Unemployment Insurance Experience Rating and Labor Market Dynamics

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Abstract

Unemployment insurance experience rating imposes higher payroll tax rates on firms that have laid off more workers in the past. To analyze the effects of UI tax policy on labor market dynamics, this paper develops a DSGE search model of unemployment with heterogeneous firms and realistic UI financing. The model predicts that higher experience rating reduces both job creation and job destruction. Using firm-level data from the Quarterly Census of Employment and Wages, the model is tested by comparing job creation and job destruction across states and industries with different UI tax schedules. The empirical analysis shows a strong negative relationship between job flows and experience rating. Consistent with the empirical results, comparative steady state tax experiments show that a 5% increase in experience rating reduces job flows between 1% and 2%. The unemployment rate falls between .1 and .3 percentage points but the effect on tax revenues is ambiguous. The model is extended to include shocks to aggregate productivity. Higher experience dampens the response of layoffs and unemployment to an aggregate shock.

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"I might consider adding a new salesperson because my company appears to be getting busier. But if in two months I realize that business is not in fact coming back as quickly as I had thought, and I need to lay off this person, I will likely end up paying out $5,000, $10,000, or even $20,000 in unemployment taxes for the person I hired and then laid off...the disincentives far outweigh the incentives."

–Jay Goltz, NY Times You're the Boss.

1 Introduction

The United States is the only OECD country to finance unemployment insurance (UI) through a tax system which penalizes layoffs. The original intent of this institution, know as "experience rating," was to apportion the costs of UI to the highest turnover firms and thereby stabilize employment.[1]

Experience rating can stabilize employment through a layoff cost. The layoff cost is levied when a firm lays off a worker and is assessed a higher tax rate in the future. The cost of layoffs, therefore, reduces the incentive for a firm to shed workers. On the other hand, an increased firing burden causes firms to reduce hiring given the prospect of having to lay off workers in the future. In this paper, I study experience rating both theoretically and empirically, analyzing its effects on the dynamics of the labor market.

Due to the sharp increase in unemployment during the Great Recession, state UI trust funds are deeply in debt. Between 2007 and 2011, state trust fund reserves fell by $62 billion; as of 2011, states owe $40 billion in loans to the federal government.[2] State governments are therefore grappling with new UI financing policies to cover these trust funds and ensure solvency into the future. I use a general equilibrium model of experience-rated taxes to study the labor market effects of tax changes that are similar to those currently under consideration.

This paper is the first to empirically quantify the relationship between job flows and UI financing. Macroeconomists have long recognized that job flows are large compared to net employment growth. In fact, declining rates of job destruction can account for a substantial fraction of decreasing unemployment between the 1980's and the mid-2000's.[3] This paper sheds light on the types of labor market policies that drive gross job flows and the policy changes that might affect employment volatility. This paper also advances the literature on the effect of microeconomic employment adjustment costs on hiring and firing.[4] This paper studies a quantifiable adjustment cost and provides novel evidence on its effect on job flows using firm-level data.

[1] The origin of the idea for experience rating is attributed to John R. Commons who helped draft the 1932 Wisconsin bill that introduced "merit-rating."

[2] See Vroman (2011) for a summary of UI finances since the Great Recession.

[3] See Davis et al. (2010).

[4] A comprehensive literature review is beyond the scope of this paper. See, for example, Hamermesh and Pfann (1996).

After reviewing the relevant features of UI experience rating, I present a dynamic labor demand problem for a firm facing increasing payroll taxes as a function of its endogenously-determined, individual layoff history. One important contribution of this paper is that I model realistic UI tax schedules. In practice, states set minimum and maximum tax rates and therefore not all firms face increasing tax rates from a layoff. This induces economically important non-linearities in firm labor demand depending on its past layoff history.

Much of the previous literature has instead modeled experience rating as an exogenous linear layoff cost, for instance in Anderson (1993). Consistent with the linear layoff cost model, I show that experience rating induces a "band of inaction" in which the firm does not hire or fire over a range of labor productivity. In contrast to the linear layoff cost model, experience rating imposes a cost that is a function of the stock rather than the flow of layoffs. I show that this implies a band of inaction that is a function of each firm's entire history of layoffs. Hence, I find that firm heterogeneity in layoff experience is crucial to understanding the general equilibrium effects of experience rating.

The model predicts how experience rating affects job flows. The higher is the fraction of benefits paid back in higher taxes, the lower are the rates of both job creation and job destruction. Having established that experience rating reduces both job creation and job destruction in a dynamic model of firm labor demand, I test this prediction empirically. I collect a dataset of UI tax schedules and financing rules across states between 2001-2010. With these data, I calculate the "marginal tax cost" of experience rating following, for example, Topel (1983) and Card and Levine (1994). The marginal tax cost gives the fraction of benefits charged to a firm that are paid back in future higher taxes. I combine these data with confidential firm-level data on gross job flows from the Quarterly Census of Employment and Wages (QCEW). The results show that increasing experience rating by 5% would reduce job destruction by about 2% and job creation by 1.5%.

In the next section, I embed the firm's dynamic problem in a search model of unemployment to study the effect of experience rating on the aggregate labor market. While previous work such as l'Haridon and Malherbet (2009) and Albertini (2011) has examined experience rating in a search model, the model presented is the first to study UI taxes that are endogenously determined in a heterogeneous agent, DSGE framework. I build on the model developed by Elsby and Michaels (2011) who introduce firm heterogeneity with endogenous job destruction and aggregate uncertainty in a search and matching model of unemployment. I use the idiosyncratic layoff histories across firms to match the empirical cross-sectional distribution of firms across UI tax rates.

I then present results from tax experiments in the long-run and the short-run. Because I capture more realistic features of UI tax schedules as well as heterogeneity across firms in UI tax rates, I can analyze the effect of a rich set of tax experiments which previous models could not consider. First, I study various changes to the tax schedule that all imply an equal increase in experience rating but have different effects on the labor market. All experiments that raise experience rating reduce

job creation and destruction. A 5% increase in experience rating reduces job flows between 1.1% and 1.9%. These results are quantitatively consistent with the empirical estimates, which imply a drop between 1% and 2% in job flows. The unemployment rate across tax experiments is reduced by .1 to .3 percentage points (a drop of 1.8% to 4.5%). The differential effects on unemployment depend on whether the tax burden and firm profits increase or decrease.

Finally, I solve the model with aggregate uncertainty using the approximate equilibrium method of Krusell and Smith (1998). Model impulse responses from an aggregate shock show that experience rating reduces the amplitude of the labor market response to aggregate productivity shocks. For instance, a 10% difference in experience rating reduces the unemployment rate impulse response by .045 percentage points, amounting to a 6.8% smaller labor market slump. I also find that experience rating introduces strong non-linearities and asymmetries in the business cycle response to aggregate shocks. Unemployment rises more than proportionately with the aggregate shock due to the incidence of higher UI tax rates. There is also a slower recovery of unemployment as the larger stock of accumulated layoffs leads to persistently higher tax rates.

The plan of the paper is as follows. Section 2 reviews important institutional details of UI financing. Section 3 develops a theoretical prediction for job flows and Section 4 estimates this relationship empirically. Section 5 presents a DSGE model of the labor market with realistic UI financing and Section 6 conducts policy experiments. Section 7 discusses some related literature and Section 8 concludes.

2 Experience Rating of Unemployment Insurance Taxes

Before reviewing the related literature, it is necessary to understand the basic structure of UI finance. The United States finances its unemployment insurance system through a payroll tax that increases with a firm's past layoffs. In 1938, Wisconsin introduced the first experience rating system in which each firm was independently assessed a tax rate to cover benefits drawn by its laid off workers. By 1948, all states had adopted some system of experience rating for UI financing.

Each firm pays a payroll tax on its current wage bill. For each employee, the firm pays a tax on a capped base of salary, determined by each state. In 2010, this taxable base varied from $7,000 to $36,800. Federal law mandates that employers with at least three years of experience with layoffs must be experience-rated but allows states to charge new employers a reduced rate not less than 1%.[5]

The system of experience rating, however, is imperfect since tax rates are capped at statutory minimum and maximum levels. Firms with no layoff risk are mandated to contribute to the pool

[5] In practice, most states offer a "standard" flat rate to new employers between 1% and 6.2% for one to three years before implementing experience rating. The reduced rates in some states led to a practice known as SUTA dumping by which firms would change account numbers before eligibility for the higher experience-rated rate. Legislation in 2004 attempted to curb this practice.

of funds whereas firms with the highest layoff risk pay a lower rate than they would under a perfectly rated system. Across all states in 2010, the minimum rate varied from 0% to 2.2% and the maximum rate was no lower than 5.4% and reached 13.6%.[6] Thus, the finance system induces a cross-subsidy from low to high layoff firms and industries.

States generally use one of two types of experience rating. In 2010, 17 states used a "benefit ratio" method and 33 states used the "reserve ratio."[7] Figures 1 and 2 show examples of typical tax schedules for a reserve ratio and a benefit ratio state. In Nevada, the minimum rate charged is .25% up to a maximum rate of 5.4% with the tax rate increasing in the firm's experience factor (on the x-axis), determined by its reserve ratio. In Alabama, firms with the lowest benefit ratio (on the x-axis) are charged the minimum rate of .74% while the highest benefit ratio firms are charged the maximum rate of 7.14%.

In the benefit ratio system, each employer pays a payroll tax based on the ratio of benefits drawn by that firm's layoffs to the size of its covered payroll over a three to five year window. The tax rate takes on a minimum value for firms with low benefit ratios and a maximum value for firms with high ratios. In a reserve ratio system, states maintain an account for each firm that is debited due to benefits associated with its layoffs and is credited with tax payments. The net reserve as a ratio of the firm's payroll over a three to five year period determines the payroll tax rate, again between some minimum and maximum rates. Therefore, an additional layoff reduces the firm's reserve ratio and increases the tax rate assuming it is not at the minimum or maximum rate.

Given the complexity of UI taxes, many previous studies, such as Topel (1983), calculated the "marginal tax cost" to quantify the degree of experience rating. The marginal tax cost is defined as the present discounted value of benefits paid back in future taxes by a firm. Consider a firm on the sloped portion of the tax schedule. If that firm lays off an additional worker, it draws benefits that are charged to the firm, causing the tax rate to rise according to the given tax schedule. The marginal tax cost determines the fraction of those additional benefits the firm pays back in taxes. Further details of the specific financing systems and marginal tax cost formulas are given in Section 4.

3 A Theoretical Prediction for Job Flows

In this section, I establish a theoretical prediction for the effect of experience rating on job creation and job destruction to be tested empirically. I present a stripped down version of the full model presented later in order to characterize qualitatively the effect of experience rating on labor demand and job flows.

[6] The minimum value of the maximum tax rate is set by a federal tax credit of 5.4% in 2010.

[7] Michigan and Pennsylvania use a combination but predominantly use the benefit ratio. Oklahoma and Delaware use a benefit wage ratio system. These four states are therefore excluded from the empirical analysis.

A firm maintains a stock of workers, n_{-1}, and a stock of layoffs, ℓ_{-1}. Of the laid off, a fraction δ are no longer counted on the firm's books for taxation purposes. This occurs if the laid off find other jobs or there is a statutory time limit for benefit liability. The firm observes idiosyncratic productivity x and decides to hire or fire. If it fires, it sends those workers into the pool, ℓ. Firms take the wage, w, as given and pay all workers the same rate.[8] Note that I have assumed that firms cannot recall workers from their stock of layoffs. Appendix B relaxes this assumption and shows that allowing the firm to rehire from its stock of layoffs is similar to reducing the marginal cost per layoff. The stock of layoffs evolves according to the following equation of motion

$$\ell = (1-\delta)\ell_{-1} + \mathbb{1}^{-}\Delta n,$$

where $\mathbb{1}^{-}\Delta n$ is the number of layoffs if the firm is firing ($\mathbb{1}$ is used throughout as the indicator function). Tax rates are set as follows. The firm pays a payroll tax on its current employment, n, where the tax *rate* $\tau(\ell)$ is

$$\tau(\ell) = \begin{cases} \underline{\tau} & \text{if } \ell < \underline{\ell} \\ \tau_c \cdot \ell & \text{if } \ell \in [\underline{\ell}, \bar{\ell}] \\ \bar{\tau} & \text{if } \ell > \bar{\ell}. \end{cases}$$

Figure 3 graphs the tax schedule as a function of layoffs. The tax schedule the firm faces thus matches the salient features of realistic state UI schedules: the tax rate is linearly increasing between a statutory minimum and maximum rate.

The firm's labor demand problem is to choose n to maximize profits as given by the following dynamic programming problem, subject to the equation of motion for ℓ:

$$\Pi(n_{-1}, \ell_{-1}, x) = \max_{n} \left\{ xF(n) - wn - \tau(\ell)wn + \beta \int \Pi(n, \ell, x')dG(x'|x) \right\} \tag{1}$$

3.1 Firm policy functions

I first describe the qualitative nature of the firm's labor demand functions. Suppose ℓ is low enough such that the firm is on the flat portion of the tax schedule at the minimum rate. It could lay off workers and end up at the maximum rate (eqn. 2), the sloped portion (3), or remain at the minimum rate (4). Alternatively, it could hire and remain on the flat portion (5). The first order

[8] In the model developed in Section 5, I endogenize the wage.

conditions for those possibilities are as follows

$$xF'(n) - w - w\bar{\tau} + \beta \frac{\partial}{\partial n} \int \Pi(n, \ell > \bar{\ell}, x') dG = 0 \tag{2}$$

$$xF'(n) - w - w\tau(\ell) + \beta \frac{\partial}{\partial n} \int \Pi(n, \ell \in [\underline{\ell}, \bar{\ell}], x') dG = wn\tau'(\ell) \tag{3}$$

$$xF'(n) - w - w\underline{\tau} + \beta \frac{\partial}{\partial n} \int \Pi(n, \ell < \underline{\ell}, x') dG = 0 \tag{4}$$

$$xF'(n) - w - w\underline{\tau} + \beta \frac{\partial}{\partial n} \int \Pi(n, \ell_{-1}(1-\delta) < \underline{\ell}, x') dG = 0. \tag{5}$$

The first three terms of equation (2)-(5) are simply the marginal product of labor minus the after-tax wage. The following term is the discounted future marginal value of labor which depends on the choice of n and ℓ and the expectation over future productivity. The term on the right hand side of (3) represents the layoff cost imposed by experience rating on the sloped portion of the tax schedule. Before examining that more closely, I turn to equations (4) and (5).

It is important to note that the flow costs in the first order conditions in equations (4) and (5) are identical. They differ only because the continuation value depends on the future stock of layoffs. The stock of layoffs is higher if the firm lays off a worker rather than hiring a worker (or remaining at n_{-1}). Since higher layoffs lead to weakly higher payroll taxes, the forward value is weakly declining in the stock of layoffs (for a given n and x). Therefore, even away from the sloped portion of the schedule, the firm's decision is affected by the potential of increasing taxes. This highlights the importance of modeling experience-rated taxes in which the tax rate depends on the history of each firm's layoff decisions, in contrast to the previous literature, such as Anderson (1993), which has generally modeled experience rating as a linear layoff cost.

Examining equation (3) further highlights the importance of realistically modeling experience rating. Recall that this is the first order condition for a firm that begins the period at the minimum rate (i.e., $\ell_{-1} < \underline{\ell}$) but lays off enough workers so that its choice of ℓ is on the sloped portion. Again, the first three terms on the left hand side are the marginal product of labor minus the after-tax wage. Here, the after-tax wage is increasing in the marginal layoff. On the right hand side, the layoff cost is represented by $wn\tau'(\ell)$, which is the additional payroll tax paid on the *entire* wage bill. Therefore, the layoff cost under experience rating is importantly *not only* on the flow of layoffs but rather a higher tax paid on *all* inframarginal workers, with the rate based on the entire stock of layoffs.

In contrast to this model, suppose instead the firm had to pay a constant linear cost of $\tau_f > 0$ for each worker it laid off. In that case the first order condition for the firm, irrespective of its previous layoffs would be

$$xF'(n) - w + \beta \frac{\partial}{\partial n} \int \Pi(n, x') dG = -\tau_f. \tag{6}$$

This is the standard linear adjustment cost model. In this case, the policy function would exhibit a band of inaction at n_{-1} since the first layoff is always costly. In this simpler model, however, the firm's labor demand decision is a not affected by its previous history of layoffs. The firm also does not take into account the higher tax rate it must pay on its *entire* current stock of employed workers.

