THE ECONOMIC EFFECTS OF CORPORATE INCOME TAXATION

By

LI LIU

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Rosanne Altshuler

and

Hilary Sigman

and approved by

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ABSTRACT OF THE DISSERTATION

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By Li Liu

Dissertation Director:
Rosanne Altshuler and Hilary Sigman

This dissertation consists of three essays studying the economic impact of corporate taxation. Chapter 1 models and estimates the incidence of the corporate income tax under imperfect competition. Identification comes from variation in the effective marginal tax rates across industry and time. The empirical results suggest that labor shares the burden of corporate taxes. A ten percentage increase in the tax rates decreases the average wage rate by 0.45-0.56 percent. Consistent with the theoretical prediction, the elasticity of wage with respect to the tax rates increases with the industry concentration. Labor bears at least 87 percent of the burden of corporate income taxes.

The U.S. corporate income tax system provides investment incentives that vary across asset types. In Chapter 2, I study the effect of corporate income taxes on the allocation of new capital investment by constructing an industry-level panel data from 1962 to 1997. My preferred-IV estimates of the asset substitution elasticities suggest a sizable interasset distortion effect of corporate income taxes. Substitutability is the strongest between machinery equipment and computing and electronic equipment. Compared to a revenue-neutral uniform tax scheme, differential corporate income taxes cause under-investment in computing and electronic equipment and over-investment in machinery and transportation equipment.

Corporations were taxed at a lower rate than non-corporate firms in the early twentieth century. Chapter 3 examines the effect of relative taxation of corporate to
non-corporate income using state-level panel data during 1909-1919. I find that the tax cost to incorporate had a significant impact on the corporate share of establishments and related economic activities including employment and production. The regression results suggest a large response of income shifting—about 1.5 to 2 more times than the largest estimates in studies using more recent data. Income shifting was more responsive to the tax policies during the early days of income taxes. The implicit tax subsidy encourage about 8,300 business to be organized under the corporate form during this period.
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Dedication

To my parents, Dongxiu and Zhenming Liu
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Part I
Introduction

1 Passing It On: The Incidence of the Corporate Income Tax under Imperfect Competition

The true burden of the corporate income tax has been controversial. The conventional wisdom holds that owners of capital bear most of the burden of the corporate income taxes. But the economic incidence of the corporate income tax suggests that the corporate income tax can be shifted to various candidates including investors, workers, and consumers. In particular, the burden of the corporate income tax can fall on labor. When faced with a higher production costs due to the corporate income tax, firms can pass the burden of this tax by decreasing their wage payment. Current literature suggests that the corporate income tax is passed onto workers, although these studies mainly focus on the cross-country evidence. It is less clear whether the burden of the corporate income tax is shifted to labor within the United States. In addition, no empirical study that investigates the incidence of corporate income taxes in the presence of imperfect competition.

At the international level, capital is more mobile than labor. An increase in the home country’s corporate income tax rate tends to drive capital abroad. Consequently, the tax is shifted to immobile factors such as labor. Built on this intuition, a handful of empirical papers have found that labor shares a significant burden of the corporate income tax using cross-country data. Another common feature of the existing studies is the assumption of perfectly competitive market. To the degree that this assumption departs from reality, the estimating equations may be misspecified. As Auerbach (2006) points out, before-tax corporate profits arising from imperfect competition can respond to corporate income taxes. Noncompetitive rents occur due to restricted output below the competitive level in the product market. When the
corporate income tax further restricts the output level, it is possible that producers will shift the tax to workers.

Based on the Davidson and Martin (1982) general equilibrium model, we show that the elasticity of wage with respect to corporate income tax is an increasing function of industry concentration level. We empirically test this hypothesis using data on individual U.S. workers matched with industry-level effective corporate tax rates and concentration ratios from 1982 through 1997. We use a first-stage employment equation to correct for the potential endogenous selection of the working sample. The second-stage wage equation controls for individual characteristics that might determine wage rates. We find a statistically significant and negative relationship between the wage rates and corporate taxes. The relationship between wage rates and the interaction between tax rates and concentration ratio is also negative and statistically significant, suggesting that the degree of industry competitiveness matters for analyzing the incidence of corporate income tax. A one percent increase in the concentration level increases the wage elasticity by 9.5 percent, *ceteris paribus*.

To account for the possibility that wage setting is only relevant for the marginal worker in the labor market, we carry out the regression analysis at the industry level. Estimates from the industry-level regressions further suggest that industry competitiveness plays an important role in determining how much the corporate income tax is shifted to labor. Tests of exogeneity of the concentration ratio support that the OLS estimates are consistent. Our preferred industry-level estimates indicate that the mean elasticity of wage with respect to the corporate income tax is −0.051. On average, a ten percent increase in the corporate tax rates would decrease wages by 0.05 percent.

Translating this wage elasticity into a labor share of the corporate income tax, we show that the burden borne by labor by a dollar increase in the tax liability is around 96 cents. The lower bound of labor share of the tax burden is 89 cents in the most
conservative confidence interval. Labor bears a substantial burden of the corporate income tax. The estimated labor share of the tax burden agrees with the theoretical results reported by Harberger (2006). It is also considerably smaller than estimates from most research based on the international experience.

2 Do Taxes Distort Investment Choices? Evidence from Industry-Level Data

Measuring the inter-asset distortion effect of the corporate income tax has received little attention despite the well-documented differences in the taxation of different capital assets (see, for example, Auerbach (1983a, 1996), Gravelle (1994), King and Fullerton (1984), and Mackie (2002)). While policy makers have made efforts to impose more uniform corporate tax policies, no empirical study exists to quantify the extent to which corporate income taxes have altered the structure of business investment. This is rather unfortunate because, as pointed out in Feldstein (1982), capital consists of many different types of equipment and structures. At any point in time there may be over investment in one type and under investment in another due to differential tax incentives. Asset substitution and the effect of tax incentives on the composition of new investment can be substantial and important for evaluating the efficiency and distributional effects of alternative tax policies.

In Chapter 2 I examine the effect of corporate income taxes on the allocation of new capital investment in the U.S. economy. The corporate tax code offers a range of tax instruments to encourage business investment. While a reduction in the statutory corporate tax rate applies uniformly to all investment types, the investment tax credit (ITC) and accelerated depreciation allowances are targeted tax incentives. The ITC, while no longer part of the U.S. tax code, allows a portion of the investment cost to be deducted from corporate tax liability but applied only to new equipment and public utility property. Accelerated depreciation provides a more generous deduction in present value compared to economic depreciation, generating different effective tax
rates for assets with different life durations.\(^1\) The combined effect of these tax incentives is therefore asset specific, depending on the characteristics of the physical asset and, to a lesser extent, the industry in which the asset is placed. Given the differential tax incentives at the asset level, to what degree do corporations’ investment choices respond to these differences in tax treatment? And what are the efficiency costs that result from the tax-induced changes in the investment choices?

I begin my analysis by constructing a panel data of investment share, the user cost of capital, and other control variables for 35 types of sub asset and four asset categories at the industry level from 1962 to 1997 in the United States. I calculate the Hall and Jorgenson (1967) user cost of capital (\(CoC\)), which summarizes the overall effect of the tax treatment and macroeconomic incentives on investment. The asset-level data allows me to analyze the elasticity of substitution among capital inputs within the Seemingly Unrelated Regression (SUR) framework. To obtain the causal effect of the user cost of capital despite its endogeneity due to tax-favored financing methods and capital structure, I instrument the cost of capital with industry-level financial variables that affect the overall debt level but are uncorrelated with the corporate income taxes. Based on my preferred-IV estimates, I gauge the impact of differential taxes on investment choices by calculating the own-\(CoC\) and cross-\(CoC\) elasticities of investment demand for each asset category. The cross-\(CoC\) elasticities capture responses of investment to tax incentives of other asset types. Therefore, a non-zero cross-\(CoC\) elasticity indicates the inter-asset distortionary effect of corporate taxes. I also conduct robustness checks to verify estimation efficiency gains from production constraints and to rule out the possibility of estimation bias from potential tax capitalization.

My empirical estimates show that taxes distort corporations’ investment choices. Investment in a particular asset responds to its own tax incentives and in addition,

\(^1\)A particular method of accelerated depreciation, bonus depreciation, has been a common feature of recent tax bills to stimulate investment in equipment.
to the tax incentives of other asset types. The own-CoC elasticities of investment demand range from $-0.57$ for transportation equipment to $-2.56$ for machinery equipment. Investment in structures is less responsive to its own tax incentives due to a higher adjustment cost. Nevertheless the estimated own-CoC elasticity of $-1.29$ is still statistically significant. The cross-CoC elasticities demonstrate that corporate taxes distort the allocation of investment across asset classes. Substitutability is the strongest between machinery and computing and electronic equipment. To examine the efficiency costs that result from the tax-induced changes in investment choices, I perform a revenue-neutral experiment and simulate the investment path for each asset under an uniform corporate income tax. I find that differential corporate income taxes lead to under-investment in computing and electronic equipment and over-investment in machinery and transportation equipment. Differential corporate taxes also distort investment in structures, for which there is under-investment before the passage of Tax Reform Act of 1986 and a slight over-investment afterwards.

Estimates of the asset substitution elasticities suggest a sizable inter-asset distortion effect of corporate income taxes. With a large asset substitution elasticity, changes in the relative tax treatment of different assets result in a significant change in the mix of investment, implying a relatively large efficiency cost. Ignoring this corporate tax distortion would overstate the efficiency gain from using tax instruments applicable to a particular type of investment. To approximate the lower bound of the inter-asset distortion of corporate taxes, I suggest an unitary substitution elasticity as a rule of thumb for major asset categories.\footnote{This is consistent with the Cobb-Douglas production function used in Auerbach (1981) and Gravelle (1981).} Given the magnitude of my substitution elasticity estimates, the marginal excess burden of the investment tax credit is at least 37 cents as found in Fullerton and Henderson (1989b), indicating that increase in the ITC is the least favorable corporate tax policy among the statutory corporate income tax rate, the investment tax credit rate, depreciation lifetimes, and declining
balance rates for depreciation allowances from an efficiency standpoint. When taking the interasset distortion of corporate income taxes into consideration, the efficiency gain from lowering the dispersion in the user cost of capital by reducing the ITC or the depreciation rate is considerably larger than from increasing in the statutory corporate income tax rate.

3 Tax or Subsidy? Some Unexpected Consequence of the Corporate Income Tax in the Early Twentieth Century

The United States enacted significant changes to the income tax during the first two decades of the twentieth century. The federal corporate income tax was enacted in 1909. The Sixteenth Amendment to the Constitution in 1913 empowered the congress to tax income without apportionment among the states. Shortly thereafter, the Revenue Act of 1913 established the first permanent personal income tax. The income taxes have become an important part of the U.S. tax system ever since. Observing the success of the federal income taxes in revenue collection, many states quickly followed suit and enacted state income taxes in the next ten years.

The corporate income tax collected much more revenue than the personal income tax during this period. In 1919, corporate tax revenue accounted for 4.4 percent of GDP, and personal tax revenue accounted for only 1.7 percent of GDP. In contrast, corporate tax revenue was only 1.3% of GDP in 2009, while the personal tax was the largest income tax revenue source and accounted for 8.3% of total GDP.

But the early corporate tax was more than a tool for revenue collection. The major motivation for the corporate tax was to regulate corporations, a rather non-tax purpose (Kornhauser, 1990; Avi-Yonah, 2004; Friese, Link and Mayer, 2008). Government gained information access to corporate business through the tax filing and publicity requirements, which was viewed as a form of federal supervision over corporations. On the other hand, the corporate tax had some other unintended consequence on the economy soon after the personal income tax was enacted. For
many taxpayers, income earned through a corporate business was taxed at a lower rate than through a non-corporate business. In addition, the double taxation of corporate income was essentially nonexistent as corporate dividends and net earnings were deductible from personal taxable income during this period. Corporate income was taxed favored relative to non-corporate business income, creating an incentive for income shifting to the corporate sector. I show in Chapter 3 that income shifting was very responsive to the income tax differentials in the early 20th century.

The idea that income taxes induce income shifting through the choice of organizational forms is not novel. A number of recent studies including Mackie-Mason and Gordon (1997), Goolsbee (1998, 2004), de Mooij and Nocodeme (2008) and Egger et al. (2008) suggest that by taxing the income of corporate firms at a different rate than non-corporate firms, taxes play an important role in a firm’s decision to incorporate. The presence of income shifting between the corporate and non-corporate sector in response to the tax incentives has important policy implications. If increases in the personal tax rate induce change in the reported corporate taxable income (or vice versa), then the corporate tax revenue and the overall tax revenue will be affected as a result of income shifting. When some high-income taxpayers shift their income to take advantage of differences in the taxation of business organized in different legal form, it generates a loss in the overall tax revenue and hence a loss in efficiency.

This study extends the literature by considering the effect of relative taxation on incorporation in the early twentieth century using state-level panel data during 1909-1919. The income tax system was new and at the elementary stage of its development during this period. Thus it would be interesting to see whether taxpayers recognized and responded to the tax differential incentives. Another advantage of this period is that corporate and personal tax rates experienced frequent changes both at the federal and state level, allowing credible identification of the tax effects from contemporaneous changes in other aggregate factors. On the other hand, during a period
with rapid and frequent tax policy changes, the relative taxation of corporate income might be endogenous to the size of corporate tax base. Therefore I test for the endogeneity of the tax cost using a bootstrap Durbin-Wu-Hausman test. The results of this test suggest that the tax cost to incorporate is not endogenous in the sense of leading to inconsistent OLS estimates. In addition, I explore the tax effects in two factional response models to account for the fact that the dependent variables in analysis are fractions of various economic activities.

The baseline OLS results suggest a large response of income shifting—about 1.5 to 2 more times than the largest estimates in studies using more recent data. The overall average marginal effect of tax cost is very similar to the marginal effect suggested by an OLS specification: On average, a one percentage point increase in the tax cost decreases the corporate share of establishments by around 2 percent. The corporate income tax generated an implicit subsidy for corporations and encouraged around 8,300 establishments to incorporate during the sample period.
Part II

Chapter 1
Passing It On: The Incidence of the Corporate Income Tax under Imperfect Competition

1.1 Introduction

The true burden of the corporate income tax has been controversial. The conventional wisdom holds that owners of capital bear most of the burden of the corporate income taxes. But the economic incidence of the corporate income tax suggests that the corporate income tax can be shifted to various candidates including investors, workers, and consumers. In particular, the burden of the corporate income tax can fall on labor. When faced with a higher production costs due to the corporate income tax, firms can pass the burden of this tax by decreasing their wage payment. Current literature suggests that the corporate income tax is passed onto workers, although these studies mainly focus on the cross-country evidence. It is less clear whether the burden of the corporate income tax is shifted to labor within the United States. In addition, no empirical study that investigates the incidence of corporate income taxes in the presence of imperfect competition.

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to restricted output below the competitive level in the product market. When the corporate income tax further restricts the output level, it is possible that producers will shift the tax to workers.

Based on the Davidson and Martin (1982) general equilibrium model, we show that the elasticity of wage with respect to corporate income tax is an increasing function of industry concentration level. We empirically test this hypothesis using data on individual U.S. workers matched with industry-level effective corporate tax rates and concentration ratios from 1982 through 1997. We use a first-stage employment equation to correct for the potential endogenous selection of the working sample. The second-stage wage equation controls for individual characteristics that might determine wage rates. We find a statistically significant and negative relationship between the wage rates and corporate taxes. The relationship between wage rates and the interaction between tax rates and concentration ratio is also negative and statistically significant, suggesting that the degree of industry competitiveness matters for analyzing the incidence of corporate income tax. A one percent increase in the concentration level increases the wage elasticity by 9.5 percent, ceteris paribus.

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Translating this wage elasticity into a labor share of the corporate income tax, we show that the burden borne by labor by a dollar increase in the tax liability is around
96 cents. The lower bound of labor share of the tax burden is 89 cents in the most conservative confidence interval. Labor bears a substantial burden of the corporate income tax. The estimated labor share of the tax burden agrees with the theoretical results reported by Harberger (2006). It is also considerably smaller than estimates from most research based on the international experience.

The rest of this paper proceeds as follows, Section 2 reviews the existing literature on the incidence of corporate income tax. In Section 3, we introduce the theoretical background. By extending the Davidson and Martin (1985) general equilibrium model of corporate tax incidence under imperfect competition, we show that the effect of the corporate income tax on wages increases with the degree of imperfect competition. Section 4 presents the empirical specification and identification strategy. Section 5 describes the data. Section 6 discusses the results and various econometric issues. The last section concludes and points out some caveats of this paper. The Appendix provides a full derivation of our theoretical prediction as well as an industry concordance we have developed to construct the dataset.

1.2 Previous Empirical Work on Labor Burden

A handful of recent empirical studies have tested the effect of the corporate income tax on wages using cross-country data. Arulampalam, Devereux and Maffini (2008) considers the possibility that corporate income taxes are passed on to workers in the form of lower wages through the process of union wage bargaining. To test their hypothesis, they use firm-level data in nine European countries over the period 1996 to 2003. The dependent variable, wage rate, is the logarithm of annual average company wage per worker. The tax variable is the firm-level tax liability per worker. To control for the dependence of this tax variable on firms’ profits, they instrument the tax rate using the lagged tax variable, the country-level effective marginal tax rate, the effective average tax rate and the statutory corporate tax rate. In addition, they use measures of aggregate union density and minimum log wage per employee to
capture the intensity of union bargaining. Their estimation results indicate that the negative effect of corporate taxes on wages is statistically significant. The elasticity of employee compensation with respect to corporate taxes is $-0.119$ in the short run and $-0.114$ in the long run. Conditional on value added per employee, a $\$1$ increase in the tax bill tends to reduce the median real wages by 92 cents.

While Arulampalam, Devereux and Maffini (2008) consider how corporate taxes affect wages within the framework of bargaining between firms and employees, the rest of the literature considers the effect of corporate taxes on wage from a different perspective: the long-run general equilibrium effects of tax rates on wages through investment and capital flow$^1$. Using aggregate wage and tax data within the manufacturing sector from 72 countries over the period 1981-2002, Hasset and Mathur (2006) find that wages are responsive to the corporate tax rate. To control for the possibility that more productive workers get a higher wage, they include value added per worker in the manufacturing sector and gross GDP per capita as additional explanatory variables. However, later studies cast some doubt on the exogeneity of value added per worker. If a higher tax rate generates a net outflow of capital, the value added per worker is likely to decrease as well. Despite the possibility that endogenous value added per worker may bias upward the effect of tax rates, Hasset and Mathur estimate that the elasticity of wage rates with respect to corporate income tax rates ranges from $-0.83$ to $-0.919$ across different specifications. As pointed out by Gravelle and Hungerford (2008), the large magnitude of this elasticity is very sensitive to use of alternative exchange rates (nominal vs. purchase power parity) and time intervals (five-year average vs. annual data).

Felix (2007) uses aggregate data on wages of workers grouped by skill levels from 19 OECD countries over the period 1979-2000. Using total trade over GDP to control for the openness of the economy, she finds that a one percentage point increase in

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$^1$Some theoretical studies in this literature include (but not limited to) Randolph (2006), Gravelle and Smetters (2006) and Harberger (1995, 2006).
the top statutory corporate tax rate decreases annual wages by 0.7 percent. She also considers the shifting patterns of the corporate income tax to labor of different skills and finds no statistically significant evidence.

Desai, Foley and Hines (2007) use data from US multinational firms operating in 50 countries (excluding the U.S.) and directly estimate the share of the corporate taxes born by labor and capital. The tax rate measure is the ratio of aggregate foreign income tax payments to the sum of aggregate net income and foreign income tax payments. Imposing the constraint that the total tax effect should add up to one, they find that the share of the corporate tax burden born by labor varies between 0.45 to 0.75 depending on the sample period and specification. Overall, this new literature has provided evidence that labor bears a large burden from the corporate tax at the country level.

1.3 Theoretical Background on the Incidence of the Corporate Income Tax

Theory on the incidence of corporate income tax dates back to Harberger (1962). In a two-sector economy, the corporate and noncorporate sectors produce separate goods. There are two factors of production, capital and labor. The total supplies of labor and capital are fixed and mobile across sectors. The corporate income tax is modeled as an additional tax on capital in the corporate sector.

A source-based tax on corporate capital affects the price of capital and labor through two channels: the output effect and the factor substitution effect. The tax increases the cost of production, which in turn depresses the output and drives up the price of goods in the corporate sector. This is the output effect of the capital tax. Capital and labor will both leave the corporate sector, but the effect of the capital tax on their prices will depend on the relative factor intensity in the two sectors. When the corporate sector is labor intensive, the noncorporate sector will absorb less labor than what has been shed in the corporate sector. The price of capital and labor will both fall in the corporate sector.
Corporate producers will substitute labor for capital as the labor cost is deductible, driving up the capital intensity in the noncorporate sector. The price of capital will fall and the price of labor will rise in the corporate sector. While the capital tax unambiguously decreases the price of capital, its overall impact on the price of labor in the corporate sector depends on the joint force of the output and substitution effects. Harberger (1962) calibrated parameter values for factor shares, input/output substitution elasticity and found that capital income bears the full burden of the corporate tax.

When the assumption of perfect competition and closed economy is relaxed, the theoretical prediction of how wage is affected by the corporate income tax yields different possibilities. Theoretical studies on the incidence of corporate income tax in an open economy have demonstrated that when capital is internationally mobile while labor is not, a domestic capital tax drives capital abroad for a higher after-tax worldwide rate of return. The burden of corporate income tax is left to the immobile production factors such as labor and land.

The incidence of corporate income tax under imperfect competition has been examined in work by Dixit and Stiglitz (1977), Atkinson and Stiglitz (1980) and Davidson and Martin (1985). Building on Dixit and Stiglitz (1977), Atkinson and Stiglitz (1980) characterizes the monopolistic behavior of firms in the corporate sector by a declining cost curve due to fixed capital cost. Within the framework of Cournot-Nash competition, a corporate tax increases the fixed costs and the average production cost, which in turn reduces firms’ profit and the replacement investment. Through a reduced demand for capital, the corporate income tax changes the relative factor prices.

In order to capture the strategic effects in imperfect competition, Davidson and Martin (1985) analyze the incidence of the corporate income tax in a two-sector economy with competitive (noncorporate) and oligopolistic (corporate) sectors. The corporate sector consists of N oligopolists. This group of oligopolists (the cartel)
play a repeated game in which each produces constrained quantities of a single good X under constant cost. Friedman’s grim trigger strategies support the constrained production which maximizes joint oligopolistic profits subject to no cheating. If any firm cheats by producing a higher quantity at time $t$, every firm will revert permanently to the Nash output level. The potential cheater compares the current gain from cheating to the present value of profit loss by permanently producing at a lower output level. The sustainable level of output depends on the capitalized value of net gains from cheating.

When imbedded in a general equilibrium model, a capital tax in the corporate sector will have the usual output effect and factor substitution effect. In addition, the capital tax will decrease the net return to capital, which measures not only the return to capital but also the time preference. A fall in the time preference increases the present value of profit loss due to cheating and allows the corporate sector to sustain a lower output and higher price. Reinforcing the output effect of the corporate tax, imperfect competition further drives down the price of labor when the corporate sector is labor intensive.

