National Tax Journal, March 2013, 66 (1), 215–238

MEASURING THE BURDEN OF THE CORPORATE INCOME TAX UNDER IMPERFECT COMPETITION

Li Liu and Rosanne Altshuler

We model and estimate the incidence of the corporate income tax under imperfect competition. Identification comes from variation in effective marginal tax rates in the United States across industries and time. Our empirical results suggest that labor bears a significant portion of the burden of the corporate income tax. In addition, we find that the elasticity of wages with respect to the corporate marginal effective tax rate increases with industry concentration. Over all industries, our estimates suggest that a $1.00 increase in corporate tax revenue decreases wages by approximately $0.60.

Keywords: tax incidence, wage determination, corporate income tax, market structure

JEL Codes: H22, H25, H31

I. INTRODUCTION

Over the past two decades, most countries in the Organisation for Economic Co-operation and Development (OECD) have lowered their corporate statutory tax rates. An important yet open question is who benefits from such corporate tax reforms. While the methodology for assigning the burden of changes in the personal income tax is straightforward — the individual who actually pays the tax is typically assumed to bear the burden of the tax — assigning the burden of the corporate income tax has proven to be a difficult and controversial undertaking.

Since the seminal analysis of the incidence of the corporate income tax using the Harberger (1962) model, public finance economists have considered how relaxing different assumptions of the model will change Harberger's finding that the corporate tax is likely borne by all owners of capital.[1] For example, once we allow for an open

[1] Fullerton and Metcalf (2002) provide an excellent review of extensions of the Harberger model.

Li Liu: Centre for Business Taxation, University of Oxford, Oxford, United Kingdom (li.liu@sbs.ox.ac.uk)

Rosanne Altshuler: Department of Economics, Rutgers University, New Brunswick, NJ, USA (altshule@rci.rutgers.edu)

economy with international capital mobility, domestic owners of capital may be able to escape the tax by moving capital abroad and, as a result, domestic labor may bear a substantial burden of the corporate income tax. While researchers have built and simulated theoretical models that relax many of the assumptions of the Harberger analysis (including Harberger, 1995, 2008), there have been relatively few attempts to econometrically estimate who bears the burden of the corporate income tax.

Statutory corporate tax rates do not change often within a country. Recognizing this, researchers have recently begun to exploit cross-country variation to identify the impact of corporate taxes on wages (Arulampalam, Devereux, and Maffini, 2012; Desai, Foley, and Hines, 2007; Felix, 2007; and Hassett and Mathur, 2010). These models implicitly assume that policy makers do not react to corporate tax rate changes in the countries they compete with to attract internationally mobile capital. However, if countries engage in tax competition then corporate tax rates will be endogenous.[2] Not accounting for the endogeneity of corporate tax rates is one weakness of the recent work in this area. Taking tax competition into account could lead to different conclusions regarding the incidence of the corporate income tax. Empirical work with cross-country data may also suffer from omitted variable bias and measurement error (if variables used in the analysis are not measured consistently across countries).

Researchers have also used variation in state corporate tax rates to explore the impact of corporate taxes on wages (Gyourko and Tracy, 1989; Felix, 2009; Felix and Hines, 2009; Carroll and Prante, 2010). But these studies have the same problem described above. If states compete by choosing corporate tax rates, then the tax rates in the estimated equations are endogenous responses of a tax setting game and the standard ordinary least squares (OLS) estimates will be biased and inconsistent.[3] Further, the use of formulary apportionment by the states to assess corporate tax liabilities makes it difficult to measure the appropriate corporate tax rate for multi-jurisdictional firms.

We take a new approach to measuring the burden of the corporate tax. We recognize that the tax burden on a marginal investment project depends on the asset mix of the project. Since industries use different asset mixes they will face different effective marginal tax rates. We use variation in effective marginal tax rates across industries and across time in the United States to estimate the incidence of the corporate income tax. This approach avoids the problems of measurement error and omitted variable error that may plague the cross-country studies. Further, limiting the analysis to one country removes the estimation problems associated with tax competition that arise in the cross-country and cross-state analyses.

The existing empirical work implicitly assumes that the corporate sector is perfectly competitive, although market structures vary across industries. The presence of strate-

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[2] The tax competition literature (Altshuler and Goodspeed, 2002; Altshuler and Grubert, 2004; Winner, 2005; Devereux, Lockwood, and Redoano, 2008) has provided extensive empirical evidence of strategic interaction among national governments over corporate tax rates.

[3] Recent evidence on strategic competition among the U.S. states in tax rates includes Besley and Rosen (1998), Esteller-More and Solé-Ollé (2001), Rork (2003), and Devereux, Lockwood, and Redoano (2007).

gic interaction and any resulting economic rents may have implications for incidence analysis. As Auerbach (2006) points out, a tax in an industry with restricted output due to imperfect competition will be more distortionary than one in a competitive industry since it will worsen the original distortion to output. Whether tax shifting is exacerbated depends on parameters of the economy. Our empirical approach allows us to estimate the extent to which the incidence of the corporate tax varies across industry market structure.

We use the general equilibrium model presented in Davidson and Martin (1985) to show that the elasticity of wages with respect to the corporate income tax rate may increase or decrease with the industry concentration level. We use data on individual U.S. workers matched with industry-level effective marginal tax rates and industry concentration ratios. The industry concentration ratio proxies for the extent of imperfect competition in an industry — the more concentrated the industry, the less competition each firm in the industry faces. We find a statistically significant and negative relationship between wage rates and industry effective marginal corporate tax rates. Further, our estimates suggest that the presence and extent of imperfect competition matters for analyzing the incidence of the corporate income tax. A 1 percent increase in the concentration ratio increases the elasticity of wages to tax rates by 9.5 percent.

