The effects of firm specific taxes and government mandates with an application to the U.S. unemployment insurance program

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Abstract

We examine the common, but unexamined, case of a tax or government mandate whose cost differs across firms within the same labor market. Our theoretical model shows that this variation can lead to employment reallocation across firms and dead-weight losses, even if there is no aggregate employment effect. Using firm level unemployment insurance tax data, we find that while the market level tax is mostly born by the worker, individual firms can only pass on a small share of the within market differences. Thus, in some cases differences in taxes across firms can lead to large dead-weight losses.

Keywords: Tax incidence; Mandated benefits; Dead-weight loss

JEL classification: H22; J65

1. Introduction

The usual textbook example of the incidence of a payroll tax assumes that a uniform tax rate is paid by all firms in a given labor market. The same assumption is often made for the similar case of a mandated benefit, where the benefit cost is assumed to be the same for all firms. In fact, employer mandates such as the
Worker Adjustment and Retraining Notification Act (WARN), the Family Leave Act, and the Americans with Disabilities Act (ADA) only apply to large firms (over 100 employees for the WARN, over 14 for the ADA). Often, programs that use payroll taxes to finance benefits, such as Workers’ Compensation (WC) and Unemployment Insurance (UI), are experience rated, leading to variation across firms in payroll tax rates. In this paper we extend the theory of payroll tax incidence to the case of a tax which varies both within and across labor markets. We then implement this theory empirically using panel data from state UI systems. Since this large variation in UI tax rates is due to experience rating and since the tax finances a benefit, our theoretical model also allows for these features.

Analyzing the incidence of the UI payroll tax is useful not only for answering the broader question of the effects of payroll taxes and mandated benefits on wages and employment, but is also important in its own right for several reasons. First, to assess the policy effects of a UI program, we need to know whether workers or firms ultimately pay for its costs. Second, an important branch of the UI literature focuses on the incentives created by UI tax systems. In particular, the role of imperfect experience rating in encouraging layoffs has been emphasized. An underlying assumption of this work, however, is that the employer bears at least some of the UI payroll tax burden, since experience rating induced increases in tax rates will not provide an incentive to reduce layoffs if such increases can be shifted on to workers in the form of lower wages. Finally, this work may also shed light on predictions in the industrial organization literature that increases in a firm’s rivals’ costs should result in an increase in the firm’s output.

While there appears to be no past empirical work on the incidence of the UI payroll tax, there is related work on the effects of payroll taxes and benefits (mandated or not) on wages and employment. Previous studies of the incidence of payroll taxes have tended to use aggregate data, though, and often do not estimate a market equilibrium, focusing instead on one side of the market only. This literature is summarized in Hamermesh (1993) who concludes that “...it is impossible to draw any firm conclusions about the incidence of the payroll tax from these studies...” because of methodological problems and a wide range of estimates.

Past work on the effects of fringe benefits and working conditions on wages has found mixed evidence, except that in most cases a compensating differential for the risk of injury and death is found. One of the key problems discussed in this literature is that of unmeasured worker characteristics and the difficulty of

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1See Brechling (1977a), (1977b), (1981); Topel (1983), (1990); Card and Levine (1994) and Anderson and Meyer (1994), for example.

2Work following this survey which addresses some of these problems includes Gruber (1995).

measuring worker productivity. These studies also emphasize the importance of unmeasured firm characteristics that may be correlated with wages, fringe benefits and working conditions. The differences in wages across workers due to these omitted individual or firm factors will severely bias the estimation of compensating differentials.\textsuperscript{4} In this paper, we are able to address these problems by using our panel data to examine the effects of tax changes on firm average earnings. This procedure differences out firm characteristics and the characteristics of workers at these firms.

Overall, though, our approach most closely resembles that of a third literature which examines the effects of benefit mandates on worker earnings and employment. Several recent studies have examined the effects of mandated workers' compensation and health benefits and found that most of the costs of these mandates are passed on to workers through lower wages.\textsuperscript{5} These studies, however, are not able to differentiate between firm-level variation in tax rates or costs and market-level variation, as we are able to do. Thus, this paper represents a substantial step forward in our understanding of the impact of such mandates.

While this firm variation in tax rates has not been addressed in the empirical literature, its importance is emphasized in Lester's (1962) discussion of the incidence of the experience-rated UI payroll tax. He concludes that most of the incidence of the UI tax will fall on firms, based on the assumption that most firms operate in competitive input and output markets. Lester also rests his argument on evidence from the 1950's that there are firms at both the state minimum and maximum rates in most industries (generally defined at the 2-digit SIC level), and that most of the minimum rates are very low. Hamermesh (1977) also addresses the theoretical incidence of the UI tax and concludes that in the long run it will fall about half on workers and half on consumers. He argues that workers cannot avoid the federal tax by changing jobs. Furthermore, the low level of excess profits in our economy prevents the UI tax from falling heavily on profits. Thus, the state part of the tax will likely result in long run increases in prices, though it may fall on firms in the short run.

To this point, then, empirical work on tax incidence has used only cross-market variation, while the work on within-market variation has remained theoretical. Additionally, this empirical work has tended to suffer from omitted variable bias due to unmeasured firm characteristics, or has been carried out at a very high level of aggregation. This paper overcomes many of these drawbacks by using a firm panel based on administrative data from eight states to directly examine the relationship between a firm's UI tax rate and the wages paid to its employees. In

\textsuperscript{4}For statements of these problems see Brown (1980); Leibowitz (1983); Smith and Ehrenberg (1983) and Montgomery et al. (1992).

\textsuperscript{5}See Gruber and Krueger (1991) and Gruber (1994). Gruber (1995) uses Chilean firm data and a firm average tax rate, but does not include a market-level tax rate.
the next section, we present a theoretical model of the incidence of a firm-varying payroll tax, while Section 3 discusses the empirical implementation of the model. Section 4 then presents the empirical results, while Section 5 concludes.

2. The theoretical effects of the UI payroll tax on wages and employment

In the textbook example of the effects of a payroll tax, the demand curve shifts downward and to the left, reducing the equilibrium wage and employment. The magnitude of the effect on the wage and employment thus depends on the labor demand and supply elasticities. This textbook version can easily be modified to allow the tax to finance a new benefit which the worker values. Because the worker values the new benefit, there will be a downward and rightward shift of the supply curve that will exaggerate the wage effect, but which may counteract and possibly even reverse the adverse employment effects of the tax. For experience-rated systems such as UI, though, it may be the case that the demand curve does not shift fully to reflect the tax. With experience rating, a current change in taxes paid tends to generate subsequent countervailing changes which dampen the present value of the change in taxes paid. Taking these modifications into account then, we can write the demand for labor as a function of the cost of labor:

\[
D = f_m^d(W_m + \beta \tau_m),
\]

where \(W_m\) is the market wage, \(\tau_m\) is the market tax, and \(\beta\) is the true firm cost of the tax as a fraction of the tax. Similarly, we can write the supply of labor as a function of the return to labor:

\[
S = f_m(\alpha W_m + \alpha \tau_m),
\]

where \(W_m\) and \(\tau_m\) are as above and \(\alpha\) is the workers' valuation of the benefit provided as a fraction of the tax. Then, total differentiation of the equilibrium condition \(D = S\) gives the change in the wage rate in response to the tax,

\[
\frac{dW_m}{d\tau_m} = -\frac{\alpha \eta_m^s - \beta \eta_m^d}{\eta_m^s - \eta_m^d},
\]

where \(\eta_m^s\) and \(\eta_m^d\) are the market elasticity of labor supply and demand, respectively. Note that the usual case assumes \(\beta = 1\) and \(\alpha = 0\).

