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

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Abstract

The provision of unemployment benefits is an essential welfare program but entails significant costs, primarily financed through payroll taxes on employers. While in the United States employers are assigned individualized unemployment tax rates based on the benefit cost of their layoffs (experience rating), all the other countries assign a common tax rate to all employers irrespective of individual costs (coinsurance). This paper presents a framework for the optimal design of unemployment insurance financing policies specifying the central tradeoffs between experience rating and coinsurance. Coinsurance provides insurance value to employers by limiting unemployment taxes following layoffs. However, it increases layoffs, as employers internalize only a fraction of the benefit cost of their layoffs (employer moral hazard) and subsidizes the expansion of high-unemployment risk industries, generating a big share of benefit claims whose cost is spread over the broader community of employers (interindustry labor reallocation). I use unemployment tax filing data and reforms of experience rating policies in two US states as new sources of variation in unemployment taxes to estimate the understudied costs of labor reallocation and find they are empirically larger than the costs of moral hazard from the literature. Additionally, suggestive evidence indicates that insurance value to employers is lower than the combined costs of moral hazard and labor reallocation, implying that in these states the current level of experience rating may be suboptimal.

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1 Introduction

Unemployment insurance is a fundamental welfare program for workers facing job losses, helping them maintain their consumption levels when unemployed. The provision of unemployment benefits, however, comes with a substantial cost, ranging between 0.2 and 2.7% of GDP in western economies and fluctuating over the business cycles (OECD 2023). For perspective, the United States spends approximately 35 billion dollars annually in unemployment benefits – a figure surging to 125 billion during the COVID-19 pandemic. Since the effectiveness and sustainability of unemployment insurance hinge on governments' ability to secure resources and promptly allocate them to workers as needed, understanding how to best finance the program is a matter of primary importance.

Unemployment insurance is primarily funded through payroll taxes levied on employers.[1]. The specific portion of payroll taxes devoted to the funding of the program is determined as the product between employers' taxable payrolls and the unemployment tax rate. There are two ways to assign unemployment tax 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 approach, known as *"coinsurance"* stands on the principle that collective resources can be pooled to repay the benefit costs incurred by employers laying off workers because the idiosyncratic shocks hitting the various employers in the labor market balance out over time.

Whether unemployment benefits should be financed with experience rating or coinsurance remains unclear. The literature has identified three key factors to make this evaluation, two in favor and one against experience rating. Firstly, experience rating reduces the so-called *"employer moral hazard"* by making employer internalize a greater share of the benefit costs of their layoffs and providing them with the incentive to reduce layoffs (Feldstein 1976, Brechling 1977, Topel 1983, Topel 1984, Topel 1977, Kaiser 1986, Burgess et al. 1992, Anderson et al. 1994, Card et al. 1994) and stabilize employment within the year (Halpin 1979, Card et al. 1994, Anderson 1993, Katz et al. 1998) and over the business cycle (Kaiser 1986, Duggan et al. 2022). Secondly, experience rating mitigates the systematic subsidization of high-unemployment risk industries, preventing their undue expansion. With coinsurance, where all the employers contribute equally to the financing of the program, permanent differences in unemployment risk across industries result in systematic

[1] This study abstracts from the fact that most European countries, Canada, and three states in the United States (Alaska, New Jersey and Pennsylvania) also levy unemployment taxes on covered employees.

asymmetries in usage and contribution. For example, seasonal industries such as tourism or construction, characterized by systematic fluctuations in product or service demand throughout the year and regular layoffs during the low season, account for a small share of employment but a disproportionately larger share of benefit claims, whose cost is repaid collectively. (Becker 1972, Munts et al. 1980, Topel 1984, Anderson et al. 1993a, Anderson et al. 1993b, Laurence 1993, Leombruni et al. 2003)). Consequently, by reducing their labor costs coinsurance favors the reallocation of labor towards high-unemployment risk industries. (Topel et al. 1980, Deere 1991, Anderson et al. 1993a). 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 unemployment taxes may slow down economic recovery and accentuate the business cycle (Lester et al. 1939, Johnston 2021). In contrast, uniform tax rates offer *valuable insurance* to employers, who only repay a fraction of their benefit costs in the event of a negative shock.

However, these three factors have only been studied in isolation, leaving policymakers without clear guidelines to follow when deciding between experience rating and coinsurance.[2] This study brings them together in a unified framework which recognizes them as the central tradeoffs that policymakers need to consider when designing their unemployment insurance financing policies.

This paper investigates theoretically and empirically the design of unemployment insurance financing policies. The first part of the paper presents a theoretical framework to characterize the optimal degree of experience rating, or optimal share of own benefit costs that employers repay in unemployment taxes, which indicates how distant the financing of the program should be between coinsurance, where all employers pay equally, and experience rating, where each employers repays their full benefit costs. Decreasing experience rating, or increasing coinsurance, is associated with marginal values and costs. The optimal degree of experience rating equalizes the marginal values and marginal costs of providing insurance to employers. On the one hand, decreasing experience rating offers *insurance* to employers facing negative shocks, which is *valuable* for economic agents benefitting from employers' survival and continuity. On the other hand, decreasing experience rating is associated with two costs. First, the labor costs of high-unemployment risk industries

[2] In a review ofBecker (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) concludes: *"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 unexplored. Guo et al. (2021) mentions 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.*

decline and their labor demand increases, inducing the *reallocation of labor* from low- to high-risk industries. This transition may result in the misallocation of productive skills in the economy and induces a fiscal externality, since a larger employment share in high-risk industries results in more layoffs and a greater benefit cost that the government needs to finance through unemployment taxes. Secondly, the tax cost of each layoff declines, leading to more *employer moral hazard* and layoffs, imposing another fiscal externality on the government budget, as more taxes have to be raise to fund a greater benefit costs. Insurance value, labor reallocation and employer moral hazard enter the formula for determining the optimal degree of experience rating as sufficient statistics for welfare. The empirical implementation of this formula enables researchers to quantify the benefits and costs of experience rating and hence to evaluate whether it should be reduced or increased to achieve greater welfare.

The second part of the paper aims at quantifying the moral hazard and reallocation costs of providing insurance to employers. Since numerous studies measuring the inefficiencies from employer moral hazard already exist, this paper focuses on the estimation of the relatively understudied costs of interindustry labor reallocation. The target parameter to estimate is the labor demand elasticity with respect to the unemployment tax per worker in high-unemployment risk industries. Intuitive, the more elastic are employers in these industries, the more workers will flow into them or out of them as unemployment taxes change. To estimate this elasticity, I obtained access to unemployment tax filing restricted data covering the universe of employers in South Carolina and Colorado and leverage two state-level reforms of experience rating policies as novel source of variation in the unemployment tax per worker. The paper primarily focuses on South Carolina, and then shows that Colorado delivers consistent results.

Like in the rest of the United States, in South Carolina employers with higher experience with unemployment are assigned higher unemployment tax rates. In 2011, the state government changed the measure of employers' experience 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 dollar amount of all the unemployment benefits ever claimed by workers laid off by an employer and all the unemployment tax payments ever made by the employer, and thus represents 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 sum of the benefits charged to the employer during the seven years before the date of assessment (the *recent past*), The reform led to the disregard of employers' unemployment tax payments and *distant past* benefit charges and changed employers' measured experience with unemployment, eventually redistributing the tax burden across employers in the state.

My empirical strategy consists in comparing employers with similar benefit ratios but different reserve ratios in a differences-in-differences approach. Because of the similar benefit ratios, these employers behave similarly during the recent past, coinciding with the reform pre-period. Because of their different reserve ratios, they experienced different changes in their unemployment tax rates. Conditional on the benefit ratio, employers with negative reserve ratios saw their unemployment tax rate increase because the reform "forgot" their historical tax payments and emphasized any recent benefit charges. Conversely, employers with positive reserve ratios experienced a decline in their unemployment tax rates because the reform "forgot" their past benefit charges.

I find that, conditional on the benefit ratio, the reform increased the unemployment tax per worker of negative reserve ratio employers by $200 per year, equivalent to 142% of the level in 2010, relative to high reserve ratio employers. This increase led to an immediate reduction in employment, which kept declining for three years before beginning to recover. Four years later, employment was still lower than its pre-reform level. Between 2011 and 2014, low 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 this reduction in total wages is consistent with the missing employees being average-wage employees. These effects are robust to several alternative specifications, including utilizing outcomes scaled by their 2010 level, changing the approach to constructing bins of benefit ratio included as fixed effects to guarantee the comparison of similar employers, and utilizing a continuous version of treatment instead of a discrete one. 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. This value masks important heterogeneities. When I re-estimate the elasticities in the subsamples of employers in high- and low- unemployment risk industries, defined based on their seasonality in employment or utilization of the unemployment insurance system, I find that the reduction in employment and wages is concentrated in high-risk industries, despite low- and high-risk industries experience the same increase in the unemployment tax per worker. As a result, I estimate an insignificant elasticity of 0.05 for employers in low-unemployment risk industries and an elasticity of -0.26 for employers in high-risk industries. Based on the model predictions, a higher elasticity of labor demand in high-unemployment risk industries is consistent with higher unemployment taxes reducing the employment share of high-risk industries.

I find a larger elasticity of labor demand for employers in high-unemployment risk industries also when I utilize the data on Colorado employers provided by the Colorado Department of Labor and Employment and leverage the elimination of a surcharge as source of variation in unemployment taxes. 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%), 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 -2.45, while it is only -1.354 for employers in low-risk industries.

In the third part of the paper, I calibrate the other parameters in the cost-side of the formula for the optimal degree of experience rating. The costs of moral hazard are captured by the elasticity of effort to reduce unemployment risk with respect to the degree of experience rating. While effort is not directly observable, it is inversely proportional to layoffs, which, in contrast, are measurable. I show that the elasticity of effort is equal to the negative of the elasticity of layoffs, and then borrow from Topel (1984) an estimate for the layoff elasticity of -0.27. Then, I calibrate other model parameters entering the formula as scaling factors using various moments from the data. Depending on the parameter, I use the unemployment tax filing data from South Carolina and Colorado, the Quarterly Census of Employment and Wages, or the Employment and Training Report 394 redacted by the US Department of Labor.

I find that in South Carolina and Colorado the costs of labor reallocation represent 90% of the total costs of providing insurance to employers. Additionally, although the paper does not directly estimate the value of insurance for employers, it discusses suggestive evidence that it is smaller than the costs. This would imply that the current level of experience rating in these states is suboptimal.

This paper contributes to three strands of literature. First, the literature on the optimal design of social insurance programs. The paper complements the literature on the optimal provision of unemployment benefits, instituted by Baily (1978) and revisited by Chetty (2006) and Schmieder et al. (2016), by providing a framework to characterize the optimal approach to finance the targeted level of unemployment benefits. Similar to these studies, defining the optimal benefit with a tradeoff between the value and the cost of providing insurance to *workers*, this study defines the optimal degree of experience rating with a tradeoff between the value and the cost of providing insurance to *employers*, hence proposing an "employer-level Baily-Chetty formula" for optimal unemployment insurance financing. Additionally, the paper recognizes the joint contribution of employer moral hazard and interindustry labor reallocation to the cost of insurance for employers, identifies estimable parameters for each of them, and for the first time assesses their relative importance. 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. Firstly, 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 costs of labor reallocation. Secondly, my estimates capture both the fiscal externality and the misallocation of productive skills induced by labor reallocation. Secondly, this paper contributes to the literature on experience rating. Most studies investigate the effects of capping unemployment tax rates within a minimum and a maximum on employers' incentives and the degree of experience rating of the system. This paper highlights a critical but underexplored parameter in unemployment insurance financing rules and determinant of experience rating: the measure of unemployment risk utilized for unemployment tax rate assignments. In the United States, thirty-one states employ the reserve ratio and nineteen employ the benefit ratio, with infrequent transitions between the two. The transition of South Carolina from reserve ratio to benefit ratio, coupled with new data on employers' unemployment insurance accounts, offers a unique opportunity to evaluate this policy and shed light on the labor market consequences associated with using these different measures of unemployment risk. This analysis complements the existing literature on the velocity of tax collection using these two alternative measures (Lachowska et al. (2020)). Additionally, the change in the measure of experience represents a novel source of variation in unemployment tax rates with many potential applications in public economics.

Lastly, the paper contributes to the literature on the incidence of business taxes. While earlier studies found at least partial pass-through of payroll taxes on employers through reduced wages (Gruber 1997, Anderson et al. 1997, Anderson et al. 2000), recent research supports the notion that the incidence of both corporate (Suárez Serrato et al. 2016) and payroll taxes (Behaghel et al. 2008, Saez et al. 2019, Benzarti et al. 2021a, Benzarti et al. 2021b, Johnston 2021, and Guo 2023) is on employers. The findings of this paper align with this recent strand of the literature, demonstrating that employers are unable to shift the burden of unemployment taxes onto their employees. One hypothesis suggested in the European-based studies is that incidence falls on employers because union introduce wage rigidities. Interestingly, this paper's results show a similar incidence on employers in the United States, where unions have less influence. Moreover, the finding that the marginal employee not hired is an average-wage employee 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 adjust. This hypothesis, proposed by 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 industry unemployment risk. Employers in low-risk industries, characterized by stable employment, are more likely to react by reducing profits, while employers in high-risk industries, accustomed to high turnover and potentially more knowledgeable of the unemployment insurance system due to their exposure to higher unemployment taxes, may find it easier to respond by reducing the number of employees and decrease their tax burden.

The findings of this paper hold practical relevance for policymakers both in the United States, where experience rating is widely employed and states have significant flexibility in its implementation, and for other OECD countries, using coinsurance. Firstly, the paper provides guidance to policymakers by outlining the central tradeoff associated with the choice between these two alternative approaches to fund unemployment benefits. Secondly, the paper highlights the predominant role of labor reallocation as driver of the costs of coinsurance. This finding is particularly important in those situations in which employer moral hazard is considered limited. Recent quasi-experimental estimates suggest that layoffs do not respond to changes in unemployment taxes in the United States (Johnston 2021). Similarly, seasonal industries may be forced to lay off workers during the low season irrespective of how expensive it is. Additionally, the strong employment protection policies in place in many European countries limit employers' ability to lay off workers (Saez et al. 2023). My findings suggest that even in absence of moral hazard, coinsurance may have considerable welfare costs through interindustry labor reallocation. Thirdly, the analysis suggests that the current level of experience rating in South Carolina and Colorado is suboptimal. These two states and others with similar labor market and experience rating structures may increase welfare by increasing the degree of experience rating. These considerations are particularly pressing for European countries, not only because some of them recently moved towards experience rating by introducing layoff taxes (Italy), but also because the design of the European Unemployment Benefit Scheme is presently under discussion, and some experts claim it should follow the United States model (Simonetta 2017).

Secondly, these results provide insights for policymakers regarding the distributional consequences of choosing the reserve ratio or the benefit ratio as measure for assessing employers' unemployment risk when assigning tax rates. The choice between these two measures of unemployment risk, each with its distinctive lookback periods and elements considered for risk assessment, 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, the findings are relevant for understanding of employers' heterogeneous responses to unemployment taxes and payroll taxes more broadly. Governments should take these responses into consideration when evaluating approaches to increasing tax collection. These implications are particularly important in the United States, currently debating on increasing the generosity of unemployment benefit, drastically reduced after the Great Recession, through higher unemployment taxes (Wandner 2023).

This 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 **??** 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 **??** calibrates the residual parameters in the formula and discusses the implications for the optimal degree of experience rating. Section **??** concludes.

2 Model of Optimal Unemployment Insurance Financing

This section presents a theoretical framework to characterize the design of optimal unemployment insurance financing policies. The objective is to define the optimal degree of experience rating, or optimal share of own benefit costs that employers repay in unemployment taxes. This value indicates how distant tax rates should be from coinsurance, where all employers are assigned a common tax rate, and experience rating, where employers are assigned personalized tax rates reflecting their individual benefit costs. The formula for the optimal degree of experience rating encapsulates the central tradeoffs associated with the choice between experience rating and coinsurance. The three factors entering the tradeoff have been pointed by the experience rating literature: the value of insurance for employers, interindustry labor reallocation, and employers' moral hazard.

The model has three features which enable me to incorporate these three elements. Firstly, I assume that employers are exposed to product demand shocks, following which employers cease production, lay off their entire workforce, and incur additional costs. Offering insurance to employers is valuable for agents in the economy who benefit from the continuity and survival of these businesses. Secondly, I model the existence of two industries, each hosting one employer, facing different unemployment risk, or probability to experience a demand shock. The specific unemployment risk I consider is permanent attribute of an industry rather than a temporary characteristic of an employer. The low-risk employer, required to pay unemployment taxes despite not conducting layoffs, subsidizes the high-risk employer, who generates all the layoffs in the economy but only covers a fraction of these costs through unemployment taxes. Changes in unemployment taxes affect the high-risk employer's labor demand and induce the reallocation of workers across industries.

Third, I assume that employers can partially reduce unemployment risk by exerting effort to avoid product demand shocks. Changes in unemployment taxes affect employers' incentives to exert effort, with impacts on the number of layoffs occurring in the economy.

The government funds unemployment benefits through unemployment taxes and maintains a balanced budget. The key choice of the government is the degree of experience rating of this unemployment insurance system that maximizes workers' and capitalists' utilities. The optimal degree of experience rating equalizes the marginal value and costs of providing insurance to employers. This result is analogous to Baily (1978) and Chetty (2006), who characterize the optimal unemployment benefit level through a trade-off between the marginal value and the cost of providing insurance to workers. The formula for the optimal degree of experience rating includes estimable parameters for the value of insurance and the costs of moral hazard and labor reallocation, which act as sufficient statistics for welfare.

I introduce the four agents in the model, solve the model, illustrate the solution, and discuss its empirical implementation. The complete derivation of the results of the model is exposed in Appendix **??**.

2.1 Four Agents: Employers, Government, Workers, Capitalists

2.1.1 Employers

I assume the existence of two industries, each hosting one employer, facing different risk of experiencing a negative shock leading them to lay off workers, such as low product demand.[3] The low-risk employer faces no risk, $r_L = 0$ and sells product at a stable price $o_L^{good} > 0$. The high-risk employer experiences fluctuations in product demand. With probability $r_H \in (0, 1)$, it faces low product demand and output price $o_H^{bad} = 0$, sells no output and lays off all the workers. With probability $1 - r_H$ it faces positive product demand and produces and sells its product at output price $o_H^{good} > 0$. All the layoffs in this economy are thus generated by the high-risk employer. I further assume that the high-risk employer can partially mitigate the probability to face a negative shock by exerting effort. To this end its risk can be written as $r_H = p_H + \frac{1}{m}$, where p_H is an exogenous component and m is the effort level chosen by the high-risk employer. A higher choice of effort reduces the probability of laying off workers.

Employers' expected profits are obtained by summing the profits obtained in the good and bad states, weighted by the probability that each state realizes:

[EXPECTED PROFITS]

[3]The choice to use a shock to labor demand builds upon the work of Feldstein (1976), Topel (1984) and **CARDLEVINE92** and nicely reflects the existence of both idiosyncratic and seasonal fluctuations in product demand. Any other shock resulting in involuntary unemployment may be used alternatively in this model.

In the good state of the world, profits are obtained as the difference between revenues and costs, as shown in Equation **??**. Revenues are obtained by multiplying output price o_x^{good} by total production, given by a production function, which is assumed to be strictly concave and differentiable in both labor and capital $f(l_x, k_x)$, where $x \in \{L, H\}$. Each unit of labor involved in production is paid a wage w_x, assumed to be fixed.[4] Each unit of capital costs an exogenous price j. Additionally, employers pay unemployment taxes τ_x for each worker to finance unemployment benefits b for laid off workers.