We also carry out the regression analysis at the industry level to account for the fact that in the conventional labor market environment, wages are determined at the industry level rather than individually negotiated. Estimates from the industry-level regressions also point to industry competitiveness playing an important role in determining the impact of the corporate income tax on wages. Both the individual- and industry-level estimates indicate that the mean elasticity of wages with respect to the industry marginal effective corporate tax rate is around –0.03.

We translate our estimated wage elasticity into a labor share of the corporate income tax and find that the burden of a \$1.00 increase in the corporate tax liability borne by labor is about \$0.60. The lower bound of the labor share of the tax burden is \$0.42 in our most conservative confidence interval. The estimated labor share of the tax burden is in line with the general equilibrium simulation results in Harberger (2008) but somewhat smaller than that in Randolph (2006).

The remainder of this paper proceeds as follows. In Section II we briefly review empirical studies of the incidence of corporate income tax. In Section III we introduce the theoretical framework for the empirical work, and in Section IV we describe the data and present our econometric specification. We discuss our results and various econometric issues in Section V. In the final section we draw conclusions from our analysis. We provide a full derivation of our theoretical prediction as well as the industry concordance we developed to construct the dataset in our online appendix.[4]

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[4] The online appendix is available at http://econweb.rutgers.edu/altshule/research/NTJ_March13_appendix.pdf.

II. EMPIRICAL STUDIES OF THE INCIDENCE OF THE CORPORATE INCOME TAX

Several recent empirical studies have estimated the effect of the corporate income tax on wages using cross-country data.[5] Arulampalam, Devereux, and Maffini (2012) consider the possibility that corporations shift income taxes to workers through the wage bargaining process. They measure the effect of corporate income taxes paid by firms (as opposed to corporate tax rates) on employee compensation using data on more than 500,000 firms in nine European countries over the period 1996–2003. Conditional on value-added per employee, a $1 increase in the tax bill tends to reduce the median real wage by $0.49. A related study by Felix and Hines (2009) using data from the year 2000 evaluates the effect of U.S. state corporate income taxes on union wages and finds that a 10 percent lower state tax rate is associated with a 3.6 percent higher union wage premium. Their results suggest that union workers see a $0.54 decrease in wages for every $1 increase in the corporate tax bill. It is important to note that these studies do not measure general equilibrium effects of the corporate tax on wages but rather the impact of the tax on the outcome of worker and firm bargaining over economic rents.

A series of studies have attempted to provide direct evidence of the general equilibrium effect of the corporate income tax on wages using cross-country data. Using aggregate wage and tax data within the manufacturing sector for 72 countries from 1981–2002, Hassett and Mathur (2010) find that wages are highly responsive to changes in the corporate tax rate. The estimated elasticity of wages with respect to corporate income tax rates ranges from 0.4–0.6 across different specifications, indicating that a $1.00 increase in tax revenue leads to a $3.00 to $4.00 decrease in the real wage. As Gravelle and Hungerford (2008) point out, the large magnitude and significance of this elasticity is sensitive to the use of alternative exchange rates and time intervals. In addition, by including a measure of value-added per worker as a control variable, the identified tax coefficient fails to capture the effects of the corporate tax on wages through changes in value-added (Arulampalam, Devereux, and Maffini, 2012).

Felix (2007) uses aggregate data on wages of workers at different skill levels from 19 OECD countries over the period 1979–2000 and estimates that a 1 percentage point increase in the top statutory corporate tax rate decreases annual wages by 0.7 percent. She finds no difference in the extent to which the tax is shifted to labor at different skill levels. Desai, Foley, and Hines (2007) use data from U.S. multinational firms operating in 50 countries from 1989–2004 to jointly estimate the relative share of the corporate tax borne by labor and capital. Constraining the portion of the total tax burden borne by capital and labor together to be one, they find that labor bears between 45 to 75 percent of the incidence of the corporate income tax.

While some have critiqued these empirical studies (Clausing, 2013; Gravelle and Hungerford, 2008), this growing body of empirical work provides suggestive evidence that labor bears a large burden of the corporate tax. However, as discussed in the introduction, much of this work uses either cross-country or cross-state data without correcting

[5] Clausing (2013), Gravelle and Hungerford (2008), Gentry (2007), and Harris (2009) provide critical reviews of empirical studies of corporate tax incidence.

for the possible endogeneity of corporate tax rates due to tax competition.[6] In addition, the existing literature implicitly assumes that all firms operate in perfectly competitive markets. We consider imperfect competition in the next section and estimate the impact of corporate taxes on wages in a setting in which changes in tax rates in other countries should have no impact on our estimated coefficients.

III. THEORETICAL BACKGROUND

Following Harberger (1962), we discuss the general equilibrium incidence effects of the corporate income tax in the simplest setting: an economy with corporate and non-corporate sectors producing separate goods with two fixed factors of production, capital and labor. Both factors of production are mobile across sectors and the corporate income tax is modeled as an additional tax on the returns to equity capital in the corporate sector.

A source-based tax on the return to corporate capital affects the equilibrium return to capital and labor through two channels: the output effect and the factor substitution effect. The output effect arises because the tax drives up the price of goods in the corporate sector. As demand for the corporate sector good decreases in response to the price increase, capital and labor are reallocated from the corporate sector. The factor substitution effect arises because in response to the tax, corporate good producers attempt to substitute labor for capital, driving down the return to capital relative to labor. How the reallocation of capital and labor across sectors affects the relative returns to factors in equilibrium depends on the initial allocations of capital and labor in the corporate and non-corporate sectors, the degree to which firms in the corporate and non-corporate sectors can substitute labor for capital, and the elasticities of demand for corporate and non-corporate output. With calibrated factor shares, capital-labor intensities, and input/output substitution elasticities that are reasonable for the U.S. economy, Harberger (1962) finds that capital income bears approximately the full burden of the corporate tax.

