this regard.

This paper investigates theoretically and empirically the optimal design of unemployment insurance financing policies. First, I derive a formula for the optimal unemployment insurance financing scheme as a function of estimable sufficient statistics. This employer-Baily-type formula specifies that the optimal scheme balances the marginal value and cost of coinsurance. Although coinsurance acts as a safeguard for employers, insuring them against steep increases in unemployment taxes in case of negative shocks, it also comes with two costs. First, it reduces the cost of layoffs internalized by employers, leading to more frequent layoffs. This employer moral hazard imposes a fiscal externality on the government budget through a higher benefit cost. Second, it subsidizes the expansion of high-unemployment risk industries, leading to the reallocation of workers towards those industries. This both imposes a fiscal externality through a higher benefit cost and results in the misallocation of productive skills.

Second, I put the theoretical formula for the optimal degree of experience rating into practice by empirically assessing its various components. This allows me to make a direct comparison between the magnitude of the benefits and costs associated with coinsurance. The ultimate goal is to evaluate whether the degree of experience rating should be increased or decreased to achieve greater welfare. I use unemployment tax filing data from South Carolina and Colorado and leverage quasi-experimental variation in unemployment taxes from state-level reforms of experience rating policies to estimate the cost of labor reallocation. Then, I calibrate the other statistics in the formula using various moments from the data and estimates from the literature. My results suggest that labor reallocation is the primary cost of providing insurance to employers, at least as costly as employer moral hazard. Additionally, the combined cost of moral hazard and labor reallocation seems higher than the value of insurance, implying that in these states the current degree of experience rating may be suboptimal.

Additional research is essential to reinforce and complement these findings. In particular, future research should explore theoretically and empirically the value of insurance for employers. While my study indirectly estimated this value, quantifying it directly and exploring how it varies over different economic cycles is essential for determining the desirability of further experience rating in the United States.

Moreover, difference in labor market structures and institutional setups between the United States and European countries or Canada may limit the generalizability of these results to these contexts. However, assessing the desirability of experience rating for these countries where it is currently not in place seems of primary important. This is particularly relevant for European countries, where the recent introduction of layoff taxes and ongoing discussions about the design of the European Unemployment Benefit Scheme have sparked interest in potentially moving closer to the United States' experience rating model (Fuest et al. 2005, Simonetta 2017).

Rather than firmly advocating for a particular policy direction, this paper lays the groundwork for a deeper comprehension of how unemployment insurance system financing influences various aspects of the labor market. These aspects encompass the frequency of layoffs, the size of industries, and the distribution of the tax burden among employers. The primary practical significance of this paper is to therefore make policymakers aware of the tradeoffs associated with their choices in this critical area. Three primary considerations arise from my findings. First, the paper underscores the significant role of labor reallocation in driving the cost of coinsurance in South Carolina. This discovery holds particular importance in situations where moral hazard is presumed to be limited, which would provide a rationale for the adoption of coinsurance. For instance, in European countries, where layoffs are limited by strong employment protection policies (Saez et al. 2023), or in seasonal industries, where layoffs may occur regardless of their cost. My results indicate that even in the absence of moral hazard, coinsurance could impose notable welfare costs due to interindustry labor reallocation.

Secondly, these results offer insights on the distributional consequences of alternative measures of experience with unemployment. The choice between the reserve ratio and the benefit ratio, each with its distinctive lookback periods and elements considered for the assessment of experience, has substantial implications for how the burden of unemployment taxes is distributed among employers. Given the known impact of unemployment taxes on employment levels, policymakers must carefully weigh the consequences of selecting one measure over the other for assigning unemployment taxes to different groups of employers and stakeholders.

Thirdly, governments should consider the diverse responses of employers to changes in their payroll taxes. These responses not only impact various industries in different ways but also influence the size of the tax revenue. These considerations are particularly significant today in the United States, where there is an ongoing debate about enhancing the generosity of unemployment benefits, which were significantly reduced following the Great Recession, by raising unemployment taxes (Wandner 2023).

# References


Anderson, Patricia M. (1993). "Linear Adjustment Costs and Seasonal Labor Demand: Evidence from Retail Trade Firms". *The Quarterly Journal of Economics* 108.4, pp. 1015–1042.

Anderson, Patricia M. and Bruce D. Meyer (1993a). "The Unemployment Insurance Payroll Tax and Interindustry and Interfirm Subsidies", pp. 111–144.

— (1993b). "Unemployment Insurance in the United States: Layoff Incentives and Cross Subsidies". *Journal of Labor Economics* 11.1, S70–S95.

— (Dec. 1994). *The Effects of Unemployment Insurance Taxes and Benefits on Layoffs Using Firm and Individual Data*. Working Paper 4960. National Bureau of Economic Research.

— (1997). "The effects of firm specific taxes and government mandates with an application to the U.S. unemployment insurance program". *Journal of Public Economics* 65.2, pp. 119–145.

— (2000). "The effects of the unemployment insurance payroll tax on wages, employment, claims and denials". *Journal of Public Economics* 78.1. Proceedings of the Trans Atlantic Public Economics Seminar on, pp. 81–106.

Baily, Martin Neil (1978). "Some aspects of optimal unemployment insurance". *Journal of Public Economics* 10.3, pp. 379–402.

Becker, Joseph M. (1972). "Experience Rating in Unemployment Insurance: An Experiment in Competitive Socialism". *Johns Hopkins University Press.*

Behaghel, Luc, Bruno Crépon, and Béatrice Sédillot (2008). "The perverse effects of partial employment protection reform: The case of French older workers". *Journal of Public Economics* 92.3, pp. 696–721.

Bentolila, Samuel and Giuseppe Bertola (1990). "Firing Costs and Labour Demand: How Bad is Eurosclerosis?" *The Review of Economic Studies* 57.3, pp. 381–402.

Benzarti, Youssef and Jarkko Harju (2021a). "Can payroll tax cuts help firms during recessions?" *Journal of Public Economics* 200, p. 104472.

— (Mar. 2021b). "Using Payroll Tax Variation to Unpack the Black Box of Firm-Level Production". *Journal of the European Economic Association* 19.5, pp. 2737–2764.

Bernanke, Ben and Mark Gertler (1989). "Agency Costs, Net Worth, and Business Fluctuations". *The American Economic Review* 79.1, pp. 14–31.

Blanchard, Olivier J. and Jean Tirole (2008). "The Joint Design of Unemployment Insurance and Employment Protection: A First Pass". *Journal of the European Economic Association* 6.1, pp. 45–77.

Brechling, Frank (1977). "The incentive effects of the U.S. unemployment insurance tax." *Research in Labor Economics* 1.

Burdett, Kenneth and Randall Wright (1989). "Optimal firm size, taxes, and unemployment". *Journal of Public Economics* 39.3, pp. 275–287.

Burgess, Paul L. and Stuart A. Low (1992). *Unemployment Insurance and Employer Layoffs*. Unemployment Insurance Occasional Paper. U.S. Department of Labor, Employment and Training Administration, Unemployment Insurance Service.

Card, David and Phillip B. Levine (1994). "Unemployment insurance taxes and the cyclical and seasonal properties of unemployment". *Journal of Public Economics* 53.1, pp. 1–29.

Chetty, Raj (2006). "A general formula for the optimal level of social insurance". *Journal of Public Economics* 90.10, pp. 1879–1901.

Deere, Donald R. (1991). "Unemployment Insurance and Employment". *Journal of Labor Economics* 9.4, pp. 307–324.

Diamond, Peter A. (1981). "Mobility Costs, Frictional Unemployment, and Efficiency". *Journal of Political Economy* 89.4, pp. 798–812.

Duggan, Mark, Audrey Guo, and Andrew Johnston (2022). *Experience Rating as an Automatic Stabilizer*. Tech. rep.

East, Chloe N. and Elira Kuka (2015). "Reexamining the consumption smoothing benefits of Uemployment Insurance". *Journal of Public Economics* 132, pp. 32–50.

Fath, Julia and Clemens Fuest (2005). *German Economic Review* 6.4, pp. 471–483.

Feldstein, Martin (1976). "Temporary Layoffs in the Theory of Unemployment". *Journal of Political Economy* 84.5, pp. 937–957.

Fuest, Clemens and Julia Fath (Jan. 2005). "Experience Rating of Unemployment Insurance in the US: A Model for Europe?" *CESifo DICE Report* 3, pp. 45–50.

Giupponi, Giulia and Camille Landais (Dec. 2022). "Subsidizing Labour Hoarding in Recessions: The Employment and Welfare Effects of Short-time Work". *The Review of Economic Studies* 90.4, pp. 1963–2005.

Gruber, Jonathan (1997a). “The Consumption Smoothing Benefits of Unemployment Insurance”. *The American Economic Review* 87.1, pp. 192–205.

— (1997b). “The Incidence of Payroll Taxation: Evidence from Chile”. *Journal of Labor Economics* 15.S3, S72–S101.

Guo, Audrey (July 2021). “The Effects of State Business Taxes on Plant Closures: Evidence from Unemployment Insurance Taxation and Multi-Establishment Firms”. *The Review of Economics and Statistics*, pp. 1–45.

— (July 2023). *Payroll Tax Incidence: Evidence from Unemployment Insurance*. Working Paper.

Guo, Audrey and Andrew C. Johnston (2021). “The Finance of Unemployment Compensation and Its Consequences”. *Public Finance Review* 49.3, pp. 392–434.

Halpin, Terrence C. (1979). “The Effect of Unemployment Insurance on Seasonal Fluctuations in Employment”. *Industrial and Labor Relations Review* 32.3, pp. 353–362.

Hendren, Nathaniel (July 2017). “Knowledge of Future Job Loss and Implications for Unemployment Insurance”. *American Economic Review* 107.7, pp. 1778–1823.

Hopenhayn, Hugo and Richard Rogerson (1993). “Job Turnover and Policy Evaluation: A General Equilibrium Analysis”. *Journal of Political Economy* 101.5, pp. 915–938.

Johnston, Andrew C. (Feb. 2021). “Unemployment Insurance Taxes and Labor Demand: Quasi-Experimental Evidence from Administrative Data”. *American Economic Journal: Economic Policy* 13.1, pp. 266–93.

Kaiser, Carl P. (1986). “Unemployment Insurance and the Theory of Labor Demand”. *Eastern Economic Journal* 12.2, pp. 115–128.

Katz, Lawrence F., Claudia Goldin, and Katherine Baicker (1998). “A Distinctive System: Origins and Impact of U.S. Unemployment Compensation”. In: *The Defining Moment: The Great Depression and the American Economy in the 20th Century*. Ed. by M. Bordo, C. Goldin, and E. White. NBER and University of Chicago Press.

Lachowska, Marta, Wayne Vroman, and Stephen A. Woodbury (2020). “Experience Rating and the Dynamics of Financing Unemployment Insurance”. *National Tax Journal* 73.3, pp. 673–698.

Landais, Camille and Johannes Spinnewijn (Nov. 2021). “The Value of Unemployment Insurance”. *The Review of Economic Studies* 88, pp. 3041–3085.

Laurence, Louise (1993). “How large are the subsidies provided by the system of financing unemployment insurance?” *The Quarterly Review of Economics and Finance* 33.3, pp. 233–245.

Leombruni, Roberto, Adriano Paggiaro, and Ugo Trivellato (2003). *Per un pugno di euro. Storie di ordinaria disoccupazione.* Istituto per la ricerca valutativa sulle politiche pubbliche. Fondazione Bruno Kessler.

Lester, Richard A. (1960). "Financing of unemployment insurance". *ILR Review* 14.1, pp. 52–67.

Lester, Richard A. and Charles V. Kidd (1939). "The Case against Experience Rating in Unemployment Compensation". *Princeton University Press, Princeton, New Jersey.*

Mark, Curtis. E., Daniel G. Garrett, Eric Ohrn, Kevin A. Roberts, and Juan Carlos Suárez Serrato (Nov. 2021). "Capital Investment and Labor Demand: Evidence from 21st Century Tax Policy".

McCaffree, Kenneth M. (1975). *Industrial and Labor Relations Review* 28.2, pp. 331–332.

Miller, Michael and Robert Pavosevich (2019). "Alternative Methods of Experience Rating Unemployment Insurance Employer Taxes". *Public Budgeting & Finance* 39.4, pp. 28–47.

Mortensen, Dale T. (1983). "A welfare analysis of unemployment insurance: Variations on second-best themes". *Carnegie-Rochester Conference Series on Public Policy* 19, pp. 67–97.

Munts, Raymond C. and Ephraim Asher (1980). "Cross-Subsidies Among Industries From 1969 to 1980". *Unemployment Compensation: Studies and Research*, pp. 277–297.

OECD (2023). *Public unemployment spending (indicator).*

Post, The Denver (2020). *Colorado's unemployment rate is poised to double in less than three weeks. Here's what you need to know.* Tech. rep.

Saez, Emmanuel, Benjamin Schoefer, and David Seim (May 2019). "Payroll Taxes, Firm Behavior, and Rent Sharing: Evidence from a Young Workers' Tax Cut in Sweden". *American Economic Review* 109.5, pp. 1717–63.

— (2023). *Deadwood Labor:The Effects of Eliminating Employment Protection.* Working Paper.

Schmieder, Johannes F. and Till von Wachter (2016). "The Effects of Unemployment Insurance Benefits: New Evidence and Interpretation". *Annual Review of Economics* 8.1, pp. 547–581.

Simonetta, Suzanne (2017). "What the EU Can Learn from the American Experience with Unemployment Insurance". *Intereconomics* 52, pp. 142–148.

Suárez Serrato, Juan Carlos and Owen Zidar (Sept. 2016). "Who Benefits from State Corporate Tax Cuts? A Local Labor Markets Approach with Heterogeneous Firms". *American Economic Review* 106.9, pp. 2582–2624.

Topel, Robert (1977). “Unemployment and Unemployment Insurance”. *Research in Labor Economics* 7, pp. 91–135.

— (1983). “On Layoffs and Unemployment Insurance”. *American Economic Review* 73.4, pp. 541–59.

— (1984). “Experience Rating of Unemployment Insurance and the Incidence of Unemployment”. *The Journal of Law and Economics* 27.1, pp. 61–90.

Topel, Robert and Finis Welch (1980). “Unemployment Insurance: Survey and Extensions”. *Economica* 47.187, pp. 351–379.

Wandner, Stephen A. (2023). *Transforming Unemployment Insurance for the Twenty-First Century: A Comprehensive Guide to Reform*. Tech. rep.

## 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:* The table shows summary statistics for South Carolina employers in the study sample 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. They are obtained by summing the taxable wages paid in each quater of the year. Total taxes are obtained by multiplying employers' individual tax rate by taxable wages. The reserve ratio is calculated as in Equation 14.

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

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

*Notes:* This table illustrates the elasticities of employment with respect to the unemployment tax per workers and the components that contribute to their calculation for the full sample South Carolina employers with at least one and less than fifty employees in 2010 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. The elasticity is calculated using the formula in Equation 19. The $Treated \times 2013$ coefficients are the estimated $\beta$ coefficients from Equation 17.

Table 3: Cost of Labor Reallocation: Parameters' Estiamated 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 |
| $l_H$ | Employment share in the high-risk industry | Employment share of high-risk industries in South Carolina in 2006 | QCEW | 0.56 |
| $B$ | Total expected unemployment benefit cost | $bl_Hr_H$ | - | $77 |
| $f_L(l_H, k)$ | Productivity of the marginal worker in the low-risk industry | $w_L + (1-e)B$ | - | $37,293 |
| $\lambda$ | Skill misallocation and fiscal externality | Equation 12 | - | -11.26 |
| $\epsilon_{l_H,e}$ | 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 insurance due to labor reallocation** | - | - | **2.93** |

*Notes:* The table summarizes the approach and data source used to estimate or calibrate the parameters determining the marginal cost of insurance due to labor reallocation in Equation 10, along with the calibrated values for each parameter, for $\lambda$, and for the cost of insurance due to labor reallocation.