If the capital tax further constrains the corporate production level due to lack of competitiveness, then the output should be most constrained in the least competitive industries. To see whether this is the case, we derive the comparative static of the wage elasticity with respect to the number of players in the corporate sector. We show that the elasticity of wage with respect to the corporate income tax is indeed an increasing function of the industry concentration level.

1.4 Research Design

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

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

The parameters of main interest are \(\beta_1\) and \(\beta_3\). The value of \(\beta_1\) relative to zero provides insight into the degree to which the corporate income tax is shifted to workers. A negative \(\beta_1\) implies that labor is hurt more relative to capital, suggesting that the output effect dominates the factor substitution effect. A negative \(\beta_3\) implies that the marginal effect of the tax on wages increases with the level of concentration, suggesting that the output effect is manifested at the most concentrated industry. We include individual characteristics, \(X_{ij}\), to avoid biased estimation of the parameters and reduce estimation noise.

1.4.1 Sample Selection Issues

Approximately one quarter of the observations in the sample have missing wages due to zero weeks worked. This is a typical sample selection problem. The working sample is nonrandomly chosen, and the unobserved factors that determine the wage are likely to be correlated with the unobservables that influence one’s decision to work. If this is the case, all the estimated coefficients in the wage equation will be inconsistent. To correct for this sample-selection bias, we add a first-stage selection equation (Heckman, 1979) whereby the probability of being employed (\(empl_i\)) depends on one’s nonwork income (\(nwinc_i\)), education (\(educ_i\)), age, marital status (\(mrst_i\)), number of children younger than 5 (\(kids5_i\)), number of children between 6 and 19 (\(kids20_i\)), and white noise (\(u_i\)):

\[
empl_i = \begin{cases} 
1 & \text{if } \gamma_1nwinc_i + \gamma_2educ_i + \gamma_3age_i + \gamma_4kids5_i + \gamma_5kids20_i + \gamma_6mrst_i + u_i > 0, \\
0 & \text{if } \gamma_1nwinc_i + \gamma_2educ_i + \gamma_3age_i + \gamma_4kids5_i + \gamma_5kids20_i + \gamma_6mrst_i + u_i \leq 0.
\end{cases}
\]

The exclusion restriction is that nonwork income should affect one’s decision to
work but has no impact on his or her marginal utility for work. We measure nonwork income by aggregating net income received in the form of rents, dividends, interest, private transfers, and alimony payments. For married women, we also include in the nonwork income the husband’s wage and salary. We assume that the first-stage selection is independent of the industry characteristics.

1.5 Data

*Effective tax rates and four-firm concentration ratio.* We use the marginal effective tax rate to capture the effect of tax policy on a firm’s demand for investment. Expressed as the percentage difference between the pre-tax rate of return (user cost of capital) and after-tax real rate of return, the marginal effective tax rate is the share of the firm’s required return on capital that goes to the federal government rather than to investors. It summarizes investment incentives offered by statutory tax rate, depreciation allowances and investment credits that would apply to incremental uses of capital.

Previous studies have used top statutory corporate tax rates (Hasset and Mathur 2007 and Felix 2007), effective average tax rates (Desai, Foley and Hines 2007 and Arulampalam, Devereux and Maffini 2008), and effective marginal tax rates at the country level as instruments or in alternative specifications (Hasset and Mathur 2007 and Arulampalam, Devereux and Maffini 2008). Since there is no industry-level variation in the top statutory rate within the U.S., our alternative is either the average tax rate or the marginal rate. Since the dependent variable in our estimation is wage, a function of profit, the average tax rate as the ratio of tax payment over profits may be endogenous. Moreover, average tax rate can include taxes on past investment and taxes that are unrelated to investment. Average tax rate may also depend on the past profits or losses and contain noise in measurement of the actual tax incentives.

We derive the effective marginal corporate tax rates by industry as a weighted average of effective marginal tax rates by asset. Fullerton (1985) and Mackie (2002)
provide effective marginal tax rates at the asset level ($ETR_{at}$). The weight for each asset $a$ in industry $j$ in year $t$ ($W_{ajt}$) is the value of new investment measured in purchasers’ prices relative to total new investment in the industry. The industry-level ETR is calculated as $ETR_{jt} = \sum_{a=1}^{k} ETR_{at} W_{ajt}$. Our calculation for industry-level ETR follows the approach presented by Gruber and Rauh (2005).

We use the Economic Census data on industry revenue to calculate concentration ratio. Since the underlying industry classification system changed over time, we re-group data by the unified industry classes using a matching approach described in the Appendix. We compute the market concentration ratio as total revenue of the four largest firms relative to total revenue in an industry. Table 1 provides summary statistics for the marginal effective tax rate and concentration ratio. There is substantial variation in both variables across industries and time. The mean effective tax rate increased from 20.19% in 1982 to 32.49% in 1992 and 32.26% in 1997. Meanwhile, the average market concentration ratio decreased from 32.75% in 1982 to approximately 24% in the 1990s.

**Individual characteristics.** We obtain individual-level data from IPUMS-CPS, an integrated dataset of the random-sampled March Current Population Survey (CPS). For each observation, we use information on the respondent’s employment status, annual gross wage and salaries, number of weeks worked, age, education attainment, number of children, marital status, and nonwork income. We drop all the observations with age below 16 or above 65 and those in the armed forces\(^2\). The dropped observations represent approximately 25% of the sample. Wage and salaries are in 1982 dollars. We control for individual characteristics including years of schooling, experience, experience squared, number of children younger than 5, number of chil-

\(^2\)The census started to ask employment-related questions to persons of age 16 and older beginning in 1980.
children between 6 and 19. We also include an interaction term between schooling and experience to capture potential feedback effects.

Table 2 presents the summary statistics of demographic and socioeconomic variables by gender. Education levels are similar between men and women. What distinguishes the two groups are the labor market variables. Women are a larger share of non-labor force participation rate, 35% as compared to 16% for men. For those who are in the labor force, women have a lower employment rate, fewer weeks worked and a lower wage and salary income on average.

Industry Comparability: NAICS, SIC and Census Code. We collect data from various sources of different industry classification systems. Each classification system also changed at some point during the sample period. To overcome the problems due to inconsistency between classification systems, we develop an unified industry classification for the period of analysis. The detailed matching procedure is included in the Appendix and Table A2 lists descriptions of the 41 industries after matching. While this industry classification is not as refined as the 3-digit SICs, it provides a clear summary of the major industry groups. It also contains more industries than the usual classes (with only 18-20 industries) used in the tax literature.

1.6 Empirical Results and Discussion

1.6.1 Individual-level Regression

Table 3(a) shows the estimated effects of effective tax rates and concentration ratios on weekly wage; Table 3(b) summarizes the results from the first-stage selection equation. We use the same first-stage Probit selection model across all specifications.

\[ Experi = agei - s_i - 6, \]

where the number of years of schooling, \( s_i \), is imputed from the following categorical scheme: 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 = ‘12’ (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.
At the second stage, Column 1 regresses wage on effective tax rates along with other controls. In contrast, Column 2 adds the concentration ratio as another regressor; Column 3 adds the concentration ratio and its interaction with the effective tax rates. Column 4 estimates the full model using MLE. The estimated bias-correction term from the first-stage selection is only significant when the industry characteristics are not included.

The overall marginal effect of corporate tax rates is negative and statistically significant in every specification. The estimated coefficient of tax rates slightly decreases once we control industry competitiveness using the 4-firm CR. However, the difference between the estimated tax effects in Columns 1 and 2 is not statistically significant. The estimated coefficient of concentration ratio is positive but statistically insignificant, suggesting that industry competitiveness is not an omitted variable in itself.

The estimated coefficient of the interaction between the tax rates and concentration ratio is negative and highly significant. As the estimated coefficient on tax rates is also negative and statistically significant, this result suggests that the elasticity of wage with respect to the tax rates increases with the industry concentration level. This result is consistent with our theoretical prediction. The output effect dominates the factor substitution effect in the most concentrated industries, which results in downward pressure on the price of labor. When there is a uniform increase in ETR across industries, we would expect to see a lower wage level in more concentrated industries, *ceteris paribus*.

Even before considering the interplay between tax rates and concentration ratio, the estimated elasticity of wage with respect to tax rates is small compared to results in the existing studies. To see whether this difference is due to our use of different tax measures, we run one specification in Hasse and Mathur (2007) in which they regress the effective marginal tax rates on log hourly wages and find an elasticity
of 0.37. We use the industry-average data in the manufacturing sector and use the average education level as a proxy for the value added per worker variable. We find that a one percent increase in the tax rate decreases wage rates by 0.15 percent but not statistically significant. The estimated coefficient falls in the lower end of the 95 percent confidence interval of the findings of Hasset and Mathur.

1.6.2 Industry-level Regression

Literature in labor economics has shown that there exist large differences in wages for similar workers across industries, suggesting that the labor market may be different across industries. Accordingly, wages may be set only for the marginal worker in an industry labor market. If so, the relevant observation will be the industry wage rate. The individual-level data will overstate the true number of degrees of freedom. Therefore we repeat our analysis at the industry level, constructing a pseudo-panel by averaging over observations within each industry. By averaging across workers in an industry, we assume that the average worker is the relevant observation.

We run a fixed-effect regression with the pseudo-panel and report the estimation results in Table 4, Column (1). The estimated coefficient on the tax rate remains negative and highly significant. So does the estimated coefficient on the interaction term. Their magnitude is similar to the individual-level estimates. Some of the individual characteristic estimates including education are no longer statistically significant. This is not surprising since there is little variation in the mean individual characteristics after we control for industry fixed effects.

To avoid the aggregation bias that may arise from using industry averages, we run an individual-level first-stage regression with Heckman selection. We regress the mean industry-level residuals on tax rates, concentration ratio, and the interaction term. The estimation results are summarized in Table 4, Column (2). Estimates of the industry characteristics are negative and statistically significant at the second

\[^{4}\text{See Dickens and Katz (1986, 1987)}\]
stage. The magnitude of the estimates is slightly smaller than those from the industry-average regression. Using industry-level observations, we confirm that the elasticity of wage with respect to the tax rates decreases with industry competitiveness.

1.6.3 Testing the Endogeneity of Concentration Ratio

The concentration ratio quantifies how competitive an industry is, while the competitiveness level itself can be affected by past conducts and performance of firms in the industry. In search for higher profits, incumbent firms may strategically increase the entry barrier and limit the number of firms in the industry. If part of the wage payment comes from the economic rents and hence correlates with the concentration level, the coefficient on the OLS estimate of concentration ratio will be biased. The coefficient on the OLS estimate of the interaction between concentration ratio and the tax rate will also be biased. We therefore test for the endogeneity of regressors.

Advertising and research and development can lead to changes in the height of barriers to entry. 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 the 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 advertising-sales ratio lower than 2% and 1 otherwise. The dummy variable $RD$ is constructed in a similar fashion. It equals 0 for industries with R&D-sales ratio lower than 2% and 1 otherwise. As suggested in Symeonidis (2008), while the levels of advertising and R&D intensities are endogenous, whether they are above or below the 2% cutoff point is determined by exogenous industry characteristics. Namely, for industries below the cutoff point, advertising/R&D is not a very important strategic variable. Most industries stay consistently either below or above the 2% across years within the sample period.

The natural market size for an industry can also affect the concentration level due to the nature of products and transportation cost. Some industries such as per-
ishable food or beer production are geographically less mobile than others due to transportation costs. These footloose industries are confined with a smaller market size. Consequently, we expect them to have a smaller market share per firm. We estimate the annual industry-level transportation costs following Ederington, Levinson and Minier (2004). Specifically, we regress transportation costs on a vector of industry dummies by 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 transport cost. Since the transport cost data is only available for the non-service industries, we include a dummy (TMISS) taking on a value of 1 if no information on the transport cost is available.

To derive the regression-based Durbin-Wu-Hausman test, we regress the concentration ratio on the effective tax rates, the advertising and R&D dummies, and transport costs:

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

We interact the tax rate with the fitted value of the concentration ratio \( \ln CR_{jt} \) from equation (2) to instrument the endogenous interaction term (Wooldridge, 2002, p. 118-120 and 235-237):

\[ \ln ETR_{jt} \times \ln CR_{jt} = \mu + \delta_{12}ADV_{jt} + \delta_{22}RD_{jt} + \delta_{32}TRANS_{jt} + \delta_{42}TMISS_{jt} \\
+ \delta_5 \ln ETR_{jt} \times \ln CR_{jt} + c_j + \eta_t + \epsilon_{2ijt}. \] (3)

Under the maintained assumption that all the explanatory variables in equation (2) and (3) are exogenous, the structural error \( \epsilon_{ijt} \) in equation (1) should not be corre-

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5The fixed-effects coefficient is set to zero for industries with no information on transport cost. Both the industry fixed-effects coefficient and the dummy denoting a missing value for the transport cost are included in the regression.

6This 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.
lated with the reduced form error $v_{1ijt}$ and $v_{2ijt}$. To test this hypothesis, we run an augmented industry-level two-step regression with $\tilde{v}_{1ijt}$ and $\tilde{v}_{2ijt}$ as additional regressors. We perform a joint test to see whether the two coefficients on the residuals equal zero. The large $p$-value (0.50) indicates that we cannot reject exogeneity of either the concentration ratio or the interaction term$^7$.

1.6.4 Labor Share of the Corporate Income Tax

With the interaction term between effective tax rate and concentration ratio, the actual marginal effect of ETR varies across the distribution of concentration ratio. For a given level of market concentration, the elasticity of wage with respect to the effective marginal tax rate is

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

We compare in Table 5 the average wage elasticity and wage elasticity by quartiles of concentration ratio using the individual-level and industry-level estimates.

Overall, accounting for the effect of concentration ratio, the average elasticity of wage with respect to the ETR is $-0.045$ using the individual-level estimates and $-0.056/ -0.051$ using the industry-level average/two-step estimates. Computed at different quartiles of concentration ratio, the wage elasticity increases with the concentration ratio. For the least concentrated industries, the wage elasticity is positive but not statistically different from zero, indicating that there is no shifting of corporate income taxes to wages. The wage elasticity at the 4th quartile is $3 - 4$ times larger than the elasticity at the 2nd quartile, suggesting more shifting of corporate income taxes in the most concentrated industries.

On the surface, the impact of the tax rates on wage seems small comparing to the primary determinants of wage such as education and experience. Nevertheless, the

$^7$Results of the DWH test are robust to alternate cutoff points including 1.5% and 3% for the advertising and R&D intensities.
marginal elasticity of wage with respect to the corporate income tax is statistically significant. When translated into the labor share of the corporate income tax, the wage elasticity suggests that labor bears a substantial burden of the corporate income tax.

To assess the incidence of corporate income tax, we calculate the impact of a $1 increase in the corporate tax liability on total wages. In 1997, the total U.S. corporate income tax revenue is $182.29 billion. A ten percentage increase of the effective marginal rate would raise the corporate tax revenue by $18.23 billion providing the tax base remains constant. The total U.S. wage and salary is $3,874 billion. Assuming no adjustment in the total employment, a 0.45 percent drop in wage rate would decrease total compensation by $17.43 billion. The burden born by labor by $1 increase in the tax liability is around $0.96. The 95 percent confidence interval for the average elasticity suggests that the labor share of the tax burden lies between 0.95 and 0.97 times of the corporate tax revenue. Computed from the industry-level estimates, the labor share of the tax burden is approximately $1.08 – 1.20 times of the corporate tax revenue. The associated 95 percent confidence interval is (−1.51, −0.87) using the industry-average estimates and (−1.27, −0.89) using the two-step estimates. If capital and labor equally bear the burden of the tax, the share of the burden that labor bears will be in proportion to its share of income. A rule of thumb is that this share is around two thirds, which is substantially smaller than the lower bound of the labor share in the most conservative confidence interval. Therefore, labor bears a substantial burden of the corporate income tax.

1.7 Conclusion

This paper provides empirical evidence on the responsiveness of workers’ wage to changes in corporate taxes. Corporate tax rates have a negative effect on workers’ wages. Consistent with our theoretical hypothesis, the shifting of corporate taxes to wages intensifies with the degree of market concentration. The estimated effect of the
corporate income tax is in general smaller than what has been found in the existing literature using aggregate country-level data, suggesting that labor may have some leeway to avoid the incidence of the corporate income taxes by switching industries within a country.

Our findings also confirm that labor shares the burden of corporate income taxes. A direct calculation of the mean marginal effect of the corporate income tax reveals that a ten percentage increase in the tax rate would decrease the average wage rate by $0.45\% - 0.56\%$. Labor shares at least 0.87 times the burden of corporate income taxes. Clearly, further research on the labor response to the corporate income taxes is needed before we can provide a definite answer to the incidence of the corporate income taxes. Nevertheless, our empirical estimates combined with findings from the existing literature suggest that the assumption that the corporate income tax falls on the owners of capital shall be reconsidered. Labor bears a substantial portion of the burden from the corporate income tax.
Chapter 2
Do Taxes Distort Corporations’ Investment Choices?
Evidence from Industry-Level Data

2.1 Introduction

Measuring the inter-asset distortion effect of the corporate income tax has received little attention despite the well-documented differences in the taxation of different capital assets (see, for example, Auerbach (1983a, 1996), Gravelle (1994), King and Fullerton (1984), and Mackie (2002)). While policy makers have made efforts to impose more uniform corporate tax policies, no empirical study exists to quantify the extent to which corporate income taxes have altered the structure of business investment. This is rather unfortunate because, as pointed out in Feldstein (1982), capital consists of many different types of equipment and structures. At any point in time there may be over investment in one type and under investment in another due to differential tax incentives. Asset substitution and the effect of tax incentives on the composition of new investment can be substantial and important for evaluating the efficiency and distributional effects of alternative tax policies.

This paper examines the effect of corporate income taxes on the allocation of new capital investment in the U.S. economy. The corporate tax code offers a range of tax instruments to encourage business investment. While a reduction in the statutory corporate tax rate applies uniformly to all investment types, the investment tax credit (ITC) and accelerated depreciation allowances are targeted tax incentives. The ITC, while no longer part of the U.S. tax code, allows a portion of the investment cost to be deducted from corporate tax liability but applied only to new equipment and public utility property. Accelerated depreciation provides a more generous deduction in present value compared to economic depreciation, generating different effective tax
rates for assets with different life durations. The combined effect of these tax incentives is therefore asset specific, depending on the characteristics of the physical asset and, to a lesser extent, the industry in which the asset is placed. Given the differential tax incentives at the asset level, to what degree do corporations’ investment choices respond to these differences in tax treatment? And what are the efficiency costs that result from the tax-induced changes in the investment choices?

I begin my analysis by constructing a panel data of investment share, the user cost of capital, and other control variables for 35 types of sub asset and four asset categories at the industry level from 1962 to 1997 in the United States. I calculate the Hall and Jorgenson (1967) user cost of capital (CoC), which summarizes the overall effect of the tax treatment and macroeconomic incentives on investment. The asset-level data allows me to analyze the elasticity of substitution among capital inputs within the Seemingly Unrelated Regression (SUR) framework. To obtain the causal effect of the user cost of capital despite its endogeneity due to tax-favored financing methods and capital structure, I instrument the cost of capital with industry-level financial variables that affect the overall debt level but are uncorrelated with the corporate income taxes. Based on my preferred-IV estimates, I gauge the impact of differential taxes on investment choices by calculating the own-CoC and cross-CoC elasticities of investment demand for each asset category. The cross-CoC elasticities capture responses of investment to tax incentives of other asset types. Therefore, a non-zero cross-CoC elasticity indicates the inter-asset distortionary effect of corporate taxes. I also conduct robustness checks to verify estimation efficiency gains from production constraints and to rule out the possibility of estimation bias from potential tax capitalization.

My empirical estimates show that taxes distort corporations’ investment choices. Investment in a particular asset responds to its own tax incentives and in addition,

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1 A particular method of accelerated depreciation, bonus depreciation, has been a common feature of recent tax bills to stimulate investment in equipment.
to the tax incentives of other asset types. The own-\(CoC\) elasticities of investment demand range from \(-0.57\) for transportation equipment to \(-2.56\) for machinery equipment. Investment in structures is less responsive to its own tax incentives due to a higher adjustment cost. Nevertheless the estimated own-\(CoC\) elasticity of \(-1.29\) is still statistically significant. The cross-\(CoC\) elasticities demonstrate that corporate taxes distort the allocation of investment across asset classes. Substitutability is the strongest between machinery and computing and electronic equipment. To examine the efficiency costs that result from the tax-induced changes in investment choices, I perform a revenue-neutral experiment and simulate the investment path for each asset under an uniform corporate income tax. I find that differential corporate income taxes lead to under-investment in computing and electronic equipment and over-investment in machinery and transportation equipment. Differential corporate taxes also distort investment in structures, for which there is under-investment before the passage of Tax Reform Act of 1986 and a slight over-investment afterwards.

Estimates of the asset substitution elasticities suggest a sizable inter-asset distortion effect of corporate income taxes. With a large asset substitution elasticity, changes in the relative tax treatment of different assets result in a significant change in the mix of investment, implying a relatively large efficiency cost. Ignoring this corporate tax distortion would overstate the efficiency gain from using tax instruments applicable to a particular type of investment. To approximate the lower bound of the inter-asset distortion of corporate taxes, I suggest an unitary substitution elasticity as a rule of thumb for major asset categories.\(^2\) Given the magnitude of my substitution elasticity estimates, the marginal excess burden of the investment tax credit is at least 37 cents as found in Fullerton and Henderson (1989b), indicating that increase in the ITC is the least favorable corporate tax policy among the statutory corporate income tax rate, the investment tax credit rate, depreciation lifetimes, and declining

\(^2\)This is consistent with the Cobb-Douglas production function used in Auerbach (1981) and Gravelle (1981).
balance rates for depreciation allowances from an efficiency standpoint. When taking
the interasset distortion of corporate income taxes into consideration, the efficiency
gain from lowering the dispersion in the user cost of capital by reducing the ITC
or the depreciation rate is considerably larger than from increasing in the statutory
corporate income tax rate.

The rest of this chapter proceeds as follows. Section 2.2 reviews the related lit-
erature on investment and the corporate income tax. Section 2.3 gives an overview
of incentives for business investment in the U.S. corporate tax system. Section 2.4
describes the data and Section 2.5 presents the regression methodology. Section 2.6
discusses the main results and Section 2.7 discusses various econometric issues. The
last section concludes and points out some caveats of this paper. Appendix B provides
a detailed description of the variables in analysis.