The change in employment in response to the tax is then given by

\[\text{See Burkhauser and Turner (1985); Summers (1989); Gruber and Krueger (1991) and Aaron and Bosworth (1994), for example.}\]

\[\text{We are grateful to Roger Gordon for this point.}\]
\[
\frac{dE_m}{d\tau_m} = \frac{(\beta - \alpha)\eta^d_m \eta^s_m}{\eta^s_m - \eta^d_m} \frac{E_m}{W_m},
\]

where \( E_m \) is market employment. This equation is the usual one for the employment response to a tax except that it has been modified by the factor \((\beta - \alpha)\). Thus, as \( \alpha \) and \( \beta \) move toward each other, from 0 and 1 respectively, the employment effect goes from the standard case to that of no response to the tax. Note that this zero employment effect can occur with less than complete shifting of the wage, and that if \( \alpha > \beta \), the employment effect will actually be positive.

In the above equations all firms pay the same payroll tax rate. In order to analyze the effect of a tax with different rates for different firms, we note that the assumption that labor markets are competitive implies that the wage plus the worker valuation of fringe benefits will be set by the market and thus must be equal across firms,

\[
W_m + \alpha \tau_m = W_f + \alpha \tau_f,
\]

where the \( f \) subscript stands for firm.\(^8\) The assumption of competitive labor markets is standard in this literature and it seems a reasonable description of most U.S. labor markets given the scarcity of monopsony and the small union share of private sector employment.\(^9\) This market constraint, combined with the assumption that firm changes are too small to affect the market wage, allows us to obtain the effect of a change in the firm tax, holding the market tax constant,

\[
\frac{\partial W_f}{\partial \tau_f} = -\alpha.
\]

We write the demand function at the firm level as a function of the firm’s cost of labor and of the market’s cost of labor:

\[
D_f = f^d_f(W_f + \beta \tau_f, W_m + \beta \tau_m),
\]

where the second argument allows for general equilibrium shifts in the demand curve. Then, the corresponding employment effect is

\[
\frac{\partial E_f}{\partial \tau_f} = (\beta - \alpha) \frac{E_f}{W_f} \eta^d_j,
\]

where \( \eta^d_j \) is the firm elasticity of labor demand with respect to its \( j_{th} \) argument. Similarly, the effect of a change in the market tax, holding the firm tax constant, is

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\(^8\)It is important to realize that this condition will hold regardless of the structure of the output market in which the firms are operating.

\(^9\)See Ehrenberg and Smith (1994) and Hamermesh and Rees (1993), for example.
In this case the corresponding employment effect is

\[ \frac{\partial W_f}{\partial \tau_m} = \frac{(\beta - \alpha)\eta_m^d}{\eta_m^s - \eta_m^d}. \]  

(5)

Here, the second term of Eq. (6) incorporates the effect on a given firm of other firms' output market decisions. This term will be large and positive if an increase in the market tax holding the firm tax constant gives the firm in question a substantial competitive advantage. In the limiting case of perfect competition, this term would be infinite in the long run and large in the short run.

We should note that the model assumes that wages are free to adjust. To the extent that wages are sticky downward, the effects in (1), (3), (5) and (6) in response to an increase in taxes will likely be muted, while those in (2) and (4) would be exaggerated. In the extreme case of perfectly sticky wages, all but (2) and (4) would be zero, and these two would be expected to be large and negative. Ultimately, the question is an empirical one which will be answered below when we obtain estimates of these 6 derivatives. The workers' valuations of the benefits they receive and the firms' discounting of the tax are also ultimately empirical questions, but we can gain some insight into their likely magnitude by considering their determinants.

The simplest way to express the valuation of UI benefits by the workers is to write the supply of labor as a function of the utility level offered by a job rather than of the wage level. Ignoring subscripts, the supply equation becomes

\[ S = f^S(U(W, R, p)), \]

where \( U(\cdot, \cdot, \cdot) \) is utility as a function of the wage rate \( W \), the UI replacement rate \( R \), and the layoff probability \( p \). Again, totally differentiating the \( S = D \) condition yields the following analog to Eq. (1):

\[ \frac{dW}{d\tau} = \frac{\left( \frac{\partial U}{\partial W} \right)^{-1} \left( \frac{\partial U}{\partial R} \frac{dR}{d\tau} + \frac{\partial U}{\partial p} \frac{dp}{d\tau} \right) \eta^s - \beta \eta^d}{\eta^s - \eta^d}, \]  

(7)

so that the workers' valuation is

\[ \frac{\partial E_f}{\partial \tau_m} = \left[ \frac{(\beta - \alpha)\eta_m^d}{\eta_m^s - \eta_m^d} \right] \frac{E_f}{W_f} \eta_f^d + \left[ \frac{(\beta - \alpha)\eta_m^s}{\eta_m^s - \eta_m^d} \right] \frac{E_f}{W_m} \eta_f^d. \]  

(6)

\[ \frac{\partial E_f}{\partial \tau_m} = \left[ \frac{(\beta - \alpha)\eta_m^d}{\eta_m^s - \eta_m^d} \right] \frac{E_f}{W_f} \eta_f^d + \left[ \frac{(\beta - \alpha)\eta_m^s}{\eta_m^s - \eta_m^d} \right] \frac{E_f}{W_m} \eta_f^d. \]  

As discussed in more detail below, our empirical specification actually implies that for Eqs. (2), (4), (6) we estimate the derivative times \( W/E \).

As a similar change in the supply function to the firm gives analogous versions of Eqs. (7) and (8), leading to the same expression for \( \alpha \). Thus, while this discussion is phrased in terms of the overall market results, it is equally applicable to the firm-level expressions.
This expression indicates that the workers' valuation depends on how utility changes with the replacement rate and the layoff probability, and how the replacement rate and layoff probability change with the tax rate. To evaluate this expression it is useful to write \( U \) as a weighted average of utility when employed and unemployed, i.e.

\[
U(W, R, p) = pu(RW, 1) + (1-p)u(W, 0).
\]

\( u(\cdot, \cdot) \) is a von Neumann–Morgenstern utility index which is a function of income and leisure, with leisure equal to 1 when not working and 0 when working. Then,

\[
\frac{\partial U}{\partial W} = pu_1(RW, 1) + (1-p)u_1(W, 0),
\]

where \( u_1 \) is the derivative of \( u(\cdot, \cdot) \) with respect to its first argument. Similarly,

\[
\frac{\partial U}{\partial R} = Wu_1(RW, 1)
\]

and

\[
\frac{\partial U}{\partial p} = u(RW, 1) - u(W, 0).
\]

Expressions (9) and (10) are clearly positive, while (11), which is the utility of a worker receiving unemployment benefits while not working minus the utility of a worker receiving the wage \( W \) and working, requires more discussion. For many people this expression is likely to be negative, while for others who have generous UI and jobs with regular temporary layoffs it is likely to be close to zero or positive. Evidence for a preference for temporary layoffs with UI benefits comes from some union contracts with inverse seniority layoff rules (Medoff, 1979). One should also remember that a large fraction of UI benefits go to workers on temporary layoff (Katz and Meyer, 1990).

