State User Costs of Capital

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Abstract

This paper extends the theoretical model of Hall and Jorgenson (1967) in order to examine major changes in state and local tax laws and their effects on the variation in tax burdens across states. A user cost of capital series that accounts for the major provisions of federal and state tax laws is calculated for representative firms in all forty-eight contiguous U.S. states at five-year intervals during the period 1963 to 1997. Previous studies of this topic have been limited to estimates of effective marginal tax rates for only a handful of locations and time periods. The results suggest that state and local tax policies have little effect on the variation in the user cost of capital across states. Further, state and local taxes have a large effect on the variation of effective marginal tax rates across states, which is consistent with what others have found. The implication is that state and local tax policies have little effect on state-specific investment because this variable is likely to be more directly related to the investment decisions of firms.

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Introduction

This paper examines a set of user cost of capital calculations for the adhesives, electronic transformers, pharmaceutical preparations, and semiconductors industries that vary across all forty-eight contiguous U.S. states and over the period 1963 to 1997. Based on an extension of the capital budgeting model of Hall and Jorgenson (1967), these calculations represent the annualized cost of purchases of additional units of capital. An examination of these calculations gives more meaningful insight into the question of whether state and local tax policies influence state-specific investment than does the examination of the relative state tax burdens, used in much of the current literature. This is because the user cost of capital should be more directly related to investment incentives. Also, the user cost measure can be calculated for a large number of locations and different time periods.

This question is of current interest because the number of states adopting elements of corporate income tax policies believed to encourage state-specific investment levels has increased dramatically in the last twenty years. Further, states' corporate income tax laws have become increasingly complex as they have introduced incentives to encourage investment within the state. Examples include investment tax credits linked to levels of employment in enterprise zones and exemptions for purchases of machinery used in manufacturing from sales/use taxes.

The effect that the increase in these tax incentives has had on both national and state-specific investment is uncertain. Beyond the standard criticisms of model mis-specification and measurement error, many of the early studies that examine this issue are criticized because of the particular measures of state and local tax burdens used in the empirical work. Examples include statutory corporate income tax rates and corporate income tax revenues per $1,000 of personal income [*e.g.*, Bartik (1985) and Carlton (1983)]. These measures of state corporate income tax burdens bear little resemblance to the actual tax burdens placed upon firms.

More recent studies use a representative firm approach that includes more detail of the actual tax environment, in order to develop more accurate measures of the effective tax burdens across states [*e.g.*, Fischer and Peters (1998), Papke (1991), and Tannenwald (1996)].[1] These models, however, are computationally burdensome. As a result, the calculations are limited to short time periods and a small number of potential locations for the capital investment of business firms. Thus, these studies are limited in their ability to estimate the impact of corporate income tax policy on the investment decisions of firms across locations.

A more important criticism of both the early and the more recent literature is that relative state tax burdens are not directly related to the investment decision of firms. Large differences in effective state tax rates across states do not necessarily imply large differences in the user cost of capital, the appropriate decision variable for firms' capital investment decisions. Large differences in effective tax rates across states might not have much of an effect on state-specific investment, because these differences might be very small relative to the average value of the user cost of capital across states.

There are two major findings from the calculation of the user cost of capital series. First, the characteristics of federal corporate income taxation dominate any changes in the user cost of capital facing firms within states across time. Second, despite differences in effective marginal tax

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[1]These models typically compare hypothetical streams of returns to investment with and without the presence of taxation. Working out the details of the representative firm and the implied present discounted value of capital investment requires a high degree of detail.

rates, the user costs of capital across states are virtually identical for any given year examined.

This paper is organized in the following manner. Section I introduces the capital budgeting model of Hall and Jorgenson (1967). Section II discusses federal, state, and local tax policies. Further, it discusses the elements chosen for the model developed in this paper. Section III develops the model, based on the material presented in Section II. Section IV describes the data used for the calculations in this paper. Section V discusses the results of the user cost of capital calculations based on the model in Section III. Section VI concludes.

I. The Capital Budgeting Model of Hall and Jorgenson (1967)

Hall and Jorgenson (1967) derive an equation for the user cost of capital from the theory of optimal capital accumulation. They note that the economic problem facing the firm can be viewed in one of two equivalent ways. First, the firm may be viewed as renting assets from itself in order to obtain capital services that allow the firm to maximize its profits. Profits are defined as gross revenue less the cost of current inputs and the rental value of capital inputs. Second, the firm may be viewed as accumulating assets in order to supply capital services to itself. The user cost of capital, or implicit rental price, can be calculated from the relationship between the purchase price of the new capital good and the discounted value of all future services derived from the capital good. In the absence of taxation, Hall and Jorgenson specify this relationship as

$$q(t) = \int_t^\infty e^{-\rho(s-t)} c(s) e^{-\delta(s-t)} ds \tag{1.1}$$

where q is the purchase price of investment goods, t is the time of acquisition of the capital good, s is the time when services from the good are received, ρ is the rate of return, c is the cost of capital services, and δ is the true rate of economic depreciation. By differentiating equation (1.1) with respect to the time of acquisition, rearranging terms, and assuming static expectations, the following relationship can be derived:

$$c = q\left(\rho + \delta\right) . \qquad (1.2)$$

Equation (1.2) expresses the cost of capital services as a function of the purchase price of investment goods, the discount rate, and the true rate of economic depreciation.

Hall and Jorgenson continue the development of their model by considering the effect of a proportional tax at rate τ_f on business income and assuming that the federal government prescribes a depreciation formula, $D_f(t)$, that gives the depreciation allowance per dollar of original investment at time t. Further, they assume that the government allows a credit at rate ζ^i_f on new investment expenditure, and a deduction for interest payments on debt. The deduction for interest payments on debt is incorporated into the before-tax rate of return ρ to arrive at the after-tax rate of return $\rho(1 - \tau_f)$. With the inclusion of these additional elements, the relationship between the purchase price of investment goods and the present value of all future rentals and tax deductions is appropriately expressed as

$$q(t) = \int_t^{\infty} e^{-\left(1-\tau_f\right)\rho(s-t)}\left[\left(1-\tau_f\right) c(s-t) + \tau_f\left(1-\zeta^i_f\right)q(s-t)\,D_f(s-t)\right]e^{-\delta(s-t)}\,ds$$

$$+\zeta^i_f\,q(t). \qquad (1.3)$$

By differentiating equation (3.1) with respect to the time of acquisition, assuming static expectations, and rearranging terms, the following expression for the user cost of capital can be derived:

$$c = q\left[\left(1-\tau_f\right)\rho+\delta\right]\left(\frac{1-\zeta^i_f-\tau_f Z_f}{1-\tau_f}\right) \tag{1.4a}$$

where

$$Z_f = \int_t^\infty e^{-\left(1-\tau_f\right)\rho(s-t)} D_f\,(s-t)\,ds. \tag{1.4b}$$

The variable Z_f in equation (1.4b) is the present discounted value of depreciation deductions claimed on a dollar's worth of purchased capital.

A number of conclusions can be drawn from the results presented by equations (1.4a-b) about the effects of changes in tax structure assumed in Hall and Jorgenson's model. First, an increase in the investment tax credit lowers the user cost of capital by subsidizing the purchase of investment goods. Second, an increase in the present value of depreciation allowances reduces the user cost of capital. The effect of an increase in the tax rate on the user cost of capital is uncertain. Hall and Jorgenson demonstrate that if the before-tax rate of return is constant and the combined value of depreciation allowances and the investment tax credit is equal to the rate of true economic depreciation, then changes in the tax rate will not change the user cost of capital. It could be the case, however, that the after-tax rate of return, rather than the before-tax rate of return, is constant. In order to resolve the issue of the incidence of corporate taxation on the user cost of capital, an econometric model including savings as well as investment needs to be considered. The general assumption made by most models, including the model in this paper, is that the full incidence of the tax is borne by the firm. (Equivalently, the before-tax rate of return is held constant.)

II. Discussion of Federal, State, and Local Taxes

This section is organized into five parts. The first part discusses federal and state corporate income taxes. The second part discusses state sales/use taxes. Local property taxation and the federal tax treatment of foreign sales are discussed in the third and fourth parts of this section .The final part discusses the speculation about and evidence on which tax policies have the greatest effect on the user cost of capital. In light of these discussions, the user cost of capital model is developed in the following section.

General Description of Federal and State Corporate Income Tax Codes

The Internal Revenue Code (IRC) defines taxable income as operating revenues less operating expenses. The operating expenses that relate to capital include depreciation allowances and the deduction of interest on bond-financed investment. Further, the IRC has permitted various investment tax credits for equipment and foreign taxes paid over the past thirty-five years. A large number of other deductions also relate to operating expenses, but not specifically to capital expenses. These other deductions should generally not be considered in the calculation for the user cost of capital. The federal tax base is related to the tax bases used by state and local governments because state and local taxes can be deducted from the federal tax base.

The consideration of interactions between federal state and local tax policies requires a high degree of detail, for two reasons. First, definitions of taxable corporate income differ widely across states. Second, the corporate income of a firm is apportioned among states that have legitimate claims for taxing the firm, and there is no uniform formula imposed by federal law to apportion income among all states with these claims. States decide themselves how much of a firm's corporate income they are going to tax within their state.

A state government taxes a firm when it can establish that a “sufficient nexus” exists between the firm and the state. Definitions of sufficient nexus are provided by the corporate income tax laws of a particular state. A state’s definition of sufficient nexus, however, cannot violate the Commerce and Due Process Clauses of the U.S. Constitution, nor can it violate Public Law (P.L.) 86-272. The Commerce Clause of the U.S. Constitution prohibits states from enacting laws that unduly burden interstate and international commerce. For a state’s tax law to satisfy the Due Process Clause, the policy must establish some minimal connection between the activities being taxed and the taxing state, and establish that the tax imposed is not disproportionate to the taxpayer’s in-state activities. In 1959, the U.S. Congress passed P.L. 86-272, following a large amount of litigation over the interpretation of the Commerce and Due Process Clauses during the 1950s. P.L. 86-272 declares that it is illegal for a state to tax the income of a firm if it has no “physical presence” within the state. Thus, the existence of a sufficient nexus usually requires that firms have payroll or property within a state.

The fact that a sufficient nexus usually exists between a firm and many states raises the question for state policymakers of how to determine the proportion of corporate income that is subject to taxation in each of the states. States use apportionment formulas to perform this task. These formulas consist of a weighted average of apportionment factors that usually include the ratios of state sales, state property values, and state wage bills to the respective national totals for a given firm. The calculation of an apportionment formula results in an apportionment share that is multiplied by the taxable income of the firm to determine the tax base of the state. Usually, the base used in the calculation of taxable income within a state is business income. Business income refers to the income received from activities directly related to the operation of business. Nonbusiness income, such as income received from the purchase of bonds or securities for manufacturing firms, is typically added back to the taxable income in the state in which the firm is chartered before the tax rate is applied.