2.2 Literature Review

Although no previous work provides direct estimates of the effect of corporate
taxes on the mix of investment among capital assets, a number of studies address
differences in the marginal cost of investment due to corporate taxation. Differences
in the marginal cost of investment at the asset level provide indirect evidence of the
interasset distortion of corporate taxes. A few studies, including Auerbach (1983),
King and Fullerton (1984), Gravelle (1994), Auerbach and Hassett (1991) and Mackie
(2002), calculate the user cost of capital and the corresponding marginal effective tax
rates for equipment and structures under various taxation schemes. All suggest that
differential capital taxes generate variation in the user cost of capital by asset. In
addition, changes in the relevant tax provisions alter the distribution (mean and
standard deviation) of the cost of capital. Using a fixed after-tax corporate return
and inflation rate, estimates in Auerbach and Jorgenson (1980) and Jorgenson and
Sullivan (1981) suggest that accelerated depreciation and the investment tax credit
drive differences in the effective corporate tax rates across investment types under the
Economic Recovery Tax Act of 1981, which was especially favorable to equipment. Egger et al. (2009) recognize that as investment structure and financing opportunities differ across industries, an identical change in the statutory corporate tax rates or depreciation allowances will induce different changes in the user cost of capital at the industry and firm level. By computing the marginal effective tax rates for a large sample of firms, they demonstrate that industry- and firm-specific effects are important determinants of the variation in effective marginal tax rates.

Researchers have also used general equilibrium models to study the welfare costs of non-uniform capital income taxes with assumed values of asset substitution elasticities. For example, Auerbach (1983b) and Gravelle (1994) find welfare costs of differential capital taxes in the range of 0.10 to 0.15 percent of GNP assuming Cobb-Douglass production technologies. Using a disaggregated general equilibrium model, Fullerton and Henderson (1983a) suggest that the pre-TRA86 tax scheme generates larger inter-asset distortions than inter-sectoral or inter-industry distortions, provided that the asset substitution elasticity is above 0.4. Implicitly assuming a zero asset substitution elasticity, Auerbach (1989) finds that the welfare gains from a move toward uniform business taxation in TRA86 is the same order of magnitude as the welfare losses resulting from the reform’s increase in overall tax rates. Mackie (1985) finds that the measured welfare cost of misallocated assets tends to be smaller when assets are aggregated. Specifically, the welfare cost from misallocation between aggregated equipment and aggregated structures is 60 percent less than the welfare cost associated with 30 disaggregated assets.

The impact of corporate taxation on investment decisions has been an active area of research. This literature is relevant because it studies the distortionary effect of corporate taxes between consumption and savings. In contrast with a small user-cost elasticity found in early studies, results of recent work including Cummins et al. (1994, 1996), Caballero et al. (1995), Goolsbee (2000), Ramirez Verdugo (2005), Schaller
(2006) and Dwenger (2010) imply that the elasticity of aggregate investment with respect to the user cost of capital is approximately $-1$. In particular, Schaller (2006) uses a cointegrating relationship between aggregate investment in equipment and the user cost of capital and finds a long-run user-cost elasticity of $-1.6$ for investment in equipment in Canada. When applied to the total capital stock, the estimate of the user-cost elasticity is not statistically different from zero, suggesting that aggregation over types of capital might have disguised the role of user cost.

While the importance of capital heterogeneity to firms’ investment decisions has largely been ignored in the taxation and investment literature, the productivity literature has presented considerable evidence that firms substitute among heterogeneous inputs in response to price differences. Berndt and Christensen (1973) use a three-input translog production function and find that equipment and structures are closer substitutes than for labor. Most subsequent studies derive a set of input-share functions based on the translog cost function and directly estimate the share functions as a system of seemingly unrelated equations (SURs). A small selection of these important studies include Berndt and Wood (1975), Fuss (1977), Pindyck (1979), Jones (1995), Morrison (1997), Urga and Walters (2003), Stern (2009) and Serletix et al. (2010). Most focus on energy demand and interfuel substitution. Regarding factor substitutability of heterogeneous capital inputs, Berndt and Christensen (1973) is the only empirical study that explicitly incorporates differential capital taxes in the price of capital services.

2.3 Incentives for Business Investment in the U.S. Corporate Tax System

2.3.1 Overview of the Major Tax Incentives

The corporate tax code offers a range of investment subsidies designed to encourage investment in new capital including statutory corporate tax rates, depreciation

\[ \text{For an overview of the evolvement in the investment and user cost elasticity literature, see Chirinko (1993) and Hassett (2002).}\]
allowances and investment tax credits.

Depreciation applies to an asset with an estimated life expectancy longer than the taxable year. The U.S. tax code specifies depreciation deductions as a function of the asset’s cost basis, the recovery period (or useful tax life), and the depreciation method. The recovery period specifies the number of years over which depreciation deductions can be claimed and differs substantially across investments. The depreciation method specifies the annual amount of deduction and is usually related to the durability of the asset.

Depreciation affects firms’ investment decision by allowing a portion of the investment costs to be deducted from corporate revenue. Tax depreciation is neutral to investment decisions if it equals the economic depreciation. The tax code can postpone taxes on the gross stream of return by allowing a shorter useful life compared to the asset’s economic life, i.e. creating an accelerated rate of deduction relative to the economic depreciation. Firms therefore retain more after-tax income early in the depreciation cycle. Accelerated depreciation creates an investment subsidy by allowing for more depreciation towards the beginning of the asset life.

A depreciation deduction has been a part of the U.S. income tax since 1909. Accelerated depreciation was first introduced in the The Internal Revenue Code of 1954 to provide a permanent investment incentive.\textsuperscript{4, 5} Depreciation allowances were further liberalized in subsequent decades through shortened tax lives and higher de-

\textsuperscript{4}The new Code explicitly authorized the use of the double-declining balance (DDB), sum-of-the-years digits (SOY) method of computing depreciation deductions, and any other method that does not result in larger depreciation deduction during the first two-thirds of the life that exceeded amounts allowed under DDB.

\textsuperscript{5}The primary motive behind the introduction of the accelerated methods in 1954 was documented in the Senate Finance Committee:

"More liberal depreciation allowances are anticipated to have far-reaching economic effects. The incentives resulting from the changes are well timed to help maintain the present high level of investment in plant and equipment... The faster tax write-off would increase available working capital and materially aid growing businesses in the financing of their expansion. For all segments of the American economy, liberalized depreciation policies should assist modernization and expansion of industrial capacity, with resulting economic growth, increased production, and a higher standard of living."
duction rates. Major revisions in the depreciation method include the Accelerated Depreciation Range system (ADR) in the Revenue Act of 1971, which allowed the actual tax life to be 20% more or less than the prescribed tax life; the Accelerated Cost Recovery System (ACRS) in the Economic Recovery Tax Act of 1981, which established property class lives and shorter recovery periods; the Modified Accelerated Cost Recovery System (MACRS) in the Tax Reform Act of 1986, which expanded the number of property classes and introduced a half-year convention to simplify the first and final years of a property’s recovery life. In general, the depreciation scheme in the U.S. subsidizes investment by providing short tax lives and accelerated rate of cost deduction compared to the natural depreciation rate.

The investment tax credit (ITC) is a more explicit and direct subsidy to investment. An ITC is a reduction in the corporate tax liability determined as a percentage of the purchase price of an asset. It offers immediate proportional relief of tax liability within the same year when an asset is purchased. Consequently, unlike depreciation deductions, the effect of the ITC is independent of the current discount rate or inflation rate.

Introduced in 1962, the statutory rate for the ITC was 7 percent for spending on business capital equipment with tax lives longer than three years and for special-purpose structures. Public utility property (equipment and structures) also received a credit at 3 percent. The ITC was temporarily suspended twice between 1966 and 1969 in order to reduce inflation and wide fluctuation in investment. It was later reinstated to seven percent in 1971. The maximum rate of the ITC was increased to 10 percent in 1975, but was eliminated by the Tax Reform Act of 1986 (TRA86) to provide more neutral taxation on assets and to compensate for the revenue loss from corporate tax rate cuts.

There is an interaction effect between the ITC and depreciation allowances. By

---

6
Eliminating the credit would help reduce inflation and help keep the rate of change in investment on a more steady path" [U.S. Congress, House, Committee on Ways and Means, 1969, p. 178].
increasing the cash flow available for investment, the ITC can reduce the net cost of acquiring depreciable assets. On the other hand, the statutory impact of the ITC increases with the tax life of an asset.\(^7\) For the purpose of my study, frequent changes in depreciation allowances and the ITC provisions provide rich variation in the tax variables over time, and the differential tax treatment at the asset level generates variation among asset classes.

### 2.3.2 Evolution of the User Cost of Capital

Traditionally, the effects of tax policy on investment demand are summarized by the user cost of capital. A firm sets its investment level so that the marginal benefit of an additional dollar’s investment equals the marginal cost—the user cost of capital. Conceptually, the user cost of investment is the minimum return a firm needs on the next dollar’s investment to cover depreciation, taxes, and the opportunity cost of investment. The price of renting a unit of capital for one period is the product of the cost of capital and the relative price of capital good:

\[
C = CoC \times \frac{P^i}{P^k}
\]

where \(P^i\) is the price deflator for the investment good and \(P^k\) is industry output price.

I compute the cost of capital (\(CoC\)) as

\[
CoC = \frac{(r - \pi + \delta)(1 - ITC - \tau z)}{(1 - \tau)}, \quad (1)
\]

where \(r\) is the nominal discount rate, \(\pi\) is the inflation rate, \(\delta\) is the rate of economic depreciation, \(ITC\) is the investment tax credit rate, \(\tau\) is the statutory corporate tax rate, and \(z\) is the present value of depreciation allowance on a dollar of new capital.

In Equation (1), \(r - \pi\) reflects the real cost of funds, a weighted average of the costs

---

\(^7\)For example, under the 1962 legislation, eligible property with a tax life of 4 to 6 years received one-third of the ITC, and eligible property with a tax life of 6 to 8 years received two-thirds of the ITC. The full credit was given for eligible property with a tax life of 8 or more years.
of debt and equity. Consequently, the particular value of \( z \) reflects the discount rate, the lifetime for the asset, and the depreciation schedule \( D \). The term \( (1 - ITC - \tau z)/(1 - \tau) \) summarizes the intended impact of corporate taxes on investment. A taxation system for which \( (1 - ITC - \tau z)/(1 - \tau) \) equals one generates the same rate of return for investment in alternative assets and is therefore asset neutral.

When the taxation system deviates from asset neutrality, it generates distortion in the choices of prospective investment. As pointed out in Auerbach (1983b), the distortion can arise from various components of the user cost: (i) a discrepancy between the patterns of economic depreciation and those of depreciation allowances, which generates a specific cost of capital for each asset type; (ii) a lack of indexing nominal depreciation allowances for inflation, resulting in decline in the real value of depreciation allowances with inflation and an increase in the cost of capital; and (iii) the lack of investment tax credit on buildings. In particular, inflation discriminates against short-lived assets and consequently, the effect of inflation on the cost of capital depends on the value of economic depreciation rate for each asset. Therefore, the net effect of the tax incentives on the marginal investment in a particular asset depends on the interactions between the intended effect of tax policy, the industry capital structure (reflected by \( r \)), macroeconomic environment (reflected by \( \pi \)) and the asset characteristic (reflected by \( \delta \)).

A related concept often used in the tax literature is the real social rate of return. This return, \( \rho \), at which the gross future revenue from the potential investment has a zero net present value, can be expressed as the cost of capital net of depreciation:

\[
\rho^c = \frac{(r - \pi + \delta)(1 - ITC - \tau z)}{(1 - \tau)} - \delta = CoC - \delta.
\]

Consequently the marginal effective corporate tax rate is the difference between the
before-tax return $\rho^c$ and net-of-tax return $(r - \pi)$, divided by the before-tax return. Following the empirical investment literature, I use the traditional gross-of-depreciation user cost of capital to measure investment incentives.

Figure 2.1 summarizes the time-series movement of top statutory corporate tax rate, inflation rate, and the maximum investment tax credit rate from 1962 to 1997. The top statutory rate decreases over time.\(^8\) The top statutory rate and the ITC rate have moved in the same or opposite directions depending on the objectives of the fiscal policy. Table 2.1 summarizes the unweighted mean and standard deviation of the user cost of capital, the net-of-depreciation cost of capital, the marginal effective tax rate, and the present value of tax depreciation per dollar by equipment and structures. The overall net-of-depreciation cost of capital and the marginal effective tax rate are lower for equipment, as well as the present value of tax depreciation per dollar. The negative effective tax rates for equipment during the 1970s and early 1980s are mainly due to the high ITC rate and accelerated depreciation. The TRA86 clearly narrows the gap between the effective tax rates on equipment and those on structures. The overall spread of effective tax rates has also decreased since the TRA86 came into effect. Nevertheless, there is still considerable variation in the user cost of capital and effective tax rates across asset types.

2.4 Data

2.4.1 Major Data Source

I construct a balanced panel of investment shares, user costs of capital and real prices at the asset and industry level with data from the Bureau of Economic Analysis (BEA), the Bureau of Labor Statistics (BLS), and various other sources. The BEA capital flow tables show new capital investment in equipment, software, and structures by industries that purchase or lease these capital goods and services in the U.S.\(^8\) The Korean War period is the only time when the statutory rate increased.
economy. The Survey of Current Business publishes the capital flow table approximately every five years, and are available for 1963, 1967, 1972, 1977, 1982, 1992 and 1997. I match every commodity in the capital flow table to one of the standard 35 subasset categories defined in Hulten and Wykoﬀ (1981). The BLS commodity database publishes the Producer Price Index (PPI) for each of these 35 sub assets over the sample period. Another major data source is the annual Compustat Industrial, Full coverage and Research files, which provide corporate financial data for the calculation of industry-level real interest rate.

2.4.2 Construction of Variables

I compute the investment share $S_{ikt}$ as the share of investment in asset $i$ relative to the annual gross investment in new equipment and structures in industry $k$, year $t$. Investment is measured in purchasers’ price. Following Equation 1, I calculate the following inputs to estimate the user cost of capital $CoC_{ikt}$:

**The nominal discount rate**

The nominal corporate discount rate for industry $k$ in year $t$ ($r_{kt}$) is a weighted average of after-tax rates of return to debt and equity:

$$r_{kt} = \theta_{kt} \times i_t (1 - \tau_t) + (1 - \theta_{kt}) e_t,$$

where $\theta_{kt}$ is the share financed by debt in industry $k$ at year $t$ (and $1 - \theta_{kt}$ is the share financed by equity), $i_t$ is annual rate of return to debt measured by the nominal corporate AAA bond rates, and $e_t$ is the annual rate of return to equity imputed assuming a 4 percent premium following the standard approach.\textsuperscript{9} \textsuperscript{10} I use every public traded company in operation during the sample period and compute industry averages by deleting observations without a complete record on the variables included

\textsuperscript{9}Sources: Board of Governors of the Federal Reserve System (http://www.federalreserve.gov/)

\textsuperscript{10}For a recent application, see Gruber and Rauh (2005) on the effect of corporate tax rates on corporate taxable income.
in the analysis.

**The tax term of the cost of capital**

The tax term of the cost of capital for sub asset $i$ in industry $k$ at year $t$ is 

$$(1 - ITC_{it} - \tau_t z_{ikt})/(1 - \tau_t).$$

Data on top statutory tax rate $\tau_t$, investment tax credit rate $ITC_{it}$, tax life $Y_{it}$, and depreciation method $D_{it}(s_{it})$ are collected from the Internal Revenue Services (IRS) corporate income tax laws. Let $D_{it}$ denote the basic depreciation formula specifying the proportion of the purchase cost of an asset of age $s_{it}$ to be deducted from income. The present value of the depreciation deduction per dollar on sub asset $i$ in industry $k$ at time $t$ is:

$$z_{ikt} = \int_0^{Y_{it}} e^{-r_{kt}s_{it}} D_{it}(s_{it}) ds,$$

where $Y_{it}$ is the tax life of asset $i$ in year $t$ and $r_{kt}$ the nominal discount rate in industry $k$ at year $t$. A detailed calculation of depreciation allowances is included in the Appendix.

**The industry-level cost of capital**

Finally, I collect the standard estimates of economic depreciation rates by asset type ($\delta_i$) from Hulten and Wyckoff (1981) to compute the industry-level user cost of capital.\footnote{Hulten and Wyckoff (1981) estimate economic depreciation rates for individual asset classes in the U.S. They compare their used market price approach to the BEA capital stock approach and find that both approaches produce very similar estimates of economic depreciation.} The economic rates of depreciation are asset specific and time invariant. For each of the 35 sub assets in industry $k$ at time $t$, I compute the user cost of capital as:

$$CoC_{ikt} = \frac{(r_{kt} - \delta_i)(1 - ITC_{it} - \tau_t z_{ikt})}{(1 - \tau_t)}$$

At each time period, the user cost of capital varies by asset type and industry due to the interaction between the industry-level interest rate and the asset-level tax incentives. The nominal interest rate $r_{kt}$ depends on the capital structure of each
industry. The present value of the depreciation allowances $z_{ikt}$ also depends on the industry-specific nominal rate of discount $r_{kt}$, which further induces variation of the user cost at the asset–industry level.

For the price variable, I use the PPI which measures the average change over time in the selling prices received by domestic producers for their output. The real price for sub asset $i$ in year $t$ ($P_{it}$) is the selling price of asset $i$ received by domestic producers. The price index is normalized to 100 in 1982 relative to the price index of the final industry output ($P_{kt}$) and reflects the relative movement of the price series.

### 2.4.3 The Weighted Industry-Level Cost of Capital and Prices

I observe zero investment in some sub assets because almost no industry employs all of the 35 commodities in production. For example, three out of eight types of machinery equipment are designed for a particular industry (special purpose machinery): agriculture, construction, and mining machinery, industrial machinery, and commercial and service machinery. The other five types are common to all industries (general purpose machinery): metalworking, engine, turbine, and power transmission, office, computing, and accounting, electronic machinery, and other general purpose machinery. To overcome the missing value problem, I aggregate the 35 sub assets to four asset categories by nature of use: machinery equipment, computing and electronic equipment, transportation equipment, and nonresidential structures. This grouping strategy also accommodates variation in the assets’ ITC and depreciation allowance.

The dependent variable in the regression analysis therefore becomes the share of investment in four asset categories. I construct the industry-level independent variables as the weighted average of sub asset-level variables, where the weight for each sub asset is the investment in the sub asset relative to total investment in its asset category. Weights for each asset category add to one. The weight for each sub asset therefore reflects its within-group importance but remains invariant to changes in investment across the four asset categories.
2.4.4 Summary Statistics

Table 3.2 presents summary statistics for all variables used in the regression analysis. The table shows the mean, standard deviation, quartiles and number of observations for investment share, cost of capital, and real price by asset category. Machinery equipment has the largest share of investment, followed by nonresidential structures. Slow economic depreciation explains the low level of the user cost of capital for structures compared to other asset categories.

2.5 Methodology and Regression Framework

I estimate the effect of the corporate income tax on capital allocation using a translog specification, modeling the cost minimization as a two-stage process. Pioneered by Berndt and Wood (1975), Fuss (1977), and Pindyck (1979), the translog specification is the most common functional form in the productivity literature. In the first stage, the representative firm chooses the optimal levels of capital and labor to minimize the production cost. Given the total investment level is fixed, it chooses the optimal mix of capital assets to minimize the capital cost in the second stage. I focus on the second-stage minimization process because I am mainly interested in the interasset allocation of capital. The second-stage cost function is:

$$\ln C = \alpha_0 + \alpha_Q \ln Q + \sum_i \alpha_i \ln P_i + \frac{1}{2} \gamma_{QQ} (\ln Q)^2 + \sum_i \gamma_{Qi} \ln Q \ln P_i$$

$$+ \frac{1}{2} \sum_i \sum_j \beta_{ij} \ln P_i \ln P_j + \beta_{T} \text{Time} + \frac{1}{2} \beta_{T} \text{Time}^2$$

$$+ \beta_{TQ} \text{Time} \ln Q + \sum_{i=1}^{n} \beta_{Ti} \text{Time} \ln P_i + \beta_{I} \text{Industry} + \frac{1}{2} \beta_{I} \text{Industry}^2$$

$$+ \beta_{IQ} \text{Industry} \ln Q + \sum_{i=1}^{n} \beta_{Ii} \text{Industry} \ln P_i + \varepsilon,$$

where $P_i$ is the after-tax price of input $i$, $Q$ is the industry-level output, and $Time$ and $Industry$ are sets of time and industry dummies. The $\beta_{ij}$s are parameters to
be estimated and \( \varepsilon \) is the stochastic error term. By Shepherd’s Lemma, the set of cost-minimizing share equations are derived from differentiating the cost function (2) with respect to the log of the price of input \( i \):

\[
S_i = \frac{\partial \ln C}{\partial \ln P_i} = (X_i P_i)/C
= \alpha_i + \gamma_Q i \ln Q + \sum_j \beta_{ij} \ln P_j + \beta_{T_i} \text{Time} + \beta_{I_i} \text{Industry}, \quad i = 1, ..., 4.
\]

where \( S_i \) is the cost share of input \( i \). By definition, all the cost shares sum to one, and the cost function is homogeneous of degree one in price. The following properties hold for well-behaved investment share equations:

\[
\begin{align*}
\sum_i \alpha_i &= 1, \\
\sum_i \gamma_Q i &= 0,
\end{align*}
\]

and

\[
\sum_j \beta_{ij} = \sum_i \beta_{ij} = 0.
\]

The twice differentiability of the production frontier indicates that the cross-price derivatives of two capital inputs are identical when the aggregate investment is kept constant, i.e. \( \beta_{ij} = \beta_{ji} \) for all input \( i \) and \( j \). In addition, the homotheticity of the cost function restricts \( \gamma_Q i = 0 \) for all \( i \).

The set of linear restrictions (3)-(4) implies a singular variance matrix in the SUR system, requiring one investment category to be dropped for analysis. Therefore I drop the share equation of transportation equipment and divide the price of every other asset by the price of transportation equipment. The choice of transportation equipment is rather arbitrary and the final estimation results are invariant to which share equation is dropped (Greene, 2003). The resulting investment share equations consist a non-singular system to be estimated using SUR. This allows for correlated
disturbance to all investment types. The disturbance term $\varepsilon$ captures unobserved factors that are common to all capital assets in an industry, such as the perceived general health of the economy, as well as idiosyncratic factors associated with the particular asset or industry.