[PROFITS GOOD]

Employers' profits in the bad state of the world are shown in Equation **??**. Due to low product demand and null output prices, employers are unable to sell their production and lay off all their workers, but are still required to pay unemployment taxes.[5] Additionally, in case of a negative shock employers lose a cost associated to the effort they exerted, equal to $(1 - 1_{e=1}))\psi(m) + (1 + e)q$, where ψ is strictly convex and differentiable m, $e \in [0, 1]$ is the degree of experience rating of the unemployment insurance system set by the government, and q is an independent monetary cost.[6]

[PROFITS BAD]

Since by assumption $\psi(\infty) = \infty$, employers never exert infinite effort, which is associated to the minimum layoff rate: $\lim_{m\to\infty} r_H = p_H + \frac{1}{m} = p_H$. Consequently, layoffs are minimized only if $e = 1$, when the cost of effort is nullified, and employers exert infinite effort to avoid layoffs. $e = 1$ corresponds to the scenario of complete experience rating, which maximizes employers' incentives to avoid layoffs. The following section describes the experience rating structure of the unemployment insurance system in detail.

[4] This assumption may be justified with a perfectly elastic labor supply or by the existence of wage rigidities, due to collective bargaining, wage floors, equity concerns within the firm, or the inability to shift individualized taxes forward to consumer prices or backward to factor prices in a competitive market. The choice of a specific driver of fixed wages is irrelevant for the welfare analysis. Additionally, in Appendix D I develop a version of the model with flexible wages, which preserves all the results of the basic model. The key distinction is that the reallocation of workers across the two industries following a change in the degree of experience rating of the system leads to changes in the wages offered in the two industries. Since workers consume their wages, the optimal degree of experience rating depends on two additional sufficient statistics: the elasticities of wages in the two industries with respect to experience rating. Section **??** shows that these elasticities are estimated to be zero, leading us back to the scenario of fixed wages.

[5] Modeling unemployment taxes as head taxes to be paid both in the good and in the bad state of the world is consistent with unemployment insurance financing rules in the United States. There, employers pay unemployment taxes on the wages paid to a worker up to the Taxable Wage Base. Since most workers earn yearly wages exceeding the Taxable Wage Base, employers tend to pay the entire amount due for each worker with the initial tax payments of the year and do not pay taxes on the wages paid later in the year. Consequently, whether a worker is retained or not for the whole year is irrelevant for determining the due amount of unemployment taxes.

[6] This specific modeling choice for the cost of effort guarantees that the optimal effort increases with the degree of experience rating and that it is infinite with complete experience rating, when $e = 1$. Intuitively, when $e = 1$ the cost of effort is nullified, making increasing effort a purely beneficial choice for the employer. When $e < 1$, a greater degree of experience rating increases the unemployment insurance tax paid by the high-risk employer (shown in the following section), leading the employer to exert more effort, without reducing their loss under the bad state of the world. The presence of q guarantees that even when the cost of effort is nullified when $e = 1$, there is still a gap in the employer's profits across different states of the world.

2.1.2 Government Budget Constraint and Experience Rating

The government provides $\$b$ of unemployment benefits to the l_H workers laid off by the high-risk employer with probability r_H. The government funds unemployment benefits with taxes on employers, set to guarantee a balanced budget in expectation, as Equation **??** shows:

[BUDGET CONSTRAINT]

The government sets e, the degree of experience rating of the unemployment insurance system, or the cost per dollar of unemployment benefit that employers generated with layoffs that they pay in unemployment taxes. Equations **??** and **??** show that the high-risk employer pays a fraction $e \in [0, 1]$ of the total cost of unemployment benefits, and the low-risk employer pays the residual fraction $1 - e$.[7]

[TAU L] [TAU H]

The case of $e = 1$ corresponds to the scenario of complete experience rating, characterized by the absence of coinsurance, employers' moral hazard, and interindustry cross-subsidization. Firstly, no insurance is provided to the high-risk employer, who pays the full cost of the unemployment benefit claims they generated with their layoffs. Secondly, since effort costs are nullified, employers' exert maximum effort to avoid layoffs, which are minimized: $m^{*,ER} = \infty$ and $r_H = p_H$. Thirdly,

Equations **??** and **??** 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]

[SUBSIDY L ER]

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 $\sum_{t=0}^{\infty} Subsidy_{t,L}^{ER} = 0$.

The case of $e < 1$ corresponds to the risk-pooling scenario, in which the burden of the cost of unemployment benefits is shared between the two employers, even if such cost is solely generated by the high-risk employer. This scenario is characterized by the presence of insurance, employer's moral hazard, and interindustry cross-subsidization. By shifting a fraction $1 - e$ of the cost of unemployment benefits towards the low-risk employer, the government insures the high-risk employer, who only bears a fraction e of this cost in case

[7] Modeling the degree of experience rating as the per dollar cost of unemployment benefit is consistent with Feldstein 1976 and Topel 1984.

of a negative shock. However, the presence of effort costs lead the high-risk employer to exert less than infinite effort to avoid layoffs, which results in greater than minimum layoffs: $m^{*,Pool} < \infty$ and $r_H > p_H$. Additionally, coinsurance creates an imbalance in the usage and financing of the unemployment insurance system, with the low-risk employer paying part of the cost of benefits generated by the high-risk employer. Equations **??** and **??** show that unemployment insurance subsidies are non-zero under risk-pooling.

[SUBSIDY H POOL]

[SUBSIDY L POOL]

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 $\sum_{t=0}^{\infty} Subsidy_{L,t}^{Pool} = \sum_{t=0}^{\infty} -(1-\alpha)bl_H\left(p_H + \frac{1}{m}\right) = -\infty$.

2.1.3 Workers

There is a continuum of workers i. $l_H \in (0,1)$ are employed by the high-risk employer and $l_L = 1 - l_H$ are employed by the low-risk one. Workers are assumed to be risk-averse, with identical strictly concave and state-independent utility functions defined on consumption $u(c)$.[8]. When employed, workers consume their industry-specific wages: $c(e) = w_x, x \in \{L, H\}$. When unemployed, they consume the unemployment benefit: $c^u = b$. Since benefits are lower than wages, workers are averse to the income risk linked with unemployment, yet they cannot self-insure with borrowing or lending. Additionally, I assume that workers have heterogeneous relative productivity (or preference for working) in the low-risk industry $z_i \sim U[0,1]$. Higher values of z_i indicate greater relative productivity in the low-risk industry. Consequently, z_i enters positively in the utility from the low-risk job and negatively in the utility from the high-risk job. Equations **??** and **??** illustrate the utility associated with employment in the low- and high- risk industries for worker i respectively:

[UTILITY L] [UTILITY H]

[8] Like Baily (1978), I disregard the utility that workers derive from leisure, aligning with the notion that unemployed workers are active labor force agents engaged in job search rather than inactive individuals enjoying leisure. To incorporate leisure, I can assume that unemployed workers consume $b + d$, where b is the unemployment benefit and d is the consumption-equivalent value of the leisure enjoyed. The presence of d does not change the optimal experience rating equation but narrows the gap in workers' marginal utilities between the good and the bad states of the world. This reduction mitigates the distortions associated to employers' moral hazard and interindustry labor reallocation, leaning towards a lower optimal degree of experience rating. This result mirrors Chetty (2006), where introducing leisure does not change the equation for the optimal level of unemployment benefit as it is chosen optimally by the worker. However, because workers are willing to forego consumption for extended unemployment, leisure leads to a larger consumption drop and a higher optimal benefit level. In my model, the exogenous determination of the unemployment benefit b may also consider the leisure factor.

2.1.4 Capitalists

There is a continuum of capitalists owning capital k used by the employers for production. The allocation of capital between the employers is determined exogenously and is such that $k_L + k_H = k$. Capitalists consume the return from their investment. For each unit of capital invested, they receive an effective return consisting of the exogenous price of capital, j, and an exogenous fraction $\gamma \in (0, 1)$ of employers' net worth, $\Pi_L + \Pi_H$. In presence of asymmetric information between lenders (capitalists) and borrowers (employers), lenders need to audit their investment and lose part of their return in agency costs. Greater values of employers' net worth are associated to lower agency costs (Bernanke et al. 1989). This explains why capitalists returns increases in employers' net worth. Equation **??** shows capitalists' utility, assumed to be linear in consumption to reflect their risk-neutrality:

[CAPITALISTS]

2.2 Model Solution

The model unfolds as follows. Firstly, the government determines the degree of experience rating e of the unemployment insurance system that maximizes the utilitarian social welfare function, obtained as the sum of workers' and capitalists' utilities. Secondly, employers observe the government's choice of e and choose their labor demand and effort optimally, hiring workers from the most to the least productive available. Lastly, the labor demand shock is realized. I solve the model by backward induction. I begin by deriving employers' optimal responses to the government's choice of experience rating, and then calculate the government's optimal choice of experience rating taking employers' responses as given.

2.2.1 Labor demand as function of experience rating

By replacing $\tau_L l_L$ and $\tau_H l_H$ from Equations **??** and **??** in Equation **??**, I express employers' expected profits as function of the degree of experience rating e. Employers treat e as a fixed parameter and choose labor demand to maximize expected profits.

Equation **??** presents the labor demand of the high-risk employer, determined by setting the derivative of expected profits with respect to l_H equal to zero. Profits are maximized when the marginal production obtained by employing an additional unit of labor equals the marginal labor costs, given by the wage and the unemployment tax. Since f is strictly concave, $f^{'-1}$ is decreasing in l_H. It follows that increasing the degree of experience rating e reduces the high-risk employer's labor demand: $\frac{\partial l_H}{\partial e} < 0$ all else equal. Intuitively, a higher degree of experience rating increases the labor costs (the unemployment taxes) of the high-risk employer, leading to a decrease in their labor demand.

[LABOR DEMAND H]

The elasticity of the high-risk employer's labor demand with respect to the degree of experience rating, $\epsilon_{l_H,e} = \frac{\partial l_H}{\partial e}\frac{e}{l_H} < 0$, measures the percentage decrease in the employment share of the high-risk employer after a one percent increase in the degree of experience rating. As the total labor force is divided between the employers in the two industries, when l_H workers are employed in the high-risk industry, the residual portion $1 - l_H = l_L$ are employed in the low-risk one, and the labor market clears. Consequently, $\epsilon_{l_H,e}$ captures the extent of the interindustry labor reallocation occurring after a change in the degree of experience rating of the unemployment insurance system.

2.2.2 Effort as function of experience rating

After observing the government's choice of the degree of experience rating e, the high-risk employer chooses the level of effort m that maximizes expected profits. Equation **??** defines this optimal level of effort. Profits are maximized when the marginal benefits associated with exerting an additional unit of effort are equal to the marginal costs. Increasing effort yields two marginal benefits. Firstly, it enhances the probability that the good state of the world will materialize. This benefit is quantified by the difference in the profits experienced by the high-risk employer between the two states of the world. Secondly, exerting more effort reduces the employer's layoff rate, consequently reducing the size of the unemployment tax. However, because $\psi(m)$ 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 layoff rate reaches its minimum: $\lim_{m\to\infty} r_H = \lim_{m\to\infty} p_H + \frac{1}{m} = p_H$. With risk pooling, when $e < 1$, the marginal cost of effort is non-zero, and the optimal level of effort is finite and determined by comparing the marginal benefits with the marginal costs. Appendix D shows that the optimal level of effort is increasing in the degree of experience rating: $\frac{\partial m}{\partial e} > 0$. This response occurs because experience rating holds the high-risk employer financially accountable for a greater share of the benefit costs they generated with layoffs, incentivizing them to increase the effort to avoid paying such costs.

[OPTIMAL EFFORT]

The elasticity of the high-risk employer's effort with respect to the degree of experience rating, $\epsilon_{m,e} = \frac{\partial m}{\partial e}\frac{e}{m} > 0$, measures the percentage increase in effort after a one percent increase in the degree of experience rating. Since effort is inversely proportional to the employer's layoff rate, $\epsilon_{l_H,e}$ captures the change in employer's moral hazard occurring after a change in the degree of experience rating of the system.

2.2.3 Optimal degree of experience rating

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

[SWF]

Equation **??** provides the solution to this optimization problem, and defines the optimal degree of experience rating through a tradeoff between the marginal benefits and costs of increasing insurance to employers (or decreasing experience rating).

[OPTIMAL ER]

The left-hand side of Equation **??** presents the marginal benefit of additional insurance. By reducing the degree of experience rating, the government shifts a greater part of the tax-cost of unemployment benefits from the high- to the low-risk employer, providing greater insurance to the high-risk employer and narrowing the gap in the marginal profits between the bad and in the good states of the world. Reducing the marginal profits gap increases welfare by raising employers' net worth and the returns from capital investment consumed by capitalists in presence of agency costs. Equation **??** shows that the marginal profits gap equals the monetary cost of effort that the high-risk employer bears solely in the bad state of the world.

[VALUE]

The right-hand side of **??** presents the marginal costs associated with lower insurance: the inefficiencies from interindustry labor reallocation and from employers' 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 labor reallocation has three welfare effects, represented by the three elements within the parameter λ, expressed explicitly in Equation **??**. Firstly, relocated workers switch from experiencing the utility associated with low-risk job to experiencing the utility associated with a high-risk job. Depending on which is higher, this change may be beneficial or detrimental for marginal workers. This welfare effect is illustrated by the gap in the utilities from the two jobs. Secondly, relocated workers have progressively lower productivity in (or preference for) the high-risk industry. The inefficient reallocation of productive skills across industries is expressed by the relative productivity in the low-risk industry of the marginal worker employed in the high-risk industry, z_{l_H}. Thirdly, labor reallocation imposes a fiscal cost on the government budget beyond skills misallocation: a higher employment share in the high-risk industry is associated to more workers exposed to a high layoff rate, to more layoffs, and to a higher cost of unemployment benefits that the government funds by increasing unemployment taxes, which are partially shifted on the low-risk industry.

[LAMBDA]

The elasticity of the high-risk employer's effort with respect to the degree of experience rating, $\epsilon_{m,e} > 0$, is the sufficient statistic capturing the inefficiencies due to employers' moral hazard. Decreasing the degree of experience rating makes layoffs less expensive for the high-risk employer, who exerts lower effort to avoid the bad state of the world. Reduced effort has two welfare effects, illustrated by two elements in the parameter μ, explicitly expressed in Equation **??**. Firstly, the probability that workers employed by the high-risk employer are laid off and consume the unemployment benefit, rather than the wage, increases. This welfare effect is illustrated by the gap in utilities between the good and the bad states of the world for workers in the high-risk industry. Secondly, moral hazard imposes a fiscal cost on the government budget: the higher number of layoffs results into greater unemployment benefit costs, which the government funds with higher unemployment taxes partially shifted on the low-risk industry.

[MU]

2.2.4 Empirical Implementation

This section describes the data and methodology employed to assess the magnitude of the parameters in Equation **??**. Most of the effort is devoted to estimating $\epsilon_{l_H,e}$, the labor demand elasticity with respect to the degree of experience rating for employers in high-risk industries, for which there is no readily available estimate in the literature. Since in the model an increase in the degree of experience rating generates an increase in the unemployment tax per worker paid by the high-risk employer, I can equivalently estimate a labor demand elasticity with respect to the unemployment tax per worker, $\epsilon_{l_H,\tau}$. Therefore, I leverage quasi-experimental variation from reforms of unemployment financing policies in South Carolina and Colorado and estimate the reduced form causal effect of changes in the tax per worker on high-risk employers' labor demand. Notice that this elasticity involves a total derivative of labor demand with respect to the tax per worker. These reduced form effects capture all the behavioral responses from a change in the tax per worker that eventually affect labor demand and make it unnecessary to estimate all the effects separately. Then, 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. Lastly, I calibrate there are various parameters in λ and μ using several moments in the data.

Once the magnitude of all these parameters has been established, it is possible to compare the marginal costs and the marginal benefits associated with an infinitesimal change in the degree of experience rating of an unemployment insurance system. So long as the costs exceed the benefits, experience rating should be increased. To maintain consistency and make sensible comparisons, the estimates and the calibrations of the parameters all stem from the same context. The use of local estimates further implies that the policy considerations only hold policy relevance for the context in which the formula has been empirically implemented. The analysis will thus indicate how to adjust experience rating in South Carolina and in Colorado.

3 Estimating the costs of interindustry labor reallocation

This section describes the sample and the identification strategy used to estimate the elasticity of labor demand with respect to the unemployment tax per worker for employers in high-unemployment risk industries. The quasi-experimental source of variation used for this estimate comes from a reform of unemployment insurance financing policies in South Carolina. Appendix **??** describes the sample and identification strategy to produce an estimate based on quasi-experimental variation in the tax per worker in Colorado.

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 a separate Unemployment Trust Fund, where the unemployment taxes levied on employers[9] 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

[9] Alaska, New Jersey and Pennsylvania) also levy unemployment taxes on covered employees.

fund levels decrease due to high benefit demand, states increase unemployment tax rates on employers, and reduce them when once the fund is replenished.[10]

Additionally, 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. Thirty-one states employ a measure of experience known as *"reserve ratio"*, illustrated in Equation 1. 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 represent the employers' net position with respect to the unemployment insurance system and 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). Depending on whether benefit charges exceed tax payments, the reserve ratio could be positive or negative. Higher reserve ratio values indicate greater experience with unemployment, as the dollar amount of benefit charges raises relative to tax payments.[11]

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

Nineteen states measure employers' experience with unemployment using the *"benefit ratio"*, illustrated in. Equation 2. 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 3 and 7 across different states. The benefit ratio only assumes non-negative values. Higher values of benefit ratio indicate greater experience with unemployment, as recent benefit charges rise.[12]

[10] 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 A1 illustrates the trends in unemployment benefits, unemployment taxes, federal loans and trust fund reserves in the United States from 1999 to 2021. High benefit demand during the Great Recession and the COVID-19 pandemic led to a significant decline in trust fund reserves, followed by an increase in unemployment taxes to cover the cost of compensation. Thirty-three states became insolvent during the Great Recession, and eighteen during the pandemic. These states borrowed nearly 50 billion dollars from the federal government and raised their taxes to repay the debt.

[11] I have inverted the sign of the reserve ratio to guarantee that tax rates increase with all measures of unemployment risk. In reality, 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.

[12] 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 A2 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

$$\text{Benefit Ratio}_{it} = \frac{\sum_{j=x}^{t-1} \text{Unemployment Benefits}_{ij}}{\sum_{j=x}^{t-1} \text{Taxable Wages}_{ij}} \tag{2}$$

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 recent changes in the measure of experience 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"*. 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 the \$10,000 paid in the first quarter and on the \$5,000 paid in the second quarter.

The cross-sectional and temporal variations in unemployment tax rates designed to hold employers accountable for their unemployment benefit costs are unique to the United States. However, there are three categories of benefit costs that cannot be charged to specific employers. Firstly, "ineffective charges" result from employers already at 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".

3.2 Data sources and sample description

This section describes the data used for the estimation and calibration of the parameters in the formula for the optimal degree of experience rating. Firstly, I obtained access to unemployment tax filing data covering the universe of employers in South Carolina, from the South Carolina Department of Employment and Workforce (SC DEW) and in Colorado, from the Colorado Department of Labor and Employment (CO DLE). The data include the information used from SC DEW to assign unemployment tax rates to

2016.

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 code. Secondly, I collected and digitized information on the laws regulating unemployment insurance financing across the US states over the recent decades. The data enables me to identify state-level reforms of unemployment financing policies, which I use as quasi-experimental variation in unemployment taxes. Thirdly, I obtain information about employment and wages at the state-industry-year-quarter level from the Quarterly Census of Employment and Wages (QCEW). Lastly, I 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.

South Carolina, located in the coastal Southeastern region of the United States, has approximately 5 million inhabitants and 150,000 establishments in 2023. The SC DEW records cover all the employers with unemployment tax liabilities in the state.[13] To focus on employers affected by unemployment financing reforms, I restrict the original sample to private sector, experience rated 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.

