# State Investment Tax Incentives: A Zero-Sum Game?

Robert S. Chirinko
(Emory University and CESifo)

and

Daniel J. Wilson
(Federal Reserve Bank of San Francisco)

Paper Prepared for the
IFIR – CESifo Conference
*New Directions in Fiscal Federalism*
Lexington, Kentucky
September 14th to 16th, 2006

Preliminary -- Please Do Not Cite Nor Quote

* We would like to acknowledge the excellent research assistance provided by Ann Lucas and a helpful discussion with Richard Arnott. Financial support from the Federal Reserve Bank of San Francisco is gratefully acknowledged. All errors and omissions remain the sole responsibility of the authors and the conclusions do not necessarily reflect the views of the organizations with which they are associated.

# State Investment Tax Incentives: A Zero-Sum Game?


## Abstract

Though the U.S. federal investment tax credit (ITC) was permanently repealed in 1986, state-level ITCs have proliferated over the last few decades. The proliferation of state ITCs and other investment tax incentives raises two important questions: 1) Are these tax incentives effective in achieving their stated objective, to increase investment within the state?; 2) To the extent these incentives raise investment within the state, how much of this increase is due to investment being drawn away from other states?

To begin to answer these questions, we construct a detailed panel dataset for 50 states for 20+ years (depending on the series). The dataset contains series on output and capital, their relative prices, and the number of establishments. The effects of tax parameters on capital formation and establishments are measured by the Jorgensonian user cost of capital that depends in a nonlinear manner on federal and state tax parameters. Cross-jurisdiction differences in state investment tax credits, state corporate tax rates, and other tax parameters entering the user cost, combined with a panel that is long in the time dimension, are key to identifying the effectiveness of state investment incentives.

Three models are estimated: 1) a Capital Demand Model motivated by the first-order condition for profit-maximization; 2) Establishment Models that examine the response of the number and growth rate of establishments; 3) Borders Models that exploit the information available from contiguous counties separated by state borders. Several of the estimated models find an important channel for state tax incentives on own-state economic activity, and our preferred Borders Model points to important interstate effects associated with tax competition.



Corresponding Author:
Robert S. Chirinko
318 Rich Building
Department of Economics
Emory University
Atlanta, GA 30322-2240

PH: (404) 727-6645
FX: (404) 727-4639
EM: Robert.Chirinko@emory.edu

Daniel J. Wilson
Research Department
Federal Reserve Bank of
San Francisco
101 Market Street
San Francisco, CA 94105

PH: (415) 974-3423
FX: (415) 974-2168
EM: Daniel.Wilson@sf.frb.org

# State Investment Tax Incentives: A Zero-Sum Game?

## Table of Contents

## State Investment Tax Incentives: A Zero-Sum Game?

# I. Introduction

Though the U.S. federal investment tax credit (ITC) was permanently repealed in 1986, ITC's at the state level and other state investment tax incentives have proliferated over the past two decades. As shown in Figure 1, 40% of states now offer a general, state-wide tax credit on investment in machinery and buildings, and the average value of this credit exceeds 600 basis points. The abundance of state investment tax incentives raises an important empirical question -- are these tax incentives effective in increasing investment and economic activity within the state? Academic research has not reached a broad consensus on this point. In a survey paper, Wasylenko (1997, p. 38) concludes that elasticities of various forms of economic activity to tax policy "are not very reliable and change depending on which variables are included in the estimation equation or which time period is analyzed." By contrast, the overview of papers (including Wasylenko's study) presented at a conference focusing on the effectiveness of state and local taxes reports that there was general agreement that state and local policies affect economic activity within their borders, though the effects "are generally modest" (Bradbury, Kodrzycki, and Tannenwald, 1997, p. 1). A similar conclusion is reached in the encyclopedia entry by Bogart and Anderson (2005) concerning the effects of state policies on firm location.

To the extent these incentives raise investment within the state, a second question arises from a national perspective -- how much of this increase is due to investment being drawn away from other states? As noted by Stark and Wilson (2004), surprisingly few empirical studies have addressed this question. Understanding the source of the increase in capital formation (or other economic activities) is important for assessing whether the increase merely reflects a zero-sum game among states and for informing discussions about the constitutionality of certain state tax incentives in light of the U.S. Constitution's Commerce Clause.

These two questions are addressed in this paper with a comprehensive panel dataset covering all 50 states for 20+ years (depending on the series). This dataset allows us to construct variables tied tightly to theory and to utilize a variety of powerful econometric techniques. Panel data have the decided advantages of allowing us to control for factors such as infrastructure and location that are fixed or change slowly over time and for aggregate effects such as the business cycle. The relative scarcity of empirical research on interstate capital mobility and tax competition may be traceable in good part to the absence of comprehensive data. Section 2 describes the panel dataset that is drawn from a several sources, including the Annual Survey of Manufacturers, national data provided by the Bureau of Economic Analysis, and a variety of sources of information on tax rates at both the state and federal levels. Details concerning construction and sources are provided in the Appendix.

We then develop and estimate three models in the subsequent three sections. Section 3 contains a Capital Demand Model motivated by a standard first-order condition relating the capital stock to output and price variables. We specify the latter as the ratio of a states own user cost of capital relative to the user costs for competitive states. The user cost of capital is based on the Hall-Jorgenson concept that relies on the equivalence between renting and owning a durable asset. Based on this insight, durable capital can be assigned a rental price that easily incorporates a variety of tax parameters and can be analyzed with the traditional tools of price theory. In our preliminary results, we find that capital is very responsive to this relative user cost variable.

Section 4 estimates two models explaining manufacturing activity at the state level. One model is in the spirit of Papke (1991) and relates the number of establishments to the own-state and competitive-state user costs. The second establishment model focuses on growth rates in the number of establishments. There is some evidence of a significant relation between user costs and establishments when the later are specified as five-year growth rates.

Section 5 estimates two models explaining the location of establishments at the county level. The first model, which follows the spatial regression discontinuity design of Holmes (1998), posits that manufacturing activity varies smoothly across space and then utilizes the information generated by spatial breaks ("discontinuities") at state borders. We apply Holmes model to assess the effects of a particular anti-business policy, relatively higher user costs, and find only weak evidence supporting an effect of relative user costs on the number of establishments operating in a county. Our second model takes advantage of the panel structure of our data and exploits the "natural experiment" afforded by pairs of counties that are in the same geographic area but are separated by a state border. Comparing the differential outcomes of pairs of counties with common geographic conditions but differing state policies is akin to the twin studies employed frequently in labor economics and medical research, which analyze the differential outcomes of identical twins with common genetic conditions but different environmental conditions. The "Twin-Counties" Model uncovers a strong effect of user costs prevailing at the state level on the location of establishments at the county level.

Section 6 summarizes and concludes.

## 2. The Panel Dataset

The state data constructed and used in this paper measure economic activity in the manufacturing sector for all 50 states. This data set may be thought of as a state-level analog to other widely used data sets, such as the industry-level NBER Productivity Database or Dale Jorgenson's "KLEM" database or the country-level Penn World Tables. This section provides a cursory overview of the construction of the five key series used in this paper: two quantity variables (output (Y) and the capital stock (K)), their tax-adjusted prices ($P^Y$ and $P^K$, respectively), and a fifth series for the number of establishments (NE). The quantity series are available from 1982 to 2004; the price series from 1963 to 2004; and the NE series from 1977 to 2004. Substantially more detail can be found in the appendix.

The primary raw source data for the nominal output (Y$), nominal investment (I$), and NE series is the Annual Survey of Manufacturers (ASM) conducted by the U.S. Census Bureau. Since these series all come from a single, representative-survey-based source, they are of fairly high quality. The ASM data are collected from a large, representative sample of manufacturing establishments with one or more paid employees. The 2004 ASM (Appendix B, p. B-1) defines the manufacturing sector as follows,

> The Manufacturing sector comprises establishments engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products. ….. Establishments in the manufacturing sector are often described as plants, factories, or mills and characteristically use power-driven machines and materials-handling equipment. However, establishments that transform materials or substances into new products by hand or in the worker's home and those engaged in selling to the general public products made on the same premises from which they are sold, such as bakeries, candy stores, and custom tailors, may also be included in this sector.

The ASM manufacturing sector corresponds to NAICS sectors 31 to 33.

The Y series equals Y$ deflated by a price index obtained from the Bureau of Economic Analysis (BEA).

Capital stock data useful in economic analyses are not obtainable from raw sources but must be constructed from various series. The K series is computed according to a perpetual inventory formula based on real investment data (I) and depreciation rates. The I series equals I$

deflated by a price index obtained from the BEA. Depreciation rates are also obtained from BEA.

The $P^K$ series is based on the concept introduced by Jorgenson (1963) and developed and expanded by, among others, Gravelle (1994), Hall and Jorgenson (1971), Jorgenson and Yun (2001), and King and Fullerton (1984). This series is defined as the product of three objects reflecting tax credits and deductions ($TAX_{s,t}$), the purchase price of the capital good ($PRICE_{s,t}$), and the opportunity costs of holding depreciating capital ($OPPCOST_{s,t}$),

$$P^K_{s,t} = TAX_{s,t} * PRICE_{s,t} * OPPCOST_{s,t}, \tag{1a}$$

$$\begin{aligned} TAX_{s,t} = {} & 1 - ITC^{L,S}_{s,t} - ITC^{L,F}_{t} - (\tau^{E,S}_{s,t} + \tau^{E,F}_{s,t})TD_{s,t} \\ & + \left(1 - (\tau^{E,S}_{s,t} + \tau^{E,F}_{s,t})\right)PT_{s,t} \end{aligned}, \tag{1b}$$

$$PRICE_{s,t} = P^I_{mfg,t}, \tag{1c}$$

$$OPPCOST_{s,t} = \rho_{s,t} + \delta_{mfg,t}, \tag{1d}$$

where $ITC^{L,S}_{s,t}$ and $ITC^{L,F}_{t}$ are the legislated investment tax credit rates at the state and federal levels, respectively, $\tau^{E,S}_{s,t}$ and $\tau^{E,F}_{t}$ are the effective corporate income tax rates at the state and federal levels, respectively, $TD_{s,t}$ is the present value of tax depreciation allowances at the federal level, $PT_{s,t}$ is the present value of property tax payments at the state level, $P^I_{mfg,t}$ is the price deflator for investment in the manufacturing sector, $\rho_{s,t}$ is the financial cost of capital, and $\delta_t$ is the economic depreciation rate. The $P^K_{s,t}$ series and its eight components are stated at an annual rate and in continuous time. In this preliminary version of the paper, several of the federal tax components and time variation in the financial cost of capital have been omitted.

The user cost of capital concept is a relative price and is defined as follows,

$$UC_{s,t} = P^K_{s,t} / P^Y_{s,t}, \tag{2}$$

Summary statistics for the variables in the estimating equations are provided in Table 1.

## 3. Capital Demand Model

The first of the three models we use to assess the own-state and interstate effects of state tax incentives is based on the first order condition for optimal capital accumulation. This condition is at the core of the vast majority of econometric equations of capital formation (Chirinko, 1993). In sub-section 1, we derive the estimating equation and explore the sensitivity of results to state and time fixed effects. These results are based on defining the set of competitive states as the closest five states; the user cost in competitive states is then defined as an average of the user costs in those states, weighting each state by the inverse of the distance between its population centroid and that of the state in question. Sub-section 2 provides additional evidence when the competitive set of states is expanded to the 10 closest or all other states.

### *3.1. Benchmark Model*

We begin by assuming that production for state s at time t is characterized by the following Constant Elasticity of Substitution (CES) technology,

$$\begin{aligned} Y_{s,t} &= Y[K_{s,t}, L_{s,t}, A_{s,t}, B_t^K, B_t^L] \qquad (3) \\ &= A_{s,t}\left\{\phi(B_t^K K_{s,t})^{[(\sigma-1)/\sigma]} + (1-\phi)(B_t^L L_{s,t})^{[(\sigma-1)/\sigma]}\right\}^{[\sigma/(\sigma-1)]}, \end{aligned}$$

where $Y_{s,t}$ is real output, $K_{s,t}$ is the real capital stock, $L_{s,t}$ is the level of labor input, $\phi$ is the capital distribution parameter, and $\sigma$ is the elasticity of substitution between labor and capital. Technical progress is both neutral ($A_{s,t}$), and biased for capital and labor ($B_t^K$ and $B_t^L$, respectively). Neutral technical change can have both state and aggregate effects, and biased technical change, since it affects capital goods available to all industries, has an aggregate effect. Equation (3) is homogeneous of degree one in $K_{s,t}$ and $L_{s,t}$.

Constrained by the CES production function (10), a profit-maximizing firm chooses capital so that its marginal product equals the user cost of capital defined above in equations (1) and (2). Differentiating equation (3) with respect to capital and rearranging terms, we obtain the following factor demand equation for capital,

$$(K_{s,t} / Y_{s,t}) = \phi^{\sigma} \ (UC_{s,t})^{-\sigma} \ E_{s,t} , \tag{4a}$$

$$E_{s,t} \equiv A_{s,t}^{[\sigma-1]\sigma} \ B_{t}^{[\sigma-1]\sigma} . \tag{4b}$$

To capture state and aggregate fixed effects, we assume that the error term ( $E_{s,t}$ ) follows a two-way error component model,

$$E_{s,t} = \exp[e_s + e_t + e_{s,t}] , \tag{5}$$

where $e_{s,t}$ may have a non-zero mean. We augment the first-order condition in two ways. The user cost term is replaced by a relative user cost term reflecting prices in the own and competitive states in order to capture the effect of interstate tax competition. To allow for dynamic responses to tax stimuli, we enter current and lagged values of the relative user cost variable. Taking logs of the augmented first-order condition, we obtain the following estimating equation,

$$ky_{s,t} = \zeta + \alpha_0 \, ruc_{s,t} + \alpha_1 \, ruc_{s,t-1} + \alpha_2 \, ruc_{s,t-2} + e_s + e_t + e_{s,t} , \tag{6a}$$

$$ky_{s,t} \quad = Ln[K_{s,t} / Y_{s,t}], \tag{6b}$$

$$\zeta \qquad = \sigma \, Ln[\phi], \tag{6c}$$

$$ruc_{s,t} = uc_{s,t}^{own} - uc_{s,t}^{comp} , \tag{6d}$$

$$uc_{s,t}^{own} = Ln[UC_{s,t}] , \tag{6e}$$

$$uc_{s,t}^{comp} = Ln\left[ \sum_{v \neq s}^{V} \varsigma_{s,v} UC_{v,t} \right] \quad V = 5, 10, 50 , \tag{6f}$$

$$\varsigma_{s,v} = (\text{distance between centroids for states s and v})^{-1} . \tag{6g}$$

$$\Omega = \alpha_0 + \alpha_1 + \alpha_2 , \tag{6h}$$

where the user cost for the competitive set of states ( $uc_{s,t}^{comp}$ ) is defined in equation (6f) for the five closest, ten closest, or all other states. The impact of the user cost variables is assessed by $\Omega$, which is the summation of the $\alpha$'s.

There are several noteworthy features of equations (6) for estimating the effects of relative state tax incentives. First, the specification is parsimonious and linear, and tax policy effects are captured by the coefficients on the current and lagged values of the relative user cost term. Second, equation (6a) highlights the importance of state and time fixed effects, an issue that will be important in the empirical results. Third, the specification is robust to other factors that might affect production possibilities. For example, locational and geographical features that are fixed through time will be captured by the state fixed effect. Other state factors that vary through time, such as infrastructure stocks and human capital, can enter as an additional factor of production and not distort the parameter estimates from equations (6). This robustness is traceable to the strong separability that is inherent in the CES function and the effects of additional factors are absorbed by the output term.

OLS estimates of equation (6a) are presented in Panels A-C of Table 2 for estimators that differ by the inclusion/exclusion of state and year fixed effects and by the number of lags. In this subsection, we discuss the results from Panel A where the competitive user cost is defined for the five closest states. The models in columns 1 to 4 contain only the current value of the relative user cost. In column 1 with neither state nor time fixed effects, the coefficient on $ruc_{s,t}$, which is equivalent to $\Omega$ in this particular model, is positive and statistically insignificant. The inclusion of state fixed effects in column 2 leads to a major change, as $\Omega$ is now negative and both economically and statistically significant. Column 3 includes time fixed effects but excludes state fixed effects; $\Omega$ has a difficult-to-rationalize positive coefficient. Column 4 includes both fixed effects. Comparing columns 4 with both fixed effects to column 2 with only time fixed effects, we see that the time fixed effects lower the response of capital to its user cost, as the $\Omega$ of −0.684 is smaller (in absolute value) than the comparable coefficient of −0.972.

These combinations of fixed effect estimations are repeated in columns 5 to 8 and 9 to 12 for models with one and two lags, respectively. In order to enhance comparability across models, the sample is identical for the two, one, and zero lag models. The pattern of impacts of the fixed effects is the same in these models. For the preferred models with both fixed effects, the $\Omega$'s increase somewhat with additional lags, from −0.684 with zero lags to −0.777 and −0.836

with one and two lags, respectively. Further lags had a negligible impact on Ω and are not reported in Table 2.