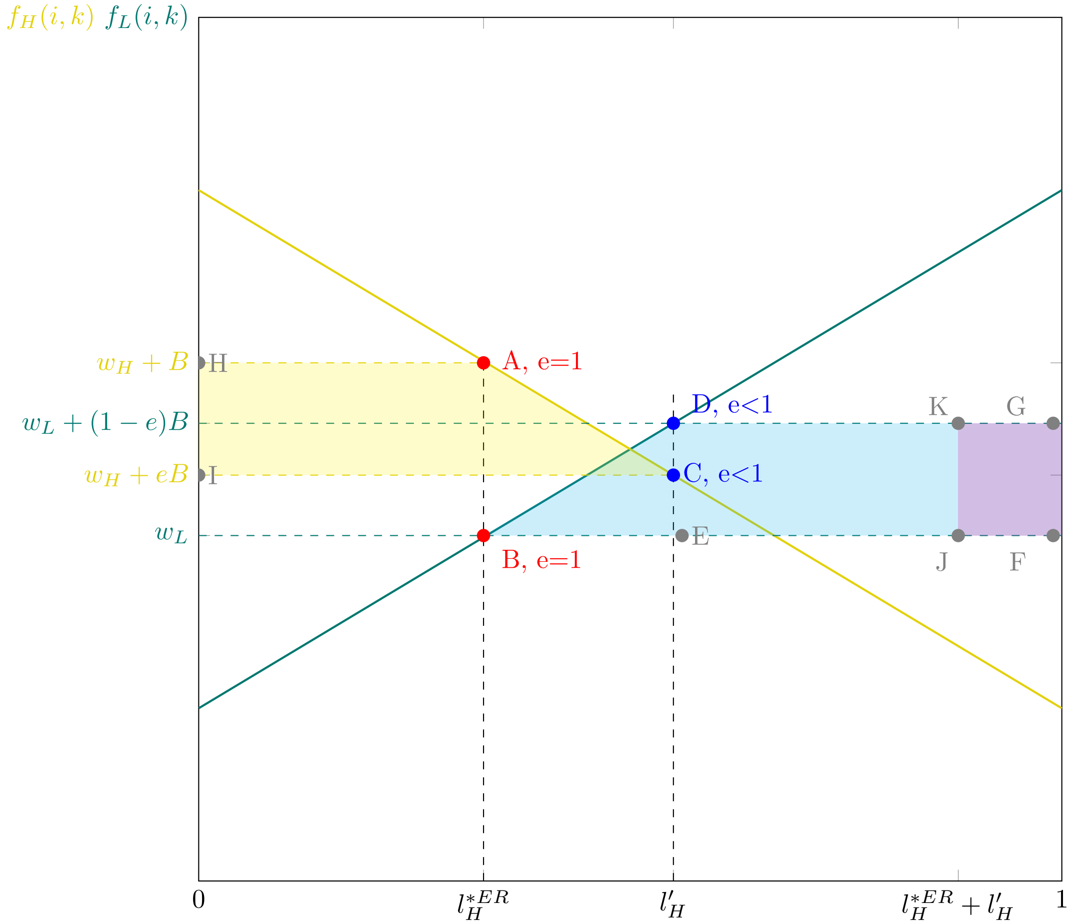
Table 4: Cost of Employer Moral Hazard: Parameters' Calibrated Values

| **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 | $r_H - r_L$ | - | .03 |
| $m$ | Effort to avoid shock | $\frac{1}{r_H - p_H}$ | - | 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 13 | - | 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:* The table summarizes the approach and data source used to estimate or calibrate the parameters determining the marginal cost of insurance due to employer moral hazard in Equation 10, along with the calibrated values for each parameter, for $\mu$, and for the cost of insurance due to employer moral hazard.

## Main Figures

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




Workers $i$

*Notes:* This graph illustrates the productivity in the low- and the high-risk industry, $f_L(i), k$ and $f_H(i,k)$ on the y-axis for each worker between 0 and 1, on the x-axis. Points A and B specify the allocation of workers between industries with complete experience rating; points C and D with coinsurance.

Figure 2: Model Timeline

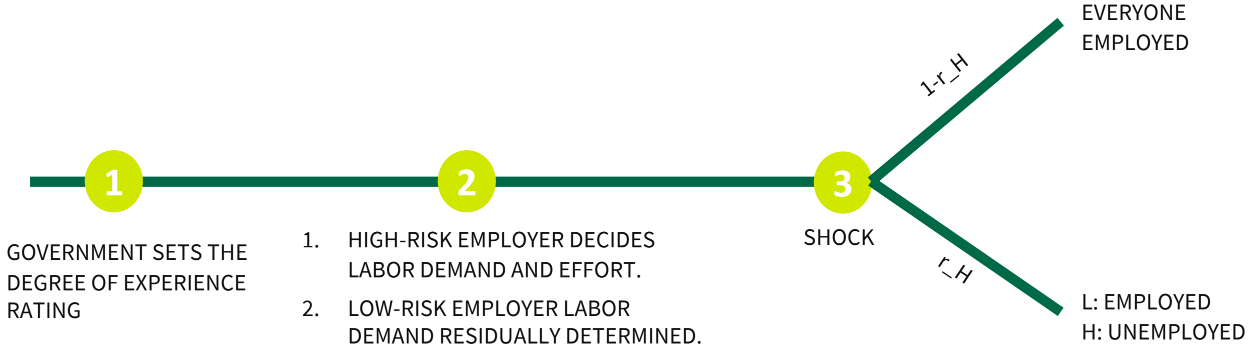
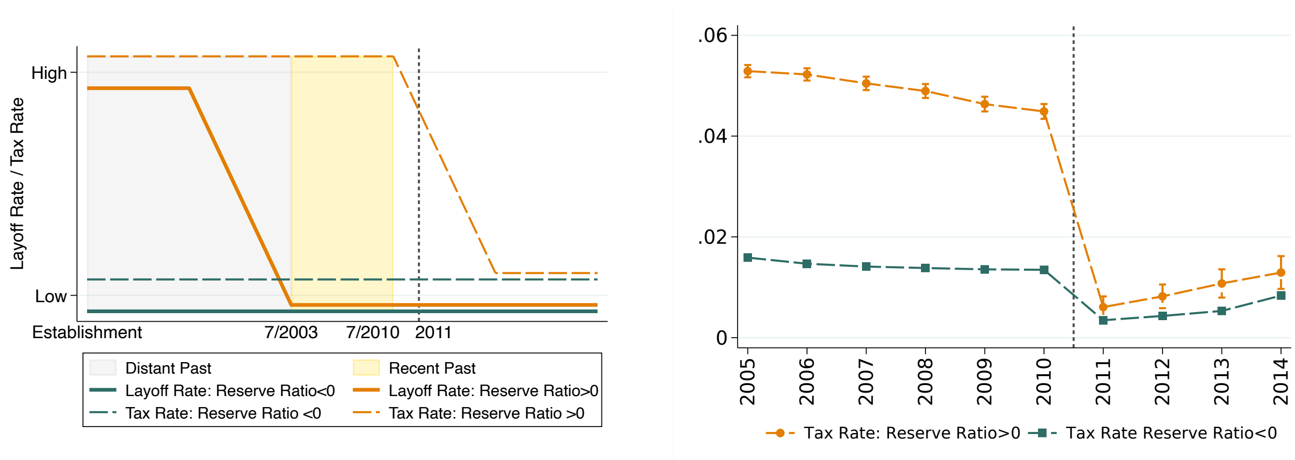



Figure 3: Variation in Unemployment Tax Rates by Reserve Ratio Conditioning on the Benefit Ratio

(a) Illustrative example

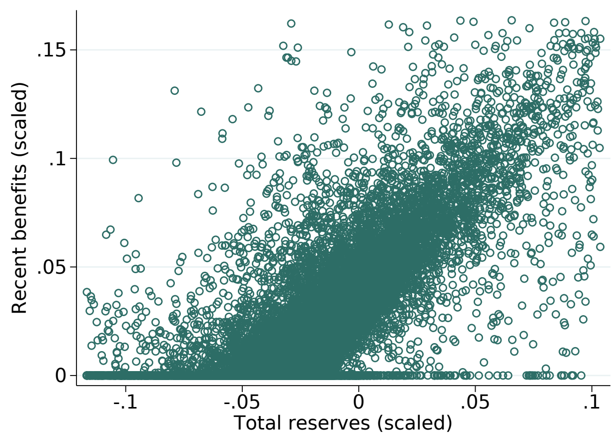
(b) Data counterpart



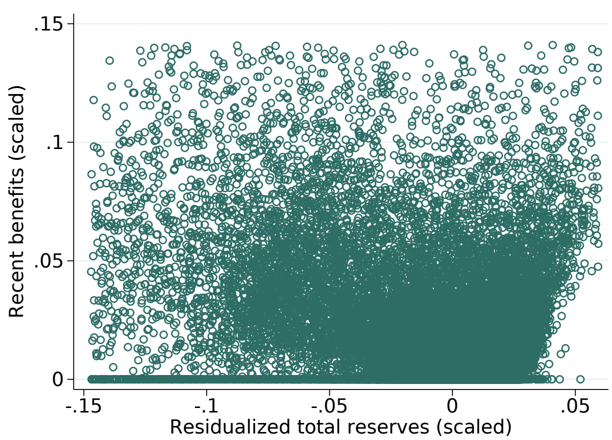

*Notes:* Panel (a) illustrates the layoff rates (solid lines) and tax rates (dashed lines) of two representative employers with equal benefit ratio but different reserve ratio (positive, blue, and negative, green) over the distant and recent past. Panel (b) plots the average tax rate for South Carolina employers with positive (blue) 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

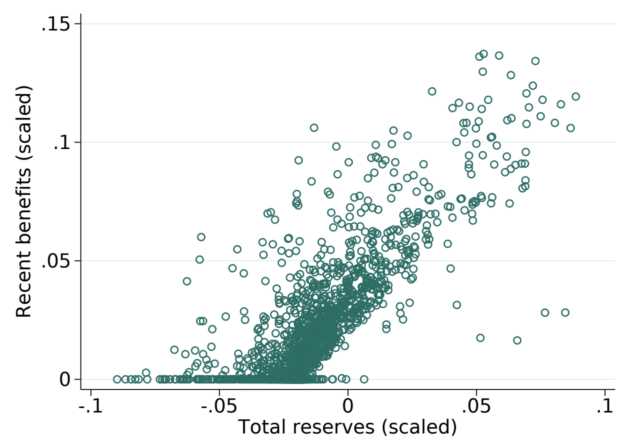
(a) Total Variation




(b) Variation due to Memory

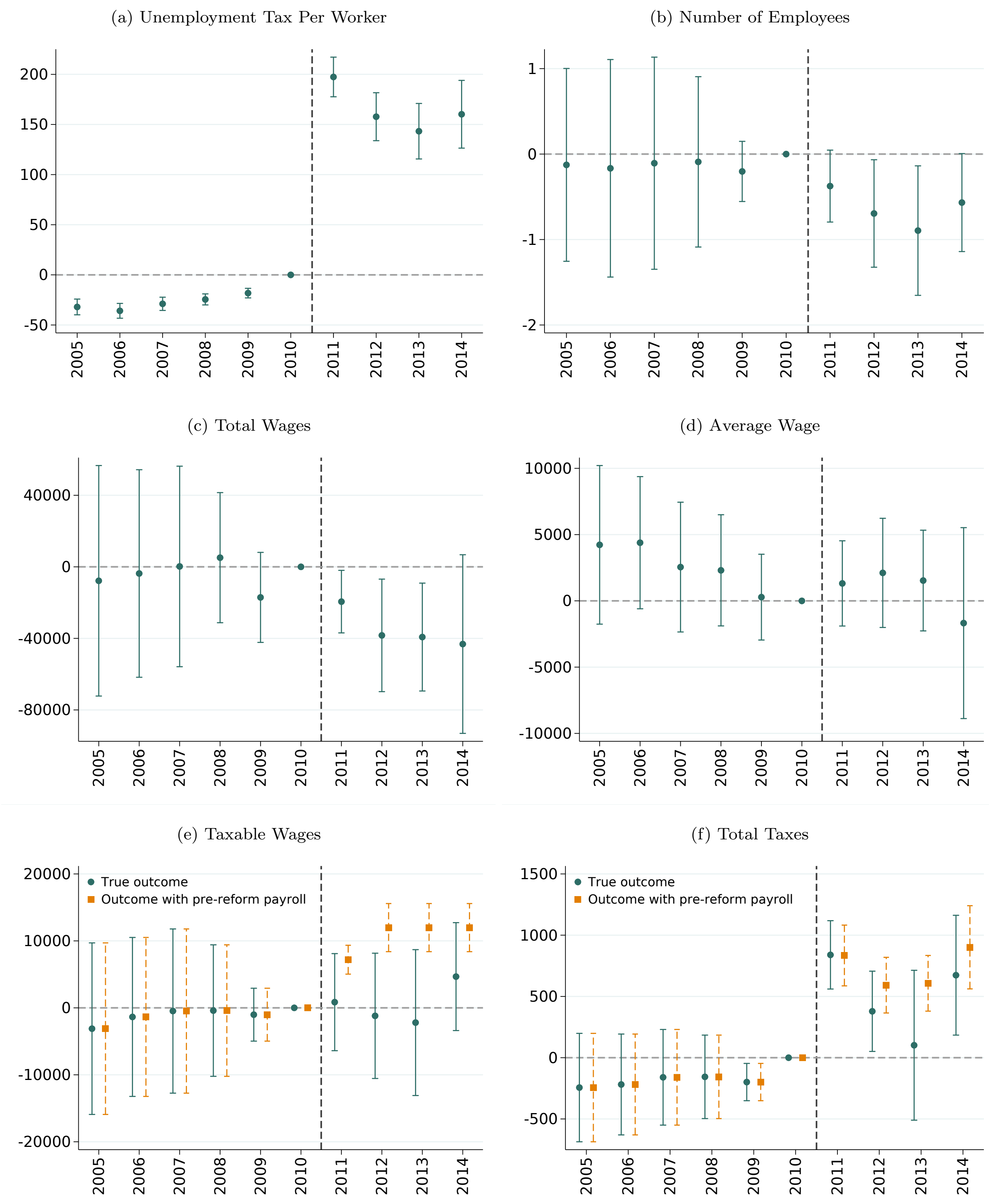



(c) Variation due to Match



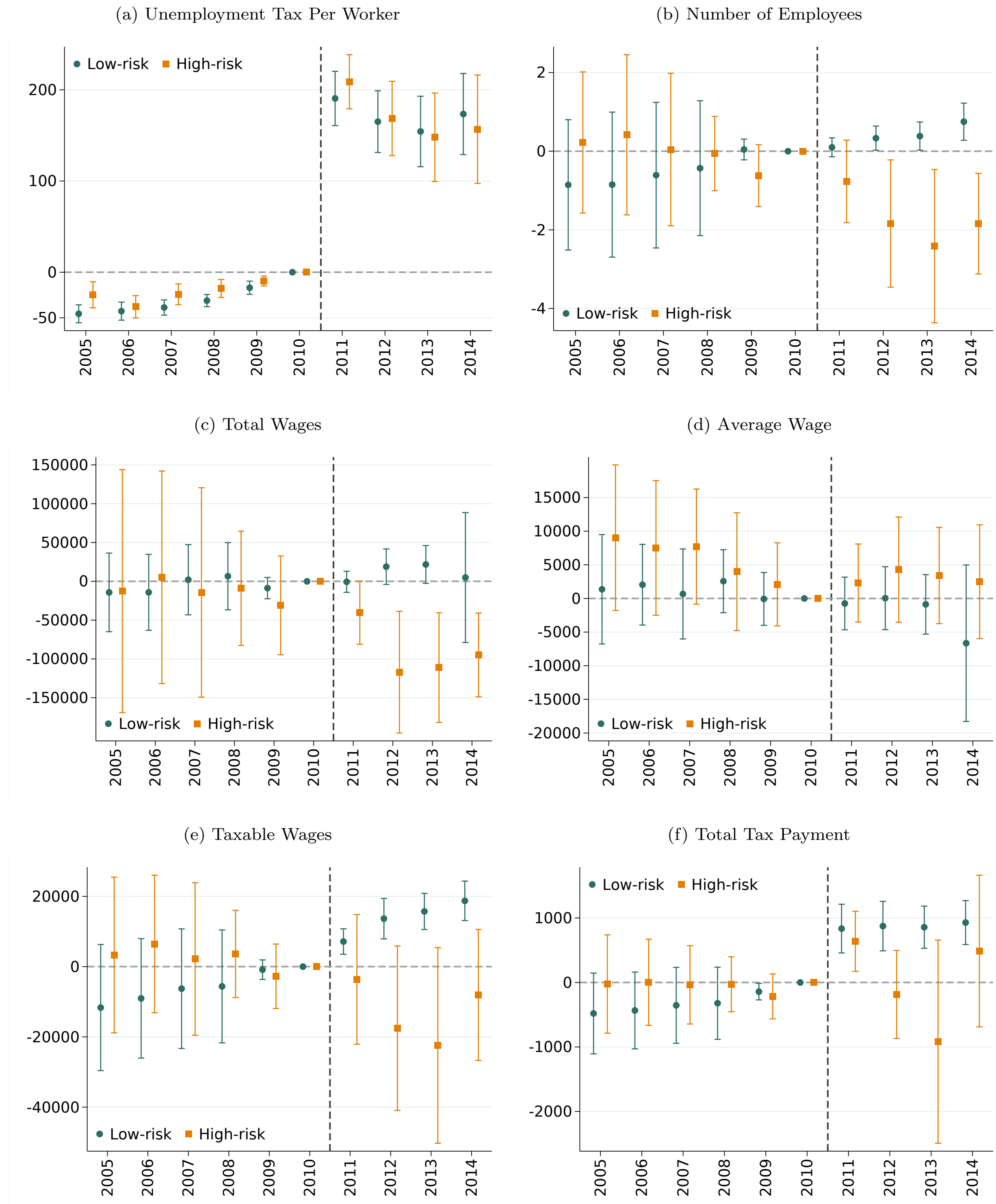

*Notes:* This figure illustrates the variation between South Carolina employers' reserve ratios and benefit ratios and the drivers of this variation. Panel (a) plots employers by their 2011 scaled recent benefits and 2010 scaled total reserves, both scaled by recent taxable wages to emphasize differences driven by the numerators. Scaled recent benefits thus coincide with the benefit ratio, while scaled recent reserves are a modified version of the reserve ratio maintaining the original numerator but using the benefit ratio's denominator. Panel (b) plots employers by their scaled recent benefits and residualized scaled total reserves, obtained from a regression of reserves on scaled recent taxes. 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. All these variables have been trimmed at the first and ninety-ninth percentile.