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 average wage offered is $30,000 and the average is $40,000. The median establishment year is 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

[13] 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 **??** reveals a closely aligned distribution of employers and employees across industries between the SC DEW data and the QCEW data in 2009, indicating that excluding the largest employers does not significantly impact the representation of specific industries in the SC DEW data.

the tax rate by the taxable wage base of \$7,000, varying between \$91 and \$427. [14]

3.3 Empirical strategy

To generate quasi-experimental variation in unemployment taxes, I leverage the 2011 reform of unemployment financing policies in South Carolina. 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 almost \$1 billion in federal loans. To rapidly repay the debt and restore fund solvency, South Carolina initiated a reform of its unemployment insurance financing policies in early 2010, with tax changes impacting employers from 2011. By the end of 2014, the federal loan was repaid, and South Carolina gradually reduced unemployment tax rates while retaining other changes introduced with the 2011 reform.[15]

The reform introduced three main changes. First, the taxable wage base increased from \$7,000 to \$14,000 over a span of five years. Second, new lower and higher tax rates were introduced. Third, South Carolina replaced the reserve ratio with the benefit ratio as measure of employers' experience with unemployment.[16] Equation 3 highlights two key differences between the two measures. First, they differ in the length of the lookback period j used for assessing employers' experiences with unemployment. The reserve ratio considers information from the employer's establishment date (or inception of unemployment insurance program if establishment was earlier) to the calculation date. In contrast, the benefit ratio relies on a rolling seven-year lookback period, and any earlier information is discarded. Second, unemployment tax payments enter the formula of the reserve ratio to define total reserves, but not in that of the benefit ratio.[17] These differences impact the pace at which unemployment taxes rise during recessions, with benefit ratio systems restoring trust fund solvency twice as fast as reserve ratio systems following shocks to benefit payments (Lachowska et al. 2020). Since most employers had built up substantial reserves through years of unemployment tax payments, charging them with new benefits during the Great Recession didn't result into significant increases

[14] Compared to the original sample, the study sample is positively selected. Table **??** shows that the selected employers have six more employees and offer average annual wages \$4,000 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.

[15] Trends in unemployment benefits, taxes, trust fund reserves and federal loans for South Carolina are shown in panel (b) of Figure A1.

[16] Figure A3 displays the recent trends in the taxable wage base in South Carolina. Figures A4 and **??** illustrate the unemployment tax rate schedules before and after the reform, respectively. The new schedule has a broader range of tax rates, assigned based on employers' benefit ratios rather than reserve ratios. Figure A5 illustrates employers' tax liability per worker for each level of reserve ratio pre-reform (panel [a]) and of benefit ratio post-reform (panel [b]). Changes in the tax per worker reflect both the reformed tax rate schedule and the higher taxable wage base. Visual inspection suggests a significant increase in tax liability per worker, with the maximum rising from \$427 to \$879. However, examining the distribution of employers' reserve ratios in 2009 and benefit ratios in 2011 in panels (c) and (d) reveals that this substantial increase affected a limited share of employers, as only 10% of them had positive reserve ratio in 2009 and only 27% had a benefit ratio higher than 0.2 in 2011.

[17] The reserve ratio and the benefit ratio also have different denominators. Given the high correlation between them (0.94 in my study sample) the difference in denominators plays a minor role to the variation in employers' measure of experience.

in their reserve ratios and unemployment tax rates. The benefit ratio, determined solely based on recent benefit charges, is much more responsive to employers' current conditions, and allowed the government to raise the tax rates of those employers with significant layoffs during the Great Recession.

The reform was a notable event among employers, and there were concerns that it could dampen labor demand and hinder economic recovery. Firm-level outcomes were thus likely affected. The Greenville Business Magaine (April 2011) reports the worries of an employer regarding the transition from reserve to 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 journal also highlights widespread concerns about the associated tax increase: *"Some business leaders fear the new rates will discourage large companies from hiring new employees as the economy begins its uptick'.'*

$$\mathrm{RR}_{it} = \frac{\sum_{j=-\infty}^{t-1} \text{Unempl. Benefits}_{ij} - \sum_{j=-\infty}^{t-1} \text{Unempl. Taxes}_{ij}}{\text{Taxable Wages}_{i,t-1}} \longrightarrow \mathrm{BR}_{it} = \frac{\sum_{j=-7}^{t-1} \text{Unempl. Benefits}_{ij}}{\sum_{j=-7}^{t-1} \text{Taxable Wages}_{ij}} \tag{3}$$

Replacing the reserve ratio with the benefit ratio resulted in the recalculation of employers' experiences with unemployment. Disregarding all the tax payments ever made by the employers and all the unemployment benefit charges made against employer before the seven-year lookback period led to a new assessment of employers' histories, and with higher tax rates linked to greater experience with unemployment, to the redistribution of the tax burden across employers in the state.

With a differences-in-differences approach, I compare employers with similar benefit ratios but different reserve ratios. Because of their similar benefit ratios, these employers displayed comparable layoff behavior and employment stability during the seven-year lookback period used to calculate the benefit ratio, 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.

Panel (a) of Figure 1 illustrates this strategy with an example. In the graph, the x-axis measures time, divided into the *"distant past"*, ranging from employers' establishment up to July, 2003, seven years prior to the reform, and the *"recent past"*, covering the seven years before the reform. The y-axis measures employers' layoff rates, represented by solid lines, and tax rates, represented by dashed lines. The figure displays two employers, one depicted in blue and one in green, with the same benefit ratio but different reserve ratios. The two employers share the benefit ratio because they both maintained a low layoff rate during the recent past and have different benefit ratio because of their different distant past behavior. The blue employer had a high layoff rate during the distant past. The benefit claimed by the laid-off workers increased this employer's account reserves, assumed to be positive, and hence the reserve ratio, leading to a high unemployment tax rate. In 2011, the reform replaced the reserve ratio with the benefit ratio. Restricting the lookback period to the recent past led to disregarding the blue employer's distant past layoffs and to emphasizing their recent stability, decreasing their unemployment tax rate. In contrast, due to their low layoff rate in the distant past but regular unemployment tax payments, the green employer had low account reserves and a low reserve ratio, and hence a low unemployment tax rate before the reform. Since this employer maintained a low layoff rate over time, the reform did not change the assessment of this employer's experience, which remains constant irrespective of whether the whole employer history or the recent past only is considered. Consequently, the green employer's tax rate remained constant around the time of the reform. Intuitively, the reform led to disregarding the elements determining the distant past reserves: tax payments for low-reserve ratio employers; and benefit charges for high-reserve ratio ones. With higher tax rates being assigned to higher-experience employers, low-reserve ratio employers experienced a disproportionate increase in their unemployment tax rates relative to high-reserve ratio employers with the same benefit ratios.

Panel (b) of Figure 1 shows that the patterns from the illustrative example also emerge in the data. The figure shows the average tax rate for employers with predicted benefit ratio[18] equal to zero in 2011 and either positive (blue) or negative (green) reserve ratio in 2009. The tax rates were evolving in parallel during the pre-reform period, indicating that the predicted benefit ratio adequately represents employers' behavior over the recent past. In 2011, the reserve ratio was replaced with the benefit ratio. Since these employers have the same predicted benefit ratio, their post-reform tax rates are very similar, identical in 2011. Equalizing tax rates that were very different pre-reform implied a reduction of 3.9 percentage points for the blue employer and of only 1 percentage point for the green employer.

These figures confirm that conditional on the benefit ratio, positive reserve ratio employers can serve as counterfactual for negative reserve ratio employers: they show what would have happened to negative reserve ratio employers if they experienced the same tax cut.

Panel (b) of Figure 1 is based on employers with predicted benefit ratio of zero. In practice, there is wide variation in employers' benefit ratio which I can leverage. Panel (a) of Figure 2 plots employers by their recent benefits (numerator of the benefit ratio) in 2011 and total reserves (numerator of the reserve ratio)

[18]The 2010 predicted benefit Ratio is the benefit ratio that employers would have had if the reform took place one year earlier. Figure A6 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.

in 2010, 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. The figure reveals a positive correlation between these two measures, indicating that they both identify employers with high experience with unemployment. However, there is significant variation between them: for every level of scaled total reserves there is a wide range of corresponding scaled recent benefits. Consequently, employers classified and treated equally under the old system end up being classified and treated differently under the new system. My identification strategy consists in comparing employers horizontally: for each level of benefit ratio on the y-axis, I compare employers with negative reserve ratios (treated) against employers with positive reserve ratio (control). The blue and green employers from Figure 1 are the employers on the first line, corresponding to the zero level of benefit ratio.

This discussion justifies the estimation of the following differences-in-differences equation:

$$Y_{i,t} = \alpha_i + \sum_{y=2005}^{2014} \beta_y 1_{y=t} Treat_i + \alpha_{b(i),t} + \epsilon_{i,t} \tag{4}$$

In Equation 4, $Y_{i,t}$ is the outcome for employer i in year t; α_i are employer fixed effects, $Treat_i$ is an indicator for employers with negative reserve ratio; b_i are predicted benefit ratio bins sized 0.000001; $\alpha_{b(i),t}$ are fixed effects for each level of predicted benefit ratio-year; and $\epsilon_{i,t}$ is an error term. Standard errors are robust to heteroskedasticity and clustered at the employer level. β_{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 likely maintained a much more stable employment than employers with positive values of predicted benefit ratio.

This strategy relies on two identifying assumptions to ensure that the β coefficients identify the evolution of the Average Treatment Effect on the Treated. The first is a parallel trend assumption, requiring that negative reserve ratio employers would have evolved as the positive reserve ratio employers within the same benefit ratio bins. Formally, the assumption requires that the reserve ratio is uncorrelated with the error term. This assumption is satisfied so long as employers' reserve ratio primarily reflect employers' distant past so that, after controlling for the recent past, the reserve ratio has no other effect on current outcomes than through the treatment.

To see whether this is the case, Equation 6 decomposes the numerator of the reserve ratio, the employer's *total reserves*, into 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 past reserves*, calculated as the difference between benefit charges and tax payments occurring during the seven years before the calculation date. Recent reserves can be further broken down into two elements: the *recent taxes* paid by the employer and *recent benefits* charged to the employer in the most recent seven years. This latter component is the numerator in the formula for the benefit ratio.

$$\begin{aligned}
\overbrace{\sum_{-\infty}^{0}\text{Benefits}_i - \sum_{-\infty}^{0}\text{Taxes}_i}^{\text{RR num= Tot. reserves}} &= \overbrace{\left(\sum_{-\infty}^{-7}\text{Benefits}_i - \sum_{-\infty}^{-7}\text{Taxes}_i\right)}^{\text{Distant past reserves}} + \overbrace{\left(\sum_{-7}^{0}\text{Benefits}_i - \sum_{-7}^{0}\text{Taxes}_i\right)}^{\text{Recent past reserves}} \qquad (5)\\
&= \underbrace{\sum_{-7}^{0}\text{Benefits}_i}_{\substack{\text{BR num.=}\\ \text{recent benefits}}} + \underbrace{\left(\sum_{\infty}^{-7}\text{Benefits}_i - \sum_{\infty}^{-7}\text{Taxes}_i\right)}_{\substack{\text{Distant past reserves}\\ \text{MEMORY}}} - \underbrace{\sum_{-7}^{0}\text{Taxes}_i}_{\substack{\text{Recent Taxes}\\ \text{MATCH}}} \qquad (6)
\end{aligned}$$

As the equation shows, there are two factors contributing to the difference between an employer's reserve ratio and benefit ratio: the distant past reserves and recent taxes. Shifting from a reserve ratio system to a benefit ratio system implied disregarding both factors for each employer. The variation in these factors generates variation in the reserve ratio of employers with the same benefit ratio. I then explore the contributions of these two factors to the total variation. Panel (b) of Figure 2 isolates the contribution of distant past reserves, or of the *memory* of the unemployment insurance system. The figure plots employers by their scaled recent benefits and residualized scaled total reserves, obtained from a regression of scaled total reserves on scaled recent taxes. The figure shows even larger variation between the two measures, suggesting that the composition of the distant past reserves is a primary determinant of the original variation. Many employers with negative distant past reserves, built up through regular tax payments over time, accumulated positive benefit charges in the recent past, likely during the Great Recession. Ignoring these negative distant past reserves results in an increase in the experience measure, explaining the high benefit ratio of many employers with low reserve ratio. Symmetrically, some employers with positive distant past reserves due to high distant past benefit charges experienced no layoffs in the recent past. Disregarding the positive reserves reduces the experience measure, explaining the low benefit ratio of many employers with high reserve ratio. Panel (c) isolates the contribution of recent taxes to the original variation. The figure 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 variation due to match appears to be more limited. Intuitively, recent taxes are determined by employers' reserve ratios, which are very sticky and primarily reflect the composition of the distant past. Focusing on employers with no distant past eliminates most of the variation in recent taxes. 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. This is reassuring because it implies that the main determinant of the reserve ratio are distant past events which, after controlling for the recent past, are likely uncorrelated with current outcomes.

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 gradual depletion of the unemployment trust fund was largely ignored until December 2008, when South Carolina became insolvent.[19] Secondly, even with the reform passed in spring 2010, employers had no means to anticipate how it would affect them individually until late November, when unemployment tax rate notifications were sent out. This is not only due to the complexity of calculating the measure of experience, which employers may not have the data for, but also because the new system assigned tax rates based on employers' ranking by experience rather than the absolute value of their experience.[20] Predicting the individual ranking in the state using a new experience formula, backing up the corresponding tax rate, and adjusting accordingly was thus impossible.[21] Lastly, classifying employers as treated and control based on their 2009 reserve ratios and using the 2010 predicted benefit ratio instead of the true 2011 benefit ratio for fixed effects further reduce the risk of anticipation effects.

I estimate Equation 4 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 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

[19] The Sun News (March 19, 2010) reports that, despite the warnings raised by the South Carolina Chamber of Commerce since 2005, the General Assembly overlooked the steady fund until March 2008, when insolvency became evident. However, the reform process only started in 2009 and was 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."* One legislator later commented: *"It's easy to say somebody should do something. If I had a magic wand, I would have waved it and fixed the fund.*. The journalist responded that *"another option would have been simply to tell someone - the press, his colleagues, anyone, and begin working on a solution in April 2008"*.

[20] See the notes to Figure **??** for details about tax rate assignment after the reform.

[21] The Greenville Business Magazine (April 2011) confirmed that *"the notices went out so late"*, *"after most companies began their fiscal years with budgets already in place"*, leaving employers with *" tens of thousands of dollars in unplanned expenses"* and *"blindsided."*.

employment during the Great Recession.[22] 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 A8 suggests that the value of 250 identifies industries with exceptionally large variation in employment within the year. Table A1 lists the forty-nine industries classified as high-risk with this definition. As shown in Figure A9, there 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 reduced form effects to elasticity estimates. Equation **??** shows the formula for the labor demand elasticity with respect to the tax per worker. In the equation, β_{l_x} and β_{τ_x} are the average of β_{2011}, β_{2012}, β_{2013} and β_{2014} from Equation 4 with employment and the unemployment tax per worker as outcome, respectively. $l_{x,2010,Treat}$ and $\tau_{x,2010,Treat}$ are the average employment share and the tax per worker in year 2010 for treated employers. x refers to the full sample or to the subsamples of high- and low- risk industries. This procedure thus enables me to estimate $\epsilon_{l_H,\tau}$ and $\epsilon_{l_L,\tau}$, the elasticities of labor demand with respect to the unemployment tax per worker in low- and high-risk industries. As discussed in Section **??**, these elasticities are equivalent to $\epsilon_{l_H,e}$ and $\epsilon_{l_L,e}$ respectively. The former captures the welfare effects of interindustry labor reallocation. As discussed in Section 2, the model predicts that $\epsilon_{l_H,e} < 0$ and $\epsilon_{l_L,e} \geq 0$.

3.4 Results

Figure 3 and Table 2 present the estimated β_y coefficients from Equation 4 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, 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 142% relative to the average tax per worker in 2010. This effect endured in subsequent years as 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, continued in 2012 and 2013, and partially recovered in 2014. The 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

[22] Figure A7 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.

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. This analysis suggests that either single high-productivity employees or that multiple low-productivity employees are missing. Fourthly, there is no effect on taxable wages, suggesting that the reduced number of employees exactly compensates the higher taxable wage base. Lastly, the unemployment taxes paid by treated employers increased by \$839 (or 59%) in 2011. Since taxable wages were unaffected, the increase needs to be driven by the higher unemployment tax rate. 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. To explore the role of employers' behavioral responses in the determination of employers' tax payments, I benchmark the effect on employers' true tax payments with the effect on "non-behavioral" tax payments. The latter represent the taxes that the employer would have paid in absence of behavioral responses, that is, if they maintained their pre-reform taxable wages.[23] Consequently, changes in non-behavioral tax payments only reflect policy changes in the tax rate and in the taxable wage base. It emerges that treated employers would have paid \$213 more in 2012, \$506 more in 2013 and \$264 more in 2014 if they did not reduce their workforce. Due to the large confidence intervals these differences are not statistically significant, but still informative for policymakers interested in raising revenue by taxing employers. These patterns 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' behavioral responses. The absence of effects on average wages and the decrease in the workforce suggest that the burden of the tax increase fell entirely on employers.

Robustness. These findings are robust to the inclusion of large employers in the estimation, to using outcomes scaled by their 2010 level rather than measured in level, and to utilizing an alternative approach to create Predicted Benefit Ratio fixed effects. These robustness tests are explained in detail in Appendix B.

Additional findings. Appendix B provides detailed descriptions of several additional analyses conducted. Firstly, the stringent measures taken by SC DEW, along with regular audits to ensure the accuracy and truthfulness of reported data, make it unlikely that the observed effects stem from employers manipulating

[23]Non-behavioral tax payments are equal to true employers' tax payments until 2010. From 2011 on, they are equal to employers' true unemployment tax rates multiplied by employers' taxable wages in 2010, scaled by the relative increase in the taxable wage base.

their data to reduce their tax burden. Secondly, the evidence suggests that the observed effects are driven by reduced hiring rather than increased separations. Thirdly, there is no significant evidence supporting liquidity effects relative to price effects as the primary drivers of these findings. Lastly, the reform does not appear to have increased firms' shutdown rate.

Heterogeneity by industries' risk. Table **??** and Figure **??** illustrates the estimated β_y coefficients from Equation 4 for South Carolina employers in low- and high-risk industries, categorized as such depending on their average within-year employment standard deviation. Despite facing similar increases in their unemployment taxes per worker, employers in low- and high-risk industries display substantially different responses. Firstly, the decline in the number of employees and in wages observed in the full sample is entirely driven by employers in high-risk industries. For these employers, the number of employees declines by 0.8-2.4, or, and wages by $40,000-117,000. For employers in low-risk industries, the number of employees increases by 0.3-0.8 over the period, although the increase seems to result from a positive trend started in the pre-period. Average wages are unaffected for employers in both types of industries. However, there are significant differences in taxable wages by industry at the time of the reform. The taxable wages of employers in low-risk industries jump up by $7,000 in 2011 and more in the later years. The taxable wages of employers in high-risk industries remain unaffected, or even decline (although the estimates are insignificant), due to the lower number of employees. As a result, taxes jump up for both employers in 2011, but remain higher for employers in low-risk industries while decline due to behavioral responsnes for employers in high-risk industries. The absence of an effect for employers in low unemployment risk industries suggest that these employers accept lower profits.

Elasticities calculation. Table 4 presents the components that contribute to the elasticity calculation and the corresponding estimated elasticities. The overall reduction in employment of 0.52 observed in the full sample conceals significant variations. Specifically, the coefficient estimated in the sample of low-risk industries is positive, although not statistically significant, while the coefficient in the sample of high-risk industries is negative and substantially larger, measuring 1.7. Considering the comparable average number of employees and Tax Per Worker for treated employers in both low- and high-risk industries, and the similar increase experienced in their Tax Per Worker with the reform, I find substantial variation in the corresponding elasticities. The elasticity of employment with respect to the Tax Per Worker, estimated at -0.039 in the full sample, equals 0.064 for employers in low-risk industries and -0.139 for high-risk industries.