In sum, these results reveal a substantial impact of individual state tax policies operating though the user cost on capital formation and the importance of controlling for state and time effects with panel data.

### *3.2. Additional Competing States*

The above results are based on the assumption that the competitive user cost was for states that are close geographically to state s. Panels B and C expand the set of competing states by defining the competitive user cost for the ten closest and all other states. The previously discussed results are confirmed in these models with additional competing states. The only systematic difference is that the Ω's rise (in absolute value) with the number of competing states, from −0.836 in Panel A to −0.972 and −1.069 in Panels B and C, respectively.

### *3.3. Zero-Sum Game?*

The prior results answer the first of the two questions that motivate this study concerning the efficacy of state tax incentives. In order to address the second question concerning the source of the increase, we reestimate the following more general model with own and competitive user costs entered separately,

$$\begin{aligned} ky_{s,t} &= \zeta + \beta_0\, uc^{own}_{s,t} + \beta_1\, uc^{own}_{s,t-1} + \beta_2\, uc^{own}_{s,t-2} \\ &\quad + \gamma_0\, uc^{comp}_{s,t} + \gamma_1\, uc^{comp}_{s,t-1} + \gamma_2\, uc^{comp}_{s,t-2} + e_s + e_t + e_{s,t} \end{aligned} \quad . \qquad (7)$$

The β's and the γ's capture the own-state and interstate tax effects, respectively. Insofar as there is a competition for scarce capital resources and competitive tax rates affect capital formation in state s, the sum of the γ's, as represented by $\Omega^{comp}$, will be positive. Alternatively, if capital is elastically provided, then the γ's will equal zero. Note that equation (7) reduces to equation (6a) under the restriction $-\beta_j = \gamma_j \ \ \forall j$.

OLS estimates of equations (6a) and (7) are presented in Table 3 for models with two lags and state and time fixed effects. Columns 1 and 2 are based on competitive user costs defined for the five closest states. The sum of the β's, as represented by $\Omega^{own}$ in column 2, are larger (in absolute value) than the comparable sum from the constrained model in column 1. However, $\Omega^{comp}$ exhibits the puzzling result of being negative and statistically significant. This result also obtains in the other models presented in Table 3.

We do not have a full understanding of this perverse result with $\Omega^{comp}$. Part of the answer is traceable to the very high correlation of approximately 0.90 between $uc_{s,t}^{own}$ and $uc_{s,t}^{comp}$. This relation is reduced somewhat when common time effects are removed. The remaining correlation of approximately 0.60 is high but not too surprising because this procedure only removes linear effects and aggregate federal tax parameters enter the user cost nonlinearly. In future work, we will try to separate the effect of state and federal tax parameters by constructing a user cost that holds federal tax parameters and other aggregate variables at their mean values, thus allowing only state variation to impact the estimates. A complementary user cost will be constructed that will hold state tax parameters at their mean values. While the results in this section document an important response of capital formation to tax policy, at the moment, we are not able to allocate this response to own-state and interstate effects.

## 4. Establishment Models

The second general model focuses on the number and growth of establishments. The sensitivity of the location of firms and establishments to tax incentives has received a great deal of attention in the literature, and the results in this section complement those presented in Section 3.

### *4.1. Count Model*

Following Papke (1991), we model the number of establishments as a count process determined by a Poisson distribution. The Poisson model is convenient because the log of the Poisson parameter, $\lambda_{s,t}$ (which defines the first and second moments of the distribution of the number of establishments) is a linear function of covariates. For the purposes of our study, the principle covariate is the difference in the own and competitive user costs ($DUC_{s,t}$). We also include time fixed effects and specify the following model,

$$\lambda_{s,t} = \alpha_0 \; DUC_{s,t} + \alpha_1 \; DUC_{s,t-1} + \alpha_2 \; DUC_{s,t-2} + e_t + e_{s,t} \;, \qquad (8a)$$

$$DUC_{s,t} \equiv UC_{s,t}^{own} - UC_{s,t}^{comp} \;. \qquad (8b)$$

In the Poisson model, state fixed effects are controlled for by conditioning on the sum of the number of establishments for each state (see Hausman, Hall and Griliches (1984) and Papke (1991) for further details). All of the estimates reported in this section are based on the competitive user cost for the five closest states.

Estimates of equation (8a) are presented in Table 4 where we revisit the issue of including various combinations of fixed effects. However, the results are difficult to interpret, as the sum of the α's are positive. These perverse results persist in column 5, which enters $UC_{s,t}^{own}$ and $UC_{s,t}^{comp}$ separately.

In sum, the empirical results from the Poisson model do not prove useful in interpreting own-state and interstate effects of state investment incentives.

*4.2. Growth Model*

This sub-section presents results for the growth rate of the number of establishments,

$$ne_{s,t} - ne_{s,t-1} = \alpha_0 \ ruc_{s,t} + \alpha_1 \ ruc_{s,t-1} + \alpha_2 \ ruc_{s,t-2} + e_s + e_t + e_{s,t} , \qquad (9)$$

where the user costs have been entered as the difference in the logarithms of the own and competitive user costs. Estimates of equation (9) are presented in Table 5. Columns 1 to 4 contain various combinations of fixed effects, and these results parallel those for the capital stock reported in Tables 2. The inclusion of state effects substantially raises the elasticity of establishment growth, and this elasticity is lowered by the inclusion of time fixed effects. The elasticity in column 4 (which incorporates both state and time fixed effects) is -0.064; this low elasticity is not statistically significant at conventional levels.

These results may be affected by the short-run variation affecting annual growth rates. As shown in Table 1, the coefficient of variation for the one-year growth rate is 20 times larger than for the five-year growth rate. In order to emphasize longer-run variation, we compute a five-year growth rate for the number of establishments and estimate the following model,

$$ne_{s,t} - ne_{s,t-5} = \alpha_0 \ ruc_{s,t-5} + \alpha_1 \ ruc_{s,t-6} + \alpha_2 \ ruc_{s,t-7} + e_s + e_t + e_{s,t} , \qquad (10)$$

The results from estimating equation (10) are presented in columns 6 and 7 of Table 5. In contrast to the results with the one-year growth rate, the elasticities are significant both economically and statistically. The value of $\Omega$ is $-0.487$, which is toward the upper range of location elasticities. When the own and competitive user costs are entered separately, only the own user cost is statistically significant. The results for the five-year growth rate provide some evidence for the efficacy of state investment tax incentives.

## 5. Borders Models

Both of the above models confront the problem of separating the state policy effects that are the primary object of our analysis from the nonpolicy effects, that are undoubtedly quantitatively important but not of immediate interest. In this section, we address this problem by exploiting the spatial discontinuity in government policy that occurs at state borders. This strategy was pioneered by Holmes (1998) in his study of right-to-work laws and other pro-business policies on the location of manufacturing activity. Subsection 5.1 applies Holmes' model to the current context and finds only weak evidence for the efficacy of state tax policy. We develop an alternative model in the spirit of Holmes that takes advantage of the panel structure of our dataset. The model exploits the "natural experiment" afforded by pairs of counties that are in the same geographic area, and hence have quite similar nonpolicy conditions, but are separated by a state border. Comparing differential outcomes of pairs of counties with common geographic conditions but different state policies is akin to the "twin studies" employed frequently in labor economics and medical research, which analyze the differential outcomes of identical twins with common genetic conditions but different environmental conditions (e.g., Ashenfelter and Krueger, 1994). The Twin-Counties Model uncovers a strong effect of user costs prevailing at the state level on the location of establishments at the county level.

### *5.1. Holmes Model*

Holmes (1998) develops several different tests for identifying the effects of pro-business regulations. This section follows the development of the cross-section model presented in his equation (3) modified to the current situation,

$$gr_c = nonpolicy_c + \theta \ policy_c + e_c \,, \tag{11a}$$

$$nonpolicy_c = f_b[x_c] + g_b[x_c] dist_c \,, \tag{11b}$$

$$nonpolicy_c = \eta_{0,b} + \eta_{1,b} \, x_c + \eta_{2,b} \, x_c^2 + \eta_{3,b} \, dist_c \,, \tag{11c}$$

where c indexes counties (about 3000 in the 48 contiguous U.S. states) and b indexes the 109 borders. Equation (11a) is a general decomposition between nonpolicy and policy influences on the growth rate ($gr_c$) in some economic activity variable in county c. Holmes proposes a unique method for modeling the nonpolicy influences on the establishment growth based on two geographic characteristics of county c -- $dist_c$, the minimum distance from the population centroid for county c to its closest state border, and $x_c$, the distance between an arbitrary fixed point (on this closest border) and the point along the border that minimizes the distance from the population centroid (Holmes refers to $x_c$ as the "milemark"). The focus on state borders is key to the analysis. "At state borders, the geographic determinants of the distribution of manufacturing ….. are approximately the same on both sides of the border" (Holmes, 1998, p. 671). Holmes' method depends on $dist_c$ and the polynomial approximations in $x_c$ given by $f_b[.]$ and $g_b[.]$ to map the geographic data of the counties into a Cartesian plane in order to isolate the geographic determinants of the distribution of manufacturing (see Holmes (1998, Sections II.B and 4) for further discussion). The polynomial approximations are presented in equation (11c). Note that these approximations are only valid for a given year, and hence the model must be estimated as a cross-section. If the model is analyzed with panel data, it must be estimated as a series of cross-section regressions in which the η's are reestimated each year.

We estimate a series of cross-section models of the growth rate in the number of establishments (computed over a five-year span) based on a policy variable that reflects the user cost in county c compared with the user cost in the bordering county ($ruc_{c,t}$). The first model is closest to that used by Holmes, and defines an "anti-business" variable as an indicator variable in terms of the ratio of user costs,

$$gr_{c,t} = \eta_{0,t} + \eta_{1,t}\, x_{c,t} + \eta_{2,t}\, x_{c,t}^2 + \eta_{3,t}\, dist_{c,t} + \theta_t \text{ anti-business}_{c,t} + e_{c,t}\,, \tag{12a}$$

$$gr_{c,t} = \left(NE_{c,t} - NE_{c,t-5}\right) / \left((NE_{c,t} + NE_{c,t-5})/2\right), \tag{12b}$$

$$\begin{aligned} \text{anti-business}_{c,t} &= 1 \text{ if } ruc_{c,t} \geq 1 \\ &= 0 \text{ if } ruc_{c,t} < 1 \end{aligned}\,. \tag{12c}$$

The second model replaces the indicator variable by a continuous variable in the ratio of user costs,

$$gr_{c,t} = \eta_{0,t} + \eta_{1,t}\, x_{c,t} + \eta_{2,t}\, x_{c,t}^2 + \eta_{3,t}\, dist_{c,t} + \theta_t \text{ } ruc_{c,t} + e_{c,t}\,. \tag{13}$$

The results are presented in Figures 2 and 3, respectively, and they are quite similar. While most of the $\theta_t$'s are negative, none are statistically distinguishable from zero. These results provide no support for the role of state tax policy and further warn of the dangers in drawing inferences based on a limited number of cross-section regressions.

*5.2. Twin-Counties Model*

The essential piece of information generated by examining bordering counties is that the non-policy effects are identical at the border. Holmes measures these non-policy effects through polynomial approximations of geographic characteristics. In this subsection, we continue to rely on the information generated at the border but develop a different model to identify policy effects. Consider the following general decomposition for the number of establishment in a pair of neighboring counties that are in different states,

$$ne_{c,t} = \alpha_c + \beta_t + nonpolicy_{c.t} + \theta \, policy_{c,t} + e_{c,t} \, , \tag{14a}$$

$$ne_{c',t} = \alpha_{c'} + \beta_t + nonpolicy_{c'.t} + \theta \, policy_{c',t} + e_{c,t} \, , \tag{14b}$$

where $ne_{c,t}$ is the logarithm of the number of establishments, $\alpha_c$ is a county fixed effect (that can incorporate distance from the population centroid to the border, position along the closest state border, latitude, longitude, climate, etc.), $\beta_t$ is a time fixed effect impacting both counties equally, $nonpolicy_{c,t}$ represents one or more variables, $policy_{c,t}$ can also represent one or more variables but it should be equated to the user cost for the development of this particular model, $e_{c,t}$ is an error term, and $\theta$ is the parameter of interest. The critical piece of information is that, for sufficiently small ranges around a state border, counties c and c' are “twins” and hence $nonpolicy_{c,t} = nonpolicy_{c',t}$. We exploit this relation by taking cross-county differences of a pair of counties (labeled p),

$$\nabla ne_{p,t} = \alpha_p + \theta \nabla policy_{p,t} + e \, , \tag{15a}$$

$$\nabla x_{p,t} \equiv x_{c,t} - x_{c',t} \qquad x = \{ne_{p,t}, policy_{p,t}\} \tag{15b}$$

$$\nabla policy_{p,t} \equiv uc_{c,t} - uc_{c',t} \equiv ruc_{p,t} \, . \tag{15c}$$

where the county fixed effects have been absorbed into $\alpha_p$, the $\beta_t$'s cancel by construction, and the nonpolicy variables cancel by the "twins" assumption at the border. The policy variable that enters equation (15a) is a relative user cost ($ruc_{c,t}$), where the relative relation is drawn across a pair of bordering counties. If state tax investment incentives are effective, we would expect $\theta$ to be negative and statistically significant.

The Twin-Counties Model permits an additional test of tax effectiveness and tax competition. We would expect policy to be more effective the closer are the paired counties, where closesness is measured by the distance between the border and the population centroid. Establishments in close counties are more likely to respond by moving operations across the state line than establishments that are further from the border. We would thus expect $\theta$ to decrease as equation (15a) is estimated for counties further away from the border. This monotonicity hypothesis is evaluated with the following modified version of equation (15a),

$$\nabla^{md} ne_{p,t} = \alpha_p + \theta \nabla^{md} policy_{p,t} + e, \qquad (16)$$

where the superscript md denotes the maximum distance from the population centroid to the border for each county forming the county pair.

Estimates of the Twin-Counties model for various values of md are presented in Table 6 and Figure 4. The first column of Table 6 is for md = 10, and the $\theta$ is large, negative, and statistically significant. For a pair of counties located within 10 miles of a border, a 1% decrease in the user cost will lead to a 2.39% increase (for the county favored by the tax incentive) in the ratio of establishments in the two counties. This elasticity is about three times as large as the upper bound elasticity reported in the literature (Stark and Wilson, 2006, p. 159). Moreover, this elasticity decreases as we expand the dataset by increasing the maximum distance between the border and the population centroid. At 50 miles, the effect is nil. This finding suggests that there are several unfavorable effects following from state investment tax incentives -- such as an increase in other, non-corporate income taxes or a reduction in public services -- that lead establishments to migrate away from state s.

Figure 4 provides a more detailed assessment of the relation between distance from the border and the policy elasticity. We begin with the minimal distance (md = 6) that will provide us with 1,000 county/year observations. Equation (16) is then estimated for successive values of md from 6 to 50, and the θ's are plotted in Figure 4. Apart from some initial fluctuations for the first few estimates, θ reaches its minimum value at md = 11 and then increases nearly monotonically toward zero. The 95% confidence interval first crosses the zero axis for md = 32 and then hovers tightly around zero for the remaining regressions. The monotonic behavior displayed by θ in Figure 4 confirms that tax competition is quantitatively important.

## 6. Summary and Conclusions

Pending

## References

Ashenfelter, Orley, and Krueger, Alan B., "Estimates of the Economic Returns to Schooling from a New Sample of Twins," *American Economic Review* 84 (December 1994), 1157-1173.

Bogart, William T., and Anderson, Nathan B., "Business Location, Taxation and," in Joseph J. Cordes, Robert D. Ebel, and Jane G. Gravelle (eds.), *The Encyclopedia of Taxation and Tax Policy*, Second Edition (Washington: The Urban Institute Press, 2005), 39-41.

Bradbury, Katharine, L., Kodrzycki, Yolanda K., and Tannenwald, Robert, "The Effects of State and Local Public Policies on Economic Development: An Overview," *New England Economic Review* (March/April 1997), 1-12.

Chirinko, Robert S., "Business Fixed Investment Spending: Modeling Strategies, Empirical Results, and Policy Implications," *Journal of Economic Literature* 31 (December 1993), 1875-1911.

Gravelle, Jane G., *The Economic Effects of Taxing Capital Income* (Cambridge: MIT Press, 1994).

Hall, Robert E., and Jorgenson, Dale W., "Application of the Theory of Optimum Capital Accumulation," in Gary Fromm (ed.), *Tax Incentives and Capital Spending* (Washington: Brookings Institution, 1971), 9-60.

Hausman, Jerry A., Hall, Bronwyn H., and Griliches, Zvi, "Econometric Models for Count Data with an Application to the Patents-R&D Relationship," *Econometrica* 52 (1984), 909-938.

Holmes, Thomas J., "The Effect of State Policies on the Location of Manufacturing: Evidence From State Borders," *Journal of Political Economy*, 106 (August 1998), 667-705.