The U.S. Supreme Court has made no attempt to impose a uniform apportionment formula across states. Some states follow the apportionment prescription of the Uniform Division of Income for Tax Purposes Act (UDITPA) that was drafted by the National Conference of Commissioners on Uniform State Tax Laws in 1957. UDITPA prescribes a uniform apportionment formula based upon equal one-third weightings of sales, property, and payroll.[2] Slightly more than half of the states currently follow the prescriptions of UDITPA. Most of the states that do not follow the UDIPTA prescriptions give a greater weight to sales than to property or payroll, in an attempt to place a greater amount of the state's corporate tax burden on firms that conduct most of their manufacturing outside of the state. Giving more weight to the sales factor is also believed to promote the development of export-oriented firms that hire workers within the state. A few states use apportionment formulas that consist of a weighted average of only two apportionment factors; some states use just one apportionment factor. A state may use an apportionment formula that is based on factors other than sales, although it is still precluded under P.L. 86-272 from taxing a firm that does not have physical presence in the state.

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[2] UDITPA also prescribes that if a firm has only sales in a state that total less than $100,000, then the state should tax gross sales. Many of the states that have adopted UDITPA over the years, such as Arkansas, California, and Kansas, effectively ignore this recommendation by not specifying the alternative tax rate or providing other laws that supersede the UDITPA sections of their laws.

The apportionment of income across states is further complicated by the adoption of "throwback" rules by many states. A throwback rule mandates that if any of a firm's out-of-state income has escaped taxation due to a lack of a physical presence or a lack of a corporate income tax in another state, the state from which the output originated will tax this income. Throwback rules apportion income back to the state from which the output was shipped, with the exception of Massachusetts. Massachusetts bases its current throwback rule on the state in which the output was billed.

Throwback rules can have substantial effects on the amount of taxable income apportioned to a particular state for industries whose firms have payroll, property, or sales concentrated in a few states. For example, semiconductors are sold primarily to computer manufacturers, many of which are located in states that do not have corporate income taxes, such as Texas and South Dakota. For a new semiconductor firm located in Massachusetts, sales to computer manufacturers in Texas and South Dakota that are billed in Massachusetts are used in the apportionment calculation for Massachusetts. The magnitude of the effect of a throwback rule is influenced by the taxing state's apportionment formula. To continue the example, since Massachusetts currently uses an apportionment formula with double-weighted sales, the current apportionment of throwback income for Massachusetts is given double-weight in the apportionment formula. The lack of a uniform set of apportionment formulas across states, along with the lack of consistently applied to throwback provisions, means that 100 percent of the federal taxable income of many firms is not allocated among states.

It is very likely that a value other than 100 percent of the federal taxable income of many firms would be taxed by all states combined even if all states imposed uniform apportionment formulas, because there is variation in how states define taxable income. Most states use the federal definition of taxable income as a starting point for the state's definition of taxable income. This practice is referred to as "piggybacking," and it results in a high degree of conformity between state and federal tax laws. However, many states do not follow the practice of piggybacking, and all states that do piggyback modify the federal tax base to arrive at their definitions of taxable income. It is these modifications, along with differing apportionment formulas, that cause state income tax bases to differ.

The primary cause of the differing sets of modifications to federal taxable income is the differing goals of state governments. Many times these differences arise in response to changes in federal tax policy. For instance, during the period 1981 to 1986, the variations in states' definitions of taxable income increased in response to the Economic Recovery Act (ERA) of 1981. The ERA of 1981 introduced the Accelerated Cost Recovery System (ACRS), which provided more rapid depreciation allowances for federal tax purposes than the previous legislation. Faced with the threat of revenue losses, many, but not all, states decided to require additions to federal taxable income to mitigate the effects of ACRS when determining the taxable income of corporations within the state. In 1986, however, Congress passed the Tax Reform Act of 1986, which introduced the Modified Accelerated Cost Recovery System (MACRS). MACRS extended the useful life of many capital assets for federal tax purposes. Many states have responded to this development by passing legislation that phased in the same deductions for depreciation allowances as provided by federal law. Thus, state tax bases have become more uniform since 1986.

States that piggyback require many other adjustments to federal taxable income, beyond additions or subtractions to federal taxable income for ACRS or MACRS and interest on federal debt. For example, most states require that all state and local taxes be added back into the definition of federal taxable income. A few states require that only their state tax liabilities be added back to federal taxable income. Other additions include, but are not limited to, income from municipal bonds, local income taxes, local franchise taxes, state excise taxes, and federal tax carryovers for operating losses. A few states currently allow the deduction of federal corporate income taxes from their state tax bases. Some states limit the deduction of federal corporate income taxes paid to a fixed percentage of the amount of income that is apportioned to the state.

Local Property Taxes

Local governments are usually permitted to choose the tax rates that apply to personal and real property within their localities but have little control over other aspects of property tax laws. Most of the local property tax provisions are mandated by a state's constitution and laws. Specifically, a state's constitution and laws determine whether local property taxes apply to particular classes of property, and whether different classes of property need to be assessed at different ratios to market value. Provisions in many states' Assembly Laws, such as those allowing local governments to tax real but not personal property, could possibly have a great influence on the user cost of capital. Many states mandate that particular classes of personal property, such as manufacturing machinery and equipment, are exempt from personal property taxation. Exemption from sales/use taxes lowers the user cost of capital, because firms need to receive a smaller rate of return on capital to pay bondholders and shareholders their desired rates of return. In effect, state tax policy determines the "base" of the property tax system for local governments within a state.

Local governments do have some role in the determination of local tax policy beyond choosing the property tax rate that is imposed upon the base once the property has been assessed at the prescribed legal level. Local governments can also determine whether certain investments are fully or partially exempt from property taxes and for how many years, so long as they act within the state-defined limits for such abatement.

State and Local Sales/Use Taxes

State and local governments impose sales and use taxes on the purchase of inputs used in production, including the purchase of capital. A sales tax refers to a tax placed upon the purchase of goods and services within a state. States that impose a sales tax typically impose a complementary use tax. A use tax is imposed on the use or consumption of goods and services within the state. Further, almost all states that impose use taxes allow the deduction of sales taxes paid to other states from the use tax base within the state. For instance, in 1987, only two states did not allow such a deduction. Thus, use taxes are primarily used by states that impose sales taxes to keep buyers from purchasing goods in other states in which sales are not levied. A characteristic of state sales and use tax law that causes a great variation in the sales/use taxes paid by firms across different locations is the exemption of expenditures on machinery and equipment used in manufacturing. This exemption from sales/use taxes causes the user cost of capital to decrease as a result of lower acquisition costs and, hence, lower financing costs.

The Tax Treatment of Foreign Sales

The Internal Revenue Code maintains that all of a U.S. corporation's taxable income is to be considered in the calculation of taxable income at the federal level. The IRC, however, allows corporations to apply a foreign tax credit or a foreign tax deduction to the federal tax base. So long as a corporation's foreign tax liability is smaller than its federal tax liability, taxes paid to foreign governments will not affect the user cost of capital calculations through the effects of federal tax policy, as long as the credit is claimed. Even firms that export a large percentage of their output are likely to have federal tax liabilities that exceed their foreign tax liabilities. This is because many corporations supply exports to domestic export trade corporations or foreign subsidiary corporations.

States generally do not allow foreign tax credits or deductions. The exemption of foreign sales at the state level is accounted for through the system of apportionment formulas. If a firm produces all of its output in the United States and exports 50 percent of it, then the remaining 50 percent is roughly apportioned across states within the system of apportionment formulas.

Discussion of the Elements Chosen for the Model

Authors who concern themselves with the effects of various provisions of state and local tax policies on state-specific investment speculate on the particular provisions that are likely to cause the greatest variation in the user cost of capital and marginal effective tax rates across locations. Papke and Papke (1986) argue that the most important features that should be considered in a study that examines the effects of state tax policy are tax rates, rules for the deductibility of taxes imposed in other jurisdictions, rules for apportionment, depreciation allowances, and rules for carrying net operating losses (NOLs) forward or backward.

Fischer and Peters (1998) use a representative firm approach to compare the differences in effective tax rates resulting from changes in the tax policy of a state. With their assumptions regarding rates or return and the location of sales, they find that a sales tax exemption is the most valuable incentive. The next most valuable incentive is the use of a double-weighted sales factor in a state's apportionment formula. The explanation for this finding is that many firms that supply goods to a national market receive a low apportionment percentage in the state in which they are franchised because of the double-weighted sales factor, and they also receive low apportionment percentages in many other states because these states use an equally weighted three-factor formula and the firm has no property or payroll in them. The third most important feature is an allowable deduction under the state income tax for federal income taxes paid. Fischer and Peters find quite a bit of variation in the effective tax rates of states. The coefficient of variation for state effective tax rates is usually as large as the mean effective rate. They also discover that once state and local taxes are considered in the analysis, the coefficient of variation relative to the mean drops to one-half.

In this paper, the development of a user cost of capital across regions considers all of the characteristics of state and local tax laws mentioned by Papke and Papke, along with those mentioned by Fischer and Peters, with the exception of NOLs and deductions of other state corporate income taxes paid at the state tax level. The inclusion of NOLs and the deduction of state taxes paid from state tax bases would require a model that is analytically difficult to solve.

A few other characteristics regarding the effects of tax laws on firm location also are not considered in the model. First, "demand side" programs aimed at stimulating entrepreneurship, research and development, or technological transfer are not modeled.[3] Second, discretionary industrial incentives that are negotiated between a firm and state or local governmental officials

[3] Factors that increase the quality of factors of production, such as local public expenditures on public education, might influence the location of new manufacturing plants and can be included in empirical specifications. Many of these factors, however, should not affect the user cost of capital. The text refers specifically to demand side programs that influence the user cost of capital.

are not modeled. Third, the effects of enterprise zones are not considered. Fourth, small fixed fees for doing business within a state (*i.e.*, business franchise taxes) are not included. Fifth, personal tax rates within states are not included in the model. Sixth, state investment tax credits are not included in the model. Seventh, the method of financing is not modeled as an endogenous decision.

Demand side programs are not modeled, for two reasons. First, most of these programs, such as industrial revenue bond (IRB) financing programs and Department of Agriculture programs, are federally financed programs that are applied across most localities in the nation or are focused on rural areas, respectively. It seems unlikely that many manufacturing firms actually consider establishing plants located in rural areas, because of the absence of skilled labor.[4] Second, these specific programs are not commonly mentioned in the existing literature as having a significant influence on the variation of tax burdens across locations.