Further work, including Mutti and Gruber (1985), Harberger (1995, 2008), Gravelle and Smetters (2006), and Randolph (2006) examines the incidence of corporate income tax in an open economy in which capital can move across countries in response to changes in factor returns.[7] As in the original Harberger model, the corporate sector is assumed to be characterized by perfect competition. The conclusions of the open

[6] Researchers have recently begun to use data from Germany to study the incidence of corporate taxes. Dwenger, Rattenhuber, and Steiner (2011) exploit variation in corporate tax rates across firms due to corporate reforms to estimate the extent to which the burden of the corporate income tax is passed to labor through wage bargaining. Unlike previous work, they consider the effect of any change in wages in the demand for labor. Their findings suggest that labor bears a little more than half the burden of the corporate income tax. Fuest, Peichl, and Siegloch (2012) use administrative data linking employees and employers combined with information on corporate taxes at the federal and municipal level to examine the impact of German business taxes on wages paid by German companies. They estimate a wage elasticity with respect to the effective corporate marginal tax rate of –0.18 percent and find that the effects of changes in corporate tax rates on wages are strongest for low-skilled workers and those without strong bargaining agreements.

[7] Gravelle (2013) provides a review of results from general equilibrium tax incidence models of the corporate income tax.

economy general equilibrium models are straightforward: if it is feasible and profitable for capital to avoid a tax by shifting to other sectors (and abroad in an open-economy model), then the burden will fall primarily on labor, assuming labor is immobile. The extent to which such a shift is feasible and profitable depends on a variety of assumptions.

The assumption of perfect competition fails to characterize the structure of some U.S. industries. Davidson and Martin (1985) (hereafter DM) capture the strategic effects of imperfect competition on tax incidence in a two-sector general equilibrium model.[8] We use this model to motivate our empirical study of the extent to which corporate income taxes are passed to labor through reductions in wages under imperfect competition. In this section, we briefly discuss the economic intuition of the model — the full derivation of the model is available in the online appendix.

The economy consists of a competitive (non-corporate) and an imperfectly competitive (corporate) sector. The corporate sector has a small number of firms. The corporate group plays a repeated game in which each firm produces constrained quantities of a single good under constant cost. Constrained production maximizes joint corporate profits subject to no cheating. At a given point of time, if any firm produces higher output, every firm will revert permanently to the lower Nash output level. Each firm therefore compares the current gain from a higher output level to the present value of lower profits from permanently producing at a lower output level. The present value of the lower profits due to producing at a lower level is discounted using the return to capital.

The corporate tax has the usual output and factor substitution effects. However, there is also another route by which the equilibrium return to factors may be affected. The corporate tax decreases the net return to capital and this rate of return is used to discount the value of lower profits due to deviating from the constrained output level. A decrease in the discount rate increases the present value of the reduction in profits from diverting to a higher output level. This additional effect of the corporate tax works in the same direction as the output effect magnifying the decrease in the return to labor (capital) when the corporate sector is labor (capital) intensive. As a result, the change in relative factor prices due to the corporate tax is larger (smaller) as the corporate sector is more capital (labor) intensive.

The elasticity of the wage with respect to the corporate income tax rate increases as the number of firms in the corporate sector decreases if the corporate sector is capital intensive. The result, however, is ambiguous if the corporate sector is labor intensive. The sensitivity of wages to changes in the corporate income tax may increase or decrease as the number of firms in an industry decreases.

Our theoretical model relies on cartelization to explain market power and uses concentration ratios to proxy for cartelization. We recognize that cartelization is likely more relevant for industries with high concentration ratios. We could, alternatively, use a different theoretical model of imperfect competition to generate predictions of how market structure affects the incidence of the corporate tax. Ultimately, the key insight

[8] Dixit and Stiglitz (1977) and Atkinson and Stiglitz (1980) provide partial equilibrium analyses of the incidence of corporate tax under imperfect competition.

from the economic theory is that the incidence of corporate income taxes depends on a few underlying economic parameters. It is an empirical question to quantify the extent to which the incidence of corporate income taxes is borne by different factors of production. In the next section, we present a reduced form model that allows us to estimate the impact of the corporate income tax on wages and test whether any impact changes with industry concentration. The measure of industry concentration is a proxy for cartelization in the Davidson-Martin model and more general, the amount of competition among firms within the same industry.

IV. RESEARCH DESIGN AND DATA

We model the natural logarithm of weekly wages for individual i in industry j in year t, w_{ijt}, as a function of the corporate tax rate (T_{jt}), the market concentration ratio (CR_{jt}), the interaction between the tax rate and the concentration ratio, as well as individual characteristics (X_{ijt}) and industry and time-specific fixed effects (c_j and η_t):

$$(1) \quad \ln w_{ijt} = \boldsymbol{X_{ijt}\alpha} + \beta_1 \ln T_{jt} + \beta_2 \ln CR_{jt} + \beta_3(\ln T_{jt} \times \ln CR_{jt}) + c_j + \eta_t + \varepsilon_{ijt}.$$

The main parameters of interest are β_1 and β_3. The value of β_1 measures the extent to which the corporate tax affects wages, while the value of β_3 indicates whether industry concentration influences how taxes impact wages.

Our measure of the industry corporate tax is the industry-level effective marginal corporate tax. This summary tax measure is a function of effective marginal tax rates on the assets employed in an industry. The asset-level effective marginal tax rates, discussed further in the next section, are calculated taking statutory tax rates as well as tax incentives, such as depreciation allowances and investment tax credits, into account. The statutory rate applies to all assets and changes across our sample period. Depreciation allowances and the investment tax credit vary both across capital asset types and across time. For each industry and year, we calculate a weighted-average effective marginal tax rate based on the asset mix in the industry in the year being examined.