Jorgenson, Dale W., "Capital Theory and Investment Behavior," *American Economic Review* 53 (May 1963), 247-259; reprinted in *Investment, Volume 1: Capital Theory and Investment Behavior* (Cambridge: MIT Press, 1996), 1-16.

Jorgenson, Dale W., and Yun, Kun-Young, *Investment Volume 3: Lifting the Burden: Tax Reform, the Cost of Capital, and U.S. Economic Growth* (Cambridge: MIT Press, 2001).

King, Mervyn A., and Fullerton, Don (eds.), *The Taxation of Income from Capital* (Chicago: University of Chicago Press (for the NBER), 1984).

Papke, Leslie E. "Interstate Business Tax Differentials and New Firm Location: Evidence From Panel Data." *Journal of Public Economics*, 1991.

Stark, Kirk J., and Wilson, Daniel J., "What Do We Know about the Interstate Effects of State Tax Incentives?," *The Georgetown Journal of Law & Public Policy* 4 (Winter 2006), 133-164.

Wasylenko, Michael, "Taxation and Economic Development: The State of the Economic Literature," *New England Economic Review* (March/April 1997), 37-52.

White, Halbert, "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity," *Econometrica* 48 (May 1980), 817-838.

# Appendix: A State Level Database For The Manufacturing Sector: Construction And Sources

N.B. Not all of the variable constructions described in this appendix have been implemented in this draft of the paper.

This appendix describes the construction of and data sources for a state-level productivity data set covering the U.S. manufacturing sector. This data set may be thought of as a state-level analog to other widely used productivity data sets such as the industry-level NBER Productivity Database or Dale Jorgenson's "KLEM" database or the country-level Penn World Tables. Four series describe output ( $Y_{s,t}$ ) and capital ( $K_{s,t}$ ), as well as their tax-adjusted prices, $P^{Y}_{s,t}$ and $P^{K}_{s,t}$ , respectively. The series are for the 50 states plus the District of Columbia (indexed by subscript s and hereafter referred to collectively as "states") and for the period 1963 to 2004 (indexed by subscript t), unless otherwise noted.[1] Each of the four series is described in a separate section. Section 5 describes the data sources for a series on the number of manufacturing establishments ( $NE_{s,t}$ ). The general organizing principle for each section is to first define the seven series mentioned above and then discuss the components for each series. For each component, general issues concerning the construction of the series (if pertinent) and then data sources are discussed. Section 6 contains a Legend describing abbreviations and sources.

The state data described in this paper measure economic activity in the manufacturing sector. The primary raw source data for the state-level totals of output, investment, labor and establishments counts is the Annual Survey of Manufacturers (ASM) conducted by the U.S. Census Bureau. State-level totals (which the Census Bureau refers to as "AS-3" data) are reported in the yearly volumes of the ASM publication. From 1994 onward, these data also can be found in the yearly ASM Geographic Area Statistics (ASM-GAS) publications. Hereafter, we will refer to the ASM data on state-level totals for all years as the ASM-GAS data. The ASM data are collected from a large, representative sample of manufacturing establishments with one or more paid employees. The 2004 ASM (Appendix B, p. B-1) defines the manufacturing sector as follows,

---

[1] The most notable exception is that the Annual Survey of Manufacturers was not conducted from 1979 to 1981.

> "The Manufacturing sector comprises establishments engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products. The assembling of component parts of manufactured products is considered manufacturing, except in cases where the activity is appropriately classified in Sector 23, Construction. Establishments in the manufacturing sector are often described as plants, factories, or mills and characteristically use power-driven machines and materials-handling equipment. However, establishments that transform materials or substances into new products by hand or in the worker's home and those engaged in selling to the general public products made on the same premises from which they are sold, such as bakeries, candy stores, and custom tailors, may also be included in this sector. Manufacturing establishments may process materials or may contract with other establishments to process their materials for them. Both types of establishments are included in manufacturing."

The ASM manufacturing sector corresponds to NAICS sectors 31 to 33.

## 1. OUTPUT -- $Y_{s,t}$

Output is measured by real value added, and it is defined as nominal value added divided by a price deflator,

$$Y_{s,t} = Y\$_{s,t} / P^{BT,Y}_{mfg,t} ,$$

where $Y\$_{s,t}$ is nominal value added output and $P^{BT,Y}_{mfg,t}$ is the price index for manufacturing output net of sales and excise taxes but before corporate income tax adjustments. Since the $P^{BT,Y}_{mfg,t}$ series is based on producer price indices, it measures average prices received by domestic producers (PPI). Our database presents $Y_{s,t}$ in billions of constant 2000 dollars.

The $Y\$_{s,t}$ series is obtained from ASM GAS (e.g., in 2004, the data are published in Table 1, column F). Our database presents $Y\$_{s,t}$ in billions of dollars.

The $P^{BT,Y}_{mfg,t}$ series is obtained from INDUSTRY, the table labeled "Chain-Type Price Indexes for Value Added by Industry," Line 12. Our database presents $P^{BT,Y}_{mfg,t}$ as an index number with a base year value in 2000 of 1.0.

## 2. PRICE OF OUTPUT (TAX-ADJUSTED) -- $P^{Y}_{s,t}$

The price of output (tax-adjusted) is defined as the price index for manufacturing output adjusted by the effective corporate income tax rates at the state and federal levels,

$$P^{Y}_{s,t} = P^{BT,Y}_{mfg,t}\left(1-(\tau^{E,S}_{s,t}+\tau^{E,F}_{s,t})\right),$$

where $P^{BT,Y}_{mfg,t}$ is the price index for manufacturing output before tax adjustments (defined in Section 1), $\tau^{E,S}_{s,t}$ is the effective corporate income tax rate at the state level, and $\tau^{E,F}_{s,t}$ is the effective corporate income tax rate at the federal level. (As discussed below, the effective federal tax rate depends on state tax parameters, and hence is subscripted by s.) The $P^{BT,Y}_{mfg,t}$ series was discussed in Section 1. Since $P^{BT,Y}_{mfg,t}$ is the price of output paid by purchasers (per Section 1), $P^{Y}_{s,t}$ is the price of output received by producers. Our database presents $P^{Y}_{s,t}$ as an index number with 2000 as the base year. The two tax components are discussed in the following subsections.

**The Effective Corporate Income Tax Rate At The State Level -- $\tau^{E,S}_{s,t}$**

The effective corporate income tax rate at the state level is lower than the legislated (or statutory) corporate income tax rate ($\tau^{L,S}_{t}$) due to the deductibility (in some states) against state taxable income of taxes paid to the federal government.[2] Some states allow full deductibility of federal corporate income taxes from state taxable income, Iowa and Missouri allow only 50% deductibility, and some states allow no deductibility at all. The deductibility provision in state tax codes is represented by $\upsilon_{s,t} = \{1.0, 0.5, 0.0\}$, and the provisional effective corporate income tax rate at the state level is as follows,

$$\tau^{\#,E,S}_{s,t} = \tau^{L,S}_{t}(1-\tau^{\#,E,F}_{s,t}\upsilon_{s,t}).$$

[2] Some states refer to their corporate income taxes as "franchise" or "excise" taxes.

The effect of federal income tax deducibility is represented by the provisional *effective* corporate income tax rate at the federal level (defined below). (This formulation has been validated by "brute force" computations of state and federal taxes paid based on state and federal legislated tax rates.)

The $\tau^{L,S}_{s,t}$ and $\upsilon_{s,t}$ series are obtained from several sources. For recent years, data are obtained primarily from various issues of BOTS and STH, as well as actual state tax forms. Data for earlier years are obtained from various issues of BOTS and SFFF. Additional information has been provided by TAXFDN. Many states have multiple legislated tax rates that increase stepwise with taxable income; we measure $\tau^{L,S}_{t}$ with the marginal legislated tax rate for the highest income bracket. Our database presents $\tau^{L,S}_{t}$ in percentage points (e.g., 0.05) as opposed to basis points (e.g., 5).

**The Effective Corporate Income Tax Rate At The Federal Level -- $\tau^{E,F}_{s,t}$**

The effective corporate income tax rate at the federal level is lower than the legislated corporate income tax rate ( $\tau^{L,F}_{t}$ ) due to the deductibility against federal taxable income of taxes paid to the state. The provisional effective corporate income tax rate at the federal level is as follows,

$$\tau^{\#,E,F}_{s,t} = \tau^{L,F}_{t}(1-\tau^{\#,E,S}_{s,t})$$

The effect of state income tax deducibility is represented by the *effective* corporate income tax rate at the state level. (This formulation has been validated by "brute force" computations of state and federal taxes paid based on state and federal legislated tax rates.) The $\tau^{L,F}_{t}$ series is obtained from GRAVELLE, Table 2.1. Our database presents $\tau^{L,F}_{t}$ in percentage points.

It has not generally been recognized that, owing to deductibility of taxes paid to another level of government, the effective corporate income tax rates at the state and federal levels are functionally related to each other. As shown in the above equations, these interrelationships yield two equations in two unknowns, and thus can be solved for the effective corporate income tax rates at the state and federal levels, respectively, as follows,

$$\tau_{s,t}^{E,S} = \tau_{s,t}^{L,S}\left[1-\upsilon_{s,t}\tau_{t}^{L,F}\right] \Big/ \left[1-\upsilon_{s,t}\tau_{s,t}^{L,S}\tau_{t}^{L,F}\right],$$

$$\tau_{s,t}^{E,F} = \tau_{t}^{L,F}\left[1-\tau_{s,t}^{L,S}\right] \Big/ \left[1-\upsilon_{s,t}\tau_{s,t}^{L,S}\tau_{t}^{L,F}\right].$$

The overall corporate income tax rate is the sum of $\tau_{s,t}^{E,S}$ and $\tau_{s,t}^{E,F}$. In the limiting case where federal corporate income taxes are not deductible against state taxable income ($\upsilon_{s,t} = 0$), this sum reduces to the more frequently used formula, $\tau_{s,t}^{L,S} + \tau_{t}^{L,F} - \tau_{s,t}^{L,S} * \tau_{t}^{L,F}$.

## 3. CAPITAL -- $K_{s,t}$

Capital input is measured by the real (constant-cost) replacement value of equipment (excluding software) and structures, and this series is constructed from the following perpetual inventory formula,

$$K_{s,t} = K_{s,\tau}(1-\delta_{mfg,t})^{t-\tau} + I_{s.t} \qquad t = \tau+1,...,T \ ,$$

where $K_{s,\tau}$ is the initial value of the real capital stock (where the index $\tau$ represents the initial period), $\delta_{mfg,t}$ is the rate of economic depreciation (hence $(1-\delta_{mfg,t})$ is the survival rate), and $I_{s,t}$ is real total capital expenditure. This definition departs in a small way from the one usually employed in capital stock construction by allowing the depreciation rate to vary over time. The capital stock is dated end-of-period (EOP). Our database presents $K_{s,t}$ in billions of constant 2000 dollars. Each component determining the capital stock is discussed in the following subsections.

**The Initial Value Of The Capital Stock -- $K_{s,\tau}$**

The $K_{s,\tau}$ series is measured by the book value of the capital stock adjusted for inflation,

$$K_{s,\tau} = K_{s,\tau}^{BV} * \left(K_{mfg,\tau}^{CoC} / K_{mfg,\tau}^{HC}\right),$$

where $K_{s,\tau}^{BV}$ is the book value (historical-cost) of the capital stock for state s, $K_{mfg,\tau}^{CoC}$ is the constant-cost value of the capital stock for the manufacturing sector, and $K_{mfg,\tau}^{HC}$ is the historical-cost value of the capital stock for the manufacturing sector. All capital stock series are EOP. Inflation drives a wedge between book value capital stocks (based on the original purchase cost of investment) and real capital stocks useful in economic analyses. The $\left(K_{mfg,\tau}^{CoC} / K_{mfg,\tau}^{HC}\right)$ ratio provides an approximate adjustment for the inflation wedge based on national manufacturing industry data. Our database presents $K_{s,\tau}$ in billions of constant 2000 dollars.

We compute initial values of the real capital stock EOP for $\tau = 1962$ and $\tau = 1981$. Note we "re-initialize" the capital stock in 1981 (as opposed to simply using the perpetual inventory formula starting with the 1962 initial stock estimate) for two reasons. First, the 1962 initial stock is estimated (as described below) rather than observed and so we do not want to rely too heavily on it. Second and more importantly, data on capital expenditures are missing for 1979 to 1981. Thus, the initial capital stock for 1981, based on book value data, likely is a better measure of the true capital stock in 1981 than a capital stock measure based in part on imputed investment data from 1979 to 1981.

A provisional estimate of $K_{s,1962}$, $K^{\#}_{s,1962}$, is estimated by solving backward using the perpetual inventory formula, beginning with the 1975 data on the book value of capital (adjusted for inflation), subtracting investment data from 1963 to 1975, and weighting these terms by survival rates,

$$K^{\#}_{s,1962} = K^{\#}_{s,1975}(1-\delta_{1975})^{-(1975-1962)} - \left(\sum_{j=0}^{(1975-1962-1)} (1-\delta)^{-(1975-1962-j)} I_{s,1975-j}\right)$$

$$K^{\#}_{s,1975} = K^{BV}_{s,1975} * \left(K^{CoC}_{mfg,1975} / K^{HC}_{mfg,1975}\right)$$

The first part of the first of the equations above starts with the 1975 book value of capital (adjusted for inflation) and adds back all of the 1962 capital stock that has depreciated since 1962. The second part then subtracts all of the investments made from 1963 to 1975, after adding back to each year's investment the portion that has depreciated from when the investment was made and 1962. In essence, this formula undoes all of the additions to and depreciation from the original capital stock of 1962 and subsequent investments from 1963 to 1975. Note we choose 1975 as the year from which to work backwards since it is the earliest year in which book value data are available from the ASM.

The final estimate of $K_{s,1962}$ is then obtained by rescaling the provisional state estimates by the national real capital stock total in 1962 from the BEA, $K^{CoC}_{mfg,1962}$. Specifically,

$$K_{s,1962} = K^{\#}_{s,1962} * \left( K^{CoC}_{mfg,1962} \Big/ \sum_{s=1}^{51} K^{\#}_{s,1962} \right).$$

A potential inconsistency exists in using the BEA data to rescale our provisional estimate based on ASM data. Software investment is included in the BEA data but excluded in the ASM data. During the early 1960's, the discrepancy introduced by software investment is tiny. In 1963, software investment was 1.3% of manufacturing investment (though software embedded or bundled in computers and other equipment is not reflected in this figure). The impact of software investment is likely less than this figure for two reasons. First, for the vintages of investment entering the 1962 capital stock, their share is likely to be even smaller than 1.3%. Second, software depreciates more rapidly than other capital. It would seem safe to conclude that that the discrepancy owing to the different treatment of software investment is less than 1% of the 1962 capital stock.

The $K^{BV}_{s,\tau}$ series is obtained from ASM (e.g., in 1975, the data are published in Table 4, row 5). Our database presents $K^{BV}_{s,\tau}$ in billions of dollars.

The $K^{CoC}_{mfg,\tau}$ series is the product of a quantity index and a base year value that converts the index into a real stock,

$$K^{CoC}_{mfg,\tau} = INDEXK^{CoC}_{mfg,\tau} * K^{CuC}_{mfg,t=2000},$$

where $INDEXK^{CoC}_{mfg,\tau}$ is the chain-type quantity index for the real capital stock and $K^{CuC}_{mfg,t=2000}$ is the base year value for the current-cost value of the capital stock for the manufacturing sector. Our database presents $K^{CoC}_{mfg,\tau}$ in millions of dollars. The $INDEXK^{CoC}_{mfg,\tau}$ is obtained from FIXED, Table 4.2, line 7, and this series is divided by 100. Our database presents $INDEXK^{CoC}_{mfg,\tau}$ as an index number with a base year value in 2000 of 1.0. The $K^{CuC}_{mfg,t=2000}$ datapoint is obtained from FIXED, Table 4.1, line 7. Our database presents $K^{CuC}_{mfg,t=2000}$ in millions of dollars.

The $K^{HC}_{mfg,\tau}$ series is obtained from FIXED, Table 4.3, line 7. Our database presents $K^{HC}_{mfg,\tau}$ in millions of dollars.

**The Rate Of Economic Depreciation -- $\delta_{mfg,t}$**

The $\delta_{mfg,t}$ series is measured by the flow of annual depreciation divided by the capital stock existing at the beginning of the year,

$$\delta_{mfg,t} = \frac{D^{CuC}_{mfg,t}}{K^{CuC}_{mfg,t-1}},$$

where $D^{CuC}_{mfg,t}$ is the current-cost flow of depreciation in manufacturing industries and $K^{CuC}_{mfg,t-1}$ is the current-cost capital stock in manufacturing industries. Our database presents $\delta_{mfg,t}$ in percentage points.

The $D^{CuC}_{mfg,t}$ series is obtained from FIXED, Table 4.4, line 7. Our database presents $D^{CuC}_{mfg,t}$ in millions of dollars.

The $K^{CuC}_{mfg,t-1}$ series is obtained from FIXED, Table 4.1, line 7. Our database presents $K^{CuC}_{mfg,t-1}$ in millions of dollars.

