Measuring the Incentive Effects of State Tax Policies Toward Capital Investment

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December 3, 2001

Preliminary: Please do not quote or cite without permission.

Abstract

Empirical research on the effects of differential business taxation across jurisdictions relies on the appropriate measurement of the burden of tax in each location. While numerous summary measures have been proposed and used in various contexts to make such comparisons, most fail to account for the full effects of each state's tax system and the interactions of state tax systems with both local and federal taxes. This paper addresses these issues and employs an approach used in recent state tax reform studies to measure tax burdens. The advantages of this "representative firm" approach over traditional measures are discussed, and its empirical significance is tested.

The empirical properties of tax burdens measured via a representative firm are very different from simpler, conventional measures. Taxes are estimated to play a negligible role in decisions concerning where to locate capital investment. This result, coupled with recent results showing the responsiveness of sales and employment decisions to apportionment changes, is consistent with the hypothesis of the existence of a hierarchy of behavioral responses to tax changes.

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In times of economic competition for businesses, the effects of tax differences across borders, whether domestic or international, have been of critical concern to policymakers. Recent technological and political changes have enhanced the geographic mobility of businesses and extended their geographic range, intensifying economic competition both within the United States and throughout the world. Yet, while fierce interjurisdictional rivalry has induced many states to reduce the tax burdens they impose on business, there has also been an increase in demand for state and local services such as education, road construction, and health care.

Within the past decade the majority of states have undertaken or proposed large-scale tax reform studies, with at least some emphasis on the competitiveness of the state's business environment. And while interested parties often claim to have found a plan that would make reform worthwhile, most plans offered by such groups are at best incomplete and often contradictory. At the heart of this debate is the problem of evaluating the attractiveness of a state's tax system relative to those of rival states competing for mobile business capital. Although economists have been addressing the issue for decades, they have generally failed to identify valid indicators of business tax burden. Partially as a result, they disagree on the extent to which taxes affect firms' locational decisions.[1]

With few exceptions, measures of business tax burden employed by economists, although easily computed, fail to focus on those tax characteristics that should matter most to profit-maximizing firms contemplating investment. Mindful of this failure, we employ an analytic framework used by Papke (1987, 1991) and two Massachusetts tax study commissions (Commonwealth of Massachusetts 1987 and Tannenwald 1996). We evaluate the tax competitiveness in 1991 of 22 states through the eyes of a rational, profit-maximizing business that is weighing alternative sites for a new facility. In so doing, we incorporate tax laws faced by such a business at all levels of government and how these laws interact. We then estimate the effect of interstate differences in tax competitiveness on the geographic allocation of manufacturers'capital spending, based upon the firm's expected after-tax return on such investment and other demographic factors, and we compare the results to those found in studies using statutory tax rates.

Such an after-tax approach, while used by individual firms, consulting firms (including those within the large accounting firms), and some recent economic studies, has not been widely used in cross-sectional tax analyses. Part of the reason for this lack of widespread use may be the difficulty in obtaining all of the data necessary to construct the variables, but it is precisely this level of detail at which the accounting literature has been able to make significant contributions to empirical academic and public policy debates.

Our work complements research by Klassen and Shackelford (1998) on the relationship between sales apportionment and sales, work by Goolsbee and Maydew (2000) on the relationship between the weighting of payroll in apportionment formulas and employment, and work by Alexander, Porter, and Rhodes-Catanach (2000) on the relationship between apportionment choices and investment results. We examine firms' marginal investment decisions in a detailed cross-sectional setting. Our comparison shows the benefits of a more comprehensive measure of tax effects and demonstrates the limitations of other measures. In application, and in contrast to the results examining sales and employment, we find the business tax structure of a state exerts at best a small, if not negligible, effect on capital expenditures, with other economic and demographic characteristics of states exerting more significant influences. These results are in agreement with other recent investment studies that have emphasized the role of state infrastructure and other non-tax factors as being important in attracting businesses.[2] That marginal capital expenditures appear to be relatively unaffected by the current distribution of after-tax returns across states while sales and employment levels are affected is also consistent with the hierarchy outlined by Slemrod (1995) that real decisions, such as investment, will be the least responsive to tax changes.