### 2.6 Main Specification and Results

#### 2.6.1 SUR Specifications: COC and Price Covariates

A profit-maximizing firm responds to the effective service price of capital input, which is the product of the before-tax market price and the user cost of capital. To capture the potentially different incentive effects of these two prices, I include the individual asset price and the user cost of capital in separate logarithms. This specification disentangles variation in the user cost from variation in the price, allowing a direct examination of the tax effect on investment. The basic SUR specification for the investment share of asset $i$ in industry $k$ ($s_{ik}$) at time $t$ is

$$
S_{ikt} = \alpha_i + \sum_j \beta_{ij} \ln\left(\frac{\text{COC}_ikt}{\text{COC}_{\text{trans},kt}}\right) + \sum_j \gamma_{ij} \ln\left(\frac{P_{ikt}}{P_{\text{trans},kt}}\right) + \eta_k + \gamma_i + \varepsilon_{ikt},
$$

with the symmetry restrictions

$$
\beta_{ij} = \beta_{ji} \text{ and } \gamma_{ij} = \gamma_{ji} \text{ for all } i \neq j.
$$

Table 2.3 summarizes the estimation results from pooled regressions (Column 1 and 4), time fixed-effect regressions (Column 2 and 5) and two-way fixed-effect regressions (Column 3 and 6). Compared to Column 1-3, specifications in Column 4-6 include real asset prices as additional controls. The Breusch-Pagan Lagrange multiplier test for error independence in the full specification (Column 6) is 55.87 (with a $p-$value $= 0.00$) and has a $\chi^2(3)$ distribution. The null hypothesis of no contemporaneous correlation among cross-equation residuals is strongly rejected, suggesting
that different investment categories are likely to subject to similar underlying determinants. The SUR method as in equation 5 is thus more efficient. (See Greene (2005) and Zellner (1962))

The parameter estimates themselves have little economic meaning. Nevertheless, I can draw two implications from the different estimation results in Table 2.3. First, it is important to control for unobserved industry heterogeneity. Choices of capital inputs are likely to be determined by unobserved industry-specific factors. For example, high-tech industries may use a disproportionately large share of computers and electronic equipment. Durable-good industries may rely more heavily on traditional machinery equipment. If the unobserved industry heterogeneity is correlated with the user cost of capital, estimates of the substitution elasticities would be biased and inconsistent. Comparing the results in Column 4 and 6 (or Column 1 and 3) in Table 2.3, inclusion of industry fixed effects corrects the signs of the CoC coefficient estimates.

Second, the magnitude of the CoC coefficients are slightly increased once price variables are included in the regression, although the changes are not statistically significant. Compared to Column 1-3, the specifications in Column 4-6 include price variables as additional controls. Consequently, the CoC estimates in Column 6 are slightly larger, indicating a negative correlation between the user cost of capital and the market price. This negative correlation suggests a test for tax capitalization as a robustness check. The additional price variables also improve the estimation precision of the regression results.

2.6.2 Instrumental Variables Specifications

The instrumental variable (IV) approach makes the estimation robust to endogeneity in the user cost of capital. A main component of the user cost, the real interest rate, may be endogenous for two reasons. First, there exists potential reverse causality between the interest rate and investment level. An investment shock may increase the investment demand, putting upward pressure on the real interest rate.
This problem is less of a concern, however, when investment is measured as a relative share instead of level. Second, the interest rate depends on the debt and equity shares, but the capital structure itself is influenced by the corporate tax. Interest payment is deductible from the corporate taxable income, but the cost of equity capital is not. Consequently, debt-financed investment faces a lower effective tax rate, which encourages the use of debt finance.\textsuperscript{12} Given that differential tax treatment influences leverage decisions, the real interest rate is also likely to be endogenous.

I instrument the user cost of capital using financial variables that affect the overall leverage level but are uncorrelated with the preferential tax treatment of debt. Following the corporate finance literature, I use industry size, expected future return, earning volatility and industry growth rate as instruments.\textsuperscript{13} Definitions and descriptions of the instruments are included in the Appendix B.

Table 2.4 presents the second-stage results of the IV specifications using two different sets of instruments. Both specifications include industry-time fixed effects. Instruments in Column 1 include the set of financial variables and the exogenous components of the user cost including the contemporaneous investment tax credit and economic depreciation rate. Instruments in Column 2 include the first lag of the user cost, which reduces the number of observation to 136. Most Column 2 coefficients are estimated without precision, indicating a potential weak instrument problem. The weak instrument problem is confirmed by the F-statistics for excluded instruments, none of which pass the threshold of 10 suggested by Staiger and Stock (1997) for the case of three endogenous regressors. This is not surprising because there is a five-year lag between the user cost of capital and its first lag and the correlation between them can be weak. Therefore, my preferred IV estimates are those in Column 1.

Most of the IV estimates in Column 1 are significant and have the expected sign.

\textsuperscript{12}See, for example, Modigliani and Miller (1963), DeAngelo and Masulis (1980), and the survey by Graham (2003).

\textsuperscript{13}See Titman (1988) and Rajan and Zingales (1995) for example.
Compared to the basic regression results, IV estimates of the substitution elasticity become larger for the machinery equation. Before calculating demand elasticities, I perform a heteroskedasticity-robust regression-based overidentification test to check the exogeneity of the instruments (Wooldridge, 2008). The J statistic for each of the three investment share equations is distributed as $\chi^2(3)$, with value about 4.92 (with $p$-value $= 0.18$), 4.90 (with $p$-value $= 0.18$), and 2.23 (with $p$-value $= 0.53$), respectively. The overidentifying restrictions are not rejected at any reasonable significance level. Overall, the results from the basic estimation are robust to IV strategies.

### 2.6.3 Elasticities of Demand and Substitution

In this section I use the parameter estimates from the preferred IV specification in Table 2.4 to assess investment elasticities. I provide estimates for input demand elasticities to characterize investment response to tax incentives. The derived demand elasticity measures the relative change in demand for two capital inputs due to a relative change in their user cost of capital. For the translog cost function, elasticities of factor demand are calculated as:

$$
\xi_{ij} = (\hat{\beta}_{ij} + S_i S_j)/S_i, \text{ for all } i \neq j \tag{6}
$$

$$
\xi_{ii} = (\hat{\beta}_{ii} + S_i^2 - S_i)/S_i, \text{ for all } i, \tag{7}
$$

where $S_i$ is the investment share in asset $i$ and the $\hat{\beta}$s are the price parameters from the estimated translog cost function (Berndt and Wood, 1979). These elasticities are derived under the assumption that the total capital investment is held constant. I compute variance of the price elasticities using the Delta method (Pindyck, 1979; Greene, 2005):

$$
V(\xi_{ij}) = -(1/S_i)^2 \times V(\hat{\beta}_{ij}), \text{ for all } i, j.
$$

Evaluated at the mean cost shares, the estimated elasticities of demand are summa-
rized in Table 2.6.

All the own-\(CoC\) elasticities are negative and significant at 1% significance level except for transportation equipment. Excluding transportation equipment, investment responses to tax incentives are ranked in the following declining order: machinery equipment \((-2.56)\), computing and electronic equipment \((-2.55)\), and nonresidential structures \((-1.29)\). The own-\(CoC\) elasticities for investment in equipment categories are larger compared to the user-cost elasticity of \(-2.0\) reported by Ramirez Verdugo (2005) and the long-run user-cost elasticity of \(-1.6\) by Schaller (2006). This is not surprising because the SUR estimation method allows us to disentangle the direct incentive effect of corporate income taxes from the interasset distortion effect. These two forces tend to work in opposite directions for capital classes that are substitutes, yielding a smaller user-cost elasticity of aggregate investment on net.

Relative to investment in equipment, investment in structures is much less responsive to own tax incentives as would be expected with a higher adjustment cost. Previous studies often obtain small and insignificant estimates of the user-cost elasticity of investment in structures. One possible explanation could be that the elasticity estimate confounds the direct effect of tax incentive with the interasset substitution effect between investment in equipment and structures.

I find evidence that corporate taxes distort the allocation of investment across capital classes. Out of twelve cross-\(CoC\) elasticities, six are positive and significantly different from zero. Machinery is a substitute for investment in every other category. Substitutability is the strongest between machinery and computing and electronic equipment. A 1 percent change in the user cost of computing and electronic equipment leads to a 1.09 percent change in investment in machinery. Conversely, a 1 percent change in the user cost of machinery increases investment in computing and electronic equipment by 2.57 percent. Investment in computing and electronic equipment is more sensitive to changes in the \(CoC\) of machinery equipment because the cross-
$CoC$ elasticity is inversely related to the investment share. A small investment share implies an inclination to switch out of this particular asset category and into the large-share categories.

Findings in the productivity literature echo the substitution pattern between the two asset groups. Dewan and Min (1997) find that information technology capital is a net substitute for the ordinary capital including equipment and structures in all sectors of the U.S. economy. Morrison (1997) finds that machinery capital and office and information technology equipment are substitutes in durable-good industries, although the substitutability is less clear for the nondurable-good industries. Nevertheless, the magnitudes of the above-cited elasticities are not directly comparable with my estimates because the price variables do not capture the effects of corporate income taxes. Consequently, substitution elasticities in the productivity literature are silent on the inter-asset distortion of capital due to differential corporate taxes.

There is also substantial substitutability between machinery and structures, consistent with the early study of Berndt and Christensen (1973). The estimated elasticity of investment in machinery with respect to the $CoC$ of structure is 0.83, with a 95% confidence interval between 0.34 and 1.32. The estimated elasticity of investment in structure with respect to the $CoC$ of machinery is 1.25, with a 95% confidence interval between 0.52 and 1.98. I also observe some substitutability between machinery and transportation equipment. All the pairwise cross-$CoC$ elasticities are smaller than the own-$CoC$ elasticities, suggesting that the first-order tax incentive effect outweighs the corresponding inter-asset distortion effect.

To quantify the size of interasset distortions resulting from differential tax treatment, I impute the hypothetical distribution of investment under a neutral taxation scheme. Operationally, for each year I assign all assets the average user cost of capital in the manufacturing sector. I then use the SUR elasticity estimates to predict the investment shares corresponding to the equalized user cost. By assumption, the
total investment level is held fixed. Therefore, the total corporate tax revenue is held constant and this is a revenue-neutral experiment. I plot the hypothetical investment shares against the actual investment shares in Figure 2.2.

Compared to a neutral tax scheme, on average differential corporate taxes induce overinvestment in machinery and transportation equipment and underinvestment in computing and electronic equipment. The largest discrepancy occurs for computing and electronic equipment. There is underinvestment in structures before the TRA86 due to favorable tax treatment of machinery equipment. Once the TRA86 decreases the tax price of structure relative to equipment, it stimulates investment in structures and I observe some over-investment in structures compared to the investment pattern under neutral taxation. A closer look at the difference by year suggests that the size of distortion for machinery equipment has noticeably decreased under the current tax system, while for other asset categories the size of distortion has slightly increased in recent years.

The magnitudes of the substitution elasticity estimates lends support to several studies of the welfare implication of differential corporate taxes (in particular, Fullerton and Henderson (1989a, 1989b). The substitution elasticity is a key parameter for computing the welfare loss generated by differential taxation or for calculating the marginal excess burden of various capital tax instruments. However, since no previous empirical estimates of substitution elasticity among disaggregate assets were available, these studies assumed an arbitrary value or a range of values for this parameter. For example, Fullerton and Henderson (1989a) conclude that the pre-TRA86 tax scheme generates larger interasset distortions compared to intersectoral or interindustry distortions provided that the asset substitution elasticity is above 0.4. My substitution elasticity estimates verify that these studies use a reasonable elasticity value so that the welfare implication of these studies is quantitatively sound.
2.7 Robustness Checks

2.7.1 Test of Coefficient Equality

In this section I test whether investment shares respond equally to changes in the pretax return and in the user cost of capital using a likelihood ratio test. I constrain coefficients of the user cost of capital and coefficients of the before-tax price to be equal by estimating the following model:

\[ S_{ikt} = \alpha_i + \sum_j \beta_{ij} \ln\left( \frac{C_{ik} \times P_{ikt}}{C_{trans,kt} \times P_{trans,kit}} \right) + \eta_k + \gamma_t + \varepsilon_{ikt}, \quad (8) \]

with restrictions \( \beta_{ij} = \beta_{ji}, \) for all \( i \neq j. \)

Under the null hypothesis of equal coefficients of the user cost and before-tax price, equation (8) is nested with the unconstrained model (5). The resulting likelihood ratio is distributed as a \( \chi^2 \) statistics with 6 degree of freedom. The large value of the likelihood ratio 36.31 suggests a rejection of the null. For estimations with robust standard errors, I use a direct joint test of the equality of the two sets of coefficients. Once again, the large value of the \( F_6 \) statistic 15.26 suggests that investment shares respond differently to changes in the pre-tax market price and the user cost of capital. Intuitively, the price variable is measured with considerable noise. The measurement error in the price variable biases the coefficients toward zero, which may explain the discrepancy in the two sets of coefficients.

2.7.2 Tax Capitalization

Investment incentives may have a high revenue cost if they simultaneous increase investment demand and the prices of investment goods. This would be the case if the short-run supply of capital goods are fixed or highly inelastic. I use the disaggregated data on asset-specific investment good to address this issue. Specifically, I regress the price of investment good \( i \) in industry \( k \) at time \( t \) \( (P_{ikt}) \) on the corresponding user
cost of capital \((CoC_{ikt})\):

\[
\ln P_{ikt} = \theta_i + \delta \ln CoC_{ikt} + \eta_k + \gamma_t + \varepsilon_{ikt},
\]

with \(\eta_k\) and \(\gamma_t\) the usual industry and time fixed effects. The estimated \(CoC\) coefficient is \(-0.1258\) with a \(p\)-value of 0.13, suggesting that the effect of the tax incentives on investment good price is statistically insignificant. I estimate the long-run effect of tax policy on capital-good prices. In the long run, capital goods are mobile in the international market. This result is consistent with Hasse and Hubbard (1998), who find that local investment tax credits have a negligible effect on prices paid for capital goods and tax parameters have no effect on capital-goods prices.

2.8 Conclusion

The empirical results in this paper demonstrate the important distortionary effect of corporate income taxes on capital allocation. There is significant variation in the tax treatment of corporate income from different capital assets. Exploiting the exogenous variation in the user cost of capital at the asset and industry level in the U.S. economy from 1962 to 1997, estimates of the asset substitution elasticity reveals a statistically significant and economically sizable inter-asset distortion of corporate income taxes.

This paper contributes to the existing literature that examines the welfare cost of alternative corporate taxation schemes as it quantifies the inter-asset distortion generated from differential corporate taxes. It is important to incorporate this dimension of distortion when evaluating the overall effect of corporate tax policy or proposal. For example, policy makers are considering fiscal instrument such as bonus depreciation of new equipment to stimulate business investment during economic downturns. Accounting for the inter-asset distortionary effects is important for understanding the efficiency and welfare consequences of such policy proposals. In particular, my
findings suggest that ignoring the inter-asset distortion of corporate taxes will lead to a downward biased estimate of the deadweight loss.
Chapter 3

Tax or Subsidy? Some Unintended Consequence of the Corporate Income Tax in the Early Twentieth Century

3.1 Introduction

The United States enacted significant changes to the income tax during the first two decades of the twentieth century. The federal corporate income tax was enacted in 1909. The Sixteenth Amendment to the Constitution in 1913 empowered the congress to tax income without apportionment among the states. Shortly thereafter, the Revenue Act of 1913 established the first permanent personal income tax. The income taxes have become an important part of the U.S. tax system ever since. Observing the success of the federal income taxes in revenue collection, many states quickly followed suit and enacted state income taxes in the next ten years.

The corporate income tax collected much more revenue than the personal income tax during this period. In 1919, corporate tax revenue accounted for 4.4 percent of GDP, and personal tax revenue accounted for only 1.7 percent of GDP. In contrast, corporate tax revenue was only 1.3% of GDP in 2009, while the personal tax was the largest income tax revenue source and accounted for 8.3% of total GDP.

But the early corporate tax was more than a tool for revenue collection. The major motivation for the corporate tax was to regulate corporations, a rather non-tax purpose (Kornhauser, 1990; Avi-Yonah, 2004; Friese, Link and Mayer, 2008). Government gained information access to corporate business through the tax filing and publicity requirements, which was viewed as a form of federal supervision over corporations. On the other hand, the corporate tax had some other unintended consequence on the economy soon after the personal income tax was enacted. For many taxpayers, income earned through a corporate business was taxed at a lower rate than through a non-corporate business. In addition, the double taxation of
corporate income was essentially nonexistent as corporate dividends and net earnings were deductible from personal taxable income during this period. Corporate income was taxed favored relative to non-corporate business income, creating an incentive for income shifting to the corporate sector. This paper, by studying the relative taxation of corporate to personal income, shows that income shifting was very responsive to the income tax differentials in the early 20th century.

The idea that income taxes induce income shifting through the choice of organizational forms is not novel. A number of recent studies including Mackie-Mason and Gordon (1997), Goolsbee (1998, 2004), de Mooij and Nocodeme (2008) and Egger et al. (2008) suggest that by taxing the income of corporate firms at a different rate than non-corporate firms, taxes play an important role in a firm’s decision to incorporate.

The presence of income shifting between the corporate and non-corporate sector in response to the tax incentives has important policy implications. If increases in the personal tax rate induce change in the reported corporate taxable income (or vice versa), then the corporate tax revenue and the overall tax revenue will be affected as a result of income shifting. When some high-income taxpayers shift their income to take advantage of differences in the taxation of business organized in different legal form, it generates a loss in the overall tax revenue and hence a loss in efficiency.

This study extends the literature by considering the effect of relative taxation on incorporation in the early twentieth century using state-level panel data during 1909-1919. The income tax system was new and at the elementary stage of its development during this period. Thus it would be interesting to see whether taxpayers recognized and responded to the tax differential incentives. Another advantage of this period is that corporate and personal tax rates experienced frequent changes both at the federal and state level, allowing credible identification of the tax effects from contemporaneous changes in other aggregate factors. On the other hand, during a period with rapid and frequent tax policy changes, the relative taxation of corporate income
might be endogenous to the size of corporate tax base. Therefore I test for the endogeno-

ey of the tax cost using a bootstrap Durbin-Wu-Hausman test. The results of this test suggest that the tax cost to incorporate is not endogenous in the sense of leading to inconsistent OLS estimates. In addition, I explore the tax effects in two factional response models to account for the fact that the dependent variables in analysis are fractions of various economic activities.

The baseline OLS results suggest a large response of income shifting—about 1.5 to 2 more times than the largest estimates in studies using more recent data. The overall average marginal effect of tax cost is very similar to the marginal effect suggested by an OLS specification: On average, a one percentage point increase in the tax cost decreases the corporate share of establishments by around 2 percent. The corporate income tax generated an implicit subsidy for corporations and encouraged around 8,300 establishments to incorporate during the sample period.

### 3.2 Background

#### 3.2.1 A Tax To Regulate Corporation

The first two decades of the twentieth century witnessed a significant expansion of government control over corporations, with antitrust legislation directly targeted at large corporations and corporate tax policies indirectly. During the presidency of Theodore Roosevelt and William Taft, the government launched 134 antitrust lawsuits against the largest U.S. corporations including the Standard Oil Company, the American Tobacco Company, and the U.S. Steel Corporation. The Federal Trade Commission was established in 1904 to investigate business fraud and tighten business regulation. The Clayton Act was passed in 1914 to eliminate anticompetitive practices by prohibiting particular types of business conduct.

In conjunction with the antitrust legislation, tax policies were enacted to respond
to the social concerns about the growing economic and political power of large corporations. The Tariff Act of 1909 introduced the federal corporate income tax in the form of “a special exercise tax with respect to the carrying on or doing business”. The tax rate was 1% of net income over $5,000 of “every corporation, joint stock company or association organized for profit”. As pointed out by many historians and legal experts, the major motivation for this act was to regulate corporations through the filing and publicity requirements (Kornhauser, 1990; Avi-Yonah, 2004; Friese, Link and Mayer, 2008). Every corporation was required to file a return with the Internal Revenue Service regardless of its tax liability. Moreover, all the corporate tax returns were subject to public inspection.1 The reporting feature granted the federal government accesses to corporate business information. Overall, the corporate income tax was intended as a vehicle to publicize and control the wealth and power of corporations.2

The general public opposed the corporate tax on the ground that the law discriminated against those doing business in the corporate form as opposed to those doing business as individuals or partnerships. The publicity provisions were regarded as intrusive to corporations. Kornhauser (1990) documented that the New York Times, for example, editorialized that the disclosure of earnings and other information might lead to bankruptcy if creditors became aware of a corporation’s financial difficulty. Owners of small corporations, in particular, worried about large corporations would obtain relevant information to hurt their competitiveness. Despite the general senti-

1“All returns, together with any corrections thereof which may have been made by the Commissioner, shall constitute public records and be open to inspection as such.” (Act of Aug. 5, 1909, ch.6, 36 Stat. 11, 116)

The publicity requirement was amended in 1910 so that “returns shall be open to inspection only upon the executive order of the President”.

2In a letter to Frederick Fish 1 (June 28, 1909), Taft expressed his support for the corporate exercise tax as means to regulate corporations:

*The things that were required in the Bill were two: First, the tax as an excise tax upon corporations, and, second, a certain degree of publicity with reference to the returns. That publicity gives a kind of federal supervision over corporations, which is quite a step in the direction of similar reforms I am going to recommend at the next session of Congress....* (Nelson W. Aldrich Papers, Library of Congress, Manuscript Division, Reel 34)
ment against the corporate tax, it was upheld by the Supreme Court in 1911. The Sixteenth Amendment was further passed in 1913 and the personal income tax was enacted shortly afterwards.

### 3.2.2 Corporations in the Progressive Era

The number of U.S. corporations proliferated during this period even though the general business environment was perceived to be difficult. The total number of corporations in the manufacturing sector almost doubled from 51,097 in 1904 to 91,517 in 1919. Corporations produced 73.7% of the total manufacture production in 1904 and 86.6% of the total manufacture production in 1919. Figure 3.1 summarizes the corporate share of activities in manufacturing between 1904 and 1919, indicating that the number of corporations increased steadily with the total production and value added by corporations during this period. Corporations played an important economic role in many other industries than manufacturing. The manufacturer sector accounted for 21.9% of the total corporations, but there were equivalently many corporations in the trade or financial sector as indicated in Figured 3.2. On the other hand, the gross corporate income in manufacturing accounted for over 50 percent of total U.S. corporate income during this period, indicating that the manufacturing sector is important and representative of the overall economy.

### 3.2.3 Tax and the Decision to Incorporate

Corporations enjoy the advantages of limited liability and easier access to capital market compared to the non-corporate form. But there is also tax penalty to incorporate, in particular the double taxation of corporate income and restriction of no-loss offset against other forms of income. The publicity requirement was also a non-trivial cost to incorporate during this sample period. To illustrate the impact of taxation on incorporation, I use a simple stylized model developed in Mackie-Mason and Gordon (1997), Goolsbee (2004) and de Mooij and Nicodeme (2008).

A firm earns the same income, $I$, regardless of the organizational form. $I$ is taxed
at the ordinary personal income rate $t_p$ if the firm operates as a sole proprietorship or partnership, and the after-tax income is

$$I_{nc} = (1 - t_p)I.$$

If the firm incorporates, $I$ is taxed at the corporate income tax rate $t_c$, and the after-tax income becomes

$$I_c = (1 - t_c)(1 - t_e)I,$$

where $t_c$ is the corporate tax rate and $t_e$ is the tax rate on equity income. Assuming the net non-tax benefits of corporation, $G$, are not taxable, a firm will incorporate if

$$G > I(t_c + (1 - t_c)t_e - t_p).$$

The differential term $t_c + (1 - t_c)t_e - t_p$ summarizes the tax cost to incorporate. It also shows that the tax effect on incorporation depends on the firms’ income. Assuming that $G$ follows a uniform distribution, the relationship between the corporate share of companies and the tax differential term depends on the distribution of the income $I$.