Turning to the policy functions in this model, it is useful to break the firm's decision into three cases (see Figure 3): Case 1 is for firms that begin the period at the minimum tax rate; Case 2 is when the firm begins on the sloped portion and Case 3 is when the firm is at the maximum tax rate. The policy function for Case 1 is depicted in Figure 4a, with the log of employment on the y-axis and the log of productivity on the x-axis.[9] The horizontal line gives the firm's stock of employment at the beginning of the period ($\ln(n_{-1})$). Because the firm is on the flat portion of the schedule, the firm locally hires and fires costlessly; the policy function is, therefore, linear through $\ln(n_{-1})$.[10]

The firm's marginal lay off is costless at $\ln(n_{-1})$. For a low enough $\ln(x)$, however, the firm must decide between shedding workers and incurring a tax increase or maintaining a higher workforce than otherwise would be optimal. For a range of $\ln(x)$, the profit maximizing choice is to halt layoffs to avoid the adjustment cost. Because the firm defers layoffs for a slightly lower productivity, the policy function is flat for a range of x draws as shown in the flat "band of inaction" on the labor demand schedule in Figure 4a. At a certain point, the draw of x is low enough so that a lower employment level generates higher profits despite the higher tax rate. When an additional layoff does warrant the adjustment cost, the firm chooses a tax rate on the sloped portion of tax schedule. Since the first layoff generates a discontinuous cost due to the higher tax rate on current payroll, the firm sheds a fraction of its employment. This is evident in the steep negative slope of the policy function at that point.

The bottom panel of this figure plots the associated tax rate that the firm optimally chooses. As described above, the firm chooses to remain at the minimum rate until a bad enough shock induces a bout of layoffs. In that case, the tax rate (at just below $\ln(x) = 0$) jumps up on to the sloped portion. As the firm lays off more workers, the tax rate continues to rise.

Figure 4b shows the policy function for Case 2 in which the firm begins the period on the sloped portion of the schedule. In Case 2, since the firm is on the sloped portion, the band of inaction rests at $\ln(n_{-1})$ as the marginal layoff is costly. As ℓ_{-1} increases, the policy function shifts to the right since the firm pays a higher tax rate per employee and thus holds a lower stock of employment for a given $\ln(x)$. The dashed blue line depicts a policy function for a firm that starts with a relatively higher stock of layoffs. For a low enough shock (around -.1), this firm sheds enough workers to

[9] I choose the log of the firm's states since, in the frictionless model, the labor demand schedule is linear in the logs.

[10] With the addition of search costs, the firm would also have a band of inaction at n_{-1}.

reach the maximum tax rate. The dashed blue line shifts down as the firm reaches the maximum tax rate. Finally, the demand schedule in Case 3 (not shown) would mimic the frictionless demand schedule since the cost of an additional layoff is zero. The schedule would then be linear in the log of employment. Due to the positive payroll tax, however, the level of employment is lower than it would be without the tax.

3.2 Job Flows and Experience Rating

What does the model predict for job flows? For firms that face the upward sloping tax schedule, the marginal layoff is costly so firms defer layoffs and maintain a higher than optimal workforce. The firm would prefer to decrease its stock of employment due to lower productivity per worker, but for each layoff it pays a higher tax rate on its entire remaining workforce. As is also true in standard layoff cost model, the firing cost also acts as a hiring cost. For any worker that is hired today, the firm will pay a layoff cost for that worker with a positive probability. Millard and Mortensen (1996) show that in a standard Mortensen-Pissarides model, linear layoff costs unambiguously reduce both job creation and job destruction. This section shows that in a model where layoff costs are determined by the entire stock of layoffs and the costs is paid on each inframarginal worker, the same is true.

I use the model of the previous section to preview the prediction for job flows by varying the degree of experience rating. Starting from the calibrated parameters of the full model of Section 5 but abstracting from search costs ($c = 0$), I vary the degree of experience rating and measure job flows.[11] In practice, I do this by varying the upper threshold of the tax schedule to increase or decrease its slope. As fully described later, I calculate a marginal tax cost for this model in a similar fashion as the empirical literature—the present discounted value of benefits paid back in future taxes.[12]

Job flows are calculated from simulated data as they are in the empirical analysis following Davis and Haltiwanger (1992). They define job creation (destruction) as the gross increase (decrease) in employment at expanding (contracting) firms. The job creation (destruction) rate is gross job creation (destruction) divided by the average of the current and previous employment over all firms. Formally, let N_t be employment at time t and $X_t = .5\sum(N_t + N_{t-1})$ be the average of employment in time t and $t-1$. Then the rates of job creation and job destruction are given by

$$JC = \frac{\sum_{\Delta n>0} \Delta N_t}{X_t},\ JD = \frac{\sum_{\Delta n<0} |\Delta N_t|}{X_t}. \tag{7}$$

Job reallocation, a measure of the total amount of churn in the labor market, is given by $JR = JC + JD$. Net employment growth is $Net = JC - JD$. Recall that in any steady state without

[11] The previous section assumed fixed wages for ease of exposition. In this simulation, I assume the bargained wage as derived in Section 5.2. The results of the simulation are robust to the wage assumption.

[12] The equation giving the model's marginal tax cost is described fully below in Section 5.5.

trend growth, $\Delta N \equiv 0$ implies $JC \equiv JD$. Therefore, the sign of the change of JR with respect to a change in the marginal tax cost gives the sign of the change in both JC and JD.

Figure 5 shows the simulated job flows plotted for a range of marginal tax costs between 15% and 78%. Job reallocation falls monotonically with marginal tax cost, going from over 16% with a marginal tax cost of 15% to under 6% with a MTC of 78%. As shown below, the slope of this line implies a 23% decrease in job flows if states implemented 100% experience rating from a mean of 54%. Do firms behave as the model predicts in practice? To answer this question, I now turn to an empirical evaluation of experience rating and job flows.

4 Empirical Evaluation of Experience Rating

In this section, I exploit state and industry variation in experience rating to evaluate its effect on the U.S. job flows. Unfortunately, firm-level data on UI tax contributions are not available across states and industries. While these data would be preferable, I study differences in jobs flows across detailed industries that face varying UI tax schedules at the state level. I first compile a dataset of state UI tax provisions from the Department of Labor. For each state and year, I collect data on the minimum rate, maximum rate, and the slope of the tax schedule.[13] I combine these tax schedules with firm-level data from the Quarterly Census of Employment and Wages to estimate the relationship between experience rating and job flows. I turn first to describing the data used to analyze the effect of experience rating on job flows. I then describe how I quantify the level of experience rating across states and industries for the econometric analysis that follows.

4.1 QCEW Data

The data used to measure labor market outcomes are from the Quarterly Census of Employment and Wages (QCEW). The QCEW is a census of establishments with employment covered by UI, making it an ideal source of data for the questions at hand. The entire database covers 99.7% of wage and salary employment. Establishments in the QCEW are linked across quarters to create the Longitudinal Database of Establishments from 1990 Q2-2010 Q2.

I have been granted access by the Bureau of Labor Statistics to QCEW micro-data for 40 states, including Puerto Rico and the Virgin Islands (shown in Table A1). The remaining states are either excluded due to the legal arrangement or due to incomparable experience rating systems.[14] Establishments in the data are identified by an UI tax account number. I define a firm as an agglomeration of establishments with a common UI account number. This implicitly treats firms as single-state entities and ignores employment decisions across states that may be due to differing

[13] Primarily these data come from Section C of the 204 report collected by the DOL from state UI agencies. These data are available in a consistent format between 2001-2010.

[14] Table 6 and Appendix C show a robustness check using additional data from the missing states.

marginal tax costs.

There are several additional restrictions in the data that are worth noting. Monthly employment at the establishment is defined as employment in the pay period including the 12th of the month. Following BLS procedure, quarterly employment is defined as the third month of each quarter's employment. I also only consider firms that are continuing between quarters and therefore abstract from openings and closing.[15] In addition, I exclude from the analysis establishments within firms that engaged in a consolidation or breakout between quarters due to difficulties in correctly apportioning the employment change across quarters. These exclusions allow me to extend the QCEW back to the second quarter of 1990.[16]

Multi-establishment firms can potentially have establishments in several industries. In order to examine firm behavior by industry, I assign the industry of largest establishment to the entire firm. Finally, I exclude public sector establishments and NAICS sectors 92 and 99 from the analysis as UI finance differs in the public sector.

After applying these restrictions, I calculate statistics at the 3-digit NAICS-by-state level. This results in 3,377 3-digit NAICS-by-state cells observed for 80 quarters from 1990 Q2 to 2010 Q1. For each cell, I calculate the job creation and job destruction rates as given above in (7). Recall that job reallocation is $JR = JC + JD$ and the net change is $JC - JD$. These variables are the primary outcomes examined in the econometric analysis below. I now describe in detail the two primary UI financing systems in order to construct a measure of experience rating across states and industries.

4.2 Reserve Ratio System

The most common system of UI tax determination is the "reserve ratio" system. In reserve ratio states, firms have an account with the state from which unemployment benefits charged are debited and to which taxes payments are credited. Each year, the firm's reserve ratio is calculated as the ratio of its reserve balance, R_t, to the average of its payroll over the past three years. The reserve ratio is then converted into a tax rate based on the tax schedule that will be in effect for the next year.[17] Recall that taxes are paid on each employee up to a maximum taxable wage base (between $7,000 and $37,000).

The tax schedule in a reserve ratio state is a declining function of the reserve balance, R_t. Firms with a highly negative account balance are subject to the statutory maximum rate while firms with the most positive balances are subject to the statutory minimum rate. Between the minimum and

[15]The effect of experience rating on openings and closing is an important extension given the concern with SUTA dumping. Estimates of firm birth and death rates on experience rating do not indicate that this is quantitatively important, however.

[16]Faberman (2008) extends the LBD back to 1990 using a careful matching algorithm to account for breakouts and consolidations.

[17]Computation dates are typically January 1st. Four states use July 1st.

maximum rates, firms with more negative balances are required to pay higher tax rates. A linear approximation of the tax schedule between the minimum and maximum rates is: $\tau_t = \lambda_0 - \lambda_1 r_{t-1}$. The reserve ratio, r_t, is given by $r_t = \frac{R_t}{\bar{wn}}$, where $\bar{wn}$ is average taxable payroll.

Calculation of Marginal Tax Cost

Due to the unavailability of individual firm tax rates, I follow Card and Levine (1994) and calculate the marginal tax cost for an average firm in a given state and industry. Let n be the level of employment and $1 + g_n$ be the gross annual growth of employment in a given industry within a state at time t. Further, let w be the taxable wage base in that state and $1 + g_w$ be the annual growth in the taxable wage base. In the data, I estimate $(1 + g_n)$ and $(1 + g_w)$ as the average annual growth rates from 2001 Q1 to 2007 Q4, the business cycle peaks over the relevant time frame. Consider the reserve balance of an industry in a particular state on the sloped portion of the tax schedule

$$R_t = R_{t-1} + \tau_t w_t n_t - B_t, \tag{8}$$

where B_t is the dollar value of benefits charged to the industry. B_t is composed of the proportion of benefits that are charged to firms in each state, χ, and the value of benefits, b_t, paid to the those beneficiaries.[18] So, $B_t = \chi b_t$. The reserve ratio is the ratio of the reserve balance, R_t, and the average taxable payroll over a three year period. Due to the assumption of constant growth of n and w, average payroll is just $w_{t-1}n_{t-1}$. Converting to a reserve ratio by dividing both sides by $w_{t-1}n_{t-1}$ gives the approximate reserve ratio:

$$r_t \approx \frac{R_t}{w_{t-1}n_{t-1}} = \frac{r_{t-1}}{(1+g_n)(1+g_w)} + (1+g_n)(1+g_w)\tau_t - \frac{\chi b_t}{w_{t-1}n_{t-1}}. \tag{9}$$

If a firm is at the minimum or maximum tax rate, an addition dollar of benefits charged does not increase the tax rate, so the marginal tax cost is zero. If the industry is on the sloped portion, then the tax rate is linearly related to the reserve ratio as given by

$$r_t = \frac{\lambda_0 - \tau_{t+1}}{\lambda_1}. \tag{10}$$

Substituting for r_t and manipulating gives

$$\lambda_0(1-(1+g_n)(1+g_w))w_t n_t + \tau_t w_t n_t(1-\lambda_1(1+g_n)(1+g_w)) + \lambda_1(1+g_n)^2(1+g_w)^2\chi b_t = \tau_{t+1}w_{t+1}n_{t+1}. \tag{11}$$

The present discounted value of future taxes, assuming a discount rate i, with respect to an increase in benefits is

[18] χ is typically less than 100% since certain types of benefits are not fully charged to firms.

$$MTC = \frac{\chi\lambda_1(1+g_n)^2(1+g_w)^2}{i+\lambda_1(1+g_n)^2(1+g_w)^2}. \tag{12}$$

The marginal tax cost is linearly increasing in χ, the fraction of benefits charge to firms. The MTC is also decreasing in the interest rate. In a reserve ratio state, due to discounting future tax payments by the discount rate, the marginal tax cost is necessarily below 100%. In the simple case where $g_n = g_w = 0$, however, it is easy to verify that the MTC is increasing in the slope of the tax schedule if $\lambda_1 > -i$, which will be satisfied for any positive interest rate. Under plausible values of g_n and g_w, the MTC is also increasing in the slope of the tax schedule.

4.3 Benefit Ratio System

The other method of experience rating a firm's tax rate is the benefit ratio system. States charge a tax rate that is proportional to the value of benefits drawn by laid off workers divided by its payroll. The previous three to five years of benefits and payrolls are used in determining the benefit ratio.

Calculation of Marginal Tax Cost

Call T the number of years of benefits and payrolls used in the calculation. Then the benefit ratio is given by

$$BR_t = \frac{\sum_{j=1}^{T}\chi B_{t-j}}{\sum_{j=1}^{T} w_{t-j}n_{t-j}}. \tag{13}$$

Under the assumption of constant growth of employment and taxable wages as above, the benefit ratio can be approximated by

$$BR_t \approx \frac{\sum_{j=1}^{T}\chi B_{t-j}}{T\bar{w}\bar{n}}$$

and the tax schedule by

$$\tau_t = \lambda_0 + \lambda_1 BR_t.$$

After some manipulation, the tax bill of a firm can be written as

$$w_t n_t \tau_t = w_t n_t \lambda_0 + \lambda_1 w_t n_t \frac{\sum_{j=1}^{T}\chi B_{t-j}}{T\bar{w}\bar{n}}.$$

The discounted present value of an additional dollar of benefits is

$$MTC = \chi\lambda_1(1+g_n)^2(1+g_w)^2\frac{1-(1+i)^{-T}}{Ti}. \tag{14}$$

In a benefit ratio system, it is clear that the marginal tax cost can rise above 100% depending upon the slope of the tax schedule. Further, inspecting the equation shows that the marginal tax

cost for a benefit ratio state is linearly increasing in the slope of the tax schedule and the fraction of benefits charged to firms. With a bit of algebra, it can be shown that the marginal tax cost is also decreasing in the discount rate.

4.4 Accounting for the minimum and maximum tax rates

The above calculations for the marginal tax cost only apply to firms on the sloped portion of the tax schedule. For firms that are on the flat portion—either assigned the minimum or maximum tax rates—the marginal tax cost of an additional layoff is approximately zero.[19] I use newly available QCEW tabulations on the overall UI tax contributions at the 3-digit industry and state cell to place an average firm in each cell on the sloped or flat portion of the tax schedule.

Using these data, I calculate for each state and industry cell the average tax rate for each quarter from 2001 forward. If the industry's tax rate is above the maximum or below the minimum, therefore, I set the marginal tax cost to zero. Requiring the average tax rate in a cell to be at the minimum or maximum is a very restrictive assumption which is infrequent in the sample. Therefore, I implement this in the following way. If an industry is ever at the minimum or maximum, I set the marginal tax cost to zero in all years. Depending on the distribution of firms across tax rates within each industry, this is a conservative method of assigning cells to the sloped portion which would tend to attenuate regression coefficients. As a robustness check, I also assign zeros only in those quarters in which the tax rate is at the statutory minimum or maximum rates. The results are robust to the different methods.

These newly available data on tax rates provide a significant improvement over the previous literature. In previous studies, it is commonly assumed that over a long period of time, tax contributions must equal benefits paid. Given this assumption, researchers used the average unemployment rate within each cell to determine the level of taxes required to fund those benefits in steady state. If these steady state tax rates were below the minimum or above the maximum, the marginal tax cost was set to zero.