BACKGROUND

Previous studies (Pomp 1987; Tannenwald 1987, 1993, 1996) have set forth the attributes of a good indicator of tax competitiveness and critiqued many indicators frequently cited in public debate. A brief summary is provided here.

Since businesses are primarily interested in making profits, indicators of tax competitiveness should focus on those taxes that most affect after-tax rates of return. Any indicator should also measure such taxes'impact on the profitability of marginal business investment projects. A business rarely moves its entire operation from one site to another just to lower its taxes. However, when deciding where to locate a marginal facility, such as a new plant, taxes are more likely to become a factor in the decision.[3]

Any measure of relative tax effects used to measure incentives should evaluate the tax burden that a marginal facility will bear over its entire lifetime, not just during the first years of its existence. Such a measure should be more than just the statutory marginal tax rate, and it should take into account the entirety of the state tax structure. Any measure should also take into account taxes paid to all levels of government and how the interaction of taxes affects an investment's profitability. For example, in addition to knowing the rate of tax in a state, one must also know how the base to which it is applied is measured, and account for the deductibility of local taxes against state taxes and the deductibility of both state and local taxes in determining federal taxable income. While we expect firms to care about their total tax burden, it is unlikely that they care much about the level of government to which they are paid.

The most frequently used indicators of state tax competitiveness generally lack these qualities. During a recent debate over business tax policy in Massachusetts, for example, three different sets of statistics were often cited by proponents of different sides of the debate: 1) the statutory corporate income tax rate, 2) state corporate income taxes as a percentage of statewide personal income, and 3) the sum of state and local taxes on corporate income and nonresidential property as a percentage of statewide personal income.[4] Despite their widespread use in policy debates, each is a poor measure of a state's relative tax attractiveness.

Consider first the statutory tax rate on corporate income, which is often used to control for state or other multiple jurisdictional tax effects (for example, Klassen and Shackelford 1998; Goolsbee and Maydew 2000; Alexander, Porter, and Rhodes-Catanach 2000). By itself, the rate fails to take into account most taxes and fees paid by businesses, such as taxes on net worth, property, payroll, and purchases of intermediate inputs. This is important, because a tax change within a state that lowers the maximum statutory rate while increasing other rates (for example, unemployment insurance or the property tax) in a way that keeps the after-tax return unchanged would appear to be a tax decrease, even though the marginal tax burden is unchanged. Second, as described by Omer (1997), a single corporate tax rate may not apply to all businesses within a state, introducing measurement error in any empirical study.[5] Third, a single rate, even if accurate, fails to take into account differences across states in the definition of taxable corporate income. Some states with a high statutory rate define taxable profits narrowly, allowing relatively generous deductions and exclusions. Others permit favorable apportionment formulas[6] or allow generous credits against tax.[7,8] In addition, a reversal of causality is likely to have occurred, with a state's rate structure having been driven by the composition of business in the state at the time of enactment.

Other measures are similarly limited. Corporate income tax collections as a percentage of personal income focuses on only a small portion (about one-tenth) of state and local taxes paid by businesses.[9] As the denominator contains personal income rather than corporate income, it also bears little relation to the ratio of business taxes paid to profits earned. In recent years, corporations have increased reported profits by cutting costs, including their number of employees and their payroll. Such changes will depress measures of personal income. As a result, corporate taxes as a percentage of personal income could be high, even if corporate taxes as a percentage of profits is average or low.[10]

A final measure, state and local income and property taxes paid by businesses per $1,000 of personal income, does take into account property taxes paid by both incorporated and unincorporated businesses—an improvement over the first two measures. This is an important addition, given that property taxes account for the largest fraction of all state and local business taxes in the United States, approximately one-fourth, and can have large effects on the rankings of states' tax burdens.[11] However, the denominator of the measure, personal income, is still not the appropriate benchmark against which to measure taxes paid.