The industry-level effective marginal tax rate captures how the tax incentives to invest in the average investment project differ across industries. It is well-suited for our incidence analysis since our goal is to identify the effect of the corporate income tax on wages through its impact on factor reallocation across industries. Another advantage of the effective marginal tax rate is that unobserved shocks to individual wages are unlikely to be correlated with the industry-level characteristics. Therefore, the industry-level tax and industry concentration provide plausible exogenous determinants of wages at the individual level.

A. Sample Selection Issues

Approximately one-quarter of the observations in our sample (described below in Section IV.B.2) have missing wages because the individual did not work, presenting a standard sample selection problem. The working sample is non-randomly chosen, and the unobserved factors that determine the wage are likely to be correlated with the unobservables that influence one's decision to work. It is well known that a simple OLS regression on the working sample would yield biased and inconsistent estimates.[9] To correct for the sample selection bias, we add a first-stage selection equation, in which the probability of being employed ($empl_i$) depends on one's nonwork income (inc_i), education ($educ_i$), age, marital status ($married_i$), number of children younger than age 5 ($child5_i$), number of children between age 6 and 19 ($child20_i$), and white noise (u_i).

$$empl_i = \begin{cases} 1, & \gamma_1 inc_i + \gamma_2 educ_i + \gamma_3 age_i + \gamma_4 child5_i + \gamma_5 child20_i + \gamma_6 married_i + u_i > 0 \\ 0, & \gamma_1 inc_i + \gamma_2 educ_i + \gamma_3 age_i + \gamma_4 child5_i + \gamma_5 child20_i + \gamma_6 married_i + u_i \leq 0. \end{cases}$$

The exclusion restriction is that nonwork income should affect one's decision to work but should not impact the marginal utility from work. We measure nonwork income by aggregating net income received in the form of rents, dividends, interest, private transfers, and alimony payments. We model married women as the secondary earner of the household and include the husband's wage and salary in their nonwork income.

B. Data

1. Effective Tax Rates

We use the effective marginal tax rate to capture the effect of tax policy on investment. As is well known, the marginal effective tax rate is the percentage difference between the pre-tax and after-tax rate of return on a marginal investment project. This rate summarizes all modeled tax provisions (the statutory tax rate, present value of depreciation allowances, and investment credits) that apply to an incremental dollar of capital investment in a hypothetical project.

We calculate the effective marginal corporate tax rate for each industry by taking a weighted average of the effective marginal tax rates on all of the assets used in the industry. We obtain asset-level effective tax rates (ETR_{at}) from Fullerton and Henderson (1985) and Mackie (2002). Both papers follow the Hall-Jorgenson cost-of-capital approach and compute the effective marginal corporate tax rates for 34 types of investment in equipment and nonresidential structures. Cross-time variation in effective tax rates comes from two sources: changes in the tax system due to the Tax Reform Act of 1986 (TRA86) and changes in macroeconomic conditions reflected in the real interest and inflation rates.[10] The tax rates in Fullerton and Henderson (1985) are calculated

[9] Heckman, Lochner, and Todd (2006) provide an excellent survey on wage estimation with correction for sample selection bias.

[10] After TRA86, there was only one major change to the corporate tax in our sample period. The Omnibus Budget Reconciliation Act of 1993 added a new fourth bracket to the corporate tax subject to a rate of 35 percent.

for 1982 while those in Mackie (2002) are calculated for 1992 and 1997. Both before and after TRA86, there is variation in effective tax rates across assets as a result of differences in depreciation schedules. Before TRA86 there is additional variation across asset types due to the presence of the investment tax credit for equipment.

We use the capital flow tables provided by the Bureau of Economic Analysis (BEA) of the U.S. Commerce Department to construct asset-specific weights for our industry-level marginal effective tax rates. The capital flow tables are published in the Survey of Current Business and are available approximately every five years. We use information for 1982, 1992, and 1997 since we have calculated marginal effective tax rates for assets only for these years. The tables provide information on new capital investment in equipment and structures by industry. We compute the weight for each asset a in industry j in year t (W_{ajt}) as the value of new investment relative to total industry new investment.[11] The year-specific industry ETR is calculated as[12]

$$ETR_{jt} = \sum_{a=1}^{34} ETR_{at} W_{ajt}.$$

2. *Industry Concentration Ratios*

We use Economic Census data on industry revenue to calculate concentration ratios for each industry. The market concentration ratio is the total revenue of the four largest firms relative to total industry revenue.

Table 1 provides summary statistics for the industry effective marginal tax rates and concentration ratios. There is substantial variation in both variables across industries and time. The mean effective tax rate increased from about 20 percent in 1982 to 32 percent in 1992 and 1997. Meanwhile, the average market concentration ratio decreased from about 33 percent in 1982 to approximately 24 percent in the 1990s.

3. *Individual Characteristics*

Our individual-level data is from the Integrated Public Use Microdata Series (IPUMS), an integrated dataset of the randomly-sampled March Current Population Survey (CPS). The CPS data provide individual-level information on wages and industry affiliation. We restrict our sample to full-time private sector workers between ages 17 and 65, and exclude students and those working in the armed forces. The final sample contains 287,111 individuals.

Table 2 reports information on the demographic and socioeconomic characteristics of the sample. We impute years of schooling from nine categories of educational attain-

[11] We effectively assume that the distribution of new capital across assets is equal to the existing distribution of capital across assets. This gives us an average marginal effective tax rate for each industry.

[12] The effective tax rate calculation for each industry parallels that of Gruber and Rauh (2007) and Dwenger and Steiner (2008).