Figure 5: Reduced Form Effects of Reserve-to Benefit Ratio Shift on Employer Outcomes



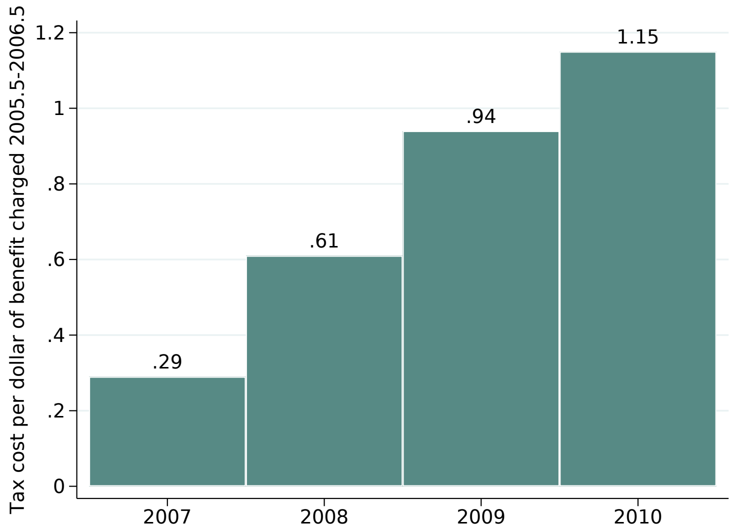

*Notes:* This figure illustrates the estimates of the $\beta_y$ coefficients from Equation 17 estimated for South Carolina employers with 1-50 quarterly employees in 2010. See the notes to Table 1 for details on the outcomes. Taxable wages based on the 2010 payroll are equal to true taxable wages until 2010, and to the taxable wages in 2010, scaled by the relative increase in the taxable wage base from 2011 on. Total taxes based on the 2010 payroll are obtained by multiplying taxable wages based on the 2010 payroll and employers' unemployment tax rates. 95% confidence intervals are reported. The coefficients and standard errors are reported in Table **??**.

Figure 6: Reduced Form Effects of Reserve-to Benefit Ratio Shift on Employer Outcomes by Industry Risk



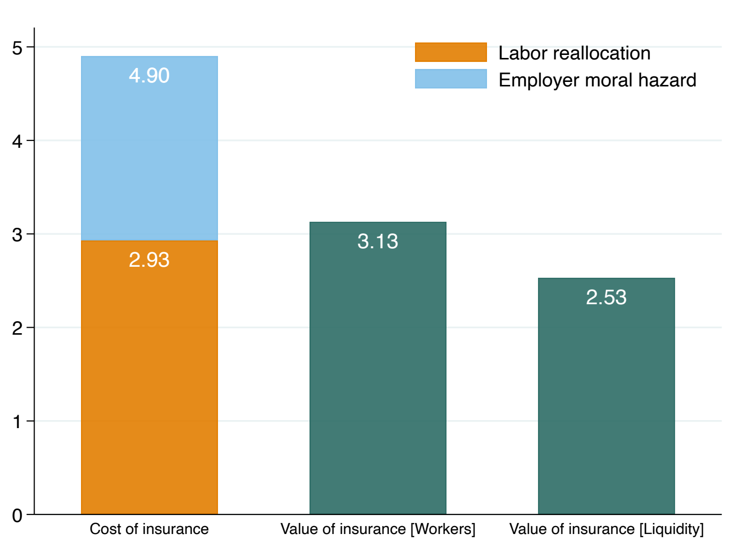

*Notes:* This figure illustrates the estimates of the $\beta_y$ coefficients from Equation 17 estimated for the full sample of South Carolina employers and the two subsamples of employers in low- and high- risk industries. Each of these samples is restricted to employers with 1-50 quarterly employees in 2010. High-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 between 2001 and 2006. See the notes to Table 1 for details on the outcomes. 95% robust confidence intervals are reported. The coefficients and standard errors are reported in Table **??**.

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




*Notes:* The figure illustrates the median cumulated tax cost in 2007, 2008, 2009 and 2010 per dollar of unemployment benefit charged to South Carolina employers between July 2005 and July 2006. The broad sample of South Carolina employers is restricted to include employers observed continuously between 2007 and 2010 with no other benefit charge between July 2003 and July 2011. For each year I plot the median of ratio between the dollar value of the tax payments made between 2007 and the considered year and the dollar value of the benefits charged between July 2005 and July 2006.

Figure 8: Comparing the Marginal Cost and Benefit of Increasing Insurance for Employers in South Carolina




*Notes:* This figure illustrates the calibrated marginal cost and marginal value of increasing insurance for employers through a reduction in the degree of experience rating in South Carolina. The marginal cost is obtained by summing the cost of interindustry labor reallocation, calibrated in Table 5 and the cost of employer moral hazard, calibrated in Table 6. The value of insurance [worker] is the estimated value of insurance for worker from Landais et al. (2021). The value of insurance [liquidity] is the estimated value of insurance for employers with liquidity constraints from Giupponi et al. (2022).

## 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:* The table illustrates the distribution of employers and employees and the average wage across broad economic sectors in South Carolina in 2009 using the administrative dataset provided by the South Carolina Department of Employment and Workforce (SC DEW), which excludes the top 1% employers, and the Quarterly Census of Employment and Wages (QCEW), covering all private sector employers.

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: Employer Characteristics* | | | | | | | | |
| Number of employees | 31,878 | 11.980 | 20.422 | 71,978 | 5.686 | 18.705 | 6.293 | 0 |
| Total wages | 31,878 | 451,578.079 | 953,671.469 | 71,975 | 172,348.859 | 647,988.999 | 279,229.220 | 0 |
| Average wage | 31,583 | 40,225.009 | 59,957.251 | 62,052 | 35,983.206 | 92,069.699 | 4,241.803 | 0 |
| Year of establishment | 31,878 | 1991.553 | 10.978 | 81,893 | 2002.622 | 8.160 | -11.069 | 0 |
| Primary | 31,767 | .016 | .126 | 81,668 | .009 | .096 | .007 | 0 |
| Construction | 31,767 | .121 | .326 | 81,668 | .149 | .356 | -.029 | 0 |
| Manufacturing | 31,767 | .060 | .238 | 81,668 | .037 | .188 | .024 | 0 |
| Trade | 31,767 | .221 | .415 | 81,668 | .190 | .393 | .031 | 0 |
| Transport | 31,767 | .024 | .152 | 81,668 | .029 | .168 | -.005 | 0 |
| Services | 31,767 | .557 | .497 | 81,668 | .585 | .493 | -.028 | 0 |
| *Panel B: Unemployment Tax Data* | | | | | | | | |
| Reserve ratio | 31,855 | -.051 | 6.629 | 79,671 | -5.068 | 895.472 | 5.018 | .317 |
| Tax rate | 31,878 | .018 | .011 | 82,120 | .026 | .012 | -.007 | 0 |
| Taxable wages | 31,878 | 97,559.060 | 168,956.792 | 82,120 | 41,571.602 | 133,931.239 | 55,987.458 | 0 |
| Tax per worker | 31,878 | 128.258 | 79.020 | 82,120 | 179.759 | 82.704 | -51.501 | 0 |
| Total tax payment | 31,878 | 1,890.495 | 4,151.008 | 82,120 | 1,020.303 | 3,694.009 | 870.191 | 0 |

*Notes:* The table presents summary statistics for a set employer characteristics in 2009 and tests for difference in means between employers in the South Carolina study sample and the remaining South Carolina employers in the SC DEW dataset, who do not satisfy the inclusion criteria discussed in Section 3.2.

Table A3: List of High-Unemployment Risk Industries

| NAICS Code | Denomination | SC | CO |
|---|---|---|---|
| 1112 | | N | Y |
| 1113 | Fruit and Tree Nut Farming | Y | N |
| 1114 | | N | Y |
| 1119 | Other Crop Farming | Y | N |
| 1151 | | N | Y |
| 2111 | | N | Y |
| 2131 | | N | Y |
| 2211 | Electric Power Generation, Transmission and Distribution | Y | N |
| 2361 | Residential Building Construction | Y | Y |
| 2362 | Nonresidential Building Construction | Y | Y |
| 2371 | | N | Y |
| 2373 | | N | Y |
| 2381 | Foundation, Structure, and Building Exterior Contractors | Y | Y |
| 2382 | Building Equipment Contractors | Y | Y |
| 2383 | Building Finishing Contractors | Y | Y |
| 2389 | Other Specialty Trade Contractors | Y | Y |
| 3131 | Fiber, Yarn, and Thread Mills | Y | |
| 3132 | Fabric Mills | Y | |
| 3133 | Textile and Fabric Finishing and Fabric Coating Mills | Y | |
| 3141 | Textile Furnishings Mills | Y | |
| 3222 | Converted Paper Product Manufacturing | Y | |
| 3252 | Resin, Synthetic Rubber, and Artificial and Synthetic Fibers and Filaments Manufacturing | Y | |
| 3261 | Plastics Product Manufacturing | Y | |
| 3359 | Other Electrical Equipment and Component Manufacturing | Y | |
| 3341 | | N | Y |
| 3344 | | N | Y |
| 3363 | Motor Vehicle Parts Manufacturing | Y | |
| 4235 | Metal and Mineral (except Petroleum) Merchant Wholesalers | Y | |
| 4422 | | N | Y |
| 4431 | Electronics and appliance stores. | Y | Y |
| 4441 | Building Material and Supplies Dealers | Y | Y |
| 4442 | | N | Y |
| 4451 | Grocery Stores | Y | Y |
| 4461 | Health and personal care stores | Y | |
| 4471 | Gasoline stations | Y | Y |
| 4481 | Clothing stores | Y | Y |
| 4511 | Sporting Goods, Hobby, and Musical Instrument Stores | Y | Y |
| 4521 | Department Stores | Y | Y |
| 4529 | | N | Y |
| 4811 | | N | Y |
| 4842 | | N | Y |
| 4881 | | N | Y |
| 4921 | Couriers | Y | Y |
| 5112 | | N | Y |
| 5121 | Motion Picture and Video Industries | Y | Y |
| 5171 | | N | Y |
| 5221 | Depository credit intermediation | Y | |
| 5222 | Nondepository Credit Intermediation | Y | Y |
| 5223 | | N | Y |
| 5231 | | N | Y |
| 5239 | | N | Y |
| 5312 | Offices of Real Estate Agents and Brokers | Y | Y |
| 5322 | | N | Y |
| 5411 | Legal Services | Y | |
| 5412 | Accounting, Tax Preparation, Bookkeeping, and Payroll Services | Y | Y |
| 5413 | Architectural, Engineering, and Related Services | Y | Y |
| 5415 | | N | Y |
| 5416 | Management, Scientific, and Technical Consulting Services | Y | Y |
| 5419 | | N | Y |
| 5511 | | N | Y |
| 5613 | Employment Services | Y | Y |
| 5616 | Investigation and Security Services | Y | Y |
| 5617 | Services to Buildings and Dwellings | Y | Y |
| 5619 | | N | Y |
| 6111 | | N | Y |
| 6211 | Offices of Physicians | Y | Y |
| 6214 | | N | Y |
| 6216 | Home Health Care Services | Y | |
| 6221 | General Medical and Surgical Hospitals | Y | Y |
| 6241 | | N | Y |
| 6244 | | N | Y |
| 7112 | Spectator Sports | Y | Y |
| 7131 | Amusement Parks and Arcades | Y | Y |
| 7139 | Other Amusement and Recreation Industries | Y | Y |
| 7211 | Traveler Accommodation | Y | Y |
| 7212 | | N | Y |
| 7221 | Full-Service Restaurants | Y | Y |
| 7222 | Limited-Service Eating Places | Y | Y |
| 7223 | Special Food Services | Y | Y |

*Notes:* The table reports the NAICS four-digits code and the denomination of high-unemployment risk industries. These 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 between 2001 and 2006.

Table A4: Full Sample Reduced Form Effects of the Shift from Reserve to Benefit Ratio on Employer Outcomes

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| Outcome: | Tax per worker | Employees | Tot wages | Avg wage | Tax wages | Tax wages (2010 payroll) | Tot taxes | Tot taxes (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:* The table reports the estimates of the $\beta_y$ coefficients from Equation 17 estimated 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. See the notes to Table 1 for details on the outcomes. Taxable wages based on the 2010 payroll are equal to true taxable wages until 2010, and to the taxable wages in 2010, scaled by the relative increase in the taxable wage base from 2011 on. Total taxes based on the 2010 payroll are obtained by multiplying taxable wages based on the 2010 payroll and employers' unemployment tax rates. *** p<0.01, ** p<0.05, * p<0.1.

Table A5: Reduced Form Effects of Reserve-to Benefit Ratio Shift on Employer Outcomes by Industry 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 unempl. risk: | *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 Y 2010 | 139.1 | 139.1 | 8.126 | 8.126 | 315906 | 315906 | 40674 | 40674 | 66509 | 66509 | 1417 | 1417 |

*Notes:* The table reports the estimates of the $\beta_y$ coefficients from Equation 17 estimated for the subsamples of South Carolina employers in low- and high- risk industries. The samples are restricted to employers with 1-50 quarterly employees in 2010. High-risk industries have average within-year standard deviation of employment greater than or equal to 250 according to the Quarterly Census of Employment and Wages data for South Carolina between 2001 and 2006. See the notes to Table 1 for details on the outcomes. *** p<0.01, ** p<0.05, * p<0.1

Table A6: Elasticities of Layoffs with respect to 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 |

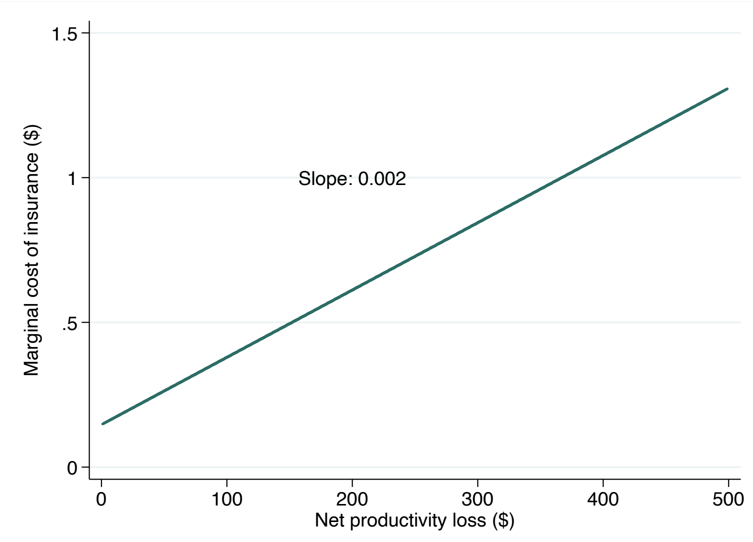
*Notes:* This table lists estimated values for the elasticity of layoffs with respect to the degree of experience rating.