In examining firms' decisions across jurisdictions, the appropriate measure of tax burden should be the amount of tax that will be paid at the margin on the income stream of a new investment. Such a measure would be consistent with theoretical models of firm behavior and with the tax literature's focus on developing measures of the present value of corporate income taxes (see, for example, Shevlin 1990). None of the three measures described above adequately addresses the marginal nature of the evaluation. At best they provide a poor measure even of average tax burdens. We attempt to overcome these problems by measuring the burden of state and local taxes on a hypothetical "representative firm" evaluating each state as a potential location for expansion. Our approach is described in the next section.

METHODOLOGY

To overcome the shortcomings of the summary measures described above, recent studies have begun to employ a "representative firm" approach.[12] This approach begins with the assumption that firms representative of selected industries are currently located at a variety of sites in a number of different states. It is also assumed that the firms'pre-tax rate of return, asset mix, capital/labor ratio, and non-tax costs are identical at all sites. As a result, the only differences between each site are the state and local tax characteristics. For each industry-state combination of business sites included in the study, each firm's local, state, and federal tax liabilities and net after-tax cash flow are computed for a minimum of 20 years into the future. The analysis is not limited to taxes on corporate profits and net worth, but includes non-income state and local taxes, such as unemployment insurance taxes and property taxes. Each hypothetical firm is then assumed to build a new facility at each site, including the current site. Post-expansion profits, taxes, and cash flows are calculated before and after expansion, and the long-run, after-tax rate of return (AFTAX) of the new facility is determined for each industry-state site.[13]

We use the AFTAX measure developed in the 1993 Massachusetts Tax Competitiveness study in our analysis.[14] In the 1993 Massachusetts study, 22 states (including Massachusetts) were evaluated after having been determined as potential competitors with Massachusetts for business expansions in five different industries.[15] An overview of the treatment of specific taxes included in the calculation of rates of return in this measure is presented in Table 1.

While it may be possible to extend the analysis to more than the 22 states we examine, it is unlikely to lead to more relevant empirical or policy results and may introduce spurious correlations. Not all states compete for the same marginal investment, and a business currently in one location or a set of locations is more likely to place a high weight on proximity to its current operations. In the context of this paper, one can think of a New England company examining expansion in states generally viewed as direct competitors for the types of industries that have tended to locate in Massachusetts. While other states excluded from this analysis, such as Alaska, Hawaii, Montana, or Oklahoma, may have favorable tax climates, they are not generally viewed as direct competitors of New England-type firms in the industries we study. As a result, we focus on obtaining the best estimates of the tax systems of the most relevant states by measuring the specific types of taxes a subset of manufacturing industries would face on their operations, and which would be considered when an expansion was planned.

Table 2 provides a side-by-side comparison of the maximum statutory tax rates in each state and the average value of AFTAX. The comparison of the two tax measures in Table 2 shows the advantage of a comprehensive measure of tax burdens, such as AFTAX. For example, even though Texas and Washington had no tax on corporate income, they do not have the highest estimated rates of return. In fact, Washington state has one of the lowest rates of return, due to the high level of unemployment insurance taxes in the state and the structure of its gross receipts tax. At the other extreme, Alabama, which allows the deductibility from state income of the amount of federal taxes paid, has the highest estimated rate of return. The correlation between the statutory tax rates and AFTAX is -0.246, statistically significant at the 1-percent level, and it is consistent with the expectation that higher statutory tax rates reduce after-tax returns.

As our purpose in this paper is both to demonstrate the empirical effects of different tax measures and to provide estimates of taxes' effects on investment, we estimate six variants of the following equation:

$$NK_{i,j} = \alpha + \beta_1 TAX_{i,j} + \beta_2 AVGWAGEsubi, j + \beta_3 ENERGY_{i,j} + \beta_4 PRODUCTIVITY_{i,j}$$
$$+ \beta_5 PWINDEX_j + \beta_6 POLFIRE_j + \beta_7 PPEXPsubj + \beta_8 TEMP_j + \sum_i \beta_i D_i + \varepsilon_{i,j}$$

WHERE:

NK = new capital expenditures per production worker[16]

TAX = tax variables compared in this paper, either MAXRATE, the maximum statutory tax rate, or AFTAX, the measure of after-tax rate of return on a marginal investment

AVGWG = average wage of production workers in each industry in each state

ENERGY = industrial sector energy cost in each state

PRODUCTIVITY = labor productivity in the state

PWINDEX = an index of the change in the number of production workers in the state from 1987 to 1991

POLFIRE = statewide average per capita expenditures on fire and police protection at the local level

PUBSCHOOL = state average per pupil education expenditure

TEMP = average daily temperature of the state (or average of largest cities)

D = industry dummy variable

and the subscripts refer to the ith industry and the jth state. Thus, the dependent variable is the amount of new capital expenditures per production worker by firms in a particular industry in a particular state (for example, by fabricated metals firms in Massachusetts).