Table 1

Summary Statistics: Effective Tax Rate (*ETR*) and Concentration Ratio (*CR*)

	Mean	SD	Min	Max	N
ETR					
Overall	28.38	7.76	5.93	40.25	122
Across year		3.67	15.01	37.17	
Across industry		6.87	12.63	44.54	
CR					
Overall	26.51	18.40	1.88	91.80	96
Across year		17.56	3.95	88.19	
Across industry		5.33	12.21	39.24	
By Year					
ETR 82	20.19	5.82	10.72(18)	33.40(36)	40
ETR 92	32.49	4.78	7.92(35)	38.67(38)	41
ETR 97	32.26	5.12	5.93(35)	40.26(36)	41
CR 82	32.75	18.96	5.10(33)	91.80(9)	28
CR 92	23.49	19.17	1.88(36)	89.88(9)	34
CR 97	24.38	16.29	5.67(35)	82.88(9)	34

Notes: *ETR* is the effective marginal tax rate and *CR* is the four-firm concentration ratio. The associated industry code is in parentheses. For 1982, *ETR* is missing for the "Motion Picture" industry (39). For all years, *CR* is missing for the following industries: Agriculture (1), Forestry and Fishing (2), Mining (4)–(6), Construction (7); Additional *CR* is missing in 1982 for Transportation (29), Communication (30), Electric, Gas, and Sanitary Services (31), Finance and Insurance (34), Real Estate (35), and Health, Educational, and Social Services (41).

ment.[13] We compute work experience (*Exper*) as the difference between age and the years of schooling minus six ($Exper_i = age_i - s_i - 6$). Socioeconomic characteristics include annual nonwork income, an indicator for being married, age, number of children younger than five years old, and number of children between the ages of six and 20. Table 2 also reports average weekly wages for workers. As discussed in Section IV.B.1, we model the decision to work as a function of the socioeconomic variables. The wage process is determined by the individual characteristics described above (with the exclu-

[13] We impute the number of years of schooling, S_i, from the following categorical scheme of educational attainment: 1 = "None or preschool" (0 years); 2 ="1-4 grades" (2.5 years); 3 ="5-8" (6.5 years); 4 ="9" (9 years); 5 ="10" (10 years); 6 ="11" (11 years); 7 ="1" (12 years); 8 = "1-3 years of college" (14 years); 9 = "4+ years of college" (16 years). Education is measured as the highest level reported in CPS.

Table 2

Summary Statistics: Demographic and Socioeconomic Characteristics

	Mean	Standard Deviation
Age	37.87	13.45
Number of children ages 0–5	0.21	0.52
Number of children ages 5–17	0.74	1.10
Married	0.60	0.49
Employment	0.67	0.76
Unemployment	0.07	0.08
Not in labor force	0.26	0.16
Weeks worked	35.79	21.49
Wage and salary income	15,165	21.57
Log weekly earnings (positive values)	5.55	0.91
Nonwork income (positive values)	9.95	21.13
Imputed years of schooling	12.53	2.87
Years of college (4+)	18.68	20.75
Years of college (1–3)	22.44	21.75
12th grade	36.43	34.28
11th grade	5.36	5.39
10th grade	5.65	5.71
9th grade	3.80	3.99
5–8th grade	6.02	6.43
1–4th grade	1.15	1.21
None or preschool	0.47	0.49
Sample size	275,789	

sion of nonwork income), as well as the industry characteristics including the effective marginal corporate tax rate, concentration ratio, and the interaction term between the tax rate and concentration ratio.

4. Industry Comparability: NAICS, SIC, and Census Code

We use data from three major sources: the BEA Capital Flow tables, the Economic Census, and the IPUMS-CPS. Each uses a different industry classification system and these systems changed over the sample period. As a result, we needed to develop a unified industry classification. The detailed matching procedure is described in the online appendix, which provides descriptions of the 41 matching industries. While this industry classification is not as refined as the BEA's 3-digit SICs, it contains more industries than typically used in the effective tax rate literature.[14]

V. EMPIRICAL RESULTS AND DISCUSSION

A. Individual-Level Evidence

Table 3 reports the estimated effects of effective marginal tax rates and concentration ratios on the weekly wage. Table 4 summarizes the estimation results from the first-stage selection equation. We use the same first-stage Probit selection model for all specifications. At the second stage, we regress wages on the effective marginal corporate tax rates and concentration ratios, controlling for individual characteristics (years of education, experience, experience-squared, number of children younger than five, number of children between six and 20, marital status, and region dummies). We estimate the wage equation with year and industry fixed effects to account for unobserved industry heterogeneity. In Table 3, the estimated tax coefficient in column (1) is negative and statistically different from zero. Wages are higher for workers in industries with lower effective marginal tax rates.

The remaining columns of Table 3 take imperfect competition into account. As shown in column (2), the magnitude of the estimated tax coefficient decreases slightly once we control for industry concentration (although the difference between the tax coefficients in columns (1) and (2) is statistically insignificant). Columns (3) and (4) present estimates of the full model including the interaction between the tax rate and concentration ratio from the two-stage Heckman regression and maximum likelihood estimation. The coefficient of the interaction term is negative and highly significant. Combining the coefficient estimate on the interaction term with the negative tax coefficient suggests that the elasticity of wages with respect to the tax rate increases with the industry concentration level. This result suggests that for a uniform increase in the effective tax rates in U.S. economy, workers in the concentrated industries bear a larger share of the corporate tax burden.

B. Industry-Level Evidence

Labor economists have documented a wide dispersion in wages across industries for workers with similar socioeconomic characteristics. These industry wage premiums are highly persistent over time (Krueger and Summers, 1988; Dickens and Katz, 1987a, b), and there is no evidence of arbitrage activities in employment movement (Dickie and Gerking, 1998; Helwege, 1992). These findings suggest that labor market conditions may vary at the industry level in equilibrium, generating industry-specific market-clearing

[14] Gravelle (1994), Mackie (2002), and Gruber and Rauh (2007) provide examples of the industries typically used in the effective tax rate literature.