Based on the model presented in Section 2, the substantially higher elasticity of employment in high-unemployment risk industries compared to low- risk industries is consistent with higher unemployment taxes reducing the employment share of high-risk industries. I will then use these estimates of the elasticities of labor demand to estimate the elasticity of labor reallocation.

3.4.1 The Colorado Experiment

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

4.1 Calibrating the costs of employer's moral hazard

This section quantifies the elasticity of effort to reduce unemployment risk with respect to the degree of experience rating, $\epsilon_{m,e}$, capturing the marginal costs associated with employers' moral hazard. While effort to avoid layoffs is not directly observable, layoffs themselves are measurable, suggesting that the layoff elasticity is informative about the effort elasticity with respect to the degree of experience rating. More precisely, Appendix X shows that the effort elasticity is equal to the negative of the layoff elasticity. Table A2 provides estimates of the layoff elasticities from the literature on employer moral hazard, ranging between -0.43 and zero. I do not use the zero estimate from Johnston (2021) because it is based on a sample of employers in Florida with the highest unemployment tax rates – hence, either firms who have already laid off their workers or firms with a constantly high layoff rate irrespective of the cost of layoffs. This zero estimate thus likely represents a lower bound when applied to a more representative employer sample. However, it is crucial to notice that the zero estimate holds reliability as it is the only one derived from quasi experimental variation. If it was representative for the broader sample of employers in the state, it would suggest that the costs associated with moral hazard are zero, and that the only costs associated with decreasing experience rating arise from interindustry labor reallocation. Among the non-zero estimates, I adopt the -0.27 estimate from Topel (1984), lying in the middle of the range, and explore the implications of using alternative estimates.

4.2 Calibrating the other parameters in the formula for the optimal degree of experience rating

Table 5 describes the data source and approach used to either estimate or calibrate the parameters in Equation **??**. This section focuses on the parameters contained in the scaling factors λ and μ. First, I calibrate e, the degree of experience rating of the unemployment insurance system, by calculating the median tax cost per dollar of unemployment benefits claimed in South Carolina between 2003 and 2010, equal to 0.78. Second, I calibrate b, the dollar amount of the unemployment benefit consumed by each unemployed worker in the model, with the average dollar amount of unemployment benefit claimed in South Carolina in 2006, before the onset of the Great Recession, using the ET394 data. Then, I calibrate l_H and w_H, the employment share and average wage of high-unemployment risk industries, using the QCEW data from South Carolina in 2006 and maintaining the usual classification of high-unemployment risk industries.

4.3 Optimal degree of experience rating

The estimation and calibrations of the parameters in Equation **??** enable me to quantify the costs associated with an infinitesimal decrease in the degree of experience rating. Using Equation **??**, I obtain a total value for λ of X which, multiplied by the estimated value for the labor demand elasticity for the high-risk employer of X, gives a total marginal cost of interindustry labor reallocation of X. Using Equation **??**, I obtain a total value for μ of Y which, multiplied by the calibrated value for the effort elasticity, gives a total marginal cost of moral hazard of Y. Combined, these values indicate that the total costs from an infinitesimal decrease in the degree of experience rating equal X.

To achieve policy relevance, this number must be compared with the estimated marginal value of decreasing experience rating for employers. This paper does not estimate this value directly, but attempts to benchark it.

5 Conclusions

The provision of unemployment benefits costs between 0.2 and 2.7% of the GDP in western economies. The program is primarily financed with payroll taxes on employers, with considerable differences in implementation across countries. While in the United States employers are assigned a personalized unemployment tax rate reflecting the unemployment benefit costs resulting from their layoffs, an approach known as experience rating, all the other countries assign employers a common tax rate irrespective of employers' individual utilization of the system, an approach known as coinsurance. Although the literature has explored several desirable and undesirable labor market effects of experience rating, whether experience rating is preferable to coinsurance is unclear, and policymakers are left without a basis to identify the tradeoffs associated with this choice and make choices.

This paper presents a theoretical framework characterizing the optimal unemployment insurance financing policy. The model provides a formula for the optimal degree of experience rating, or share of own benefit costs that employers should pay in unemployment taxes, which encapsulates the relevant tradeoffs that policymakers need to consider. On the one hand, decreasing the degree of experience rating is beneficial for employers who value insurance against negative shocks. On the other hand, decreasing experience rating is associated with two costs: first, the so-called employer moral hazard, where employers internalize a lower share of the cost of their layoffs on society and lay off more workers; second, the cost of increasing the subsidization of high-unemployment risk industries, which grow larger because their large share of unemployment benefit costs is repaid collectively. I use data from two large states in the US and novel quasi-experimental variation from reforms of experience rating in the states to quantify the costs of insurance for employers.

I find that the costs from labor reallocation are the primary source of inefficiency associated with coinsurance. This finding is important because moral hazard has been historically considered the primary distortion associated with lower experience rating, and moral hazard is likely lower outside the United States, where employment protection policies are stronger. This result sheds light on the fact that even if employers are prevented from freely lay off workers, there are substantial costs from the inefficient reallocation of workers across low- and high-unemployment risk industries.

Additionally, the paper does not estimate the value of insurance for employers, but finds suggestive evidence that the value is lower than the costs. This would indicate that the current level of experience rating in these states is suboptimal. Other US states with similar experience rating structure and labor market compositions should likely increase experience rating too. Other countries without experience rating in place should consider adopting it given the more prominent role of labor reallocation relative to moral hazard.

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Main Tables

Table 1: Summary Statistics for South Carolina Employers in 2009

	N	Mean	St.d 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 Employer 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 1.

Table 2: Full Sample Reduced Form Effects of the Shift from Reserve to Benefit Ratio on Employer Outcomes

	(1) Tax per worker	(2) Employees	(3) Tot wages	(4) Avg wage	(5) Tax wages	(6) Tot taxes	(7) Tot taxes (non-behav.)
Treated × 2005	-31.999***	-0.126	-7,801.086	4,225.389	-3,109.353	-243.931	-243.931
	(4.003)	(0.576)	(32,870.821)	(3,053.167)	(6,534.490)	(225.698)	(225.698)
Treated × 2006	-35.865***	-0.166	-3,721.700	4,384.293*	-1,357.292	-218.614	-218.614
	(3.763)	(0.649)	(29,593.527)	(2,543.703)	(6,055.655)	(210.029)	(210.029)
Treated × 2007	-28.877***	-0.107	217.805	2,538.698	-477.089	-160.087	-160.087
	(3.367)	(0.633)	(28,594.760)	(2,497.522)	(6,254.873)	(199.126)	(199.126)
Treated × 2008	-24.484***	-0.091	5,123.444	2,304.781	-409.987	-156.198	-156.198
	(2.803)	(0.509)	(18,555.025)	(2,139.768)	(5,010.487)	(173.741)	(173.741)
Treated × 2009	-18.204***	-0.203	-17,086.746	281.252	-1,019.697	-198.974**	-198.974**
	(2.441)	(0.180)	(12,837.579)	(1,651.321)	(2,014.504)	(77.630)	(77.630)
Treated × 2011	197.396***	-0.374*	-19,447.029**	1,315.849	850.952	839.321***	834.164***
	(10.086)	(0.215)	(8,914.287)	(1,640.091)	(3,698.944)	(142.305)	(126.471)
Treated × 2012	157.744***	-0.695**	-38,320.585**	2,111.868	-1,192.993	378.604**	591.968***
	(12.200)	(0.321)	(16,045.541)	(2,101.427)	(4,771.922)	(167.081)	(115.900)
Treated × 2013	143.267***	-0.895**	-39,252.149**	1,532.872	-2,201.282	101.648	607.170***
	(14.116)	(0.387)	(15,382.852)	(1,938.172)	(5,557.137)	(312.096)	(115.905)
Treated × 2014	160.190***	-0.567*	-43,169.141*	-1,677.485	4,665.711	673.278***	901.010***
	(17.231)	(0.292)	(25,472.853)	(3,675.095)	(4,110.560)	(249.413)	(173.229)
Observations	184,610	184,610	184,610	182,663	184,610	184,610	184,610
R-squared	0.555	0.916	0.921	0.670	0.887	0.785	0.797
Mean dep. var 2010	139.1	8.126	315906	40674	66509	1417	1417
P-value post	0	0.241	0.103	0.691	0.0370	0	0
P-value pre	0	0.825	0.307	0.671	0.740	0.173	0.173

Notes: The table reports the estimates of the β_y coefficients from Equation 4 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. Non-behavioral taxes are equal to true employers' taxes until 2010, and to employers' true unemployment tax rates multiplied by employers' taxable wages in 2010, scaled by the relative increase in the taxable wage base from 2011 on. *** p<0.01, ** p<0.05, * p<0.1

Table 3: Reduced Form Effects of the Shift from Reserve to Benefit Ratio on Employer Outcomes by Industry Unemployment Risk

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Tax per worker		Employees		Total wages		Average wage		Taxable wages		Total taxes	
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 β_y coefficients from Equation 4 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 4: 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: β	-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: β	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: β	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 **??**. The $Treated \times Post$ coefficients are the estimated β coefficients from Equation **??**. The treatment group includes employers with Reserve Ratio smaller than zero. The control group includes employers with Reserve Ratio equal to or greater than zero. $Post_t$ is an indicator equal to one for years from 2011 onwards. Predicted Benefit Ratio fixed effects are based on bins sized .000001.

Table 5: Estimates for the Parameters in the Equation for the Optimal Degree of Experience Rating

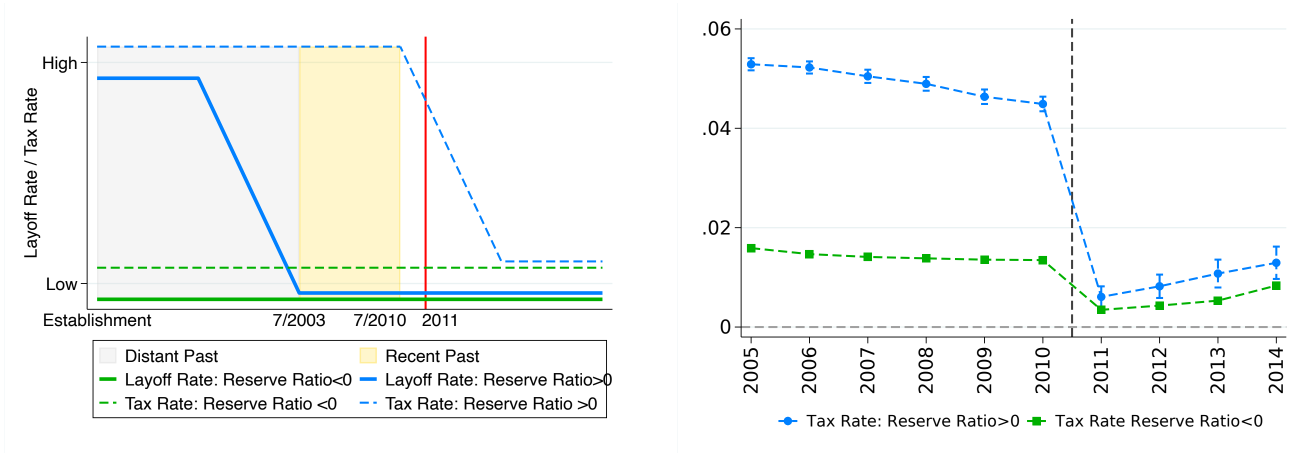
Parameter	Definition	Estimation description	Data source	Estimate value
$\epsilon_{l_H,e}$	High-risk employer's labor demand elasticity w.r.t. experience rating	Labor demand elasticity w.r.t. unemployment tax per worker in subsample of employers in high-risk industries (high-average employment standard deviation industries)	SC DEW	.124
$\epsilon_{m,e}$	High-risk employer's elasticity of effort w.r.t. experience rating	Negative of elasticity of temporary layoffs w.r.t. experience rating	Topel (1984)	0.27
l_H	Share of workers employed by the high-risk employer	Share of workers employed in high-risk industries (high-average employment standard deviation industries) in South Carolina in 2006	QCEW	.56
$l_H b \left(p_H + \frac{1}{m}\right)$	Total cost of unemployment benefits	Unemployment benefits claimed in South Carolina in 2006	ET Financial Handbook 394 (US DOL)	$311,281,000
w_L	Wage offered by the low-risk employer	Average yearly wage in low-risk industries (low-average standard deviation industries) in South Carolina in 2006	QCEW	$37,274
e	Degree of experience rating of the unemployment insurance system	Median tax cost per $ of benefit charged between June 2003 and June 2010 among employers with positive benefit charges	SC DEW	.78
z_{l_H}	Productivity in low-risk job of marginal worker in high-risk job			
$u(w_L) - (1 - r_H)u(w_H) - r_H u(b)$	Δ utility between low- and high-risk job	Compensating wage differential between the two jobs: average unemploymet benefit in SC in 2006	ET 394	$2985
$u(w_H) - u(b)$	Δ utility between good and bad state			
λ	X	Equation ??	X	
μ	X	Equation ??	X	
$\lambda\epsilon_{l_H,e}$	Marginal costs of labor reallocation	Equation ??	X	
$\lambda\epsilon_{m,e}$	Marginal costs of moral hazard	Equation ??	X	X

The table summarizes the approach and data source used to estimate each parameter in Equation ?? characterizing the optimal degree of experience rating.

Main Figures

Figure 1: Variation in Unemployment Tax Rates by Reserve Ratio Conditioning on the Benefit Ratio

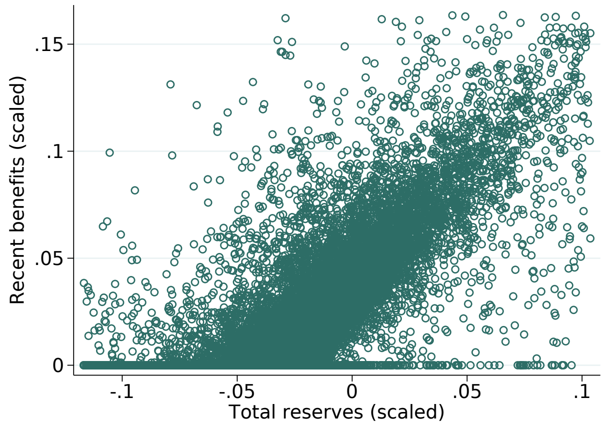
(a) Illustrative example (b) Data counterpart



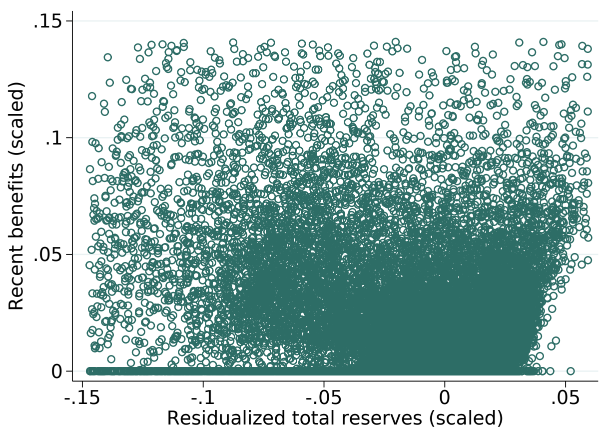
Notes: Panel (a) illustrates the layoff rates (solid lines) and tax rates (dashed lines) of two representative employers with equal benefit ratio but different reserve ratio (positive, blue, and negative, green) over the distant and recent past. Panel (b) plots the average tax rate for South Carolina employers with positive (blue) or negative (green) reserve ratio and a predicted benefit ratio equal to zero. 95% confidence intervals are reported.

Figure 2: Variation between South Carolina Employers' Reserve Ratios and Benefit Ratios

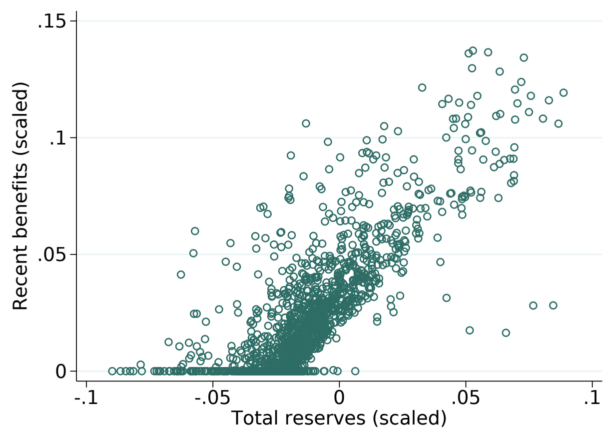
(a) Total Variation



(b) Variation due to Memory

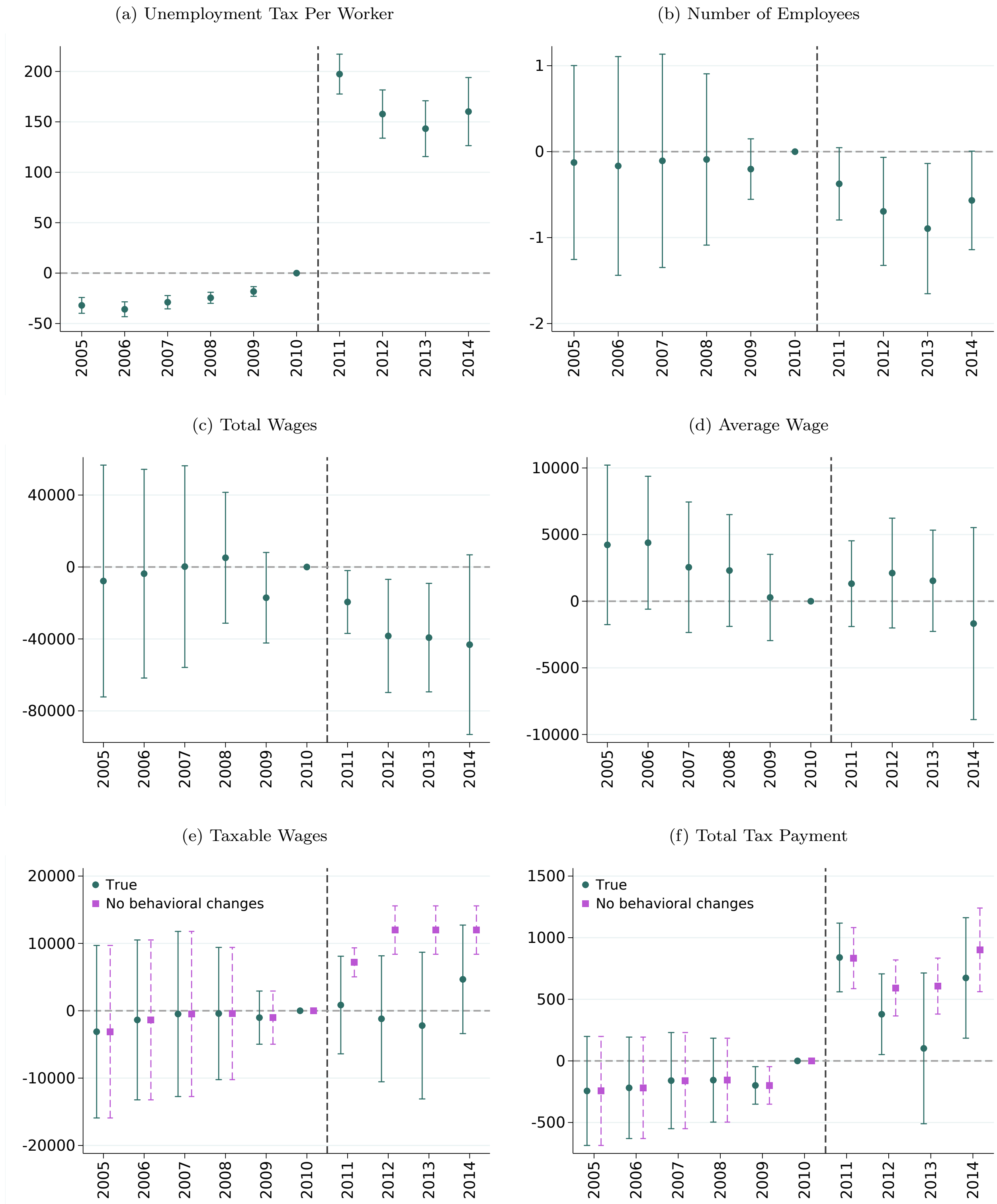


(c) Variation due to Match



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.