There are several problems encountered with this method. First, as Pavosevich (2009) points over, over the time period of this study, tax contributions fell far short of benefits paid causing large deficits in many state trust funds. Therefore, the steady state tax assumption is less appropriate in recent years. Indeed, over the recent period, the steady state tax rates implied by this method swamp the maximum tax rate in nearly all cells. Second, while a state must eventually equate contributions with benefits, it is not necessarily true that this must hold for each industry within a state, especially since persistent industry cross-subsidies are inherent in the system. Third, assigning the marginal tax cost to zero as a function of each state-by-industry unemployment

[19]As pointed out in the model above, the marginal tax cost for a firm that approaches the sloped portion is non-zero. I follow the literature and assign the marginal tax cost as zero at the minimum rate as well. Importantly, imposing this assumption biases the results against finding a significant effect of experience rating.

rate induces a simultaneity in the dependent variable—the temporary unemployment probability in Card and Levine (1994)— with the calculated marginal tax cost. The method in this paper, therefore, reduces misclassification of zero marginal tax cost cells as well as avoids the simultaneity problem inherent in previous studies.

4.5 Discount Rate Calculation

In both experience rating systems, the nominal interest rate is an important parameter since previous benefits are charged to the firm in nominal terms. I apply several different values for the interest rate. First, I follow the literature and set the nominal interest rate to 10%. Second, I calculate the interest rate as the sum of a nominal interest rate on corporate paper and add to that the quarterly probability of firm closure in the QCEW micro data.[20] This discount rate varies over state and industry but is only available from the detailed micro data from the QCEW in this study. Third, as a robustness check, I use interest rates of 5% and 15% as well (see Table 4). Overall, the results with different interest rates are qualitatively similar.

4.6 Econometric Analysis

Table 1 shows summary statistics for several of the variables for the states listed in Table A1. First, the average marginal tax cost using the exogenous interest rate is 54% with a maximum of 217%. The average is slightly lower than the 68% in Card and Levine (1994) whereas the maximum in their sample was 1.6.[21] The lower average over the recent period accords with Pavosevich (2009) who shows that states are charging firms too little to finance their UI trust funds. Figure 6 graphs the marginal tax cost by two digit industry. Variation within each two digit industry is across state and also 3-digit industries within the 2-digit sector. From this graph we can see that the largest spikes at zero marginal tax cost (either from the minimum or maximum rate) are in mining, construction, and arts and entertainment. I find that retail trade is less likely to be at the maximum tax rate than is found in Card and Levine (1994).

The average marginal tax cost with the estimated interest rate is similar to the exogenous interest rate. The average is a 61% MTC with the same standard deviation and a slightly higher maximum value of 220%. Over the entire sample, the job destruction rate averaged 6.48 and job creation averaged 6.23 for a mean net creation rate of -.25 over the entire period. Total churn in the labor market, measured by the job reallocation rate, was 12.5% per quarter. I now turn to the econometric analysis of experience rating and job flows.

The baseline specification is a standard fixed effects model with the job destruction rate, job creation rate, net creation rate, or the reallocation rate as outcomes. I follow the literature and

[20] I use the 3 month AA non-financial corporate paper rate from the FRED database (DCPN3M).

[21] Regressions omitting $MTC > 1.5$ yielded substantially similar results.

average the marginal tax cost over all of the observations within each 3-digit industry and state cell and apply that average to all quarters of data. Therefore, the variation that is exploited in this regression is the *between* variation in the level of the marginal tax cost. This requires assuming that there are fixed differences at the 3-digit industry across states as well as fixed state effects (constant across industries). The full specification is

$$Y_{isyq} = \varsigma + \varsigma_i + \varsigma_s + \varsigma_y + \varsigma_q + \beta MTC_{is} + x'_{isyq}\kappa + \epsilon_{isyq} \tag{15}$$

The ς's are fixed effects for 3-digit industry, state, year, and quarter.[22] x_{isyq} includes the level of employment and the number of firms in each cell to control for the size of the cell and κ are the associated coefficients. The dependent variable, Y, will be either job creation, job destruction, job reallocation, or net job creation. β is the coefficient of interest and gives the effect of going from 0% to 100% MTC on the dependent variable.

Table 2 shows results from the regression with the averaged marginal tax cost using the exogenous interest rate of 10%. The coefficient on the marginal tax cost is -2.4 implying that a change from the mean of 54% to 100% marginal tax cost would reduce job destruction by 17%. The coefficient on job creation is -1.86. The point estimate suggests that implementing perfect experience rating would reduce job creation by 13.7%. Moreover, an average state instituting a 100% MTC would reduce job reallocation by 10%. The right panel is the same analysis conducted using on the period 2001-2010, as these are the actual years that I measure marginal tax costs. The results are qualitatively similar with larger coefficients for job destruction and job reallocation.

Table 3 presents estimates using two different marginal tax cost measures. The left panel shuts down employment growth in the marginal tax cost calculation, i.e. $g_n = 0$.[23] In this specification, job destruction would fall by 15.8% and job creation by 15.4% after instituting 100% experience rating. As another robustness check, I calculate the marginal tax cost as in Topel (1983) which amounts to setting $g_n = g_w = 0$ and $\chi = 1$, shown in the right panel of Table 3. Note that this regression only exploits variation in the slope of the tax schedule across states. The results are much the same with a slightly larger decrease in job creation than job destruction (13.4% vs. 16.5%).

Table 4 presents estimates using alternative discount rates. The first two panels use alternative exogenous interest rates. The coefficients on the marginal tax cost in each of these regressions are significant. Using a 5% interest rate, job destruction is predicted to fall by 12.2% if perfect experience was instituted. With a 15% interest rate, job destruction would fall by 22%. Results for the other outcomes are similar to those found in Tables 2 and 3. The right-most panel uses an estimated interest rate adding the estimated death rate in the QCEW to the corporate paper rate for each quarter.[24] I estimate this on the subsample over which I calculate the marginal tax costs

[22] Specifications with year × quarter dummies are nearly identical.
[23] I also try specifications including g_n, g_w, and χ as regressors. Results are similar.
[24] Corporate paper rate is from the Fred database. See Section 4.4

from 2001-2010. The result are even stronger in this specification. Going from average to perfect experience rating would reduce job destruction by 29% while reducing job creation by 23% (both significant). Job reallocation would de reduced by about 20% and net creation is economically and statistically significantly positive.

In the next set of estimates in Table 5, I regress the job destruction and creation rates including several additional measures of the tax schedule as controls. In the left column of each panel (labeled (1)), I include the proportion of the state's accounts that are on the sloped portion of the schedule as well as its interaction with the marginal tax cost. The motivation for this is that the higher the fraction on the sloped portion, the more likely the marginal tax cost will be to bind. Therefore, we should expect a negative sign on the interaction.[25] As expected, the interaction effect is significantly negative, showing that if the slope is binding for more firms, there is a larger negative effect of increasing experience rating on job flows.

Column (2) of each panel includes the proportion on the slope (not interacted) as well as the percent of benefits charged, and the minimum and maximum statutory rates. These turn out to be insignificant with the exception of the maximum rate on job destruction. The coefficient on the marginal tax cost remains large and significant.[26]

The empirical evidence presented in this section strongly confirms the prediction that higher experience rating reduces the firm's incentives to both create and destroy jobs. I now turn back to a fully-specified macroeconomic model to understand the effect of experience rating on long-run and short-run aggregate labor market outcomes.

5 Macroeconomic Equilibrium and Dynamics with Tax Experiments

In this section, I develop a search model of unemployment with heterogeneous firms that face UI taxes based on endogenously-determined, individual layoff histories. I analyze this model to understand the effect of experience rating on the dynamics of the labor market and to consider counterfactual UI financing. The model is an extension of Elsby and Michaels (2011) who develop a search and matching model of the labor market with large firms and endogenous job destruction.

The economy is populated by a measure one of firms and measure $\mathbb{L}$ of workers. Aggregate productivity at a given time is p_t and follows an autoregressive process in logs: $\ln p_t = \rho_p \ln p_{t-1} + \epsilon_t^p$. Idiosyncratic productivity is also assumed to follow an AR(1) process in logs: $\ln x_t = \rho_x \ln x_{t-1} + \epsilon_t^x$. Firms have access to identical production functions and workers are ex-ante homogeneous. Productivity at the firm level is merely the product of the level of each, px. Firms observe aggregate

[25]Admittedly, this suggests that the method of assigning a zero MTC as described in Section 4.4 does not fully disentangle firms on the sloped portion from the flat portions.

[26]See Appendix C and Table 6 for an additional robustness check with missing states.

and idiosyncratic productivity and workers observe aggregate productivity and the idiosyncratic productivity of its employer or potential match.

Workers and firms meet through a process of search and matching governed by an aggregate matching function. The rates of job finding and job filling are determined by the aggregate number of vacancies, V, and the aggregate number of searchers, U. As is standard in the literature, the matching function is assumed to be constant returns to scale: $M(U,V) = M(1, \frac{V}{U})$. Define labor market tightness, $\theta \equiv \frac{V}{U}$. The higher is θ, the more job openings per searching worker and, therefore, the tighter the labor market.

Unemployed workers meet a job posting at the job finding rate, $f(\theta) \equiv \frac{M(U,V)}{U}$. The standard assumptions apply: $f'(\theta) > 0$ and $f(0) = 0$. A posted vacancy is filled at the job queueing rate, $q(\theta) \equiv \frac{M(U,V)}{V}$; $q'(\theta) < 0$ and $q(\infty) = 0$.

Unemployment insurance benefits, b, are financed through two forms of taxes. (1) firm specific payroll taxes, τ, based on individual firm's history of layoffs; (2) lump sum taxes, T, on firms and all workers (whether unemployed or not). These taxes are set each period to balance the government budget constraint. Since they are equally levied and non-distortionary, they do not affect the optimal decisions of the agents. Thus, they are ignored in exposition of the model below.[27]

The timing of events in the model is as follows. At the beginning of each period, firms evaluate the idiosyncratic and aggregate state of the economy and decide to post vacancies or lay off workers. Unemployed workers meet firms and bargain over wages while laid off workers cycle into unemployment. After all job flows are complete, production occurs and wages are paid, which completes a time period.

The model's key endogenous variables are determined mainly by the labor demand decision of individual firms, to which I now turn.

5.1 Firm's Problem

The firm's labor demand problem is similar to that presented in Section 3. Recall that the firm has a stock of workers, n_{-1}, and a stock of layoffs, ℓ_{-1}. Of the laid off, a fraction δ no longer determine the firm's UI tax. Previous layoffs are no longer counted in a firm's stock if the laid off find other jobs or there are statutory benefit liability time limits.[28]

The firm observes idiosyncratic productivity, x, and aggregate productivity, p, and decides to hire or fire. Let the number of hires be denoted by h and the number of fires as s. As opposed to the costless hiring in Section 3, the firm must post vacancies at a cost of c per vacancy. Each

[27] In reality, firms pay taxes on a capped portion of payroll. I abstract from this for simplicity.

[28] Geometric depreciation of layoffs through δ is a parsimonious reduced form method to model laid off workers finding new jobs without tracking their employment history. In addition, it captures the statutory maximum amount of time that previous benefits are charged to a firm. Even in reserve ratio states in which previous benefits are forever counted, previous layoffs are diminished through tax contributions over time that restore a firm's balance. It is also worth noting that δ will also be integral in matching the distribution of firms across tax rates.

vacancy meets a worker with probability q so that a firm hiring h workers must post $\frac{h}{q}$ vacancies. If it fires s workers, it sends those workers into the layoff pool, ℓ. Therefore, the equations of motion for the firm's state variables are

$$n = n_{-1} + h - s$$

$$h = qv$$

$$\ell = (1 - \delta)\ell_{-1} + s.$$

Since $s \equiv -\mathbb{1}^{-}\Delta n > 0$, it is possible to rewrite the equation of motion for layoffs as: $\ell = (1 - \delta)\ell_{-1} - \mathbb{1}^{-}\Delta n$. In addition, $h \equiv \mathbb{1}^{+}\Delta n = qv$. Total hiring costs are given by $cv \equiv \frac{c}{q}\mathbb{1}^{+}\Delta n$. The firm's optimization problem is written entirely in terms of n and Δn according to these equations.

In addition to idiosyncratic state variables, the firm must take account of several aggregate states. Along with the level of aggregate productivity, the firm must predict future queuing rates to make optimal intertemporal vacancy posting decisions. In this model, that amounts to forecasting future labor market tightness, θ'. The reason for this is fairly intuitive. Suppose that aggregate productivity was in a long drought so that many firms had shed workers. After aggregate productivity recovers, firms will be looking to hire a large number of workers and labor market tightness will be high. On the other hand, suppose that aggregate productivity had realized a series of positive shocks. Firms will have a larger than typical stock of workers; in response to the same positive shock, firms will hire fewer workers and so tightness will be relatively lower. Therefore, aggregate productivity is not sufficient for firms to determine the price of hiring.

In order to forecast labor market tightness, the firm must keep track of the type distribution of firms across state variables, $\{n, \ell, x\}$. Call this distribution Ξ and the transition equation $\Xi' = \Gamma(p, \Xi)$ which is a function of aggregate productivity as well. It is important to note that endogenous aggregate variables depend on aggregate productivity and the type distribution of firms: $\theta = \theta(p, \Xi)$, $f = f(\theta(p, \Xi))$, $q(\theta(p, \Xi))$. In what follows, the dependence of these variables on the aggregate state is suppressed. Therefore, the following is the firm's Bellman equation

$$\Pi(n_{-1},\ell_{-1},x,p,\Xi)=\max_{n}\Big\{pxF(n)-wn-\tau(\ell)wn-\frac{c}{q}\mathbb{1}^{+}\Delta n$$
$$+\beta\int\int\Pi(n,\ell,x',p',\Xi')dG(x'|x)dP(p'|p)\Big\} \quad (16)$$

such that

$$\ln x' = \rho_x \ln x + \epsilon^x \quad (17)$$
$$\ell = (1-\delta)\ell_{-1} - \mathbb{1}^{-}\Delta n \quad (18)$$
$$\mathbb{1}^{+}\Delta n = qv \quad (19)$$
$$\ln p' = \rho_p \ln p + \epsilon^p \quad (20)$$
$$\Xi' = \Gamma(p,\Xi). \quad (21)$$

5.2 Wage Setting

For tractability, the workers side of the model is kept extremely simple. I abstract from the situation in which laid off workers remain on call with their previous firm. If firms could recall (as Appendix B shows), this would give rise to an option value of remaining on recall with that firm versus searching in the general labor market. I leave this interesting extension for future research.

Workers can either be employed at a firm with n employees, ℓ laid off workers, and productivity x, or unemployed. An unemployed worker earns a flow unemployment benefit of b. Unemployed workers find a job with probability f. The Bellman equation for an unemployed worker is given by

$$W^u(p,\Xi)=b+\beta E\left[f'W^e(n',\ell',x',p',\Xi')+(1-f')W^u(p',\Xi')\right]. \quad (22)$$

An employed worker in the current period earns wage w and is fired with probability $\tilde{s}$ into the layoff pool.

$$W^e(n,\ell,x,p,\Xi)=w+\beta E\left[\tilde{s}'W^u(p',\Xi')+(1-\tilde{s}')W^e(n',\ell',x',p',\Xi')\right]. \quad (23)$$

For additional simplicity, I will assume that wages are simply the weighted average, with bargaining power η, of the average flow surplus from working and the average flow surplus from employing n workers, gross of adjustment costs.[29] [30] The flow surplus from working is just $w-b$. The average

[29]Several papers make this assumption such as Barlevy (2002), Shimer (2001), and others.

[30]Stole and Zwiebel (1996) bargaining is intractable in this model due to the interaction of the layoff cost and the unknown policy function in the continuation value of the firm's problem. Numerical derivatives of value functions are subject to substantial error at early stages of value function iteration. This makes numerically solving the full bargaining problem intractable.

flow surplus from employing n workers is

$$\frac{pxF(n) - (1 + \tau(\ell))wn}{n}. \tag{24}$$

The assumed bargain is, therefore,

$$\eta \left[\frac{pxF(n) - (1 + \tau(\ell))wn}{n} \right] = (1 - \eta) [w - b]. \tag{25}$$

Solving for the wage gives

$$w = \frac{\eta \frac{pxF(n)}{n} + (1 - \eta)b}{1 + \eta\tau(\ell)} = \frac{\eta pxn^{\alpha-1} + (1 - \eta)b}{1 + \eta\tau(\ell)}. \tag{26}$$

There are several important features of the wage in comparison to the standard bargained wage that should be noted. First, as is standard, conditional on labor productivity, the wage is declining in n due to diminishing marginal productivity. Second, as expected, the wage is (weakly) decreasing in the UI tax rate. In the standard model, the wage is typically a function of future labor market productivity—firms must compensate workers when the labor market is tighter as the outside of option of finding another job is easier.[31] Therefore, the wage will co-vary with productivity substantially less without this additional term. As is well known, this will lead to substantial amplification of shocks relative to comparable models.