A number of empirical studies suggest a significant impact of corporate taxes on incorporation and related corporate activities. Mackie-Mason and Gordon (1997) examine how the share of assets held by C corporations has changed during 1957-1986 in response to the relative taxation of corporate incomes and find a tax coefficient of 0.05-0.10. Goolsbee (1998) find a similar tax effect using data during the early 1900-1939 period. Using cross-sectional census data across states and industries in the retail trade sector in 1992, Goolsbee (2004) show that the relative taxation of corporate to personal income play an important role in the corporate share of real economic activity. An increase in the corporate tax rate by 0.10 reduces the corporate
share of firms in a state by about 0.25 and the corporate share of sales and employment by 7-15%. Egger et al. (2008) use large cross-section firm-level data in European manufacturing and find that higher corporate tax rates reduce a firm’s probability to incorporate. Using country-level panel data for 20 European countries during 1998-2003, de Mooij and Nicodeme (2008) find a positive and significant effect of the tax term on the incorporate rate of both new and active companies. They show that a reduction in the corporate tax rate equivalent to one euro will only reduce the corporate tax revenue by 82 cents and thus between 10%-17% of corporate tax revenue can be attributed to income shifting.

The important implications of income shifting between the corporate and non-corporate sector are systematically discussed in Gordon and Slemrod (2000). First, income shifting has adverse tax revenue implication. If increases in the personal tax rate induce change in the reported corporate taxable income, then the corporate tax revenue and the overall tax revenue will be affected as a result of income shifting. When some high-income taxpayers shift their income to take advantage of differences in the taxation of business organized in different legal form, it generates a loss in the overall tax revenue and hence a loss in efficiency. Second, the presence of income shifting complicates measures of income distribution over time. Estimates of income distribution are net of the accruing but unrealized capital gains income. If tax changes induce income shifting which in turn changes the relative importance of accruing capital gains, the observed income distribution may become misleading. Last but not least, income shifting may explain changes in the observed corporate rates of return. To the extent that at least some taxpayers engage in income shifting, the reported corporate income will include capital as well as non-wage labor income which cannot be deducted as expenses.
3.2.4 Early History of Income Taxation

Tax policies changed frequently during the this period both at the federal and state level. Corporate income was first taxed at a flat rate of 1% on income over $5,000.\(^3\) Between 1913 and 1917 the corporate tax applied to all business income without exemption. Revenue acts in the following years raised the corporate tax rate to 2% in 1916, 6% in 1917, and 12% in 1918. By 1919 the tax rate was 10% on corporate income over $2,000.

The federal personal income tax was taxed at a progressive rate in 1913: net personal incomes above $3,000 were taxed at 1 percent with a 6 percent surtax on incomes above $500,000. The 1916 Act raised the lowest tax rate to 2 percent and the top rate to 15 percent. In 1919, the personal tax structure was extremely progressive. There were 56 income brackets, with the bottom rate 6 percent and the top rate 73 percent.

Dividends and net earnings received from corporations were deductible from personal income during this period. Double taxation of corporate income did not exist until the Revenue Act of 1936 mandated that corporation dividends paid to individuals should be taxed as ordinary personal income. However, the income tax did not distinguish capital gains so that realized capital gains were taxed as regular income between 1913 and 1921.

Various states enacted income taxes observing the success of the federal income tax in raising revenues. In 1911 Wisconsin pioneered the income tax which then began to be adopted by more and more states.\(^4\) Oklahoma, Connecticut, and West Virginia passed the next state income tax laws in 1915, joined by Massachusetts in 1916, New York, Montana, Missouri, and Delaware in 1917. Another three states, New Mexico, North Dakota, and Alabama, followed suit in 1919. By 1919, out of the 29 states in my sample, seven collected corporate income taxes and six collected

\(^3\)Equivalent to $117,900 of tax-exempt business income in 2009.

\(^4\)Laws of Wisconsin, 1911, ch. 658.
individual income taxes.

State income taxes differed in entities taxed and rate structure. Connecticut, Massachusetts, and New York taxed corporate income at a higher rate than personal income, while Alabama, Delaware, and Missouri taxed personal and corporate income at the same rate. The tax rate in the last three states was a flat rate, while the tax rate in New York and Wisconsin was progressive. Massachusetts started taxing individual income at 1.5 percent in 1916 and corporate income at 3 percent in 1919, while all other states taxed individual income no early than corporate income. With the exception of New York, every state allowed deduction of the federal tax from state tax liabilities.

Figure 3.3 provides a snapshot of the effective state tax rate, taking into account deduction of the federal tax liabilities. While corporate incomes were tax favored at the federal level, it was not at the state level. The effective corporate tax rates along the $y$ axis are all above the 45 degree line, suggesting that at the state level corporate income was at a tax disadvantage to personal income in the states with nonzero income taxes.

### 3.3 Data

I collect data on organizational form from the quinquennial Census of Manufactures for four years–1904, 1909, 1914, and 1919. The Census characterizes an establishment as one of the three ownership categories: Individual, Corporation, and All others. The “All other” group includes establishments operated by firms, cooperative associations, and miscellaneous forms of ownership that could not be classified as “Individual” or “Corporations.” The Character of Ownership table provides information on the number of establishments, the total number of wage earners, and value of production by ownership at the state level. The Census excluded establish-

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6 the Census of Manufactures, 1919, pp. 340.
ments with an annual product value of $500 or less. The Census schedule removed inquiries on the character of ownership of establishments from 1921 onwards, so the earlier period provides the most extensive public record of ownership characteristics by state.

I aggregate the 1914-1919 data by state as ownership data were available by leading cities in each state. It is reasonable to assume that production activity in the leading cities fairly represents the state-level production during the sample period. The dependent variable is the corporate share of activity including number of establishments, employment, and value of production in each state. I drop observations in 1904 as there was no income taxes in place. Eliminating all the states with missing information, I obtain a balanced panel data for 29 states with 87 observations.

To compute the tax cost to incorporate \( t_c + (1 - t_c) t_e - t_p \), I calculate the combined federal and state income tax rate for corporate and personal income. The combined tax rate is the sum of the federal rate and the effective state tax rate, where the effective state rate accounts for the deductibility of federal tax liability. For example, the combined corporate tax rate, \( t_c \), is the sum of the federal corporate rate \( t_{fc} \) and the effective state corporate rate:

\[
t_c = t_{fc} + (1 - t_{fc}) t_{sc}
\]

where \( t_{sc} \) is the state corporate tax rate.

I collect the federal corporate and individual income tax rates from the U.S. Federal Individual and Corporate Income Tax Rates History tables compiled by the Tax Foundation.\(^7\) I use the top marginal corporate tax rate for \( t_c \) and the personal marginal tax rate for an individual with $20,000 income for \( t_p \). As pointed out in Goolsbee (1998), federal personal income tax was extremely progressive during this period with the top marginal rate as high as 73%. To use the top marginal personal rate would be

\(^7\)http://www.taxfoundation.org/research/show/151.html
misleading because few individuals were subject to this rate. Alternatively, $20,000 seems to be a reasonable income level as people earning $20,000 or more received approximately 90% of dividend payouts during this period (Goolsbee, 1998). In 1919, people with a net income of $20,000 or more represented the top twenty percent of income distribution. For comparison, one needs a household income of $100,000 or above to be at the same percentile of the income distribution in 2007. The marginal tax rate at the income bracket of $20,000 was 5 percent in 1914 and 17 percent in 1919. I collect state income tax rates from state income tax laws in various years.

The effective tax rate on equity income is computed as a weighted average of the tax on dividends and the tax on capital gains, where the weight is determined by the average dividend payout ratio (Mackie-Mason and Gordon, 1997). Because dividend income was deductible from the gross personal income during this period, taxpayers faced a zero tax rate on dividends. Mackie-Mason and Gordon (1997) conclude that the accrual equivalent of capital gains account for more than 3/4 of the capital gains and hence most studies treat the tax rate on capital gains as zero (see, e.g., Gordon and Slemrod (2000), Goolbee (2004) and de Mooij and Nicodeme (2004)). Following the standard approach I use the corporate tax rate as a benchmark indicator for the tax on the corporate sector.

Changes in the general condition of labor markets may also affect the decision to incorporate (Goolsbee, 2004). I collect data on state-level population density (person per square km), percent of immigrants (% of foreign born population), and percent of illiterate population (% of illiterate persons 10 years of age or over) from the 1910 and 1920 Census of Population and Housing. I compute the total value of production in each state as an indicator for the macroeconomic environment.

Table 3.1 provides summary statistics for the main variables. On average, the corporate sector accounted for a considerable portion of production (86.60%) and employment (84.35%) but less so in terms of numbers of establishments (36.01%).
The mean tax cost is -2.27 percentage points, suggesting that corporate income was taxed more than 2 points below personal income during the analyzed period.

3.4 Estimation Results

Following equation (1), the fraction of firms that incorporate is a function of the tax cost $T$. The basic specification of interest is

$$S_{\text{number},it} = \alpha + \beta T_{it} + Z_{it}\gamma + \lambda_i + \eta_t + \varepsilon_{it},$$

where $S_{\text{number},it}$ is the corporate share of firms in state $i$ in year $t$, $Z_{it}$ is a vector of state characteristics that may influence the likelihood to incorporate, and $\lambda_i$ and $\eta_t$ are vectors of state and year fixed effects. The tax term $T$ measures the additional cost to incorporate and is expected to have a negative coefficient. I study whether the tax cost has any effect on the economic activities of corporations such as employment and total production.

3.4.1 OLS Results

Table 3.2 contains the basic fixed-effects regression results explaining the corporate share of establishments, employment, and value of production as a function of the tax cost and other control variables. The tax cost coefficient is negative and statistically significant, implying that taxes play an important role in incorporation. A 10 percentage point increase in the difference between the corporate tax rate and personal tax rate reduces the corporate share of establishments by 12.3%, the share of corporate employment by 12.5%, and the share of corporate production by 13.9%. This is consistent with income shifting from the personal to corporate tax base when the relative corporate tax rate is lower. The effect of tax cost on the corporate share of establishments is nontrivial considering that the average corporate share of establishment is 36% in the sample.

To compare the OLS estimates to previous studies I compute the semi-elasticity of
the tax base, assuming that the corporate share of establishments is a good indicator of the corporate share of business income. As indicated in Table 3.1, the average corporate share of establishments is 36.01 percent during this period. The resulting semi-elasticity of the tax base is therefore -3.42, suggesting that the corporate tax base will change 3.42% in response to a 1 percentage point change in the tax cost to incorporate. This semi-elasticity is comparable to the estimate in Gordon and Slemrod (2000), which suggests that a one percentage point increase in the tax differential between corporate and personal taxes increases reported labor income by 3%. It is also comparable to the estimate in de Mooij and Nicodeme (2008), which find a tax-base elasticity of 2.6 for existing firms. Fuest and Weichenrieder (2002) find that a one percentage point reduction in the relative corporate tax rate increases the fraction of corporate savings by 2.6%, which is slightly smaller than my estimate. Meanwhile, this semi-elasticity is considerably larger than the estimates in Mackie-Mason and Gordon (1997) and Goolsbee (2004), which are in the range of 0.2-1.1.

3.4.2 Testing for endogeneity of the tax cost

While firms incorporate in response to tax incentives, state governments can also set tax rates according to the corporate tax base. This may be particularly the case in the early days when many states started to use the income tax as alternative avenue to produce revenue. If the size of the corporate tax base affects the relative degree of corporate taxation, a simple regression of corporate establishments on tax cost to incorporate may suffer from reverse causality and the OLS estimates may become inconsistent.\footnote{For example, the Wisconsin State Tax Commission in its report of 1907 stated clearly: “The very inefficient manner in which the personal property tax has been assessed and the resulting gross inequalities in taxation, as well as the agitation of the subject of credit exemption, have brought about the pending constitutional amendment authorizing a graduated income tax.”}

\footnote{An interesting anecdote to the 1911 Wisconsin income tax legislation suggests that the initial corporate tax rate was set higher than the personal rate to tax the special privileges granted to corporations.}
To address the potential endogeneity of the tax cost term, I exploit information on the political economy of income taxation. Recent political economy research including Roemer (2008) and Alt and Sibieta (2008) has stressed the importance of politicians’ ideology in shaping tax policies. Left and Right parties have different philosophies in taxing business and redistributing income. Political characteristics of the governor, therefore have an important influence on the choice of tax base. On the other hand, the fiscal well-being of the state, in particular lagged debt, may also reflect the demand for additional revenue sources. At the same time, these characteristics are unlikely to be correlated with the size of the corporate tax base.

I use these insights to construct two instruments for the tax cost term: party of the governor and lagged debt. Data on the party variable is available for all states during the sample period. The Census published data on internal revenue collection and gross debt less sinking fund assets by state every ten years during this period. Due to this data constraint, I use state-level debt in year 1902 and 1912 to instrument for tax cost in 1909, and 1914-1919, respectively. To test for endogeneity of the tax cost term, I perform a bootstrap Hausman test for all three equations (establishment, employment and value of production) with 500 replications with replacement (Cameron and Trivedi, 2010). The results of this test suggest that none of the corporate shares were found to be endogenous in the sense of leading to inconsistent OLS estimates.\textsuperscript{10} Since an attempt to use IV estimates for these variables could lead to imprecision of the estimates, I proceed by treating the tax cost term as exogenous.

### 3.4.3 NLS Regression

The linear function form has some limitations in estimating fractional responses variable such as the corporate share of economic activities. The main drawback of the linear form is that it restricts the effect of the tax cost to be constant throughout its

\textsuperscript{10}The \( p \)-values of the bootstrap Hausman test are: 0.9084 for the establishment equation; 0.8373 for the employment equation; and 0.6517 for the production equation.
range, which is very unlikely in the fractional response model (Papke and Wooldridge, 1996). In addition, the linear regression does not guarantee the predicted dependent variable to lie within the unit interval.

To overcome these limitations, I use two alternative nonlinear specifications to estimate Equation 2. Because the corporate share of establishment is strictly between zero and one, I model the log-odds ratio of the corporate share as a linear function of the tax cost and other controls:

$$\log\left(\frac{S_{\text{number},it}}{1 - S_{\text{number},it}}\right) = \alpha + \beta T_{it} + Z_{it}\gamma + \lambda_i + \eta_t + \varepsilon_{it},$$

(3)

where all the variables are as previously defined. The coefficient $\beta$ now indicates the effect of one-unit increase in tax cost on the log-odds to incorporate. Unfortunately, without further independence assumptions of the error structure it is impossible to recover the expected value of $S_{\text{number},it}$ with estimates from Equation (3) (Wooldridge, 2008). Alternatively, I estimate the conditional mean of the corporate shares in a fractional logit model:

$$S_{\text{number},it} = \frac{\exp(\alpha + \beta T_{it} + Z_{it}\gamma + \lambda_i + \eta_t + \varepsilon_{it})}{1 + \exp(\alpha + \beta T_{it} + Z_{it}\gamma + \lambda_i + \eta_t + \varepsilon_{it})},$$

(4)

where the year and state fixed effects are differenced out to avoid the incidental parameters problem. Developed by Papke and Wooldridge (1996), the fractional logit model has been applied in a number of empirical studies including Hausman and Leonard (1997), Liu et al. (1999), and Loudermilk (2007). Its major advantage over the log-transformation is that it allows us to recover the conditional expectation of the dependent variable and compute the marginal effects for the variables of interest.

Table 3.3 summarizes the nonlinear regression results using robust inference. Consistent with the OLS estimates, the estimated tax effect is a negative and statistically significant on incorporation.
Using the estimates in the establishment equation, I compute the marginal effect of a one percentage point increase in the corporate tax rate relative to the personal tax rate at four different levels of the tax cost: the 25th, 50th, 75th percentile and the average of tax cost in the sample. Table 3.4 summarizes these marginal effects with their robust standard errors and the 95% confidence interval. All the marginal effects are statistically significant and pairwise different at 95% level. The mean marginal effect is slightly smaller (but statistically different) than the OLS estimate: 1.18 percentage points decrease in the corporate share of establishments when the tax cost to incorporate increases by one percentage point.

The pattern of the marginal effects suggest a somewhat increasing effect of tax cost on incorporation, although the differences in marginal effects are small in magnitude. The largest marginal effect is at the 25th percentile of the tax cost, where the corporate tax rate is 7 percentage point lower than the personal tax rate. Less firms respond to the tax incentives as the gap between the corporate and personal tax rates shrink. For example, at the 25th percentile decrease the tax cost by one percentage point would increase the corporate share of establishment by 1.26 percentage point, while an identical change at the 75th percentile of the tax cost would increase the corporate share by 1.13 percentage point.

3.4.4 Discussion

To quantify the economic impact of the corporate income taxes during this period, I simulate the corporate share of establishments had the same tax rate applied to both corporate and personal incomes. I compare in Table 3.5 the predicted share with income shifting induced by the tax incentives with the predicted share without income shifting had the corporate income been taxed at the same rate as the personal income. Note that the predicted shares of establishments are very close to the actual shares. If there was no income shifting between the corporate and non-corporate sector, the average corporate share of establishments would be 33.15 percent during 1909-1919.
As a result of lower corporate taxes, the predicted corporate share of establishments increased by almost 3 percentage point to 36.01 percent. Considering the total number of establishment was around 290,105, this implicit tax subsidy encouraged about 8,300 establishments to incorporate during the sample period. A breakdown of predicted shares by year reveals a clear pattern of the tax effects on incorporation. In 1909 there was only corporate but no personal income taxes. The positive tax cost to incorporate discouraged the corporate activities because the hypothetical corporate share of establishments was actually higher than the predicted share with actual tax cost. As the persona tax rate surpassed the corporate rate in later years, the tax cost became negative and resembles an implicit subsidy for incorporation.

The overall associated excess burden arising from differential taxes can be approximated by:

\[ L = -0.5 \times T^2 \times \frac{\Delta S}{\Delta T}, \]

where \( T \) is the tax wedge between the corporate and personal rate, and \( \Delta S/ \Delta T \) is the (compensated) change in the tax base induced by the tax difference (Goolsbee, 1998). Using the average tax cost and semi-elasticity of the tax base, the deadweight loss is approximately 3% of the corporate tax revenue, which is similar to the 3-5% deadweight loss reported in Goolsbee (1998). In 1909, corporate tax revenue accounted for 4.4 percent of GDP and therefore, the resulting estimated excess burden as a percent of GDP is around 0.132% of GDP.

4. Conclusion

The empirical analysis shows that the relative taxation of corporate to personal income has significant impact on firms’ decision to incorporate. On average, a one percentage point increase in the tax cost to incorporate decreases the corporate share of establishment by 1.18-1.23 percent. The marginal effect of the tax cost decreases when the gap between the degree of corporate and personal income tax increases.
The magnitude of the behavioral response is significantly larger than estimates from studies using more recent data, suggesting that firms have been responding to the tax incentives since the early days of income taxes.

The historical experience studied here suggests that the structure of the corporate income tax should not be designed in isolation from the personal income taxes. Consequently, the revenue effect of changes in corporate income taxation should also be analyzed in combination with changes in personal tax revenues. As firms shift between corporate and non-corporate forms in response to the tax cost, any change in the corporate taxes will partly show up in the personal tax base.
Tables

Table 1.1: Summary Statistics: ETR and Concentration Ratio

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ETR</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>28.38</td>
<td>7.76</td>
<td>5.93</td>
<td>40.25</td>
<td>122</td>
</tr>
<tr>
<td>Between</td>
<td>3.67</td>
<td>15.01</td>
<td>37.17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within</td>
<td>6.87</td>
<td>12.63</td>
<td>44.54</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CR</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>26.51</td>
<td>18.40</td>
<td>1.88</td>
<td>91.8</td>
<td>96</td>
</tr>
<tr>
<td>Between</td>
<td>17.56</td>
<td>3.95</td>
<td>88.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within</td>
<td>5.33</td>
<td>12.21</td>
<td>39.24</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A Close Look by Year

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
<th>N</th>
</tr>
</thead>
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<tr>
<td><strong>ETR82</strong></td>
<td>20.19</td>
<td>5.82</td>
<td>10.72</td>
<td>33.40</td>
<td>40</td>
</tr>
<tr>
<td><strong>ETR92</strong></td>
<td>32.49</td>
<td>4.78</td>
<td>7.92</td>
<td>38.67</td>
<td>41</td>
</tr>
<tr>
<td><strong>ETR97</strong></td>
<td>32.26</td>
<td>5.12</td>
<td>5.93</td>
<td>40.26</td>
<td>41</td>
</tr>
<tr>
<td><strong>CR82</strong></td>
<td>32.75</td>
<td>18.96</td>
<td>5.1</td>
<td>91.8</td>
<td>28</td>
</tr>
<tr>
<td><strong>CR92</strong></td>
<td>23.49</td>
<td>19.17</td>
<td>1.88</td>
<td>89.88</td>
<td>34</td>
</tr>
<tr>
<td><strong>CR97</strong></td>
<td>24.38</td>
<td>16.29</td>
<td>5.67</td>
<td>82.88</td>
<td>34</td>
</tr>
</tbody>
</table>

ETR is the effective marginal tax rate and CR is the four-firm concentration ratio. Associated industry code in parentheses. For 1982, ETR is missing for "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).
Table 1.2: Basic Descriptive Statistics for Socioeconomic Variables

<table>
<thead>
<tr>
<th></th>
<th>Full Sample</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>37.56</td>
<td>37.40</td>
<td>37.71</td>
</tr>
<tr>
<td>No. Children of 0-5 years</td>
<td>0.20</td>
<td>0.19</td>
<td>0.22</td>
</tr>
<tr>
<td>No. Children of 5-17 years</td>
<td>0.72</td>
<td>0.65</td>
<td>0.78</td>
</tr>
<tr>
<td>Married</td>
<td>0.59</td>
<td>0.58</td>
<td>0.59</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Labor market variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employment</td>
<td>0.67</td>
<td>0.76</td>
<td>0.61</td>
</tr>
<tr>
<td>Unemployment</td>
<td>0.07</td>
<td>0.08</td>
<td>0.04</td>
</tr>
<tr>
<td>Not in labor force</td>
<td>0.26</td>
<td>0.16</td>
<td>0.35</td>
</tr>
<tr>
<td>Weeks worked</td>
<td>34.61</td>
<td>39.50</td>
<td>30.09</td>
</tr>
<tr>
<td>Wage and salary income</td>
<td>14.603</td>
<td>19.892</td>
<td>9.721</td>
</tr>
<tr>
<td>Log weekly earnings (positive values)</td>
<td>5.88</td>
<td>6.26</td>
<td>5.58</td>
</tr>
<tr>
<td>Nonwork income (positive values)</td>
<td>9,856</td>
<td>1,980</td>
<td>15,214</td>
</tr>
<tr>
<td><strong>Education variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Imputed years of schooling(*)</td>
<td>12.42</td>
<td>12.45</td>
<td>12.39</td>
</tr>
<tr>
<td>Years of college (4+)</td>
<td>18.68</td>
<td>20.75</td>
<td>16.78</td>
</tr>
<tr>
<td>Years of college (1-3)</td>
<td>22.44</td>
<td>21.75</td>
<td>23.08</td>
</tr>
<tr>
<td>12th grade</td>
<td>36.43</td>
<td>34.28</td>
<td>38.43</td>
</tr>
<tr>
<td>11th grade</td>
<td>5.36</td>
<td>5.39</td>
<td>5.32</td>
</tr>
<tr>
<td>10th grade</td>
<td>5.65</td>
<td>5.71</td>
<td>5.58</td>
</tr>
<tr>
<td>9th grade</td>
<td>3.80</td>
<td>3.99</td>
<td>3.62</td>
</tr>
<tr>
<td>5-8th grade</td>
<td>6.02</td>
<td>6.43</td>
<td>5.64</td>
</tr>
<tr>
<td>1-4th grade</td>
<td>1.15</td>
<td>1.21</td>
<td>1.09</td>
</tr>
<tr>
<td>Non or preschool</td>
<td>0.47</td>
<td>0.49</td>
<td>0.45</td>
</tr>
<tr>
<td>Sample size</td>
<td>287,111</td>
<td>137,794</td>
<td>149,317</td>
</tr>
</tbody>
</table>