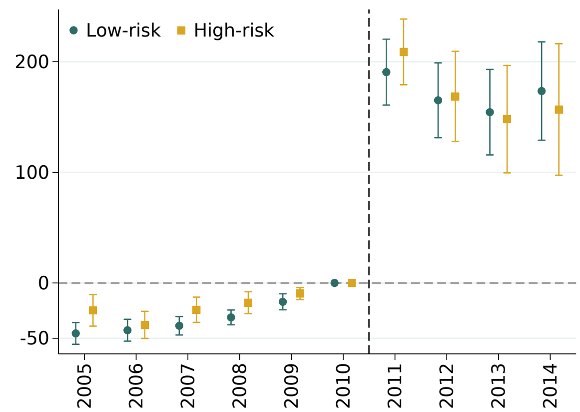
Figure 3: Reduced Form Effects of Reserve-to Benefit Ratio Shift on Employer Outcomes



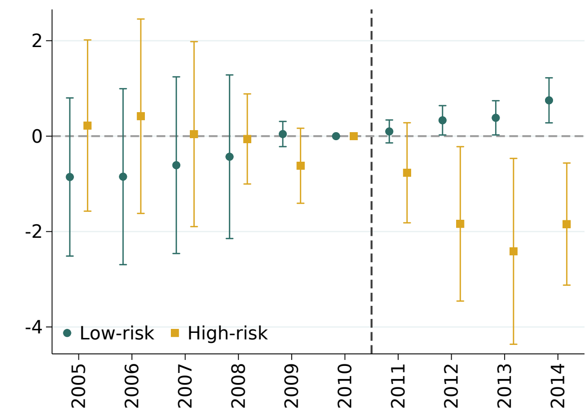
Notes: This figure illustrates the estimates of the β_y coefficients from Equation 4 estimated for South Carolina employers with 1-50 quarterly employees in 2010. See the notes to Table 1 for details on the outcomes. Non-behavioral taxable wages are equal to employers true taxable wages until 2010. From 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 4: Reduced Form Effects of Reserve-to Benefit Ratio Shift on Employer Outcomes by Industry Risk

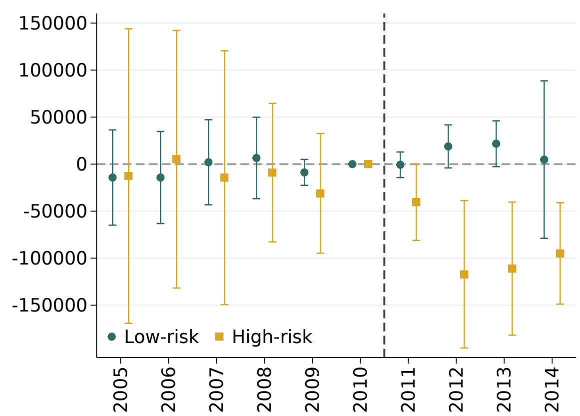
(a) Unemployment Tax Per Worker



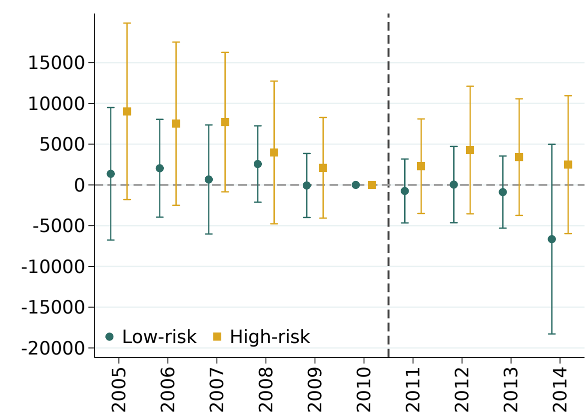
(b) Number of Employees



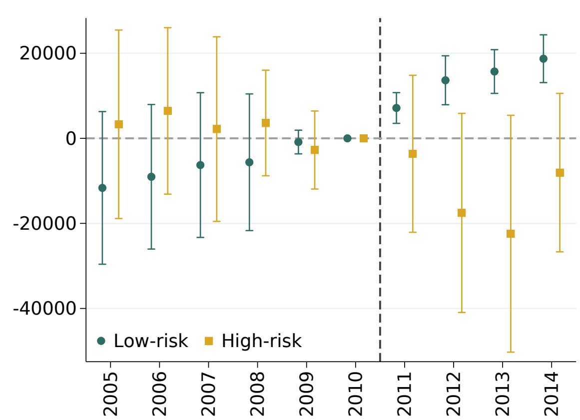
(c) Total Wages



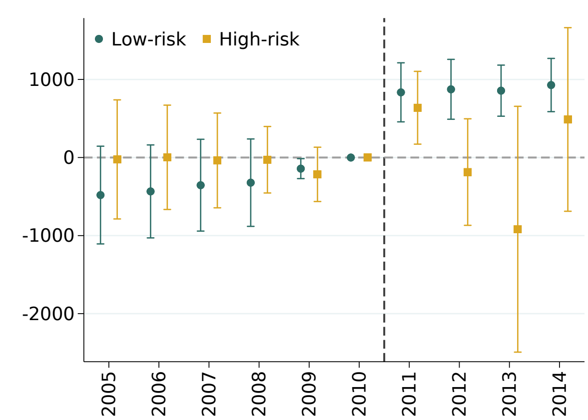
(d) Average Wage



(e) Taxable Wages



(f) Total Tax Payment



Notes: This figure illustrates the estimates of the β_y coefficients from Equation 4 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.

Online Appendix

"Optimal Unemployment Insurance Financing: Theory and Evidence from two US States"

by Sara Spaziani

A Supplementary Tables and Figures

Table A1: List of High-Unemployment Risk Industries

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

Notes: 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.

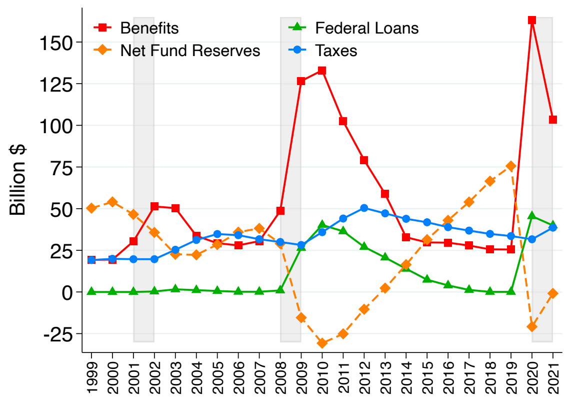
Table A2: Elasticities of Layoffs with respect to Experience Rating from the Literature

Paper	Estimate	Notes
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

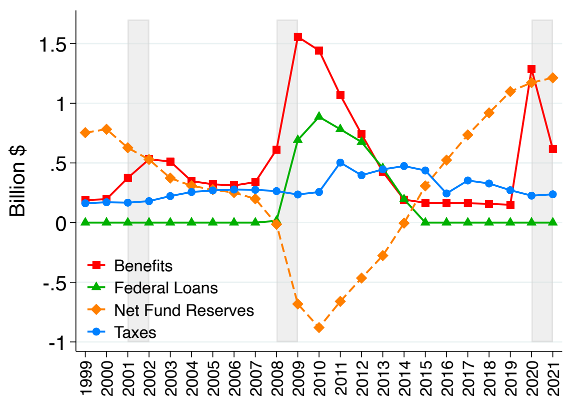
Notes: This table lists the elasticities of layoffs with respect to the degree of experience rating from the existing literature on employers' moral hazard.

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

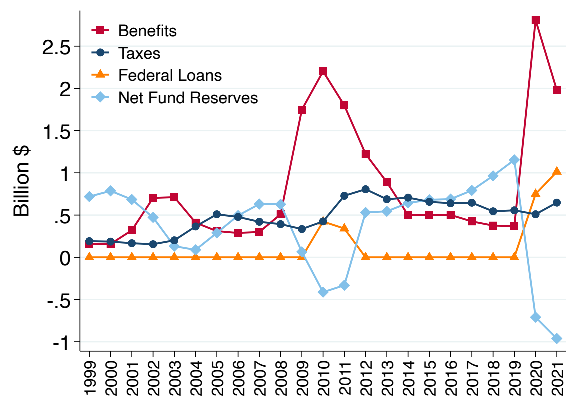
(a) United States



(b) South Carolina

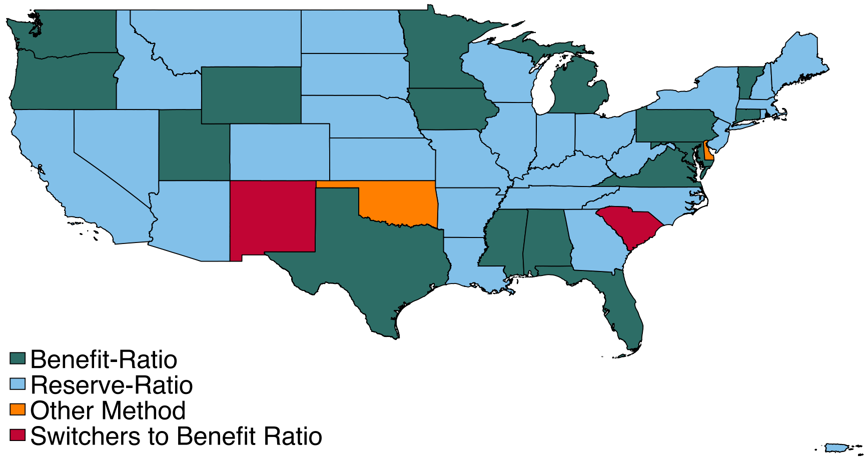


(c) Colorado



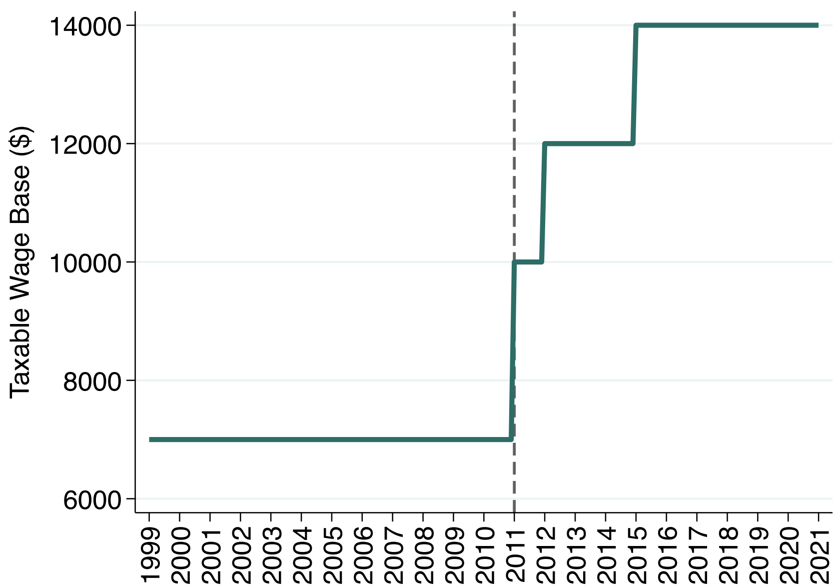
Notes: The figure illustrates the evolution over time of the total amount of unemployment benefits paid out to workers (regular, extended and emergency benefits), federal government loans, reserves in the Unemployment Trust Fund net of federal government loans, and unemployment taxes collected in the United States (panel [a]), in South Carolina (panel [b]), and in Colorado (panel [c]). 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 A2: States' Measure of Unemployment Risk for Tax Rate Assessment



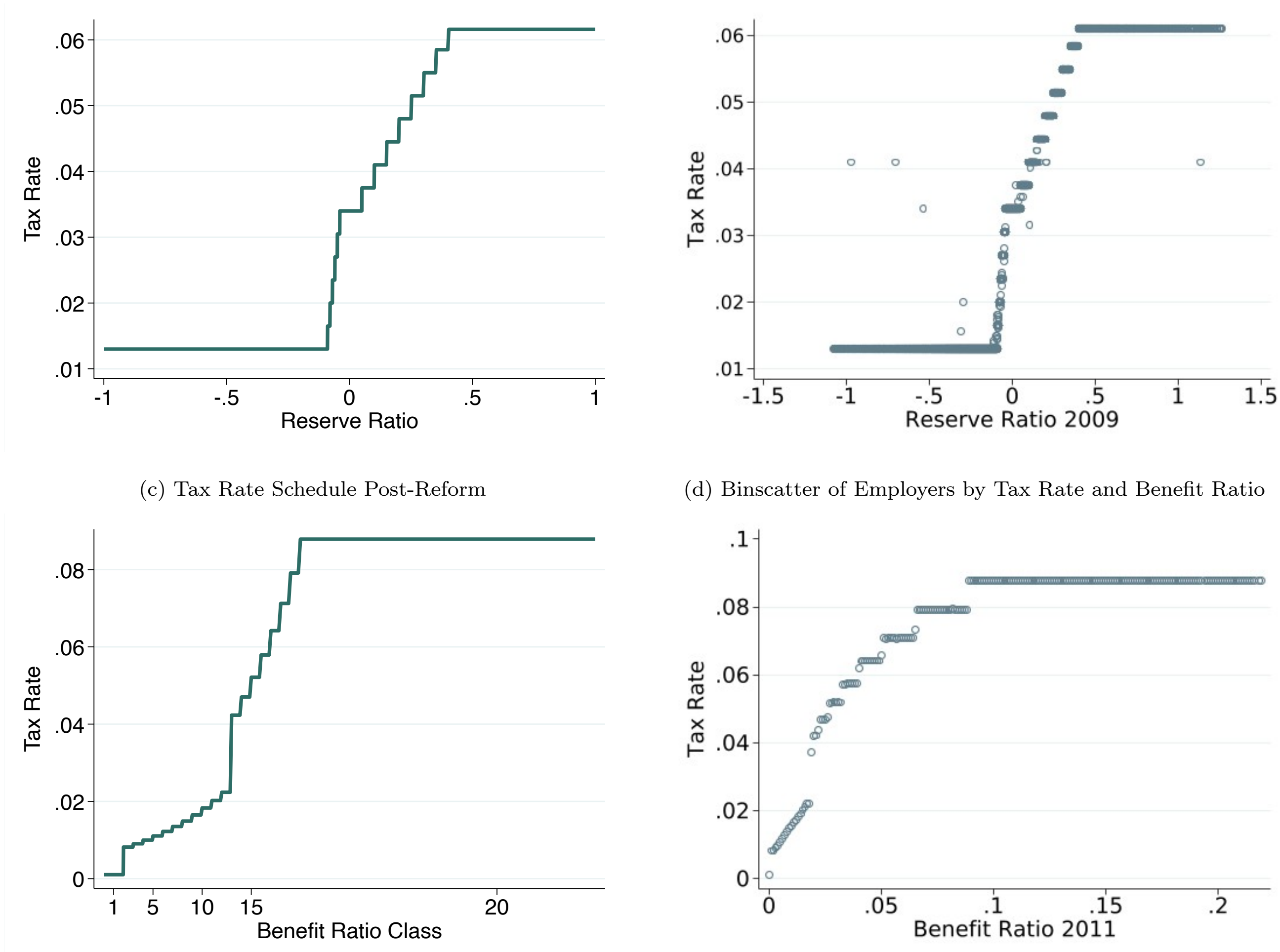
Notes: The figure shows the states using Benefit Ratio, Reserve Ratio, and other measures of employers' unemployment risk used to assign unemployment tax rates to employers.

Figure A3: 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 A4: Pre- and Post-Reform Unemployment Tax Rate Schedules in South Carolina



(a) Tax Rate Schedule Pre-Reform

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

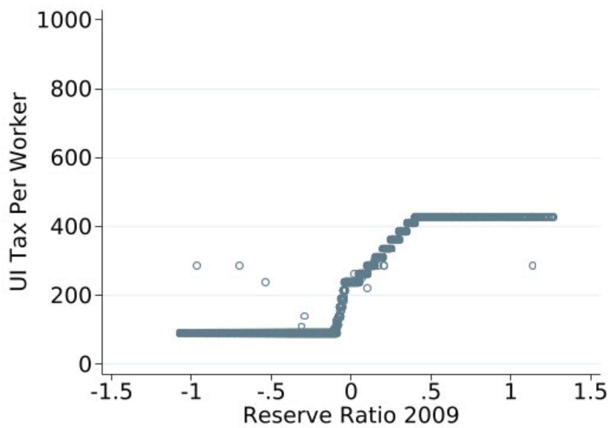
(c) Tax Rate Schedule Post-Reform

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

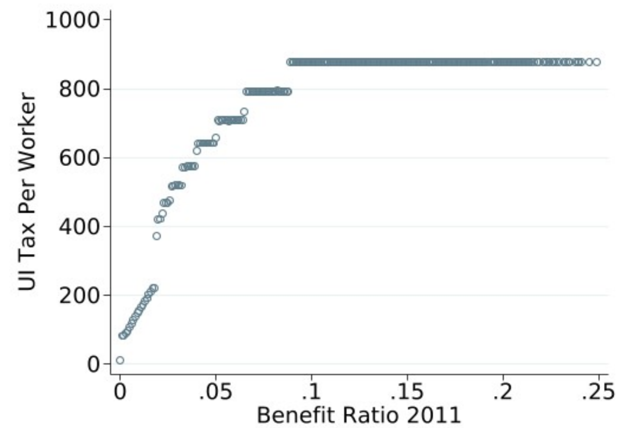
Notes: Panel (a) illustrates the unemployment tax rate schedule in effect in South Carolina between 2004 and 2010 from the Unemployment Insurance Financing Policy database. The schedule specifies the unemployment tax rates, ranging from 1.3 to 6.1%, associated to various ranges of reserve ratio. Panel (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 A5: Unemployment Tax Per Worker by Unemployment Risk in South Carolina around the Reform

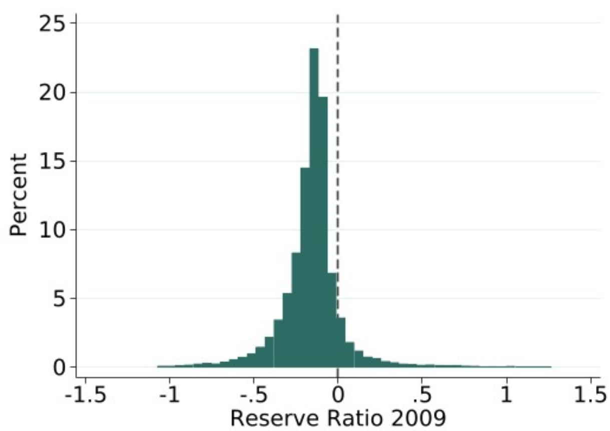
(a) Unemployment Tax Per Worker by Reserve Ratio in 2009



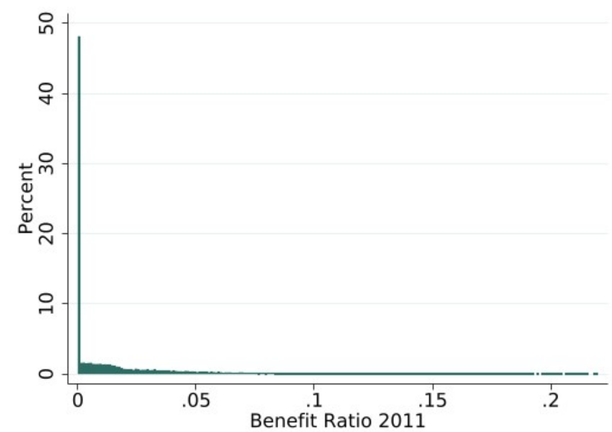
(b) Unemployment Tax Per Worker by Benefit Ratio in 2011