5.3 Aggregation and Equilibrium

Let the policy function for the firm be denoted as

$$n^* \equiv \Phi(n, \ell, x, p, \Xi), \quad \Delta_p(n, \ell, x, p, \Xi) \equiv= \Phi(n, \ell, x, p, \Xi) - n. \tag{27}$$

and

$$\ell^* = (1 - \delta)\ell - \mathbb{1}^- \Delta_p(n, \ell, x, p, \Xi). \tag{28}$$

where $\mathbb{1}^{\{+,-\}}$ is an indicator for positive or negative employment adjustment. Total separations are given by

$$S = \int_n \int_\ell \int_x \mathbb{1}^- \Delta_p(n, \ell, x, p, \Xi) d\Xi(n, \ell, x), \tag{29}$$

Total hires are described by

$$H = \int_n \int_\ell \int_x \mathbb{1}^+ \Delta_p(n, \ell, x, p, \Xi) d\Xi(n, \ell, x). \tag{30}$$

[31] Mechanically, this term is the only remaining term from the continuation values of the firm and worker.

Employment is simply the average employment level across firms

$$\bar{N} = \int_n \int_\ell \int_x \Phi(n, \ell, x, p, \Xi) d\Xi(n, \ell, x). \tag{31}$$

Employment evolves according to the following difference equation

$$\bar{N} = \bar{N}_{-1} + H - S. \tag{32}$$

Finally, the evolution of the aggregate stock of layoffs is

$$\bar{L} = (1-\delta)\bar{L}_{-1} - \int_\ell \int_n \int_x \left[\mathbb{1}^{-}\Delta_p(n, \ell, x, p, \Xi)\right] d\Xi(n, \ell, x). \tag{33}$$

These accounting rules allow me to define an equilibrium of the model.[32] A *recursive stationary equilibrium* is a set of functions

$$\left\{\Pi, \Phi, H, S, \bar{N}, \bar{L}, W^e, W^u, w, \theta, f, \bar{s}, \Gamma\right\}$$

such that:

1. Firm's problem: taking θ as given, firms maximize Π subject to the bargained wage, w, and the optimal choice is consistent with Φ.

2. Wage bargaining and worker flows: the wage function, w, splits the flow surplus between the worker and firm. The finding and separation rates along with the wage bargain and the value of leisure satisfy the worker's Bellman equations

3. Hiring and separations consistent with f and $\bar{s}$:

   - Hiring, H, is consistent with Φ and $f = \frac{H}{\mathbb{L} - \bar{N}}$
   - Separations, S, are consistent with Φ and imply $\bar{s} = \frac{S}{\bar{N}}$
   - θ is given by the matching function and is consistent with f.

4. Employment Dynamics: $\bar{N} = \bar{N}_{-1} + H - S$

5. Model Consistent Dynamics: The evolution of aggregate employment and layoffs given by Γ is consistent with Φ and the processes for p and x.

5.4 Solution Method

The solution to the dynamic labor demand problem stated above is analytically intractable, therefore I use to numerical methods to solve the model. The crux of the solution is to pin down the

[32] Note that the government fills any holes in UI financing through a lump sum tax that does not distort the optimal choices of any of the agents. It is therefore abstracted from here.

policy function for the firm, Φ. To accomplish this, I use value function iteration on the firm's recursive problem stated in equation (16).

Specific details of the algorithm are described in Appendix A. I briefly describe the computational method to solve for the steady state allocation here. First, I discretize the state space which consists of $\{n, \ell, x\}$. I discretize the shock process x using the method in Tauchen (1986). I discretize n on an equally spaced grid between one-half of the minimum frictionless employment level and two times the maximum frictionless employment level. In order to reduce computation time, I restrict the firm to choose points on the discrete grid for n.

I then discretize the grid for layoffs: the maximum of the layoff grid is chosen as the maximum employment change in the frictionless model. Since the firm chooses an employment level which pins down the layoff stock next period, I linearly interpolate at points off the layoff grid. In practice, firms in equilibrium do not reach the highest point of the layoff grid. Therefore, I use an unequally spaced grid with more points at the bottom two-thirds of the grid. Finally, in the simulations, I ensure that firms do not hit the end points of either the employment or layoff grids.

After I solve the firm's policy function, I simulate the model for 10,000 firms and 3,000 periods, discarding the first 1,000 observations as the burn-in period. I simulate the continuous shock process in logs and piece-wise linearly interpolate between points on the grid.[33] The aggregation of the simulation across all time periods and agents following equations (29)-(33) constitutes the solution to steady state equilibrium.

Approximate Aggregation

In each period, firms decide on vacancy posting given their idiosyncratic state vector and the aggregate state of the economy. In order to predict future levels of labor market tightness (and therefore vacancy posting costs), firms must forecast the entire type distribution of firms across the state space. This dependence is shown in the inclusion of Ξ in the firm's optimization problem. Since Ξ is an infinite-dimensional object, the exact equilibrium is not computable. I follow the Krusell and Smith (1998) approximate equilibrium approach.[34]

The approach is as follows. Instead of forecasting the entire distribution of firms across states, I assume the firm is boundedly rational and only keeps track of a finite set of moments of the distribution. Suppose that the set of moments chosen is called ξ and the transition of these moments is governed by γ. Therefore, Ξ is replaced by ξ in the dynamic programming problem to make the

[33] I experiment with log-linearly interpolating along the x and n dimensions, but the results are similar in the steady state.

[34] See Bils et al. (2011), Elsby and Michaels (2011), and Fujita and Nakajima (2009) for examples of using this method in similar contexts.

problem computable.

$$\Pi(n_{-1}, \ell_{-1}, x, p, \xi) = \max_{n} \Big\{ pxF(n) - wn - \tau(\ell)wn - \frac{c}{q}\mathbb{1}^{+}\Delta n \\ + \beta \int\int \Pi(n, \ell, x', p', \gamma(\xi)) dG(x'|x) dP(p'|p) \Big\}. \quad (34)$$

The task is to solve for the transition equation: $\xi' = \gamma(p, \xi)$. I assume the moments are the mean of the employment distribution, $\bar{N}$, and the mean of the layoff distribution, $\bar{L}$ and conjecture log-linear transition equations

$$\ln \bar{L}' = \gamma_{\ell 0} + \gamma_{\ell 1} \ln \bar{L} + \gamma_{\ell 2} \ln \bar{N} + \gamma_{\ell 3} \ln p$$

$$\ln \bar{N}' = \gamma_{N0} + \gamma_{N1} \ln \bar{L} + \gamma_{N2} \ln \bar{N} + \gamma_{N3} \ln p.$$

Note that the firm takes these forecasts for the aggregate state and estimates labor market tightness in order to calculate expected future vacancy posting costs. That is the last equation

$$\ln \theta' = \gamma_{\theta 0} + \gamma_{\theta 1} \ln \bar{L}' + \gamma_{\theta 2} \ln \bar{N}' + \gamma_{\theta 3} \ln p'.$$

The solution algorithm is to find the parameters, γ, that accurately forecast aggregate variables. I discretize p via the method of Tauchen (1986) and solve the value function on the state space: $\{n, \ell, x, p, \bar{N}, \bar{L}, \theta, \xi\}$. I simulate the model for 10,000 firms and 2,000 periods and estimate the coefficients via OLS on the simulated data. Further details are in Appendix A.

In practice, the means of the distribution provide adequate information for the firm to forecast the distribution of firms across states as measured by the sufficiently high R^2's in the regressions for the forecast coefficients. Higher R^2's are easily obtained with the use of larger stochastic sample sizes, but the results of the forecast coefficients are similar. Further details as well as the R^2's from the solution of the baseline model are given in Appendix A.

In the present model, market clearing every period is defined through an equilibrium labor market tightness that coincides with the flows of workers into and out of unemployment. In the standard Krusell and Smith (1998) model, market clearing is insured by the set up of the model—the labor market clears in every period as unemployment is exogenously determined. In the present model, however, the equilibrium for the labor market must be determined in every stage of the simulation.

In principle, firms know the aggregate state of the economy $\{p, \bar{N}, \bar{L}\}$ and can therefore predict equilibrium θ. However, forecast errors can lead to a situation in which the true market clearing level of θ is different from the forecasted level. Therefore, I forecast θ from the equation using the guess for γ_θ, but I solve the value function on a grid of θ's. Then, in every time period of the

simulation, I iteratively solve for the market clearing θ, $\bar{N}$, and $\bar{L}$. Further details of the solution algorithm are in Appendix A.

5.5 Calibration

A model period is calibrated to be one month in length. There are several parameters that are set externally before determining other parameters. I set $\beta = .996$ corresponding to an annual interest rate of 5%. The curvature of the production function, α, is set at .59. Average labor productivity is normalized to one in steady state. The elasticity of the matching function, ϕ, is set to .6 following Petrongolo and Pissarides (2001) and the bargaining parameter, η is set to .4, which is in the range used in the literature. I now turn to the calibration of the other parameters of the model. The calibration strategy of the standard parameters borrows from Elsby and Michaels (2011). Table 7 contains a full list of the calibrated parameters, their meaning, and the moment they target.

Fourteen parameters remain to be calibrated: $\mathbb{L}$, the size of the labor force; σ^x and ρ_x, the parameters of the idiosyncratic shock process; σ^p, ρ_p, the parameters of the aggregate shocks process; b, the flow value of unemployment; c, the flow cost of vacancy posting; μ, the level of matching efficiency; δ, the depreciation of layoffs; $\underline{\tau}$, $\bar{\tau}$, the minimum and maximum tax rates; $\underline{\ell}$ $\bar{\ell}$, the tax schedule thresholds; MTC, the marginal tax cost. I now discuss each of these parameters in turn.

The job finding rate for the United States is targeted at 45% per month on average (Shimer (2005)). In addition, I follow Pissarides (2007) and target labor market tightness in steady state at .72. These two targets pin down matching efficiency, μ, according to the following relationship

$$f = \mu\theta^{1-\phi} \Rightarrow \mu = \frac{.45}{.72^{1-.6}} = .5132.$$

Firms take aggregate labor market tightness, θ, as given when determining optimal labor demand. In order to set steady state tightness at .72, I fix the labor force so that aggregate hiring implies a labor market tightness of .72. In other words, I set $\mathbb{L}$ according to the following steady state relationship

$$H = (\mathbb{L} - \bar{N})f \Rightarrow \mathbb{L} = \frac{H}{f} + \bar{N} \Rightarrow \mathbb{L} = \frac{H}{m\theta^{1-\phi}} + \bar{N}.$$

The shock process for idiosyncratic productivity consists of two parameters: the standard deviation of innovations to $\ln(x)$, σ^x, and the persistence of $\ln(x)$, ρ^x. In order to pin these parameters down, I target two moments from the QCEW data. First, the persistence of shocks, conditional on other parameters, will determine the extent of employment changes in equilibrium. If shocks are long-lived, firms will adjust less frequently. I follow Elsby and Michaels (2011) and target the fraction of employment adjustments that are less than 5% at a quarterly frequency. In the QCEW,

this moment is 54.5% at a quarterly frequency.

The standard deviation of innovations controls the degree of job creation and job destruction in the model. The intuition for this is that the higher the standard deviation of shocks, the larger is the fraction of workers that are shed and hired in steady state. In the QCEW, the job reallocation rate, the sum of job creation and job destruction, is 12.5% per quarter. Therefore, I target the model job reallocation rate to pin down σ^x.

For a given set of parameters, further, the reservation productivity for shedding workers is decreasing in the value of leisure, b, due to the wage bargain. Therefore, a higher b will lead to a higher separation rate. I target a monthly separation rate of 3.12%. Along with a finding rate of 45%, this implies a steady state unemployment rate of 6.48%.

The flow cost of posting a vacancy imposes a hiring cost on the firm to the extent that each vacancy takes time to be filled. I target an estimate of hiring costs in Silva and Toledo (2005). They find that hiring costs are roughly 14% of average quarterly wages. Hiring costs in the model are given by $\frac{c}{q(\theta)}$, so I choose c to make this hiring cost 14% of quarterly wages.

I target the persistence of average labor productivity of $\rho^p = .983$ to coincide with a persistence of output per hour of about .95 quarterly. In addition, I choose the standard deviation of aggregate productivity shocks of $\sigma^p = .005$ to generate a standard deviation of average labor productivity at roughly 2%.

UI finance calibration and calculation of MTC

I now turn to calibration of the UI experience rating tax system. Recall that the marginal tax cost is the present discounted value of a dollar in benefits paid back in taxes. The marginal tax cost is calculated in the data for a firm always on the sloped portion of the schedule. I calculate the analogous measure in the model. Consider exogenously increasing a firm's layoff stock by one. This laid off worker receives unemployment benefits, b, for each period he is unemployed. In expectation, therefore, he receives $\frac{b}{1-\beta(1-f)}$ in present discounted value of unemployment benefits. On the other hand, the firm pays increased taxes of $\tau_c wn$ for this worker with a depreciation rate of $(1-\delta)$ each period. Therefore, the proportion of increased taxes paid back by the firm is the analogue to the empirical marginal tax cost. It is given by

$$MTC = \zeta \frac{\tau_c \bar{w}\bar{n}}{b},$$

where $\zeta = \frac{1-\beta(1-f)}{1-\beta(1-\delta)}$.[35] In this formula, the average wage bill, $\bar{w}\bar{n}$ is from the simulation for firms on the sloped schedule. From this equation, it is clear that the marginal tax cost is proportional to slope of the tax schedule, as it is in the data. In addition, δ helps determine the steady state distribution of firms across UI tax rates. In turn, $\underline{\ell}$ and $\bar{\ell}$ determines the slope of the tax schedule,

[35] $\chi = 1$ in the model.

given minimum and maximum tax rates.

I set the minimum and maximum statutory rates as the average minimum and maximum rates across states in 2010 (weighted by employment). This implies a value of $\underline{\tau} = .042\%$ and $\bar{\tau} = 8.44\%$. It is important to discuss these tax rates in more detail. As discussed above, firms pay these payroll taxes only a capped portion of payroll, ranging between \$7,000 and \$37,000. I abstract from the capped payroll in the model for simplicity. Using a tax rate proportional to total payroll is another potential calibration strategy. Since I target a marginal tax cost to the data, the level of the tax rates should not affect the quantitative results given an appropriately re-calibrated marginal tax cost.

All things equal, the parameter δ helps to pin down the distribution of firms across tax rates. Across states in 2010, an average of 17.7% and 6.7% of firms paid the minimum and maximum tax rates, respectively (again using the employment-weighted average). I choose δ to mimic this distribution of tax rates.

Model outcomes

The target moments along with their calibrated outcomes are listed in Table 8. Overall, the model moments are relatively close to their targets. In the worst case, I undershoot the fraction of employment changes that are small as well as the average quarterly job flow rate. In particular, the fraction of adjustments less than 5% is only 45% in the model as opposed to 54% in the data. In addition, the equilibrium job reallocation rate is 7.05% which is substantially lower than 12.5% in the QCEW data. The reason for the low model moments for each is that increasing the standard deviation of the idiosyncratic productivity reduces the fraction of small adjustments. In order to more accurately capture the cross-sectional distribution of employment growth, a richer model of persistent differences across firms is likely necessary.[36]

In addition, the separation rate in steady state is slightly higher than the targeted rate at 3.5% vs. 3.1%. This implies a steady state unemployment rate of 7.27% vs. a target of 6.5%. Hiring costs as a fraction of quarterly wages is near its target at 14.7%. The simulated process for average labor productivity is slightly less persistent (.94) and slightly less volatile (.0172).[37] The distribution of firms across taxes is very close to the data, as shown in Figure 7. Roughly 17.43% (compared to 17.7% in the data) of firms are subject to the minimum rate while 6.76% (compared to 6.6%) are subject to the maximum rate.

[36] Elsby and Michaels (2011), for instance, consider the Pareto distribution for idiosyncratic shocks and include persistent firm fixed effects to better match the cross-section of firms.