Notes: (*) Years of schooling are imputed from the following categorical scheme: 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 = ‘12’ (12 years); 8 = ‘1-3 years of college’ (14 years); 9 = ‘4+ years of college’ (16 years). Wage income are in 1982 dollars.
Table 1.3 (a): Regression Results: the Wage Equation

<table>
<thead>
<tr>
<th></th>
<th>(1) 2-Stage</th>
<th>(2) 2-Stage</th>
<th>(3) 2-Stage</th>
<th>(4) MLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ln T</td>
<td>-0.103***</td>
<td>-0.076***</td>
<td>-0.236***</td>
<td>-0.201***</td>
</tr>
<tr>
<td></td>
<td>(0.009)</td>
<td>(0.016)</td>
<td>(0.029)</td>
<td>(0.027)</td>
</tr>
<tr>
<td>Ln CR</td>
<td>0.009</td>
<td>-0.099***</td>
<td>-0.087***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.007)</td>
<td>(0.018)</td>
<td>(0.016)</td>
<td></td>
</tr>
<tr>
<td>Ln T×Ln CR</td>
<td></td>
<td>-0.095***</td>
<td>-0.082***</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.014)</td>
<td>(0.013)</td>
<td></td>
</tr>
<tr>
<td>Years of Schooling</td>
<td>0.154***</td>
<td>0.161***</td>
<td>0.161***</td>
<td>0.165***</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>Experience</td>
<td>0.108***</td>
<td>0.110***</td>
<td>0.110***</td>
<td>0.060***</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Experience²</td>
<td>-0.001***</td>
<td>-0.001***</td>
<td>-0.001***</td>
<td>-0.001***</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>Yrs of Schooling × Exper.</td>
<td>-0.003***</td>
<td>-0.003***</td>
<td>-0.003***</td>
<td>-0.003***</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>N</td>
<td>253,600</td>
<td>215,578</td>
<td>215,578</td>
<td>215,578</td>
</tr>
<tr>
<td>Censored Observations</td>
<td>74,505</td>
<td>74,505</td>
<td>74,505</td>
<td>74,505</td>
</tr>
</tbody>
</table>

Note: The regression model is:
\[
\ln w_{ijt} = \mu + \alpha X_{ij} + \beta_1 \ln T_{jt} + \beta_2 \ln CR_{jt} + \beta_3 \ln T_{jt} \times \ln CR_{jt} + c_j + \eta_t + \epsilon_{ijt}.
\]
Other than the variables shown in the table, \( \alpha X_{ij} \) also includes a constant, number of children less than 5 years old, number of children between age 6 and 19 and married dummies. \( c_j \) is the industry fixed effects. \( \eta_t \) is the year fixed effects. Standard errors in parentheses are bootstrapped by 250 random draws with replacement. * significant at 0.10 level, ** significant at 0.05 level, *** significant at 0.01 level.
Table 1.3 (b): Regression Results: the Employment Equation

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2-Stage</td>
<td>2-Stage</td>
<td>2-Stage</td>
<td>MLE</td>
</tr>
<tr>
<td>Nonwork Income</td>
<td>-0.008***</td>
<td>-0.007***</td>
<td>-0.007***</td>
<td>-0.004***</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>Years of Schooling</td>
<td>0.120***</td>
<td>0.131***</td>
<td>0.131***</td>
<td>0.137***</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Age</td>
<td>-0.009***</td>
<td>-0.009***</td>
<td>-0.009***</td>
<td>-0.006***</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>Kids5</td>
<td>-0.174***</td>
<td>-0.183***</td>
<td>-0.183***</td>
<td>-0.159***</td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td>(0.006)</td>
<td>(0.006)</td>
<td>(0.006)</td>
</tr>
<tr>
<td>Kids20</td>
<td>0.077***</td>
<td>0.073***</td>
<td>0.073***</td>
<td>0.072***</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>Married</td>
<td>0.263***</td>
<td>0.223***</td>
<td>0.223***</td>
<td>0.151***</td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.007)</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.704***</td>
<td>-0.974***</td>
<td>-0.974***</td>
<td>-0.861***</td>
</tr>
<tr>
<td></td>
<td>(0.1439)</td>
<td>(0.015)</td>
<td>(0.015)</td>
<td>(0.015)</td>
</tr>
<tr>
<td>N</td>
<td>253,600</td>
<td>215,578</td>
<td>215,578</td>
<td>215,578</td>
</tr>
</tbody>
</table>

Note: The regression model is:

\[ empl_i = \begin{cases} 
1 & \text{if } \gamma_1 nwin_i + \gamma_2 educ_i + \gamma_3 age_i + \gamma_4 kids5_i + \gamma_5 kids20_i + \gamma_6 marst_i + u_i > 0, \\
0 & \text{if } \gamma_1 nwin_i + \gamma_2 educ_i + \gamma_3 age_i + \gamma_4 kids5_i + \gamma_5 kids20_i + \gamma_6 marst_i + u_i \leq 0. 
\end{cases} \]

This is the first-stage equation which corrects for sample selection bias in the wage equation. Standard errors in parentheses are bootstrapped by 250 random draws with replacement. * significant at 0.10 level, ** significant at 0.05 level, *** significant at 0.01 level.
Table 1.4: Industry-level Estimation Results

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Industry-Average</td>
<td>Two-Step Regression</td>
</tr>
<tr>
<td>Ln T</td>
<td>-0.215***</td>
<td>-0.145**</td>
</tr>
<tr>
<td></td>
<td>(0.070)</td>
<td>(0.054)</td>
</tr>
<tr>
<td>Ln CR</td>
<td>-0.081</td>
<td>-0.063</td>
</tr>
<tr>
<td></td>
<td>(0.052)</td>
<td>(0.042)</td>
</tr>
<tr>
<td>Ln T × Ln CR</td>
<td>-0.101**</td>
<td>-0.060*</td>
</tr>
<tr>
<td></td>
<td>(0.041)</td>
<td>(0.032)</td>
</tr>
<tr>
<td>Year FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>N</td>
<td>95</td>
<td>95</td>
</tr>
</tbody>
</table>

Note: The regression model in Column 1 is:
\[\ln w_{jt} = \mu + \alpha X_{jt} + \beta_1 \ln T_{jt} + \beta_2 \ln CR_{jt} + \beta_3 \ln T_{jt} \times \ln CR_{jt} + c_j + \eta_t + \varepsilon_{jt}.\]

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 \[\ln w_{ijt} = \mu + \alpha X_{ijt} + \varepsilon_{jt}.\]

Robust standard errors in parentheses. * significant at 0.10 level, ** significant at 0.05 level, *** significant at 0.01 level.
Table 1.5: Marginal Effects of the ETR across the Distribution of CR (%)

<table>
<thead>
<tr>
<th></th>
<th>(1) Individual-Level</th>
<th>(2) Industry-Average</th>
<th>(3) Industry Two-Step</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average ME</td>
<td>-0.045</td>
<td>-0.056</td>
<td>-0.051</td>
</tr>
<tr>
<td>CR Quartile 1</td>
<td>0.027</td>
<td>0.037</td>
<td>0.004</td>
</tr>
<tr>
<td>CR Quartile 2</td>
<td>-0.035</td>
<td>-0.038</td>
<td>-0.040</td>
</tr>
<tr>
<td>CR Quartile 3</td>
<td>-0.062</td>
<td>-0.086</td>
<td>-0.068</td>
</tr>
<tr>
<td>CR Quartile 4</td>
<td>-0.127</td>
<td>-0.142</td>
<td>-0.101</td>
</tr>
</tbody>
</table>

The wage elasticity is determined by calculating the marginal effect of ETR, increasing the tax rate by one percent, and recomputing the marginal effect. The wage elasticity is the resulting change in the marginal effects.
Table 2.1: Mean and Standard Deviation of Selected Tax Parameters

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CoC: Equipment</td>
<td>23.39</td>
<td>21.11</td>
<td>18.39</td>
<td>24.38</td>
</tr>
<tr>
<td></td>
<td>(7.83)</td>
<td>(7.27)</td>
<td>(6.78)</td>
<td>(8.72)</td>
</tr>
<tr>
<td>CoC: Structures</td>
<td>13.83</td>
<td>12.44</td>
<td>12.18</td>
<td>10.76</td>
</tr>
<tr>
<td></td>
<td>(4.36)</td>
<td>(4.42)</td>
<td>(4.44)</td>
<td>(4.24)</td>
</tr>
<tr>
<td>CoC: Overall</td>
<td>19.43</td>
<td>17.42</td>
<td>15.51</td>
<td>18.36</td>
</tr>
<tr>
<td></td>
<td>(8.12)</td>
<td>(7.55)</td>
<td>(6.59)</td>
<td>(9.80)</td>
</tr>
<tr>
<td>ρ: Equipment</td>
<td>8.42</td>
<td>6.23</td>
<td>4.59</td>
<td>9.74</td>
</tr>
<tr>
<td></td>
<td>(4.20)</td>
<td>(3.70)</td>
<td>(3.14)</td>
<td>(3.84)</td>
</tr>
<tr>
<td>ρ: Structures</td>
<td>10.87</td>
<td>9.46</td>
<td>9.20</td>
<td>7.78</td>
</tr>
<tr>
<td></td>
<td>(4.10)</td>
<td>(4.25)</td>
<td>(4.21)</td>
<td>(4.05)</td>
</tr>
<tr>
<td>ρ: Overall</td>
<td>9.44</td>
<td>7.61</td>
<td>6.73</td>
<td>8.87</td>
</tr>
<tr>
<td></td>
<td>(4.33)</td>
<td>(4.26)</td>
<td>(4.33)</td>
<td>(4.05)</td>
</tr>
<tr>
<td>ETR: Equipment</td>
<td>29.32</td>
<td>-0.21</td>
<td>-44.04</td>
<td>27.65</td>
</tr>
<tr>
<td></td>
<td>(13.01)</td>
<td>(25.47)</td>
<td>(35.47)</td>
<td>(10.44)</td>
</tr>
<tr>
<td>ETR: Structures</td>
<td>50.76</td>
<td>39.88</td>
<td>40.39</td>
<td>36.28</td>
</tr>
<tr>
<td></td>
<td>(5.22)</td>
<td>(10.92)</td>
<td>(5.81)</td>
<td>(6.71)</td>
</tr>
<tr>
<td>ETR: Overall</td>
<td>38.56</td>
<td>16.86</td>
<td>-4.86</td>
<td>22.63</td>
</tr>
<tr>
<td></td>
<td>(14.69)</td>
<td>(28.57)</td>
<td>(49.63)</td>
<td>(10.61)</td>
</tr>
<tr>
<td>z: Equipment</td>
<td>0.76</td>
<td>0.80</td>
<td>0.86</td>
<td>0.57</td>
</tr>
<tr>
<td></td>
<td>(0.09)</td>
<td>(0.08)</td>
<td>(0.05)</td>
<td>(0.05)</td>
</tr>
<tr>
<td>z: Structures</td>
<td>0.33</td>
<td>0.46</td>
<td>0.43</td>
<td>0.38</td>
</tr>
<tr>
<td></td>
<td>(0.05)</td>
<td>(0.14)</td>
<td>(0.05)</td>
<td>(0.09)</td>
</tr>
<tr>
<td>z: Overall</td>
<td>0.58</td>
<td>0.66</td>
<td>0.66</td>
<td>0.49</td>
</tr>
<tr>
<td></td>
<td>(0.23)</td>
<td>(0.20)</td>
<td>(0.22)</td>
<td>(0.12)</td>
</tr>
</tbody>
</table>

Note: Unweighted mean and standard deviation of selected tax parameters for all industries. Standard deviation in parentheses. z is the present value of tax depreciation per dollar. All variables winsorized at the 1 and 99 percent of the empirical distribution.
Table 2.2: Summary Statistics, 1963-1997

<table>
<thead>
<tr>
<th>Asset Class</th>
<th>Mean</th>
<th>Std. Dev</th>
<th>25%</th>
<th>50%</th>
<th>75%</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Machinery equipment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investment share</td>
<td>0.42</td>
<td>0.19</td>
<td>0.29</td>
<td>0.47</td>
<td>0.55</td>
<td>161</td>
</tr>
<tr>
<td>$CoC$ (in %)</td>
<td>19.41</td>
<td>5.02</td>
<td>15.52</td>
<td>17.62</td>
<td>23.15</td>
<td>161</td>
</tr>
<tr>
<td>Real price index</td>
<td>96.23</td>
<td>10.73</td>
<td>88.84</td>
<td>97.61</td>
<td>103.31</td>
<td>161</td>
</tr>
<tr>
<td><strong>Computing and Electronic equipment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investment share</td>
<td>0.18</td>
<td>0.13</td>
<td>0.08</td>
<td>0.15</td>
<td>0.24</td>
<td>161</td>
</tr>
<tr>
<td>$CoC$ (in %)</td>
<td>28.12</td>
<td>6.65</td>
<td>22.75</td>
<td>26.63</td>
<td>32.08</td>
<td>161</td>
</tr>
<tr>
<td>Real price index</td>
<td>108.36</td>
<td>5.11</td>
<td>105.22</td>
<td>109.86</td>
<td>111.94</td>
<td>161</td>
</tr>
<tr>
<td><strong>Transportation equipment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investment share</td>
<td>0.13</td>
<td>0.14</td>
<td>0.04</td>
<td>0.09</td>
<td>0.15</td>
<td>161</td>
</tr>
<tr>
<td>$CoC$ (in %)</td>
<td>37.66</td>
<td>5.83</td>
<td>33.34</td>
<td>37.40</td>
<td>40.67</td>
<td>161</td>
</tr>
<tr>
<td>Real price index</td>
<td>82.58</td>
<td>18.26</td>
<td>69.92</td>
<td>82.39</td>
<td>101.23</td>
<td>161</td>
</tr>
<tr>
<td><strong>Nonresidential structures</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investment share</td>
<td>0.28</td>
<td>0.16</td>
<td>0.18</td>
<td>0.24</td>
<td>0.32</td>
<td>161</td>
</tr>
<tr>
<td>$CoC$ (in %)</td>
<td>14.33</td>
<td>6.02</td>
<td>10.37</td>
<td>12.15</td>
<td>17.07</td>
<td>161</td>
</tr>
<tr>
<td>Real price index</td>
<td>95.49</td>
<td>17.68</td>
<td>85.50</td>
<td>94.99</td>
<td>103.31</td>
<td>161</td>
</tr>
</tbody>
</table>

Note: Summary statistics given for all industries in the manufacturing sector. Investment share are computed as the dollar investment in the specific asset class relative to the total industry new capital investment. $CoC$ is the user cost of capital expressed in percentage. Real prices are expressed relative to 1982 price level, which equals 100 in 1982.
Table 2.3: Seemingly Unrelated Regressions: CoC and Price

<table>
<thead>
<tr>
<th>Equation</th>
<th>Machinery:</th>
<th>Computing:</th>
<th>Structure:</th>
<th>Add. price variables:</th>
<th>Year fixed effects?</th>
<th>Industry fixed effects?</th>
<th>N</th>
<th>$R^2_{machinery}$</th>
<th>$R^2_{computing}$</th>
<th>$R^2_{structure}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$CoC_{mach}$</td>
<td>-0.7501***</td>
<td>-0.10724***</td>
<td>-0.6167***</td>
<td>-0.7571***</td>
<td>-1.0693***</td>
<td>-0.6457***</td>
<td>161</td>
<td>0.1529</td>
<td>0.0825</td>
<td>0.0512</td>
</tr>
<tr>
<td>$CoC_{comp}$</td>
<td>0.4165***</td>
<td>0.2772***</td>
<td>0.3353***</td>
<td>0.4204***</td>
<td>0.2755***</td>
<td>0.3532***</td>
<td>161</td>
<td>0.3790</td>
<td>0.3712</td>
<td>0.2834</td>
</tr>
<tr>
<td>$CoC_{struc}$</td>
<td>0.0814</td>
<td>0.2792**</td>
<td>0.1014</td>
<td>0.0857</td>
<td>0.2797***</td>
<td>0.1161</td>
<td>161</td>
<td>0.6591</td>
<td>0.6214</td>
<td>0.5369</td>
</tr>
<tr>
<td>$CoC_{struc}$</td>
<td>-0.2209***</td>
<td>-0.4184***</td>
<td>-0.3399***</td>
<td>-0.2173**</td>
<td>-0.4319***</td>
<td>-0.3613***</td>
<td>161</td>
<td>0.1617</td>
<td>0.0917</td>
<td>0.0632</td>
</tr>
<tr>
<td>$CoC_{struc}$</td>
<td>-0.1466***</td>
<td>-0.0051</td>
<td>0.0462</td>
<td>-0.1542***</td>
<td>-0.0035</td>
<td>0.0505</td>
<td>161</td>
<td>0.3979</td>
<td>0.3886</td>
<td>0.2997</td>
</tr>
<tr>
<td>$CoC_{struc}$</td>
<td>0.0887**</td>
<td>-0.0370</td>
<td>-0.0623</td>
<td>0.0897**</td>
<td>-0.0405</td>
<td>-0.0875</td>
<td>161</td>
<td>0.6715</td>
<td>0.6424</td>
<td>0.5487</td>
</tr>
</tbody>
</table>

Note: Industry investment on new capital consists of investment in four broad asset classes: machinery equipment, computing and electronic equipment, transportation equipment, and nonresidential structures. Investment share equation for transportation equipment is omitted to satisfy the estimation constraints. Standard errors in parentheses. * significant at 0.10 level, ** significant at 0.05 level, *** significant at 0.01 level.
Table 2.4: SUR-IV Regression

<table>
<thead>
<tr>
<th>Equation</th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machinery:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$CoC_{mach}$</td>
<td>-0.8272***</td>
<td>-0.0856</td>
</tr>
<tr>
<td></td>
<td>(0.2249)</td>
<td>(0.2072)</td>
</tr>
<tr>
<td></td>
<td>(0.4028)</td>
<td>(0.3368)</td>
</tr>
<tr>
<td>$CoC_{comp}$</td>
<td>0.3812***</td>
<td>0.2086*</td>
</tr>
<tr>
<td></td>
<td>(0.1126)</td>
<td>(0.1100)</td>
</tr>
<tr>
<td></td>
<td>(0.1509)</td>
<td>(0.1294)</td>
</tr>
<tr>
<td>$CoC_{struc}$</td>
<td>0.2313**</td>
<td>-0.0664</td>
</tr>
<tr>
<td></td>
<td>(0.1042)</td>
<td>(0.0906)</td>
</tr>
<tr>
<td></td>
<td>(0.1744)</td>
<td>(0.1683)</td>
</tr>
<tr>
<td>Computing:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$CoC_{comp}$</td>
<td>-0.3054**</td>
<td>-0.3829***</td>
</tr>
<tr>
<td></td>
<td>(0.1010)</td>
<td>(0.1107)</td>
</tr>
<tr>
<td></td>
<td>(0.1555)</td>
<td>(0.1813)</td>
</tr>
<tr>
<td>$CoC_{struc}$</td>
<td>0.0473</td>
<td>0.1437**</td>
</tr>
<tr>
<td></td>
<td>(0.0654)</td>
<td>(0.0674)</td>
</tr>
<tr>
<td></td>
<td>(0.1105)</td>
<td>(0.1152)</td>
</tr>
<tr>
<td>Structure:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$CoC_{struc}$</td>
<td>-0.1591</td>
<td>-0.0640</td>
</tr>
<tr>
<td></td>
<td>(0.0987)</td>
<td>(0.0889)</td>
</tr>
<tr>
<td></td>
<td>(0.1443)</td>
<td>(0.1298)</td>
</tr>
<tr>
<td>IV included:</td>
<td></td>
<td>$COC_{ik,t-1}$</td>
</tr>
<tr>
<td></td>
<td>ind.size, exp. return</td>
<td></td>
</tr>
<tr>
<td></td>
<td>earning volatility, growth rate</td>
<td></td>
</tr>
<tr>
<td>Control variables included</td>
<td>$P_{mach}$, $P_{comp}$, $P_{struc}$</td>
<td>$P_{mach}$, $P_{comp}$, $P_{struc}$</td>
</tr>
<tr>
<td>Year/industry fixed effects?</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>N</td>
<td>161</td>
<td>136</td>
</tr>
<tr>
<td>$R^2_{machinery}$</td>
<td>0.6606</td>
<td>0.7738</td>
</tr>
<tr>
<td>$R^2_{computing}$</td>
<td>0.6314</td>
<td>0.6152</td>
</tr>
<tr>
<td>$R^2_{structure}$</td>
<td>0.5434</td>
<td>0.6601</td>
</tr>
</tbody>
</table>

Note: Standard errors in parentheses; Standard errors in the second parenthase in Column (3) are bootstrapped by 250 random draws with replacement. * significant at 0.10 level, ** significant at 0.05 level, *** significant at 0.01 level.
Table 2.5: Parameter Estimates: IV Specification

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>95% C.I.</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta_{\text{mach, mach}}$</td>
<td>-0.8272</td>
<td>(0.2249)</td>
<td>-1.2680 -0.3864</td>
</tr>
<tr>
<td>$\beta_{\text{comp, comp}}$</td>
<td>-0.3054</td>
<td>(0.1010)</td>
<td>-0.5034 -0.1073</td>
</tr>
<tr>
<td>$\beta_{\text{trans, trans}}$</td>
<td>0.0280</td>
<td>(0.1489)</td>
<td>-0.2639 0.3199</td>
</tr>
<tr>
<td>$\beta_{\text{struc, struc}}$</td>
<td>-0.1591</td>
<td>(0.0987)</td>
<td>-0.3525 0.0344</td>
</tr>
<tr>
<td>$\beta_{\text{mach, comp}}$</td>
<td>0.3812</td>
<td>(0.1126)</td>
<td>0.1605 0.6019</td>
</tr>
<tr>
<td>$\beta_{\text{mach, trans}}$</td>
<td>0.2147</td>
<td>(0.1482)</td>
<td>-0.0757 0.5051</td>
</tr>
<tr>
<td>$\beta_{\text{mach, struc}}$</td>
<td>0.2313</td>
<td>(0.1042)</td>
<td>0.0271 0.4355</td>
</tr>
<tr>
<td>$\beta_{\text{comp, trans}}$</td>
<td>-0.1231</td>
<td>(0.0919)</td>
<td>-0.3032 0.0570</td>
</tr>
<tr>
<td>$\beta_{\text{comp, struc}}$</td>
<td>0.0473</td>
<td>(0.0654)</td>
<td>-0.0808 0.1755</td>
</tr>
<tr>
<td>$\beta_{\text{trans, struc}}$</td>
<td>-0.1196</td>
<td>(0.0819)</td>
<td>-0.2801 0.0410</td>
</tr>
</tbody>
</table>