Discretionary incentives also are not modeled. First, doing so would require data that do not exist. One cannot research every single deal that might have been offered by state and local governments for each new plant. Even developing a rough estimate of these offers is difficult to do. Second, Swales (1989) argued that it is the automatic incentives provided by existing laws that influence the location of new plants. The argument is that these elements can be incorporated into the early stages of the planning process because there is very little uncertainty regarding their

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[4] Fischer and Peters (1998) provide the most rigorous model of the effects of tax policy and industrial incentives on rates of return to capital investment with their Tax And Incentive Model (TAIM). They do not include demand side programs for the same reason mentioned in the main text. Papke (1991) is the only author who has included the effects of local IRB financing in an empirical study of the firm location decision. Her finding is that local IRB financing does not significantly affect the location decision for the four industries considered in her study.

existence when the plant begins to operate.

Enterprise zones are not modeled for two reasons. First, the establishment of enterprise zones is a relatively new development.[5] Second, these zones are generally very small areas that are hard to identify in the data. They usually are smaller than a county, the smallest geographic unit of analysis for which most economists can obtain data. The user cost of capital calculations should include the effects of tax policy regarding enterprise zones if the majority of likely sites for industrial expansion within an industry are located in an enterprise zone. This is difficult to determine, however, and collection of enterprise zone data across the United States would take an inordinate amount of effort that would likely add little to the analysis.

Indirect business taxes also are not modeled. First, taxes such as corporate franchise taxes, which establish a fixed fee for the right of conducting business in the state, are difficult to include successfully in a model for the user cost of capital.[6] Second, these taxes are generally fees that are small relative to other taxes placed upon firms.

Personal income or capital gains taxes are not included in the model because the ultimate interest in calculating the series is to examine the allocation of capital among competing uses. It is

[5] As noted by Fischer and Peters (1998), no enterprise zones existed prior to 1980. Fischer and Peters also note that they have found very little evidence that the establishment of enterprise zones leads to greater levels of employment, implying that they probably have little effect on the plant location decision as well. Further, the establishment of these zones does not result in lower effective tax rates in many states considered in their study.

[6] Devereux and Griffith (1998) argue that the average tax rate for new investment is more relevant than the marginal tax rate in the determination of where a firm will build a new manufacturing plant. Their conclusions are based on the "lumpiness" associated with such a purchase of capital. Their study, however, is cast in an international context. In the United States almost all business-related taxes are proportional, or at least near proportional. As long as business franchise taxes are small, the wedge between the average and marginal user costs of capital should be very small. It is the marginal user cost of capital that is calculated in this paper.

assumed that the firm makes its financing decisions based on the interest rates it must pay on the national market. As long as the bond and equity markets are large, and risk is similar for projects across different regions, the opportunity cost does not depend on the particular characteristics of those who buy the bonds.[7] Thus, personal taxes should not matter.

The model does not account for investment tax credit provisions of states. The problematic feature of incorporating this element into the model is that these credits are often linked to sales or employment growth. Although the exclusion of state investment tax credits eliminates some of the variation in the user cost of capital series, it could not substantially change the conclusions drawn from the calculations. These credits are small relative to the federal tax credit, typically 1 to 3 percent versus 10 percent. Also, the deduction for federal tax purposes translates into a much larger decrease in the tax burden because of higher federal income tax rates.

An endogenous financing decision is not included because basic economic theory does not provide a convincing argument for why firms choose a combination of financing methods. Although there is no generally accepted model of the determination of the method of financing capital investment, A.B. Atkinson and J.E. Stiglitz (1980) provide one that treats the financing decision as endogenous. Their model generates results that are consistent with the assumptions made for the ratios used in this paper. The model predicts that financing is done through retained earnings and then through borrowing for the common case where the effective corporate tax rate is less than that of the effective personal tax rate. If the effective personal tax rate is less than the

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[7] There might be some effect of personal income taxes on the location of manufacturing firms, but it will not occur through the user cost of capital if the stated assumptions hold. For instance, personal income taxes might have an influence through the their effect on labor costs.

effective corporate tax rate, then the firm does all of its financing through the issuance of debt. The existence of a mix of financing methods is explained by Atkinson and Stiglitz as firms issuing a level of debt or new shares that is consistent with an "acceptable minimum." According to this model, the financing ratio should not change across locations unless the effective corporate tax rate in one location is above the effective personal income tax rate for some regions, but not others. This would imply large shifts in financing methods across regions, which are generally not observed.

III. Methodology

This section is composed of two parts. The first presents the theoretical model that determines the equations used to calculate the user cost of capital series across states. The second discusses the calculations used to determine effective marginal tax rates.

The Theoretical Model

Consider a firm that is taxed in a set of states, L = {1, 2, 3, . . ., k}. Further, let j denote a particular state in the set L, α_j denote the percentage of taxable income apportioned in state j, and τ_j^c denote the marginal tax rate for state j. The federal tax base over the life of an asset purchased at time t, $B_f(t)$, with current tax laws holding for the whole life of the asset, is given by the following equation:

$$B_f(t) = \int_t^{\infty} \left[c(s) - \xi_f(s-t) - \sum_{j \in L} \alpha_j \tau_j^c B_j(t) \right] ds \tag{3.1}$$

where s is time; *c(s)* is the return to a dollar's worth of capital services (i.e., the rental rate of capital services), which is assumed to be constant across states because capital is supplied to a national market; $\xi_f (s - t)$ is a placeholder for federal deductions from the federal tax base other than state corporate income taxes over the life of the asset; and $B_j (t)$ is the tax base for state j (before apportionment is applied) existing in L over the life of the asset, with laws at time t holding during the life of the asset.[8] The tax base for each state j existing in L is given by the following equation:

$$B_j(t) = \int_t^\infty \left[c(s) - \xi_j(s-t) - \zeta_j^f \tau_f B_f(t) \right] ds. \tag{3.2}$$

where $\xi_j (s - t)$ is a placeholder for deductions from a state's corporate income tax base other than federal income taxes paid over the life of the asset, with the current state tax laws in effect over the life of the asset; ζ_j^f is the proportion of a deduction state j allows for federal income taxes paid; and τ_f is the marginal federal tax rate.

The next step in the derivation of an user cost of capital equation is to solve for the reduced form equation that specifies a firm's after-tax cash flow resulting from a dollar's worth of investment, X_j. The general equation for cash flow for a firm located in state j is given by the following equation:

$$X_j(t) = \int_t^\infty c(s) ds - \tau_f B_f(t) - \sum_{j \in L} \alpha_j \tau_j B_j(t) \tag{3.3}$$

where $B_f (t)$ and $B_j (t)$ are in present value form. Appendix A demonstrates that two cases need to be considered. In the first case, federal taxes paid are not deducted from the tax base of any state that taxes the firm. In the second case, federal income taxes paid are deducted from the tax base

[8] This characteristic is consistent with the assumption of static expectations used to make the model more tractable.

of at least one state that taxes the firm.

<u>Case 1</u>*: Federal taxes are not deducted from the tax base of any state that taxes the firm.*

Appendix A demonstrates that in the case where federal taxes are not deducted from the tax base of any state that taxes the firm, the reduced form equation for after-tax cash flows over the life of the asset is given by the following equation:

$$X_j(t) = \int_t^{\infty}\left\{\left[\left(1-\tau_f\right)\left(1-\chi\right)-\tau_j^p\right]c(s)+\tau_f\xi_f(s-t)+\left(1-\tau_f\right)\chi^{\xi}(s-t)\right\}ds \tag{3.4}$$

where χ is the average state tax rate weighted by apportionment shares across states; τ^p_j is the effective average personal property tax rate in state j in which the investment is located; $\xi_f(s - t)$ is the placeholder for federal deductions for the corporate income tax other than state corporate income taxes; and $\chi^{\xi}(s - t)$ is the placeholder for the average deductions from state corporate income taxes weighted by apportionment shares and tax rates across states.

Appendix A discusses in more detail how equation (3.4) implies that the condition that the purchase price of capital equal the discounted value of all future services derived from the capital good in this case is given by the following equation:

$$\begin{aligned} q_j(t) &= \int_t^{\infty} e^{-\rho(s-t)}\left(1-\tau_f\right)\left[\left(1-\chi\right)-\tau_j^p\left(1-\chi^p\right)\right]c(s)\,e^{-\delta(s-t)}ds \\ &\quad+\int_t^{\infty} e^{-\rho(s-t)}\left[\tau_f\left(1+\tau_j^u\right)D_f(s-t)+\left(1-\tau_f\,\chi^D\right)\right]q_j(t)ds-\left(\tau_j^u-\zeta_f^i\right)q_j(t) \end{aligned} \tag{3.5}$$

where

$$\rho(s-t)=\lambda\left(1-\tau_f\right)\left(1-\chi^r\right)\rho_1(s-t)+\left(1-\lambda\right)\rho_2(s-t);$$

and χ^p is the state-level average deduction for local property taxes weighted by apportionment shares and corporate tax rates across states; τ^u_j is the sales/use tax rate for the state where the new capital is located; D_f is the federal depreciation allowance; χ^D is the state-level average depreciation allowance, weighted by apportionment shares and corporate income tax rates across states; λ is the proportion of investment financed through debt; χ^r is the state-level average deduction for interest on debt, weighted by apportionment shares and corporate tax rates across states; ρ_1 is the real rate of return on debt; and ρ_2 is the real rate of return on equity.

An expression for the user cost of capital is found by differentiating equation (3.5), assuming static expectations, and rearranging the result algebraically. This process results in the following equation for the user cost of capital in state j:

$$c_j = q(\rho + \delta)\left\{\frac{1 - \zeta_f^i + \tau_j^u - \tau_f(1 + \tau_j^u)Z_f - (1 - \tau_f)\chi^Z}{(1 - \tau_f)\left[(1 - \chi) - \tau_j^p(1 - \chi^p)\right]}\right\} \tag{3.6a}$$

where

$$Z_f = \int_t^\infty e^{-\rho(s-t)} D_f(s)ds, \tag{3.6b}$$

and

$$\chi^Z = \sum_{j \in L} \alpha_j \tau_j^c (1 + \tau_j^u) \int_t^\infty e^{-\rho(s-t)} D_j(s)ds \tag{3.6c}$$

where Z_f is the present discounted value of federal depreciation deductions and χ^z is the average present discounted value of state depreciation allowances weighted by apportionment shares. Equations (3.6a) and (3.6c) reflect the fact that sales/use taxes are allowable deductions that can be used to adjust the base for depreciation allowances.