Besides the expressions in Eqs. (9)–(11), \( dR/d\tau \) and \( dp/d\tau \) also determine the sign and magnitude of \( \alpha \). In a cross-section, the tax rate is likely to be highly correlated with the layoff rate due to experience rating, so that \( dp/d\tau \) will be strongly positive. However, when we examine changes in taxes below, most of the variation in taxes has little to do with contemporaneous changes in firm layoffs. Instead, it reflects current changes in state UI tax schedules or changes in layoffs at the firm level a year or more in the past due to the timing of experience rating. Furthermore, as described below, quantitatively the vast majority of the variation in tax changes is due to changes in state tax schedules. Therefore, \( dp/d\tau \) is likely

\[\text{See Besley and Case (1994) for a similar derivation of } \alpha \text{ for workers' compensation.}\]
to be close to zero when the variation in \( \tau \) is the change from one year to the next. For these reasons and because state schedules lead to little variation in firm replacement rates within a state, \( dR/d\tau \) is likely to be of even less importance.

In conclusion, these observations indicate that the worker valuation of differences in tax rates will vary by type of worker and firm and depend on the source of variation in \( \tau \). In a cross-section, \( \alpha \) could even be negative. For the changes in tax rates that we examine and for firms with extensive UI-compensated temporary layoffs it is likely that one or both of \( \partial U/\partial p \) and \( dp/d\tau \) are close to zero, implying that \( \alpha \) is likely to be close to zero.

The perceived cost of a tax to a firm as a fraction of the tax, \( \beta \), is a bit easier to evaluate than \( \alpha \), but there are some subtle issues.\(^{13}\) If a change in the tax is a permanent one because of an increase in benefit levels or layoff practices, we would expect \( \beta \) to be one. However, if the increase is due to a one-time shock to a firm the true cost to the firm in reserve ratio experience rating states is just \( 1 - \epsilon \), where \( \epsilon \) is the marginal tax cost of a layoff. This marginal tax cost is measured as the fraction of a dollar in UI benefits which will be paid back in present value through higher future taxes. The reason that \( \beta \) equals \( 1 - \epsilon \) in this case is that an increase in taxes paid affects the reserve ratio in the same way as a decrease in benefits charged. Thus, while an increase in taxes of a dollar immediately costs the firm one dollar, the firm recoups a fraction of that dollar in present value through lower taxes in the future.

A detailed derivation of \( \epsilon \) can be found in several places, including Anderson and Meyer (1994), but in its simplest form, \( \epsilon \) can be expressed as

\[
\frac{\eta}{i + \eta},
\]

where \( \eta \) is the slope of the tax schedule and \( i \) is the interest rate. Empirically \( \epsilon \) averages about 0.6 in our states, but there is a great deal of variation across states and industries and across firms within a given state and industry (see Anderson and Meyer, 1994 for details). In conclusion, permanent shifts in the level of taxes are likely associated with a \( \beta \) of 1, while transitory firm movements along a schedule are likely associated with a \( \beta \) of \( 1 - \epsilon \).

2.1. Summary

Table 1 provides a summary of the theoretical predictions for the sign and magnitude of the effects of firm- and market-level taxes on wages and employment. The results are given in terms of the implied regression coefficients in wage and employment equations. The top panel, which corresponds to Eqs. (3) through (6), gives predictions for firm-level regressions which include both firm and

\(^{13}\)While this discussion is phrased in terms of the firm, it is also applicable to a market average.
Table 1
Summary of theoretical predictions and implied regression coefficients

<table>
<thead>
<tr>
<th>Firm-level regression</th>
<th>Earnings Equation</th>
<th>Employment Equation</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient on market tax</td>
<td>Coefficient on firm tax</td>
</tr>
<tr>
<td>$\alpha = 0, \beta = 1$</td>
<td>Negative</td>
<td>Zero</td>
</tr>
<tr>
<td>$0 &lt; \alpha &lt; \beta$</td>
<td>Less negative</td>
<td>Becomes negative ($=-\alpha$)</td>
</tr>
<tr>
<td>$\alpha = \beta$</td>
<td>Zero</td>
<td>Negative ($=-\alpha$)</td>
</tr>
<tr>
<td>$\alpha &gt; \beta$</td>
<td>Positive</td>
<td>Negative ($=-\alpha$)</td>
</tr>
</tbody>
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<table>
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<tr>
<th>Market-level regression</th>
<th>Coefficient on market tax</th>
<th>Coefficient on market tax</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha = 0, \beta = 1$</td>
<td>Negative</td>
<td>Negative</td>
</tr>
<tr>
<td>$0 &lt; \alpha &lt; \beta$</td>
<td>More negative</td>
<td>Less negative</td>
</tr>
<tr>
<td>$\alpha = \beta$</td>
<td>Even more negative</td>
<td>Zero</td>
</tr>
<tr>
<td>$\alpha &gt; \beta$</td>
<td>Negative</td>
<td>Positive</td>
</tr>
</tbody>
</table>

An increase in the tax at the market-level causes a competitive firm to face a new, lower wage rate. Holding constant the firm-level tax, then, we expect a negative wage effect and a positive employment effect of an increase in the market-level tax (except in the special case where $\alpha \geq \beta$). Similarly, holding constant the market tax, a wage-taking firm will be unable to lower its wage in response to an increase in its own tax, except to the extent that the implied additional benefits are valued ($\alpha > 0$), and will respond with a reduction in employment unless $\alpha \geq \beta$. The bottom panel, which corresponds to Eqs. (1) and (2), gives market-level regression predictions. At the market level, an increase in the tax always reduces the wage and also reduces employment unless $\alpha \geq \beta$. Our model and discussion also indicates that values of $\alpha$ near zero and $\beta$ between 0.4 and 1.0 are likely. While in the standard case (i.e. $\alpha = 0, \beta = 1$, only a market level tax) the wage equation coefficient would be expected to be in the interval $[-1, 0]$, where $-1$ implies the incidence is fully on the workers and 0 implies the incidence is fully on the firm, this restriction will not necessarily hold in the more general case here. For some values of $\alpha$ and $\beta$, the coefficient may be outside of the unit interval.\(^{14}\)

\(^{14}\)We also note that models of tax effects in oligopolistic output markets (Katz and Rosen, 1985 and Stern, 1987) have noted the possibility of a different type of overshifting of a tax, due to firms increasing their profits by moving toward the collusive output level.
3. Empirical implementation

3.1. Data

Our data are from the UI administrative records of 8 states which participated in the Continuous Wage and Benefit History (CWBH) project. For each of these 8 states, quarterly wage records were collected for a random sample of the state’s covered workers for several years during 1978 to 1984, with the exact sample period and sampling rate differing by state. These individual wage records include the firm’s total quarterly payroll and average monthly employment over the quarter, allowing us to calculate average quarterly earnings at the firm as their ratio. Thus, we are able to create a firm-level data set which includes both employment and earnings from the individual wage records. All earnings measures are indexed to the third quarter of 1978 using state average weekly earnings.

We then calculate the firm’s effective UI tax rate using the firm tax rate reported on each wage record. The firm does not pay this tax rate on the entire payroll, rather there is a tax base which varies across states and over time. In addition, there is a small federal tax of 0.7% on a base of $6000 prior to 1983 and 0.8% on a $7000 base after that. To appropriately account for the tax base being only part of wages, we calculate a firm tax rate using the tax bill as a fraction of actual earnings.