Note: Standard errors in parentheses; Parameter estimates related to transportation equipment are imputed using regression results from Table 2.4 Column 1.
Table 2.6: Demand Elasticities: IV Specification

<table>
<thead>
<tr>
<th>Factor i</th>
<th>Machinery Equipment Shares</th>
<th>Computing and Electronic Equipment Shares</th>
<th>Transportation Equipment Shares</th>
<th>Nonresidential Structures Shares</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Shares</td>
<td>0.4146</td>
<td>0.1799</td>
<td>0.1268</td>
<td>0.2786</td>
</tr>
<tr>
<td>Fitted Shares</td>
<td>0.4159</td>
<td>0.1766</td>
<td>0.1264</td>
<td>0.2811</td>
</tr>
<tr>
<td>Price Elasticities</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Factor i</td>
<td>ξ_{i,mach}</td>
<td>ξ_{i,comp}</td>
<td>ξ_{i,trans}</td>
<td>ξ_{i,struc}</td>
</tr>
<tr>
<td>Machinery Equipment</td>
<td>-2.5632***</td>
<td>1.0897***</td>
<td>0.6410*</td>
<td>0.8325***</td>
</tr>
<tr>
<td></td>
<td>(0.5386)</td>
<td>(0.2696)</td>
<td>(0.3548)</td>
<td>(0.2495)</td>
</tr>
<tr>
<td>Computing and</td>
<td>2.5715***</td>
<td>-2.5486***</td>
<td>-0.5689</td>
<td>0.5460</td>
</tr>
<tr>
<td>Electronic Equipment</td>
<td>(0.6363)</td>
<td>(0.5710)</td>
<td>(0.5192)</td>
<td>(0.3694)</td>
</tr>
<tr>
<td>Transportation Equipment</td>
<td>2.1102*</td>
<td>-0.7937</td>
<td>-0.6524</td>
<td>-0.6641</td>
</tr>
<tr>
<td></td>
<td>(1.1681)</td>
<td>(0.7244)</td>
<td>(1.1741)</td>
<td>(0.5383)</td>
</tr>
<tr>
<td>Structures</td>
<td>1.2479***</td>
<td>0.3469</td>
<td>-0.3024</td>
<td>-1.2924***</td>
</tr>
<tr>
<td></td>
<td>(0.3739)</td>
<td>(0.2346)</td>
<td>(0.2941)</td>
<td>(0.3543)</td>
</tr>
</tbody>
</table>

Note: Standard errors in parentheses; * significant at 0.10 level, ** significant at 0.05 level, *** significant at 0.01 level.
Table 3.1: Summary Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corporate share of Establishments</td>
<td>87</td>
<td>0.3601</td>
<td>0.0957</td>
<td>0.1805</td>
<td>0.5866</td>
</tr>
<tr>
<td>Corporate share of Employment</td>
<td>87</td>
<td>0.8435</td>
<td>0.0900</td>
<td>0.5530</td>
<td>0.9795</td>
</tr>
<tr>
<td>Corporate share of Production</td>
<td>87</td>
<td>0.8660</td>
<td>0.0853</td>
<td>0.6087</td>
<td>0.9897</td>
</tr>
<tr>
<td>Tax Cost (in % pts.)</td>
<td>87</td>
<td>-2.2737</td>
<td>3.3642</td>
<td>-7.6000</td>
<td>1.0000</td>
</tr>
<tr>
<td>Ln (Total Production)</td>
<td>87</td>
<td>15.0424</td>
<td>3.5773</td>
<td>10.5816</td>
<td>21.9380</td>
</tr>
<tr>
<td>Ln (Population Density)</td>
<td>87</td>
<td>4.1012</td>
<td>1.0938</td>
<td>1.9459</td>
<td>6.3393</td>
</tr>
<tr>
<td>% of Migrants</td>
<td>87</td>
<td>0.1477</td>
<td>0.0988</td>
<td>0.0030</td>
<td>0.3300</td>
</tr>
<tr>
<td>% of Illiterate</td>
<td>87</td>
<td>0.0678</td>
<td>0.0644</td>
<td>0.0100</td>
<td>0.2900</td>
</tr>
</tbody>
</table>
Table 3.2: OLS Regression: Corporate Share of Economic Activities

<table>
<thead>
<tr>
<th></th>
<th>(1) Establishment</th>
<th>(2) Employment</th>
<th>(3) Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tax Cost</td>
<td>-0.0123***</td>
<td>-0.0125***</td>
<td>-0.0139***</td>
</tr>
<tr>
<td></td>
<td>(0.0034)</td>
<td>(0.0040)</td>
<td>(0.0039)</td>
</tr>
<tr>
<td>Ln (Total Production)</td>
<td>-0.0122***</td>
<td>-0.0062***</td>
<td>-0.0048**</td>
</tr>
<tr>
<td></td>
<td>(0.0028)</td>
<td>(0.0022)</td>
<td>(0.0022)</td>
</tr>
<tr>
<td>Ln (Population Density)</td>
<td>-0.2206*</td>
<td>-0.0765</td>
<td>-0.1685*</td>
</tr>
<tr>
<td></td>
<td>(0.1248)</td>
<td>(0.0898)</td>
<td>(0.0857)</td>
</tr>
<tr>
<td>% Immigrants</td>
<td>0.4463*</td>
<td>0.5803*</td>
<td>0.4729</td>
</tr>
<tr>
<td></td>
<td>(0.2458)</td>
<td>(0.3199)</td>
<td>(0.3036)</td>
</tr>
<tr>
<td>% Illiterate</td>
<td>-0.2485</td>
<td>0.1893</td>
<td>0.6747</td>
</tr>
<tr>
<td></td>
<td>(0.5609)</td>
<td>(0.3029)</td>
<td>(0.3973)</td>
</tr>
<tr>
<td>Constant</td>
<td>1.3706**</td>
<td>1.1240***</td>
<td>1.4820***</td>
</tr>
<tr>
<td></td>
<td>(0.4997)</td>
<td>(0.3304)</td>
<td>(0.3133)</td>
</tr>
<tr>
<td>Observations</td>
<td>87</td>
<td>87</td>
<td>87</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.715</td>
<td>0.691</td>
<td>0.633</td>
</tr>
</tbody>
</table>

Note: Robust standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. 
Table 3.3: Nonlinear Regression: Log-Odds Ratio vs. Fractional Logit Model

<table>
<thead>
<tr>
<th></th>
<th>Log-Odds Ratio</th>
<th>Fractional Logit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1) Establishment</td>
<td>(2) Employment</td>
</tr>
<tr>
<td>Tax Cost</td>
<td>-0.0299***</td>
<td>-0.0849***</td>
</tr>
<tr>
<td></td>
<td>(0.0063)</td>
<td>(0.0166)</td>
</tr>
<tr>
<td>Ln (Total Production)</td>
<td>-0.0622***</td>
<td>-0.0422***</td>
</tr>
<tr>
<td></td>
<td>(0.0100)</td>
<td>(0.0142)</td>
</tr>
<tr>
<td>Ln (Population Density)</td>
<td>-0.0101</td>
<td>-0.1307</td>
</tr>
<tr>
<td></td>
<td>(0.0450)</td>
<td>(0.0924)</td>
</tr>
<tr>
<td>% Immigrants</td>
<td>-0.4875</td>
<td>1.4928</td>
</tr>
<tr>
<td></td>
<td>(0.6425)</td>
<td>(1.3665)</td>
</tr>
<tr>
<td>% Illiterate</td>
<td>0.5756</td>
<td>0.0839</td>
</tr>
<tr>
<td></td>
<td>(0.7097)</td>
<td>(1.3119)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.3506*</td>
<td>2.4924***</td>
</tr>
<tr>
<td></td>
<td>(0.1826)</td>
<td>(0.3662)</td>
</tr>
<tr>
<td>Observations</td>
<td>87</td>
<td>87</td>
</tr>
<tr>
<td>State FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Note: Robust standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Instruments included political party of the governor and state debt from previous years.
## Table 3.4: Marginal Effects of Tax Cost: Fractional Logit Model

<table>
<thead>
<tr>
<th>ME on Incorporation (% pts)</th>
<th>Estimate</th>
<th>SE</th>
<th>95% C.I.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average tax cost</td>
<td>-0.0118</td>
<td>0.00012</td>
<td>-0.0120</td>
</tr>
<tr>
<td>25 pctl of the tax cost</td>
<td>-0.0126</td>
<td>0.00005</td>
<td>-0.0127</td>
</tr>
<tr>
<td>50 pctl of the tax cost</td>
<td>-0.0117</td>
<td>0.00008</td>
<td>-0.0118</td>
</tr>
<tr>
<td>75 pctl of the tax cost</td>
<td>-0.0113</td>
<td>0.00008</td>
<td>-0.0114</td>
</tr>
</tbody>
</table>

Note: Estimate=parameter estimate; SE=standard error; Marginal effects of the tax cost are calculated by moving every observation in the sample above by 1 percentage point. All marginal effect estimates are significant at the 95% level.
Table 3.5: Predicted Corporate Establishments: With and Without Tax-Induced Income Shifting

<table>
<thead>
<tr>
<th>Dependent Variable: Corporate Share of Establishments</th>
<th>Actual Share</th>
<th>Predicted Share with Income Shifting</th>
<th>Predicted Share without Income Shifting</th>
</tr>
</thead>
<tbody>
<tr>
<td>1909-1919</td>
<td>0.3601</td>
<td>0.3601</td>
<td>0.3315</td>
</tr>
<tr>
<td></td>
<td>(0.0757)</td>
<td>(0.0640)</td>
<td>(0.0401)</td>
</tr>
<tr>
<td>1909</td>
<td>0.2742</td>
<td>0.2735</td>
<td>0.2840</td>
</tr>
<tr>
<td></td>
<td>(0.0598)</td>
<td>(0.0096)</td>
<td>(0.0090)</td>
</tr>
<tr>
<td>1914</td>
<td>0.3891</td>
<td>0.3900</td>
<td>0.3775</td>
</tr>
<tr>
<td></td>
<td>(0.0336)</td>
<td>(0.0088)</td>
<td>(0.0078)</td>
</tr>
<tr>
<td>1919</td>
<td>0.4168</td>
<td>0.4167</td>
<td>0.3330</td>
</tr>
<tr>
<td></td>
<td>(0.0324)</td>
<td>(0.0202)</td>
<td>(0.0165)</td>
</tr>
</tbody>
</table>

Note: Robust standard error in parentheses.
Figures

Figure 2.1: Top Statutory Corporate Tax Rate, Inflation Rate and Maximum ITC: 1962-1997

Note: Data on top statutory corporate tax rate are from the World Tax Database; data on inflation rate are from the Federal Reserve Bank-St. Louis; The ITC rates are summarized from various tax legislations during 1962-1997.
Figure 2.2: Fitted Investment Shares under Different Tax Regimes

Note: Fitted investment share under differential taxation in solid line. Fitted investment share under neutral taxation in dash line. Difference by year between investment share under these two tax schemes are summarized as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Machinery</th>
<th>Computing and Electronic Equipment</th>
<th>Transportation Equipment</th>
<th>Structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1963</td>
<td>0.2158</td>
<td>-0.2005</td>
<td>0.0074</td>
<td>-0.0227</td>
</tr>
<tr>
<td>1967</td>
<td>0.2396</td>
<td>-0.2073</td>
<td>0.0027</td>
<td>-0.0349</td>
</tr>
<tr>
<td>1972</td>
<td>0.1859</td>
<td>-0.1802</td>
<td>0.0136</td>
<td>-0.0193</td>
</tr>
<tr>
<td>1977</td>
<td>0.2093</td>
<td>-0.1866</td>
<td>0.0113</td>
<td>-0.0340</td>
</tr>
<tr>
<td>1982</td>
<td>0.2497</td>
<td>-0.2155</td>
<td>-0.0046</td>
<td>-0.0296</td>
</tr>
<tr>
<td>1992</td>
<td>0.1769</td>
<td>-0.2647</td>
<td>0.0434</td>
<td>0.0444</td>
</tr>
<tr>
<td>1997</td>
<td>0.1774</td>
<td>-0.2512</td>
<td>0.0317</td>
<td>0.0412</td>
</tr>
</tbody>
</table>
Figure 3.1: Corporate Share of Economic Activities in the U.S., 1904-1919

Source: author’s calculation based on data from the US Census of Manufacturers.
Figure 3.2: Distribution of Corporations by Industry Group in 1919

Source: author’s calculation based on data from the US census.
Figure 3.3: State Tax Rates in 1919

Source: author’s calculation based on data from various state tax legislations.
Appendix A

1 Theory

In this section we first summarize the Davidson and Martin (1985) model on the incidence of the corporate income tax in a two-sector economy with competitive (noncorporate) and imperfectly competitive (corporate) sectors. The imperfectly competitive sector is characterized by tacit collusion among a group of firms. When the imperfectly competitive sector is labor intensive, a tax on capital is shifted to labor. Based on this observation, we show that the wage elasticity with respect to the corporate tax is an increasing function of the concentration level. A lack of competitiveness results in a larger share of the tax burden shifted to labor.

1.1 Partial Equilibrium in the Imperfectly Competitive Sector

Suppose that there are $I$ industries in the economy. Each industry has a perfectly competitive sector and an imperfectly competitive sector. The imperfectly competitive sector consists of $N$ firms. This group of firms (the cartel) play a repeated game in which each produces constrained quantities of a single good $X$ under constant cost. Friedman’s grim trigger strategies support the constrained production which maximizes joint oligopolistic profits subject to no cheating. Namely, if any firm cheats by producing a higher quantity at time $t$, every firm will revert permanently to the Nash output level. The potential cheater compares the current gain from cheating to the present value of profit loss by permanently producing at a lower output level. The net gains from cheating ($Z$) are

$$Z = (\pi^{ch} - \pi^c) - \frac{1}{r}(\pi^c - \pi^n)$$  \hspace{1cm} (1)

where $\pi^{ch}$ denotes the profit from cheating, $\pi^c$ the profit per firm under constrained production, and $\pi^n$ the profit per firm in the static Nash equilibrium.

Let $Q_c$ denote the constrained production quantity per firm. The cartel chooses $Q_c$ from the set of sustainable outputs defined as $Q \equiv \{Q_c : Z \leq 0, Q_c \geq 0\}$. The cartel’s profit is:

$$\pi^c = Q_c[P(X_c, \omega) - c]$$  \hspace{1cm} (2)

where $P(\cdot, \omega)$ is the inverse demand function for good $X^1$, $c$ the constant unit cost of production and $\omega$ is a vector of shift parameters. The static Nash profit is:

$$\pi^n = \max_{Q_n} Q_n \left\{ P[(N - 1)\bar{Q} + Q_n, \omega] - c \right\}$$  \hspace{1cm} (3)

$^{1}$ $P(\cdot, \omega)$ is assumed to be single peaked and twice differentiable to guarantee a well-defined maximization problem.
for which we assume there exists a symmetric solution. Lastly, the profit from cheating is:

\[ \pi^{ch} = \max_{Q_{ch}} \{ P[(N - 1)Qc + Q_{ch}, \omega] - c \} \] (4)

Focusing on the special case in which the representative consumer has a utility function of the form:

\[ U(X, Y) = (1 - \alpha) \ln Y + \alpha \ln X, \]

the inverse demand curve for \( X \) is therefore

\[ P_x = \frac{\alpha M}{X}, \] (5)

where \( M \) is the total income, and \( \alpha \) is the budget share of good \( X \).

Substituting equation (5) into profit functions (3) and (4), we solve for \( \pi^n \) and \( \pi^{ch} \). Further substituting \( \pi^n, \pi^{ch} \) and \( \pi^c \) into equation (1) and setting \( Z(Q_c) = 0 \), we solve for \( Q_c \):

\[ Q_c = \frac{\alpha M(N - 1)(rN - 1)^2}{cN^2(rN + 1)^2} \] (6)

The inverse demand curve for \( X \) now becomes

\[ P_x = \frac{N(rN + 1)^2}{(N - 1)(rN - 1)^2c}. \] (7)

In general, the inverse demand function under tacit collusion is a function of the basic parameters in the model:

\[ P_x = P_x(\omega, c, r) \] (8)

Under perfect competition and cost minimization, \( r \) represents the net return to capital and its impact on \( P \) enters through increasing \( c \). Under imperfect competition, \( r \) enters (8) as a separate argument. This separate effect captures the impact of the price of capital on the pricing decision of the cartel. Specifically,

\[ \frac{dP_x}{dr} = \frac{\partial P_x}{\partial c} \left( \frac{\partial c}{\partial r} \right) + \frac{\partial P_x}{\partial r} \] (9)

The first term in (9) is positive since a rise in \( r \) increases the cost of capital. \( r \) decreases prices through increasing the cost of production. The second term in (9) is negative since a rise in \( r \) represents a greater inducement to increase output, which leads to a lower price. It captures the "collusive-pricing" of the change in \( r \) under imperfect competition. The overall impact of \( r \) on the price depends on the relative magnitude of these two effects.
1.2 The Imperfectly Competitive Sector in General Equilibrium

Now we embed the model of oligopoly into the standard two-sector general equilibrium model. There are two goods in each industry, \( X \) and \( Y \), each produced under constant returns. Perfect competition prevails in the \( Y \) sector, while \( X \) sector is oligopolistic. Both sectors employ capital \((K)\) and labor \((L)\), which are fixed in supply and fully mobile between sectors. All firms are price takers in the capital market.

Following standard notation, \( q_j \) the gross-of-tax output price of good \( j \), \( c_j \) the unit cost function for good \( j \), \( w \) and \( r \) the net returns to labor and capital, respectively, \( T_j \) one plus the \textit{ad valorem} output tax on good \( j \), \( T_{ij} \) one plus the partial factor tax on input \( i \) used in the production of good \( j \), and \( M \) the aggregate income.

Assuming \( Z(Q_c) > 0 \); the cartel’s gross price is given by
\[
q_x = q_x(q_y, M, c_x T_x, r). \quad (10)
\]
Assuming perfect competition in the \( Y \) sector, the price of \( Y \) equals the marginal cost of production:
\[
q_y = c_y(wT_{Ly}, rT_{Ky})T_y. \quad (11)
\]
Aggregate demands for the two products are
\[
X = X(q_x, q_y, M), \quad (12)
\]
\[
Y = Y(q_x, q_y, M), \quad (13)
\]
and all income is spent in equilibrium
\[
M = q_x X + q_y Y. \quad (14)
\]
We also assume fixed supplies of labor \((L_0)\) and capital \((K_0)\) and full employment:
\[
c_{Lx}X + c_{Ly}Y = L_0 \quad (15)
\]
\[
c_{Kx}X + c_{Ky}Y = K_0 \quad (16)
\]
where \( c_{ij} \) are the partial derivatives of the \( j \)th unit cost function with respect to the \( i \)th factor and represent the \( i \)th input requirement per unit of output of the \( j \)th good.

By Walras’ law, we choose \( w \) as the numeraire and drop equation (12) from the system, leaving six equations in six unknowns. Substituting the behavior of the oligopolist characterized by equation (7) into (10) we get
\[
q_x = \frac{N(rN + 1)^2}{(N - 1)(rN - 1)^2 c_x T_x} \quad (17)
\]
Finally, differentiating (11) and (17) and subtracting we get
\[
\hat{q}_x - \hat{q}_y = - \left( \theta^* + \Psi \right) \hat{r} + (\hat{T}_x - \hat{T}_y) + \theta_{Kx} \hat{T}_{Kx} - \theta_{Ky} \hat{T}_{Ky}, \quad (18)
\]
where the circumflex denotes proportional change, \( \theta^* = \theta_{Lx} - \theta_{Kx} \) measures the value of factor intensity, and \( \theta_{Lj} \equiv w c_{Lj} T_j / c_j \) measures labor’s share in industry \( j \). The second term \( \Psi \equiv 4rN / [(rN)^2 - 1] \), where \( r > 1/N \), captures the effect of change in \( r \) on the ability of the cartel to enforce its output restriction.

Differentiating and differencing the demand (12)-(13) and full-employment conditions (15)-(16) we get

\[
\hat{X} - \hat{Y} = - (\hat{q}_x - \hat{q}_y) \quad \text{(19)}
\]

\[
\lambda^* \hat{X} - \hat{Y} = -(a_x \sigma_x + a_y \sigma_y) \hat{r} - a_x \sigma_x \hat{T}_x - a_y \sigma_y \hat{T}_y, \quad \text{(20)}
\]

where \( \sigma_j < 0 \) the elasticity of substitution between \( K \) and \( L \) in the production of the \( j \)th good with respect to a change in relative rental prices, \( \lambda^* \equiv \lambda_{Lx} - \lambda_{Kx} \) where \( \lambda_{ij} = c_{ij} \hat{i}_0 \) measures the share of factor \( i \) in industry \( j \), and \( a_j \equiv \theta_{Kj} \lambda_{Lj} + \theta_{Lj} \lambda_{Kj} > 0 \).

Equations (18)-(20) constitute a three-equation general equilibrium model with three unknowns: \( \hat{X} - \hat{Y} \), \( \hat{q}_x - \hat{q}_y \), and \( \hat{r} \). We now consider the incidence of a capital tax \( T_{Kx} \) in the corporate sector.

A tax on capital in the corporate sector \( T_{Kx} \) decreases the net return of capital \( r \). Note that \( r \) has two effects on the oligopolistic sector: it allocates the fixed supply of capital between industries and measures time preference. In the latter role, the level of \( r \) determines the present value of profit loss due to cheating. A fall in \( r \) reduces the inducement to cheat, and allows the cartel to sustain a lower output and higher price.

In particular, by setting \( \hat{T}_x = \hat{T}_y = \hat{T}_{Ky} = 0 \) in (18)-(20) and solving for the elasticities of relative outputs, prices, and factor returns, we characterize the impact of a corporate income tax by the following system of equations:

\[
\hat{r} D^* = (\theta_{Kx} \lambda^* - a_x \sigma_x) \hat{T}_{Kx} \quad \text{(21)}
\]

\[
(\hat{X} - \hat{Y}) D^* = -(\theta_{Ky} a_x \sigma_x + \theta_{Kx} a_y \sigma_y + a_x \sigma_x \Psi) \hat{T}_{Kx} \quad \text{(22)}
\]

\[
(\hat{q}_x - \hat{q}_y) D^* = (\theta_{Ky} a_x \sigma_x + \theta_{Kx} a_y \sigma_y + a_x \sigma_x \Psi) \hat{T}_{Kx} \quad \text{(23)}
\]

As in the standard model of tax incidence, \( T_{Kx} \) induces an output effect \( \theta_{Kx} \lambda^* \) and a factor substitution effect \( a_x \sigma_x \) in the right-hand side of equation (21). Recall that \( \lambda^* = \lambda_{Lx} - \lambda_{Kx} \) measures the relative factor intensity in the corporate sector. The output effect will increase (decrease) \( r/w \) if the corporate sector is capital (labor) intensive. The factor substitution effect decreases \( r/w \) unambiguously. As \( T_{Kx} \) decreases the net return of capital \( r \), it also reduces the inducement to cheat and results in a lower output level. The output effect of imperfect competition further decrease the output level\(^2\). When the imperfect-competitive sector is labor intensive, this additional output effect will further decrease wage.