**Real Total Capital Expenditure -- $I_{s,t}$**

Real total capital expenditure is defined as nominal capital expenditures deflated by a price index,

$$I_{s,t} = \frac{I\$_{s,t}}{P^{I}_{mfg,t}},$$

$$I\$_{s,t} = I\$^{NEW}_{s,t} + I\$^{USED}_{s,t},$$

where $I\$_{s,t}$, $I\$_{s,t}^{NEW}$, and $I\$_{s,t}^{USED}$ are total, new, and used nominal capital expenditures, respectively, and $P_{mfg,t}^{I}$ is the price deflator for investment for the manufacturing sector. Our database presents $I_{s,t}$ in billions of constant 2000 dollars. The $I\$_{s,t}$ and $P_{mfg,t}^{I}$ series are discussed in the following subsections.

**Total Nominal Capital Expenditure -- $I\$_{s,t}$**

The $I\$_{s,t}$ series is obtained in three different ways each of which are based on the ASM-GAS and depend on disjoint time periods. (This mixture of direct and indirect estimates is forced upon us because of some anomalies in the ASM-GAS.) The series represents nominal expenditures on equipment (excluding software) and structures. Our database presents $I\$_{s,t}$ in billions of dollars.

For 1977, 1978, and 1982 to 2004, the series is obtained directly from ASM-GAS (e.g, in 2004, the data are published in Table 2, column I).

For 1963 to 1976, the ASM-GAS only publishes data for $I\$_{s,t}^{NEW}$. For these years, $I\$_{s,t}$ is derived based on a state's mean ratio of $I\$_{s,t}^{NEW}$ to $I\$_{s,t}$,

$$\begin{aligned} I\$_{s,t} = I\$_{s,t}^{NEW} * MEAN_s \left\{ I\$_{s,v} / I\$_{s,v}^{NEW} \right\} \\ t = 1963,...,1976 \qquad , \\ v = 1977,\ 1978,\ 1982,...,\ 2004. \end{aligned}$$

where the $MEAN_s\{.\}$ is computed separately for each state and over all available observations represented by the index v.

For 1979 to 1981, the ASM was not conducted, and hence no ASM-GAS source data are available for $I\$_{s,t}$, $I\$_{s,t}^{NEW}$, nor $Y_{s,t}$. The missing investment data for these three years are estimated with the following three-step procedure. First, we rely on the availability of alternative output data from BEA for these three years and the workhorse of investment theory, the accelerator model, to estimate the missing total capital expenditure data. Output is defined as real Gross State Product (GSP) for the manufacturing sector.[3] With these data and the available data for $I_{s,t}$, we estimate the following flexible accelerator model,

$$I_{s,t} / Y'_{s,t} = \alpha_s + \beta_{s,0}(\Delta Y'_{s,t} / Y'_{s,t-1}) + \beta_{s,1}(\Delta Y'_{s,t-1} / Y'_{s,t-2}) + \beta_{s,2}(\Delta Y'_{s,t-2} / Y'_{s,t-3}) + \varepsilon_{s,t} , \quad t = 1977, 1978, 1982, ..., 2004$$

where $\alpha_s$ is a state-specific constant capturing state fixed effects, the $\beta_s$'s are state-specific slope parameters, $\varepsilon_{s,t}$ is an error term, and $Y'_{s,t}$ is real manufacturing GSP. The $Y'_{s,t}$ series is nominal manufacturing GSP divided by a price deflator. Nominal manufacturing GSP is obtained from the BEA's Regional Economic Accounts (REA) data. (In 1997, the data are reported on both SIC and NAICS bases; we use the SIC figures.) The deflator is $P^{BT,Y}_{mfg,t}$ discussed in Section 1.

Second, we use the estimated parameters (represented by ^'s over the $\alpha$ and the $\beta$'s), data for $Y'_{s,t}$ and $P^I_{s,t}$, and a transformed version of the above equation to generate a provisional estimate of $I\$_{s,t}$ ($I\$^{\#}_{s,t}$) for the missing nominal capital expenditure observations,

$$I\$^{\#}_{s,t} = \left[ \hat{\alpha}_s + \hat{\beta}_{s,0}(\Delta Y'_{s,t} / Y'_{s,t-1}) + \hat{\beta}_{s,1}(\Delta Y'_{s,t-1} / Y'_{s,t-2}) + \hat{\beta}_{s,2}(\Delta Y'_{s,t-2} / Y'_{s,t-3}) \right] * Y'_{s,t} * P^I_{s,t} . \quad t = 1979, 1980, 1981$$

Third, for each year (1979, 1980, 1981), we rescale states' nominal investment so that it equals the national total, $I\$^{ASM}_{mfg,t}$, which we estimate by applying the growth rate of the BEA's nominal private nonresidential fixed investment (net of software) for the manufacturing sector,

[3] For all intents and purposes, Gross State Product is conceptually identical to Gross Domestic Product, though small differences exist in some minor categories.

$I\$_{mfg,t}$, to the previous year's value of national investment reported in the ASM. Specifically, we multiply each state's provisional estimate by the ratio of national manufacturing investment to the national sum of the provisional estimates,

$$I\$_{s,t} = I\$_{s,t}^{\#} * \left( I\$_{mfg,t}^{ASM} \Big/ \sum_{s=1}^{51} I\$_{s,t}^{\#} \right), \quad t = 1979, 1980, 1981$$

$$I\$_{mfg,1979}^{ASM} = \sum_{s=1}^{51} I\$_{s,1978} \left( \frac{I\$_{mfg,1979}}{I\$_{mfg,1978}} \right)$$

$$I\$_{mfg,1980}^{ASM} = I\$_{mfg,1979}^{ASM} \left( \frac{I\$_{mfg,1980}}{I\$_{mfg,1979}} \right).$$

$$I\$_{mfg,1981}^{ASM} = I\$_{mfg,1980}^{ASM} \left( \frac{I\$_{mfg,1981}}{I\$_{mfg,1980}} \right)$$

The $I\$_{mfg,t}$ series is obtained from FIXED, Table 4.7, line 7 less the sum of software investment over all manufacturing industries (NAICS sectors 31 to 33) from DETAILED, row 9

The ASM-GAS data for $I\$_{s,t}$ need to be adjusted for additional missing values and an error. The additional missing values occur because the ASM-GAS did not report data for Minnesota for the years 1970 and 1971. We use the relation between BEA data for the manufacturing sector and state data for Minnesota on investment expenditures to impute the missing values with the following relation,

$$I\$_{s=minnesota,t} = MEAN \left\{ \frac{I\$_{s=minnesota,v}}{I\$_{mfg,v}} \right\} * I\$_{mfg,t}$$
$$t = 1970,\ 1971$$
$$v = 1967,\ 1968,\ 1969,\ 1972,\ 1973,\ 1974$$

where $I\$_{mfg,t}$ is nominal capital expenditures on new and used capital by the manufacturing sectors defined above and the mean of the ratio is computed for three years before and after the missing values. The $I\$_{mfg,t}$ series was discussed previously in this subsection.

The error occurs for $I\$_{s=ohio,t=1996}$. In 1996, ASM-GAS shows a 400% jump in nominal total capital expenditures in Ohio from about \$8 billion in 1995 to \$40 billion in 1996 and then back down to \$9 billion in 1997. This enormous jump can be traced to the motor vehicles sector (\$35 billion), which suggests a huge capital investment – equal to 85% of the sector's national capital expenditures – for the building of an auto plant(s) in Ohio in 1996. We dismiss this number for three reasons. First, the magnitude of this investment is implausible. By comparison, DaimlerChrysler's jeep plant expansion in Toledo in 1998 was \$1.2 billion of total investment over several years. Second, correspondence with experts on the Ohio manufacturing sector (including one at the Ohio Department of Economic Development) could not confirm any massive capital expenditure programs in 1996. Third, the 1996 value for national total capital expenditures reported in the ASM-GAS is inconsistent with and about \$32 billion higher than a comparable figure reported in a separate ASM publication, Statistics for Industry Groups and Industries (ASM-SIGI). These two publications disagree on national capital expenditures only in 1996, suggesting an error is present. We thus conclude that $I\$_{s=ohio,t=1996} = \$40$ billion is erroneous.

We fill in the 1996 Ohio data point by simply taking national manufacturing capital expenditures from the alternative ASM publication, ASM-SIGI, and subtracting the sum of capital expenditures from all other states.

### Price Deflator For Investment -- $P^I_{mfg,t}$

The price deflator for investment is constructed as an implicit deflator,

$$P^I_{mfg,t} = \frac{I\$_{mfg,t}}{I_{mfg,t}},$$

where $I\$_{mfg,t}$ and $I_{mfg,t}$ are nominal and real total capital expenditures, respectively, for the manufacturing sector. Our dataset presents $P^{I}_{mfg,t}$ as an index number with a base year value in 2000 of 1.0.

The $I\$_{mfg,t}$ series was discussed in the preceding subsection (Total Nominal Capital Expenditure).

The $I_{mfg,t}$ series is the product of a quantity index and a base year value that converts the index into real investment expenditures,

$$I_{mfg,t} = INDEXI_{mfg,t} * I\$_{mfg,t=2000},$$

where $INDEXI_{mfg,t}$ is the chain-type quantity index for real investment expenditures and $I\$_{mfg,t=2000}$ the base year value for current investment expenditures. Our database presents $I_{mfg,t}$ in billions of dollars. The $INDEXI_{mfg,t}$ is obtained from FIXED, Table 4.8, line 7, and this series is divided by 100. Our database presents $INDEXI_{mfg,t}$ as an index number with a base year value in 2000 of 1.0. The series containing the $I\$_{mfg,t=2000}$ datapoint was discussed in the preceding paragraph.

## 4. PRICE OF CAPITAL (TAX-ADJUSTED) -- $P^{K}_{s,t}$

The price of capital (tax-adjusted) is defined as the product of three objects reflecting tax credits and deductions ($TAX_{s,t}$), the purchase price of the capital good ($PRICE_{s,t}$), and the opportunity costs of holding depreciating capital ($OPPCOST_{s,t}$),

$$P^{K}_{s,t} = TAX_{s,t} * PRICE_{s,t} * OPPCOST_{s,t},$$

$$\begin{aligned} TAX_{s,t} = {} & 1 - ITC^{L,S}_{s,t} - ITC^{L,F}_{t} - (\tau^{E,S}_{s,t} + \tau^{E,F}_{s,t})TD_{s,t} \\ & + \left(1 - (\tau^{E,S}_{s,t} + \tau^{E,F}_{s,t})\right)PT_{s,t} \end{aligned},$$

$$PRICE_{s,t} = P^{I}_{mfg,t},$$

$$OPPCOST_{s,t} = \rho_{s,t} + \delta_{mfg,t},$$

where $ITC^{L,S}_{s,t}$ and $ITC^{L,F}_{t}$ are the legislated investment tax credit rates at the state and federal levels, respectively, $\tau^{E,S}_{s,t}$ and $\tau^{E,F}_{t}$ are the effective corporate income tax rates at the state and federal levels, respectively, $TD_{s,t}$ is the present value of tax depreciation allowances at the federal level, $PT_{s,t}$ is the present value of property tax payments at the state level, $P^{I}_{mfg,t}$ is the price deflator for investment in the manufacturing sector, $\rho_{s,t}$ is the financial cost of capital, and $\delta_{t}$ is the economic depreciation rate. The $P^{K}_{s,t}$ series and its eight components are stated at an annual rate and in continuous time. Four of the components have been discussed previously -- $\tau^{E,S}_{s,t}$, $\tau^{E,F}_{s,t}$, $P^{I}_{mfg,t}$, and $\delta_{mfg,t}$; the remaining four components are discussed in the following subsections. Note that the user cost of capital, which was introduced by JORGENSON in 1963 and extended by, among others, HALL-JORGENSON, GRAVELLE, JORGENSON-YUN, and KING-FULLERTON, equals $P^{K}_{s,t}$ divided by $P^{Y}_{s,t}$ (the latter discussed in Section 2).

### The Legislated Investment Tax Credit, State -- $ITC^{L,S}_{s,t}$

The state investment tax credit is a credit against state corporate income tax liabilities. In general, the effective amount of the investment tax credit is simply the legislated investment tax credit rate ( $ITC^{L,S}_{s,t}$ ) multiplied by the value of capital expenditures put into place within the state in a tax year. The effective rate is lower than the legislated rate in a handful of states for two reasons. First, five states (Connecticut, Idaho, Maine, North Carolina, and Ohio) permit the state investment tax credit to be applied only to equipment. Since equipment investment is approximately 85% of ASM total national investment, we multiply $ITC^{L,S}_{s,t}$ by 0.85 for these five states. Second, several states require basis adjustments deducting the amount of the credit from the asset basis for depreciation purposes; this adjustment is considered in the subsection on the Present Value of Tax Depreciation Allowances.

The $ITC^{L,S}_{s,t}$ series is obtained directly from states' online corporate tax forms and instructions. For most states with an investment tax credit, both current and historical credit rates are provided in the current year instructions (since companies applying for a credit based on some past year's investment apply that year's credit rate rather than the current rate). In those few cases where some or all historical rates were missing from the online forms and instructions, the missing rates are obtained via direct communication with the state's department of taxation. In some states, the legislated investment tax credit rate varies by the level of capital expenditures; we use the legislated credit rate for the highest tier of capital expenditures. Our database presents $ITC^{L,S}_{s,t}$ in percentage points.

**The Legislated Investment Tax Credit Rate, Federal -- $ITC^{L,F}_{t}$**

The federal investment tax credit enters the price of capital in a manner similar to that of $ITC^{S,F}_{s,t}$ and is a credit against federal corporate income tax liabilities. In general, the effective amount of the investment tax credit is simply the legislated investment tax credit rate ( $ITC^{L,F}_{t}$ ) multiplied by the value of capital expenditures put into place in a tax year. The effective credit rate is lower than the legislated credit rate because of basis adjustments specifying that the amount of the credit must be deducted from the asset basis for depreciation purposes; this adjustment is considered in the subsection on the Present Value of Tax Depreciation Allowances.

Legislated investment tax credit rates generally increase with asset lives (as determined by the tax authorities). Thus, the $ITC_t^{L,F}$ series is a weighted-average of the legislated investment tax credit rates by equipment+software asset type ($ITC_{a,t}^{L,F}$),

$$ITC_t^{L,F} = \sum_{a=1}^{22} \omega_{a,t}\ ITC_{a,t}^{L,F},$$

$$\omega_{a,t} = \frac{K_{a,t-1}^{CuC}}{\sum_{a=1}^{22} K_{a,t-1}^{CuC}},$$

where the weights are the ratio of the current-cost capital stock for asset *a* to the total over 22 nonresidential equipment assets. (Note that software assets, which are excluded from our measure of capital, are not included in the 22 nonresidential equipment assets used to compute the $\omega_{a,t}$ weights.) We thus assume that weights based on data for the nonresidential sector are appropriate for the manufacturing sector. Current-cost capital stocks are used in computing weights because the divisia-aggregated constant-cost capital stocks are not additive across components.

The $ITC_{a,t}^{L,F}$ series is obtained from GRAVELLE, Table B3. Our database presents $ITC_{a,t}^{L,F}$ in percentage points.

The $K_{a,t-1}^{CuC}$ series are obtained from FIXED, Table 2.1, lines 3 to 34. Our database presents $K_{a,t-1}^{CuC}$ in millions of dollars.

**The Present Value of Tax Depreciation Allowances -- $TD_{s,t}$**

Tax depreciation allowances accrue over the useful life of the asset. Since the pioneering work of Hall and Jorgenson, they have been modeled as a present value that depends on tax service lives, tax depreciation patterns, and discount rates. The present value of tax depreciation allowances is computed almost exclusively according to the rules prescribed by the federal tax authorities. The two exceptions incorporated into our computations occur with the states' treatment of bonus depreciation and state tax variables in the financial cost of capital. Similar to investment tax credits, the present value of depreciation allowances effectively lowers the purchase price of investment.

The general formula for the present value of tax depreciation allowances ( $TD_t^{GENERAL}$ ) stated in continuous time for asset *a* in state *s* at time *t* is as follows,

$$TD_{a,s,t}^{GENERAL} = \left\{ \int_t^{\infty} e^{-\rho_{s,t}(v-t)} \; D_{a,t}^{GENERAL}[v-t] \, dv \right\} * \left(1 - BA_{s,t}\right),$$

where $\rho_{s,t}$ is the nominal discount rate equal to the financial cost of capital, and $D_{a,t}^{GENERAL}[v-t]$ is the general tax depreciation pattern that varies across assets and over time., and $BA_{s,t}$ represents basis adjustments to depreciable assets due to the state and federal investment tax credits.