Construction of a similar tax measure for the labor market requires that we make several choices. First, we need to choose a level of industry aggregation to define the labor market. While labor markets are probably best delineated by occupation or skill level, we rely on the correlation between industry and occupation and skill in defining markets. We group similar 3-digit standard industrial classifications (SIC’s) into about 150 different classes and define a market in this way. Second, since we are concerned with labor market effects, we define the market to be local (i.e. state level), rather than national. However, if there are less than 5 firm observations in the local market, all of the observations from that market are dropped. This restriction provides an additional assurance that the markets are competitive as assumed. Third, the relevant market tax is

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15 The eight states, the only ones for which data are still available are Georgia, Idaho, Louisiana, Missouri, New Mexico, Pennsylvania, South Carolina and Washington.
16 We also only include observations with quarterly earnings between $1000 and $50 000. Note that a worker employed for 30 hours per week at the 1978 minimum wage of $2.65 would have quarterly earnings of $1034.
17 The rates are set by a state schedule that relates a firm’s tax rate to its past experience with the UI system. See Anderson and Meyer (1993) and Anderson and Meyer (1994) for additional details on the UI system.
18 Below we describe the effects on our estimates of using either narrower or broader industry definitions.
19 The average market so defined contains 57 firms. Weighting markets by employment, this average is 108.
theoretically the vertical difference between the sum of all firms' post-tax labor demand schedules and the sum of the firms' pre-tax demand schedules. We measure this difference by calculating an average tax rate over all firms in the market, weighted by the average of firm employment over the two periods. This measure will also be the tax rate for an average worker's alternative employer.

Our other variable of interest is the level of employment. As was noted above, each individual wage record also contains the firm's average monthly employment over the quarter. Thus, our firm-level data set will allow us to investigate both the earnings and employment effects of the UI payroll tax. Finally, by aggregating the firm observations we also create a market-level data set, where a market is a group of 3-digit industries defined above. In this case, employment is totalled over all firms in the industry, and earnings are calculated as total industry payroll divided by total employment.

One final concern must be addressed before turning to the empirical specification. Because our firm-level earnings measure is calculated by dividing total quarterly payroll by average monthly employment, it is greatly affected by both within-quarter employment changes and data recording errors. These factors lead to a substantial number of outliers in this earnings measure. Because of the outliers, for our main estimates we only include firm observations with a change in log earnings in the range \((-0.5, 0.5\)). This restricted sample is then aggregated to obtain a corresponding market-level sample. Descriptive statistics for the key variables in each of the data sets used in the main analysis are presented in Table 2.

3.2. Regression specifications

Our theoretical model implies that in order to estimate the derivatives of Eqs. (1) through (6), we should estimate earnings and employment equations both at

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Descriptive statistics for key variables</th>
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<tbody>
<tr>
<td></td>
<td>Mean</td>
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<tr>
<td>Firm-Level Data</td>
<td></td>
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<tr>
<td>Δ Firm-Level Tax Rate</td>
<td>-0.0004</td>
</tr>
<tr>
<td>Δ Market-Level Tax Rate</td>
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<tr>
<td>Δ Ln(Earnings)</td>
<td>0.011</td>
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<tr>
<td>Δ Ln(Employment)</td>
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<tr>
<td>Industry-Level Data</td>
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<td>Δ Market-Level Tax Rate</td>
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<td>-0.005</td>
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<tr>
<td>Δ Ln(Employment)</td>
<td>0.003</td>
</tr>
</tbody>
</table>

Notes: Changes are annual changes calculated using quarterly data (i.e. 1983:3–1982:3, 1983:4–1982:4, etc.). See text for details.
the market level and at the firm level, with the firm-level regressions including both firm-level taxes and market-level taxes as explanatory variables. Our ability to measure actual firm tax rates differentiates us from most past work which has estimated only market-level regressions (or individual-level earnings regressions) including only market-level tax rates. For comparison purposes we also replicate these types of specifications, though. While the coefficients from our specifications directly give some of the main policy effects of the tax, we also use these coefficients below to solve for the structural parameters of our model.

An important aspect of our empirical implementation is our use of panel-data techniques to address one of the major shortcomings of much of the previous work on benefits and wages. By differencing our longitudinal data we can remove unmeasured characteristics of a firm's working conditions, benefits package, and average worker characteristics. This differencing thus removes factors which many previous authors have argued severely bias empirical estimates of wage determinants. We should note, however, that to the extent that these characteristics systematically change in the course of a calendar year our differencing will not completely eliminate their influence. Since our data include only a few firm-level characteristics and no individual level characteristics besides those of the employer, some part of the change in these factors would remain.

In all cases, we difference the data at annual frequencies to avoid the complications of seasonality and because tax rate and base changes generally occur once a year. Thus, for the firm-level data we calculate annual changes within firms. Each of our specifications is estimated using data from the 3rd and 4th quarters only. Because each of our states base a firm’s tax rate only on information available up through June 30 of the previous year, this restriction insures that all events which affect the tax rate will precede the time periods being differenced.

The changes in firm-level taxes that we use in our empirical models are due to state tax schedule and taxable wage base changes, as well as from movements of the firm along a given state tax schedule. Such movements along a tax schedule are a result of experience rating, meaning that all else equal, a firm which increases its use of the system should see an increase in its tax rate. Recall, though, that this change in tax rates is only the result of firm behavior which occurred before the quarters being differenced. At the market level, the variation in tax rates is due to the same state-level changes, as well as to the aggregated effect of changes due to individual firms’ movements along a given schedule.

In our 8 states, 6 changed their tax schedules at least once during our sample period. One-half of the 6 states implemented tax increases due to automatic adjustments in response to state-wide declines in the UI trust fund. The other 3 states legislatively changed their schedules, with 2 mostly raising rates, and 1 mostly cutting rates. These tax schedule changes affected firms on different parts of the tax schedule in different ways and the changes interacted with different firm average wage levels to produce different effects for different firms.

In order to better understand the importance of each of the three sources of
variation in tax rates in our analysis, we do the following exercise. We begin by defining three alternative firm-level tax measures along with their market level analogs, each of which relies only on one of the sources of tax variation. The first measure uses only the tax schedule changes, the second uses only the tax base changes, and the third uses only the firm reserve ratio changes. Note that changes in the reserve ratio represent firm movements along the tax schedule. The result is four market-level rates and four firm level rates, i.e. the overall rate and its three component rates. We then calculate the variance of the four market rates, as well as of the four firm rates minus the corresponding market rates.

These calculations reveal first, that the deviation of the firm rate from the market rate has a variance nearly eight times that of the market rate. Thus, the vast majority of the variance of the change in tax rates is at the firm level. Second, schedule changes are responsible for almost four times as much variance as firm movements along a given schedule, both for the firm minus the market rate and for the market rate. Third, for both tax rates, tax base changes are even less important than firm movements along a given schedule. Thus, the vast majority of the variation in taxes stems from state changes in the tax schedules and the resulting variation in firm tax rates.

While the sources of the tax changes are clear, the correct lag structure in wage and employment changes that we should expect in response to the tax changes is somewhat less clear. The annual tax changes we study have been in effect on average nine months at the time that we examine employment and wages (the 3rd and 4th quarter), with the tax changes known to each firm approximately a month or two before they go into effect. Additionally, some firms may have an estimate of what their tax change will be earlier based on their knowledge of their layoffs, their estimate of the weeks of UI received by their former workers, and their estimate of the state UI trust fund balance. Hamermesh (1993) reports that studies of the speed of labor demand adjustment imply that adjustment lags are relatively short, with the majority completed within 6 months. Based on this evidence, then, it seems reasonable to expect that the annual changes used in this study represent close to full adjustment.