\(^2\)Here \( D^* \equiv a_x \sigma_x + a_y \sigma_y + \lambda^*(\theta^* + \Psi) \) and must be positive for stability. See Davidson and Martin for a detailed discussion of the stability properties.
1.3 Comparative Statics with Imperfect Competition

Having laid out the general conclusions of the Davidson and Martin model, we are interested in the impact of the degree of competitiveness on the elasticity of wage with respect to the corporate tax. We answer this question by deriving the comparative static of the wage elasticity with respect to the number of players in the corporate sector. Writing out equation (21) explicitly, we have

$$\frac{\tilde{r}}{w} = \frac{(\theta_{Kx} \lambda^* - a_x \sigma_x)}{a_x \sigma_x + a_y \sigma_y + \lambda^*(\theta^* + \Psi)} \tilde{T}_{Kx}. \quad (24)$$

Since percentage deviations from equilibrium equal the natural log-deviations up to first order, we have

$$\ln w - \ln r = \frac{-(\theta_{Kx} \lambda^* - a_x \sigma_x)}{a_x \sigma_x + a_y \sigma_y + \lambda^*(\theta^* + \Psi)} \ln T_{Kx} + c, \quad (25)$$

where $c = \ln w^* - \ln r^* - \ln T_{Kx}^*$, the difference in pre-perturbation equilibrium values.\footnote{$T_{Kx}^* = 0$ before the introduction of capital tax in the $X$ sector.} Rearranging we get

$$\ln w = \frac{-(\theta_{Kx} \lambda^* - a_x \sigma_x)}{a_x \sigma_x + a_y \sigma_y + \lambda^*(\theta^* + \Psi)} \ln T_{Kx} + \ln r + c. \quad (26)$$

Let $\eta_{wT}$ denote the elasticity of wage with respect to the corporate income tax. $\eta_{wT}$ depends on the model parameters as follows:

$$\eta_{wT} = \frac{\partial \ln w}{\partial \ln T_{Kx}} = \frac{-(\theta_{Kx} \lambda^* - a_x \sigma_x)}{a_x \sigma_x + a_y \sigma_y + \lambda^*(\theta^* + \Psi)}. \quad (27)$$

Based on equation (27), we derive two key observations. First, $\eta_{wT}$ is negative if $\theta_{Kx} \lambda^* - a_x \sigma_x > 0$. This condition is guaranteed when the corporate sector is labor intensive, which holds in general for the corporate sector in the United States. Second, $\eta_{wT}$ depends on the degree of industry competitiveness. Specifically,

$$\frac{\partial \eta_{wT}}{\partial N} = \frac{(\theta_{Kx} \lambda^* - a_x \sigma_x)}{[a_x \sigma_x + a_y \sigma_y + \lambda^*(\theta^* + \Psi)]^2} \frac{\partial \Psi}{\partial N} < 0,$$

as $\theta_{Kx} \lambda^* - a_x \sigma_x > 0$ and

$$\frac{\partial \Psi}{\partial N} = \frac{4r[(rN)^2 - 1] - 4rN[2(rN) \times r]}{[(rN)^2 - 1]^2} = \frac{-4r - 4r^3N^2}{[(rN)^2 - 1]^2} < 0. \quad (28)$$

The magnitude of the wage elasticity decreases with the number of players in the
corporate sector. When there are only a handful players in an industry, each firm gets a larger share of the joint profit. In addition, the monitoring and enforcement cost is likely to be small. The output effect due to imperfect competition is manifested in the most concentrated industries. We use the four-firm concentration ratio to measure the degree of industry competitiveness in the empirical specification. Consequently, we expect $\eta_{WT}$ to increase with the concentration ratio$^4$.

2 Derivation of A Consistent Industry Classification

We collect data from there major sources: Bureau of Economic Analysis (BEA) Capital Flows for the calculation of effective tax rates, Economic Census for the calculation of concentration ratio, and IPUMS-CPS for other person-level variables. Each data source uses a different industry classification system. The BEA’s industry groups are based on the Standard Industrial Classification (SIC) system. The Census uses SICs for market concentration data, and the IPUMS-CPS uses the Census Industrial Classification (CIC) system. Each classification also changes over time. The SIC system was entirely replaced by NAICS in year 1997. To overcome the problems due to inconsistency among classification systems, we develop an unified industry classification for the period of analysis.

2.1 The Unified Industry Classification

The first step in creating an unified industry series is to create the baseline industry categories. This baseline classification is constrained by the most aggregated classification system in the data sources, the industry groups in the 1992 BEA capital flow table. Following the industry classification of the 1992 national input-output accounts, 1992 BEA capital flow table groups industries into 64 categories based on the 1987 SICs. Most grouping are based on the 2-digit SICs, while some are based on the 3-digit level.

We further refine this baseline classification due to cross-time matching constraint. Using a concordance between the 72 and 87 SICs, we wanted to assign the 80 industries in 1982 into the 64 groups as in the 1992 BEA data. However, while most industries are grouped at a more detailed 72 SIC level, a few are grouped at a more aggregated than their 82 counterparts$^5$. These few exceptions require us to further aggregate industries to 41 categories based on the 2-digit 1987 SICs$^6$. 

$^4$As a special case, $\partial \Psi / \partial N \rightarrow 0$ as $N \rightarrow \infty$. The wage elasticity converges to the standard prediction in a two-sector GE model.

$^5$For example, information is only available for transportation and warehousing in 1972, while in 1982 detailed information are available for each of the subcategories including railroad transportation (40,474), local and interurban passenger transportation (41), trucking and warehousing (42), water transportation (44), transportation by air (45), pipeline, except natural gas (46), transporation services (472,473,478).

$^6$With the exception that the Transportation Equipment class is based on the 3-digit SICs.
2.2 Match with SICs and NAICS

The second step is to match 72 SICs and 97 NAICS to the unified classification. For the first match, the 1987 Standard Industrial Classification manual provides a 4-digit code crosswalk between the 1972 and 1977 SICs and between the 1977 and 1987 SICs. Based on this correspondence, all the changes from 1972 to 1987 SIC industries are within the 41 categories. There are no crossover changes. The 72 SICs are directly mapped 87 SICs and the unified industry classes. For the match between 97 NAICS and 87 SICs, we use a crosswalk provided by the Census which links each 4-digit NAICS to their corresponding 4-digit 87 SICs. Although a 4-digit 1987 SIC can be assigned to multiple NAICS, this problem is minimized at 2-digit level, i.e. grouping NAICS by their 2-digit SICs. This is another advantage of our 2-digit SIC based classification system.

2.3 Match with CICs

For this match, we rely on the census’ classified index of industries and occupations, which provides a crosswalk between the title of each industry and its 3-digit SICs. We assign each CIC a unified industry number by further aggregating the 3-digit SICs at 2-digit level. The 1970 CICs are based on 1967 SICs and the 1990 CICs are based on 1987 SICs. We check group comparability across time using a crosswalk provided by the 1972 and the 1987 SIC manual. All the changes from 1967 to 1987 SIC industries are within the 41 categories. There are no crossover changes. Figure A illustrates the matching procedure.
Table A1: Key Parameter Values for ETR Calculation

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$u$</td>
<td>statutory corporate tax rate</td>
<td>0.46</td>
<td>0.35</td>
</tr>
<tr>
<td>$\pi$</td>
<td>expected rate of inflation</td>
<td>0.07</td>
<td>0.03</td>
</tr>
<tr>
<td>$i$</td>
<td>nominal interest rate</td>
<td>0.20</td>
<td>0.11</td>
</tr>
<tr>
<td>$s$</td>
<td>real after-tax return</td>
<td>0.04</td>
<td>0.04</td>
</tr>
</tbody>
</table>
Table A2: An Unified Industry Classification System

<table>
<thead>
<tr>
<th>UIC</th>
<th>Industry Description</th>
<th>Related 87SIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Agricultural Production</td>
<td>01,02</td>
</tr>
<tr>
<td>2</td>
<td>Agricultural Services, Forestry, and Fishing, Hunting and Trapping</td>
<td>07,08,09</td>
</tr>
<tr>
<td>3</td>
<td>Metal Mining</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>Coal Mining</td>
<td>12</td>
</tr>
<tr>
<td>5</td>
<td>Oil and Gas Extraction</td>
<td>13</td>
</tr>
<tr>
<td>6</td>
<td>Mining and Quarrying of Nonmetallic Minerals, Except Fuels</td>
<td>14</td>
</tr>
<tr>
<td>7</td>
<td>Construction</td>
<td>15,16,17</td>
</tr>
<tr>
<td>8</td>
<td>Food and Kindred Products</td>
<td>20</td>
</tr>
<tr>
<td>9</td>
<td>Tobacco Products</td>
<td>21</td>
</tr>
<tr>
<td>10</td>
<td>Textile Mill Products</td>
<td>22</td>
</tr>
<tr>
<td>11</td>
<td>Apparel and Other Finished Products</td>
<td>23</td>
</tr>
<tr>
<td>12</td>
<td>Lumber and Wood Products, Except Furniture</td>
<td>24</td>
</tr>
<tr>
<td>13</td>
<td>Furniture and Fixtures</td>
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<tr>
<td>14</td>
<td>Paper and Allied Products</td>
<td>26</td>
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<tr>
<td>15</td>
<td>Printing, Publishing, and Allied Industries</td>
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<td>16</td>
<td>Chemicals and Allied Products</td>
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<tr>
<td>17</td>
<td>Petroleum Refining and Related Industries</td>
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<tr>
<td>18</td>
<td>Rubber and Miscellaneous Plastics Products</td>
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<td>19</td>
<td>Leather and Leather Products</td>
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<td>20</td>
<td>Stone, Clay, Glass, and Concrete Products</td>
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<tr>
<td>21</td>
<td>Primary Metal Industries</td>
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<tr>
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<td>Fabricated Metal Products, Except Machinery and Transportation Equipment</td>
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<td>23</td>
<td>Industrial and Commercial Machinery and Computer Equipment</td>
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<td>24</td>
<td>Electronic and Other Electrical Equipment and Components, Except Computer</td>
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<td>25</td>
<td>Motor Vehicles and Motor Vehicle Equipment</td>
<td>371</td>
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<td>26</td>
<td>Transportation Equipment, Except Motor Vehicles</td>
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<td>27</td>
<td>Measuring, Analyzing and Controlling Instruments</td>
<td>38</td>
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<td>28</td>
<td>Miscellaneous Manufacturing Industries</td>
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<td>29</td>
<td>Transportation</td>
<td>40-7</td>
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<td>Communications</td>
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<td>31</td>
<td>Electric, Gas, and Sanitary Services</td>
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<td>32</td>
<td>Wholesale Trade and Retail Trade</td>
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<td>Eating and Drinking Places</td>
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<td>34</td>
<td>Finance and Insurance</td>
<td>60-67</td>
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<td>35</td>
<td>Real Estate</td>
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<td>36</td>
<td>Lodging, Personal, and Miscellaneous Repair Services</td>
<td>70,72,76</td>
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<td>37</td>
<td>Business, Legal, Engineering, Accounting, Research, Management, and Related Services7</td>
<td>73,81,87,89</td>
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<td>38</td>
<td>Automotive Repair, Services, and Parking</td>
<td>75</td>
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<td>39</td>
<td>Motion Pictures</td>
<td>78</td>
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<tr>
<td>40</td>
<td>Amusement and Recreation Services</td>
<td>79</td>
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<tr>
<td>41</td>
<td>Health, Educational and Social Services, Museums, Galleries and Zoos, Membership Organizations</td>
<td>80,82-84,86</td>
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</table>

7 Including Services not elsewhere classified
Appendix B

I use data from the Bureau of Economic Analysis (BEA), the Bureau of Labor Statistics (BLS), and various other sources to construct a panel of investment shares, user cost of capital and prices by asset type and industry. This Data Appendix provides additional information on how the dataset for Chapter 2 are constructed.

1 User Cost of Capital

1.1 The nominal discount rate

The nominal discount rate of the corporation for industry \( j \) in year \( t \) \( (r_{jt}) \) is computed as a weighted average of after-tax rates of return to debt and equity:

\[
r_{jt} = \theta_{jt} \times i_t (1 - \tau_t) + (1 - \theta_{jt}) e_t,
\]

where \( \theta_{jt} \) is the share financed by debt (and \( 1 - \theta_{jt} \) is the share financed by equity), \( i_t \) is annual rate of return to debt measured by the nominal corporate AAA bond rates, and \( e_t \) is the annual rate of return to equity imputed assuming a 4% premium following the standard approach in the user cost and effective tax rates literature.\(^1\)

I impute debt and equity shares by collecting debt and equity data on every public traded company that remains operating during the entire sample period from the annual Compustat Industrial, Full coverage and Research files. Industry averages are computed by deleting observations without a complete record on the variables included in the analysis. The nominal discount rate \( r_{jt} \) reflects the capital structure at the firm and hence industry level. The real discount rate is \( r_{jt} - \pi_t \), where \( \pi_t \) is the annual inflation rate at year \( t \).\(^2\)

As the weights are the respective annual shares of debt and equity in each industry, the nominal discount rate varies at the industry level at each time period.

1.2 Tax Term of the User Cost

The tax term of the user cost of capital for asset \( i \) in year \( t \) \( (1 - ITC_{it} - \tau_t z_{it})/(1 - \tau_t) \), for which I collect data on top statutory tax rate \( \tau_t \), investment tax credit rate \( ITC_{it} \), tax life \( Y_{it} \) and depreciation method \( D_{it}(s_{it}) \) from IRS corporate income tax laws. The tax code specifies three methods of depreciation: straight-line, declining balance depreciation with a switch to straight line, and sum of the years’ digits depreciation. Denote \( D_{it}(s_{it}) \) the basic depreciation formula which gives the proportion of the original cost of an asset of age \( s_{it} \) that may be deducted from income for tax purposes.

\(^1\)Data on the nominal corporate AAA bond rates is from the Federal Reserve at St. Louis website (available at http://research.stlouisfed.org/fred2/series/AAA).

\(^2\)Data on annual inflation are provided by the Bureau and Labor Statistics (BLS).
The present value of the depreciation deduction on one dollar’s investment on asset \( i \) in industry \( k \) at time \( t \) is:

\[
z_{ikt} = \int_0^{Y_{it}} e^{-r_{kt}s_{it}} D_{it}(s_{it}) ds,
\]

where \( Y_{it} \) is the tax life of asset \( i \) specified by IRS in year \( t \) and \( r_{kt} \) the nominal discount rate in industry \( k \) at year \( t \). The depreciation allowance is computed by one of the three depreciation methods as described below:

1. **Straight-Line Depreciation.** This method allows a constant-dollar amount to be claimed annually over the tax life of an asset. Therefore, the annual deduction \( D \) as a function of life length is:

\[
D(s) = \begin{cases} 
\frac{1}{Y}, & \text{for } 0 \leq s \leq Y \\
0, & \text{otherwise}
\end{cases}
\]

The present value of straight-line depreciation, \( z_{sl} \), is obtained by discounting those depreciation amounts at the nominal discount rate, \( r \), of the firm making the investment.

\[
z = \int_0^Y e^{-rs} \frac{Y}{s} ds = \frac{1 - e^{-rY}}{rY}.
\]

2. **Sum of the Years’ Digits Depreciation.** The deduction declines linearly over the lifetime for tax purposes:

\[
D(s) = \begin{cases} 
\frac{2(Y-s)}{Y^2}, & \text{for } 0 \leq s \leq Y \\
0, & \text{otherwise}
\end{cases}
\]

Depreciation in each year is the number of years of remaining life \((Y-s)\) divided by the sum of the years in the life \( Y^2/2 \). The present value of deduction is:

\[
z = \int_0^Y e^{-rs} \frac{2(Y-s)}{Y^2} ds = \frac{2}{rY} \left[ 1 - \frac{1}{rY} (1 - e^{-rY}) \right].
\]

3. **Declining-Balance Depreciation with a Switch to Straight-Line Depreciation.** The declining-balance method is actually a constant-percentage rate of depre-
ciation, so the dollar amount of depreciation declines in each successive period. To allow taxpayers to fully recover investments when declining-balance depreciation is used, depreciation schedules switch to the straight-line method before the recovery period ends. The time chosen is the year in which straight-line depreciation on the remaining balance would give the same or a larger depreciation allowance. The deduction is

\[
D(s) = \begin{cases} 
\frac{b}{Y} e^{-(b/Y)s}, & \text{for } 0 \leq s \leq Y^* \\
\frac{1-e^{-(b/Y)Y^*}}{Y-Y^*}, & \text{for } Y^* \leq s \leq Y^* \\
0, & \text{otherwise}
\end{cases}
\]

The present value of depreciation deductions taken by the declining-balance method with a switch to straight-line depreciation at point \(Y^*\) is given by

\[
z = \frac{b}{Y} \int_0^{Y^*} e^{-(r+b/Y)s} ds + \frac{1-e^{-(b/Y)Y^*}}{Y-Y^*} \int_{Y^*}^{Y} e^{-rs} ds
\]

\[
= \frac{\beta}{\beta + r} \left[ 1 - e^{-(\beta+r)Y^*} \right] + \frac{1-e^{-\beta Y^*}}{(Y-Y^*)r} \left[ e^{-rY^*} - e^{-rY} \right]
\]

where \(\beta\) the rate of decline in value equals \(b/Y\). For example, for a 200 percent declining balance over five years, \(\beta = 2/5\). \(Y^*\) the optimal switching time is

\[
Y^* = Y(1 - \frac{1}{b}).
\]

When the degree of acceleration is double the straight-line rate, the switching point is halfway through the recovery period, \(Y/2\). When the degree of acceleration is 1.5, the switching point is one-third of the way through the recovery period, \(Y/3\).

The estimated average asset tax life for 1962 is given in Gravelle (1982). Measurement of tax lives for certain equipment investments presents some difficulties, particularly under the ADR system where lives for these assets are specified by using industry rather than by asset type. In these cases, Gravelle (1982) used data supplied by the Department of Treasury to estimate the average tax lives by industry. Average lives for each asset type are then weighted by the share of the asset held by each industry based on investment shares in the 1972 capital flow tables. Minimum ADR lives are assumed for all equipment except in some cases where choice of a longer life resulted in a larger investment credit and a greater combined value of depreciation and credits.

Note that the present value of depreciation allowance also depends on the nominal discount rate \(r_{kt}\). Calculation of the tax term in 1963 follows the special basis adjustment rule in Revenue Procedure 62-21. The basis in calculating tax depreciation for
an asset is reduced by the value of the ITC the asset receives. This base reduction was repealed by Revenue Act of 1964. Consequently, the 1963 tax term of the user cost of capital for asset $i$ is adjusted as $$(1 - ITC_{i,1963} - (1 - ITC_{i,1963} \tau_{1963} z_{i,1963})/(1 - \tau_{1963}).$$ Both the depreciation formula and the tax life vary across asset and year due to policy changes.

### 1.3 User Cost of Capital at Industry Level

To compute the industry-level user cost of capital, I collect the standard estimates of economic depreciation rates by asset type ($\delta_i$) from [?]. The economics rates of depreciation are asset specific and time invariant. For each of the 35 asset categories in industry $k$ at time $t$, I compute the user cost of capital as

$$coc_{ikt} = \left( r_{kt} + \delta_i \right) \left( 1 - ITC_{it} - \tau_{it} z_{ikt} \right) / \left( 1 - \tau_{it} \right).$$

At each time period, the user cost of capital varies by asset type and industry due to the interaction between the industry-level interest rate and the asset-level tax incentives. The nominal interest rate $r_{kt}$ depends on the capital structure of each industry. The industry-specific financial cost of capital drives the variation of the user cost across industry. The present value of the depreciation allowances $z_{ikt}$ also depends on the industry-specific nominal rate of discount $r_{kt}$, which further induces variation of the user cost at the asset–industry level.

### 2 Price

One limitation of the PPI series is that the BLS did not collect price for building until 1986. Using data during 1986-2002, I project backward the PPI for building from a log-linear equation

$$\ln P_{mt} = \mu + X_{mt} \gamma + \phi_m + year_t + year_t^2 + \epsilon_{mt},$$

where $P_{mt}$ is the PPI for building at month $m$ year $t$, $X_{mt}$ includes earnings of construction workers and the PPI for steel at month $m$ year $t$, $\phi_m$ is monthly dummy, $year_t$ is a year trend, and $\epsilon_{mt}$ is white noise. The within-sample $R^2$ is 0.99.

Assuming that $\epsilon_{mt}$ is independent of the explanatory variables, the predicted PPI for building is of the form:

$$E(P_{mt}|X_{mt}, \phi_m, year_t) = \alpha_0 \exp(\mu + X_{mt} \gamma + \phi_m + year_t + year_t^2),$$

where $\alpha_0$ is the expected value of $\exp(\epsilon_{mt})$. Following Wooldridge (2008, p. 211-218), I create $\lambda_{mt} = \exp(\ln P_{mt})$ and regress $P_{mt}$ on $\lambda_{mt}$ without intercept to obtain an estimated coefficient on $\alpha_0$. The predicted price is $\hat{\alpha}_0 \exp(\ln P_{mt})$. The within-sample correlation between the actual price and the predicted price is 0.9969. The out-of-sample predicted price for building is the annual average of monthly PPI in 1963,

3 Instrumental Variables

I use the total assets in the industry to measure size. Direct bankruptcy costs appear to constitute a larger proportion of a firm’s value as that value decreases. Relatively large firms tend to be more diversified and less prone to bankruptcy, suggesting that large firms should be more highly leveraged.

I measure the expected future return as a weighted average of earnings from previous and current period. I assume that the realized values as (imperfect) proxies of the values expected when a firm makes the capital structure decision. The earning volatility is measured by the standard deviation of five-year earnings previous to the current period. The earning volatility measures the income uncertainty of corporations. According to the corporate finance literature, there exists an inverse relationship between uncertainty and debt level. The growth rate is computed as total capital expenditure over total asset value. Equity-controlled firms tend to invest suboptimally to expropriate wealth from the firm’s bondholders. The cost associated with this agency relationship is likely to be higher for firms in growing industries, which have more flexibility in their choice of future investments and leverage level.

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3Two other measures of expected future return are constructed and the IV results are almost identical.
References


Vita

Li Liu

2011     Ph.D. in Economics, Rutgers University, New Brunswick, New Jersey
2009     M.A. in Economics, Rutgers University, New Brunswick, New Jersey
2005     B.S. in Economics, The College of New Jersey, Ewing, New Jersey

2010–Present  Research Fellow, Centre for Business Taxation, University of Oxford, United Kingdom