Table A7: 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 |

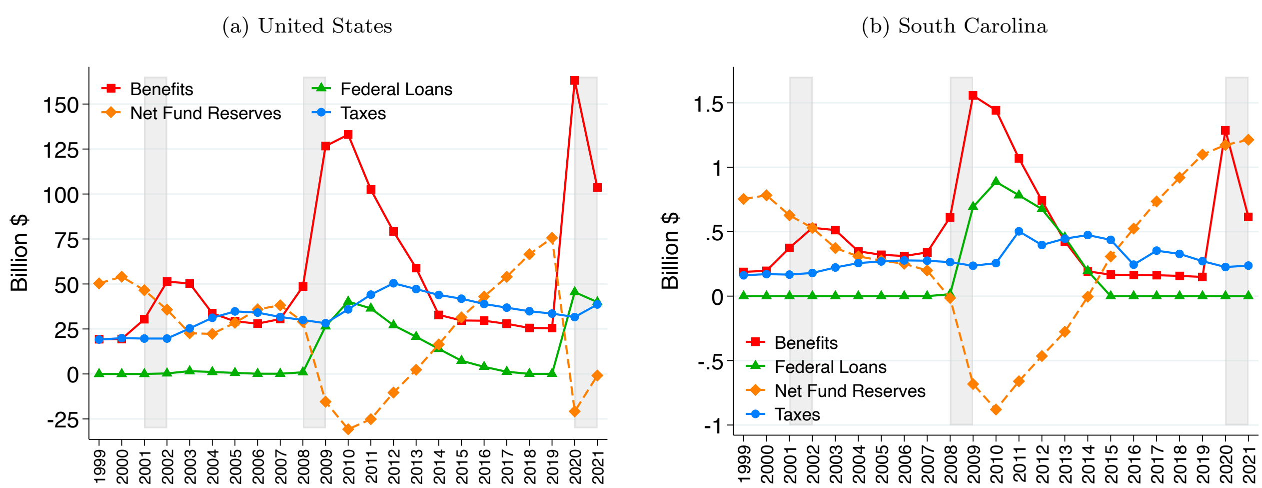
*Notes:* This table lists various estimates of the value of insurance for workers. The value of 0.89 for Gruber (1997a) is obtained by multiplying the percentage drop in consumption at layoff, 22.2% in their Table 1 by the highest value of risk aversion cosidered, 4. The value of 1.32 for Hendren (2017) 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: Marginal Cost of Insurance and the Net Productivity Loss: Simulation



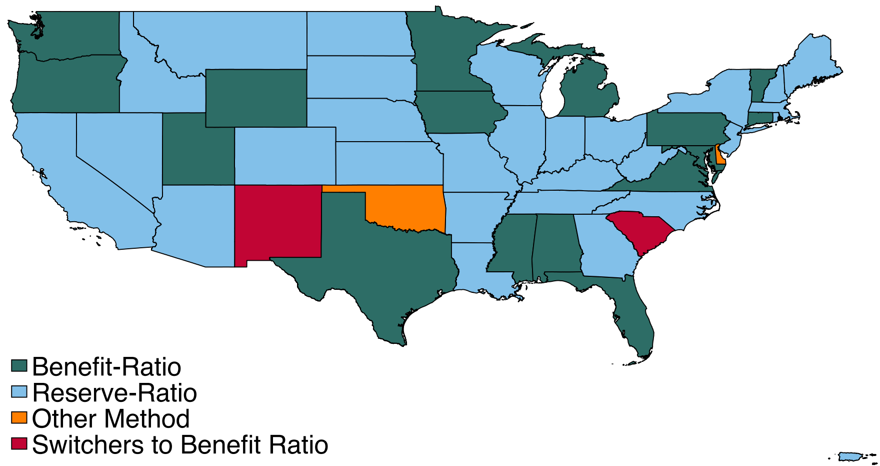

*Notes:* This figure illustrates how the marginal cost of insurance changes with the net productivity loss. The marginal cost of insurance is the sum of the cost of reallocation and the cost of moral hazard, defined in Equation 10. The net productivity loss is equal to the gap between the productivity of the marginal worker employed in the high-risk industry if they were employed in the low-risk industry and the low-risk wage. The net productivity loss affects the cost of insurance through $\lambda$, defined in Equation 12.

Figure A2: Recent Trends in Unemployment Benefits, Taxes, and Trust Fund Solvency in the United States



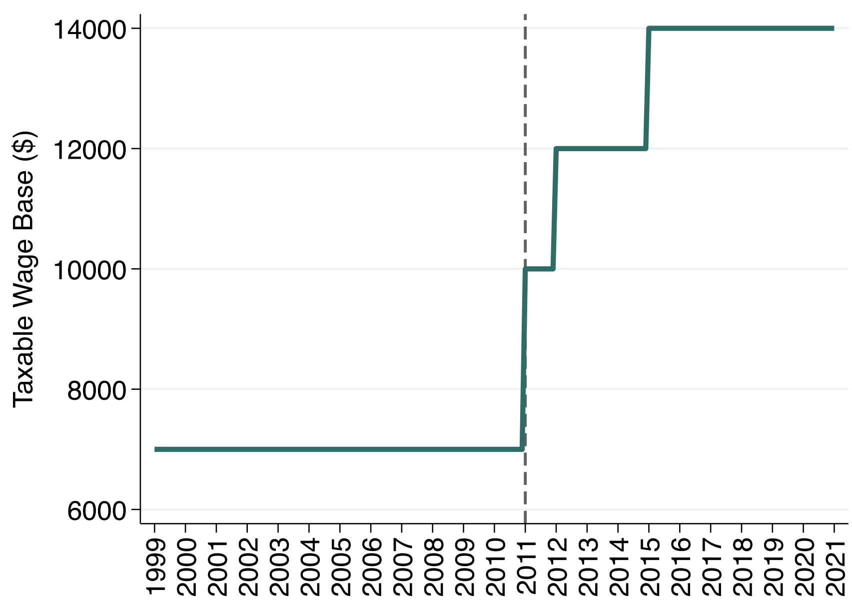

*Notes:* The figure illustrates the evolution over time of the total amount of unemployment benefits paid out to workers (regular, extended and emergency benefits), federal government loans, reserves in the Unemployment Trust Fund net of federal government loans, and unemployment taxes collected in the United States (panel [a]) and in South Carolina (panel [b]). The totals in panel (a) are obtained by summing state values. 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 A3: States' Measure of Unemployment Risk for Tax Rate Assessment



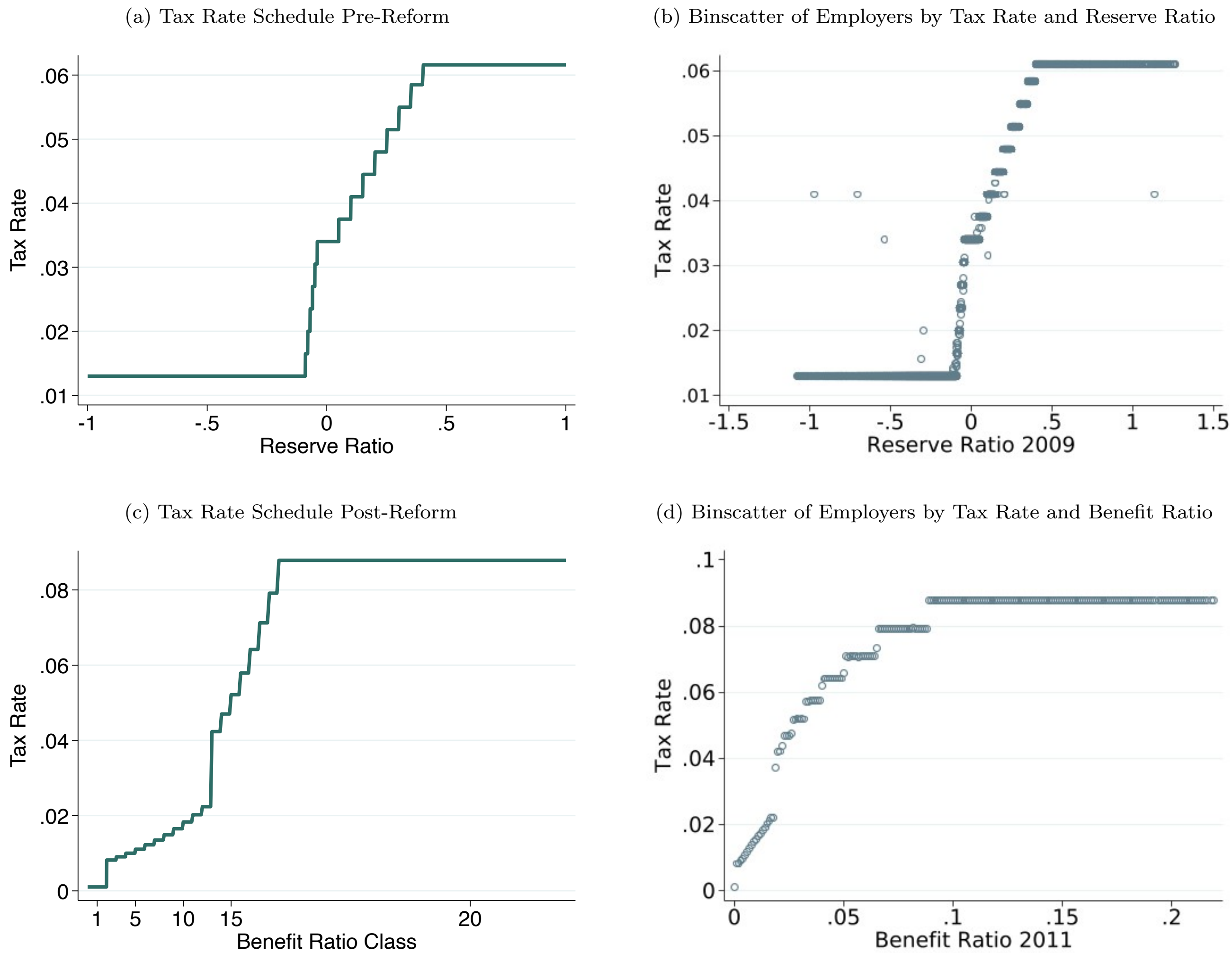

*Notes:* The figure shows the states using Benefit Ratio, Reserve Ratio, and other measures of employers' unemployment risk used to assign unemployment tax rates to employers.

Figure A4: Taxable Wage Base in South Carolina




*Notes:* The figure illustrates the evolution of the Taxable Wage Base in South Carolina between 1999 and 2021 as reported in the Unemployment Insurance Financial Data Handbook (ET Financial Handbook 394) redacted by the United States Department of Labor.

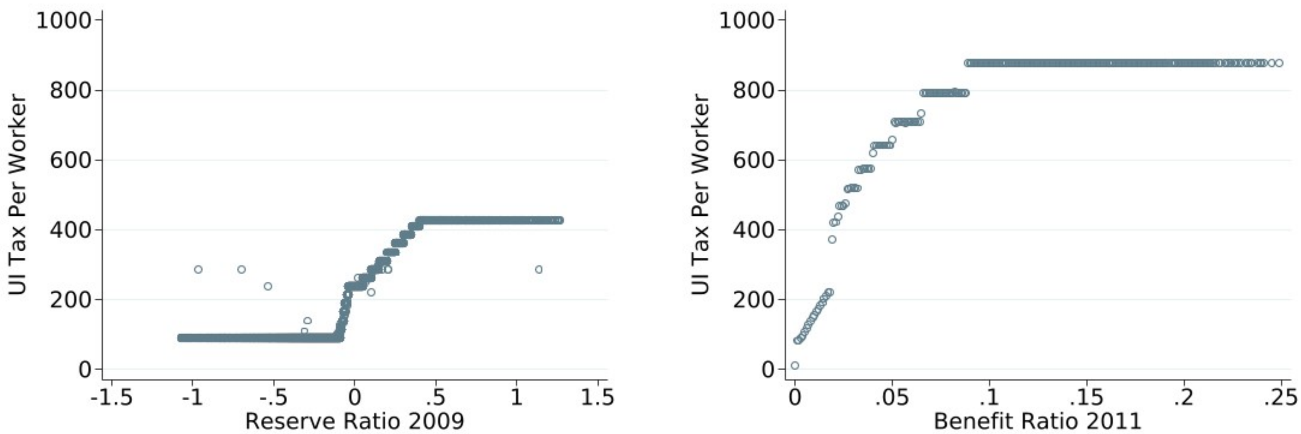
Figure A5: Pre- and Post-Reform Unemployment Tax Rate Schedules in South Carolina




*Notes:* Panel (a) illustrates the unemployment tax rate schedule in effect in South Carolina between 2004 and 2010 from the Unemployment Insurance Financing Policy database. The schedule specifies the unemployment tax rates, ranging from 1.3 to 6.1%, associated to various ranges of reserve ratio. Panel (b) is a binscatter of South Carolina employers, plotted by their effective unemployment tax rates and reserve ratios in 2009. Panel (c) illustrates the unemployment tax rate schedule in effect in South Carolina in 2011 from the 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 .103% for bottom class employers to 8.789% for top class employers. Panel (d) is a binscatter of South Carolina employers, plotted by their effective unemployment tax rates and benefit ratios in 2011. Both before and after the reform, the binscatters match the schedules, confirming compliance with unemployment financing rules.

Figure A6: Unemployment Tax Per Worker by Unemployment Risk in South Carolina around the Reform

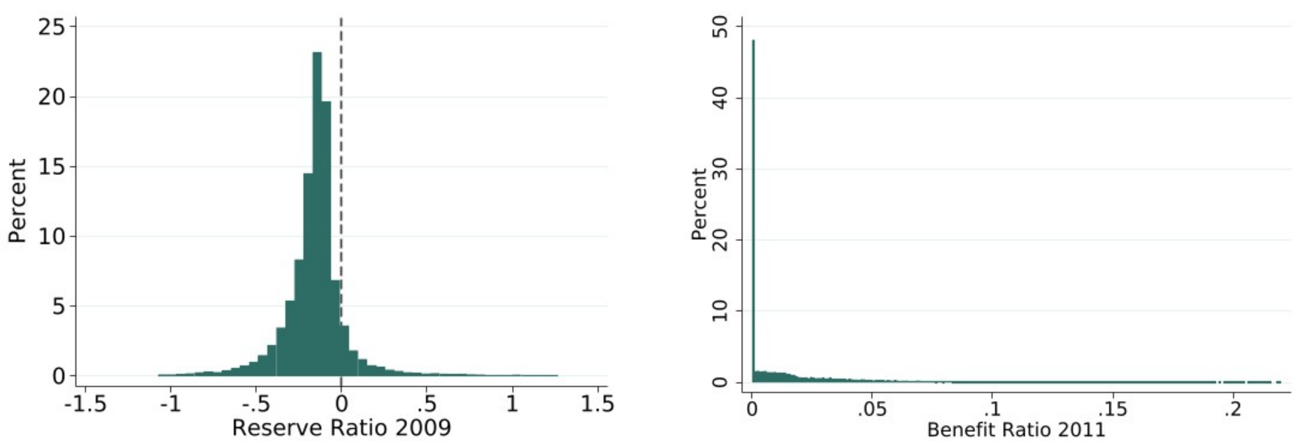
(a) Unemployment Tax Per Worker by Reserve Ratio in 2009 (b) Unemployment Tax Per Worker by Benefit Ratio in 2011