The $BA_{s,t}$ series contains separate terms for state and federal basis adjustment rules. These rules effectively require firms to increase corporate taxable income by some percentage of the investment tax credit. This increase enters the price of capital by reducing the amount of the asset eligible for tax depreciation allowances and is specified as follows,

$$BA_{s,t} = \frac{\left(\tau_{s,t}^{E,S} * ITC_{s,t}^{L,S} * \psi_{s,t}^{S}\right) + \left(\tau_{s,t}^{E,F} * ITC_{t}^{L,F} * \psi_{t}^{F}\right)}{\left(\tau_{s,t}^{E,S} + \tau_{s,t}^{E,F}\right)},$$

where $\psi_{s,t}^{S}$ and $\psi_t^F$ are indicator variables equal to a non-zero value if a state or the federal government, respectively, require a basis adjustment, zero otherwise. When no basis adjustment is required, $BA_{s,t} = 0$ . Note that tax depreciation term enters the price of capital equation multiplied by $-(\tau_{s,t}^{E,S} + \tau_{s,t}^{E,F})$ . Consequently, the $BA_{s,t}$ variable is divided by $(\tau_{s,t}^{E,S} + \tau_{s,t}^{E,F})$ , and increases in $BA_{s,t}$ result in increases in the price of capital.

The $\psi^{S}_{s,t}$ series is obtained directly from states' online corporate tax forms and instructions.

The $\psi^{F}_{t}$ series is obtained from GRAVELLE, Table B3. It equals 1.0 in 1962 and 1963, 0.5 from 1982 to 1986, and 0.0 elsewhere.

The $\rho_{s,t}$ series is discussed in the next subsection. It is computed at an annual rate for a ten-year horizon. We use the period t value of $\rho_{s,t}$ in computing the period t present value of tax depreciation allowances, thus assuming static expectations for the discount rate used in this specific computation.

Tax depreciation patterns are assigned to specific assets by the federal tax code, and these assignments vary over time. Tax depreciation also depends on tax service lives ($TSL_{a,t}$) that vary across assets and over time. The federal tax code has utilized three tax depreciation patterns -- straight-line (SL), sum-of-the-years-digits (SYD), and $\varsigma$% declining-balance ($\varsigma$%DB), where $\varsigma$ is 150, 175, or 200,

$$D^{SL}_{a,t}[v-t] = \left(TSL_{a,t}\right)^{-1},$$

$$D^{SYD}_{a,t}[v-t] = \frac{2\left(TSL_{a,t} - (v-t)\right)}{\left(TSL_{a,t}\right)^{2}},$$

$$D^{\varsigma\%DB}_{a,t}[v-t] = e^{-(\varsigma / TSL_{a,t})(v-t)} \left(\varsigma / TSL_{a,t}\right),$$

where the above equations are evaluated for $v = \{t, TSL_{a,t}\}$. The formulas for these three tax depreciation patterns and their corresponding present values below are taken from HALL-JORGENSON, pp. 18-20. The $TSL_{a,t}$ series is obtained from GRAVELLE, Table B.2. Our database presents $TSL_{a,t}$ in years.

Owing to its exponential formulation, the third depreciation pattern has the quirk that 100% of the purchase cost will never be depreciated in finite time. Consequently, the tax code permits users of $\varsigma\%DB$ to switch to SL. The point at which the switch occurs will be that period when the tax depreciation deductions are equal for $\varsigma\%DB$ and SL; after this point, SL tax depreciation deductions will exceed those for $\varsigma\%DB$. This point is represented by v* = $TSL_{a,t}(1-\varsigma^{-1})$. We label this mixture of two depreciation patterns as $\varsigma\%DB + SL$.

Inserting the above formulas for tax depreciation patterns into the general formula for the present value of tax depreciation allowances and integrating, we obtain the following expressions for the present value of tax depreciation allowances for an asset depreciated according to SL, SYD, and $\varsigma$%DB+SL patterns, respectively,

$$TD^{SL}_{a,s,t} = \left\{ \left(\rho_{s,t}\ TSL_{a,t}\right)^{-1} \left(1 - e^{-\rho_{s,t}\ TSL_{a,t}}\right) \right\} * \left(1 - BA_{s,t}\right),$$

$$TD^{SYD}_{a,s,t} = \left\{ 2\left(\rho_{s,t}\ TSL_{a,t}\right)^{-1} \left(1 - \left(\frac{1 - e^{-\rho_{s,t}\ TSL_{a,t}}}{\rho_{s,t}\ TSL_{a,t}}\right)\right) \right\} * \left(1 - BA_{s,t}\right),$$

$$TD^{\%DB+SL}_{a,s,t} = \left\{ \begin{array}{l} \dfrac{(\varsigma / TSL_{a,t})}{\rho_{s,t} + (\varsigma / TSL_{a,t})} \left(1 - e^{-(\rho_{s,t} + (\varsigma / TSL_{a,t}))v*}\right) \\ + \dfrac{e^{-(\varsigma / TSL_{a,t})v*}}{\rho_{s,t}(TSL_{a,t} - v*)} \left(e^{-\rho_{s,t}\ v*} - e^{-\rho_{s,t}\ TSL_{a,t}}\right) \end{array} \right\} * \left(1 - BA_{s,t}\right).$$

For a given asset *a* in state *s* at time *t*, the present value of tax depreciation allowances will depend on one of five depreciation patterns -- SL, SYD, or a declining-balance pattern depending on one of the three values of $\varsigma$, 200%DB+SL, 175%DB+SL, or 150%DB+SL. We define an indicator variable ($\Omega^{p}_{a,s,t}$) that, for a given *a*, *s*, and *t*, takes the value of one for one of these tax depreciation patterns (represented by the superscript *p*) and zero for the remaining four tax depreciation patterns. The $\Omega^{p}_{a,s,t}$ series is obtained from GRAVELLE, Table B.4. The provisional measure of the present value of tax depreciation allowances ($TD^{\#}_{a,s,t}$) is computed as follows,

$$TD^{\#}_{a,s,t} = \sum_{p \in PATTERNS} TD^{p}_{a,s,t} \ \Omega^{p}_{a,s,t} ,$$

$$PATTERNS = \{SL,\ SYD,\ 200\%DB + SL,\ 175\%DB + SL,\ 150\%DB + SL\}.$$

Our database presents $TD^{\#}_{a,s,t}$ and the $TD^{p}_{a,s,t}$ in percentage points.

The $TD^{\#}_{a,s,t}$ series needs to be adjusted for the "bonus depreciation" legislation enacted in 2002 and 2003. (See CCHTB for details.) Under the Job Creation and Worker Assistance Act adopted in March 2002, qualifying property put in place after September 10, 2001 are permitted the following tax deductions: 30% of the investment can be expensed and the remaining 70% depreciated according to extant rules. Under the Jobs and Growth Tax Relief Reconciliation Act enacted in May 2003, the percentages are changed from 30/70 to 50/50 for qualifying property acquired after May 1, 2003 and before January 1, 2005. We assume that the 2002 legislation had no effect on 2001 capital formation and that the 2003 legislation affected capital formation decisions beginning April 1, 2003. Both the 2002 and 2003 Acts restricted "bonus depreciation" to assets with tax service lives of 20 years or less. We impose this restriction with an indicator variable ( $\kappa_{a,t}$ ) equal to one if the asset has a tax service life of 20 years or less, zero otherwise For 2002 and 2003, the second provisional measure of the present value of tax depreciation allowances ( $TD^{\#\#}_{a,s,t}$ ) is computed as follows,

$$TD^{\#\#}_{a,s,t} = TD^{\#}_{a,s,t} \qquad t = \{1960, ..., 2002\}$$

$$TD^{\#\#}_{a,s,t=2002} = \left(0.30 + 0.70 * TD^{\#}_{a,s,t=2002}\right) * \kappa_{a,t=2002} + TD^{\#}_{a,s,t=2002} * (1 - \kappa_{a,t=2002})$$

$$TD^{\#\#}_{a,s,t=2003} = \left[0.25 * \left(0.30 + 0.70 * TD^{\#\#}_{a,s,t=2003}\right) + 0.75\left(0.50 + 0.50 * TD^{\#\#}_{a,s,t=2003}\right)\right] * \kappa_{a,t=2003}$$
$$+ TD^{\#}_{a,s,t=2003} * (1 - \kappa_{a,t=2003})$$
$$= \left(0.45 + 0.55 * TD^{\#}_{a,s,t=2003}\right) * \kappa_{a,t=2003} + TD^{\#}_{a,s,t=2003} * (1 - \kappa_{a,t=2003})$$

The states' reaction to the two "bonus depreciation" pieces of federal legislation is highly varied among the states and necessitates an additional adjustment. Four cases need to be identified concerning the conformity of the state tax code to the 2002 and 2003 federal Acts,

1) Recognize both the 2002 and 2003 Acts;
2) Recognize only the 2002 Act;
3) Recognize only the 2003 Act;
4) Recognize neither the 2002 and 2003 Acts.

We impose these restriction with an indicator variable ( $\zeta_{s,t}$ ) equal to the following sets of values for the above four cases,

1) $\zeta_{s,t=2002} = 1,\ \zeta_{s,t=2003} = 1;$
2) $\zeta_{s,t=2002} = 1,\ \zeta_{s,t=2003} = 0;$
3) $\zeta_{s,t=2002} = 0,\ \zeta_{s,t=2003} = 1;$
4) $\zeta_{s,t=2002} = 0,\ \zeta_{s,t=2003} = 0;$

The $\zeta_{s,t}$ series is determined from the information in CCHTB, Table "Federal Conformity Summary." We define a third provisional measure of the present value of tax depreciation allowances ( $TD^{\#\#\#}_{a,s,t}$ ) that is based on, among other variables, the first provisional measure,

$$TD^{\#\#\#}_{a,s,t} = TD^{\#}_{a,s,t} \qquad t = \{1960,...,2002\}$$

$$TD^{\#\#\#}_{a,s,t=2002} = \left[\begin{array}{l}\left(0.30 + 0.70 * TD^{\#}_{a,s,t=2002}\right) * \zeta_{s,t=2002} \\ +\left(\tau^{E,F}_{s,t=2002} \big/ (\tau^{E,S}_{s,t=2002} + \tau^{E,F}_{s,t=2002})\right) TD^{\#}_{a,s,t=2002} * (1-\zeta_{s,t=2002})\end{array}\right] * \kappa_{a,t=2002}$$
$$+ \ TD^{\#}_{a,s,t=2002} * (1-\kappa_{a,t=2002})$$

$$TD^{\#\#\#}_{a,s,t=2002} = \left[\begin{array}{l}\left(0.45 + 0.55 * TD^{\#}_{a,s,t=2003}\right) * \zeta_{s,t=2003} \\ +\left(\tau^{E,F}_{s,t=2003} \big/ (\tau^{E,S}_{s,t=2003} + \tau^{E,F}_{s,t=2003})\right) TD^{\#}_{a,s,t=2003} * (1-\zeta_{s,t=2003})\end{array}\right] * \kappa_{a,t=2003}$$
$$+ \ TD^{\#}_{a,s,t=2003} * (1-\kappa_{a,t=2003})$$

where the object multiplying the $(1-\zeta_{s,t})$'s adjust for the nondeductibility of tax depreciation allowances against state taxes (recall that $TD_{s,t}$ is multiplied by $(\tau^{E,S}_{s,t} + \tau^{E,F}_{s,t})$ in the equation defining the price of capital at the beginning of this section).

Finally, the $TD_{s,t}$ series is constructed as a double weighted-average. First, we weight the 22 nonresidential equipment assets to compute the present value of tax depreciation allowances for total equipment. Second, we weight this equipment aggregate together with tax depreciation for manufacturing structures,

$$TD_{s,t} = \vartheta_{mfg,t}\left(\sum_{a=1}^{22} \omega_{a,t} \ TD^{\#\#\#}_{a,s,t}\right) + (1-\vartheta_{mfg,t})\, TD^{\#\#\#}_{mfgstr,s,t} \, ,$$

$$\omega_{a,t} = \frac{K^{CuC}_{a,t-1}}{\sum_{a=1}^{22} K^{CuC}_{a,t-1}} \, ,$$

$$\vartheta^{EQ}_{mfg,t} = \frac{K^{EQ,CuC}_{mfg,t}}{K^{EQ,CuC}_{mfg,t} + K^{ST,CuC}_{mfg,t}} \, ,$$

$$\vartheta^{ST}_{mfg,t} = \frac{K^{ST,CuC}_{mfg,t}}{K^{EQ,CuC}_{mfg,t} + K^{ST,CuC}_{mfg,t}},$$

where, as with the construction of $ITC^{L,F}_{s,t}$, one set of weights (the $\omega_{a,t}$'s) is the ratio of the current-cost capital stock for asset *a* to the total over 22 nonresidential equipment assets. The $K^{CuC}_{a,t-1}$ series was discussed in the preceding subsection (The Effective Investment Tax Credit Rate, Federal).

The second set of weights, $\vartheta^{EQ}_{mfg,t}$ and $\vartheta^{ST}_{mfg,t}$, is the ratio of the current-cost capital stock for equipment ($K^{EQ,CuC}_{mfg,t}$) and structures ($K^{ST,CuC}_{mfg,t}$), respectively, to the sum of equipment and structures; all assets are for the manufacturing sector.

The $K^{EQ,CuC}_{mfg,t}$ series is the product of the current-cost capital stock for equipment+software for the manufacturing sector ($K^{EQ+SO,CuC}_{mfg,t}$) and an adjustment for the software assets that need to be removed from the $K^{EQ+SO,CuC}_{mfg,t}$ series,

$$K^{EQ,CuC}_{mfg,t} = K^{EQ+SO,CuC}_{mfg,t} * (1 - \chi^K_t),$$

$$\chi^K_t = \frac{K^{SO,CuC}_{nonres,t}}{K^{EQ+SO,CuC}_{nonres,t}},$$

where the adjustment factor ($\chi^K_t$) is the ratio of the current-cost capital stock for software in the nonresidential sector ($K^{SO,CuC}_{nonres,t}$) to the total current-cost capital stock for equipment+software in the nonresidential sector ( $K^{EQ+SO,CuC}_{nonres,t}$ ).[4] The $K^{EQ+SO,CuC}_{mfg,t}$ series is obtained from FIXED, Table 4.1, line 8. The $K^{SO,CuC}_{nonres,t}$ series is obtained from FIXED, Table 2.1, line 6. The $K^{EQ+SO,CuC}_{nonres,t}$ series is obtained from FIXED, Table 2.1, line 3. Our database presents $K^{EQ+SO,CuC}_{mfg,t}$, $K^{SO,CuC}_{nonres,t}$, and $K^{EQ+SO,CuC}_{nonres,t}$ in millions of dollars.

The $K^{ST}_{mfg,t}$ series is obtained from FIXED, Table 4.1, line 9. Our database presents $K^{ST}_{mfg,t}$ in millions of dollars and $TD_{s,t}$ and the $TD^{\#\#\#}_{a,s,t}$ in percentage points.

**The Present Value Of Property Tax Payments -- $\mathbf{PT_{s,t}}$**

The formula for the present value of property tax payments ( $PT_{s,t}$ ) is conceptually similar to the one for the present value of tax depreciation allowances. Both involve a stream of commitments that follow upon purchasing an asset. In the case of property taxes, this stream involves tax payments beginning in period t and extending into the indefinite future based on the remaining value of the asset.

The $PT_{s,t}$ series is constructed according to the following formula stated in continuous time,

$$PT_{s,t} = \int_t^{\infty} e^{-(\rho_{s,t} + \delta_{mfg,t})(v-t)} \; ptr_{s,t} \; dv ,$$

where $\rho_{s,t}$ is the nominal discount rate equal to the financial cost of capital, $\delta_{mfg,t}$ is the rate of economic depreciation for the manufacturing sector, and $ptr_{s,t}$ is the effective property tax rate on commercial and industrial (C&I) property, which varies across states and over time. Conceptually, the variable $ptr_{s,t}$ equals C&I property taxes paid to the state and all its localities

---

[4] The $K^{SO,CuC}_{nonres,t}$ series excludes software embedded or bundled in computers and other equipment and, hence, $\chi^K_t$ does not provide a complete adjustment for removing software assets from $K^{EQ+SO,CuC}_{mfg,t}$.

divided by the market value of C&I property. Data on market value generally is not available though data is available on assessed value ($AV_{s,t}$) and the ratio of assessed value to market value ($RATIO_{s,t}$). Thus, it is useful to express $ptr_{s,t}$ as,

$$ptr_{s,t} = \left(PTREV_{s,t}/AV_{s,t}\right)RATIO_{s,t},$$

where $PTREV_{s,t}$ is property tax revenues of state and local governments within state *s*.