Case 2: Federal taxes are deducted from the tax base of at least one state in which the firm is taxed.

Appendix A discusses in more detail how, in the case where federal taxes are deducted from the tax base of at least one state that taxes the firm, the reduced form equation for after-tax cash flow at any given point in time for one unit of capital is

$$X_j(t) = \int_t^{\infty} \left\{ \left[T_f (1-\chi) - \tau_j^p \right] c(s) + \left[1 - T_f \right] \xi_f (s-t) + T_f \chi^{\xi} (s-t) \right\} ds \tag{3.7}$$

where the following definition is used to simplify notation:

$$T_f \equiv \frac{1-\tau_f}{1-\tau_f \chi^f},$$

and χ^f is the average value of the deduction of federal income taxes paid from state corporate income taxes, weighted by apportionment shares.

Appendix A demonstrates that in this case the condition that the purchase price of capital equal the discounted value of all future services derived from the capital good is given by the following equation:

$$\begin{aligned} q_j(t) = & \int_t^{\infty} e^{-\rho(s-t)} T_f \left[(1-\chi) - \tau_j^p \left(1 - \chi^r\right) \right] c(s) e^{-\delta(s-t)} ds \\ & + \int_t^{\infty} e^{-\rho(s-t)} \left[(1-T_f)(1-\chi)(1+\tau_j^u) D_f (s-t) + T_f \chi^D \right] q_j(t) ds \\ & - \left(\tau_j^u - \zeta_f^i \right) q_j(t) \end{aligned} \tag{3.8}$$

where

$$\rho(s-t) = \lambda T_f \left(1-\chi^r\right) \rho_1 (s-t) + (1-\lambda) \rho_2 (s-t).$$

An expression for the user cost of capital is found by differentiating equation (3.8), assuming static expectations, and rearranging the result algebraically. This process results in the following equation for the user cost of capital in state j:

$$c_j = q(\rho + \delta) \left\{ \frac{1 - \zeta_f^i + \tau_j^u - (1-T_f)(1+\tau_j^u) Z_f - T_f \chi^Z}{T_f \left[(1-\chi) - \tau_j^p \left(1 - \chi^p\right) \right]} \right\}, \tag{3.9}$$

where χ^p is the average value of the deduction of interest on debt weighted by apportionment shares. The same general form for the equations defining the user costs of capital in equations (3.6) and (3.9) can be seen by noting that the value of $(1 - T_f)$ that appears in this second case can be thought of as the value of τ_f from the first case, with the necessary adjustments made for the fact that federal taxes can be deducted from some state corporate income taxes.

Calculation of Effective Marginal Tax Rates

Effective marginal state tax rate series are calculated from the weighted user cost of capital series. The effective marginal total tax rates are calculated as the difference between the user cost of capital with the presence of all taxation and the user cost of capital without the presence of any taxation, divided by the user cost of capital without the presence of any taxation within each state. The effective marginal state tax rates are calculated as the difference between the user cost of capital with the presence of all taxation and a user cost of capital without the presence of state taxation, divided by the user cost of capital without the presence of state taxation within each state. Since profit-maximizing firms should invest until the annualized cost of the last additional unit of capital equals its annualized rate of return, these calculations should result in the same value for an effective marginal tax rate as that calculated using annualized rates of return, which is more common in the literature.

IV. Description of the Data Used in the Study

The sources of data used to determine the characteristics of the relevant state tax policies are discussed in Appendix C. The data for the federal corporate income tax for Census years during the period 1963 to 1997 (1963, 1967, 1972, 1977, 1982, 1987, 1992, and 1997) are presented in Table 4.1. Table 4.1 demonstrates that there is a great deal of variation in the federal corporate income tax structure during the sample period. First, the federal tax rate declines over the period of the study. More noteworthy changes occur in the tax treatment of depreciation allowances and the investment tax credit. The shorter depreciation lifetimes for both equipment and structures in later years reflect the adoption of ACRS. The investment tax credit for equipment is increased from 7 percent to 10 percent in 1977, but decreases to 3.33 percent in 1982. This decrease is due to the fact that a smaller proportion of investment qualified for the credit because of the shorter depreciation lifetime assigned by ACRS. By 1987, the investment tax credit had been repealed.

The data for state corporate income tax bases for Census years during the period 1963 to 1997 are presented in Table 4.2. Table 4.2 demonstrates a high degree of variation in the particular provisions in state tax laws across states. For all time periods in Table 4.2, the percentage of states that tax corporate income with any one of the particular provisions examined is almost always between 15 percent and 50 percent. There is also a high degree of variation over time. In particular, in the last fifteen years examined, there is a large increase in the percentage of states that use an apportionment formula with extra-weighted sales. It is also noteworthy that there is a great deal of variation over time in the percentage of states that allow for an exemption of purchases of machinery used in manufacturing from sales/use taxes. In the earlier years, the percentage of states that impose sales/use taxes on capital increases because more states adopt sales/use taxes. In later years, a number of states adopt provisions allowing the deduction of purchases of machinery for use in manufacturing from sales/use taxes.

V. Empirical Findings

This section is composed of two parts. The first presents the main results of the user cost of capital calculations for each of the four industries. The second compares the results with those of Fischer and Peters (1998) and explains why there is so little variation in the user cost of capital series across states.

Presentation of the Main Results

The results of three different sets of user cost of capital series are presented for each industry. The first and second sets are the results of the calculations for equipment and structures within each industry. The third set consists of investment-weighted series within each industry. This last series is constructed by weighting the two previous series by the proportion of new investment in each type of capital for each year in the whole industry.[9]

The results of the user cost of capital calculations for equipment in the adhesives industry are presented graphically in Figure 5.1.1. It is apparent from Figure 5.1.1 that movements in the average value of the user cost of capital series across states are primarily determined by federal tax policies. This finding can be seen by recognizing two characteristics of the series. First, there is a larger variation in the user cost of capital series over time than across states in any given year. Second, the results of the series are consistent with the findings of other authors [*e.g.*, Hulten, Robertson, and Davies presented in Fullerton (1983), and Fullerton and Karayannis (1993)] who

[9] It is unclear whether it would be more illuminating to calculate a series weighted by proportions of each type of capital stock relative to total capital stock rather than a series weighted by proportion of expenditures on each type of capital relative to total capital expenditures. New capital expenditures were used because they are the only series that the U.S. Census Bureau has collected over the whole period of the study. Capital stock figures were not collected prior to the 1977 *Census of Manufactures*. Further, expenditures on used capital goods are not consistently broken down into separate categories for equipment and structures.

have studied the effects of federal tax policy on the user cost of capital. The lower average user costs of capital in earlier years presented in the figure reflect the substantial federal investment tax credit on purchases of machinery during these years. The lowest average user cost of capital is in 1977, shortly after the assets in question qualified for a full 10 percent federal investment tax credit, the highest credit rate permissible for these assets over the entire sample period. The user cost of capital actually increases by 1982 despite the adoption of ACRS between the two periods. This is because the adoption of ACRS shortened the depreciable lifetime of the assets in question by enough so that they qualified for only one-third of the 10 percent federal investment tax credit. The lower amount of federal investment tax credit for which the assets qualified caused an increase in the user cost of capital that was greater than the decrease resulting from the greater depreciation allowances. The large increase in the average user cost of capital across states in 1987 is primarily due to the repeal of the federal investment tax credit and the adoption of MACRS.

The results of the user cost of capital calculations for structures in the adhesives industry are presented graphically in Figure 5.1.2. There, results are characterized by the domination of federal tax policies, just like the results for equipment within the industry. The series average does not exhibit as much variation over time as the series for equipment does because there is no variation in an investment tax credit for this type of capital. However, the series still exhibits more variation over time than across states. Most notably, the value of the user cost of capital declines with the shortening of depreciation allowance asset lives, reaching its lowest value shortly after the federal adoption of ACRS. The user cost of capital increases as depreciation allowances are lengthened after the federal adoption of MACRS.

It can be inferred that the exemption of equipment used in manufacturing from sales taxes has one of the stronger impacts on the user cost of capital from the set of state tax characteristics examined in this study. In Figure 5.1.1, the average user cost of capital across states is actually smaller than the value of the cutoff for first quartile. This is because a few states with very low user costs of capital relative to other states are pulling the average down. This characteristic cannot be seen in the user cost of capital series across states for structures. By 1987, most states were using the same definitions for depreciation allowances as the federal government. Thus, the main difference in these two series is that there is not an exemption for buildings used for manufacturing.

The results of the investment-weighted series for the adhesives industry are presented in Figure 5.1.3. As can expected from the results presented in Figures 5.1.1 and 5.1.2, there is more variation in the average user cost of capital across time than in the individual user costs of capital over states in any given year of the study. However, the series does not show quite as much variation as the series for equipment does because of the lower amount of variation in the user costs of capital for structures within the industry. The proportion of investment in equipment is roughly three-fourths of total investment, so the user costs of capital for equipment generally drive the results of the investment-weighted series.

The statistics for the user cost of capital series presented for the adhesives industry in Table 5.1 further demonstrate that there is very little variation in the user cost of capital series across states in all of the sample years. The coefficient of variation (standard deviation divided by the mean) across states ranges from 0.016 to 0.032.[10] This degree of variation is tiny. In fact, when the author calculated the difference between the minimum and maximum values for the year with the greatest standard deviation, the difference was about fifteen times smaller than the average value. The coefficient of variation across states increases slightly in 1992 and 1997, primarily because a number of states adopted provisions for the exemption of purchases of machinery used in production from sales/use taxes, as well as apportionment formulas with double-weighted sales. The general trend for firms to become more levered in recent years mitigates an increased variation in the actual user cost of capital series because interest on debt is generally exempt from federal and state taxation.

The statistics presented in Table 5.1 also demonstrate that the variation in state effective tax rates is much larger than the underlying variation in the user cost of capital series. For instance, the coefficient of variation across states in 1997 is 0.643. The underlying coefficient of variation of user cost of capital series across states in the same year, however, is only 0.032. To give a more concrete example, the author found a difference in the marginal effective tax rates between Iowa and Nebraska in 1992 of 9.83 percent, whereas the difference in the underlying user costs of capital was only 120 basis points. This is because the variation in effective marginal tax rates is essentially based on the relative sizes of the differences in user cost of capital with and without the presence of state taxation, and not the very small differences in relative sizes of the overall user cost of capital. Thus, one should be careful in attaching much importance to the

[10] Note that these results are not sensitive to the assumption made that firms supply goods to a national market. When the assumption is made that firms supply goods only to the state in which their plant is located, the standard deviations of the series across states increase only in the ten-thousandths place.

variation in effective marginal tax rates. It is the user cost of capital that is the more relevant variable for the investment decision of firms. Even if one believes that the variation in marginal effective tax rates is “large,” this would not necessarily imply that the large differences have much of an impact on state-specific investment.