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

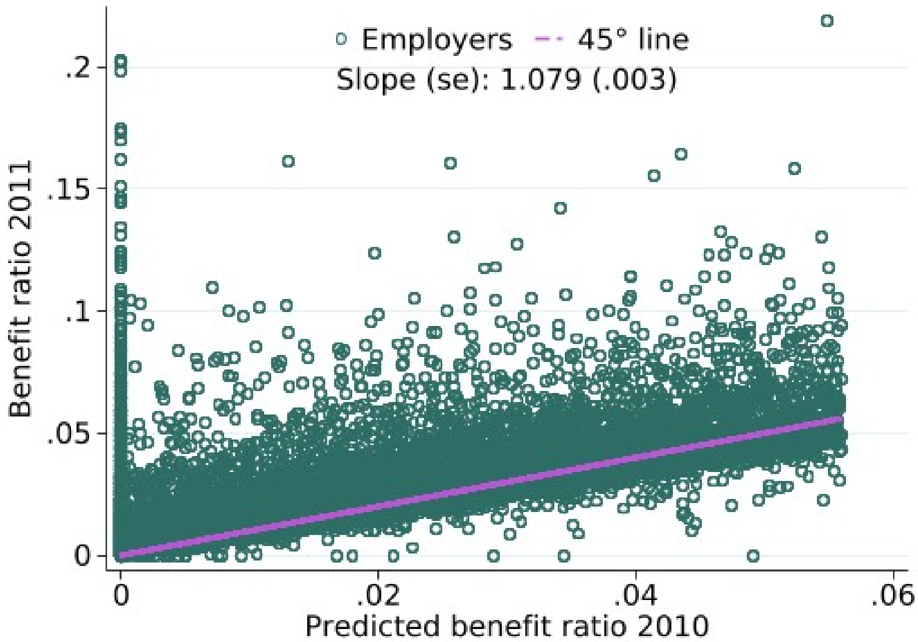
Figure A7: Unemployment Tax Per Worker by Unemployment Risk in South Carolina around the Reform

(a) Distribution of Reserve Ratio in 2009 (b) Distribution of Benefit Ratio in 2011



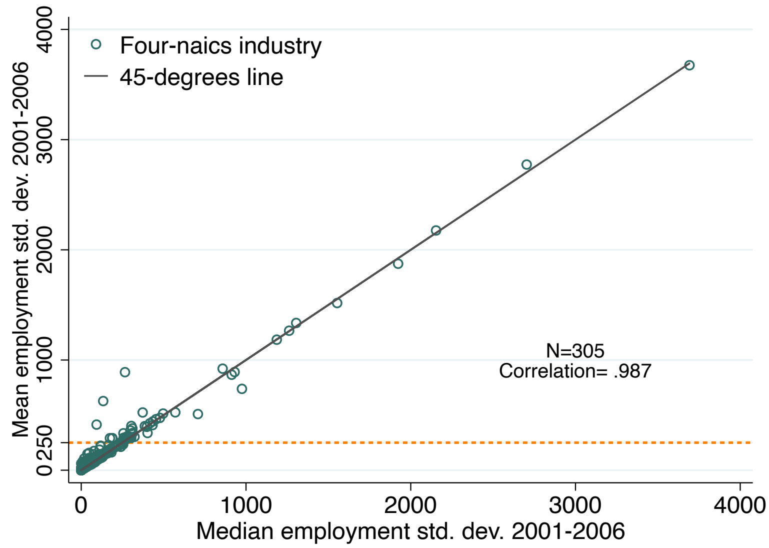

*Notes:* This figure illustrates the distribution of employers' reserve ratios in 2009 (panel [a]) and benefit ratios in 2011 (panel [b]).

Figure A8: The Relationship between True Benefit Ratio in 2011 and Predicted Benefit Ratio in 2010



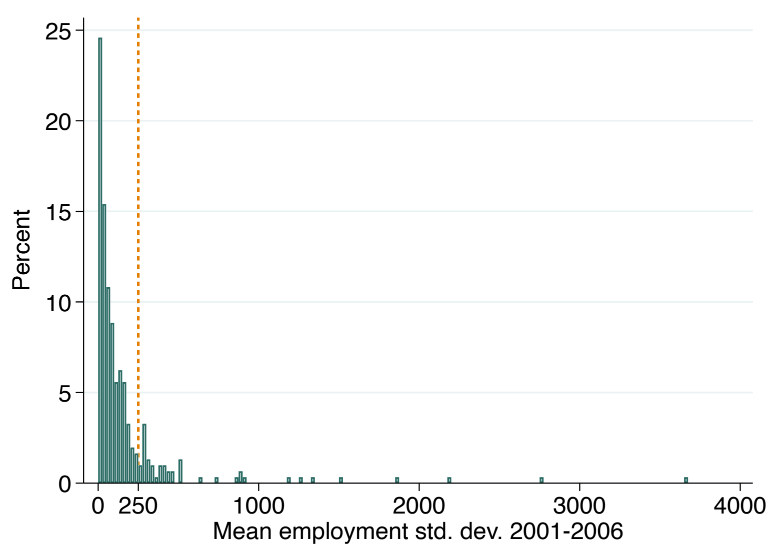

*Notes:* This figure plots South Carolina employers by their Benefit Ratio in 2011 and their Predicted Benefit Ratio in 2010. The latter is the Benefit Ratio that the employer would have had if the reform took place in 2010 instead of 2011. Because of data availability, it is calculated over a lookback period of six years instead of seven. This means that it is obtained as the ratio of the total benefits charged to the employer between July 1, 2003 and July 1, 2009 to the toal axable wages paid during the same period. Due to the presence of outliers, both the Benefit Ratio in 2011 and the Predicted Benefit Ratio in 2010 have been trimmed to the $95^{th}$ percentile. The figure also reports the slope and standard error of a regression of the Benefit Ratio in 2011 on the Predicted Benefit Ratio in 2010. One reason why the Benefit Ratio tends to be larger than the Predicted Benefit Ratio may be the high probability to be charged unemployment benefits between July 1, 2009 and July 1, 2010. This year is included in the lookback period of the Benefit Ratio in 2011 but not in that of the Predicted Benefit Ratio in 2010.

Figure A9: Mean and Median Industry Within-Year Standard Deviation in Employment



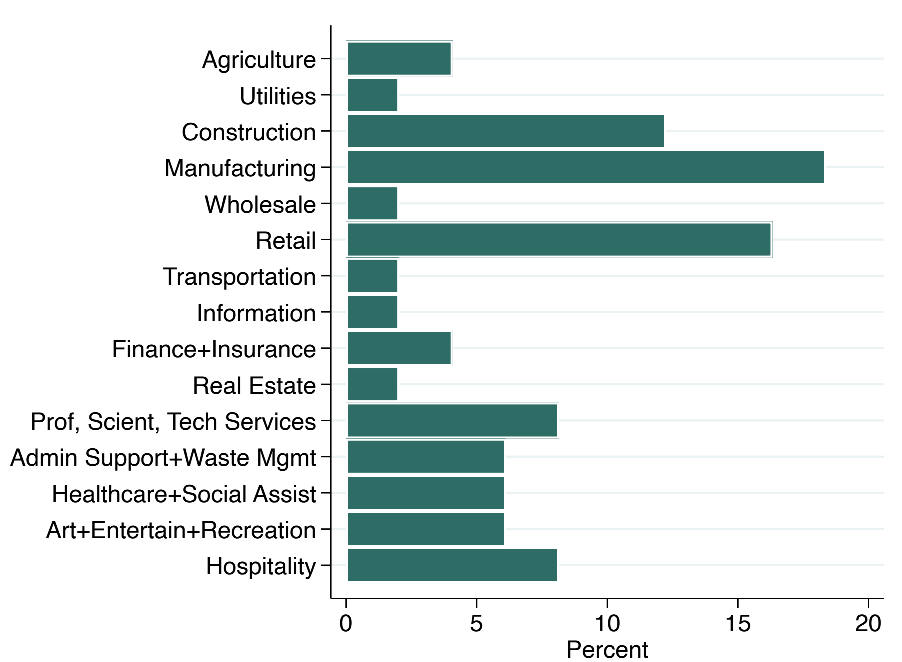

*Notes:* The figure illustrates the correlation between industries' mean and median employment within-year standard deviations between 2001 and 2006 in South Carolina from the QCEW data. Each marker corresponds to a different industry identified by a NAICS four-digit code. Markers tend to be distributed 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 A10: Distribution of industries mean within year standard deviation



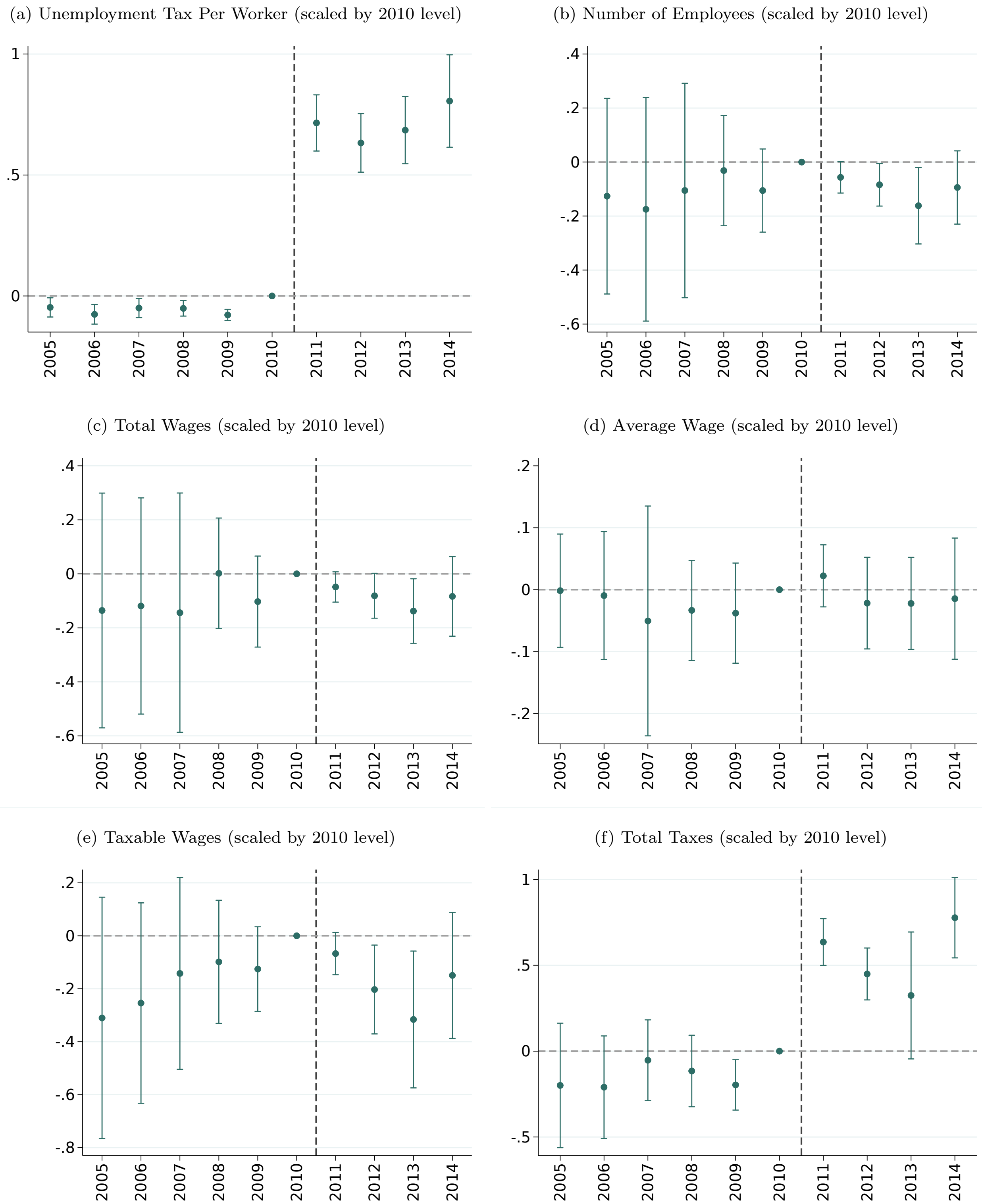

*Notes:* The figure illustrates the distribution of the mean within-year standard deviation of employment between 2001 and 2006 for South Carolina industries in 2006. The dashed line indicates the value of the mean distinguishing high- (above) and low- (below) unemployment risk industries. Each bar corresponds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

Figure A11: Broad Sectoral Distribution of High-Unemployment Risk Industries.



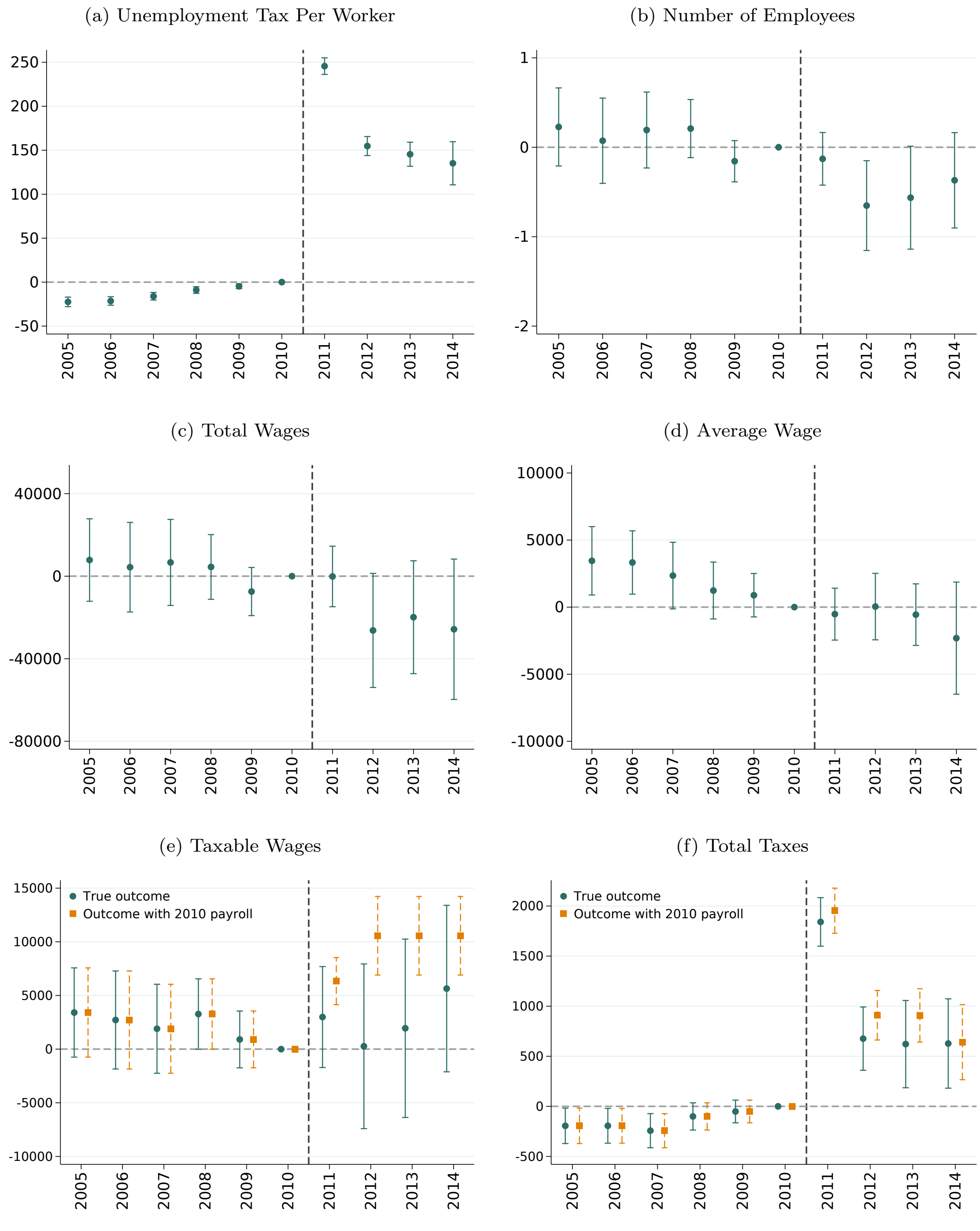

*Notes:* The figure illustrates the distribution of high-unemployment risk industries in South Carolina across broad economic sectors. Industries are defined using NAICS four-digit codes. High-unemployment risk industries have average within-year standard deviation of employment greater or equal to 250 according to the Quarterly Census of Employment and Wages data for South Carolina between 2001 and 2006. Broad economic sectors are defined using NAICS two-digit codes.

Figure A12: Full Sample Effects: Large Employers and Scaled Outcomes




*Notes:* This figure illustrates the estimates of the $\beta_y$ coefficients from Equation 17 estimated for South Carolina employers with at least one employee in 2010. All the outcome variables are scaled by their 2010 level. See the notes to Table 1 for details on the outcomes. 95% confidence intervals are reported.