(c) Distribution of Reserve Ratio in 2009

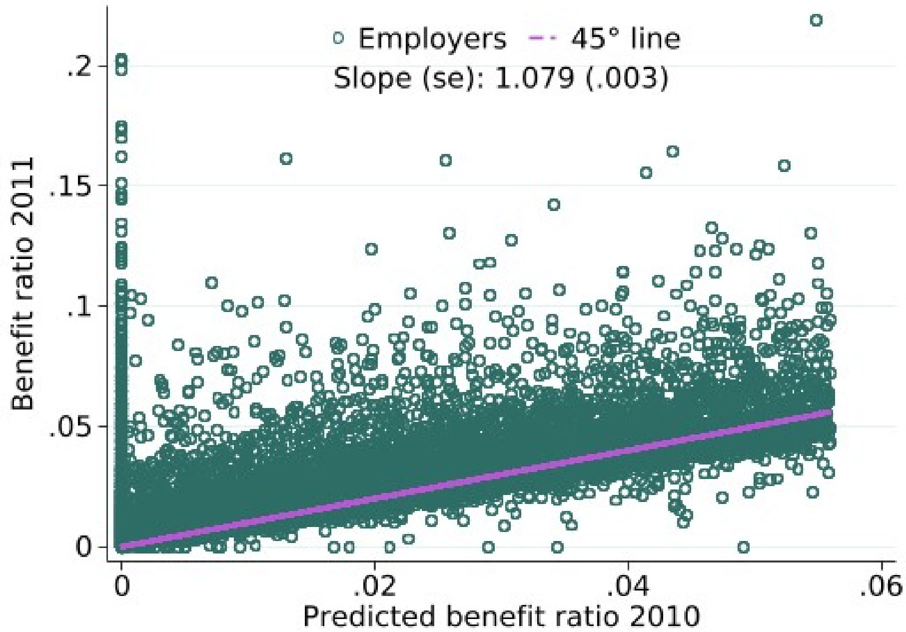


(d) Distribution of Benefit Ratio in 2011



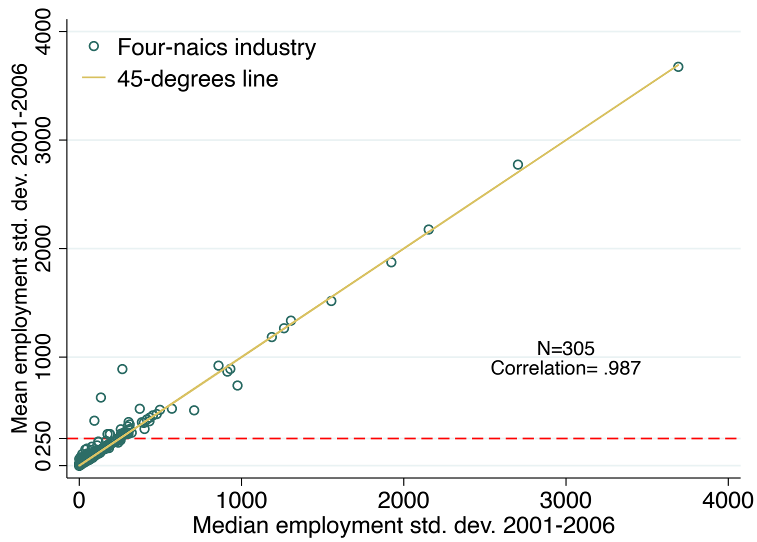
Notes: This figure illustrates the Unemployment Tax Per Worker associated to each level of Unemployment Risk before and after the 2011 reform of unemployment insurance financing rules in South Carolina. The maximum Unemployment Tax Per Worker for a given level of unemployment risk is obtained by multiplying the unemployment tax rate associated to that level of unemployment risk by the Taxable Wage Base. Consequently, the Tax Per Worker schedule has the same visual representation of the tax rate schedule in a given year, with the y-axis scaled up by the Taxable Wage Base. Panel (a) plots South Carolina employers by their maximum Tax Per Worker and Reserve Ratio in 2009. Panel (b) plots South Carolina employers by their maximum Tax Per Worker and Benefit Ratio in 2011. Panels (c) and (d) illustrate the distribution of employers' Reserve Ratios in 2009 and Benefit Ratios in 2011 respectively. These distributions help the reader understand how many employers are subject to each level of Unemployment Tax Per Worker before and after the reform.

Figure A6: The Relationship between True Benefit Ratio in 2011 and Predicted Benefit Ratio in 2010



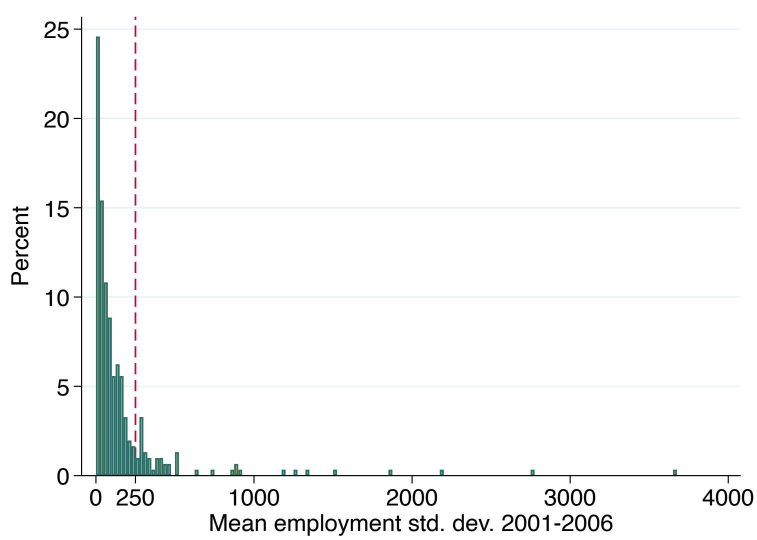
Notes: This figure plots South Carolina employers by their Benefit Ratio in 2011 and their Predicted Benefit Ratio in 2010. The latter is the Benefit Ratio that the employer would have had if the reform took place in 2010 instead of 2011. Because of data availability, it is calculated over a lookback 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 A7: Mean and Median Industry Within-Year Standard Deviation in Employment



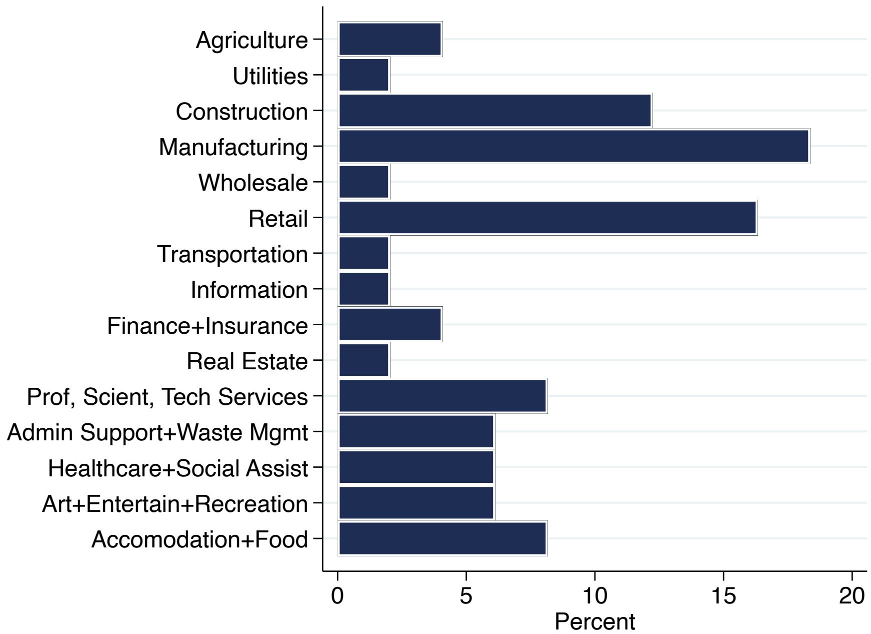
Notes: The figure illustrates the correlation between industries' mean and median employment within-year standard deviations between 2001 and 2006 in South Carolina from the QCEW data. Each marker corresponds to a different industry identified by a NAICS four-digit code. Markers tend to be distributed 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 A8: 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 A9: 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.

B Supplementary Analyses

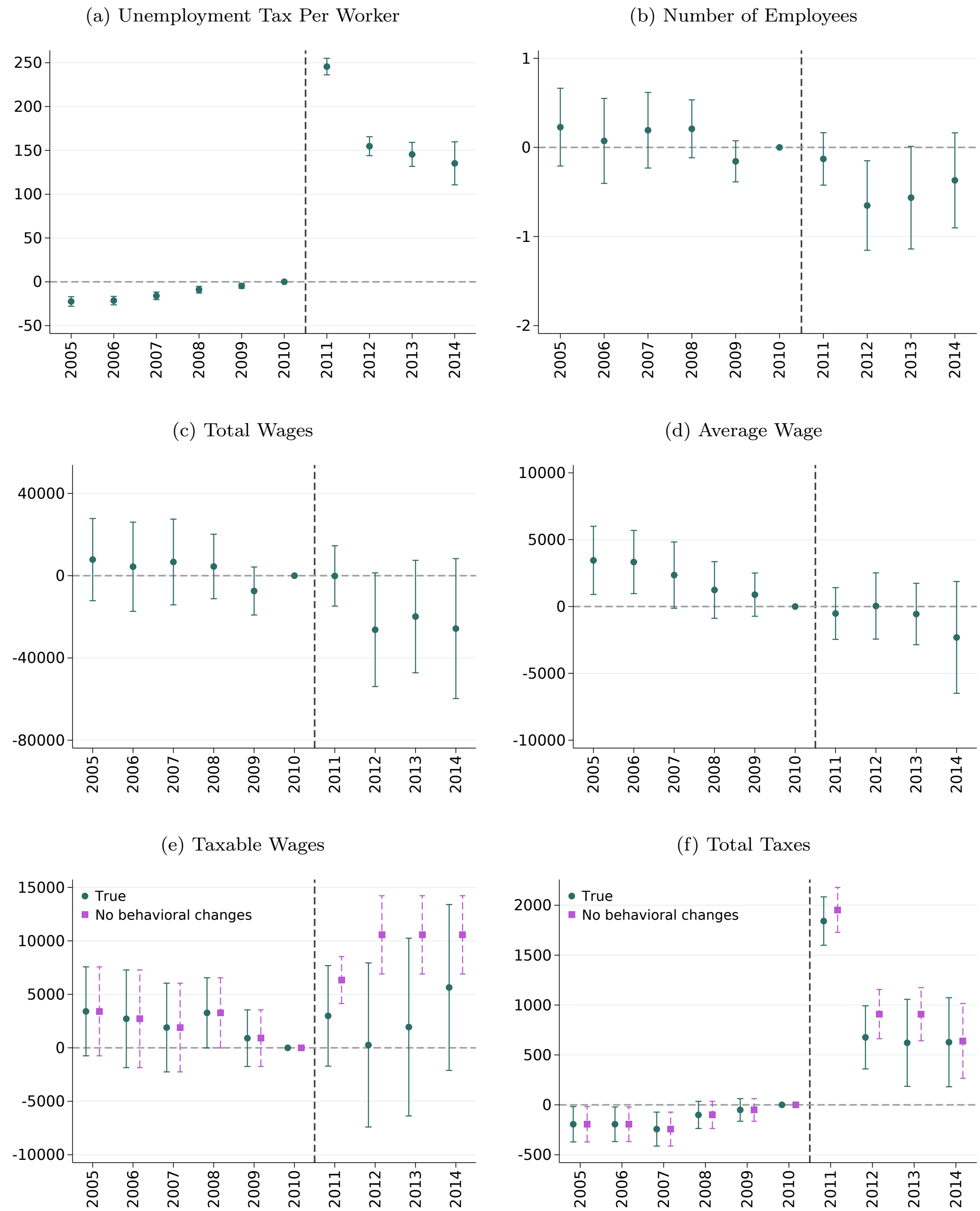
B1: Robustness tests

I test the stability of my findings in several ways. Firstly, I expanded the sample to also include employers with more than than fifty employees in 2010. Given the large variability introduced by large employers, I rescale the outcomes by their level in 2010. Figure **??** presents the β coefficients from Equation 4 estimated for the sample of employers with an year-average number of employees greater than one. The figure shows that the reform increased the Unemployment Tax Per Worker of employers with low Reserve Ratio by 60% compared to employers with high Reserve Ratio. Additionally, low Reserve Ratio employers reduced their number of employees by 4-21%, their total wages by 3-13%, and their taxable wages by 5-33%. Unemployment taxes grew by 64% in 2011 and by approximately 30% in

2012 and 2013. However, taxes would have grown by 73 and 65% respectively in the absence of behavioral responses. 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.

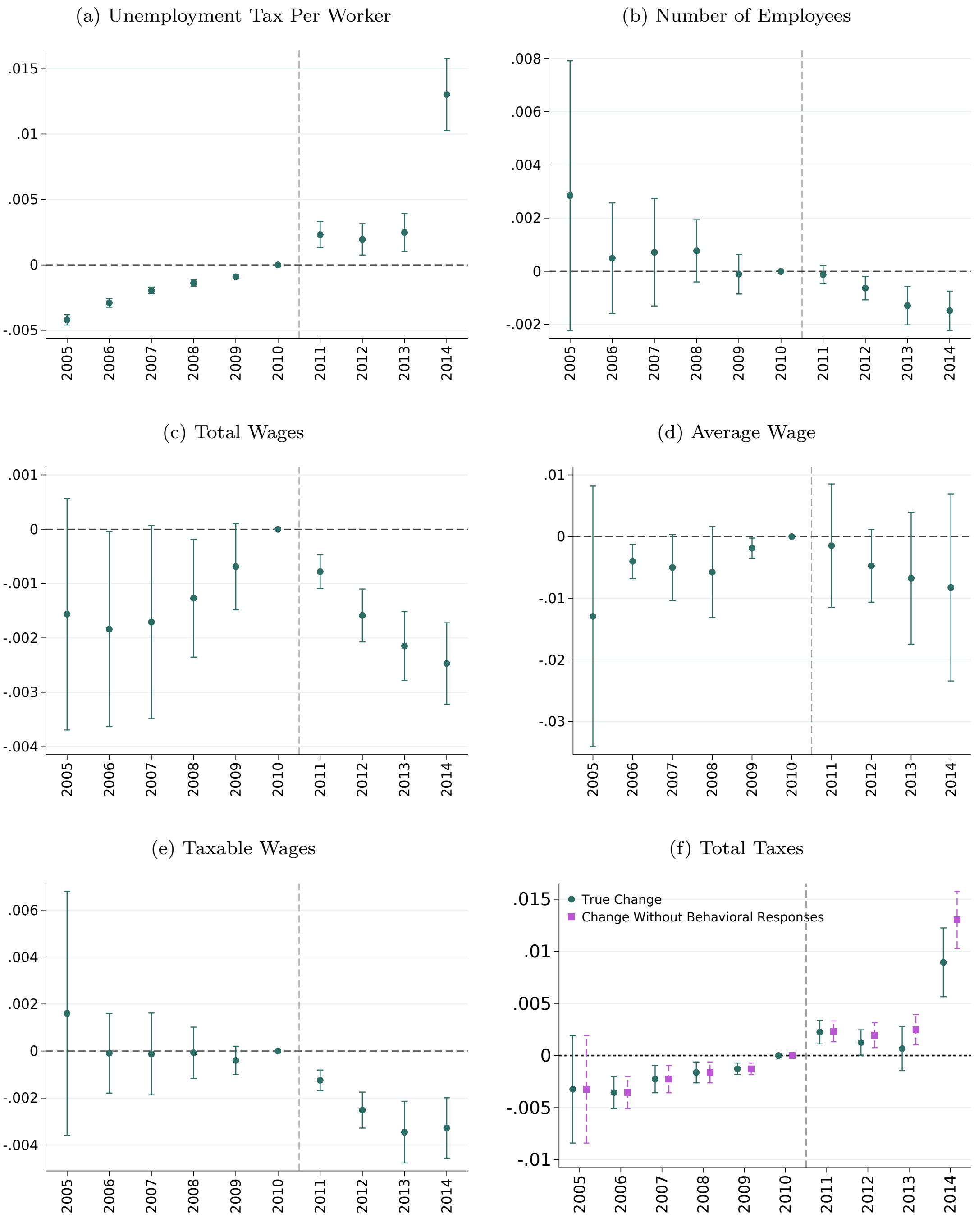
Secondly, my findings are robust to using a different set of fixed effects. My original approach consists in creating very small bins (sized 0.000001) of Predicted Benefit Ratio and include fixed effects for each of these bins. Alternatively, I calculated yearly Benefit Ratios for each employers based on the benefits charged and the taxable wages paid in each of the seven-year lookback period used to calculate the Benefit Ratio. I then create bins of the yearly Benefit Ratios and of the Predicted Benefit Ratio, and create groups of 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. 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 A10 and **??** present the reduced form effects of the reform on firm outcomes in levels and scaled by their 2010 level, respectively, using this alternative set of fixed effects. The results remain robust and show similar magnitudes compared to my original approach. One notable difference is that, in addition to observing a decline in employment, the average wage of the employed workers declined by 5%, suggesting a partial pass-through of the tax on workers.

Figure A10: Reduced Form Effects of Reserve-to Benefit Ratio Shift on Employer Outcomes



Notes: This figure illustrates the estimates of the β_y coefficients from Equation 4 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. 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.

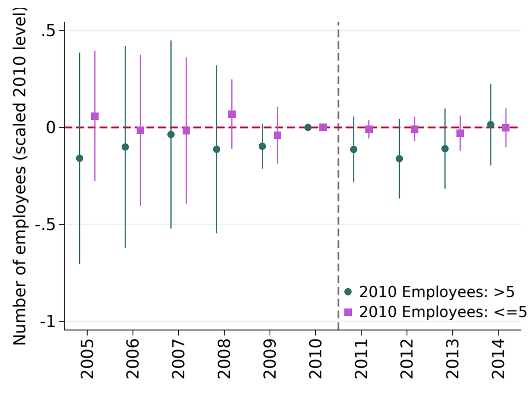
Figure A11: Reduced Form Effects of Reserve-to Benefit Ratio Shift on Employer Outcomes



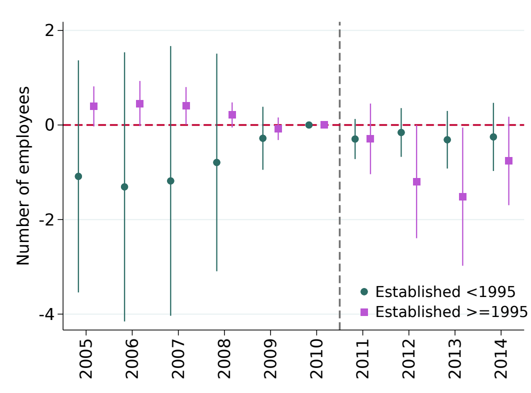
Notes: CONTINUOUS TREATMENT 95% confidence intervals are reported.