[37] Due to the computational intensity of solving the approximate equilibrium, converging on the precise process for average labor productivity in simulated data is impractical.

6 Experience Rating Experiments

6.1 Steady State Comparative Statics

In this section, I show comparative statics from changes to the marginal tax cost. These results shed light on the effect of different possible sources of increasing experience rating. The previous literature which treated experience rating as a simple linear firing cost could not address these experiments. The reason for this is two-fold. First, modeling the institution as a linear firing cost ignores the fundamental fact that firms must pay a payroll tax. Any level increase in payroll taxes reduces labor demand and therefore potentially offset the benefits of a higher layoff cost. Second, the simple linear firing cost ignores important firm heterogeneity across the tax schedule. This is important to accurately measure the revenue effects of tax changes. Suppose that all firms were at the minimum rate. Then increasing the maximum tax rate would very little, if any, effect on tax revenues while still possibly changing layoff incentives.

The marginal tax cost in the model is calculated as in the data: it is the fraction of benefits paid back in taxes. Recall that in the model and the data, the marginal tax cost is proportional to the slope of the tax schedule. In the model, that implies the following relationship to the parameters of the tax schedule

$$MTC \propto \tau_c \equiv \underbrace{\left(\frac{\bar{\tau} - \underline{\tau}}{\bar{\ell} - \underline{\ell}}\right)}_{\text{slope}}.$$

Different possible changes to the slope are shown in Figure 8—they include an increase in the lower threshold, $\underline{\ell}$; a decrease in the minimum tax rate, $\underline{\tau}$; a decrease in the upper threshold, $\bar{\ell}$; or an increase in the maximum tax rate, $\bar{\tau}$. The experiments are run as follows. I adjust each parameter so as to increase the marginal tax cost by 5%. I then find the new equilibrium steady state (i.e., the equilibrium tightness) with the higher marginal tax cost. The results are shown in Table 9.

For each of the changes to the slope of the tax schedule, job creation and job destruction fall, with magnitudes quantitatively similar to the empirical results. Job creation and job destruction rates fall between 1.1% to 1.9% due to a 5% increase in MTC in the model. To compare, Table 2 shows that a 5% increase in MTC decreases job creation by 1.5% and job destruction about 2% in the baseline specification.[38] The effect on the unemployment rate is also negative in each of these specifications, but the magnitude depends on the relative effect on the change in tax revenues.[39]

The reason that unemployment falls between 1.8% and 4.5% is due to the associated change in the tax burden on firms. For experiments in which the average tax burden on firms rises, overall labor demand falls, mitigating the effect of lower job destruction. Overall, unemployment

[38] These calculations are done by multiplying the coefficient on JD (-2.4) by .05 and dividing by 6.48, for instance.

[39] The job finding rate increases by small percentages in the second and fourth columns (.8% and 1.2% respectively, not shown). In the first and third row, the job finding rate increases by 3.6% and 5.3%.

still falls for each of this experiment regardless of the change in tax receipts. Larger decreases in unemployment are consistent, however, with reducing taxes. Moving the upper threshold to the left or increasing the maximum tax rate *increases* the tax rate on many firms. For instance, moving the lower threshold to the right or the minimum tax down *reduces* the tax revenue by 8.6% in each case. On the other hand, decreasing the upper threshold or raising the maximum rate actually increases revenue by 2.3%.

Increasing taxes while reducing unemployment might appear at first to constitute a Pareto improvement. In column 6 of Table 9, however, I find that the average enterprise value of firms falls in experiments in which taxes are increased. I calculate this comparative static by taking the average across of the firm's value function in equation 16.[40] Row four is the experiment that decreases unemployment the most while still raising tax revenue. In this case, profits fall by about .4%. In the case that both taxes fall and unemployment falls by the most (three tenths of a percent, row 3), profits increase by about .07%. Therefore, there is an offsetting effect of lower firm profits when tax revenues are increased.

Given that the unemployment rate falls in both experiments in which tax revenue is increased, it is possible to alter experience rating in a revenue neutral fashion and still decrease unemployment. As an example, I conduct the following experiment. I start from the experiment of raising the maximum tax rate in the fourth row of Table 9. In that experiment, I increased $\bar{\tau}$ by .4 percentage points to raise the marginal tax cost by 5%, which raised tax revenues by 2.3% in the new steady state. In this experiment, I then iteratively lower the minimum tax rate to achieve revenue neutrality in steady state. This will further increase the slope of the tax schedule and therefore slightly increase the marginal tax cost.

In order to remain revenue neutral in steady state, the lower tax rate must fall by 10% (or .04 percentage points) as shown in Table 10. The marginal tax cost in the revenue neutral experiments is ultimately 56.7%, a 5.5% increase. In this new equilibrium, job creation and job destruction fall by 1.6% and the unemployment rate is 7.06%, down from 7.27% in the calibrated model, a drop of 2.9%. The fraction of firms at the minimum tax rate increases by 2.8% due to the higher slope and lower tax rate. More importantly, the fraction of firms at the maximum tax rate falls by almost 6% due to the higher tax rate firms face for high layoff histories. While tax revenues remain constant, average firm value falls by .2%, which is less than it fell in the revenue enhancing experiments of Table 9. Of course, firm profit falls because they are made to internalize a larger share of the cost of unemployment benefits through a higher marginal tax cost.

Finally, it is worth noting that these experiments highlight the necessity of modeling the cross-sectional distribution of firms across tax rates. The large differences in tax revenue from equal changes to the measured marginal tax cost is an important aspect of evaluating the efficacy of proposals to increase experience rating.

[40]The results are quantitatively similar by comparing flow profits.

6.2 Aggregate Dynamics

The previous section showed the steady state effects of a change in experience rating. In this section, I analyze the dynamics of the labor market in response to aggregate shocks. Due to experience-rated taxes, firms are reluctant to lay off workers and face higher tax rates. The layoff cost therefore dampens the response of the labor market to aggregate shocks. Due to accumulated layoffs and the resulting higher tax burden, the model also exhibits non-linearities and asymmetries in the unemployment response to aggregate shocks.

I now turn to understanding the effect of experience rating on the labor market after an aggregate productivity shock. I construct impulse responses to a decline in aggregate productivity under different tax schedules. For each tax experiment, I re-solve the approximate aggregate equilibrium forecast equations. I then simulate the path of endogenous variables following a temporary 1% decline in aggregate productivity.

In Figure 9, I plot the impulse responses of productivity, unemployment, the separation rate, and the finding rate for two different marginal tax costs, 51% and 56.7% (5% above and below the baseline of 54%). Examining the dashed lines first, in response to a 1% aggregate shock, the unemployment increases on impact and peaks after two quarters, increasing to about 11% above its steady state.[41]

The increase in unemployment is driven by a spike in separations on impact. This is shown in the bottom left panel of Figure 9. Here we see that the separation rate increases by just over 10% on impact but declines quickly, as is standard in endogenous separation models. In addition, the job finding rate falls as workers exit to unemployment and vacancy posting falls. The job finding rate falls by just over 6% and also takes two quarters to reach its nadir. In contrast to similar models without experience rating, the job finding rate (and labor market tightness) does not peak on impact. This is seen in the fact that the job finding rate reaches its trough in the second quarter after the shock. The inclusion of experience rating appears to add modest propagation of shocks since it takes time for firms to recover from the higher tax rates.

Comparing the impulse responses under the two marginal tax costs shows that a higher marginal tax cost reduces the amplitude of recessions. The higher marginal tax cost impulse responses are depicted by the solid lines. Instead of unemployment increasing by 11%, unemployment increases by 6.8% less, a difference of about .045 percentage points. In addition, the separation rate increases by 7.8% more and the job finding rate falls by 3.3% more under lower experience rating. The results in this section show that experience rating can in fact tend to stabilize employment by reducing separations and mitigating the effect of recessions on unemployment.

Since the layoff cost in UI financing is on the *stock* of accumulated layoffs, it is possible that this system induces non-linearities in the response of the labor market to larger shocks. In order

[41]It is worth noting that the impulse response of unemployment is similar in magnitude to a 1% drop in productivity as those shown in similar models such Fujita and Nakajima (2009).

to examine this further, I show the impulse response of unemployment to a two percent negative shock to productivity. I plot the impulse response keeping the marginal tax cost constant at 56.7% from the previous experiment (solid blue lines). In order to make the one percent and two percent shock responses comparable, I halve the response to the two percent shock given by red-dashed line shown in Figure 10. From this figure, we can see that there is more non-linearity in the impulse responses than is typically found in similar models such as Fujita and Nakajima (2009). Since firms have accumulated a larger stock of layoffs, unemployment does not decline as quickly from the larger shock; the largest difference between these two responses is, in fact, in the 6th quarter after the shock. Because firms are still coping with higher taxes from the recession-induced shock to layoffs, the path of recovery of unemployment is relatively slower.

In addition to non-linearities, experience rating introduces important asymmetries between positive and negative shocks. First, comparing the solid lines in Figures 9 and 11, it is clear that the impulse response to the negative shock induces a much larger recession than the positive shock causes a boom. This is due mostly to the asymmetric affect on the separation rate which rises by 10% from a negative shock but only falls by 4.5% after a positive shock. There is also asymmetry in the effect of experience rating. In Figure 9, the finding rates react relatively similarly regardless of the marginal tax cost. In response to the boom, higher experience rating has a substantial effect on the finding rate behavior. The higher marginal tax cost causes the finding rate to rise by almost 10% less (.3 percentage points) and stays about 15% lower for twelve quarters relative to the lower marginal tax cost economy. The strong effect on the finding rate in the higher marginal tax cost example is due to the fact that firms anticipate that the boom times are temporary. If they hire a lot of workers but subsequently must lay them off as shock dissipates, they will owe a substantial fraction in increased UI taxes. Therefore, higher experience rating dampens the effects of a positive shock when firms expect to lay off workers as the boom fades.

7 Related Literature

Brechling (1975) and Feldstein (1976) were two of the earliest examinations of the theoretical implications of experience rating. Feldstein (1976) found that imperfect experience accounted for a large portion of temporary layoffs and the resulting unemployment from an economic downturn. In a series of seminal papers, Topel (1983, 1984) first studied the empirical effects of imperfect experience rating. Exploiting state variation in the marginal tax cost, Topel found that firms only pay around 75% of benefits charged. Using Current Population Survey (CPS) data along with state UI tax schedules, he shows that layoffs could be reduced by 20% with perfect experience rating. Card and Levine (1994) also study the effect of higher marginal tax costs on layoff rates. They find that full experience rating would reduce layoffs at a higher rate in recessionary periods.

Anderson (1993) and Anderson and Meyer (2000) study the effect of experience rating in the

context of a linear layoff cost model. Anderson (1993) is one of the only papers to use micro-level data to study the effect of experience rating. Anderson finds that the presence of the linear adjustment cost due to experience rating decreases the response of employment changes to seasonal variation—the labor market is less volatile because of the experience rating. In addition, she finds that the level of employment is slightly higher on average. In fact, moving to perfect experience rating would increase employment by 4.3% over the seasonal cycle.

The general equilibrium effect of layoff costs on employment depend crucially on the structure of the labor market, as shown by Ljungqvist (2002). Albrecht and Vroman (1999) further show in an efficiency wage model, experience rating reduces unemployment relative to a model with privately financed unemployment insurance. On the other hand, Hopenhayn and Rogerson (1993) find that linear layoff costs reduce employment, although their model abstracts from search frictions and instead considers employment determined by lotteries. In the context of search models, Millard and Mortensen (1996) show that layoff costs unambiguously reduce both job creation and job destruction but the overall effect on employment is ambiguous depending on which effect dominates. Lower unemployment in search and matching models with endogenous job destruction is driven by reduced job reallocation externalities at the cost of a potentially less efficient allocation of labor.

This paper finds that higher layoff costs reduces unemployment. In a labor market without search frictions, such as in Hopenhayn and Rogerson (1993), there is no externality caused by layoffs. Lower employment is generated by workers substituting towards leisure since the private gain from employment is reduced due to lower wages. In search models, the search externalities arise since each layoff clogs the market for all searchers through lower finding and filling rates. Therefore, it can be the case that in equilibrium, layoff costs reduce the rate of churn in the labor market and therefore reduce the unemployment rate.

Several additional papers explore experience rating in the context of search models. First, l'Haridon and Malherbet (2009) study UI finance in a standard job search model. The firing cost from experience rating, unlike in this paper, is exogenously determined. They also find that higher experience rating reduces the unemployment rate. In more recent theoretical work, Albertini (2011) studies the reserve ratio experience rating system in a search model. Albertini (2011) is the only other paper to tie the firm's tax rate to its experience. Similarly, he finds that higher experience rating reduces the amplitude of recessions. This paper, however, does not model heterogeneity in firms and instead uses a representative agent framework. The model, therefore, is less suited to study the tax incidence from changes in experience rating as a richer model with heterogeneity allows.

8 Conclusion

The United States finances unemployment insurance by imposing a tax schedule that penalizes firms for layoffs with higher tax rates. In this paper, I study the labor market effects of experience rating empirically and theoretically. I show that a model of labor demand under experience-rated taxes predicts that both the rates of job creation and job destruction fall with higher experience rating. The intuition for this is that firms face a positive marginal cost of a layoff and therefore have an incentive to minimize layoffs. Because of the possibility of laying off a newly hired worker, experience rating can also act as a hiring deterrent.

This paper is the first to examine the relationship between experience rating and job flows. I confirm the model prediction using firm-level data from the Quarterly Census of Employment and Wages. I find that robust evidence that higher experience rating reduces job destruction and job creation, leading to a decrease in total churn in the labor market. In the baseline specification, I find that going from average marginal tax cost to 100% marginal tax cost would reduce job destruction by 17%, job creation by 13.7%, and job reallocation by about 10%.

I then embed the model of firm labor demand into a DSGE model with search unemployment. Using this model, I conduct steady state tax experiments. I find that higher experience rating reduces job flows as well as reduces unemployment. Quantitatively, the model predicts that job flows fall by roughly the same amount as is predicted by the empirical results. The relative effect on unemployment depends on the type of tax change. Those that reduce tax revenues have a larger effect on unemployment while those that raise revenues reduce unemployment by far less. In experiments that raise revenue, I also find that there is a small decrease in firm profits. Since state tax schedules are not set optimally, I also show that it is possible to increase experience rating while maintaining revenue neutrality and reducing unemployment.

Finally, I solve the model with aggregate uncertainty using the method of Krusell and Smith (1998). I find that the labor market response to an aggregate shock is dampened by higher experience rating as firms do not shed as many workers in response to the shock. Unemployment peaks by 6.8% less since layoffs upon impact of the shock due to a smaller increase in separations. Since the layoff cost is a function of the accumulated stock of layoffs, experience rating introduces non-linear effects from larger shocks. It takes unemployment longer to recover from larger shocks since firms must shed the relatively larger overhang of accumulated layoffs. I also find that higher experience rating has a substantial and asymmetric effect on firms hiring behavior from a positive shock relative to a negative shock. Since firms expect the boom to be temporary, any current hires will have to be laid off as the economy returns to steady state. Therefore, the job finding rate spikes substantially less from a positive shock relative to a negative one.

For the present study, the welfare analysis of these changes is not addressed. There are at least two caveats to inferring welfare gains from the results in this paper. Since the model above

abstracts from on-the-job search and heterogeneity in workers, there may be reasons that workers benefit from job churn, such as finding better job matches. If this is the case, then it is not clear reducing job flows is welfare enhancing.

Moreover, I have assumed that the government does not impose distortionary taxes to fill any holes in UI financing. In practice, states and the federal government typically use general revenue funds to fill gaps in UI funding. If changing experience rating imposes an additional burden of distortionary taxes, the effects on the labor market and welfare may be different. However, the paper suggest that states might alter tax schedules to help plug UI trust fund deficits without harming the economic recovery in the labor market.

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A Numerical Algorithm

This section describes in detail the steps to solve the steady state and aggregate uncertainty versions of the model. I start by describing the solution to the steady state model.

I solve the firm's problem by standard value function iteration on a discretized grid of its state variables. The firm's state variables are n, ℓ, x. I discretize the continuous choice variables n and ℓ into E_p and L_p points, respectively. The firms optimal decision for employment, conditional on its states, determines ℓ. I discretize ℓ independently of n, however, and piecewise linearly interpolate the value function at points off the ℓ grid. I restrict the firm to choose employment on the discretized grid. By virtue of choosing a fairly fine number of grid points (minimum of 75), this restriction does not substantially effect the firm's policy functions. Robustness checks using polynomial interpolation off the employment grid yield similar results.