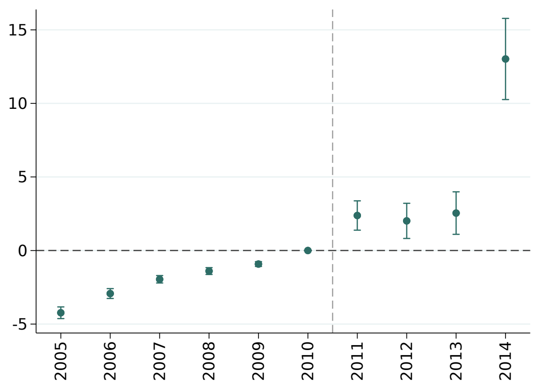
Figure A13: Full Sample Effects: Alternative Benefit Ratio Groups



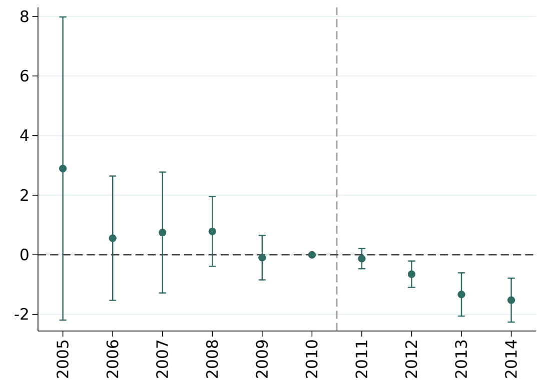

*Notes:* This figure illustrates the estimates of the $\beta_y$ coefficients from Equation 17 estimated for South Carolina employers with 1-50 quarterly employees in 2010. The figure is based on a different definition of employers' benefit ratio groups. I calculated "yearly benefit ratios" for each employers 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 create bins of the yearly benefit ratios and of the predicted benefit ratio, and create groups for employers falling in the same bins. The bins are larger than in the original approach (sized 0.1 and 0.001 respectively) to guarantee the presence of enough employers sharing the same history. See the notes to Table 1 for details on the outcomes.Taxable wages based on the 2010 payroll are equal to true taxable wages until 2010, and to the taxable wages in 2010, scaled by the relative increase in the taxable wage base from 2011 on. Total taxes based on the 2010 payroll are obtained by multiplying taxable wages based on the 2010 payroll and employers' unemployment tax rates. 95% confidence intervals are reported.

Figure A14: Full Sample Effects: Continuous Treatment

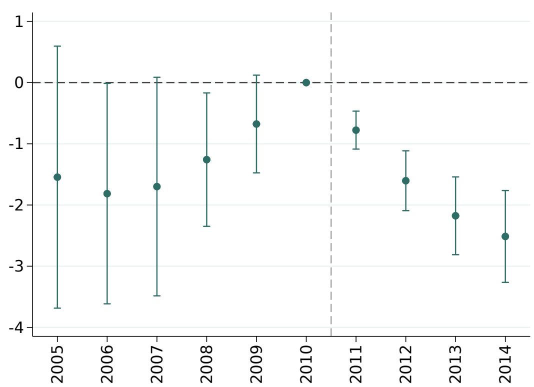
(a) Unemployment Tax Per Worker (scaled by 2010 level)



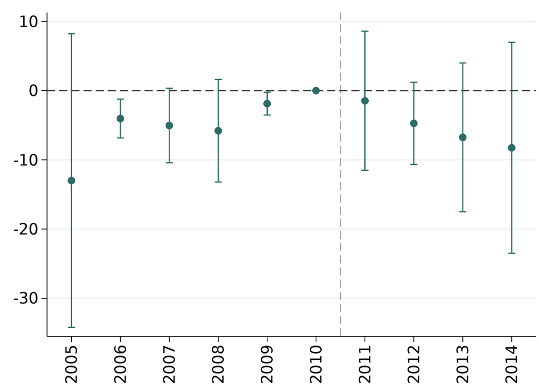
(b) Number of Employees (scaled by 2010 level)



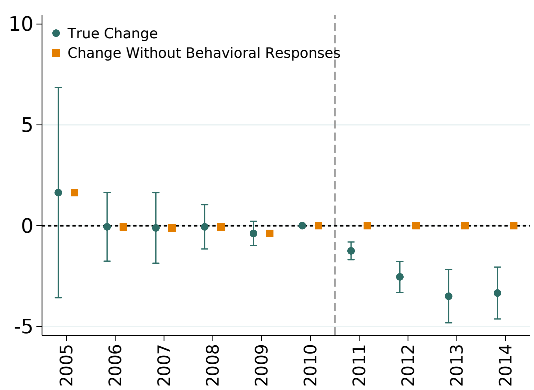
(c) Total Wages (scaled by 2010 level)



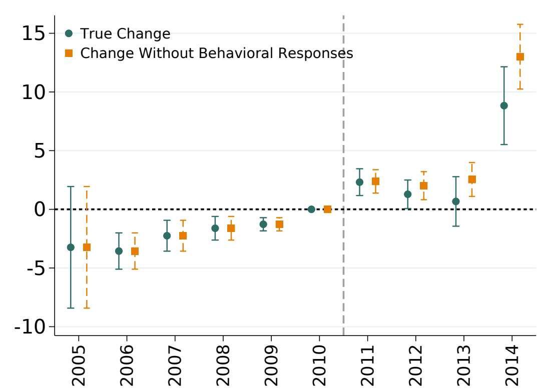
(d) Average Wage (scaled by 2010 level)



(e) Taxable Wages (scaled by 2010 level)



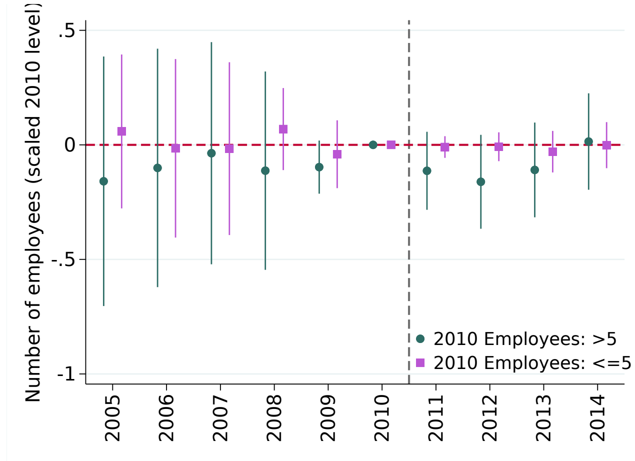

(f) Total Taxes (scaled by 2010 level)



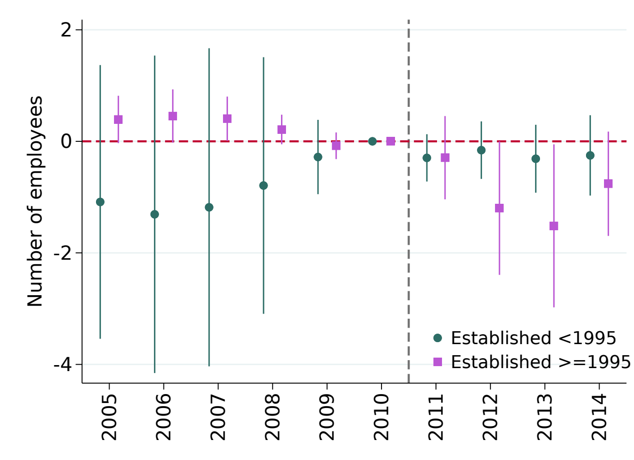

*Notes:* This figure illustrates the estimates of the $\beta_y$ coefficients from Equation 17 estimated for South Carolina employers with 1-50 quarterly employees in 2010. The figure is based on a different definition of treatment, which is now a continuous variable measuring employers' account reserves 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. See the notes to Table 1 for details on the outcomes. Non-behavioral taxable wages are equal to employers true taxable wages until 2010. From 2011 on, they are equal to taxable wages in 2010 scaled by the increase in the taxable wage base in each year relative to 2010. Non-behavioral total taxes are obtained by multiplying employers' individual unemployment tax rates by non-behavioral taxable wages. 95% confidence intervals are reported.

Figure A15: Heterogeneous Effects on Employment by Firm Size, Age, and Productivity

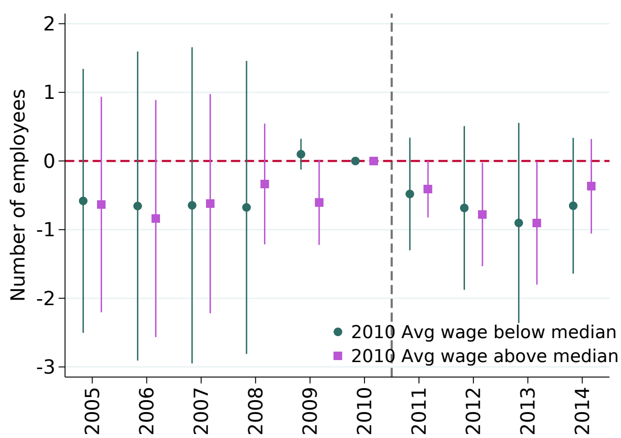
(a) by Firm Size




(b) Firm Age

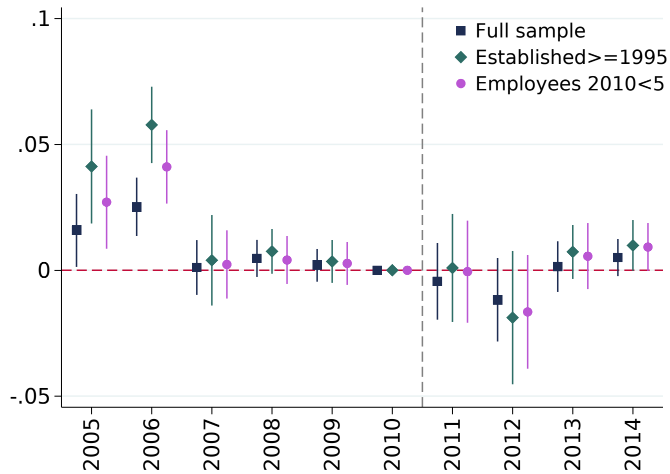



(c) Productivity



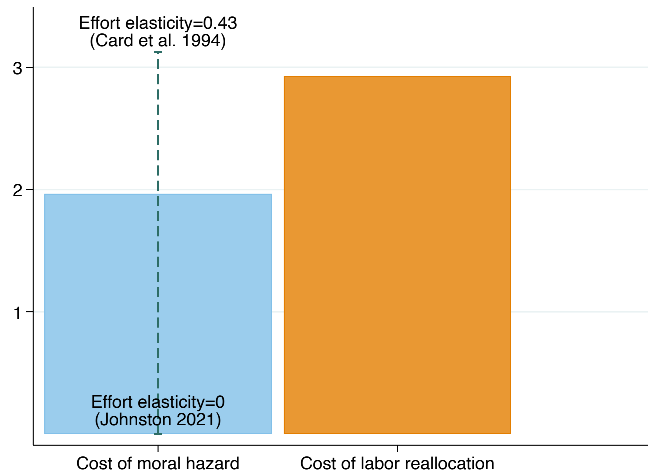

*Notes:* This figure illustrates the estimates of the $\beta_y$ coefficients from Equation 17 estimated separately in the samples of small and big firms (panel [a]), old and young firms (panel [b]), and productive above and below median (panel [c]) Small firms are firms with up to five employees. Young firms are established after 1995. Productive firms have average wage above the median across firms in 2009. 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 A16: The Impact of the Transition from Reserve Ratio to Benefit Ratio on Firm Exit Rate



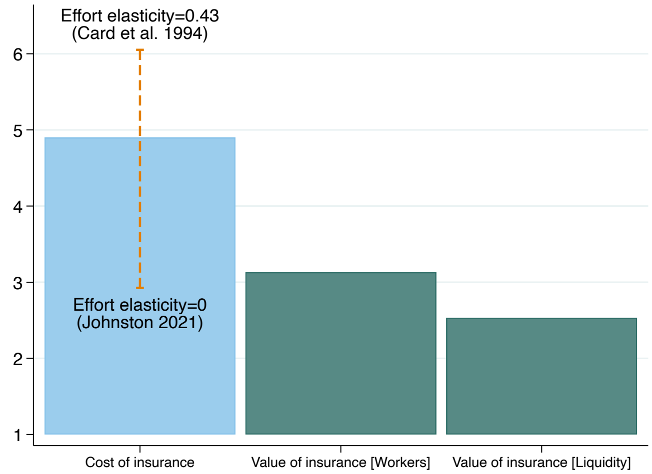

*Notes:* This figure illustrates the estimates of the $\beta_y$ coefficients from Equation 17 estimated in the sample of all South Carolina employers observed between 2005 and 2014, including those that enter and exit the sample in this period. The outcome is an indicator equal to one in the last year in which an employer is observed. I also perform the estimation for the sample 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 A17: Bounds to the Cost of Employer Moral Hazard with Alternative Layoff Elasticities




*Notes:* This figure illustrates calibrated cost of moral hazard under with alterative values for the layoff elasticity. The lower bound to the cost is 0, corresponding to the cost of labor reallocation and resulting when using the null layoff elasticity from Johnston (2021). The upper bound is 3.13, emerging when using the layoff elasticity $\epsilon_{r_H,e} = 0.43$ from Card et al. (1994). The cost of moral hazard is compared with the cost from labor reallocation, calibrated in Table 5.

Figure A18: Bounds to the Cost of Insurance with Alternative Layoff Elasticities




*Notes:* This figure illustrates calibrated marginal cost and marginal value of increasing insurance for employers through a reduction in the degree of experience rating in South Carolina. The marginal cost is obtained by summing the cost of interindustry labor reallocation, calibrated in Table 5 and the cost of employer moral hazard, calibrated in Table 6. The figure also illustrates how the cost of insurance changes with alterative values for the layoff elasticity. The lower bound to the cost is 2.93, corresponding to the cost of labor reallocation and resulting when using the null layoff elasticity from Johnston (2021). The upper bound is 6.05, emerging when using the layoff elasticity $\epsilon_{r_H,e} = 0.43$ from Card et al. (1994). The cost of insurance is compared with the two calibrated values of the value of insurance for employers. The value of insurance [worker] is the estimated value of insurance for worker from Landais et al. (2021). The value of insurance [liquidity] is the estimated value of insurance for employers with liquidity constraints from Giupponi et al. (2022).

# 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 B.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 B.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 B.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 B.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 B.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 B.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:

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

In Equation 20, $Y_{i,t}$ 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 B.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 B.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 B.6 and Table B.4 present the $\beta$ coefficients obtained from Equation 20. 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 B.7 illustrates the $\beta$ coefficients obtained by estimating Equation 20 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 B.5 reports the estimated $\gamma$ coefficients from Equation 21:

$$Y_{i,t} = \alpha_i + \sum_{y=-8}^{8} \beta_y 1_{y=t} Treat_i + \sum_{y=-8}^{8} \gamma_y 1_{y=t} Treat_i \times \text{High Risk}_i + \epsilon_{i,t} \tag{21}$$

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 19. 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.

$$\epsilon_{Employment,\tau} = \frac{\beta_{Employment}}{\beta_{\tau}} \frac{\tau_{t-1,Treat=1}}{Employment_{t-1,Treat=1}} \tag{22}$$

The reduced form effects employed in the calculation of the elasticity are obtained from estimating Equation 23, which pools together all the pre-period and post-period coefficients.

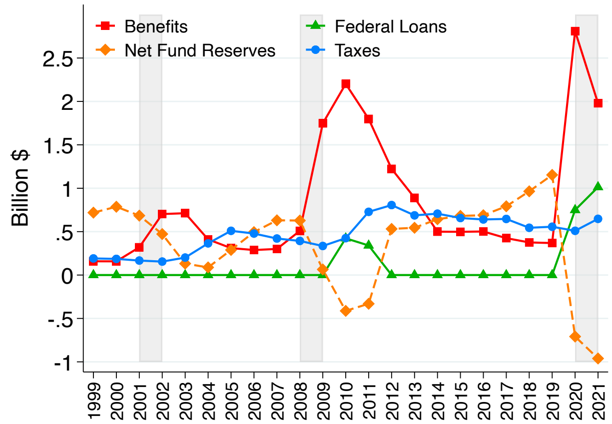
$$Y_{i,t} = \alpha_i + \beta 1_{y=t} Treat_i \times Post_t + +\epsilon_{i,t} \tag{23}$$

Table 4 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.