Figure A12: Heterogeneous Effects on Employment by Firm Size, Age, and Productivity

(a) by Firm Size



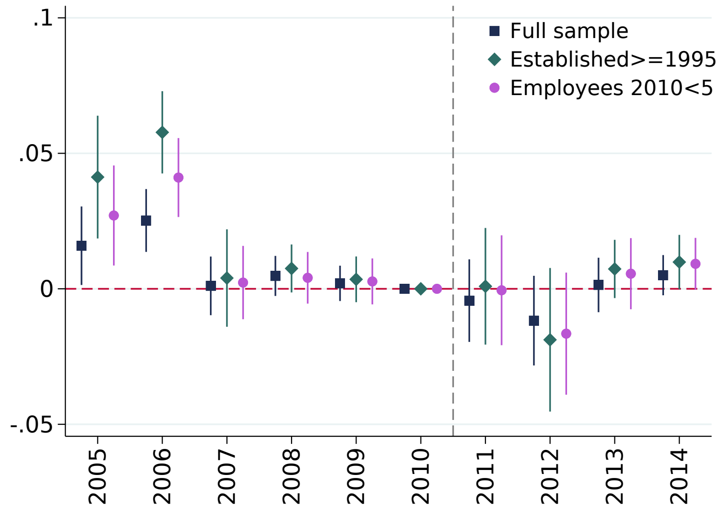
(b) Firm Age



(c) Productivity

Notes: This figure illustrates the estimates of the β_y coefficients from Equation 4 estimated separately in the samples of small and big firms (panel [a]) and old and young firms (panel [b]). The estimation is performed for the sample of employers with an year-average number of employees greater than one. The treatment group includes employers with Reserve Ratio smaller than zero. The control group includes employers with Reserve Ratio equal to or greater than zero. Predicted Benefit Ratio fixed effects are based on bins sized .000001. The outcome is the yearly-average number of employees scaled by the level in 2010. Small firms are firms with up to five employees. Young firms are established after 1995. 95% robust confidence intervals are reported.

Figure A13: The Impact of the Transition from Reserve Ratio to Benefit Ratio on Firm Exit Rate



Notes: This figure illustrates the estimates of the β_y coefficients from Equation 4 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% robust confidence intervals are reported.

Appendix B. 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.

B.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.1 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 τ% from the schedule had to pay a final tax rate equal to $(\tau \times 1.2394)$%. Figure **??** 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.2. 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.

B.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.4 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:

$$Y_{i,t} = \alpha_i + \sum_{y=-8}^{8} \beta_y Treat_i \times 1_{y=t} + \epsilon_{i,t} \tag{7}$$

In Equation 7, $Y_{i,t}$ is the outcome for employer i at time t, measured in quarters relative to the time of event; α_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 β_y coefficients measure the differential effect of the elimination of the surcharge on the treated cohort relative to the control cohort. β_{-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.3), 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.

B.3 Findings

B.3.1 Reduced form effects of the elimination of the surcharge

Figure B.5 and Table B.4 present the β coefficients obtained from Equation 7. 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.

B.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.6 illustrates the β coefficients obtained by estimating Equation 7 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 γ coefficients from Equation 8:

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

The γ 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 **??**. 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 τ. Then, I multiply this ratio by the ratio of the average Tax Per Worker to the average Employment of the treatment group in 2010.

$$\epsilon_{Employment,\tau} = \frac{\beta_{Employment}}{\beta_\tau} \frac{\tau_{t-1,Treat=1}}{Employment_{t-1,Treat=1}} \tag{9}$$

The reduced form effects employed in the calculation of the elasticity are obtained from estimating Equation 10, which pools together all the pre-period and post-period coefficients.

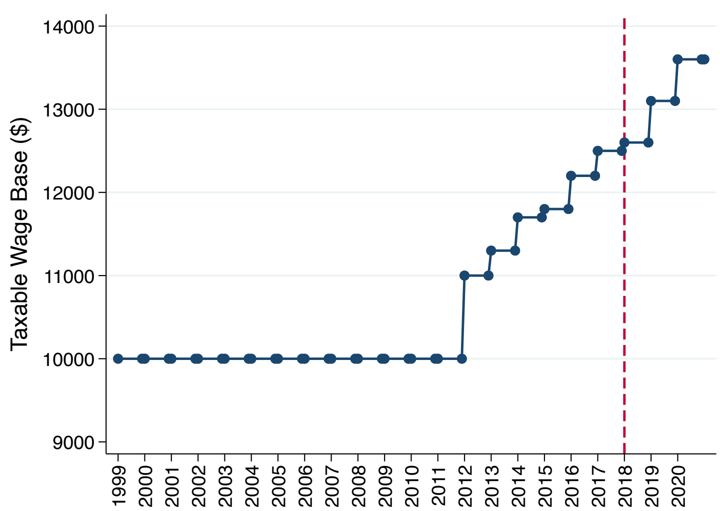
$$Y_{i,t} = \alpha_i + \beta 1_{y=t} Treat_i \times Post_t + +\epsilon_{i,t} \tag{10}$$

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.

B.4 Colorado Tables and Figures

Figure B.1: 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.

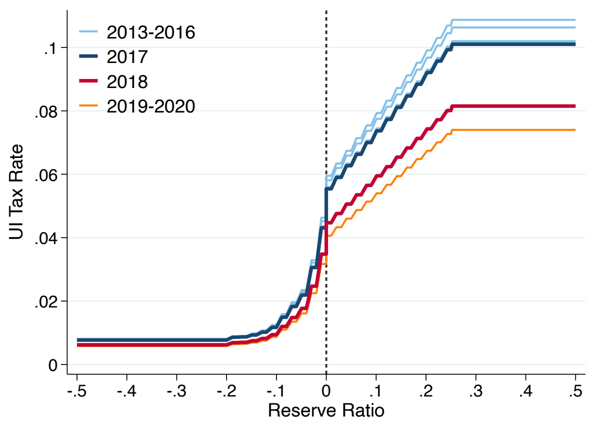
Table B.1: Surcharges in Colorado between 2013 and 2019

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

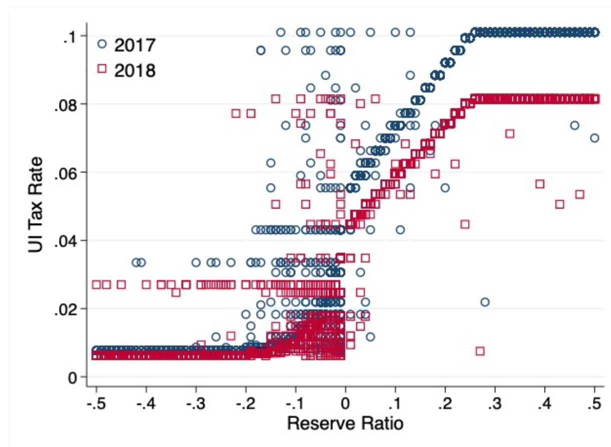
Notes: The table reports the surcharges in effect in Colorado between 2013 and 2019. The surcharge represents the percent amount by which the unemployment tax rates in the schedule in effect in each year had to be incremented to obtain the final effective tax rates.

Figure B.2: Unemployment Financing Rules in Colorado

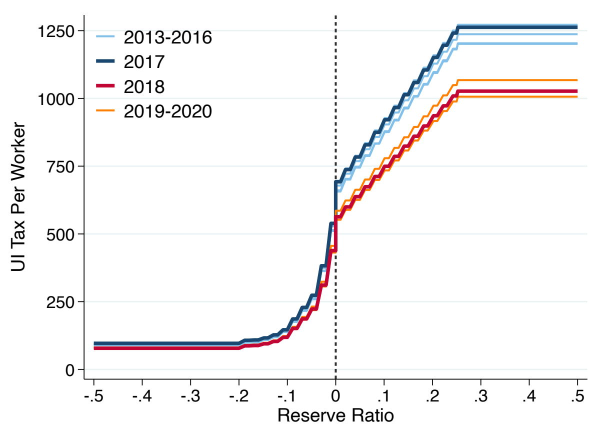
(a) Unemployment Tax Rate Schedule



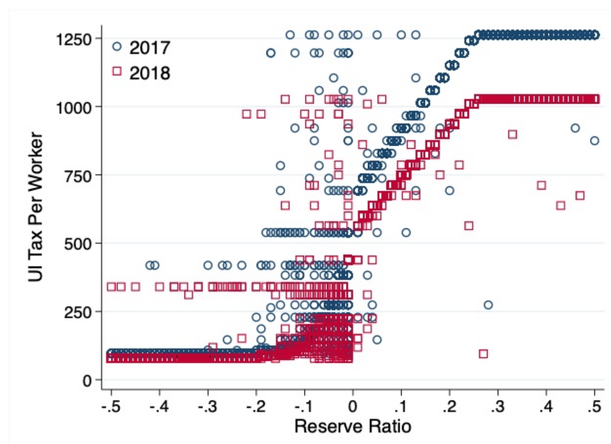
(b) Binscatter of Employers by Tax Rate and Reserve Ratio



(c) Maximum Unemployment Tax Per Worker

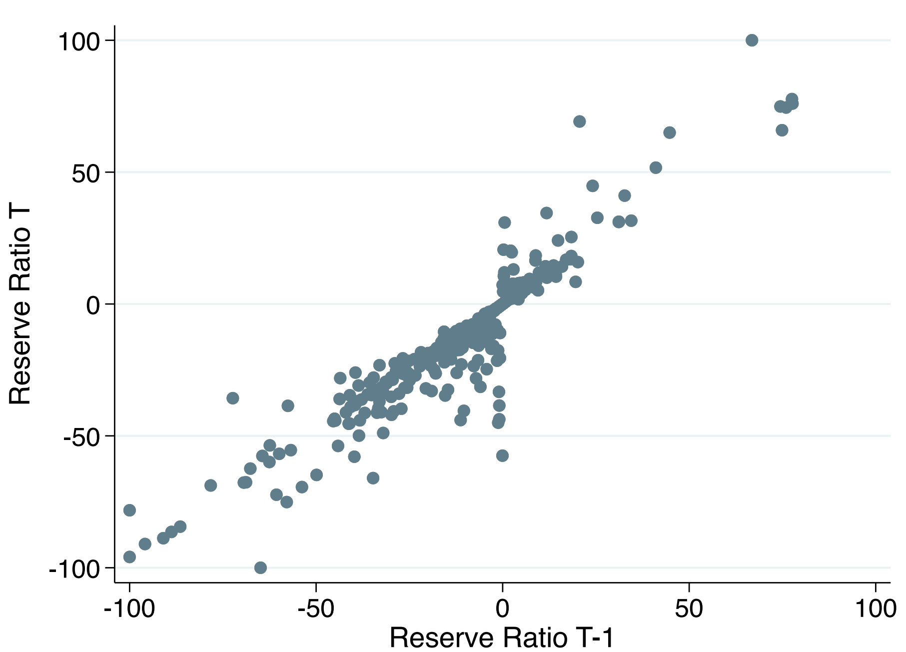


(d) Binscatter of Employers by Tax Per Worker and Reserve Ratio



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.3: Correlation in Employers' Reserve Ratio Over Time



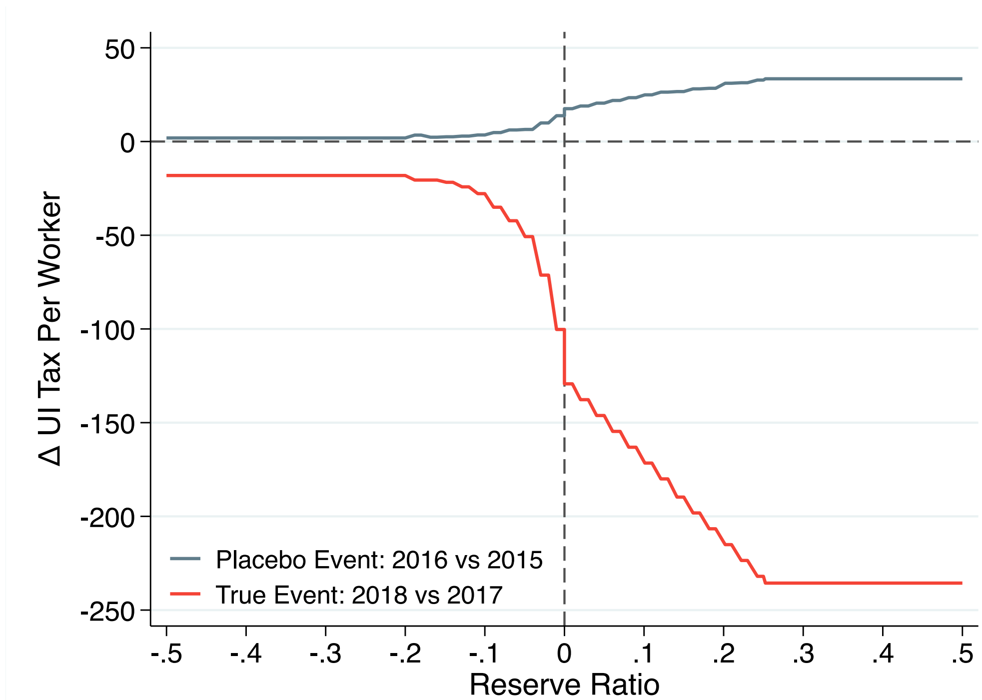
Notes: This figure plots Colorado employers by their Reserve Ratio in year T and Reserve Ratio in year T-1, with T=2014, 2015, 2016, 2017, 2018. The Reserve Ratio in year T has been rounded to the first decimal place. Each marker corresponds to the average of the Reserve Ratio in year T-1 for employers 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.4: Variation in Unemployment Tax Per Worker by Reserve Ratio in True and Placebo Year



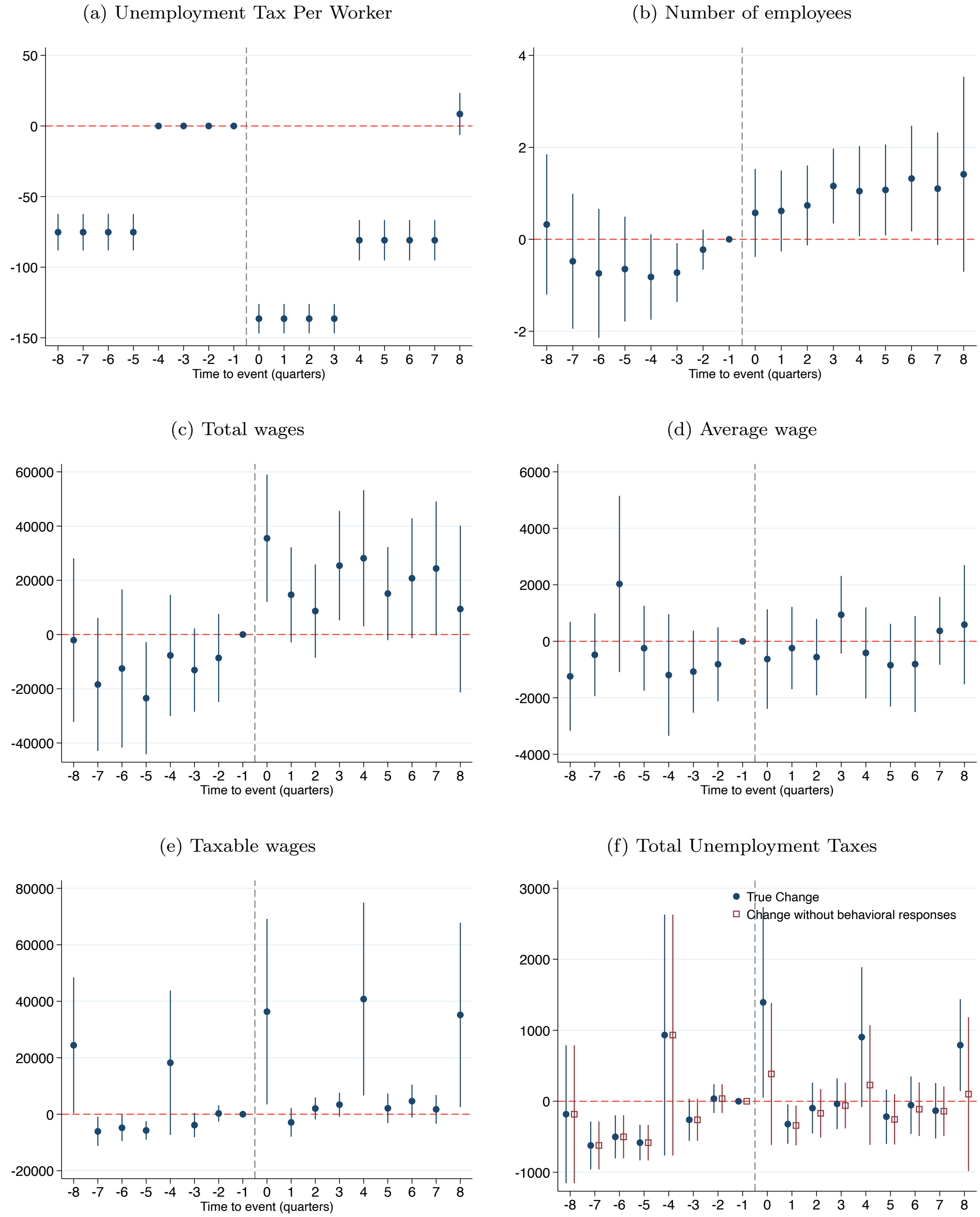
Notes: This figure illustrates the variation in the Unemployment Tax Per Worker associated to each level of Reserve Ratio between 2017 and 2018 (the true event year) and between 2015 and 2016 (the placebo event year).

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: Employer Characteristics								
Number of 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
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
Panel B: Unemployment Taxes								
Reserve Ratio	2435	0.121	0.176	1786	0.114	0.174	0.007	0.175
UI Tax Rate	2435	0.072	0.016	1786	0.070	0.015	0.001	0.002
Max UI Tax Per Worker	2435	848.597	188.540	1786	880.324	186.541	-31.727	0.000
Taxable Wages	2435	17087.057	105156.599	1786	23457.222	127418.331	-6370.166	0.076
Total UI Taxes	2435	1133.960	8014.412	1786	1492.809	7632.521	-358.849	0.143
Benefits Charged	2435	1637.573	22356.336	1786	1238.285	6340.755	399.289	0.463

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.5: Reduced Form Effects of the Elimination of the Surcharge on Firm Outcomes