Idiosyncratic shocks are assumed to be log-normally distributed. I therefore discretize the space of idiosyncratic shocks using Tauchen's method described in Carroll (2011).[42] Due to the highly non-linear nature of the policy function from experience rating, I use at least 11 equiprobable points in the grid.

I start with a guess of Π^j. At each iteration I evaluate optimal choice conditional on not adjusting, hiring, or firing. I then take the max over those three possible choices as the updated guess for Π^{j+1}. If the maximum percentage deviation of Π^j and Π_{j+1} is less than a pre-specified tolerance, the value function has converged. I use the optimal choice at each grid point to define $n^* = \Phi(n, \ell, x')$, the policy function.

Armed with the policy function, I generate a simulated panel dataset of firms over T periods. I simulate the continuous log-AR(1) shock process and linearly interpolate the policy function to points off each grid. I ensure that during the simulation (after the system has settled into steady state) that each state variable remains on the grid so that no extrapolation procedure is needed. Extrapolating is subject to large approximation error as well as computational intensity. I restrict the points for x to remain on the grid. Due to the equiprobable choice of the grid, this happens

[42] I thank Ryan Michaels for the matlab code to produce this discretization.

with probability $\frac{1}{N_x+1}$. Experimentation with polynomial interpolation and linear interpolation in the logs (as opposed to levels) did not change the results substantially.

Calibration of the model is performed using a coarse grid search across the relevant state space and then a numerical minimization of the sum of squared residuals from the target moments. For this, I use the package *fminsearchbnd* which implements a simplex search method optimization routine. This method is often preferable to a gradient based method as it is more robust to discontinuities in the objective function.

Finally, I conduct the steady state tax schedule experiments as follows. A new steady state of the model consists of finding an equilibrium θ that is consistent with firm behavior. I do this by iteration on θ until the aggregated micro behavior of a panel of firms generates the conjectured θ. I update θ using a convex combination of the conjecture and the simulated tightness with a relatively low damping parameter.

A.1 Approximate Equilibrium Algorithm

The solution to the approximate aggregate equilibrium is as follows. As state above, I conjecture log-linear equations of motion for the aggregate "states":

$$\ln \bar{L}' = \gamma_{l0} + \gamma_{l1} \ln \bar{L} + \gamma_{l2} \ln \bar{N} + \gamma_{l3} \ln p$$

$$\ln \bar{N}' = \gamma_{N0} + \gamma_{N1} \ln \bar{L} + \gamma_{N2} \ln \bar{N} + \gamma_{N3} \ln p$$

$$\ln \theta' = \gamma_{\theta 0} + \gamma_{\theta 1} \ln \bar{L}' + \gamma_{\theta 2} \ln \bar{N}' + \gamma_{\theta 3} \ln p'$$

Again, the forecast equation for θ is used by the firm to form expectations of hiring costs today and in the future period. The task is to solve for the coefficients $\{\gamma_L, \gamma_N, \gamma_\theta\}$.

Implementing this procedure is computationally burdensome as it requires an additional four state variables for the firm's problem: $p, \bar{N}, \bar{L}, \theta$. It is important to discuss why θ must be a state variable for the firm. In principle, firms know the aggregate state of the economy and can therefore predict θ from $\bar{N}, \bar{L}, p$. However, forecast errors can lead to a situation in which the true market clearing level of θ is different from the forecasted level. Therefore, I forecast θ from the equation above but I solve the value function on a grid including 75% and 125% of that forecasted $\theta(\bar{N}, \bar{L})$. I use a coarse grid of 5 points in both $\bar{N}$ and $\bar{L}$ and three points for θ.

While the forecast equations ultimately are very accurate, it is not enough to use the forecasted aggregate variables $\bar{N}, \bar{L}, \theta$ as the equilibrium aggregate state at each stage of the simulation. Instead, in each period of the simulation, I iterate on $\bar{N}, \bar{L}, \theta$, using the firm's optimal policy for each guess of the aggregate state, until the micro behavior is consistent with the aggregate state.

In summary, the algorithm proceeds as follows:

1. Guess $\Pi^0(n, \ell, x, p, \{\bar{N}, \bar{L}, \theta\}; \gamma^{\mathbf{j}})$ and $\gamma^{\mathbf{j}}$

2. Solve for the value function, Π^j, and associated policy function, Φ^j

3. Simulate the model for 2000 periods and 10,000 agents per period starting each firm at the steady state level of the idiosyncratic states. I discard the first 200 periods.

4. In each period, t, of the simulation solve for the market clearing aggregate state. I start with last period's aggregate state as a guess. I iterate on $\{\bar{N}, \bar{L}, \theta\}$ until the aggregate micro behavior is consistent with the guessed state.

5. Run OLS regressions to obtain simulated $\gamma_{\mathbf{OLS}}$ coefficients. If the difference between the $\gamma^{\mathbf{j}}$ and $\gamma_{\mathbf{OLS}}$ is smaller than a pre-specified tolerance, stop.

6. Otherwise, set the conjecture for $\gamma^{\mathbf{j+1}} = \lambda\gamma^{\mathbf{j}} + (1-\lambda)\gamma_{\mathbf{OLS}}$, $\lambda \in (0,1)$ and start at 1.

For the calibrated parameters, the equilibrium forecast equations are as follows:

$$\ln \bar{L}' = .0062 + .9724 \ln \bar{L} + .0167 \ln \bar{N} - .0823 \ln p,\ R^2 = .997$$

$$\ln \bar{N}' = -.0315 + .0118 \ln \bar{L} + .8692 \ln \bar{N} + .1303 \ln p,\ R^2 = .971$$

$$\ln \theta' = 3.2596 + .6804 \ln \bar{L}' + 15.4623 \ln \bar{N}' + 8.6422 \ln p',\ R^2 = .988$$

The R^2 for this solution are in the same ballpark as those in Bils et al. (2011). It is worth mentioning that since I use a simple stochastic simulation with only 10,000 agents and 2,000 periods, the R^2 are low due to simulation error. Increasing the size of the panel and the length of the panel would increase the R^2 but with the lost of a large increase in computational time. I simulate aggregate data and impulse responses using the optimal decision policy of the firm as solved above.

B Firm's Problem with Recall

In this section, I generalize the model to allow firms to rehire some of its laid off workers. I assume that laid off workers are recalled without the flow cost c. To maintain hiring from both the general pool of unemployed and the temporarily laid off, I assume that if a firm wanted to hire h workers, it may hire up to the proportion p^T from its stock of lay offs. I assume for simplicity that firms still post "vacancies" for each recall and meets those vacancies with rate q. Of those hired from outside its layoff pool, the firm posts a vacancy, v_r at a flow cost c. This allows me define the finding and queueing rates in the same manner as above.

The equations of motion and costs of hiring will depend on the size of the stock of layoffs relative to the desired level of hiring. I now describe these in more detail. Suppose that the firm considers hiring Δn^+ workers. If the fraction it will recall from ℓ is less than its stock available for recall, i.e. $p_T \Delta n^+ < \ell_{-1}(1-\delta)$, then

$$(1-p^T)\Delta n^+ = qv_r \rightarrow v_r = (1-p^T)\frac{\Delta n^+}{q}.$$

On the other hand, suppose that it wants to hire so many workers such that it depletes its stock of layoffs. Then, $p_T \Delta n^+ \geq \ell_{-1}(1-\delta)$ and

$$\Delta n^+ = \ell_{-1}(1-\delta) + qv_r \rightarrow v_r = \frac{\Delta n^+ - \ell_{-1}(1-\delta)}{q}.$$

Notice that if $p_T = 0$, the first condition–$p_T \Delta n^+ \leq \ell_{-1}(1-\delta)$–always holds and $v = \frac{\Delta n^+}{q}$, as in the standard model. We can now state the general equations of motion for the stock of layoffs for a firm

$$\ell = (1-\delta)\ell_{-1} - \underbrace{\Delta n^-}_{\text{layoffs}} - \underbrace{\min\{\Delta n^+ p_T, (1-\delta)\ell_{-1}\}}_{\text{recalls}}, \quad \ell \geq 0.$$

Note that total vacancies are v_r plus the amount of recalls because of my assumption that each hire must be associated with a vacancy.

$$v = v_r + p^T \Delta n^+.$$

The addition of recalls reduces the cost of laying off a worker since you can rehire that worker without cost in the future. Consider the case where $p^T = 1$. In this case, firms can costlessly rehire from its stock of layoffs up to the point that it depletes its entire stock. Assuming a large enough stock, this reduces the firm's problem to the frictionless one. To see this, the equation of motion for ℓ becomes

$$\ell = (1-\delta)\ell_{-1} - \Delta n^- - \Delta n^+ \rightarrow \ell = (1-\delta)\ell_{-1} - \Delta n.$$

In this case, there is no kink in the adjustment cost. At the point at which the firm recalls all of its workers, the marginal hire will cost c per vacancy and thus the firm behaves as in the standard linear hiring cost model. For $p^T < 1$, there remains a linear layoff cost, but its magnitude falls with p^T. The band of inaction shown in the policy functions in Figure 4 will correspondingly shrink with p^T.

I take the calibrated model of Section 6 and allow the firm to rehire up to 10% of its hires from its layoffs.[43] The steady state effects are as expected: the fraction of firms at both the low and high tax rates are higher. At the low tax rate, the mass increases from 17.43% to 18.27% and the low tax rate the perfect of firms changes from 6.76% to 7.75%. This is because firms are more likely to

[43] p^T is an unobservable parameter from standard sources of data on the labor market. Data from the CPS suggest that 17% is an upper bound on the fraction of hires that are from temporarily laid off workers. This fraction assumes that *all* temporarily laid off workers who are hired are hired by the firm that laid them off. Therefore, 10% is in the range of plausible values for p^T.

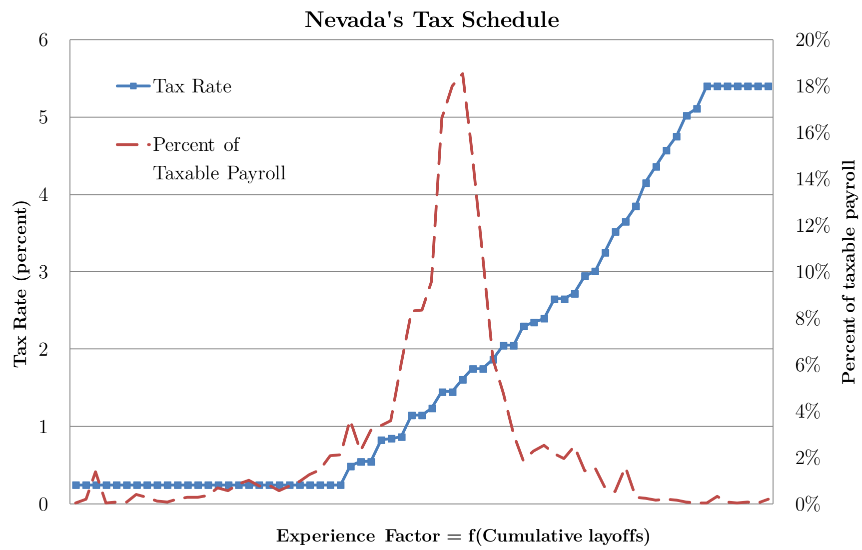
hold higher layoff stocks as the cost of that stock is lower due to the recall possibility. In addition, firms recall more of their layoffs and so more firms are at the low tax rate.

C Data Analysis with Missing States

Table A1 denotes states that I was restricted from accessing due to legal restrictions between the state and the BLS. The BLS provided a dataset of job flow statistics calculated at the establishment level for all states at the 2-digit NAICS level. With these data, I provide an additional robustness check to ensure that the missing states do not materially affect the econometric results.

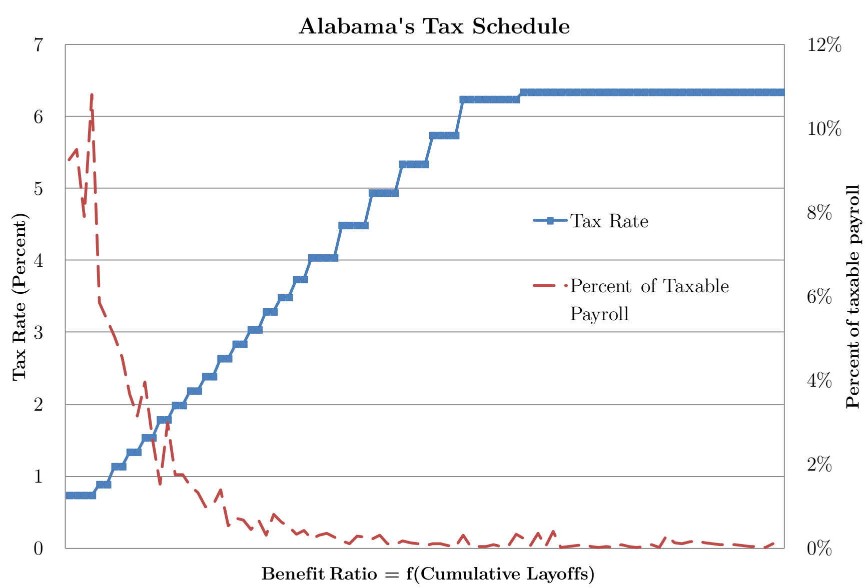
The main difference between these data and the firm-level data is that job flows are calculated at the establishment level. In addition, they include opening and closing establishments in the job creation and job destruction measures. Nonetheless, the regressions in Table 6 provide a useful check on the empirical results. Table 6 shows that including the additional states does not change the main results that higher experience rating reduces both job destruction and job creation rates. With these data, I find that increasing the marginal tax cost to 100% would reduce job destruction by 12.7% and job creation by 13.3% (Table 6).

Figure 1: Typical Tax Schedule, Reserve Ratio



Source: Department of Labor.

Figure 2: Typical Tax Schedule, Benefit Ratio



Source: Department of Labor.