We use the period t values of $\rho_{s,t}$ and $ptr_{s,t}$ in computing the period t present value of property tax payments, thus assuming static expectations for the discount and property tax rates used in this specific computation. We further assume that the assessed market value depreciates over time at rate $\delta_{mfg,t}$. The above equation can be integrated to obtain the following expression for the present value of property tax payments, which is similar to an annuity,

$$PT_{s,t} = ptr_{s,t} \ / \ (\rho_{s,t} + \delta_{mfg,t}) = ptr_{s,t} \ / \ OPPCOST_{s,t}.$$

The series for $PTREV_{s,t}$, $AV_{s,t}$, and $RATIO_{s,t}$ are obtained from the Census of Governments (CG). Note that while our data for $RATIO_{s,t}$ are specific to C&I property, the data for $PTREV_{s,t}$ and $AV_{s,t}$ are for all property. We are thus assuming that the mill rate, ($PTREV_{s,t}/AV_{s,t}$), for C&I property is approximately equal to the overall mill rate. CG provides data on PTREV for years 1961, 1966, 1971, 1976, 1981, 1986, 1991, 1996, and 2001; data for other years in the range 1961-2004 are filled in via linear interpolation (through 2000) or extrapolation (2002-2004). CG provides data on AV for years 1961, 1966, 1971, 1976, 1981, 1986, and 1991; data for other years in the range 1961-2004 are filled in via linear interpolation (through 1990) or extrapolation (1992-2004). CG data on $RATIO_{s,t}$ is unavailable after 1981. Hence, we simply leave $RATIO_{s,t}$ constant from 1982-2004 at the 1981 value. Our database presents $ptr_{s,t}$ in percentage points.

## The Financial Cost Of Capital -- $\rho_{s,t}$

The financial cost of capital is the real discount rate applied to cash flows accruing over a long horizon and is defined as a weighted-average of the nominal costs of debt and equity less expected inflation,[5]

$$\rho_{s,t} = r_t^{DEBT} * \left(1 - (\tau_{s,t}^{E,S} + \tau_{s,t}^{E,F})\right) * LEV_t + r_t^{EQUITY} * (1 - LEV_t) - \pi_t^{e,10},$$

where $r_t^{DEBT}$ is the nominal cost of debt, $\tau_{s,t}^{E,S}$ and $\tau_{s,t}^{E,F}$ are the effective corporate income tax rates at the state and federal levels, respectively, $LEV_t$ is the leverage ratio, $r_t^{EQUITY}$ is the nominal cost of risk-adjusted equity, and $\pi_t^{e,10}$ is the expected inflation rate over a 10-year horizon. An important advantage of this definition is that the three key rates -- $r_t^{DEBT}$, $r_t^{EQUITY}$, and $\pi_t^{e,10}$ -- are each measured over long horizons. Note that the nominal cost of debt is lowered by the tax deductibility of interest payments both at the federal and state level. The $\tau_{s,t}^{E,S}$ and $\tau_{s,t}^{E,F}$ series were discussed in Section 2. The remaining four series are each discussed below.

The $r_t^{DEBT}$ series is the nominal cost of debt and equals the nominal corporate bond rate (Moody's seasoned Baa corporate bond yield). This series is obtained from ERP, Table B-73 (the underlying data source is the H15 Federal Reserve Statistical Release). Our database presents $r_t^{DEBT}$ in percentage points.

The $LEV_t$ series is the leverage ratio and equals the ratio of nominal liabilities to the sum of nominal liabilities and nominal assets, all at historical costs for the nonfarm nonfinancial corporate business sector. This series is obtained from FOF, Table B102, lines 21 and 39. Our database presents $LEV_t$ in percentage points.

---

[5] The weighted-average specification is appropriate for investments that do not change the overall level of business risk; that is, the marginal investment is financed with the same proportions of debt and equity as the average investment.. Alternatively, the marginal source of finance may be modeled as only debt or only equity by setting $LEV_t$ equal to one or zero, respectively.

The $r_t^{EQUITY}$ series is the nominal cost of risk-adjusted equity measured by the CAPM as the sum of a risk-free rate and an equity risk premium,

$$r_t^{EQUITY} = r_t^{RISKFREE} + \beta_{mfg} * \left(\mu^{MARKET} - \mu^{RISKFREE}\right),$$

where $r_t^{RISKFREE}$ is the risk-free rate measured over a long horizon, $\beta_{mfg}$ is the CAPM parameter that captures the sensitivity of the equity return to the market return, $\mu^{MARKET}$ is the average return on the market portfolio, and $\mu^{RISKFREE}$ is the average return on the risk-free asset.

The $r_t^{RISKFREE}$ series is the rate on 10 year U.S. Treasury securities (constant maturity) and is obtained from ERP, Table B-73 (the underlying data source is the H15 Federal Reserve Statistical Release). Our database presents $r_t^{RISKFREE}$ in percentage points.

The $\beta_{mfg}$ parameter is the $\beta$ for the Fidelity Select Cyclical Industries Portfolio and equals 1.45. This parameter is obtained from the "Volatility Measures" section at the following URL: http://personal.fidelity.com/products/funds/mfl_frame.shtml?316390517.

The $\mu^{MARKET}$ parameter is the average total return on the market portfolio from 1960-2003, where the market portfolio is the value-weighted CRSP index (including dividends). The CRSP index is obtained from WRDS. Our database presents $\mu^{MARKET}$ in percentage points.

The $\mu^{RISKFREE}$ parameter is the average total return on $r_t^{RISKFREE}$ from 1960-2003. This series was discussed earlier in this section. Our database presents $\mu^{RISKFREE}$ in percentage points.

The $\pi_t^{e,10}$ series is an extrapolation and interpolation of inflation expectations data from the Livingston Survey for a 10-year horizon. The econometric specification is an autoregressive model of inflation with a shifting endpoint, which is a particular case of an unobserved components model. See KOZTIN for details. This series is obtained from KOZTIN. Our database presents $\pi_t^{e,10}$ in percentage points.

The KOZTIN series is based on the inflation rate of the consumer price index (CPI), while the formal derivation of the price of capital indicates that the inflation rate of $P^{I}_{mfg,t}$ is to be used. The KOZTIN data are conceptually correct for defining the price of capital if the substantial relative declines in a few equipment assets were unexpected and the two price series are stationary. On the other hand, if part of the relative declines were anticipated, then an adjustment will be useful. No expectation data exist for the $P^{I}_{mfg,t}$ series. We correct for the discrepancy between inflation rates based on the CPI and $P^{I}_{mfg,t}$ by adjusting the financial cost of capital by subtracting the mean of CPI inflation (0.045006) less the mean of $P^{I}_{mfg,t}$ inflation, where the means are computed for the period 1963-2004.

## 5. NUMBER OF MANUFACTURING ESTABLISHMENTS -- $\mathbf{NE^{5}_{s,t}}$ and $\mathbf{NE^{C}_{s,t}}$

The number of manufacturing establishments is measured by two distinct variables that have relative strengths and weaknesses.

The $NE^{5}_{s,t}$ series is obtained from the Census of Manufacturers (CM; e.g., for 2002, the data are published in Table 6). This publication contains data for a long span, but the data are generally reported only every five years. Specifically, data are available in 1963 and then every five years beginning in 1967 and ending in 2002. In our database, $NE^{5}_{s,t}$ is presented as the number of establishments. This series has not been used in this version of the paper.

The $NE^{C}_{s,t}$ series is obtained from County Business Patterns (CBP; e.g., for 2004, the data are published in row, NAICS=”31-----“, column “est”). The coverage of the CBP begins in 1988, but it has the advantage of being available continuously through 2004. In our database, $NE^{C}_{s,t}$ is presented in numbers of establishments.

# 6. LEGEND[6]

| | |
|---|---|
| ASM: | CENSUS, *Annual Survey of Manufactures, Complete Volume* (Various Years). |
| ASM-GAS: | CENSUS, *Annual Survey of Manufacturers, Geographic Area Statistics* (Various Years). Publications for the years 1994 to 2004 (except 1997 and 2002) are available online. These data are published on an establishment basis. The data are obtained from electronic or paper documents depending on the time period: 2004 (Census website); 2003 to 1972 (CD's purchased from Census); 1971 to 1963 (paper copies). URL: http://www.census.gov/mcd/asm-as3.html. |
| ASM-SIGI: | CENSUS, *Annual Survey of Manufacturers, Statistics for Industry Groups and Industries* (1996). URL: http://www.census.gov/mcd/asm-as1.html. |
| BEA: | Bureau of Economic Analysis, U.S. Department of Commerce. URL: http://www.bea.gov. |
| BLS: | Bureau of Labor Statistics, U.S. Department of Labor. URL: http://www.bls.gov. |
| BOP: | Beginning-Of-Period t. |
| BOTS: | The Council of State Governments, *The Book of the States* (The Council of State Governments : Lexington, Kentucky, Various Issues). |
| CCHTB: | CCH Tax Briefing: *Corporate Income Tax and 'Bonus' Depreciation Special Report* (December 4, 2003). URL: http://tax.cchgroup.com/Tax-Briefings/2003-Corporate-Tax-Bonus-Depreciation.pdf. |
| CENSUS: | Bureau of the Census, U.S. Department of Commerce. URL: http://www.census.gov. |
| CG: | Census of Governments, Volume 2 (Various Years). |
| CM: | CENSUS, *Census of Manufacturers* (Various Years). Publications for 1997 and 2002 are available online. URL for the 2002 edition: http://www.census.gov/prod/ec02/ec0231sg1t.pdf. |

[6] In describing the raw data, some of the text in this paper has been taken directly from government publications.

CPB: CENSUS, *County Business Patterns.* URL: http://www.census.gov/epcd/cbp/download/cbpdownload.html.

DETAILED: BEA, Detailed Fixed Assets Tables, Nonresidential Investment, Historical-Cost. URL: http://www.bea.gov/bea/dn/FA2004/Details/xls/detailnonres_inv1.xls

EOP: End-Of-Period t.

ERP: Council of Economic Advisers, *Economic Report of the President* (Washington: U.S. Government Printing Office, 2006).

FIXED: BEA, *Standard Fixed Asset Tables.* URL: http://www.bea.gov/bea/dn/FA2004/SelectTable.asp.

FOF: Board of Governors of the Federal Reserve System, *Flow of Funds Accounts of the United States* (Washington: Board of Governors of the Federal Reserve System, various issues). URL: http://www.federalreserve.gov/releases/Z1/Current/annuals/a1995-2005.pdf.

GRAVELLE: Gravelle, Jane G., *The Economic Effects of Taxing Capital Income* (Cambridge: MIT Press, 1994) plus updates kindly provided by Jane Gravelle.

HALL-JORGENSON: Hall, Robert E., and Jorgenson, Dale W., "Application of the Theory of Optimum Capital Accumulation," in Gary Fromm (ed.), *Tax Incentives and Capital Spending* (Washington: Brookings Institution, 1971), 9-60.

INDUSTRY: BEA, *Gross-Domestic-Product-by-Industry Accounts*. URL: http://www.bea.gov/bea/industry/gpotables.

JORGENSON: Jorgenson, Dale W., "Capital Theory and Investment Behavior," *American Economic Review* 53 (May 1963), 247-259; reprinted in *Investment, Volume 1: Capital Theory and Investment Behavior* (Cambridge: MIT Press, 1996), 1-16.

JORGENSON-YUN: Jorgenson, Dale W., and Yun, Kun-Young, *Investment Volume 3: Lifting the Burden: Tax Reform, the Cost of Capital, and U.S. Economic Growth* (Cambridge: MIT Press, 2001).

KING-FULLERTON: King, Mervyn A., and Fullerton, Don (eds.), *The Taxation of Income from Capital* (Chicago: University of Chicago Press (for the NBER), 1984).

KOZTIN: Kozicki, Sharon, and Tinsley, P.A., "Survey-Based Estimates of the Term Structure of Expected U.S. Inflation," Bank of Canada (May 2006). The $\pi_t^{e,10}$ series is presented in Figure 7 as "Shifting endpoint." The data have been kindly provided by Sharon Kozicki.

NIPA: BEA, *National Income and Product Accounts Tables*. URL: http://www.bea.gov/bea/dn/nipaweb/SelectTable.asp?Selected=N.

PPI: BLS, *BLS Handbook of Methods*, Chapter 14 Producer Prices. URL: http://www.bls.gov/opub/hom/pdf/homch14.pdf.

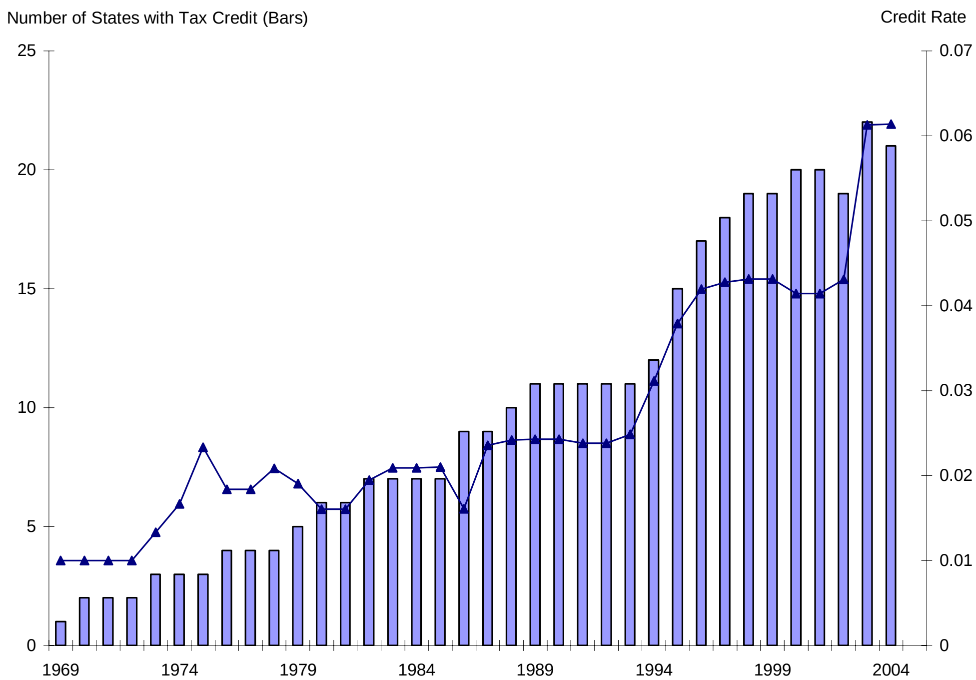
REA: BEA, *Regional Economic Accounts: Gross State Product*. URL: http://www.bea.gov/bea/regional/gsp/default.cfm?series=SIC.

SFFF: American Council on Intergovernmental Affairs, *Significant Features of Fiscal Federalism* (Washington, DC: American Council on Intergovernmental Affairs, Various Issues). URL (e.g., 1987): http://www.library.unt.edu/gpo/ACIR/SFFF/SFFF-1988-Vol-1.pdf.

STH: Commerce Clearing House, *State Tax Handbook* (Chicago: Commerce Clearing House, Various Issues).

TAXFDN: Tax Foundation web site. URL: http://www.taxfoundation.org.

**Figure 1: State Investment Tax Credits:**
**Number of States with a Credit (left vertical axis) and**
**Average Credit Rate (right vertical axis)**
**1969 to 2004**




Notes: Counted investment tax credits (ITCs) include only general, statewide ITCs. Excluded are ITCs targetted at specific geographic zones ("Enterprise" zones) or at specific industries.
Data Source: Authors' calculations based on state corporate tax forms.

**Figure 2. Coefficients on ANTIBUSINESS$_{t-5}$, by year**
**Dependent Variable: 5-year symmetric growth in establishment count**
Dashed lines represent 95% C.I.

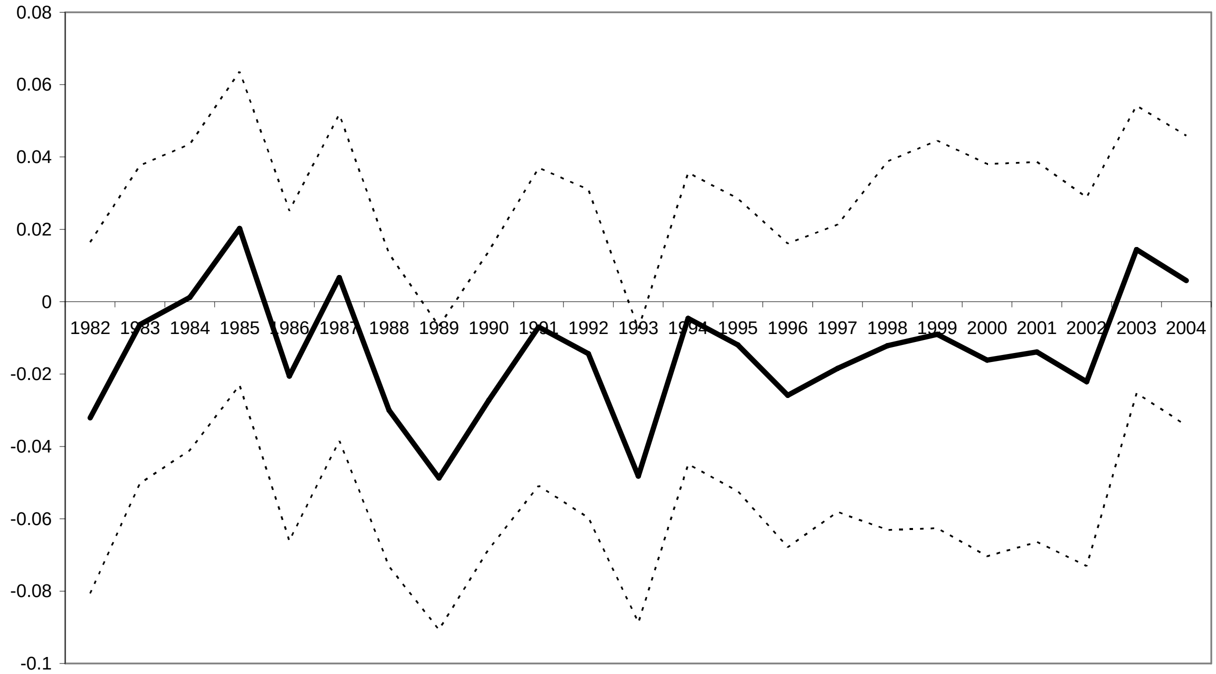


**Figure 3. Coefficients on ln($RUC_{t-5}$), by year**
**Dependent Variable: 5-year symmetric growth in establishment count**
Dashed lines represent 95% C.I.