The earnings and employment equations are estimated in log-differences. For the earnings equations, not only is a log specification the standard, but since the tax rates are expressed as a proportion of earnings, this specification provides us with a straightforward interpretation of the key tax coefficient in the market-level regression. The coefficient is simply the percentage of the tax which is passed on to workers in the form of lower earnings and thus directly corresponds to the expressions of Eqs. (1), (3), (5). This semi-log specification is even more compelling in the case of employment because the resulting coefficients are the

---

20Note that state-specific time effects are first removed, as is described below for the main analysis. Additionally, since Pennsylvania does not use a reserve ratio system of experience rating, it is not used in this exercise.
expressions on the right-hand sides of Eqs. (2), (4), (6) with the function of E and W removed. Since E and W are clearly different across firms, it is preferable to eliminate them from the specification. Thus, the estimated specifications are of the form

$$\ln(W_{y,q}) - \ln(W_{y-1,q}) = \gamma_1 \left( \frac{\tau_{y,q}}{W_{y,q}} - \frac{\tau_{y-1,q}}{W_{y-1,q}} \right) + \gamma_2 z_{y,q} + e_{y,q} - e_{y-1,q},$$

where $W_{y,q}$ is average firm earnings in year $y$ and quarter $q$, all other subscripts are defined analogously, and the additional covariates $z_{y,q}$ are interactions of state, year and quarter. We include these covariates because it is often the case in our sample that upward shifts in the state tax schedule occur after a recession, when state trust funds have been depleted. Thus, positive changes in the tax schedule will tend to be correlated with economic recovery, when employment gains are likely to be positive. In such a case, reliance on variation common to all firms due to such changes in state schedules would likely result in positively biased employment effect estimates.

The models for employment replace W with E on the left hand side of (13). As discussed above, we also aggregate firm-level taxes, $\tau_{y,q}$, earnings and employment to obtain market-level measures. These variables are substituted for the firm-level variables above to estimate models at the market-level. Additionally, in our main firm specification, the market-level tax is included with the firm-level tax, while alternative firm specifications include only the firm-level tax or only the market-level tax. This formulation builds in a mechanical endogeneity of the tax change variable from two sources. The first source is the presence of wages in the denominator of each term. The second source of endogeneity is the fact that $T_{y,q}$ the tax bill, increases with the earnings level since

$$\tau_{y,q} = \text{state rate}_y \cdot \min(\text{state base}_y, W_{y,q}) + \text{federal rate}_y \cdot \min(\text{federal base}_y, W_{y,q}).$$

To solve this endogeneity problem we instrument the change in tax variable with a variable of the same form, but with $\tilde{W} = (W_{y,q} + W_{y-1,q})/2$ substituted for $W_{y,q}$ and $W_{y-1,q}$ wherever they appear in the calculation of the change in tax variable. This instrument is only a function of changes in the tax rates and bases and the wage level and is valid as long as the tax changes are exogenous and the wage change is unrelated to the wage level. We examine the relationship between the change in the logarithm of the wage and the wage level by regressing the change on the dependent variable of (13) on $\tilde{W}$ in the firm sample. This regression indicates a significant, but extremely weak relationship as the coefficient on the average wage is zero to six decimal places. Thus, any bias due to the use of this instrument is likely to be very small.

\footnote{We are assuming that $W_i$ equals $W_{m}$, which will only be exactly true when $\tau$ is zero, but will be very close to true for the range of $\tau$ in the data.}
4. Empirical results

The top panel of Table 3 presents the results from estimating Eq. (13). In specification (1) both the change in the market-level tax rate and in the firm-level tax rate are included, while in specifications (2) and (3) only the change in either the market-level or the firm-level rate respectively is included. The models are estimated as follows. First, 2SLS estimates are obtained, where the change in the tax bill as a fraction of average earnings over the two periods is used as an instrument. Since quarterly earnings (employment) is an average (sum) for firms and industries that vary greatly in size, the error terms in these equations are heteroskedastic. To correct for heteroskedasticity we multiply each term of the equations by the square root of the inverse of the diagonal matrix of estimated error variances. The estimated error variances are obtained from regressions with

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Δ Market-Level Tax Rate</th>
<th>Δ Firm-Level Tax Rate</th>
<th>Number of Observations</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Firm Data</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) Δ Ln(Earnings)</td>
<td>-0.520</td>
<td>-0.194</td>
<td>410709</td>
<td>0.007</td>
</tr>
<tr>
<td></td>
<td>(0.315)</td>
<td>(0.088)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) Δ Ln(Earnings)</td>
<td>-0.715</td>
<td>-</td>
<td>410709</td>
<td>0.007</td>
</tr>
<tr>
<td></td>
<td>(0.292)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3) Δ Ln(Earnings)</td>
<td>-</td>
<td>-0.260</td>
<td>410709</td>
<td>0.007</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.087)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) Δ Ln( Employment)</td>
<td>1.158</td>
<td>-0.862</td>
<td>410709</td>
<td>0.011</td>
</tr>
<tr>
<td></td>
<td>(0.800)</td>
<td>(0.182)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) Δ Ln(Employment)</td>
<td>0.298</td>
<td>-</td>
<td>410709</td>
<td>0.011</td>
</tr>
<tr>
<td></td>
<td>(0.732)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3) Δ Ln(Employment)</td>
<td>-</td>
<td>-0.724</td>
<td>410709</td>
<td>0.011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.171)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Industry Data</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) Δ Ln(Earnings)</td>
<td>-0.810</td>
<td>N/A</td>
<td>7114</td>
<td>0.076</td>
</tr>
<tr>
<td></td>
<td>(0.447)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) Δ Ln(Employment)</td>
<td>0.912</td>
<td>N/A</td>
<td>7114</td>
<td>0.129</td>
</tr>
<tr>
<td></td>
<td>(0.815)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: See notes to Table 2. The change in the tax bill as a fraction of average earnings across the two years is used as an instrument. Weights are the inverse of the predicted standard deviation of the residual based on firm employment for the firm data and based on number of firms in the market for the industry data. All models also include separate state dummies for each quarter of data. See text for details.

22Note that as would be expected, OLS estimates of earnings (employment) equations are severely negatively (positively) biased by the natural endogeneity of the tax measure.
the squared residuals from the 2SLS estimates used as the dependent variable in a regression on a constant and the inverse of average employment at the firm over the two periods (employment was a much better predictor of the squared residuals than the number of firms in the industry). When both firm and market tax rates are included, the specification includes two endogenous variables which are instrumented using versions of the two tax variables constructed with average employment as described above. The form of the estimation equations is given in the Appendix on Econometric Methods (Appendix A) along with our methods of calculating standard errors.

The pattern of the results in the top panel of Table 3 is generally in accordance with the theory. Looking first at specification (1), the coefficients on both the market and firm tax are negative and the firm tax rate, while much smaller in absolute value than the industry rate coefficient, is significantly different from zero in the top half of the panel. In the bottom half of the panel, the employment effects are as expected, given the earnings effects, with positive and negative coefficients on the market and firm tax respectively, with the firm coefficient significant. Note that this last result is related to the finding of Baker and Bresnahan (1988) that firm level cost shifters used as instruments for a firm’s quantity affect other firms’ prices. Here, we examine if changes in other firms’ input prices affect a given firm’s use of inputs. Our result also supports the prediction found in the oligopoly literature that a factor which raises a firm’s rivals’ costs should decrease their output and increase the firm’s output (See Dixit, 1986 or Shapiro, 1989). Since an increase (decrease) in output would be expected to increase (decrease) the use of labor, our employment result confirms this prediction.