Figure 3: Parameterized Tax Schedule

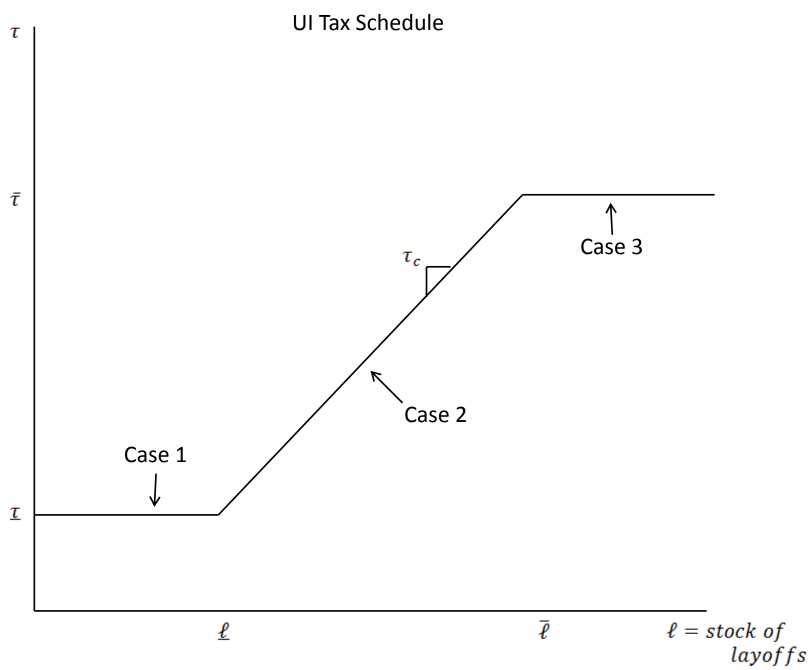


Figure 4a: Policy Function, Case 1

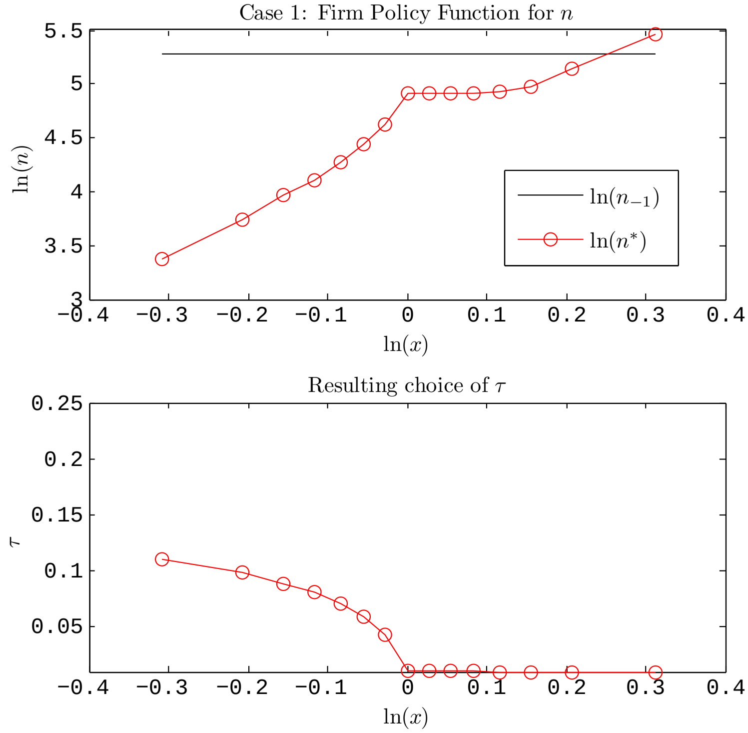


Figure 4b: Policy Function, Case 2

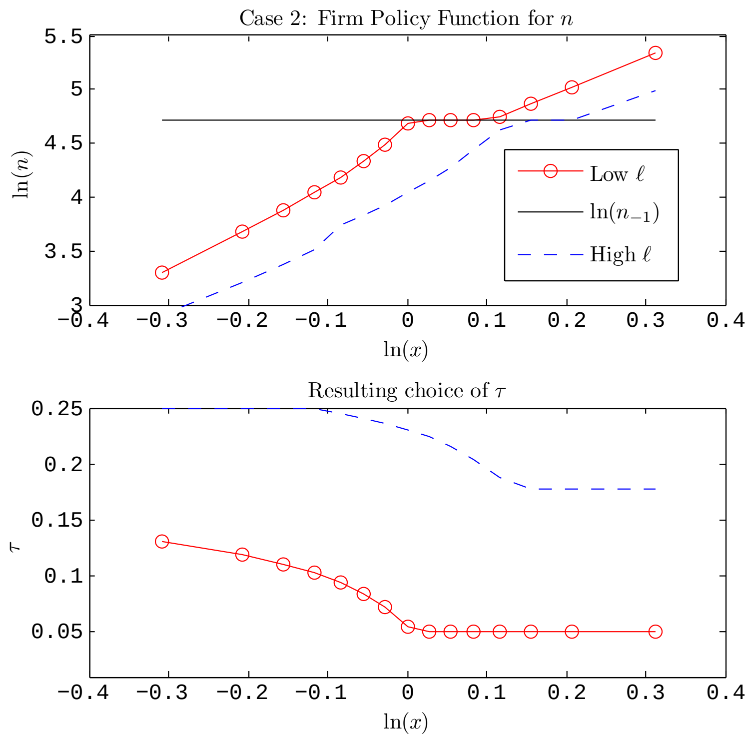


Figure 5: Experience Rating and Job Flows

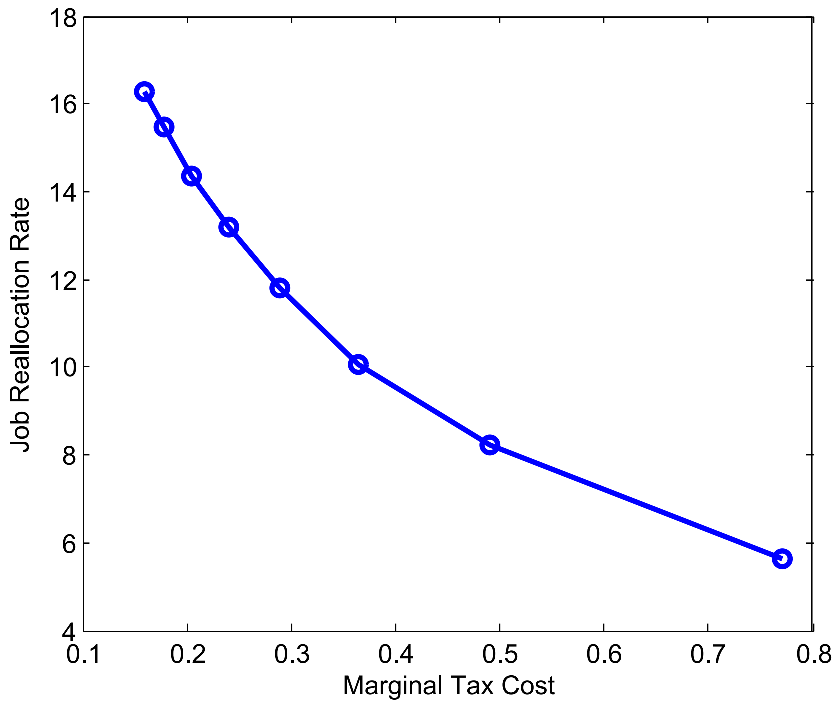


Figure 6: Distribution of Marginal Tax Costs

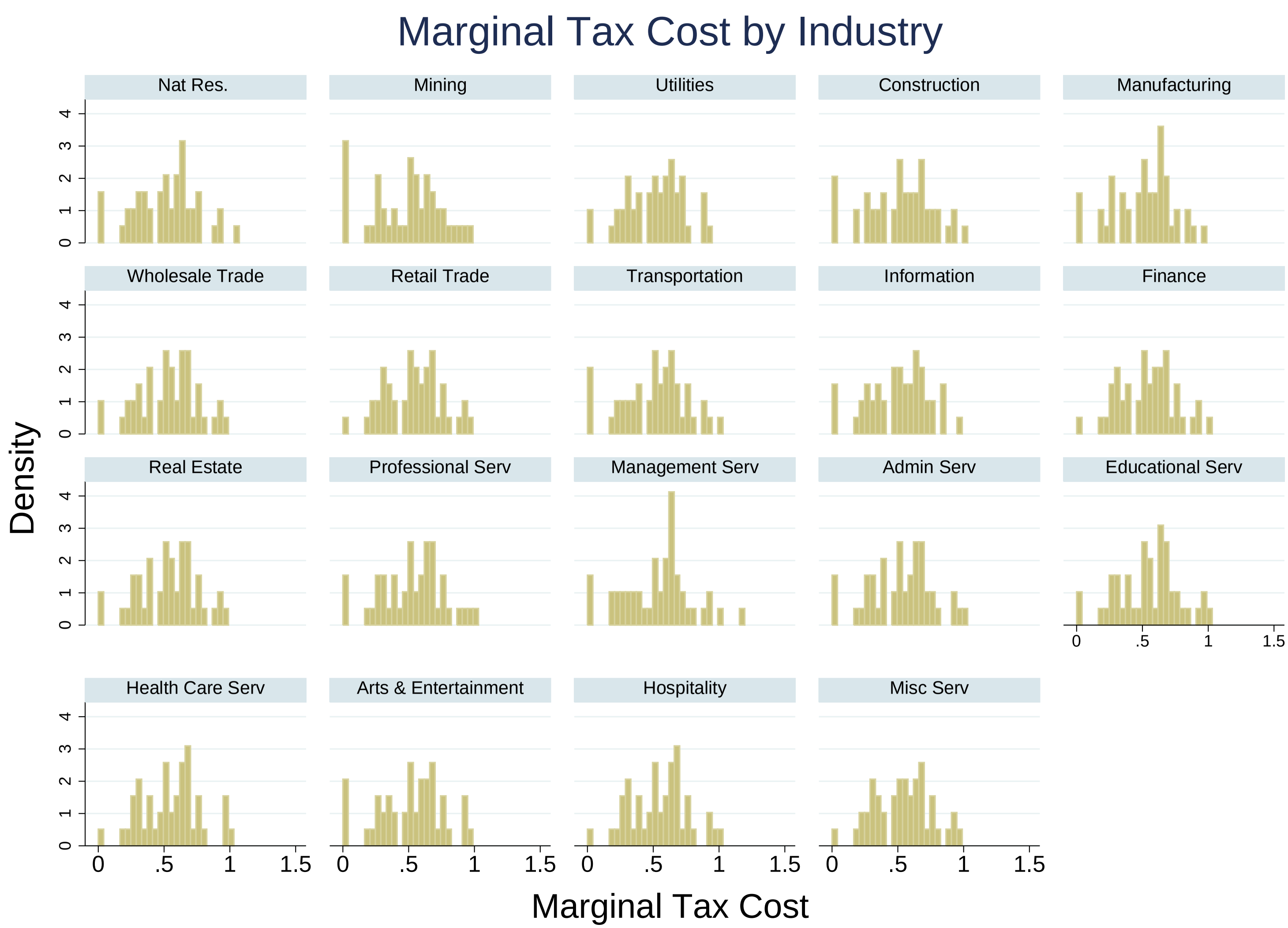


Figure 7: Distribution of Taxes in Model

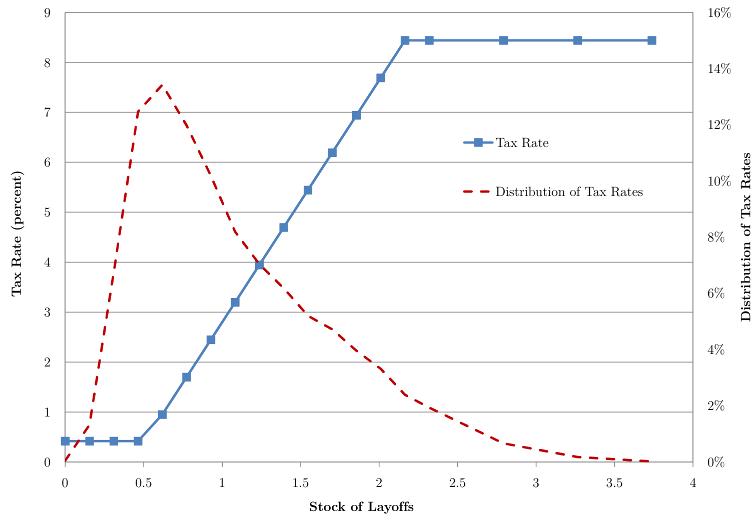


Figure 8: Types of Tax Changes

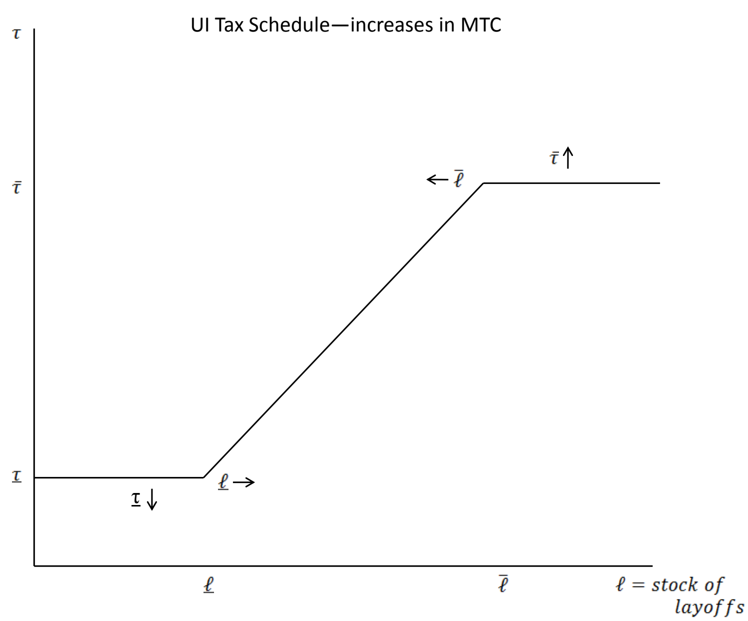


Figure 9: Impulse Response to Negative 1% Aggregate Shock

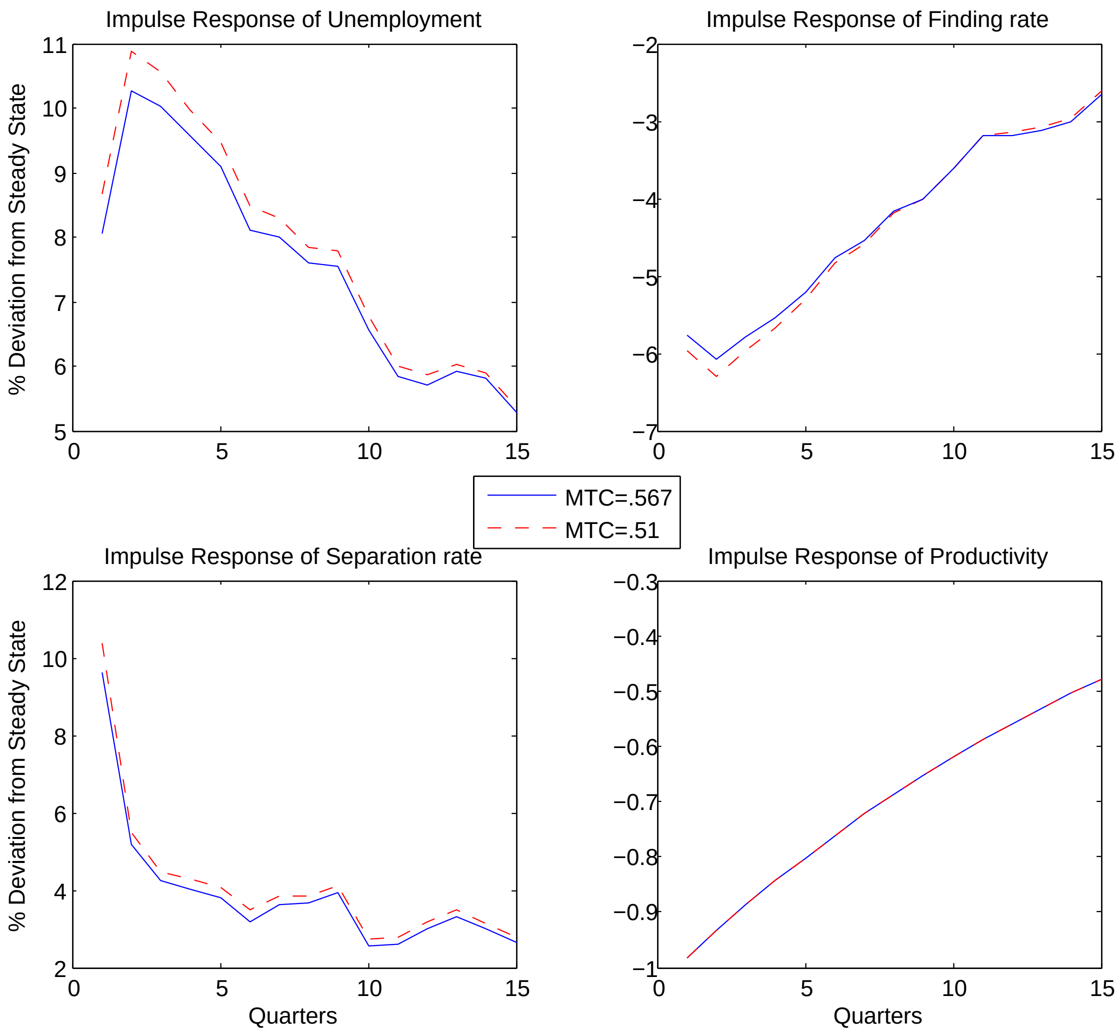


Figure 10: Impulse Response to 1% and 2% Shock

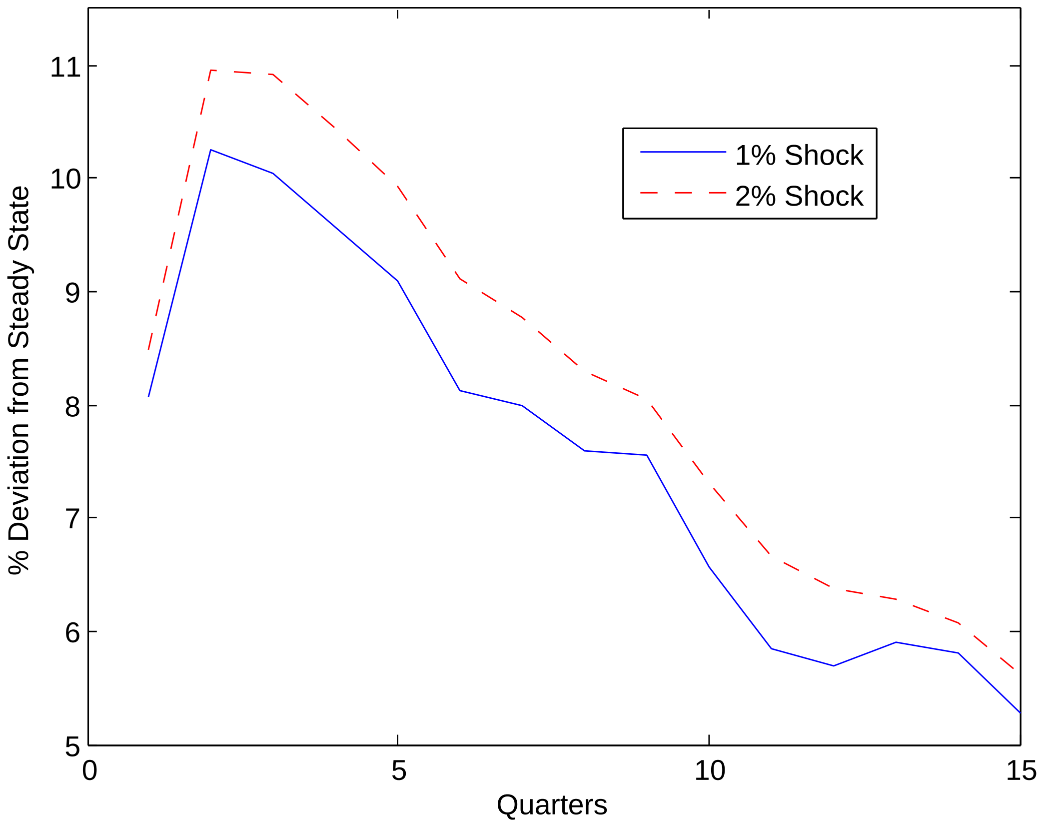


Figure 11: Impulse Response to Positive 1% Aggregate Shock

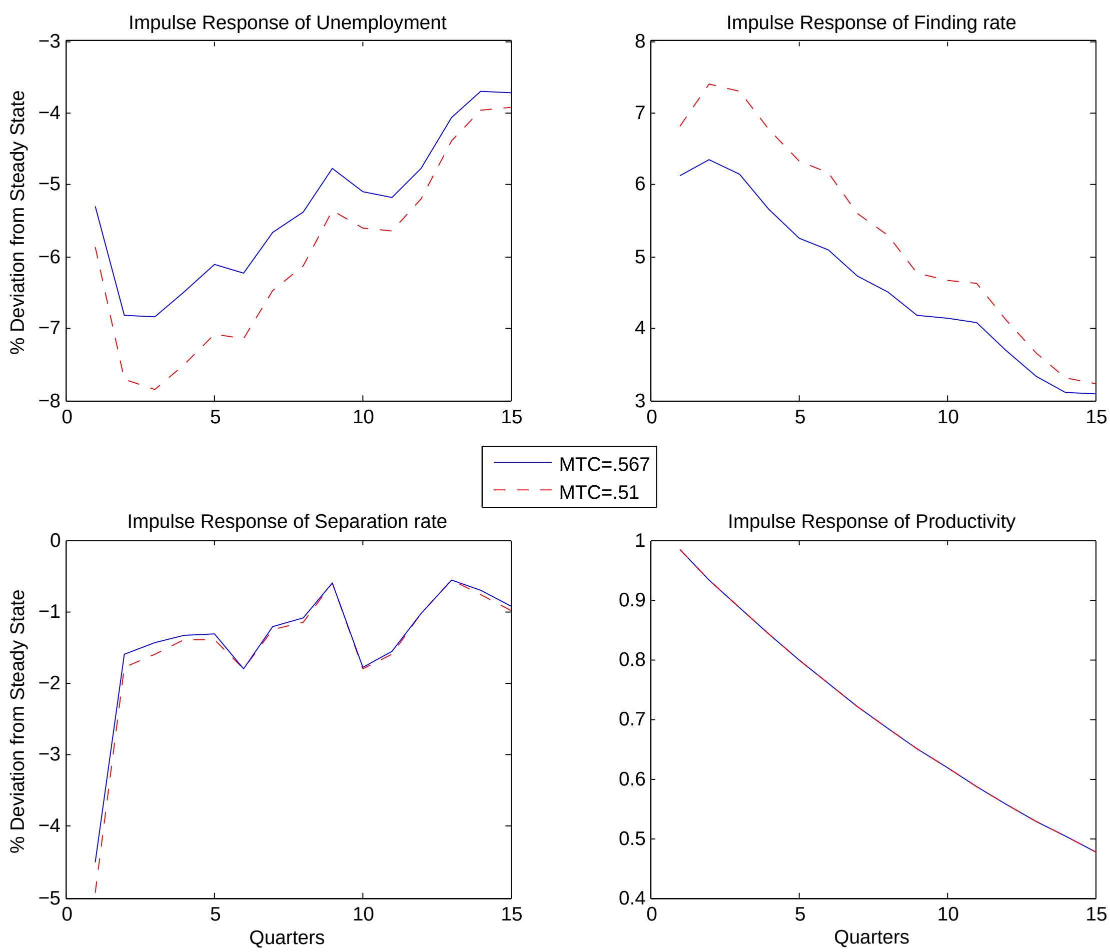


Table 1: Summary Statistics

	Mean	Std. Dev	Min	Max
Averaged MTC, i=.1, All Years	0.54	0.21	0.00	2.17
Average MTC, i=estimated, 2001-2010	0.61	0.22	0.00	2.20
Average MTC, i=.1, All Years. g_n=0	0.63	0.24	0.00	1.16
Average MTC, i=.1. All Years. Topel	0.62	0.23	0.00	1.09
Job Destruction	6.48	7.40	0.02	185.71
Job Creation	6.23	7.61	0.02	191.11
Net Creation Rate	-0.25	8.73	-176.71	175.85
Job Reallocation	12.49	9.92	0.17	182.27
Total Employment	21599	51694	1	1039293
Total Firms	1145	4785	1	274690
Number of 3-digit industry X state cells			3,377	
Number of 3-digit industry X state cells, 2001-2010			123,086	
Number of 3-digit industry X state cells, All Years			264,932	

Source: Author's analysis of QCEW data.

Table 2: Regression Analysis. Marginal Tax Cost and Job Flows

	Regressor: Averaged MTC. i=.10 All Years			Regressor: Averaged MTC. i=.10 2001-2010		
Dependent Variable	Coefficient	Mean LHS	Change from average MTC to 1	Coefficient	Mean LHS	Change from average MTC to 1
JD Rate	-2.4**	6.48	-17.0%	-3.05***	6.16	-22.7%
	(0.98)			(1.01)		
JC Rate	-1.86**	6.23	-13.7%	-1.73**	5.87	-15.6%
	(0.87)			(0.86)		
JR Rate	-2.69**	12.5	-10.0%	-3.27**	11.58	-13.0%
	(1.29)			(1.32)		
Net Creation Rate	.81**	-0.25		1.53***	-0.29	
	(0.25)			(0.34)		
N	264,932			101,301		

Author's analysis of QCEW data. Covariates: State, 3-digit NAICS, year, quarter fixed effects, total employment and total number of firms. Standard errors are clustered at the 3-digit industry X state cell. (*p<.10, **p<.05,***p<.01)

Table 3: Regression Analysis. Marginal Tax Cost and Job Flows. Alternate Marginal Tax Costs.

	Regressor: Averaged MTC. No g_n			Regressor: Averaged Topel MTC. i=.1		
	All Years			All Years		
Dependent Variable	Coefficient	Mean LHS	Change from average MTC to 1	Coefficient	Mean LHS	Change from average MTC to 1
JD Rate	-2.76***	6.48	-15.8%	-2.29***	6.48	-13.4%
	(1.04)			(0.79)		
JC Rate	-2.59***	6.23	-15.4%	-2.71***	6.23	-16.5%
	(0.98)			(0.87)		
JR Rate	-3.36**	12.5	-9.9%	-3.94***	12.5	-11.9%
	(1.37)			(1.29)		
Net Creation Rate	.41	-0.25		-.44***	-0.25	
	(0.28)			(0.25)		
N	264,932			264,932		

Author's analysis of QCEW data. Covariates: State, 3-digit NAICS, year, quarter fixed effects, total employment and total number of firms. Standard errors are clustered at the 3-digit industry X state cell. (*p<.10, **p<.05,***p<.01)

Table 4: Regression Analysis. Marginal Tax Cost and Job Flows. Alternative Marginal Tax Costs II

	Regressor: Averaged MTC. i=.05			Regressor: Averaged MTC. i=.15			Regressor: Averaged MTC. i=estimated		
	All Years			All Years			2001-2010		
Dependent Variable	Coefficient	Mean LHS	Change from average MTC to 1	Coefficient	Mean LHS	Change from average MTC to 1	Coefficient	Mean LHS	Change from average MTC to 1
JD Rate	-2.19**	6.48	-12.2%	-2.65***	6.48	-21.7%	-4.5***	6.16	-28.5%
	(0.84)			(1.12)			0.84		
JC Rate	-1.79**	6.23	-10.3%	-1.93**	6.23	-16.4%	-3.4***	5.87	-22.6%
	(0.75)			(0.98)			0.78		
JR Rate	-3.36**	12.5	-9.7%	-2.85*	12.5	-12.1%	-6.1***	11.58	-20.50%
	(1.37)			(1.47)			(0.29)		
Net Creation Rate	.62***	-0.25		.965***	-0.25		1.18*	-0.29	
	(0.20)			(0.29)			(1.19)		
N	264,932			264,932			123,898		

Author's analysis of QCEW data. Covariates: State, 3-digit NAICS, year, quarter fixed effects, total employment and total number of firms. Standard errors are clustered at the 3-digit industry X state cell. (*p<.10, **p<.05,***p<.01)

Table 5: Regression Analysis. Marginal Tax Cost and Job Flows. Additional covariates

Dependent Variable: JD Rate			Dependent Variable: JC Rate		
	(1)	(2)		(1)	(2)
Averaged MTC i=.1	1.34	-3.31***	Averaged MTC i=.1	2.82***	-1.23***
	(1.07)	(0.33)		(0.99)	(0.29)
Proportion on slope	1.94**	0.67	Proportion on slope	3.4***	1.01***