Table 3

Individual-Level Regressions: Wage Equation Estimates

	(1) 2-Stage	(2) 2-Stage	(3) 2-Stage	(4) MLE
Ln*Tax*	–0.0724***	–0.0611***	–0.2384***	–0.2183***
	(0.0089)	(0.0163)	(0.0292)	(0.0269)
Ln*CR*		0.0142**	–0.1056***	–0.0910***
		(0.0069)	(0.0178)	(0.0164)
Ln*Tax* × Ln*CR*			–0.1059***	–0.0924***
			(0.0145)	(0.0133)
Years of education	0.1544***	0.1602***	0.1603***	0.1226***
	(0.0021)	(0.0027)	(0.0027)	(0.0015)
Experience	0.1076***	0.1094***	0.1094***	0.1084***
	(0.0011)	(0.0012)	(0.0012)	(0.0010)
Experience squared	–0.0012***	–0.0012***	–0.0012***	–0.0012***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Education × Experience	–0.0031***	–0.0032***	–0.0032***	–0.0031***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Constant	Y	Y	Y	Y
Other individual characteristics	Y	Y	Y	Y
Regional dummies	Y	Y	Y	Y
Time and industry fixed effects	Y	Y	Y	Y
Number of observations	247,112	212,508	212,508	212,508
Censored observations	79,661	79,661	79,661	79,661

Notes: Additional individual characteristics included in the regression are number of children younger than age 5, number of children between ages 6 and 20, and marital status. Standard errors are in parentheses. Asterisks denote significance at the 1% (***), 5% (**), and 10% (*) levels.

wage rates. If this is the case, the relevant observation for the incidence analysis will be the industry wage rate and our individual-level data will overstate the true number of degrees of freedom.

In this section we repeat our analysis at the industry level by constructing a pseudo-panel of average wage rates and worker characteristics.[15] We run a fixed-effect regression with the pseudo-panel and report the estimation results in columns (1) and (2) of Table 5.

[15] By averaging across workers in an industry, we assume that the average worker is the relevant observation.

Table 4

Individual-Level Regressions: Employment Equation Estimates

	(1) 2-Stage	(2) 2-Stage	(3) 2-Stage	(4) MLE
Nonwork income	–0.0066*** (0.0002)	–0.0053*** (0.0002)	–0.0053*** (0.0002)	–0.0041*** (0.0001)
Years of education	0.1202*** (0.0010)	0.1293*** (0.0011)	0.1293*** (0.0011)	0.1137*** (0.0010)
Age	–0.0084*** (0.0002)	–0.0084*** (0.0002)	–0.0084*** (0.0002)	–0.0076*** (0.0002)
Number of children younger than age 5	–0.2133*** (0.0055)	–0.2220*** (0.0059)	–0.2220*** (0.0059)	–0.2051*** (0.0057)
Number of children between ages 6 and 20	0.0593*** (0.0027)	0.0545*** (0.0028)	0.0545*** (0.0028)	0.0508*** (0.0027)
Married	0.2386*** (0.0067)	0.1998*** (0.0071)	0.1998*** (0.0071)	0.1751*** (0.0068)
Constant	–0.8016*** (0.0145)	–1.0347*** (0.0155)	–1.0347*** (0.0155)	–0.8956*** (0.0146)
Number of observations	247,112	212,508	212,508	212,508

Notes: The regression model is:

$$empl_i = \begin{cases} 1, \gamma_1 inc_i + \gamma_2 educ_i + \gamma_3 age_i + \gamma_4 child5_i + \gamma_5 child20_i + \gamma_6 married_i + u_i > 0 \\ 0, \gamma_1 inc_i + \gamma_2 educ_i + \gamma_3 age_i + \gamma_4 child5_i + \gamma_5 child20_i + \gamma_6 married_i + u_i \leq 0. \end{cases}$$

This is the first-stage equation that corrects for sample selection bias in the wage equation. Standard errors are in parentheses. Asterisks denote significance at the 1% (***), 5% (**), and 10% (*) levels.

Both the estimated tax coefficient and the interaction term remain negative and statistically significant. The magnitudes of these coefficients are similar to the individual-level estimates.[16] The regression in column (2) includes additional industry fixed effects and yields a smaller tax coefficient than reported in column (1). It is important to control for unobserved industry heterogeneity in this setting because part of the variation in tax rates comes from the different asset mix across industries. But the choice of asset mix

[16] Several individual characteristic estimates including the education coefficient lose their significance in the industry-level regression due to the limited variation in averages of individual characteristics across industries.

Table 5

Industry Wage Equation Estimates

	(1) Industry Average	(2) Industry Average	(3) Industry Two-Step	(4) Industry Two-Step
Ln*Tax*	–0.3499**	–0.2277***	–0.2151	–0.1320**
	(0.1458)	(0.0735)	(0.2190)	(0.0498)
Ln*CR*	0.0228	–0.0952*	0.1542	–0.0605
	(–0.0656)	(–0.0549)	(–0.0928)	(–0.0394)
Ln*Tax* × Ln*CR*	–0.1025**	–0.1214***	–0.0370	–0.0600**
	(0.0468)	(0.0449)	(0.0698)	(0.0301)
Constant	Y	Y	Y	Y
Individual characteristics	Y	Y	Y	Y
Regional dummies	Y	Y	Y	Y
Time fixed effects	Y	Y	Y	Y
Industry fixed effects	N	Y	N	Y
Observations	95	95	95	95

Notes: The regression model in column (1) is
$\ln w_{ijt} = \mu + \boldsymbol{X}_{ijt}\boldsymbol{\alpha} + \beta_1 \ln T_{jt} + \beta_2 \ln CR_{jt} + \beta_3 \ln T_{jt} \times \ln CR_{jt} + c_j + \eta_t + \varepsilon_{jt}$.
The regression model in column (2) is
$\ln resid_{jt} = \mu + \beta_1 \ln T_{jt} + \beta_2 \ln CR_{jt} + \beta_3 \ln T_{jt} \times \ln CR_{jt} + c_j + \eta_t + \varepsilon_{jt}$, where $resid_{jt}$ is obtained from the first-step regression $\ln w_{ijt} = \mu + \boldsymbol{X}_{ijt}\boldsymbol{\alpha} + \varepsilon_{ijt}$. Robust standard errors are in parentheses. Asterisks denote significance at the 1% (***), 5% (**), and 10% (*) levels.

does not only respond to tax incentives; it can also be determined by the unobserved industry-specific factors (Liu, 2011). If the unobserved industry heterogeneity is correlated with the effective marginal tax rates, estimates of the tax coefficient would be biased and inconsistent.