Model (2) provides an estimate of the overall market effect of the UI tax, and is similar to the specifications used in much of the past work on mandated benefits. The results here are also similar, indicating that there is no employment effect, only a wage effect. While the point estimates actually imply a positive employment effect of 0.298 and that only about 70 percent of the tax is shifted, the standard errors are such that we cannot reject that the coefficients on earnings and employment are \(-1\) and \(0\) respectively. Recall, also, that the theory implies that a zero employment effect could be obtained with a less than complete drop in earnings, and that the effect could even be positive. The results from model (3) indicate that the firm-level tax effects are very different from the market-level tax effects of model (2), implying that only about one quarter of the firm-level tax is passed on. Correspondingly, there is a significantly negative effect on firm-level employment. The finding that firms are unable to pass on a substantial fraction of the difference in firm-level taxes is an important one, since it confirms what has only been assumed in past work on experience rating effects.

The overall effect of the market tax on firm employment estimated in model (2) should aggregate to a market-level effect. The bottom panel of Table 3 presents estimates using the market-level data set. The same 3-stage procedure is followed, although in this case the number of firms in the market rather than employment is
used to form the weights as it is a better predictor of the squared second stage residuals. The estimated earnings effect is very similar to that from the corresponding specification (model (2) in the top panel) using firm data, at $-0.81$ versus $-0.72$. While the point estimate of the employment effect is quite a bit larger, it is still not significantly different from zero. Thus, both the firm-level and market-level data provide evidence which agrees with past findings of no overall employment losses. The market-level analyses, however, mask the reallocation of employment across firms which is taking place at the firm level and which was seen in the top panel. By explicitly accounting for the variation within markets in firm tax rates, we are able to capture this substantial effect, which has previously been ignored.

4.1. Alternative estimates

In addition to the estimates of Table 3 presented above, we try several alternatives. To evaluate the impact of our choice of grouped 3-digit industries as our market definition, we also try 4-digit industry and 2-digit industry. These estimates are reported in Tables 4 and 5, respectively. The firm-level estimates using alternative market definitions are very similar to those reported in Table 3. There is little effect on the firm tax coefficient, but a slightly larger effect on the industry tax coefficients. In the industry-level estimates, there is little difference in the earnings equation estimates. However, in the employment equation there are sharp differences across the market definitions. The narrower 4-digit industry definition implies little overall employment effect of the tax, while the 2-digit definition implies very large positive effects on employment. Since small overall employment effects are more plausible given the large wage effect, the 4-digit industry definition results accord more with the theory.

As another check on the effect of differing market definitions, we also tried estimates which dropped all markets with less than 10 firms and which dropped all markets with less than 30 firms. The results were again quite close to the base results shown in Table 3, although using markets with at least 30 firms led to an estimated industry employment effect of 0.044. Thus as was the case in Table 4, this coefficient was much closer to zero than the base case. Overall the implication of these alternative estimates is that we appear to be capturing mostly competitive behavior, since there is little effect of increasing the number of firms in the market. Thus, with few exceptions, the results are very similar across different market definitions.

We also tried estimates which include outliers in the change in employment and earnings. In most specifications, the estimated coefficients are larger in absolute value than those from Table 3, and in all cases the standard errors have increased. Additionally, results appear somewhat less consistent with the theory across specifications, although the large standard errors make conclusions difficult to draw. Thus, while the point estimates of positive employment effects are larger
Table 4
Weighted IV estimates of the effect of UI taxes on firm and industry average earnings and employment alternate 4-digit industry definition

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Δ Market-Level Tax Rate</th>
<th>Δ Firm-Level Tax Rate</th>
<th>Number of Observations</th>
<th>( R^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Firm Data</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) Δ Ln(Earnings)</td>
<td>-0.473 (0.293)</td>
<td>-0.199 (0.088)</td>
<td>410709</td>
<td>0.007</td>
</tr>
<tr>
<td>(2) Δ Ln(Earnings)</td>
<td>-0.670 (0.270)</td>
<td></td>
<td>410709</td>
<td>0.007</td>
</tr>
<tr>
<td>(3) Δ Ln(Earnings)</td>
<td>-</td>
<td>-0.260 (0.087)</td>
<td>410709</td>
<td>0.007</td>
</tr>
<tr>
<td>(1) Δ Ln(Employment)</td>
<td>1.220 (0.683)</td>
<td>-0.872 (0.182)</td>
<td>410709</td>
<td>0.011</td>
</tr>
<tr>
<td>(2) Δ Ln(Employment)</td>
<td>0.359 (0.533)</td>
<td></td>
<td>410709</td>
<td>0.011</td>
</tr>
<tr>
<td>(3) Δ Ln(Employment)</td>
<td>-</td>
<td>-0.724 (0.171)</td>
<td>410709</td>
<td>0.011</td>
</tr>
<tr>
<td><strong>Industry Data</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) Δ Ln(Earnings)</td>
<td>-0.911 (0.355)</td>
<td>N/A</td>
<td>15639</td>
<td>0.049</td>
</tr>
<tr>
<td>(1) Δ Ln(Employment)</td>
<td>0.106 (0.655)</td>
<td>N/A</td>
<td>15639</td>
<td>0.075</td>
</tr>
</tbody>
</table>

Notes: See notes to Table 2. The change in the tax bill as a fraction of average earnings across the two years is used as an instrument. Weights are the inverse of the predicted standard deviation of the residual based on firm employment for the firm data and based on number of firms in the market for the industry data. All models also include separate state dummies for each quarter of data. See text for details.

than in Table 3, the effects remain statistically insignificantly different from zero in each case.

4.2. Recovering the structural parameters

While the effects of the UI tax on employment and wages come directly from our estimates reported in Table 3, additional information can be obtained from the structural parameters. If we want to extrapolate our results to other types of taxes or calculate dead-weight losses due to tax distortions, the structural parameters are needed. The estimates also allow an additional check on the appropriateness of our methods and the plausibility of our results. Eqs. (1) through (6) provide six nonlinear equations in six parameters: \( \alpha, \beta, \eta_{m}^{d}, \eta_{m}^{x}, \eta_{f_{1}}^{d}, \eta_{f_{2}}^{d} \), but the equations are not independent. Thus, in order to identify the system, we revert to the partial equilibrium case and set \( \eta_{f_{2}}^{d} = 0 \). We estimate these parameters using minimum
Table 5
Weighted IV estimates of the effect of VI taxes on firm and industry average earnings and employment alternate 2-digit industry definition