	(0.78)	(0.26)		(0.76)	(0.25)
Prop Slope*MTC	**-3.31****		Prop Slope*MTC	**-5.1*****	
	(1.39)			(1.30)	
% Benefits Charged		-0.36	% Benefits Charged		-0.63
		(0.50)			(0.47)
Minimum Rate		0.12	Minimum Rate		0.04
		(0.09)			(0.09)
Maximum Rate		.05*	Maximum Rate		0.04
		(0.03)			(0.03)
Years	2001-2010	2001-2010	Years	2001-2010	2001-2010
N	103,306	101,011	N	103,244	100,955

Author's analysis of QCEW data. Covariates: State, 3-digit NAICS, year, quarter fixed effects, total employment and total number of firms. Standard errors are clustered at the 3-digit industry X state cell (*p<.10, **p<.05,***p<.01)

Table 6: Regression Analysis. Marginal Tax Cost and Job Flows. Two Digit Data with Excluded States

	Regressor: Averaged MTC. i=.10 1992 Q2-2010 Q1		
Dependent Variable	Coefficient	Mean LHS	Change from average MTC to 1
JD Rate	-2.12**	7.95	-12.7%
	(0.85)		
JC Rate	-2.27***	8.13	-13.3%
	(0.86)		
JR Rate	-4.39***	16	-13.0%
	(1.68)		
Net Creation Rate	-.15	0.18	
	(0.27)		
Clusters	891		
N	98,010		

Author's analysis of QCEW data. Covariates: State, 2-digit NAICS, year, quarter fixed effects, total employment and total number of firms. Standard errors are clustered at the 2-digit industry X state cell. (*p<.10, **p<.05,***p<.01)

Table 7: Calibrated Parameters

	Parameter	Meaning	Value	Reason
Fixed	β	Discount factor	.996	Annual interest rate of 5%
	α	Scale parameter	.59	Labor's share $\approx .72$
	η	Bargaining power	.4	
	ϕ	Matching elasticity	.6	Petrongolo & Pissarides (2001)
	p	Steady state productivity	1	Normalization
	ρ_p	Persistence of p	.983	Persistence of ALP .95 quarterly
	σ^p	Std. dev. of ϵ^p	.005	$\sigma(APL) = .02$
	$\underline{\tau}$	Minimum tax rate	.417%	Average minimum tax rate in data
	$\bar{\tau}$	Maximum tax rate	8.44%	Average maximum tax rate in data
Calibrated "internally"	b	Leisure value	.7934	$s = 3.1\%$
	c	Flow cost vacancy	.2828	$\frac{c}{q} = 14\%$ quarterly wage
	ρ_x	Persistence of x	.9504	$P(\|\%\Delta n\| < .05) = 54.5\%$
	σ^x	Std. dev. of ϵ^x	.1721	$JR = 12.5\%$
	$\mathbb{L}$	Labor force	.8553	$\theta_{ss} = .72$
	μ	Matching efficiency	.5132	$f_{ss} = 45\%$
	δ	Depreciation of layoffs	.026	$P(\tau = \underline{\tau}) = .177, P(\tau = \bar{\tau}) = .066$
	$\underline{\ell}$	Lower tax threshold	.5085	$MTC = 54\%$
	$\bar{\ell}$	Upper tax threshold	2.16	

Table 8: Calibrated Targets and Moments

Moment	Symbol	Target	Value
Separation Rate (b)	s	3.1%	3.53%
Hiring Cost (c)	$\frac{c/q}{w_q}$	14%	14.74%
Non-adjustment Prob. (ρ_x)	$P(\|\%\Delta n\| < .05)$	54.5%	45%
Job reallocation (σ^x)	JR	12.5%	7.05%
Tightness ($\mathbb{L}$)	θ_{ss}	.72	.72
Finding Rate (μ)	f_{ss}	45%	45%
Minimum Rate ($\underline{\ell}$)	$P(\tau = \underline{\tau})$	17.7%	17.43%
Maximum Rate ($\bar{\ell}$)	$P(\tau = \bar{\tau})$	6.6%	6.76%
Marginal Tax Cost (δ)	MTC	54%	53.7%

Table 9: Steady State Tax Experiments. Percentage changes unless noted

Change in:	Param	MTC	JC,JD	Revenue	Π	u % pts.	$\%\Delta u$
$\rightarrow \underline{\ell}$	15.5%	5%	-1.1%	-8.6%	.06%	-.31	-4.3%
$\leftarrow \bar{\ell}$	-3.6%	5%	-1.1%	2.3%	-.38%	-.13	-1.8%
$\downarrow \underline{\tau}$	-.2% pts	5%	-1.9%	-8.6%	.07%	-.33	-4.5%
$\uparrow \bar{\tau}$	.4% pts	5%	-1.5%	2.3%	-.26%	-.18	-2.5%
Steady State		54%	7.05%	.022	76.65	7.27%	

Table 10: Revenue Neutral Experiment. Percentage changes unless noted

Change in:	Param	MTC	JC,JD	Revenue	Π	u % pts.	$\%\Delta u$
$\uparrow \bar{\tau}, \downarrow \underline{\tau}$	+.4%,-.04% pts	5.5%	-1.6%	0%	-.2%	-.21	-2.9%
Steady State		54%	7.05%	.022	76.65	7.27%	

Table A1: List of States

State	States Excluded from QCEW. Included in Table 6	State	States Excluded from QCEW. Included in Table 6
Reserve Ratio		Benefit Ratio	
Arkansas		Alabama	
Arizona		Connecticut	
California		Florida	**X**
Colorado		Iowa	
DC		Illinois	**X**
Georgia		Maryland	
Hawaii		Minnesota	
Idaho		Mississippi	**X**
Indiana		Oregon	**X**
Kansas		Texas	
Kentucky		Utah	
Louisiana		Virginia	
Massachusetts	**X**	Vermont	
Maine		Washington	
Missouri		Wyoming	**X**
Montana			
North Carolina			
North Dakota			
Nebraska			
New Hampshire	**X**		
New Jersey			
New Mexico			
Nevada			
New York	**X**		
Ohio			
Puerto Rico			
Rhode Island			
South Carolina			
South Dakota			
Tennessee			
Wisconsin	**X**		
West Virginia			
Number of Reserve Ratio States: 32		Number of Benefit Ratio States: 15	

Note: Author's analysis of DOL and QCEW data. States with an "X" were excluded in Tables 1-5 due to restrictions in QCEW data. Table 6 includes these states using analysis of 2-digit aggregated data of the QCEW provided by the BLS.