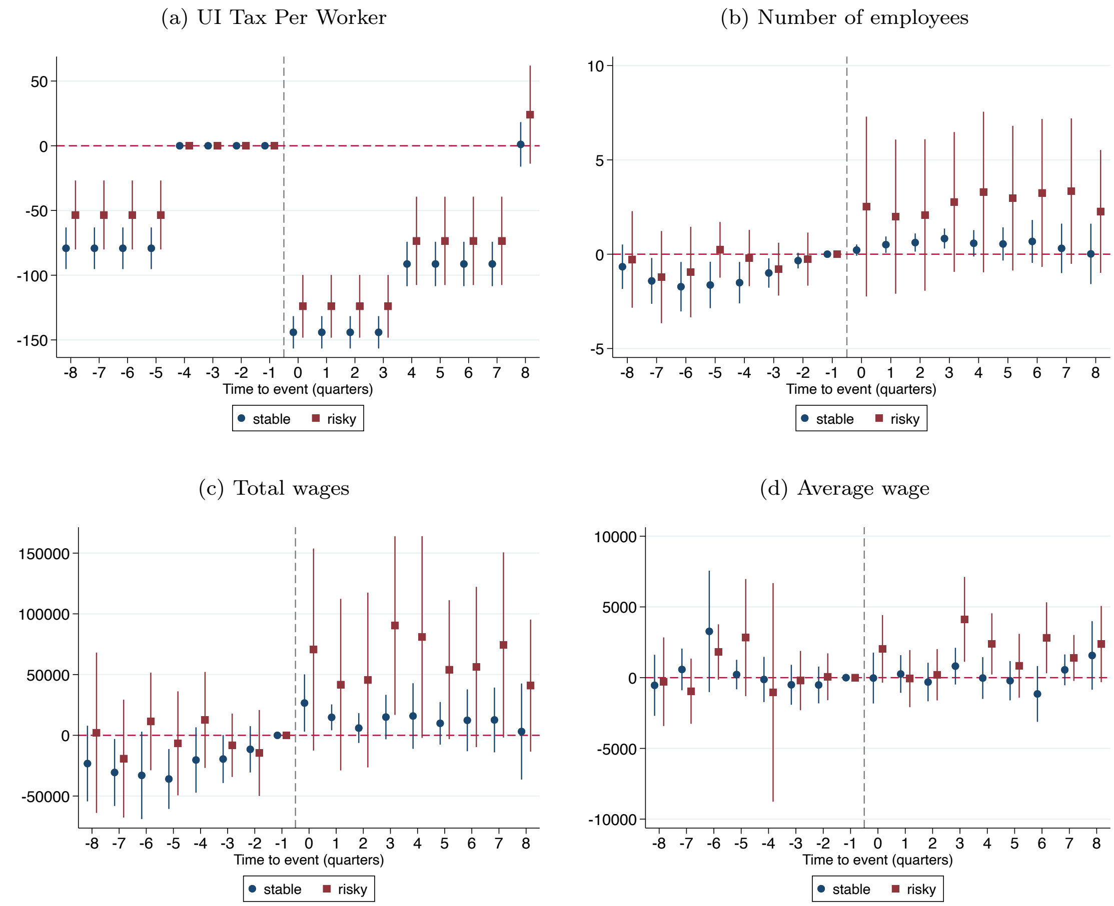
This figure illustrates the estimates of the β_y coefficients from Equation 7 for the sample of Colorado employers with positive Reserve Ratio. The treatment group includes employers with Positive Reserve Ratio in 2017. The control group includes employers with Positive Reserve Ratio in 2015. The outcomes 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) Tax Per Worker	(2) Employees	(3) Total wages	(4) Avg wage	(5) Tax wages	(6) Tot Taxes	(7) Tot taxes (non behav.)
Treated × Time to event=-7	-75.210***	-0.479	-18,427.480	-479.016	-6,064.116**	-622.630***	-622.630***
	(5.279)	(0.748)	(12,509.128)	(747.036)	(2,633.302)	(172.180)	(172.180)
Treated × Time to event=-6	-75.210***	-0.741	-12,538.383	2,030.803	-4,791.621**	-501.408***	-501.408***
	(5.279)	(0.715)	(14,861.947)	(1,592.075)	(2,403.892)	(155.015)	(155.015)
Treated × Time to event=-5	-75.210***	-0.647	-23,477.526**	-245.395	-5,726.738***	-583.367***	-583.367***
	(5.279)	(0.582)	(10,549.666)	(765.064)	(1,658.908)	(127.607)	(127.607)
Treated × Time to event= -4	-0.000	-0.820*	-7,703.016	-1,195.043	18,232.073	932.747	932.747
	(0.000)	(0.474)	(11,389.997)	(1,097.128)	(13,025.488)	(865.625)	(865.625)
Treated × Time to event= -3	-0.000	-0.725**	-13,108.757*	-1,074.771	-3,844.479*	-261.549*	-261.549*
	(0.000)	(0.326)	(7,842.222)	(741.983)	(2,193.340)	(151.250)	(151.250)
Treated × Time to event= -2	-0.000	-0.225	-8,643.417	-813.541	278.445	36.982	36.982
	(0.000)	(0.222)	(8,296.615)	(668.030)	(1,467.134)	(102.924)	(102.924)
Treated × Time to event=0	-136.450***	0.574	35,498.543***	-629.516	36,322.244**	1,393.214**	384.845
	(4.239)	(0.488)	(11,975.652)	(899.137)	(16,757.887)	(684.020)	(510.256)
Treated × Time to event= 1	-136.450***	0.617	14,659.324	-240.879	-2,885.479	-322.272**	-341.894**
	(4.239)	(0.449)	(8,944.208)	(743.157)	(2,572.189)	(141.611)	(143.228)
Treated × Time to event=2	-136.450***	0.736*	8,658.407	-560.888	2,044.742	-96.799	-169.792
	(4.239)	(0.443)	(8,768.608)	(690.362)	(1,999.560)	(182.593)	(174.452)
Treated × Time to event=3	-136.450***	1.158***	25,402.573**	939.001	3,396.112	-36.542	-60.230
	(4.239)	(0.416)	(10,294.029)	(701.815)	(2,167.517)	(181.922)	(164.386)
Treated × Time to event=4	-80.916***	1.048**	28,137.498**	-412.100	40,782.016**	903.697*	228.226
	(5.841)	(0.500)	(12,818.156)	(822.628)	(17,412.833)	(502.567)	(429.972)
Treated × Time to event=5	-80.916***	1.074**	15,095.752*	-845.507	2,109.623	-217.171	-255.910
	(5.841)	(0.504)	(8,753.445)	(746.548)	(2,644.078)	(195.840)	(180.705)
Treated × Time to event=6	-80.916***	1.321**	20,743.603*	-806.667	4,643.813	-55.021	-112.177
	(5.841)	(0.586)	(11,283.487)	(867.447)	(2,974.918)	(206.550)	(192.484)
Treated × Time to event=7	-80.916***	1.101*	24,364.076*	368.612	1,737.674	-133.236	-140.051
	(5.841)	(0.624)	(12,586.469)	(613.547)	(2,591.803)	(199.521)	(177.242)
Treated × Time to event=8	8.460	1.414	9,395.593	588.491	35,181.342**	790.149**	100.278
	(6.090)	(1.082)	(15,691.318)	(1,075.012)	(16,644.091)	(330.521)	(553.139)
Observations	71,757	71,757	71,757	69,537	71,757	71,757	71,757
R-squared	0.605	0.900	0.921	0.457	0.495	0.471	0.469
Mean Outcome $t-1$	705	12.09	208208	17460	47709	2610	2610

This table reports the estimates of the β_y coefficients from Equation 7 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.6: Differential Reduced Form Effects in High- and Low-Unemployment Risk Industries



This figure illustrates the estimates of the β_y coefficients from Equation 7 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) Tax Per Worker	(2) Employees	(3) Total wages	(4) Average wage
Treated × High Risk × Time to event =-7	25.721*	0.202	11,401.579	-1,540.901
	(12.720)	(1.389)	(28,424.018)	(1,391.369)
Treated × High Risk × Time to event =-6	25.721*	0.777	44,397.558	-1,457.996
	(12.720)	(1.392)	(27,482.810)	(2,404.392)
Treated × High Risk × Time to event =-5	25.721*	1.864*	29,344.484	2,610.240
	(12.720)	(0.979)	(25,161.858)	(2,172.634)
Treated × High Risk × Time to event =-4	0.000	1.306	32,953.924	-913.664
	(0.000)	(0.943)	(24,347.194)	(4,016.479)
Treated × High Risk × Time to event =-3	0.000	0.203	11,312.549	297.696
	(0.000)	(0.817)	(16,668.681)	(1,287.933)
Treated × High Risk × Time to event =-2	0.000	0.079	-3,051.947	578.684
	(0.000)	(0.746)	(20,462.583)	(1,072.839)
Treated × High Risk × Time to event =0	20.087	2.309	44,023.039	2,064.615
	(11.095)	(2.431)	(43,989.120)	(1,523.053)
Treated × High Risk × Time to event =1	20.087	1.484	26,934.057	-324.740
	(11.095)	(2.092)	(36,357.408)	(1,231.280)
Treated × High Risk × Time to event =2	20.087	1.461	39,559.137	513.870
	(11.095)	(2.058)	(37,153.571)	(1,155.538)
Treated × High Risk × Time to event =3	20.087	1.940	75,320.199*	3,304.825**
	(11.095)	(1.906)	(38,572.990)	(1,663.784)
Treated × High Risk × Time to event =4	17.855	2.718	65,028.383	2,413.354*
	(15.538)	(2.196)	(44,444.369)	(1,333.285)
Treated × High Risk × Time to event =5	17.855	2.426	44,122.553	1,057.569
	(15.538)	(2.003)	(30,445.060)	(1,349.905)
Treated × High Risk × Time to event =6	17.855	2.571	43,905.465	3,967.554**
	(15.538)	(2.077)	(35,999.668)	(1,624.867)
Treated × High Risk × Time to event =7	17.855	3.033	61,742.690	839.819
	(15.538)	(2.073)	(41,108.527)	(995.875)
Treated × High Risk × Time to event =8	22.997	2.250	37,811.676	805.363
	(16.958)	(1.847)	(34,238.714)	(1,845.827)
Observations	63,087	63,087	63,087	61,124
R-squared	0.605	0.916	0.925	0.425

This table reports the estimates of the γ_y coefficients from Equation 8 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: Backing up the Elasticity of Employment with respect to Unemployment Tax Per Worker

	Full Sample	Low Unempl. Risk Sectors	High Unempl. Risk Sectors
Number of Employees			
Treated × Post	1.419	1.513	3.154
Mean $t-1$ Treated	12.722	12.111	15.561
Unemployment Tax Per Worker			
Treated × Post	-58.062	-64.925	-58.366
Mean $t-1$ Treated	701.563	703.954	706.064
Elasticity of Empl. wrt Tax Per Worker	-1.348	-1.354	-2.452

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 9. The Treated×Post coefficients are the estimated coefficients from Equation 10. The treatment group includes employers with Positive Reserve Ratio in 2017. The control group includes employers with Positive Reserve Ratio in 2015.

C Model Complete Derivations

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

C.1 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 **??** in Equation **??**, I express expected profits as function of the degree of experience rating e:

$$\Pi_H = \left(1 - p_H - \frac{1}{m}\right)(o_H^{good}[f(l_H, k_H) - w_H l_H - \tau_H l_H - jk_H) + \tag{11}$$

$$\left(p_H + \frac{1}{m}\right)[-\tau_H l_H - (1 - 1_{e=1})\psi(m) - (1+e)q] \tag{12}$$

$$= \left(1 - p_H - \frac{1}{m}\right)\left[o_H^{good} f(l_H, k_H) - w_H l_H - ebl_H \left(p_H + \frac{1}{m}\right) - jk_H\right] + \tag{13}$$

$$\left(p_H + \frac{1}{m}\right)\left[-ebl_H\left(p_H + \frac{1}{m}\right) - (1 - 1_{e=1})\psi(m) - (1+e)q\right] \tag{14}$$

The labor demand of the high-risk employer is determined by taking the derivative of their profits with respect to l_H and setting it equal to zero:

$$\frac{\partial \Pi_H}{\partial l_H} = \left(1 - p_H - \frac{1}{m}\right)\left[o_H^{good} f'(l_H, k_H) - w_H - eb\left(p_H + \frac{1}{m}\right)\right] - \left(p_H + \frac{1}{m}\right)^2 eb = 0 \tag{15}$$

$$\Rightarrow f'(l_H, k_H) = \left[\frac{eb\left(p_H + \frac{1}{m}\right)}{o_H^{good}\left(1 - p_H - \frac{1}{m}\right)} + \frac{w_H}{o_H^{good}}\right] \tag{16}$$

.

To understand how labor demand changes with experience rating, I define the following function of l_H and e:

$$G(l_H, e) = f'(l_H, k_H) - \left[\frac{eb\left(p_H + \frac{1}{m}\right)}{o_H^{good}\left(1 - p_H - \frac{1}{m}\right)} + \frac{w_H}{o_H^{good}} \right] \tag{17}$$

Then, I use the Implicit Function Theorem to determine the derivative of labor demand with respect to experience rating, $\frac{\partial l_H}{\partial e}$:

$$\frac{\partial l_H}{\partial e} = -\frac{\frac{\partial G(l_H,e)}{\partial e}}{\frac{\partial G(l_H,e)}{\partial l_H}} = -\frac{-\frac{b\left(p_H+\frac{1}{m}\right)}{o_H^{good}\left(1-p_H-\frac{1}{m}\right)}}{f''(l_H, k_H)} < 0 \tag{18}$$

Since f is strictly concave in l_H, f' is decreasing in l_H, and $f''(l_H, k_H) < 0$. Consequently, a higher degree of experience rating is associated to a lower labor demand of the high-layoff rate employer: $\frac{\partial l_H}{\partial e} < 0$.

C.2 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 labor demand that maximizes expected profits. Equation 14 expresses the employer's profits as a function of experience rating. The derivative of the profit function with respect to m determines the privately optimal effort level:

$$\frac{\partial \Pi_H}{\partial m} = \frac{1}{m^2}\left[o_H^{good} f(l_H, k_H) - w_H l_H - ebl_H\left(p_H + \frac{1}{m}\right) - k_H j + ebl_H\left(p_H + \frac{1}{m}\right) + (1 - 1_{e=1}\psi(m)\right] + \tag{19}$$

$$\frac{ebl_H}{m^2} - \left(p_H + \frac{1}{m}\right)\psi'(m)(1 - 1_{e=1}) \tag{20}$$

$$= \frac{1}{m^2}\left[o_H^{good} f(l_H, k_H) - w_H l_H - k_H j + (1 - 1_{e=1}\psi(m)\right] + \frac{ebl_H}{m^2} - \left(p_H + \frac{1}{m}\right)\psi'(m)(1 - 1_{e=1}) \tag{21}$$

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 $e < 1$. With complete experience rating, when $e = 1$ and $(1 - 1_{e=1})\psi(m) = 0$, the derivative of expected profits with respect to effort, shown in Equation 22 is positive, and $m^{*,ER} \to \infty$. Intuitively, when experience rating is complete the cost of effort is nullified, and the employer finds it optimal to exert infinite effort to minimize the probability to end up in the bad state of the world. Consequently, with complete experience rating the layoff rate in the economy is minimized: $\lim_{m\to\infty} r_H = \lim_{m\to\infty} p_H + \frac{1}{m} = p_H$.

$$\frac{\partial \Pi_H}{\partial m} = \frac{1}{m^2}\left[o_H^{good} f(l_H, k_H) - w_H l_H - k_H j\right] + \frac{ebl_H}{m^2} > 0 \tag{22}$$

Under risk-pooling, when $e < 1$, the high-risk employer faces positive costs of exerting effort: $(1 - 1_{e=1})\psi(m) = \psi(m)$. Equation 24 illustrates the derivative of expected profits with respect to effort in this scenario:

$$\frac{\partial \Pi_H}{\partial m} = \frac{1}{m^2}[o_H^{good} f(l_H, k_H) - w_H l_H - k_H j + \psi(m)] + \frac{ebl_H}{m^2} - \left(p_H + \frac{1}{m}\right)\psi'(m) \tag{23}$$

$$= [o_H^{good} f(l_H, k_H) - w_H l_H - k_H j + \psi(m)] + ebl_H - \psi'(m)m - \psi'(m)m = G(m, e) \tag{24}$$

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:

$$\frac{\partial m}{\partial e} = -\frac{\partial G(m,e)\partial e}{\frac{\partial G(m,e)}{\partial m}} = -\frac{bl_H}{\psi'(m) - \psi''(m)p_H m^2 - \psi'(m)p_H 2m - \psi'(m) - \psi''(m)m} \tag{25}$$

$$= -\frac{bl_H}{-\psi''(m)p_H m^2 - \psi'(m)p_H 2m - \psi''(m)m} \tag{26}$$

Since ψ is strictly convex in m, $\psi'(m) > 0$ and $\psi''(m) > 0$. It follows that $\frac{\partial m}{\partial e} > 0$, that is, increasing the degree of experience rating incentivizes the high-risk employer to exert more effort to avoid the bad state of the world.

C.3 Welfare maximization

The government chooses the degree of experience rating e to maximize the social welfare function in Equation **??**, obtained as the sum of workers' and capitalists' utilities, subject to the government budget constraint, the tax burden allocation rules in Equations **??** and **??**, the employers' labor demand functions in Equations **??** and **??**, and the high-unemployment risk employer's effort defined in Equation **??**:

$$\max_{e} \quad l_L U_L + l_H U_H + U_C$$

$$\text{s.t.} \quad \tau_L l_L = (1-e) b l_H \left(p_H + \frac{1}{m}\right),$$

$$\tau_H l_H = e b l_H \left(p_H + \frac{1}{m}\right),$$

$$l_L = 1 - l_H,$$

$$f'(l_H, k_H) = \left[\frac{eb\left(p_H + \frac{1}{m}\right)}{o_H^{good}\left(1 - p_H - \frac{1}{m}\right)} + \frac{w_H}{o_H^{good}}\right],$$

$$\left(p_H + \frac{1}{m}\right)\psi'(m)(1 - 1_{e=1}) = \frac{1}{m^2}\left[o_H^{good} f(l_H, k_H) - w_H l_H - k_H j + (1 - 1_{e=1}\psi(m)\right] + \frac{ebl_H}{m^2}$$

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

$$\mathcal{L} =(1-l_H)u(w_L) + l_H \left[\left(1-p_H-\frac{1}{m}\right)u(w_H) + \left(p_H+\frac{1}{m}\right)u(b)\right] - \int_0^{l_H} z_i\, di + \int_{l_H}^1 z_i\, di + [\gamma(\Pi_L + \Pi_H) \tag{27}$$

$$=(1-l_H)u(w_L) + l_H \left[\left(1-p_H-\frac{1}{m}\right)u(w_H) + \left(p_H+\frac{1}{m}\right)u(b)\right] - \int_0^{l_H} z_i\, di + \int_{l_H}^1 z_i\, di \tag{28}$$

$$+\gamma\left[o_L^{good} - w_L(1-l_H) - (1-e)bl_H\left(p_H+\frac{1}{m}\right) - jk_L\right] \tag{29}$$

$$+\gamma\left(1-p_H-\frac{1}{m}\right)\left[o_H^{good}f(l_H,k_H) - w_Hl_H - ebl_H\left(p_H+\frac{1}{m}\right) - jk_H\right] \tag{30}$$

$$+\gamma\left(p_H+\frac{1}{m}\right)\left[-ebl_H\left(p_H+\frac{1}{m}\right) - (1-1_{e=1})\psi(m) - (1+e)q\right] - 1 \tag{31}$$

To determine the optimal degree of experience rating e^*, I take the derivative of the Lagrangean with respect to e, shown in Equation **??** , 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.

$$\frac{\partial \mathcal{L}}{\partial e} = -\frac{\partial l_H}{\partial e}u(w_L) + \frac{\partial l_H}{\partial e}\left[\left(1-p_H-\frac{1}{m}\right)u(w_H) + \left(p_H+\frac{1}{m}\right)u(b)\right] + l_H\left[\frac{1}{m^2}[u(w_H)-u(b)]\frac{\partial m}{\partial e}\right] - 2z_{l_H} \tag{32}$$

$$+\gamma\left[w_L-(1-e)b\left(p_H+\frac{1}{m}\right)\right]\frac{\partial l_H}{\partial e} + bl_H\left(p_H+\frac{1}{m}\right) + \frac{(1-e)bl_H}{m^2}\frac{\partial m}{\partial e} \tag{33}$$

$$+\left(1-p_H-\frac{1}{m}\right)\left[-bl_H\left(p_H+\frac{1}{m}\right)\right] + \left(p_H+\frac{1}{m}\right)^2(-bl_H-q) \tag{34}$$

$$=\epsilon_{l_H,e}\left[-\frac{l_H}{e}u(w_L) + \frac{l_H}{e}\left[\left(1-p_H-\frac{1}{m}\right)u(w_H) + \left(p_H+\frac{1}{m}\right)u(b)\right] - 2\frac{l_H}{e}z_{l_H} + \gamma\left[w_L\frac{l_H}{e} - \frac{(1-e)}{e}bl_H\right.\right. \tag{35}$$

$$+\epsilon_{m,e}\left[\frac{l_H}{em}u(w_H) - u(b) + \gamma(1-e)bl_H\right] - \left(p_H+\frac{1}{m}\right)q \tag{36}$$

$$=0 \tag{37}$$

In Equation **??**, $\epsilon_{l_H,e} = \frac{\partial l_H}{\partial e}\frac{e}{l_H}$ is the elasticity of the high-risk employer's labor demand with respect to the degree of experience rating, and $\epsilon_{m,\alpha} = \frac{\partial m}{\partial e}\frac{e}{m}$ is the elasticity of the high-risk employer's effort with respect to the degree of experience rating. I further notice that $\left(p_H+\frac{1}{m}\right)q = \Pi_H^{\prime bad} - \Pi_H^{good}$. Using these definitions, the definitions for λ and μ in Equations **??** and **??**, and rearranging the terms, I obtain Equation **??**, determining the optimal degree of experience rating.

C.4 Optimal degree of experience rating with flexible wages

Coming soon.