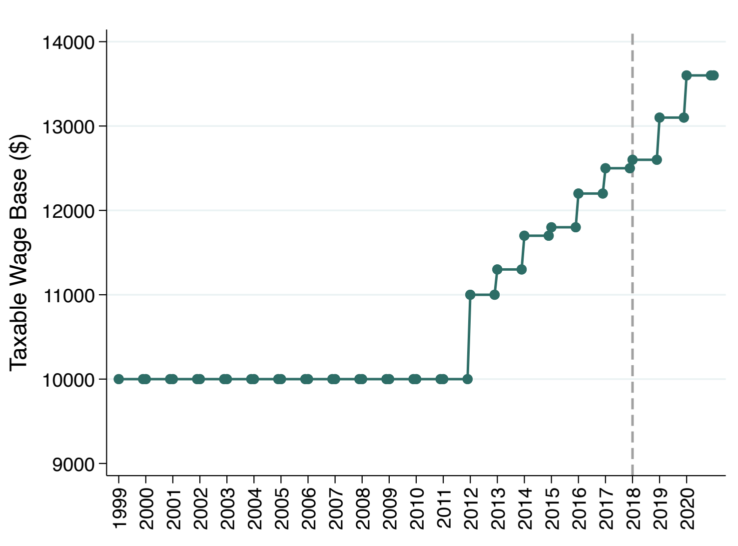
## A.4 Colorado Tables and Figures

Figure B.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 B.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.

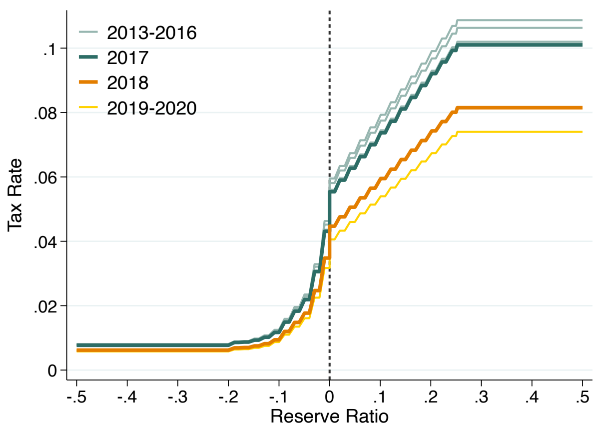
Table B.1: Surcharges in Colorado between 2013 and 2019

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

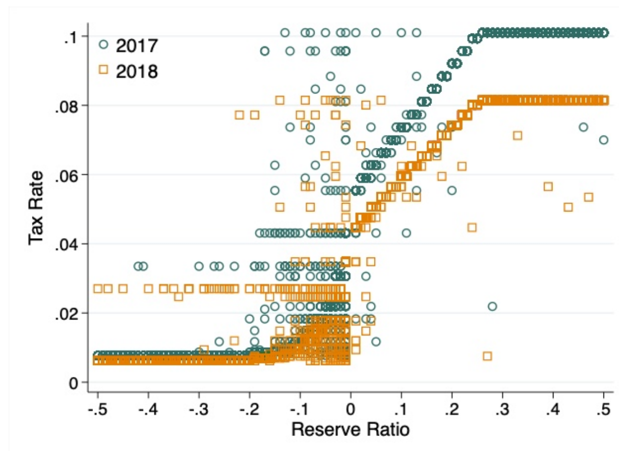
*Notes:* The table reports the surcharges in effect in Colorado between 2013 and 2019. The surcharge represents the percent amount by which the unemployment tax rates in the schedule in effect in each year had to be incremented to obtain the final effective tax rates.

Figure B.3: Unemployment Financing Rules in Colorado

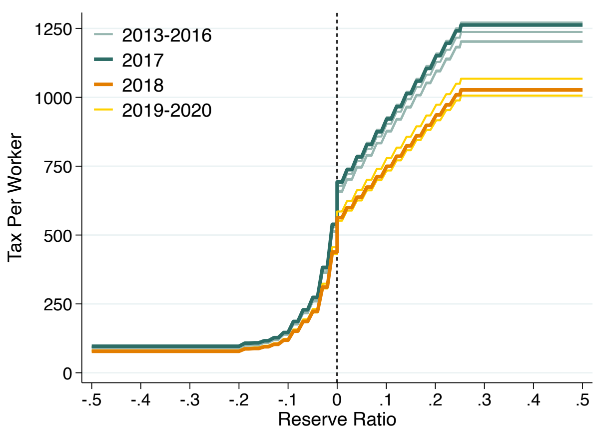
(a) Unemployment Tax Rate Schedule



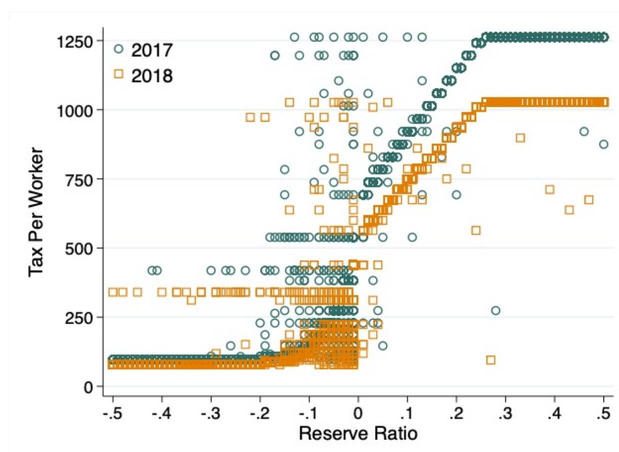

(b) Binscatter of Employers by Tax Rate and Reserve Ratio




(c) Maximum Unemployment Tax Per Worker

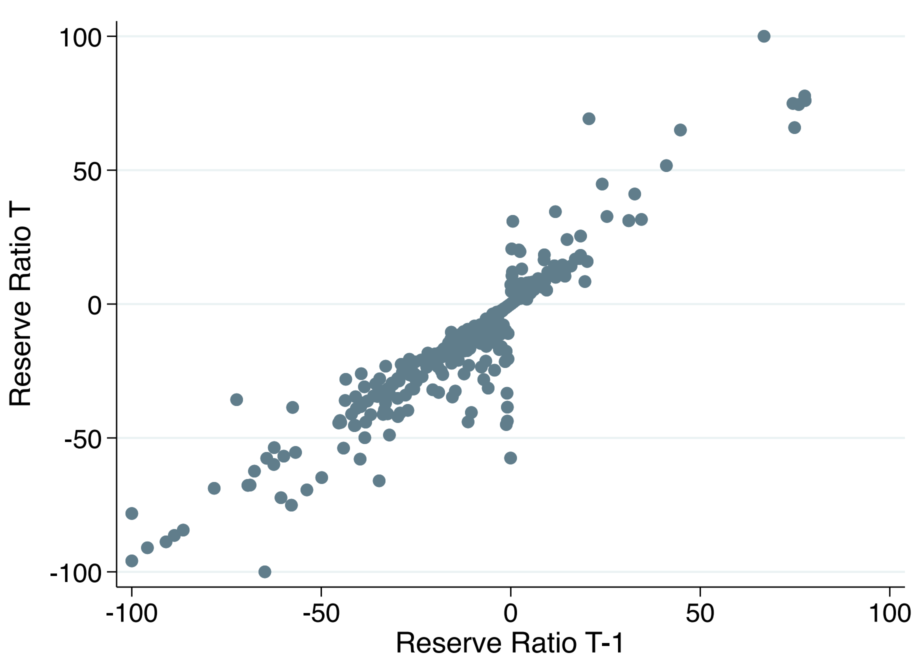



(d) Binscatter of Employers by Tax Per Worker and Reserve Ratio




*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 B.4: Correlation in Employers' Reserve Ratio Over Time



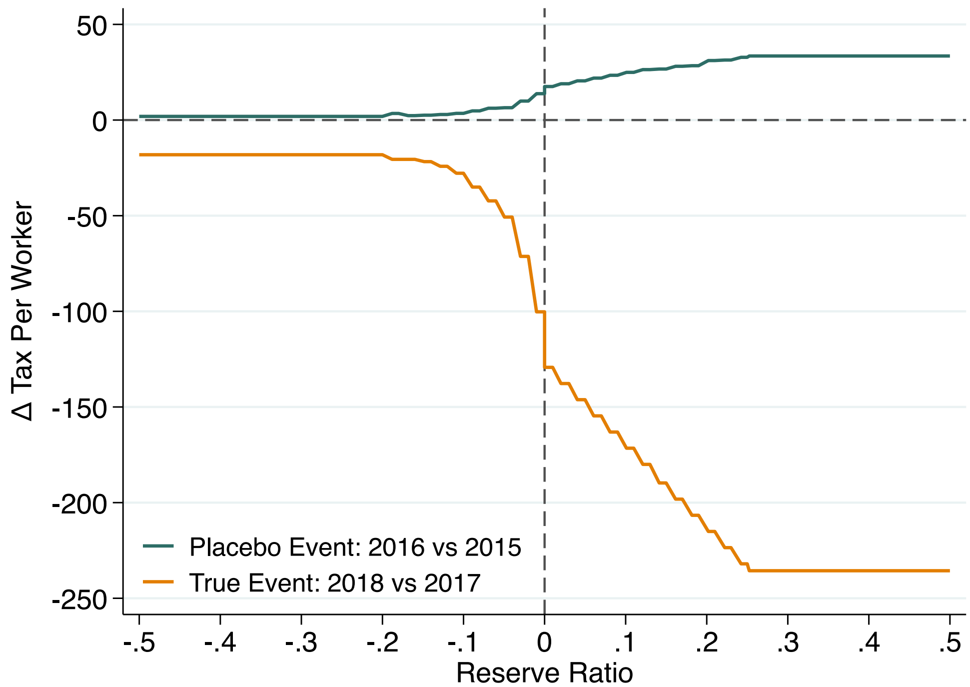

*Notes:* This figure plots Colorado employers by their Reserve Ratio in year T and Reserve Ratio in year T-1, with T=2014, 2015, 2016, 2017, 2018. The Reserve Ratio in year T has been rounded to the first decimal place. Each marker corresponds to the average of the Reserve Ratio in year T-1 for employers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

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



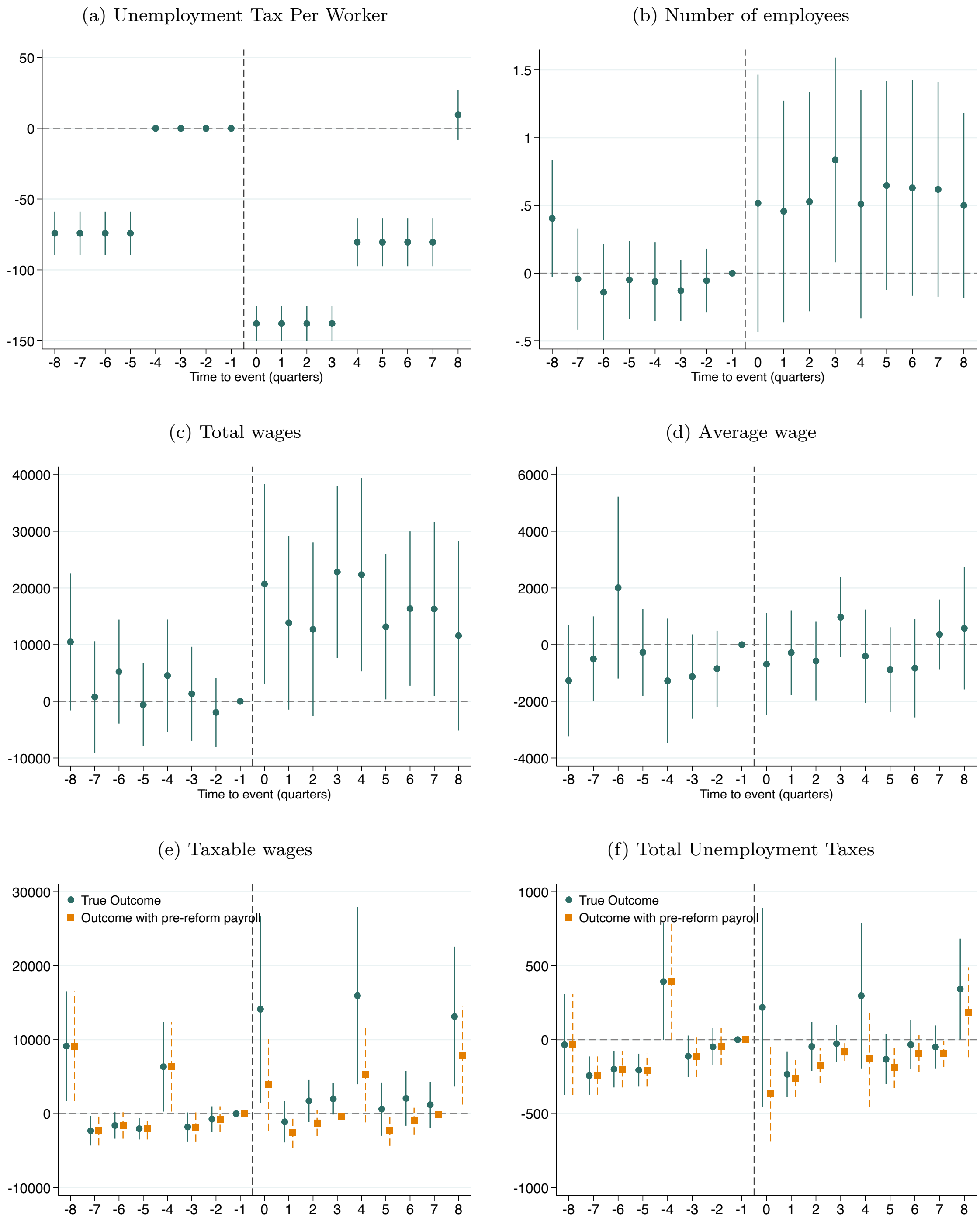

*Notes:* This figure illustrates the variation in the Unemployment Tax Per Worker associated to each level of Reserve Ratio between 2017 and 2018 (the true event year) and between 2015 and 2016 (the placebo event year).