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Δ Market-Level Tax Rate</th>
<th>Δ Firm-Level Tax Rate</th>
<th>Number of Observations</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firm Data</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) Δ Ln(Earnings)</td>
<td>-0.522</td>
<td>-0.194</td>
<td>410709</td>
<td>0.007</td>
</tr>
<tr>
<td></td>
<td>(0.341)</td>
<td>(0.088)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) Δ Ln(Earnings)</td>
<td>-0.716</td>
<td>-0.260</td>
<td>410709</td>
<td>0.007</td>
</tr>
<tr>
<td></td>
<td>(0.315)</td>
<td>(0.087)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3) Δ Ln(Earnings)</td>
<td>-</td>
<td>-0.724</td>
<td>410709</td>
<td>0.011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.171)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) Δ Ln(Employment)</td>
<td>1.117</td>
<td>-0.857</td>
<td>410709</td>
<td>0.011</td>
</tr>
<tr>
<td></td>
<td>(0.958)</td>
<td>(0.182)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) Δ Ln(Employment)</td>
<td>0.262</td>
<td>-</td>
<td>410709</td>
<td>0.011</td>
</tr>
<tr>
<td></td>
<td>(0.870)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3) Δ Ln(Employment)</td>
<td>-</td>
<td>-0.724</td>
<td>410709</td>
<td>0.011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.171)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry Data</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) Δ Ln(Earnings)</td>
<td>-0.834</td>
<td>N/A</td>
<td>3328</td>
<td>0.103</td>
</tr>
<tr>
<td></td>
<td>(0.612)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) Δ Ln(Employment)</td>
<td>3.111</td>
<td>N/A</td>
<td>3328</td>
<td>0.171</td>
</tr>
<tr>
<td></td>
<td>(1.043)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: See notes to Table 2. The change in the tax bill as a fraction of average earnings across the two years is used as an instrument. Weights are the inverse of the predicted standard deviation of the residual based on firm employment for the firm data and based on number of firms in the market for the industry data. All models also include separate state dummies for each quarter of data. See text for details.

chi-square methods, i.e. by obtaining the vector of parameters, $\hat{\delta}$, which minimize the quadratic form

$$(h(\hat{\delta}) - \hat{h})'\hat{V}^{-1}(h(\hat{\delta}) - \hat{h}),$$

where $h(\hat{\delta})$ is the vector of nonlinear expressions on the right hand sides of Eqs. (1)–(6), $\hat{h}$ is the corresponding vector of estimates, and $\hat{V}$ the associated variance–covariance matrix of these estimates.\(^{23}\)

Some of our structural parameter estimates can be compared to our a priori judgements and past findings. Recall that we predicted $\alpha$ to be fairly close to zero and $\beta$ to be between 0.4 and 1. Additionally, labor can be expected to be supplied quite inelastically to the market, since the model assumes little opportunity for

\(^{23}\)Recall that $E/W$ is eliminated from the right hand sides of (2), (4) and (6), though, by the use of a log-linear specification in (13).
across-market flows of labor. Somewhat less clear is the expected size of the elasticities of demand. While Hamermesh (1993) notes that a consensus estimate for an output-constant elasticity is between $-0.15$ and $-0.75$, the model implies using overall elasticities. Such elasticities include a scale effect which will depend heavily on the elasticity of demand in the product market. Hamermesh presents estimates of the overall elasticity from a few studies that are based on industry-level employment and from a small number of studies based on firm- or plant-level employment. The industry-level estimates are in the $-1.5$ to $-2$ range, while the firm-level estimates are in the range of $-0.3$ to $-0.9$. Differences in methods across the studies may be an important consideration, though, since one would expect that scale effects at the firm level would be larger than those at the market level. Thus, these studies likely do not provide us with sufficient guidance on the size of $\eta^d_m$ and $\eta^d_{l_i}$.

Table 6 presents the structural parameters, along with the standard errors of the estimates. The first set of estimates is obtained from the coefficients from Table 3, using a grouped 3-digit SIC industry definition of a market. With estimates (standard errors) of $0.193$ ($0.067$) and $0.595$ ($0.069$) respectively, both $\alpha$ and $\beta$ are fairly precisely estimated and are well within the range predicted by the theory. Point estimates for both $\eta^d_m$ and $\eta^d_{l_i}$ are negative as expected, at $-6.039$ ($2.404$) and $-2.149$ ($0.436$). The large standard errors make it difficult to draw firm conclusions, though. While the relative sizes of the own-wage elasticities at the market and firm levels are the opposite of what theory would predict, there is a substantial overlap of the 95% confidence intervals for the two elasticity estimates. Similarly, while the point estimate for $\eta^*_m$ is negative, at $-1.630$ ($0.819$), a 95% confidence interval includes values close to the expected zero.

The second set of estimates are obtained from the coefficients of Table 4 which use a 4-digit SIC industry definition of a market. As was the case when we compared the results of Table 3 to those of Table 4, the two sets of parameters are

<table>
<thead>
<tr>
<th>Parameter</th>
<th>3-digit SIC Industry</th>
<th>4-digit SIC Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimate</td>
<td>Standard Error</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>0.193</td>
<td>0.067</td>
</tr>
<tr>
<td>$\beta$</td>
<td>0.595</td>
<td>0.069</td>
</tr>
<tr>
<td>$\eta^d_m$</td>
<td>$-6.039$</td>
<td>2.404</td>
</tr>
<tr>
<td>$\eta^*_m$</td>
<td>$-1.630$</td>
<td>0.819</td>
</tr>
<tr>
<td>$\eta^d_{l_i}$</td>
<td>$-2.149$</td>
<td>0.436</td>
</tr>
<tr>
<td>$\eta^*_l_i$</td>
<td>0</td>
<td>N.A.</td>
</tr>
</tbody>
</table>

Note: Parameters are estimated from the coefficients in models (1) and (2) from Table 3 (3-digit SIC industry) and Table 4 (4-digit SIC industry). In order to identify the other parameters, $\eta^d_{l_i}$ is constrained to zero. See text for details.
fairly similar with two main exceptions. Here, the market supply and demand elasticities at $-0.089$ (0.061) and $-0.270$ (0.089), respectively, are much smaller and more precisely estimated than before. Overall, then, the parameter estimates are in rough agreement with our model and expectations. While some of the point estimates of the elasticities are outside of the expected range, the standard errors for these parameters are large. Those parameters which are precisely estimated, though, are quite clearly in the expected range. Thus, it appears that our overall framework captures some of the key features of the effects of taxes on wages and employment.

4.3. Implications for dead-weight loss calculations

Based on past studies' findings that the burden of a uniform payroll tax falls almost entirely on workers one would conclude that the deadweight loss (DWL) of such a tax is likely to be very small. A similar conclusion would follow from the usual assumption that the supply of labor is very inelastic (an assumption confirmed by our estimated structural parameters). To see this result formally, note that the general formula for the approximate DWL is

$$0.5\tau^2 \left[ \frac{1}{\eta^d} + \frac{1}{\eta} \right],$$

which will equal 0 when $\eta^d = 0$. However, we have shown that when a payroll tax varies across firms competing in the same labor market, these firms can only pass on a small share of the within market differences in the tax they face, leading to an employment reallocation across firms. Firms with above (below) average tax rates hire too few (many) workers so that the marginal product of labor differs across firms. Thus, total product would increase if workers were moved from low tax to high tax firms. The result of this reallocation is a potentially substantial DWL. In order to calculate such a DWL, it is important to first note that for the case of perfectly elastic supply the formula collapses to $0.5\tau^2 \eta^d$. Also, since it is the within market difference in the tax which is borne by the firm, the appropriate $\tau$ is the deviation of the firm’s tax or cost from that of the market. Similarly, the appropriate elasticity is at the firm level. Since our estimate of this firm-level elasticity is approximately 2, then $0.5\eta^d \approx 1$ and the DWL as a fraction of the wage bill will simply be $\tau^2$.

A simple example can illustrate the importance of recognizing that even if there is no overall employment loss, there can be a substantial DWL from across-firm reallocation. Imagine that a mandated benefit whose cost will equal 1% of a firm’s payroll and from which small firms (less than 100 employees) will be exempted is under consideration. Since about half of all employees work in firms with less than
100 employees (Wiatrowski, 1994), each firm will deviate from the average cost by 0.5% of payroll, leading to a DWL equal to \((0.005)^2 = 0.000025\), or 0.0025%. While this percentage may appear small, since wages and salaries in the US total over $3 trillion, it is equivalent to over $75 million. More importantly, this DWL increases with the square of the tax. Thus, doubling the expected cost of the mandate to 2% will quadruple the DWL to over $300 million, while a 4% cost would imply a DWL of over $1.2 billion.