The results for the electronic transformers, pharmaceutical preparations, and semiconductors industries presented in Figures and Tables 5.2 to 5.4 are consistent with the results found for the adhesives industry.[11] The exceptions arise because some of these industries invest more in structures than equipment. For instance, the results of the investment-weighted series for the pharmaceutical preparations industry in Figure 5.3.3 exhibit a lesser amount of variation in the user costs of capital across states than in the average user cost of capital across time, relative to the findings for the adhesives industry. This is because about 60 percent of investment within the industry was in new equipment, relative to about 80 percent of investment in the adhesives industry. Another noteworthy implication of the results for all of the industries is that the apportionment of sales does not appear to be greatly affecting the results across industries. This is because sales across all industries considered in this study are roughly proportional to population within each state.

Comparison with Fischer and Peters (1998)

It is worth comparing the results of the user cost of capital equations to the results from the model of Fischer and Peters (1998). Fischer and Peters find that the exemption of purchases of

[11] The adhesives industry was small enough prior to 1972 that it was not uniquely identified by the Standard Industry Classification (SIC) system until a major revision in the classification scheme in 1972. Without a 4-digit SIC code, no publicly available industry-level data exist for this industry. Thus, the calculations use the investment figures for SIC 3679, the aggregate category for which these products were classified for prior years.

machinery and equipment from sales/use taxes is the most effective incentive to attract new manufacturing firms. The next best incentive is the use of double-weighted sales in the state's apportionment formula. With the exception of the exemption of the double-weighting of the sales apportionment factor, the results from the user cost of capital equations are consistent with the results of Fischer and Peters.

Changing the tax laws for an average state demonstrates the effects of various tax law provisions on the user cost of capital. The state chosen for this experiment was North Carolina because it best represents the provisions of the average state. In 1997, it had a three-factor apportionment formula with equally weighted factors and the standard throwback provision, did not allow a deduction for federal income taxes paid, did not exempt purchases of machinery and equipment from sales/use taxes, and had a corporate income tax rate that was very close to the average across all states. Under these tax law provisions, the user cost of capital for equipment was 0.224. The allowance of a deduction for purchases of machinery and equipment from sales/use taxes would have lowered the user cost of capital by 0.015, producing an overall user cost of capital value of 0.209. This change could possibly affect the location of a new plant in a few cases if the plant is machinery-intensive, but the change is still not as great as one might expect. The double-weighting of sales in the apportionment formula would have lowered the user cost of capital by 0.001. The deduction of federal income taxes paid and an exemption of machinery and equipment from personal property taxation would have separately lowered the user cost of capital by only 0.001. If North Carolina had not imposed a corporate income tax, then the user cost of capital would have been lowered by 0.002. Thus, an exemption of purchases of machinery and equipment is generally a more valuable industrial incentive than eliminating a corporate income tax. The results are consistent in terms of relative magnitudes when the same experiments are performed for other states.

The results of the hypothetical tax law changes demonstrate that the lack of variation in the user cost of capital series across states is explained by the fact that the common industrial incentives provided by states' tax laws have very little impact on the user cost of capital. An alternative explanation for the lack of variation could have been that states with high tax rates offer a greater number of tax deductions and exemptions relative to other states, but this does not appear to be the case.

There are three main reasons that the user cost of capital series exhibit little variation across states. First, state and local taxes are generally about one-eighth the size of federal corporate income tax rates. Second, state and local taxes can be deducted from the federal tax base on which a much larger tax rate is imposed. Third, state corporate income taxes are generally structured as profit taxes. As described in the review of the Hall and Jorgenson (1967) model, increases in corporate tax rates could possibly lead to a lower user cost of capital, depending on the size of investment tax credits and depreciation allowances relative to the true rate of economic depreciation. Since most states piggyback off the federal income tax base, state depreciation allowances are generally the same and offset most of the potential impact that the other differences in state tax policies have on the user cost of capital. It is primarily the changes in the sales/use tax treatment of purchases of capital that explain what little variation exists across states.

VI. CONCLUSIONS

The results of the user cost of capital equations demonstrate that it is unlikely that state and local tax policies have had an effect on state-specific levels of investment. Federal tax policy is the primary determinant of variation in the user cost of capital series within states over time. Most notably, changes in federal depreciation allowances and investment tax credits can have a large impact on the average value of the user cost of capital. An analysis of state-specific user costs of capital reveals that state and local tax policies add little variation to the value of the user cost of capital across states.

One last finding is that one needs to be careful in making too much of the variation that exists in marginal effective tax rates. This paper showed that a common measure of an effective marginal tax rate had a much greater variation than the underlying user cost of capital. But the latter is the relevant variable for firms' investment decisions.

These findings have implications for empirical work that attempts to determine whether state and local tax policy can influence regional levels of investment or the location of new manufacturing firms. Since very little variation in the user cost of capital series across states and over time is due to state and local tax policy, it is unlikely that state and local tax policies influence investment or new plant location across states. Considering that there was quite a bit of variation across states and over time in the tax provisions of states during the time period studied in this paper, a further implication is that changes in state and local tax policy that are politically feasible are unlikely to influence the investment or location decisions of firms across states.

Appendix A: Equation Derivations

The derivation of a reduced-form equation for cash flows begins with the following definitions:

$$\chi \equiv \sum_{j \in L} \alpha_j \tau_j^c , \tag{A.1a}$$

$$\chi^B \equiv \sum_{j \in L} \alpha_j \tau_j^c B_j , \tag{A.1b}$$

$$\chi^\xi \equiv \sum_{j \in L} \alpha_j \tau_j^c \xi_s \text{, and} \tag{A.1c}$$

$$\chi^f \equiv \sum_{j \in L} \alpha_j \tau_j^c \zeta_j^f . \tag{A.1d}$$

Interpretations for the variables defined by equations (A.1a to A.1d) are as follows: χ is the average tax rate of states taxing the firm weighted by apportionment shares; χ^B is the total tax liability of states taxing the firm weighted by χ; χ^ξ is the average deduction of states taxing the firm weighted by χ; and χ^f is the average deduction of federal income taxes from the tax base of states taxing the firm weighted by χ. Definitions of the other variables in equations (A.1a to A.1d) are given in the main text. By repeatedly substituting the equations for the tax bases given by equations (3.1) and (3.2) in the main text into the equation for the return to capital given by (3.3) three times, and using the definitions provided by equations (A.1a to A.1d), the following result is generated:

$$X_j = \left[\left(1-\tau^f\right)-\chi\right]c - \tau_j^p c + \tau_f \xi_f + \chi^\xi + \tau_f \chi^f B^f + \tau_f \chi^B,$$

$$= \left\{\left(1-\tau_f+\tau_f \chi^f\right)-\left[\chi\left(1-\tau_f\right)+\tau_j^p\right]\right\}c + \left(\tau_f-\tau_f \chi^f\right)\xi_f + \left(1-\tau_f\right)\chi^\xi$$

$$-\tau_f^2 \chi^f B^f - \tau_f \chi^f \chi_B \quad ,$$

$$= \left\{\left(1-\tau_f+\tau_f \chi^f-\tau_f^2 \chi^f\right)-\left[\chi\left(1-\tau_f-\tau_f \chi^f\right)+\tau_j^p\right]\right\}c$$

$$+\left(\tau_f-\tau_f \chi^f+\tau_f^2 \chi^f\right)\xi_f + \left(1-\tau_f+\tau_f \chi^f\right)\chi^\xi + \tau_f^2\left(\chi^f\right)^2 B^f$$

$$+\tau_f^2 \chi^f \chi^B,$$

$$= \left[1-\tau_f+\tau_f \chi^f-\tau_f^2 \chi^f+\tau_f^2\left(\chi^f\right)^2\right]c$$

$$-\left[\chi\left(1-\tau_f+\tau_f \chi^f-\tau_f^2 \chi^f\right)-\tau_j^p\right]c$$

$$+\left[\tau_f-\tau_f+\tau_f^2 \chi^f-\tau_f^2\left(\chi^f\right)^2\right]\chi^\xi$$

$$-\tau_f^2\left(\chi^f\right)^2 B^f - \tau_f^3\left(\chi^f\right)^2 \chi^B \quad . \tag{A.2}$$

where notations for time have been dropped to simplify notation.

Two reasonable cases need to be considered at this point in the derivation of the user cost of capital. The first case involves the calculation of the user cost of capital for a firm that is taxed by a set of states that do not allow national taxes to be deducted from their tax bases. The second case involves the calculation of the user cost of capital for a firm that is taxed by at least one state that allows national taxes to be deducted from its tax base.

<u>Case 1</u>*: Federal taxes are not deducted from the tax base of any state that taxes the firm.*

The continuation of the derivation of the user cost of capital in the case where national taxes are not deducted from the tax base of any state that taxes the firm begins by noting from equation (A.1) that this case implies

$$\chi^{f} = 0 \tag{A.3}$$

from the definition given by equation (A1.1d). The condition given by equation (A.3) implies that equation (A.2) is equivalent to

$$X_{j}(t) = \int_{t}^{\infty}\left\{\left[\left(1-\tau_{f}\right)\left(1-\chi\right)-\tau_{j}^{p}\right]c(s)+\tau_{f}\xi_{f}(s-t)+\left(1-\tau_{f}\right)\chi^{\xi}(s-t)\right\}ds \tag{A.4}$$

where notations of time have been reintroduced. Equation (A.4) is repeated as equation (3.4) in the main text.

In order to address the consideration that the firm can finance investment through the issuance of debt or equity, an assumption that capital markets are competitive implies that the net return on investment equals the rate of return demanded by bondholders and shareholders. In the presence of federal and state taxation, this condition at any time period s can be represented as

$$\rho(s-t) = \lambda\left(1-\tau_{f}\right)\left(1-\chi^{r}\right)\rho_{1}(s-t)+\left(1-\lambda\right)\rho_{2}(s-t) \tag{A.5}$$

where

$$\chi^{r} \equiv \sum_{j\in L}\alpha_{j}\tau_{j}^{c}\zeta_{j}^{r},$$

$\rho(t)$ is the rate of return on the capital purchase; λ is the proportion of the investment financed through the issuance of debt that is an allowable deduction from the federal income tax base; $\rho_{1}(t)$ is the interest rate demanded by bondholders; $\rho_{2}(t)$ is the present value of dividends at time t; and

ζ^r_j is the amount of interest on debt that can be deducted from the corporate income tax of state j. Equation (A.5) is implied by the cash flow equation given by equation (A.4). The deduction of interest on debt from federal and state corporate income taxes can be substituted for the deduction from federal and state placeholders, respectively, in equation (A.4). Equation (A.5) is consistent with the assumption of perfect capital markets.