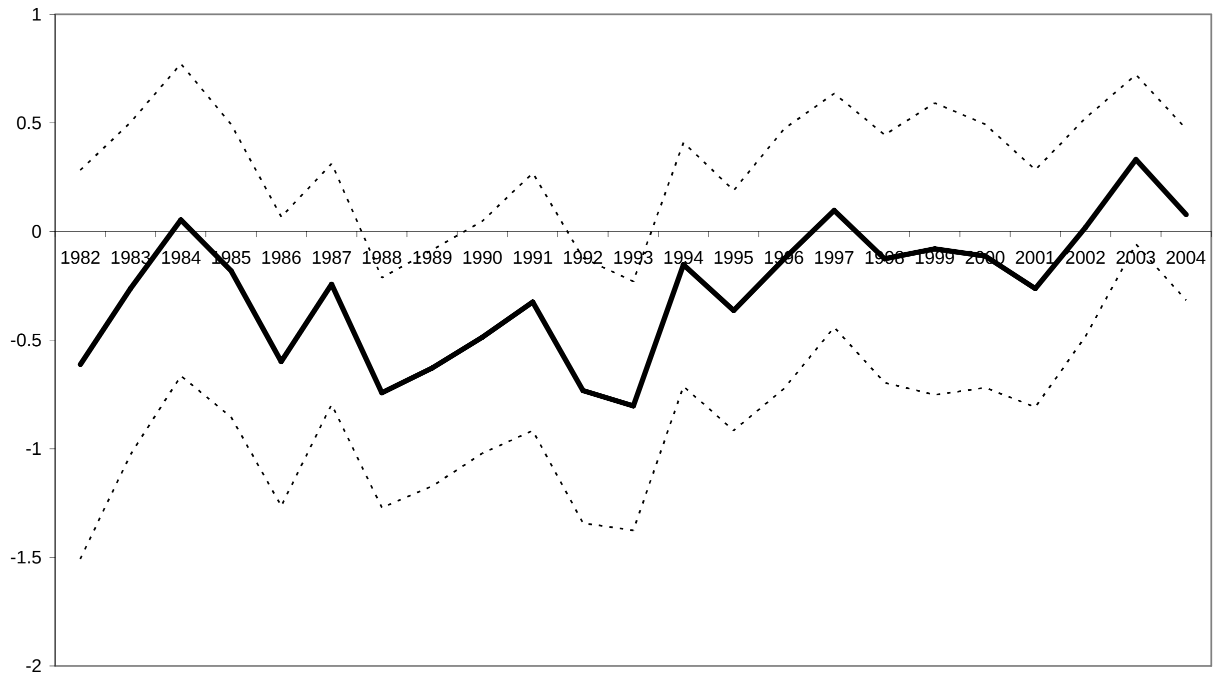


**Figure 4: Policy Coefficient vs. Maximum Area of County Pairs**
(Dashed lines represent 95% C.I.)

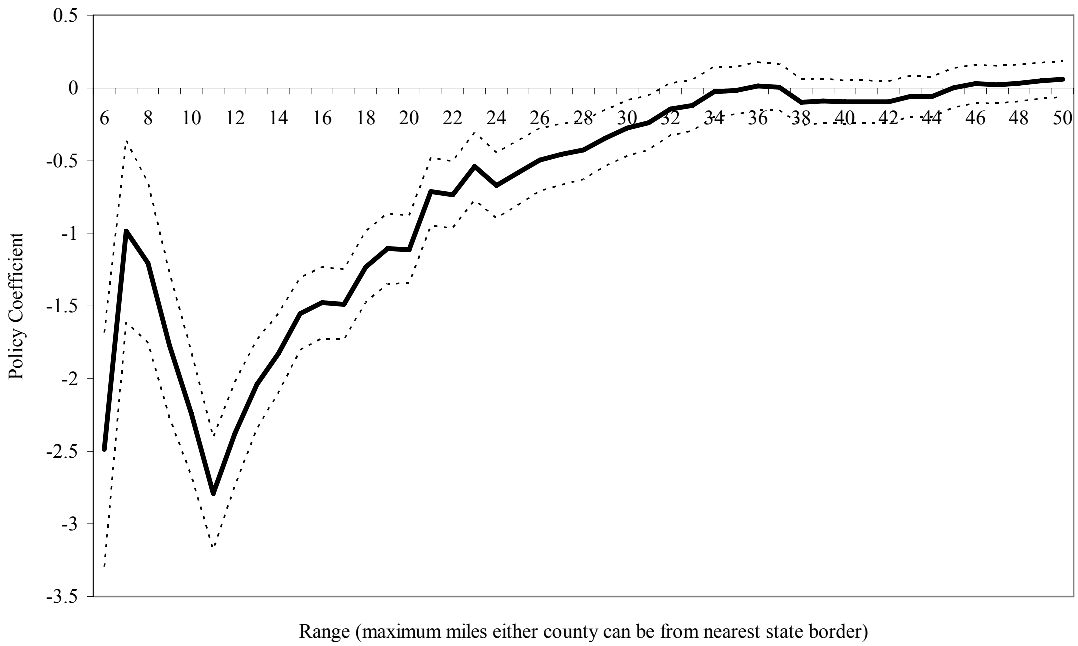


**Table 1: Summary Statistics**

| | **Mean** | **Median** | **Standard Deviation** |
|---|---|---|---|
| | (1) | (2) | (3) |
| $\mathbf{K_{s,t}}$ | 23.455 | 15.840 | 24.922 |
| $\mathbf{ky_{s,t}}$ | -0.1689064 | -0.2294005 | 0.3917745 |
| $\mathbf{ne_{s,t}}$ | 8.378678 | 8.389679 | 1.06763 |
| $\mathbf{NE_{s,t}}$ | 7373.593 | 4401.5 | 8446.357 |
| $\mathbf{ne_{s,t} - ne_{s,t-1}}$ | -0.0002165 | 0.0008819 | 0.0402581 |
| $\mathbf{ne_{s,t} - ne_{s,t-5}}$ | -0.0197284 | -0.0276184 | 0.3490982 |
| $\mathbf{ruc_{s,t}}$ **(5)** | 0.0012294 | -0.0010721 | 0.0471765 |
| $\mathbf{uc_{s,t}^{own}}$ | -1.344153 | -1.350197 | 0.0583867 |
| $\mathbf{UC_{s,t}^{own}}$ | 0.2612248 | 0.2591891 | 0.0164987 |
| $\mathbf{uc_{s,t}^{comp(5)}}$ | -1.345383 | -1.349204 | 0.0408578 |
| $\mathbf{UC_{s,t}^{comp(5)}}$ | .2606596 | 0.2594466 | 0.0108302 |
| $\mathbf{Y_{s,t}}$ | 29.909 | 19.002 | 33.792 |
| $\mathbf{\nabla^{10} ne_{p,t}}$ | 0.0074507 | 0 | 0.5328515 |
| $\mathbf{\nabla^{25} ne_{p,t}}$ | -0.0380803 | -0.0421597 | 0.5064236 |
| $\mathbf{\nabla^{10} uc_{p,t}}$ | -0.0017301 | -0.0015695 | 0.0446362 |
| $\mathbf{\nabla^{25} uc_{p,t}}$ | 0.0017084 | 0.0007373 | 0.0445739 |
| **N** | 1050 | 1050 | 1050 |

**Notes to Table 1:**
Variables are defined in the tables below. The standard deviations are computed with state or county fixed effects removed by subtracting time-series means. The $K_{s,t}$ and $Y_{s,t}$ series are in billions of 2000 dollars.

**Table 2: Capital Demand Model. Equation (6a) with Various Lags**
**Dependent Variable: Logarithm of the Capital/Output Ratio**

**A. Competitive User Cost for the Closest Five States**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **$ruc_{s,t}$** | 0.321 | -0.972 | 0.431 | -0.684 | 0.081 | -0.780 | 0.410 | -0.462 | 0.049 | -0.788 | 0.341 | -0.484 |
| | (0.215) | (0.271) | (0.179) | (0.119) | (0.629) | (0.489) | (0.541) | (0.249) | (0.635) | (0.491) | (0.564) | (0.250) |
| | | | | | | | | | | | | |
| **$ruc_{s,t-1}$** | ----- | ----- | ----- | ----- | 0.288 | -0.272 | 0.025 | -0.315 | 0.552 | -0.173 | 0.609 | -0.043 |
| | ----- | ----- | ----- | ----- | (0.738) | (0.665) | (0.628) | (0.314) | (1.043) | (0.866) | (0.976) | (0.393) |
| | | | | | | | | | | | | |
| **$ruc_{s,t-2}$** | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | -0.256 | -0.113 | -0.566 | -0.309 |
| | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | (0.847) | (0.707) | (0.753) | (0.308) |
| | | | | | | | | | | | | |
| **$\Omega$** | **0.321** | **-0.972** | **0.431** | **-0.684** | **0.369** | **-1.053** | **0.435** | **-0.777** | **0.346** | **-1.074** | **0.384** | **-0.836** |
| | **(0.215)** | **(0.271)** | **(0.179)** | **(0.119)** | **(0.252)** | **(0.371)** | **(0.213)** | **(0.156)** | **(0.275)** | **(0.407)** | **(0.228)** | **(0.169)** |
| | | | | | | | | | | | | |
| **State** | No | Yes | No | Yes | No | Yes | No | Yes | No | Yes | No | Yes |
| **Time** | No | No | Yes | Yes | No | No | Yes | Yes | No | No | Yes | Yes |
| | | | | | | | | | | | | |
| **$R^2$** | 0.002 | 0.002 | 0.397 | 0.374 | 0.002 | 0.002 | 0.397 | 0.372 | 0.002 | 0.002 | 0.397 | 0.371 |
| **N** | 1050 | 1050 | 1050 | 1050 | 1050 | 1050 | 1050 | 1050 | 1050 | 1050 | 1050 | 1050 |

**Table 2: Capital Demand Model. Equation (6a) with Various Lags**
**(cont.) Dependent Variable: Logarithm of the Capital/Output Ratio**

**B. Competitive User Cost for the Closest Ten States**

| | (1) | (2) | (3) | (4) | | (5) | (6) | (7) | (8) | | (9) | (10) | (11) | (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **$ruc_{s,t}$** | 0.316 | -1.002 | 0.404 | -0.767 | | 0.356 | -0.813 | 0.767 | -0.401 | | 0.292 | -0.817 | 0.663 | -0.425 |
| | (0.219) | (0.277) | (0.178) | (0.120) | | (0.711) | (0.498) | (0.594) | (0.256) | | (0.725) | (0.500) | (0.628) | (0.257) |
| | | | | | | | | | | | | | | |
| **$ruc_{s,t-1}$** | ----- | ----- | ----- | ----- | | -0.048 | -0.265 | -0.431 | -0.511 | | 0.475 | -0.215 | 0.427 | -0.220 |
| | ----- | ----- | ----- | ----- | | (0.817) | (0.690) | (0.678) | (0.331) | | (1.097) | (0.922) | (1.017) | (0.414) |
| | | | | | | | | | | | | | | |
| **$ruc_{s,t-2}$** | ----- | ----- | ----- | ----- | | ----- | ----- | ----- | ----- | | -0.502 | -0.056 | -0.826 | -0.327 |
| | ----- | ----- | ----- | ----- | | ----- | ----- | ----- | ----- | | (0.890) | (0.752) | (0.789) | (0.326) |
| | | | | | | | | | | | | | | |
| **Ω** | **0.316** | **-1.002** | **0.404** | **-0.767** | | **0.308** | **-1.077** | **0.336** | **-0.912** | | **0.264** | **-1.088** | **0.265** | **-0.972** |
| | **(0.219)** | **(0.277)** | **(0.178)** | **(0.120)** | | **(0.259)** | **(0.384)** | **(0.218)** | **(0.161)** | | **(0.283)** | **(0.420)** | **(0.234)** | **(0.175)** |
| | | | | | | | | | | | | | | |
| **State** | No | Yes | No | Yes | | No | Yes | No | Yes | | No | Yes | No | Yes |
| **Time** | No | No | Yes | Yes | | No | No | Yes | Yes | | No | No | Yes | Yes |
| | | | | | | | | | | | | | | |
| **$R^2$** | 0.002 | 0.002 | 0.397 | 0.372 | | 0.002 | 0.002 | 0.397 | 0.369 | | 0.002 | 0.002 | 0.397 | 0.369 |
| **N** | 1050 | 1050 | 1050 | 1050 | | 1050 | 1050 | 1050 | 1050 | | 1050 | 1050 | 1050 | 1050 |

**Table 2: Capital Demand Model. Equation (6a) with Various Lags**
**(cont.) Dependent Variable: Logarithm of the Capital/Output Ratio**

**C. Competitive User Cost for All States**

| | (1) | (2) | (3) | (4) | | (5) | (6) | (7) | (8) | | (9) | (10) | (11) | (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **$ruc_{s,t}$** | -0.102 | -1.109 | -0.002 | -0.827 | | 1.083 | -0.677 | 1.401 | -0.381 | | 0.836 | -0.702 | 1.120 | -0.414 |
| | (0.184) | (0.226) | (0.159) | (0.125) | | (0.672) | (0.486) | (0.558) | (0.251) | | (0.738) | (0.492) | (0.625) | (0.250) |
| | | | | | | | | | | | | | | |
| **$ruc_{s,t-1}$** | ----- | ----- | ----- | ----- | | -1.387 | -0.605 | -1.643 | -0.623 | | 0.268 | -0.355 | 0.248 | -0.295 |
| | ----- | ----- | ----- | ----- | | (0.770) | (0.708) | (0.637) | (0.332) | | (1.105) | (0.952) | (1.046) | (0.418) |
| | | | | | | | | | | | | | | |
| **$ruc_{s,t-2}$** | ----- | ----- | ----- | ----- | | ----- | ----- | ----- | ----- | | -1.523 | -0.274 | -1.741 | -0.360 |
| | ----- | ----- | ----- | ----- | | ----- | ----- | ----- | ----- | | (0.871) | (0.784) | (0.803) | (0.332) |
| | | | | | | | | | | | | | | |
| **$\Omega$** | **-0.102** | **-1.109** | **-0.002** | **-0.827** | | **-0.304** | **-1.282** | **-0.241** | **-1.004** | | **-0.419** | **-1.331** | **-0.372** | **-1.069** |
| | **(0.184)** | **(0.226)** | **(0.159)** | **(0.125)** | | **(0.244)** | **(0.390)** | **(0.200)** | **(0.163)** | | **(0.263)** | **(0.430)** | **(0.211)** | **(0.179)** |
| | | | | | | | | | | | | | | |
| **State** | No | Yes | No | Yes | | No | Yes | No | Yes | | No | Yes | No | Yes |
| **Time** | No | No | Yes | Yes | | No | No | Yes | Yes | | No | No | Yes | Yes |
| | | | | | | | | | | | | | | |
| **$R^2$** | 0.000 | 0.000 | 0.394 | 0.381 | | 0.002 | 0.000 | 0.397 | 0.380 | | 0.004 | 0.001 | 0.399 | 0.380 |
| **N** | 1050 | 1050 | 1050 | 1050 | | 1050 | 1050 | 1050 | 1050 | | 1050 | 1050 | 1050 | 1050 |

**Notes to Table 2:**
OLS estimates are based on panel data for 50 states for the period 1983 to 2004. Estimates are based on equation (6a). The dependent variable is the logarithm of the capital/output ratio ($ky_{s,t}$). The independent variable is the logarithm of the user cost for state s ($uc_{s,t}^{own}$) less the logarithm of the user cost for competitive states ($uc_{s,t}^{comp}$). The level of the latter variable is formed as a weighted-average of user costs across competitive sets of states, where the weights are the inverse distance between state centroids. The competitive set is defined as either the five closest states (panel A), the ten closest states (panel B), or all states (panel C). See Section 2 and the appendix for further details about data sources and construction. The models in columns (2), (4), (6), (8), (10), and (12) contain state fixed effects (when state fixed effects are absent, a constant term is included); the models in columns (3), (4), (7), (8), (11) and (12) contain time fixed effects. The Ω parameter is the summation of the immediately preceding point estimate(s). Standard errors are heteroscedastic consistent using the technique of White (1980); the standard error for Ω is the sum of the underlying variances and covariances raised to the one-half. The $R^2$ measures the amount of overall explained variation. N is the number of state/year observations.