To address the potential aggregation bias from using industry averages, we run a two-step regression where we regress the individual wage against all individual socio-economic characteristics with correction for sample selection bias. We then regress the industry-level residuals on tax rates, the concentration ratio, and the interaction term,

$$\ln resid_{jt} = \mu + \beta_1 \ln T_{jt} + \beta_2 \ln CR_{jt} + \beta_3 \ln T_{jt} \times \ln CR_{jt} + c_j + \eta_t + \varepsilon_{jt},$$

where $resid_{jt}$ is the industry average of residuals $\hat{\varepsilon}_{ijt}$ from the first-step wage regression,

$$\ln w_{ijt} = \mu + X_{ijt}\alpha + \varepsilon_{ijt}.$$

The estimation results are summarized in columns (3) and (4) of Table 5. The second-stage estimates of the tax rate and the interaction term are negative and statistically significant once we control for unobserved industry heterogeneity. The magnitudes of the estimates are smaller than those from the industry-average regression but confirm our results that the elasticity of wages with respect to tax rates decreases with industry competitiveness.

C. Testing the Endogeneity of the Concentration Ratio

We use the concentration ratio to measure industry competitiveness, which in turn may be affected by previous decisions and profits of firms in the industry. For example, in searching for higher profits, incumbent firms can strategically increase the entry barrier and limit the number of firms in an industry. If part of the wage payment comes from economic rents and hence is correlated with the concentration level, the coefficients on the OLS estimates of the concentration ratio and the interaction between the concentration ratio and the tax rate will be biased. We therefore test for the endogeneity of industry competitiveness, using variables that are exogenous to the wage determination process.

Intensive advertising as well as research and development (R&D) can result in higher industry entry barriers. Following Symeonidis (2008), we derive two dummy variables based on advertising and R&D intensity. We extract data from the Annual Compustat North America Industrial Files and use advertising and R&D expense relative to industry sales to measure advertising and R&D intensities. We construct a dummy variable *ADV* which equals 0 for industries with an advertising-sales ratio lower than 2 percent and which equals 1 otherwise. The dummy variable *RD* is constructed in a similar fashion. It equals 0 for industries with R&D-sales ratios lower than 2 percent and is 1 otherwise. While the levels of advertising and R&D intensities are endogenous, whether they are above or below the 2 percent cutoff points is determined by exogenous industry characteristics (Symeonidis, 2008). For industries below the cutoff point, either advertising or R&D is not an important strategic variable. Most industries stay consistently either below or above the 2 percent level across all of the years in the sample period.

The size of the natural market can also affect the industry concentration level due to the nature of products and associated transportation costs. Some industries such as perishable food or beverage production are geographically less mobile due to transportation costs and therefore confined to a smaller market size than footloose industries. We estimate the annual industry-level transportation costs following Ederington, Levinson, and Minier (2005). Specifically, we regress transportation costs on a vector of industry dummies for each sample year, controlling for distance and distance squared for the 15 largest exporting partners of the United States. We use the industry fixed-effects coefficient as the measure of transportation costs. Since the transportation cost data are only available for the non-service industries, we include a dummy variable (*TMISS*) that equals one if no information on transportation cost is available.[17]

[17] The fixed-effects coefficient is set to zero for industries with no information on transport cost. Both the industry fixed-effects coefficient and the dummy variable denoting a missing value for the transport cost are included in the regression.

We perform the regression-based Durbin-Wu-Hausman (DWH) test by regressing the concentration ratio on the effective tax rates, the advertising and R&D dummies, and transportation costs,

$$(2) \quad \ln CR_{jt} = \mu + \delta_{11} ADV_{jt} + \delta_{21} RD_{jt} + \delta_{31} TRANS_{jt} + \delta_{41} TMISS_{jt} + c_j + \eta_t + \upsilon_{1ijt}.$$

We interact the tax rate with the fitted value of the concentration ratio ln CR_Fitted_{jt} from (2) to instrument the endogenous interaction term (Wooldridge, 2008)

$$(3) \quad \ln ETR_{jt} \times \ln CR_{jt} = \mu + \delta_{12} ADV_{jt} + \delta_{22} RD_{jt} + \delta_{32} TRANS_{jt} + \delta_{42} TMISS_{jt} + \delta_5 \ln ETR_{jt} \times \ln CR\_Fitted_{jt} + c_j + \eta_t + \upsilon_{2ijt}.$$

Under the maintained assumption that all the explanatory variables in (2) and (3) are exogenous, the structural error ε_{ijt} in (1) should not be correlated with the reduced form errors υ_{1ijt} and υ_{2ijt}.[18] To test this hypothesis, we run an augmented industry-level two-step regression with $\hat{\upsilon}_{1ijt}$ and $\hat{\upsilon}_{2ijt}$ as additional regressors and jointly test whether the two coefficients on the residuals equal zero. The resulting large *p*-value (0.50) indicates that we cannot reject exogeneity of either the concentration ratio or the interaction term.[19]

D. Labor Share of the Corporate Income Tax

The marginal effect of changes in the effective marginal corporate tax on wages varies across the distribution of the concentration ratio. At any given concentration level, the elasticity of wages with respect to the corporate tax rate is

$$\frac{\partial \ln w_{jt}}{\partial \ln T_{jt}} = \beta_1 + \beta_3 \ln CR_{jt}.$$

Table 6 summarizes the wage elasticity at different quartiles of the concentration ratio, using both the individual-level and industry-level estimates. Overall, accounting for the effect of the concentration ratio, the average elasticity of wages with respect to the effective marginal corporate tax rate is –0.028 using the individual-level estimates from column (3) of Table 4 and –0.038 using the industry-level estimates from columns (2) and (4) of Table 5. Computed across different quartiles of the concentration ratio, the wage elasticity increases with the concentration ratio. The wage elasticity at the fourth quartile is at least four times larger than the elasticity at the second quartile, suggesting more shifting of corporate income taxes in the more concentrated industries.