Table B.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 B.6: Reduced Form Effects of the Elimination of the Surcharge on Firm Outcomes



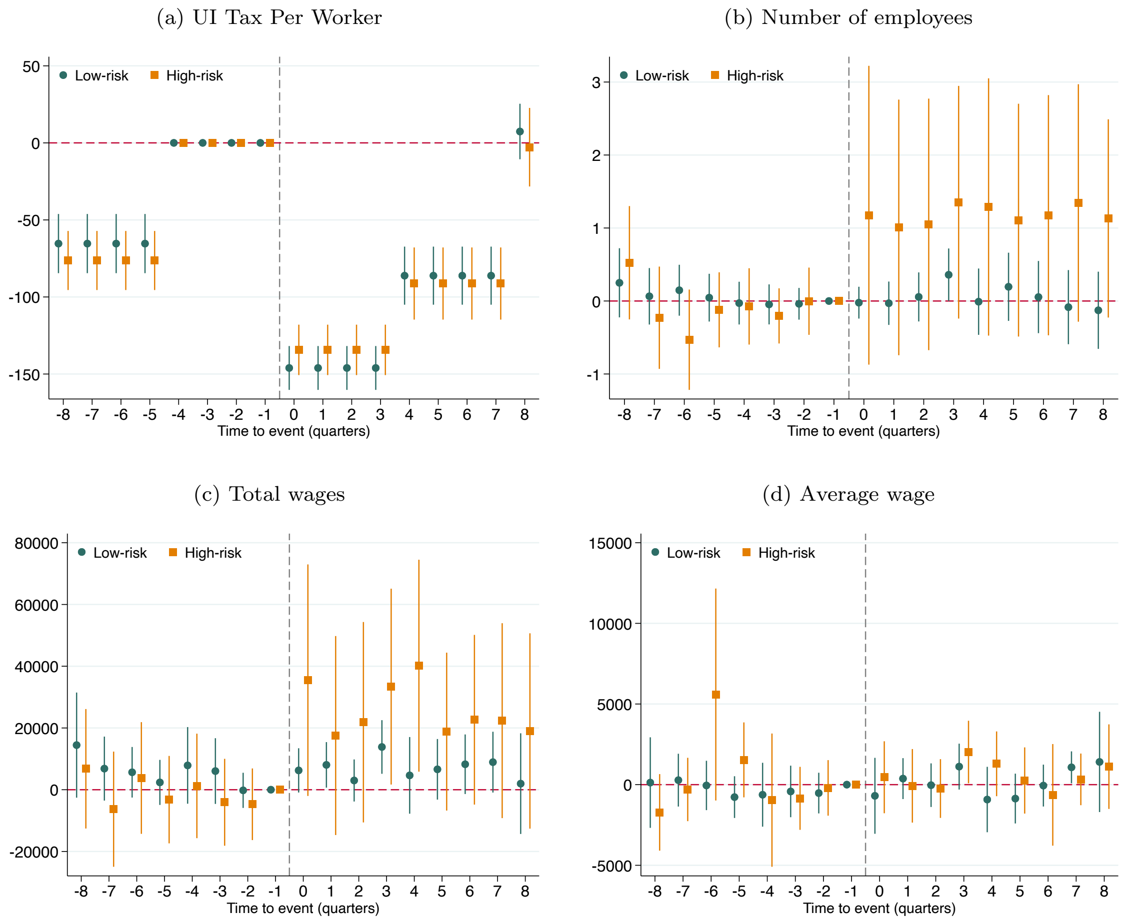

This figure illustrates the estimates of the $\beta_y$ coefficients from Equation 20 for the sample of Colorado employers with positive Reserve Ratio. The treatment group includes employers with Positive Reserve Ratio in 2017. The control group includes employers with Positive Reserve Ratio in 2015. 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 B.4: Reduced Form Effects of the Elimination of the Surcharge on Firm Outcomes

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| Outcome: | Tax per worker | Employees | Total wages | Avg wage | Tax wages | tTax wages (payroll -1) | Tot taxes | 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 20 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 B.7: Differential Reduced Form Effects in High- and Low-Unemployment Risk Industries




This figure illustrates the estimates of the $\beta_y$ coefficients from Equation 20 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 B.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 21 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 B.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 22. The Treated×Post coefficients are the estimated coefficients from Equation 23. The treatment group includes employers with Positive Reserve Ratio in 2017. The control group includes employers with Positive Reserve Ratio in 2015.

# B Model Complete Derivation

This section contains the explicit derivation of the results presented in Section 2.

## B.1 Cross-subsidization with complete and incomplete experience rating

Equations 25 and 24 show that the subsidies of the high- and low- risk employers, defined as the difference between the unemployment benefit costs that each of them generated and the unemployment taxes they pay, are equal to zero.

$$Subsidy_H^{ER} = \underbrace{bp_H l_H}_{\substack{\text{Benefit cost generated by} \\ \text{high-risk employer}}} - \underbrace{bp_H l_H}_{\substack{\text{UI taxes paid by} \\ \text{high-risk employer}}} = 0 \tag{24}$$

$$Subsidy_L^{ER} = \underbrace{0}_{\substack{\text{Benefit cost generated by} \\ \text{low-risk employer}}} - \underbrace{0}_{\substack{\text{UI taxes paid by} \\ \text{low-risk employer}}} = 0 \tag{25}$$

Consequently, if the government maintained a completely experience rated unemployment insurance system over time, the low- and the high-risk employers would cumulate zero unemployment insurance subsidies: $\sum_{t=0}^{\infty} Subsidy_{t,H}^{ER} = 0$ and $\sum_{t=0}^{\infty} Subsidy_{t,L}^{ER} = 0$.

Equations 27 and 26 show that unemployment insurance subsidies are non-zero when experience rating is incomplete.

$$Subsidy_H^{Pool} = \underbrace{bl_H \left(p_H + \frac{1}{m}\right) l_H}_{\substack{\text{Benefit cost generated by} \\ \text{high-risk employer}}} \underbrace{- ebl_H \left(p_H + \frac{1}{m}\right)}_{\substack{\text{UI taxes paid by} \\ \text{high-risk employer}}} = (1-e)bl_H \left(p_H + \frac{1}{m}\right) > 0 = Subsidy_H^{ER} \tag{26}$$

$$Subsidy_L^{Pool} = \underbrace{0}_{\substack{\text{Benefit cost generated by} \\ \text{low-risk employer}}} - \underbrace{(1-e)bl_H \left(p_H + \frac{1}{m}\right)}_{\substack{\text{UI taxes paid by} \\ \text{low-risk employer}}} = -(1-e)bl_H \left(p_H + \frac{1}{m}\right) < 0 = Subsidy_L^{ER} \tag{27}$$

Crucially, if the employers' layoff rate were drawn from a random distribution in each period, unemployment insurance subsidies would cancel out over time. However, since layoff rates are permanent features of the industries, unemployment insurance subsidies cumulate period after period, generating systematic patters of interindustry cross-subsidization: $\sum_{t=0}^{\infty} Subsidy_{H,t}^{Pool} = \sum_{t=0}^{\infty}(1-\alpha)bl_H \left(p_H + \frac{1}{m}\right) = +\infty$ and $\sum_{t=0}^{\infty} Subsidy_{L,t}^{Pool} = \sum_{t=0}^{\infty} -(1-\alpha)bl_H \left(p_H + \frac{1}{m}\right) = -\infty$.

## B.2 Optimal labor demand as function of experience rating

The high-risk employer observes the government's choice of the degree of experience rating $e$, teats it as a fixed parameter, and chooses the labor demand that maximizes expected profits. By replacing $\tau_H l_H$ from Equation 5 in Equation 1, I express expected profits as function of the degree of experience rating $e$:

$$\begin{aligned}\Pi_H = & \left(1 - p_H - \frac{1}{m}\right)\left[\int_0^{l_H} f(i,k)\,di - w_H l_H - ebl_H\left(p_H + \frac{1}{m}\right) - jk\right] \\ & + \left(p_H + \frac{1}{m}\right)\left[-ebl_H\left(p_H + \frac{1}{m}\right)(1+q) - (1 - 1_{e=1})\psi(m)\right]\end{aligned} \tag{28}$$

The privately optimal labor demand of the high-risk employer as a function of the degree of experience rating is determined by taking the derivative of their profits with respect to $l_H$ and setting it equal to zero:

$$\frac{\partial \Pi_H}{\partial l_H} = \left(1 - p_H - \frac{1}{m}\right)\left[f(l_H, k_H) - w_H - eb\left(p_H + \frac{1}{m}\right)\right] - \left(p_H + \frac{1}{m}\right)^2 eb = 0 \tag{29}$$

.

Rearranging terms, I obtain Equation 7. To understand how labor demand changes with experience rating, I define the following function of $l_H$ and $e$ and use the Implicit Function Theorem to determine the derivative of labor demand with respect to experience rating, $\frac{\partial l_H}{\partial e}$:

$$G(l_H, e) = f_H(l_H, k) - \left[\frac{eb\left(p_H + \frac{1}{m}\right)}{\left(1 - p_H - \frac{1}{m}\right)} + w_H\right] \tag{30}$$

$$\frac{\partial l_H}{\partial e} = -\frac{\partial G(l_H, e)\partial e}{\frac{\partial G(l_H,e)}{\partial l_H}} = -\frac{-\frac{b\left(p_H + \frac{1}{m}\right)}{\left(1 - p_H - \frac{1}{m}\right)}}{f'_H(l_H, k_H)} < 0 \tag{31}$$

Since $f(i,k)$ is decreasing in $i$ by assumption, $f'(l_H, k_H) < 0$, and $\frac{\partial l_H}{\partial e} < 0$.

## B.3 Optimal effort as a function of experience rating

The high-risk employer observes the government's choice of the degree of experience rating $e$, teats it as a fixed parameter, and chooses the level of effort to avoid shocks that maximizes expected profits. To determine the privately optimal effort, I take the derivative of the employer's profits, shown in Equation 28, and set it to zero:

$$\frac{\partial \Pi_H}{\partial m} = \frac{1}{m^2}\left[\int_0^{l_H} f(i,k)\,di - w_H l_H - ebl_H\left(p_H + \frac{1}{m}\right) - kj + ebl_H + (1 - 1_{e=1})\psi(m)\right] - \left(p_H + \frac{1}{m}\right)\psi'(m)(1 - 1_{e=1}) \tag{32}$$

Rearranging terms and noticing that $\int_0^{l_H} f(i,k)\,di - w_H l_H - ebl_H\left(p_H + \frac{1}{m}\right) - kj + ebl_H + (1 - 1_{e=1})\psi(m) = \Pi_H^{good} - \Pi_H^{bad} + eq$, I obtain Equation 8.

To assess how the optimal level of effort changes with the degree of experience rating, it is useful to distinguish the two cases where $e = 1$ and $e < 1$. Equation 33 shows that with complete experience rating, when $e = 1$ and $(1 - 1_{e=1})\psi(m) = 0$, the derivative of expected profits with respect to effort is positive. Consequently, it is optimal for the high-risk employer to keep increasing effort: $m^{*,ER} \to \infty$. It follows that with complete experience rating the unemployment risk in the economy is minimized: $\lim_{m\to\infty} r_H = \lim_{m\to\infty} p_H + \frac{1}{m} = p_H$.

$$\frac{\partial \Pi_H}{\partial m} = \frac{1}{m^2}\left[\int_0^{l_H} f_H(i,k)\,di - w_H l_H - bl_H\left(p_H + \frac{1}{m}\right) - kj + bl_H\right] > 0 \tag{33}$$

With coinsurance, when $e < 1$, the high-risk employer faces positive costs of exerting effort: $(1 - 1_{e=1})\psi(m) = \psi(m)$. Equation 34 illustrates the derivative of expected profits with respect to effort in this scenario:

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

To see how effort changes with the degree of experience rating, I define the implicit function $G(m,e)$ from the first order condition just derived. Using the Implicit Function Theorem, I determine the derivative of effort with respect to experience rating:

$$\frac{\partial m}{\partial e} = -\frac{\partial G(m,e)\partial e}{\frac{\partial G(m,e)}{\partial m}} = -\frac{bl_H}{-\frac{2}{m^3}[\int_0^{l_H} f_H(i,k)\,di - w_H l_H - ebl_H - kj + \psi(m)] + \frac{2\psi'(m)}{m} - p_H\psi''(m) - \frac{\psi''(m)}{m}} \tag{35}$$

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 be the same. Since $\psi$ is convex, $\psi'(m) > 0$ and $\psi''(m) > 0$, and $\frac{\partial[G(m,e)m^2]}{\partial m}$ in Equation 36 is negative, implying that $frac\partial G(m,e)\partial m < 0$ and $\frac{\partial m}{\partial e} > 0$. Effort is thus increasing in the degree of experience rating.

$$\frac{\partial G(m,e)m^2}{\partial m} = -p_H\psi''(m)m^2 - p_H 2m\psi'(m) - \psi''(m)m < 0 \tag{36}$$

## B.4 Welfare maximization

The government chooses the degree of experience rating $e$ to maximize the social welfare function in Equation 9, obtained as the sum of workers' and capitalists' utilities, subject to the government budget constraint, the tax burden allocation rules in Equations 5 and 6, labor market clearing, and the high-unemployment risk employer's effort defined in Equation 8:

$$
\begin{aligned}
\max_{e} \quad & SWF \\
\text{s.t.} \quad & \tau_L l_L = (1-e)bl_H \left(p_H + \frac{1}{m}\right), \\
& \tau_H l_H = ebl_H \left(p_H + \frac{1}{m}\right), \\
& l_L = 1 - l_H, \\
& f_H(l_H, k_H) = \frac{eb\left(p_H + \frac{1}{m}\right)}{1 - p_H - \frac{1}{m}} + w_H, \\
& \left(p_H + \frac{1}{m}\right)\psi'(m)(1 - 1_{e=1}) = \frac{1}{m^2}\left[\int_0^{l_H} f_H(i,k)\,di - w_H l_H - kj + ebl_H + (1-1_{e=1})\psi(m)\right]
\end{aligned}
$$

After normalizing $k$ to 1, the Lagrangean associated to the maximization problem is:

$$
\begin{aligned}
\mathcal{L} =& (1-l_H)u(w_L) + l_H\left[\left(1 - p_H - \frac{1}{m}\right)u(w_H) + \left(p_H + \frac{1}{m}\right)[u(b)+L]\right] + [\gamma(\Pi_L + \Pi_H) - 1] \\
=& (1-l_H)u(w_L) + l_H\left[\left(1 - p_H - \frac{1}{m}\right)u(w_H) + \left(p_H + \frac{1}{m}\right)[u(b)+L]\right] + \gamma\left[\int_{l_H}^{1} f_L(i,k)\,di - w_L(1-l_H) - (1-e)bl_H\left(p_H + \frac{1}{m}\right) - jk\right] \\
& + \gamma\left(1 - p_H - \frac{1}{m}\right)\left[\int_0^{l_H} f(i,k_H)\,di - w_H l_H - ebl_H\left(p_H + \frac{1}{m}\right) - j\right] + \gamma\left(p_H + \frac{1}{m}\right)\left[-ebl_H\left(p_H + \frac{1}{m}\right)(1+q) - (1-1_{e=1})\psi(m)\right] - 1
\end{aligned} \tag{37}
$$

To determine the optimal degree of experience rating $e^*$, I take the derivative of the Lagrangean with respect to $e$, shown in Equation 38, and set it equal to zero. Since the high-risk employer is choosing $l_H$ and $m$ optimally after observing $e$, by the Envelope Theorem $\frac{\partial l_H*}{\partial e} = \frac{\partial m*}{\partial e} = 0$. When deriving the profit function of the high-risk employer with respect to $e$, I can thus disregard that $m$ and $l_H$ are functions of $e$. I further use the workers' indifference between jobs and within the high-risk job between unemployment and employment discussed in Section 2.1 and $r_H = p_H + \frac{1}{m}$ to obtain:

$$
\begin{aligned}
\frac{\partial \mathcal{L}}{\partial e} =& -\frac{\partial l_H}{\partial e}u(w_L) + \frac{\partial l_H}{\partial e}\left[\left(1 - p_H - \frac{1}{m}\right)u(w_H) + \left(p_H + \frac{1}{m}\right)[u(b)+L]\right] + l_H\left[\frac{1}{m^2}[u(w_H) - u(b) - L]\frac{\partial m}{\partial e}\right] \\
& + \left[-f_L(l_H,k) + w_L - (1-e)b\left(p_H + \frac{1}{m}\right)\right]\frac{\partial l_H}{\partial e} + bl_H\left(p_H + \frac{1}{m}\right) + \frac{(1-e)bl_H}{m^2}\frac{\partial m}{\partial e} \\
& + \left(1 - p_H - \frac{1}{m}\right)\left[-bl_H\left(p_H + \frac{1}{m}\right)\right] + \left(p_H + \frac{1}{m}\right)\left(-bl_H\left(p_H + \frac{1}{m}\right)(1+q)\right) \\
=& -\epsilon_{l_H,e}\frac{l_H}{er_H}\left[f_L(l_H) - w_L + (1-e)br_H\right] + \epsilon_{m,e}\frac{(1-e)bl_H}{emr_H} - r_H bl_H q = 0
\end{aligned} \tag{38}
$$

I then notice that $r_H bl_H q = \Pi_H^{'good} - \Pi_H^{'bad}$, where $\Pi_H^{'good}$ and $\Pi_H^{'bad}$ are the partial derivatives of good- and bad-state profits respectively: $\Pi_H^{'good} = \frac{\partial \Pi_H^{good}}{\partial e}$ and $\Pi_H^{'bad} = \frac{\partial \Pi_H^{bad}}{\partial e}$. I then divide all factors of Equation 38 by $B = bl_H r_H$ to obtain:

$$-\epsilon_{l_H,e}\frac{1}{ebr_H^2}\left[f_L(l_H)-w_L+(1-e)br_H\right]+\epsilon_{m,e}\frac{(1-e)}{emr_H^2}=q \tag{39}$$

Using $\Pi_H^{'good} = B$ the definitions for $\lambda$ and $\mu$ in Equations 12 and 13, I obtain Equation 10, defining the optimal degree of experience rating.

## B.5 Optimal degree of experience rating with flexible wages

Coming soon.

## B.6 Optimal degree of experience rating with workers' preferences

Coming soon.

## 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:

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

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