Equations (A.4) and (A.5) imply that the user cost of capital in state j can be derived from the following condition:

$$\begin{aligned} q_j(t) &= \int_t^\infty e^{-\rho(s-t)}\left(1-\tau_f\right)\left[\left(1-\chi\right)-\tau_j^p\left(1-\chi^p\right)\right]c(s)\,e^{-\delta(s-t)}ds \\ &+\int_t^\infty e^{-\rho(s-t)}\left[\tau_f\left(1+\tau_j^u\right)D_f(s-t)+\left(1-\tau_f\,\chi^D\right)\right]q_j(t)ds-\left(\tau_j^u-\zeta_f^i\right)q_j(t) \end{aligned} \tag{A.6}$$

which is identical to equation (3.5) in the main text.

<u>Case 2</u>*: Federal taxes are deducted from the tax base of at least one state in which the firm is taxed.*

In the case where the firm is taxed by at least one state that allows federal taxes to be deducted from the state tax base, equation (A.2) reveals that the infinite process of substitution can be represented by the following equation:

$$\begin{aligned} X_j &= \left\{\left(1-\tau_f\right)\left(1-\chi\right)\sum_{i=0}^{\infty}\left(\tau_f\,\chi^f\right)^i-\tau_j^p\right\}c+\left[1-\left(1-\tau_f\right)\sum_{i=0}^{\infty}\left(\tau_f\,\chi^f\right)^i\right]\xi_f \\ &+\left[\left(1-\tau_f\right)\sum_{i=0}^{\infty}\left(\tau_f\,\chi^f\right)^i\right]\chi^\xi. \end{aligned} \tag{A.7}$$

In order for a finite solution for cash flows to exist, the following conditions must hold:

$$0 < \tau_f \chi^f < 1 . \tag{A.8}$$

The first half of equation (A.8) will hold given that there is at least one positive tax rate and the assumption of the case considered. Equation (A.8) demonstrates that it would take absurdly high tax rates or apportionment factors, along with a high number of states that allow the deduction of national taxes from their base, in order for the necessary condition for a finite solution for cash flows not to hold. Given that most states do not allow the deduction of national taxes from their bases and that the sum of apportionment factors should be around one, it seems safe to assume equation (A.8) is true. By defining,

$$T_f \equiv \frac{1-\tau_f}{1-\tau_f \chi^f},$$

equation (A.6) implies that equation (A.5) can be alternatively expressed as

$$X_j(t) = \int_t^\infty \left\{ \left[T_f (1-\chi) - \tau_j^p \right] c(s) + \left[1 - T_f \right] \xi_f (s-t) + T_f \chi^\xi (s-t) \right\} ds \tag{A.9}$$

where notations of time have been reintroduced. Equation (A.9) is the same as equation (3.7) in the main text. The assumption that capital markets are competitive implies that the net return on investment equals the rate of return demanded by bondholders and shareholders. In the presence of federal and state taxation, this condition at any time period s can be represented as

$$\rho(s-t) = \lambda T_f \left(1-\chi^r\right) \rho_1 (s-t) + (1-\lambda) \rho_2 (s-t). \tag{A.10}$$

Equation (A.9) is implied by equation (A.7) with the same explanation given for equation (A.5).

Equations (A.7) and (A.8) imply that the user cost of capital can be derived from the following condition:

$$
\begin{aligned}
q_j(t) = & \int_t^\infty e^{-\rho(s-t)} T_f \left[\left(1-\chi\right) - \tau_j^p \left(1-\chi^p\right) \right] c(s) e^{-\delta(s-t)} ds \\
& + \int_t^\infty e^{-\rho(s-t)} \left[\left(1-T_f\right)\left(1-\chi\right)\left(1-\tau_j^u\right) D_f(s-t) + T_f \chi^D \right] q_j(t) ds \\
& - \left(\tau_j^u - \zeta_f^i\right) q_j(t)
\end{aligned}
\qquad (A.11)
$$

which is identical to equation (3.8) in the main text.

Appendix B: Interpretations of Greek and Roman Letters Used in the Text

<u>*Greek Letter Bases*</u>

α_j	apportionment share of taxable income for state j
χ	average marginal corporate income tax of states taxing a firm weighted by apportionment shares of each state taxing the income of the firm
χ^{B}	average tax base weighted by the apportionment shares and tax rates of each state taxing the income of the firm
χ^{D}	average depreciation allowance weighted by the apportionment shares and tax rates of each state taxing the firm
χ^{r}	average allowable proportion of interest on debt that can be deducted from taxing states' tax bases weighted by apportionment shares and tax rates of each state taxing the firm
χ^{ξ}	average allowable deductions placeholder for state tax bases weighted by state corporate apportionment shares and income tax rates
χ^{Z}	current value of average depreciation deductions claimed on one dollar's worth of investment for state corporate income tax purposes weighted by apportionment shares and income tax rates for each state taxing the firm
δ	true rate of economic depreciation
λ	proportional share of financing done by the firm through the issuance of debt
ρ	rate of return demanded by bondholders and shareholders weighted by share of financing done through the issuance of bonds and equity
ρ_1	rate of return demanded by bondholders
ρ_2	rate of return demanded by shareholders
τ_f	federal corporate income tax rate
τ^{p}_{j}	effective marginal tangible personal property tax rate for firm's property located in state j
τ^{c}_{j}	corporate income tax rate of state j

τ^{u}_{j}	sales/use tax rate paid for a firm's property located in state j
ξ_f	placeholder for allowable deductions from the federal tax base for the derivation of after-tax cash flow
ξ_j	placeholder for allowable deductions from the tax base of state j
ζ^{f}_{j}	proportion of the amount of federal income taxes paid for which state j provides an allowable deduction
ζ^{ρ}_{φ}	proportion of the amount of interest on debt for which state j provides an allowable deduction
ζ^{ι}_{ϕ}	proportion of new capital investment that qualifies for federal investment tax credit

Roman Letter Bases

B_f	federal tax base
B_j	tax base of state j
c	cost of capital services (user cost of capital)
D_f	federal depreciation allowance per dollar of original investment for tax purposes
q	purchase price of an additional unit of capital
T_f	real rate of return on one dollar's worth of capital adjusted for federal taxes when at least one state allows the deduction of federal income taxes paid from their state income tax base
X_j	after-tax cash flows for plant located in state j
Z_f	present value of federal depreciation allowances claimed on one dollar's worth of investment

Appendix C: Data Sources

The data for the user cost of capital series relating to the provisions of the state, federal and local tax laws over the time period 1963 to 1997 come from many different sources. The laws that determine the 1997 provisions of the federal corporate income tax, the state corporate income tax, and the state sales/use tax are from the Internal Revenue Code and states' Annotated Statutes manuals. In order to determine the historical provisions of federal and state corporate income tax laws, Assembly Law manuals were used to document every relevant change in the laws of interest over the entire time period used in the study. This process resulted in a data set that allows one to determine the relevant provisions of the federal corporate income, the state corporate income, and the state sales/use taxes for the user cost of capital calculations at any time during the thirty-year period used in the study.

Additional data used in the calculations of the user cost of capital series are from various issues of the U.S. Census Bureau's *Census of Governments, Census of Manufactures,* and *Census of Wholesale Trade*. The *Census of Governments* publications provided data to calculate average effective property tax rates over time. The weights used for the proportion of investment in machinery and the proportion of investment in buildings for the weighted user costs of capital series are from various *Census of Manufactures* publications. Sales are distributed for apportionment formulas according to the state-level data for each industry reported in various issues of the *Census of Wholesale Trade*.

Assumptions are made in the model regarding the methods of finance, rates of return, and true rates of economic depreciation for the typical firm within each industry. Firms are assumed to finance 80 percent of the purchase of capital through the use of retained earnings and the issuance of equity, with the remaining 20 percent financed through the issuance of bonds. Further, the real rate of return on equity is assumed to be 8.5 percent, and the real interest on debt 5 percent, in all years. Although this practice does not capture the user cost of capital across years as accurately as does the use of financing proportions and real interest rates from industry average data, it allows for an isolation of the effects that changes in state and local tax policies have had on the user cost of capital across states and years. This practice was followed because it was feared that uncertainty regarding the appropriate rates of return and financing ratios derived from publicly available data might make it difficult to determine the role that state and local tax policy has on the variation of the user cost of capital across states and time. The rates of true economic depreciation for equipment and structures for the types of capital in each industry presented in Hulton and Wykoff (1982) are used for the calculations presented in this paper.

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Table 4.1: Federal Corporate Income Tax Characteristics at Selected Intervals During the Period of 1963-1997

Type of Capital	Year							
Variable	1963	1967	1972	1977	1982	1987	1992	1997
Equipment and Structures								
Tax rate (%)	52.0	48.0	46.0	46.0	46.0	34.0	34.0	34.0
Investment tax credit (%)	7.0	7.0	7.0	10.0	3.33	0.0	0.0	0.0
Structures								
Depreciation (years)	45.0	45.0	36.0	36.0	31.5	31.5	31.5	31.5
Depreciation (type)	SYD	SYD	SYD	SYD	DDB	SL	SL	SL
Equipment								
Depreciation (years)	12.0	12.0	10.0	12.0	4.5	4.5	4.5	4.5
Depreciation (type)	SYD	SYD	SYD	SYD	DDB	DDB	DDB	DDB

Notes: The tax rate refers to the top statutory rate. The investment tax credit refers to the credit for equipment. SYD refers to the Sum of the Years' Digits depreciation method. DDB refers to the Double Declining Balance with optimal switch-over to straight-line depreciation method. SL refers to the straight-line depreciation method.
Source: Internal Revenue Code and Assembly Laws.