To assess the incidence of the corporate income tax, we calculate the impact of a \$1.00 increase in corporate tax liabilities on total wages. In 1997 (the last year of our sample), total U.S. corporate income tax revenue was \$182.2 billion. A 10 percentage

[18] This method is equivalent to regressing the interaction term on the exogenous variables as well as a long list of additional nonlinear functions of the exogenous variables.

[19] Results of the DWH test are robust to alternate cutoff points including 1.5 percent and 3 percent for the advertising and R&D intensities.

Table 6
Marginal Effects on Wages across Concentration Ratio Distribution

	(1) Individual-Level	(2) Industry Average	(3) Industry Two-Step
Mean marginal effect	–0.0283***	–0.0379***	–0.0382***
	(0.0002)	(0.0091)	(0.0045)
ME at *CR* Quartile 1	0.0542***	0.0736***	0.0169***
	(0.0002)	(0.0135)	(0.0066)
ME at *CR* Quartile 2	–0.0167***	–0.0158***	–0.0273***
	(0.0001)	(0.0032)	(0.0016)
ME at *CR* Quartile 3	–0.0481***	–0.0731***	–0.0556***
	(0.0001)	(0.0033)	(0.0016)
ME at *CR* Quartile 4	–0.1226***	–0.1400***	–0.0886***
	(0.0002)	(0.0080)	(0.0039)
Observations	158,925	96	96

Notes: The wage elasticity is calculated as the average marginal effect of *ETR* across the distribution of the concentration ratios. Asterisks denote significance at the 1% (***), 5% (**), and 10% (*) levels.

point increase in the effective marginal tax rate would raise corporate tax revenue by $18.2 billion assuming the tax base remains constant. Total U.S. wages and salaries in 1997 were $3,874 billion.[20] Assuming no adjustment in total employment, a 0.28 percent drop in wages (our column (1) estimate from Table 6) would decrease total compensation by $11 billion. Hence, the burden borne by labor of a $1.00 increase in corporate tax liability is around $0.60. The 95 percent confidence interval for the average wage elasticity suggests that the labor share of the tax burden lies between 59 and 61 percent of corporate tax revenue.

The labor share of the corporate tax burden is approximately 80 percent of corporate tax revenue if we use the industry-level estimates. For every dollar increase in corporate tax revenue, the associated 95 percent confidence interval indicates that labor's share is between $0.42 and $1.19 using the industry-average estimates, and between $0.62 and $1.00 using the two-step estimates. These estimates suggest that labor bears a substantial share of the tax burden. If capital and labor equally bear the burden of the

[20] The annual wage estimates are from National Occupational Employment and Wage Estimates published by the Bureau of Labor Statistics, http://www.bls.gov/oes/oes_data.htm.

tax, the share of the burden that labor bears will be in proportion to its share of income, which is around two-thirds in the United States. This rule-of-thumb estimate is close to our most conservative labor share of tax burden imputed from the individual-level results, suggesting that labor possibly bears more of the corporate tax burden than its share of income.

VI. CONCLUSION

We measure the responsiveness of wages to changes in corporate income taxes. We use variation in industry-level tax changes to identify the impact of corporate income taxes on wages within the United States, allowing differences in industry concentration to affect the incidence analysis. We find that effective marginal corporate tax rates have a negative effect on workers' wages. In addition, our results suggest that the shifting of corporate taxes to wages intensifies with the degree of industry concentration.

Our findings suggest that labor shares a significant part of the burden of corporate income taxes. A direct calculation of the mean marginal effect of the corporate income tax from our estimates suggests that a 10 percent increase in the tax rate would decrease the average wage rate by 0.28–0.38 percent. Labor shares at least 42 percent of the burden of the corporate tax and possibly more. The average labor share of the corporate tax burden is around 60–80 percent.

One important caveat is that, due to the limitation of our data structure, we are unable to study the dynamic effects of corporate tax rates. While the theory of tax incidence suggests that changes in factor inputs occur instantaneously with changes in the tax rates, it is likely that the adjustment process plays out over many periods and therefore, the short-run incidence of corporate taxes may differ from the long-run incidence. In future research we plan to investigate the dynamics of corporate tax shifting.

In line with other empirical work on the incidence of the corporate income tax, we focus on the effect of corporate tax rates on wage rates. A more complete analysis would also investigate the effect of the tax on employment. Distinguishing between the quantity and price effects of corporate taxes remains an important topic for further research.

ACKNOWLEDGMENTS

We thank Steve Bond, Michael Devereux, Clemens Fuest, William Gentry, Jane Gravelle, Jennifer Gravelle, Benjamin Harris, Roger Klein, Mark Killingsworth, Jack Mintz, Hilary Sigman, and participants at the 2011 RES Annual Congress, the 2011 EEA-ESEM Annual Congress, the 2011 IIPF Annual Congress, the 2011 NTA Annual Conference, the 2012 AEA Annual Meetings, and workshops at Rutgers University and Oxford University for helpful comments. An earlier version of this paper was circulated with the title "Passing It On: The Incidence of the Corporate Income Tax under Imperfect Competition." Li acknowledges financial support from the ESRC (Grant No RES -060-25-0033). All errors are our own.

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