**Table 3: Capital Demand Model: Equations (6a) and (7) with Two Lags**
**Dependent Variable: Logarithm of the Capital/Output Ratio**

| | Closest Five States | | | Closest Ten States | | | All States | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | | (3) | (4) | | (5) | (6) |
| $\mathbf{ruc_{s,t}}$ | -0.484 | ----- | | -0.425 | ----- | | -0.414 | ----- |
| | (0.250) | ----- | | (0.257) | ----- | | (0.250) | ----- |
| | | | | | | | | |
| $\mathbf{ruc_{s,t-1}}$ | -0.043 | ----- | | -0.220 | ----- | | -0.295 | ----- |
| | (0.393) | ----- | | (0.414) | ----- | | (0.418) | ----- |
| | | | | | | | | |
| $\mathbf{ruc_{s,t-2}}$ | -0.309 | ----- | | -0.327 | ----- | | -0.360 | ----- |
| | (0.308) | ----- | | (0.326) | ----- | | (0.332) | ----- |
| | | | | | | | | |
| $\Omega$ | **-0.836** | ----- | | **-0.972** | ----- | | **-1.069** | ----- |
| | **(0.169)** | **-----** | | **(0.175)** | **-----** | | **(0.179)** | ----- |
| | | | | | | | | |
| $\mathbf{uc^{own}_{s,t}}$ | ----- | -0.413 | | ----- | -0.396 | | ----- | -0.447 |
| | ----- | (0.325) | | ----- | (0.325) | | ----- | (0.327) |
| | | | | | | | | |
| $\mathbf{uc^{own}_{s,t-1}}$ | ----- | -0.291 | | ----- | -0.277 | | ----- | -0.270 |
| | ----- | (0.582) | | ----- | (0.583) | | ----- | (0.589) |
| | | | | | | | | |
| $\mathbf{uc^{own}_{s,t-2}}$ | ----- | -0.376 | | ----- | -0.424 | | ----- | -0.365 |
| | ----- | (0.451) | | ----- | (0.452) | | ----- | (0.452) |
| | | | | | | | | |
| $\Omega^{own}$ | ----- | **-1.079** | | ----- | **-1.097** | | ----- | **-1.081** |
| | ----- | **(0.198)** | | ----- | **(0.196)** | | ----- | **(0.195)** |
| | | | | | | | | |
| $\mathbf{uc^{comp}_{s,t}}$ | ----- | -0.181 | | ----- | -1.254 | | ----- | -4.238 |
| | ----- | (0.777) | | ----- | (1.179) | | ----- | (3.122) |
| | | | | | | | | |
| $\mathbf{uc^{comp}_{s,t-1}}$ | ----- | -1.184 | | ----- | -0.276 | | ----- | 0.199 |
| | ----- | (1.301) | | ----- | (1.900) | | ----- | (5.070) |
| | | | | | | | | |
| $\mathbf{uc^{comp}_{s,t-2}}$ | ----- | 0.429 | | ----- | 0.381 | | ----- | 1.142 |
| | ----- | (0.959) | | ----- | (1.366) | | ----- | (3.614) |
| | | | | | | | | |

-- continued --

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **$\Omega^{comp}$** | ----- | **-0.936** | | ----- | **-1.150** | | ----- | **-2.896** |
| | ----- | **(0.414)** | | ----- | **(0.557)** | | ----- | **(1.116)** |
| | | | | | | | | |
| **State** | Yes | Yes | | Yes | Yes | | Yes | Yes |
| **Time** | Yes | Yes | | Yes | Yes | | Yes | Yes |
| **$R^2$** | 0.371 | 0.393 | | 0.369 | 0.396 | | 0.380 | 0.389 |
| **N** | 1050 | 1050 | | 1050 | 1050 | | 1050 | 1050 |

**Notes to Table 3:**
OLS estimates are based on panel data for 50 states for the period 1983 to 2004. Estimates reported in columns (1), (3), and (5) [(2), (4), and (6)] are based on equation (6a) [equation (7)]. The dependent variable is the logarithm of the capital/output ratio ($ky_{s,t}$). The independent variables in columns (2), (4), and (6) are the logarithm of the user cost for state s ($uc_{s,t}^{own}$) and the logarithm of the user cost for competitive states ($uc_{s,t}^{comp}$). The level of the latter variable is formed as a weighted-average of user costs across competitive sets of states, where the weights are the inverse distance between state centroids. The independent variable in columns (1), (3) and (5) is the ratio of user costs ($ruc_{s,t}$), defined as $uc_{s,t}^{own}$ less $uc_{s,t}^{comp}$. The competitive set is defined as either the five closest states (columns (1) and (2)), the ten closest states (columns (3) and (4)), or all states (columns (5) and (6)). See Section 2 and the appendix for further details about data sources and construction. All models contain fixed state and time effects. The Ω parameter is the summation of the three immediately preceding point estimates. Standard errors are heteroscedastic consistent using the technique of White (1980); the standard error for Ω is the sum of the underlying variances and covariances raised to the one-half. The $R^2$ measures the amount of overall explained variation. N is the number of state/year observations.

**Table 4: Establishment Count Model: Equation (8a) with Two Lags**
**Poisson Model of the Number of Establishments**
**Competitive States: Closest Five States**

| | **Ratio of User Costs** | | | | | **Separate Own and Competitive User Costs** |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | | (5) |
| **$DUC_{s,t}$** | -12.704 | -1.033 | -12.801 | 0.796 | | ----- |
| | (0.114) | (0.117) | (0. 116) | (0.121) | | ----- |
| | | | | | | |
| **$DUC_{s,t-1}$** | -8.942 | 1.010 | -8.724 | 0.685 | | ----- |
| | (0.167) | (0.174) | (0.168) | (0.178) | | ----- |
| | | | | | | |
| **$DUC_{s,t-2}$** | 23.340 | 0.943 | 23.231 | -1.489 | | ----- |
| | (0.126) | (0.141) | (0. 126) | (0.145) | | ----- |
| | | | | | | |
| **$\Omega$** | **1.694** | **0.920** | **1.707** | **-0.008** | | ----- |
| | **(0.039)** | **(0.076)** | **(0.040)** | **(0.080)** | | ----- |
| | | | | | | |
| **$UC^{own}_{s,t}$** | ----- | ----- | ----- | ----- | | 0.667 |
| | ----- | ----- | ----- | ----- | | (0.125) |
| | | | | | | |
| **$UC^{own}_{s,t-1}$** | ----- | ----- | ----- | ----- | | 1.366 |
| | ----- | ----- | ----- | ----- | | (0.192) |
| | | | | | | |
| **$UC^{own}_{s,t-2}$** | ----- | ----- | ----- | ----- | | -0.014 |
| | ----- | ----- | ----- | ----- | | (0.156) |
| | | | | | | |
| **$\Omega^{own}$** | ----- | ----- | ----- | ----- | | **2.019** |
| | ----- | ----- | ----- | ----- | | **(0.087)** |
| | | | | | | |
| **$UC^{comp}_{s,t}$** | ----- | ----- | ----- | ----- | | 2.960 |
| | ----- | ----- | ----- | ----- | | (0.370) |
| | | | | | | |
| **$UC^{comp}_{s,t-1}$** | ----- | ----- | ----- | ----- | | 1.898 |
| | ----- | ----- | ----- | ----- | | (0.498) |
| | | | | | | |
| **$UC^{comp}_{s,t-2}$** | ----- | ----- | ----- | ----- | | 4.620 |
| | ----- | ----- | ----- | ----- | | (0.366) |

-- continued --

| | | | | | | |
|---|---|---|---|---|---|---|
| **$\Omega^{comp}$** | ----- | ----- | ----- | ----- | | **9.478** |
| | ----- | ----- | ----- | ----- | | **(0.178)** |
| | | | | | | |
| **State** | No | Yes | No | Yes | | Yes |
| **Time** | No | No | Yes | Yes | | Yes |
| **LL** | -294.376 | -1.852 | -293.707 | -1.118 | | -0.940 |
| **N** | 850 | 850 | 850 | 850 | | 850 |

**Notes to Table 4:**
Maximum likelihood estimates of a Poisson model of the number of establishments are based on panel data for 50 states for the period 1988 to 2004. Estimates reported in columns (1), (2), (3), and (4) are based on equation (8a), and those in column (5) on equation (8a) with separate coefficients on the components of $DUC_{s,t}$. In the Poisson model, the parameter defining the first and second moments of the distribution of the number of establishments is modeled as an exponential function of the user cost terms and time fixed effects; see Hausman, Hall and Griliches, Hall (1984) and Papke (1991) for further discussion of the Poisson model and especially the modeling of state fixed effects. The independent variables in column (5) are the user cost for state s ( $UC^{own}_{s,t}$ ) and the user cost for competitive states ( $UC^{comp}_{s,t}$ ). The latter variable is formed as a weighted-average of user costs across competitive sets of states, where the weights are the inverse distance between state centroids. The independent variable in columns (1), (2), (3) and (4) is the difference in user costs ($DUC_{s,t}$), defined as $UC^{own}_{s,t}$ less $UC^{comp}_{s,t}$. See Section 2 and the appendix for further details about data sources and construction. The models in columns (2), (4), and (5) effectively contain state fixed effects based on the conditional maximum likelihood model of Hausman, Hall, and Griliches (1984) (when state fixed effects are absent, a constant term is included); the models in columns (3), (4), and (5) contain time fixed effects. The Ω parameter is the summation of the immediately preceding point estimates. Standard errors are classical standard errors; the standard error for Ω is the sum of the underlying variances and covariances raised to the one-half. LL is the pseudo log likelihood statistic in columns (1) and (3) and the log likelihood statistic in columns (2), (4), and (5); all LL entries have been multiplied by $10^{-4}$. N is the number of state/year observations.

**Table 5: Establishment Growth Rate Model: Equations (9) and (10) with Two Lags**
**Dependent Variable: Growth Rate in the Number of Establishments**
**Competitive States: Closest Five States**

| | **$ne_{s,t}$ - $ne_{s,t-1}$** | | | | | **$ne_{s,t}$ - $ne_{s,t-5}$** | |
|---|---|---|---|---|---|---|---|
| | Ratio of User Costs | Ratio of User Costs | Ratio of User Costs | Ratio of User Costs | Separate User Costs | Ratio of User Costs | Separate User Costs |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| **$ruc_{s,t}$** # | 0.028 | 0.002 | 0.008 | -0.022 | ----- | -0.328 | ----- |
| | (0.083) | (0.099) | (0.052) | (0.058) | ----- | (0.217) | ----- |
| **$ruc_{s,t-1}$** # | -0.076 | -0.134 | 0.010 | -0.036 | ----- | -0.051 | ----- |
| | (0.161) | (0.176) | (0.089) | (0.104) | ----- | (0.251) | ----- |
| **$ruc_{s,t-2}$** # | 0.036 | 0.039 | -0.026 | -0.006 | ----- | -0.108 | ----- |
| | (0.108) | (0.145) | (0.066) | (0.085) | ----- | (0.201) | ----- |
| **$\Omega$** | **-0.013** | **-0.092** | **-0.009** | **-0.064** | **-----** | **-0.487** | **-----** |
| | **(0.031)** | **(0.074)** | **(0.020)** | **(0.044)** | **-----** | **(0.164)** | **-----** |
| $uc_{s,t}^{own}$ # | ----- | ----- | ----- | ----- | -0.009 | ----- | -0.415 |
| | ----- | ----- | ----- | ----- | (0.640) | ----- | (0.235) |
| $uc_{s,t-1}^{own}$ # | ----- | ----- | ----- | ----- | -0.108 | ----- | 0.019 |
| | ----- | ----- | ----- | ----- | (0.116) | ----- | (0.280) |
| $uc_{s,t-2}^{own}$ # | ----- | ----- | ----- | ----- | 0.049 | ----- | -0.218 |
| | ----- | ----- | ----- | ----- | (0.093) | ----- | (0.216) |
| $\Omega^{own}$ | ----- | ----- | ----- | ----- | **-0.069** | ----- | **-0.614** |
| | ----- | ----- | ----- | ----- | **(0.045)** | **-----** | **(0.169)** |
| $uc_{s,t}^{comp}$ # | ----- | ----- | ----- | ----- | 0.021 | ----- | -0.119 |
| | ----- | ----- | ----- | ----- | (0.153) | ----- | (0.493) |
| $uc_{s,t-1}^{comp}$ # | ----- | ----- | ----- | ----- | -0.302 | ----- | 0.344 |
| | ----- | ----- | ----- | ----- | (0.261) | ----- | (0.626) |
| $uc_{s,t-2}^{comp}$ # | ----- | ----- | ----- | ----- | 0.296 | ----- | -0.459 |
| | ----- | ----- | ----- | ----- | (0.198) | ----- | (0.462) |

-- continued --

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $\Omega^{comp}$ | ----- | ----- | ----- | ----- | | **0.015** | | ----- | **-0.235** |
| | ----- | ----- | ----- | ----- | | **(0.086)** | | ----- | **(0.314)** |
| | | | | | | | | | |
| **State** | No | Yes | No | Yes | | Yes | | Yes | Yes |
| **Time** | No | No | Yes | Yes | | Yes | | Yes | Yes |
| $R^2$ | 0.000 | 0.000 | 0.607 | 0.602 | | 0.601 | | 0.585 | 0.600 |
| **N** | 800 | 800 | 800 | 800 | | 800 | | 600 | 600 |

**Notes to Table 5:**
OLS estimates are based on panel data for 50 states for the period 1988 to 2004. Estimates reported in columns (1), (2), (3), and (4) are based on equation (9), those in column (5) on equation (9) with separate coefficients on the components of $ruc_{s,t}$, those in column (6) on equation (10), and those in column (7) on equation (10) with separate coefficients on the components of $ruc_{s,t}$. The dependent variable is the one-year growth rate in the number of establishments, $ne_{s,t} - ne_{s,t-1}$ (where $ne_{s,t} = Ln(NE_{s,t})$) in columns (1) to (5) and the five-year growth rate in the number of establishments, $ne_{s,t} - ne_{s,t-5}$ in columns (6) and (7). The independent variables in column (5) are the logarithm of the user cost for state s ($uc_{s,t}^{own}$) and the logarithm of the user cost for competitive states ($uc_{s,t}^{comp}$). The level of the latter variable is formed as a weighted-average of user costs across competitive sets of states, where the weights are the inverse distance between state centroids. The independent variable in columns (1), (2), (3) and (4) is the ratio of user costs ($ruc_{s,t}$), defined as $uc_{s,t}^{own}$ less $uc_{s,t}^{comp}$. The #'s indicate that the independent variables in columns (6) and (7) are lagged an additional five periods (e.g., $ruc_{s,t}$ becomes $ruc_{s,t-5}$). See Section 2 and the appendix for further details about data sources and construction. The models in columns (2), (4), (5), (6), and (7) contain state fixed effects (when state fixed effects are absent, a constant term is included); the models in columns (3), (4), (5), (6), and (7) contain time fixed effects. The Ω parameter is the summation of the immediately preceding point estimates. Standard errors are heteroscedastic consistent using the technique of White (1980); the standard error for Ω is the sum of the underlying variances and covariances raised to the one-half. The $R^2$ measures the amount of overall explained variation. N is the number of state/year observations.

**Table 6: Borders / Twin-Counties Model. Equation (16)**
**Dependent Variable: Cross-County Difference In Number of Establishments**

| | **Maximum Distance (md) From County Centroids To The Common Border** | | | | |
|---|---|---|---|---|---|
| | 10 | 15 | 20 | 25 | 50 |
| | (1) | (2) | (3) | (4) | (5) |
| $\mathbf{ruc^{md}_{p,t}}$ | -2.386 | -1.557 | -1.090 | -0.595 | 0.061 |
| | (0.229) | (0.128) | (0.119) | (0.113) | (0.062) |
| | | | | | |
| **State** | Yes | Yes | Yes | Yes | Yes |
| **Time** | No | No | No | No | No |
| $\mathbf{R^2}$ | 0.001 | 0.014 | 0.004 | 0.000 | 0.000 |
| **N** | 3,452 | 8,466 | 12,021 | 15,949 | 46,381 |

**Notes to Table 6:**
OLS estimates are based on panel data for bordering counties drawn from the 50 states for the period 1977 to 2004. Estimates are based on equation (16). The dependent variable is the cross-county difference in the logarithm of employment for the pair of bordering counties c and c', $\nabla^{md} ne_{p,t} \equiv ne_{c,t} - ne_{c',t}$, where mm is the maximum mileage from the county centroids to the common border for counties c and c' and $ne_{c,t}$ is the logarithm of the number of establishments in county c at time t. The independent variable is $\nabla^{md} ruc_{p,t} \equiv uc_{c,t} - uc_{c',t}$. See Section 2 and the appendix for further details about data sources and construction. All models contain state fixed effects; none of the models contain time fixed effects (which are not part of the Twin-Counties Model). Standard errors are heteroscedastic consistent using the technique of White (1980). The $R^2$ measures the amount of overall explained variation. N is the number of twin-county/year observations.