Table 4.2: State Tax Policy Elements at Selected Intervals During the Period of 1963-1997

Class Element	Year 1963	1967	1972	1977	1982	1987	1992	1997
Corporate income tax base								
Extra-weighted sales	2.7	2.5	4.7	4.7	13.6	25.0	34.1	54.5
Deduction of federal taxes	29.7	27.5	20.9	16.3	13.6	15.9	13.6	13.6
Throwback	48.6	50.0	44.2	48.8	47.7	50.0	47.7	47.7
_N_	37	40	43	43	44	44	44	44
Tax exemptions								
Personal property taxes	6.1	6.1	8.2	12.2	10.2	10.2	10.2	10.2
Sales/use taxes	30.6	14.3	10.2	10.2	12.2	16.3	20.4	30.6
_N_	49	49	49	49	49	49	49	49
Tax rates								
Average income tax rates	4.89	5.23	5.79	6.12	6.34	6.70	6.81	6.81
	(3.09)	(2.92)	(2.86)	(2.82)	(2.85)	(2.85)	(2.91)	(2.91)
Average property tax rates	1.50	1.70	1.56	1.35	0.97	0.93	–	–
	(0.93)	(1.30)	(0.92)	(0.79)	(0.63)	(0.65)		
_N_	49	49	49	49	49	49	49	49

Notes: Percentages are for states that have the listed provisions. The table reflects the tax laws as of December 31 of the year mentioned. The notation "_N_" refers to the number of observations used to create the averages for each class of elements. If a state had a graduated rate schedule, then the top statutory rate is used in the calculations. Standard deviations of tax rates are in parentheses. Data are not available to calculate property tax rates for 1992 and 1997. The user cost of capital calculations use the most recent year that data are available with adjustments if it was known that the laws regarding assessment ratios had changed.
Source: Author's own calculations based on data from Annotated Statutes and Assembly Laws, supplemented with data from various issues of the U.S. Bureau of the Census *Census of Governments*.

Table 5.1: Coefficient of Variation for the User Cost of Capital (UCC) and Effective Marginal Tax Rates (EMTR) for the Adhesives Industry Across States at Selected Intervals During the Period of 1963-1997.

Type of Capital Variable	Year 1963	1967	1972	1977	1982	1987	1992	1997
Equipment								
UCC	0.023	0.024	0.020	0.020	0.016	0.025	0.028	0.032
EMTR (total)	0.170	0.189	0.207	0.454	0.184	0.254	0.304	0.346
EMTR (state)	0.356	0.315	0.260	0.266	0.243	0.451	0.610	0.643
Structures								
UCC	0.021	0.027	0.022	0.021	0.015	0.022	0.018	0.019
EMTR (total)	0.052	0.071	0.065	0.042	0.058	0.076	0.062	0.065
EMTR (state)	0.241	0.282	0.233	0.207	0.177	0.232	0.187	0.191
Investment-Weighted								
UCC	0.019	0.022	0.018	0.018	0.015	0.022	0.025	0.028
EMTR (total)	0.099	0.105	0.124	0.177	0.131	0.154	0.182	0.206
EMTR (state)	0.276	0.269	0.226	0.226	0.217	0.355	0.455	0.490

Source: Author's own calculations based on data from the Internal Revenue Code, Annotated Statutes manuals and Assembly Laws manuals, supplemented with data from the U.S. Census Bureau *Census of Governments*, *Census of Manufactures* and *Census of Wholesale Trade*.

Table 5.2: Coefficient of Variation for the User Cost of Capital (UCC) and Effective Marginal Tax Rates (EMTR) for the Electronic Transformers Industry Across States at Selected Intervals During the Period of 1963-1997.

Type of Capital	Year							
Variable	1963	1967	1972	1977	1982	1987	1992	1997
Equipment								
UCC	0.023	0.024	0.020	0.020	0.016	0.025	0.028	0.032
EMTR (total)	0.169	0.189	0.206	0.451	0.185	0.253	0.303	0.344
EMTR (state)	0.352	0.316	0.258	0.265	0.244	0.449	0.607	0.637
Structures								
UCC	0.021	0.027	0.022	0.021	0.015	0.022	0.018	0.019
EMTR (total)	0.053	0.071	0.064	0.042	0.058	0.075	0.062	0.065
EMTR (state)	0.238	0.283	0.227	0.204	0.176	0.227	0.185	0.188
Investment-Weighted								
UCC	0.019	0.023	0.018	0.019	0.014	0.022	0.025	0.028
EMTR (total)	0.095	0.129	0.106	0.237	0.107	0.163	0.174	0.196
EMTR (state)	0.267	0.284	0.214	0.239	0.203	0.365	0.439	0.471

Source: Author's own calculations based on data from the Internal Revenue Code, Annotated Statutes manuals and Assembly Laws manuals, supplemented with data from the U.S. Census Bureau *Census of Governments*, *Census of Manufactures* and *Census of Wholesale Trade*.

Table 5.3: Coefficient of Variation for the User Cost of Capital (UCC) and Effective Marginal Tax Rates (EMTR) for the Pharmaceutical Preparations Industry Across States at Selected Intervals During the Period of 1963-1997.

Type of Capital	Year							
Variable	1963	1967	1972	1977	1982	1987	1992	1997
Equipment								
UCC	0.023	0.024	0.020	0.020	0.016	0.025	0.028	0.032
EMTR (total)	0.170	0.189	0.206	0.450	0.185	0.171	0.303	0.344
EMTR (state)	0.356	0.315	0.258	0.265	0.244	0.297	0.606	0.638
Structures								
UCC	0.021	0.027	0.022	0.021	0.015	0.022	0.018	0.019
EMTR (total)	0.052	0.070	0.065	0.041	0.058	0.074	0.062	0.064
EMTR (state)	0.240	0.281	0.229	0.201	0.177	0.225	0.184	0.187
Investment-Weighted								
UCC	0.017	0.022	0.018	0.018	0.014	0.016	0.023	0.026
EMTR (total)	0.068	0.099	0.108	0.153	0.100	0.095	0.143	0.162
EMTR (state)	0.228	0.265	0.216	0.216	0.197	0.232	0.383	0.415

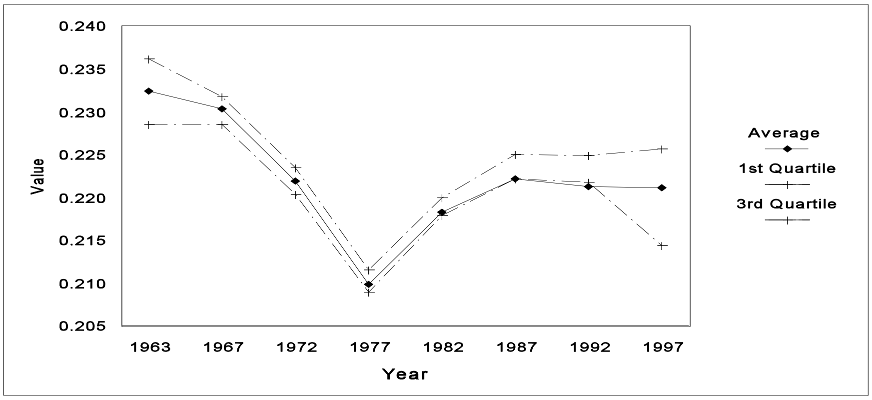
Source: Author's own calculations based on data from the Internal Revenue Code, Annotated Statutes manuals and Assembly Laws manuals, supplemented with data from the U.S. Census Bureau *Census of Governments*, *Census of Manufactures* and *Census of Wholesale Trade*.

Table 5.4: Coefficient of Variation for the User Cost of Capital (UCC) and Effective Marginal Tax Rates (EMTR) for the Semiconductor Industry Across States at Selected Intervals During the Period of 1963-1997.

Type of Capital Variable	Year 1963	1967	1972	1977	1982	1987	1992	1997
Equipment								
UCC	0.023	0.024	0.020	0.020	0.016	0.025	0.028	0.032
EMTR (total)	0.169	0.189	0.206	0.451	0.185	0.253	0.303	0.344
EMTR (state)	0.352	0.316	0.258	0.265	0.244	0.449	0.607	0.637
Structures								
UCC	0.021	0.027	0.022	0.021	0.015	0.022	0.018	0.019
EMTR (total)	0.053	0.071	0.064	0.042	0.058	0.075	0.062	0.065
EMTR (state)	0.238	0.283	0.227	0.204	0.176	0.227	0.185	0.188
Investment-weighted								
UCC	0.020	0.023	0.019	0.019	0.014	0.023	0.027	0.030
EMTR (total)	0.100	0.118	0.154	0.235	0.111	0.189	0.224	0.254
EMTR (state)	0.274	0.277	0.238	0.239	0.205	0.397	0.519	0.552

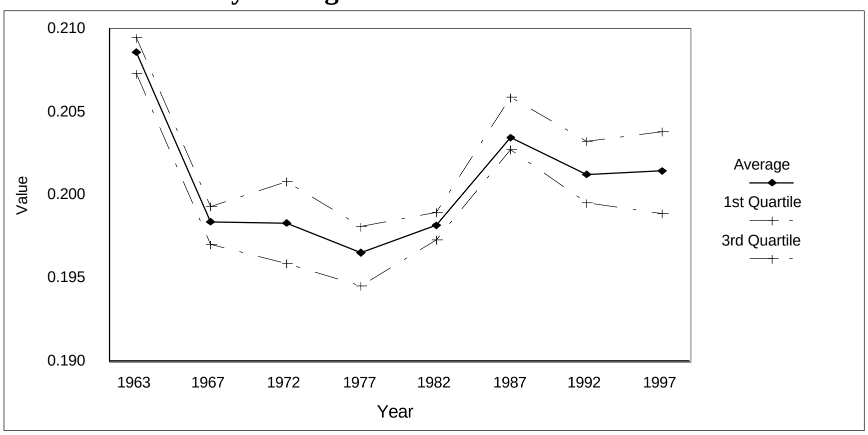
Source: Author's own calculations based on data from the Internal Revenue Code, Annotated Statutes manuals and Assembly Laws manuals, supplemented with data from the U.S. Bureau of the Census *Census of Governments*, *Census of Manufactures* and *Census of Wholesale Trade*.

Figure 5.1.1: State User Costs of Capital for Equipment in the Adhesives Industry During the Period of 1963-1997



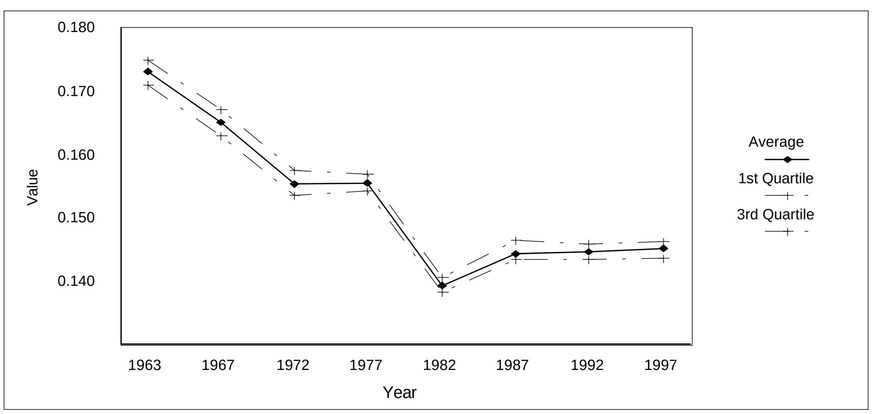
Source: Based on the author's calculations.