The above example assumes that there are no pre-existing distortions which justify the differential treatment of firms. Such an assumption is likely reasonable in this example, but may not be in other cases. Tax rates and costs vary across firms for many reasons. In addition to the common small firm exemption, there may also be differences in the costs of fulfilling mandates due to differences in such things as firm age or technology, or experience-rated taxes may be used to fund insurance programs. Thus, in order to fully understand the welfare implications of firm specific taxes, we need to consider the origin of firm tax or cost differentials. Such differentials may have offsetting benefits if they are set to serve other social purposes. In the case of UI, for example, the DWL which arises from subsidizing high layoff firms (see Anderson and Meyer, 1993) would likely be much larger without experience rating. Overall, then, while tax differentials may sometimes be justified, in general, such differentials will lead to DWLs that are proportional to the square of the differential, and which will be in addition to any DWL calculated at the market level.

5. Conclusions

In this paper we theoretically and empirically examine the common, but previously unexamined, case of a tax which differs across firms within the same labor market. While our empirical implementation uses data from the experience-rated unemployment insurance (UI) system, the differential treatment of firms (such as special considerations for small business) under tax and mandated benefits laws leads to costs which vary across firms and which are analogous to experience-rated taxes. In our theoretical model, we highlight the effect on earnings and employment of this variation in taxes or costs both within and across labor markets. In particular, we show that variation in taxes within labor markets can lead to employment being reallocated across firms, and consequently to potentially large dead-weight losses, even if there is no overall employment change.

Despite the importance of this firm-level variation in taxes and costs, past work on incidence has only explored market-level effects. Our administrative data from state UI systems provides information on firm-level taxes, along with employment
and firm average earnings, which allows us to fill this gap. Another major advantage to our approach is that we use longitudinal data which permit us to difference out unmeasured firm and worker characteristics that may be correlated with wages, fringe benefits and working conditions. By examining only annual changes in firm average earnings and employment, we remove all unmeasured characteristics which do not change in the course of a year.

Our results suggest that most of the market level tax is born by the worker. However, this does not imply that there are no employment effects of the tax. Rather, we find that individual firms can only pass on a small share of the within market differences in the tax they face, leading to substantial employment reallocation across firms. For the case of UI, this last finding is especially significant as it confirms that experience rated taxes can be used to reduce temporary layoffs since the differences in taxes are not easily shifted to workers. Additionally, we find that firm and market level taxes have opposite effects on employment. This result has been predicted by theory in the industrial organization literature, but not previously tested.

While our ability to examine both within and across market variation is a significant step forward, our market-level results remain broadly supportive of previous market-level findings of no significant impact on employment. Thus, the results verify our prediction that within market variation in taxes and costs can lead to dead-weight losses even if there is no overall effect on employment. In the case of UI, this variation in taxes reduces the distortions created by the UI layoff subsidy, and so may be beneficial. However, in many other cases, differences in taxes across firms can lead to large dead-weight losses.

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Appendix A

Appendix on Econometric Methods

Reduced form estimates

The main equations can be written in abbreviated notation as \( y = x\gamma + \epsilon \). The transformed equation which corrects for heteroskedasticity due to differing firm and industry sizes is

\[
\tilde{y} = \tilde{x}\gamma + \tilde{\epsilon},
\]

where \( \tilde{y} = Qy \), \( \tilde{x} = Qx \), \( \tilde{\epsilon} = Q\epsilon \), and \( Q \) is the matrix with the square root of the inverse of the predicted variances of \( \epsilon \) along its diagonal. We apply 2SLS to this transformed equation using the transformed instruments to obtain weighted 2SLS estimates.

Since our equation errors are correlated across observations in several ways the calculation of the variance matrix of our estimates is fairly complicated. This is particularly true because our panel is highly unbalanced with some industries with only a few dozen observations and others with a very large number. We adjust the usual weighted 2SLS covariance matrix of the estimates to account for the correlation across observations. We calculate the variance matrix for the weighted 2SLS estimates using the panel data form of the White covariance matrix, i.e.

\[
(\hat{x}' \hat{x})^{-1} \sum_i \hat{x}_i' \hat{\epsilon}_i \hat{\epsilon}_i \hat{x}_i (\hat{x}' \hat{x})^{-1},
\]

where the predicted explanatory variables are \( \hat{x} = P\tilde{x} \), the instruments are \( z \), the transformed instruments are \( \tilde{z} = Qz \), the projection matrix formed from \( \tilde{z} \) is \( P_z \), the residuals are \( \hat{\epsilon} = \tilde{y} - \tilde{x}\hat{\gamma} \), and \( i \) indexes firms or industries depending on the which we are using. This form accounts for correlation within year for a given firm or industry which is present due to our inclusion of both third and fourth quarter data when it is available. This form also accounts for the correlation over time in the errors due to their being differenced. The covariance of successive differenced errors will be one-half their variance.

In the firm specifications, we also correct for correlation in the error across firms within an industry for each state and quarter. In principle, one could use the form of the covariance matrix above to account for this correlation also, but the computational requirements were too high given the size of some industries and the dimension of \( x \) (because we include interactions of quarter and state in the controls). Instead we use the formula reported in Moulton (1986) to adjust the variance matrix. In the univariate regression case the ratio of the true variance to the naive one is
\[ r = 1 + \left[ \text{var}(m_i) / \bar{m} + \bar{m} - 1 \right] \rho, \]

where \( m_i \) is the number of observations in industry \( i \), \( \bar{m} \) is the average of the \( m_i \), \( \rho_x \) is the within industry correlation of \( x \), and \( \rho \) is the within industry correlation of the error terms. This formula is given for a univariate model, but in the multivariate context the formula should apply to the residual variation in an explanatory variable after projection on the other explanatory variables. We only apply this formula to the industry level tax coefficient when the firm level variable is also included since the residual variation in the firm tax should have a near zero correlation across firms within industry. When the correlation is zero the standard errors are correct and do not require adjustment. The residual variation would have an exactly zero correlation within industry except for the fact that the regression weights do not equal the weights used in computing the industry average rate. In the specifications where we only include the firm tax rate (and not the industry rate), we calculate \( \rho_x \) as the residual variance in the industry tax rate divided by the residual variance in the firm tax rate. We take these adjustments to the naive covariance matrix to be additive even though only the within industry and within year covariances are strictly additive.

**Structural estimates**

The next step is to recover the structural parameters. To simplify matters, we calculate the covariances between the coefficients of the earnings and employment equations under the assumption that the weights are equal in the two equations. While the weights are close to being equal, they are not exactly so. In the case of equality the covariance simplifies to the form

\[(\hat{\varepsilon}' \hat{\varepsilon}) \sigma_{12},\]

since the explanatory variables are the same in the two equations, where \( \sigma_{12} \) is the covariance of the residuals in the two equations.

Last, we calculate the variance–covariance matrix of the structural parameters using the formula

\[ \hat{V}(\hat{\delta}) = \left[ \frac{\partial h}{\partial \delta} \right] \hat{V}^{-1} \left[ \frac{\partial h}{\partial \delta} \right]' \]

where the expressions in this equation are defined in the text.

**References**