Figure 5.1.2: State User Costs of Capital for Structures in the Adhesive Industry During the Period of 1963-1997



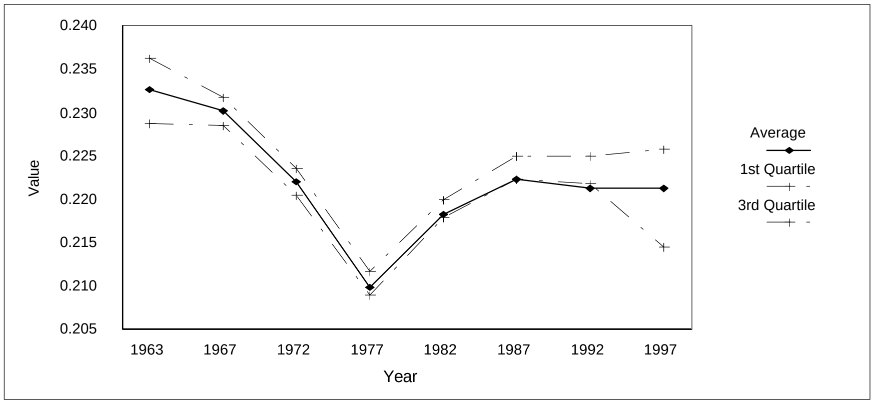
Source: Based on the author's calculations.

Figure 5.1.3: State Weighted User Costs of Capital Series for the Adhesive Industry During the Period of 1963-1997



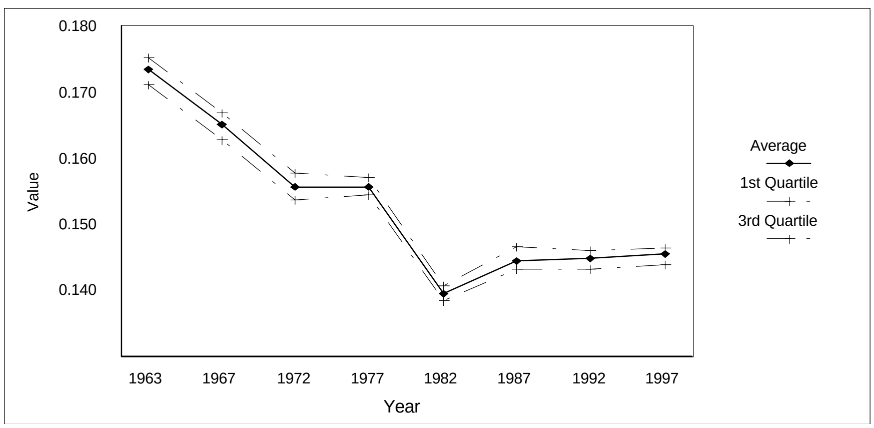
Source: Based on the author's calculations.

Figure 5.2.1: State User Costs of Capital for Equipment in the Electronic Transformer Industry During the Period of 1972-1997



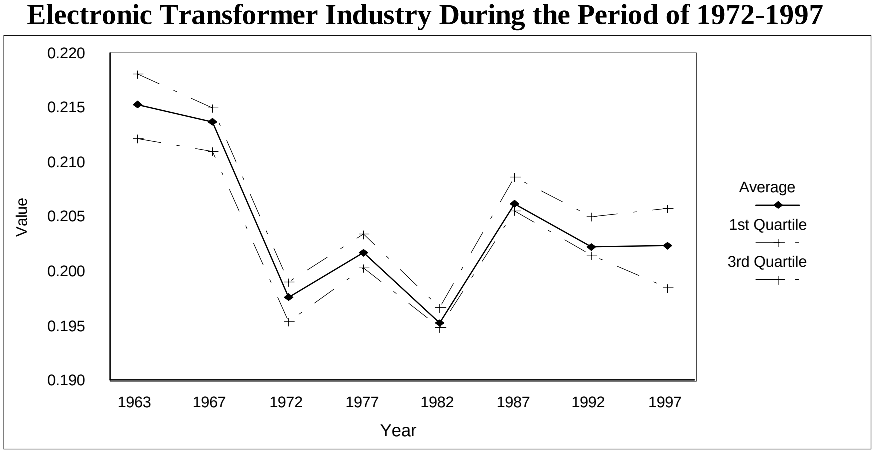
Source: Based on the author's calculations.

Figure 5.2.2: State User Costs of Capital for Structures in the Electronic Transformer Industry During the Period of 1972-1997



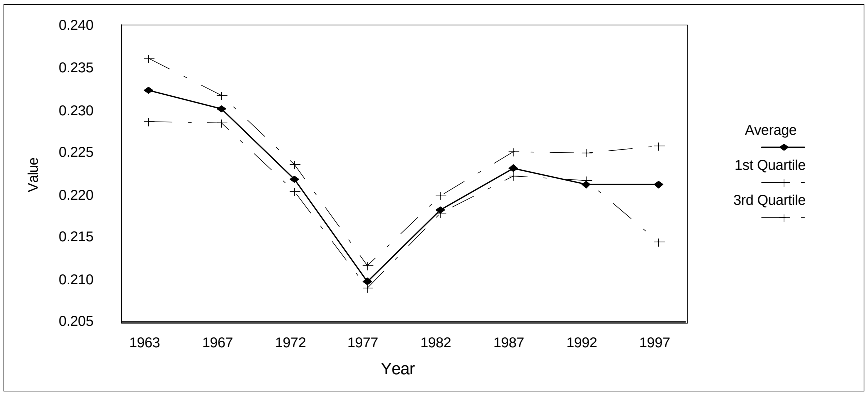
Source: Based on the author's calculations.

Figure 5.2.3: State Weighted User Costs of Capital Series for the Electronic Transformer Industry During the Period of 1972-1997



Source: Based on the author's calculations.

Figure 5.3.1: State User Costs of Capital for Equipment in the Pharmaceutical Industry During the Period of 1963-1997

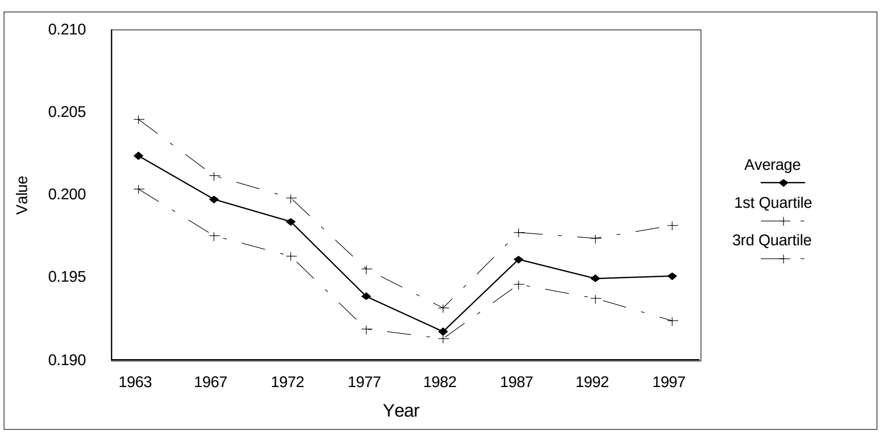


Source: Based on the author’s calculations.

Figure 5.3.2: State User Costs of Capital for Structures in the Pharmaceutical Industry During the Period of 1963-1997

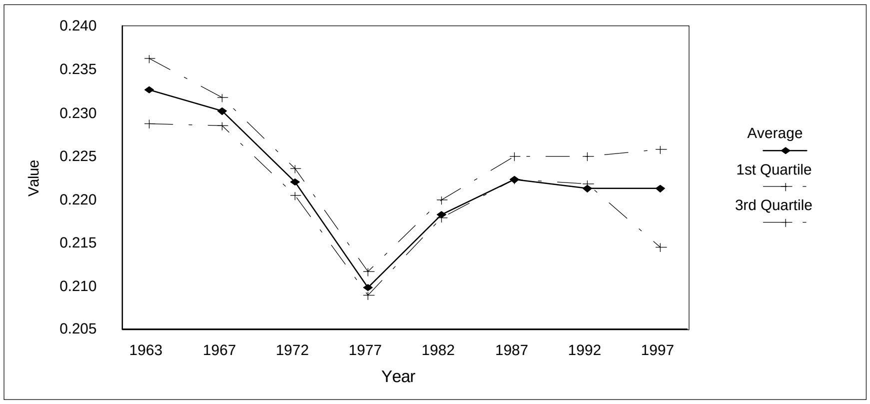
Source: Based on the author’s calculations.

Figure 5.3.3: State Weighted User Costs of Capital Series for the Pharmaceutical Industry During the Period of 1963-1997



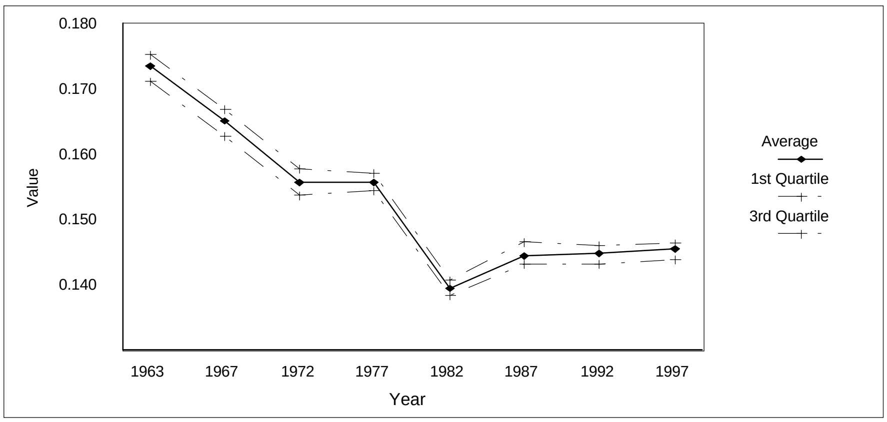
Source: Based on the author’s calculations.

Figure 5.4.1: State User Costs of Capital for Equipment in the Semiconductor Industry During the Period of 1963-1997



Source: Based on the author's calculations.

Figure 5.4.2: State User Costs of Capital for Structures in the Semiconductor Industry During the Period of 1963-1997



Source:Based on the author's calculations.

Figure 5.4.3: State Weighted User Costs of Capital Series for the Semiconductor Industry During the Period of 1963-1997

Source:Based on the author's calculations.