The six variants of this equation are created by running a set of three specifications for each tax variable, and they are explained in further detail below. The variables included in addition to AFTAX are designed to control for state- and state/industry-specific characteristics of the business climate. The first of these, AVGWG, controls for the variation in wages across the states and has an expected sign that is ambiguous. While high wages might deter businesses from building a new plant, depressing both employment and capital spending, they should also induce the substitution of capital for labor.[17] Energy is usually complementary to capital, and it is expected to have a negative coefficient. Labor productivity is included as an explanatory variable to control for differences across industries in technological processes and is expected to be positively related to investment. The index variable PWINDEX, measures the change in the number of production workers in each state between 1987 and 1991. Its purpose is to control for any bias that might otherwise be introduced by differential business conditions in each state.

Three additional variables are included to control for broader aspects of a state's attractiveness. Spending on fire and police protection is a proxy for the quality of public services of most concern to businesses, while PUBSCHOOL is the per pupil expenditures of each state on its public schools. Both are expected to be positively related to investment,[18] as is TEMP, the average monthly temperature of a state. Summary statistics for the data are presented in Table 3.

One very important distinction between the approaches to measuring tax effects becomes apparent in the summary table. While statutory tax rates vary from zero to 12.25 percent, with a standard deviation of nearly half the mean, estimated after-tax rates of return fall within a narrow range, from 14 to 16 percent, with a standard deviation of little over 0.33 percent. This smaller amount of variation is due to the incorporation of all levels of taxes on the representative firm, not just the maximum state income tax rate.

RESULTS

Columns 1 and 2 of Table 4 present the results of univariate log-log regressions of per capita capital spending, with each tax variable as the sole explanatory variable. Since we used a log-log model, each coefficient can be interpreted as an elasticity and will indicate the percentage change in capital investment that results from a 1 percent change in the independent variable. In the first case, neither the equation nor the coefficient on MAXRATE is statistically significant, although the coefficient is of the expected (negative) sign. In contrast, in the second column, the coefficient on AFTAX is both statistically significant and of the expected (positive) sign, indicating that higher expected after-tax returns will increase capital expenditures in a state. As in Papke (1987, 1991), the coefficient on AFTAX implies a very high response for investment to after-tax rates of return, with a 1 percent increase in after tax returns increasing capital spending per worker by 13 percent.

In columns 3 and 4 we introduce variables to control for the demographic and economic characteristics of the states. The inclusion of these variables dramatically increases the explanatory power of the equations from less than 0.10 to more than 0.70, with PRODUCTIVITY and PWINDEX having positive and significant coefficients in each equation, and POLFIRE significant and of the expected sign in the MAXRATE regression. The dramatic increase in explanatory power of the equation with the inclusion of these variables suggests that demographic factors are important determinants of the location of investment spending. The coefficient estimates for MAXRATE and AFTAX are both smaller, but as in the previous set of equations, only AFTAX is statistically significant. The estimated elasticity on the after-tax return falls to 8.472 from 13.004 in equation 2.

Columns 5 and 6 repeat the previous two regressions with the addition of industry dummy variables. Their purpose is to control for similar industry characteristics that are independent of the tax structure. These variables will also control for the effects that current industry composition in a state exert on additional investment. To the extent that an industry already has a presence in a state, this coefficient reflects the degree to which such location attracts or discourages additional investment.[19]

In neither case are the tax variables significant. In both columns, PRODUCTIVITY and POLFIRE are statistically significant as are the dummy variables for the Apparel and Electronic Components industries. PWINDEX is no longer significant, suggesting that the industry dummy variables capture recent changes in employment.

Two conclusions can be drawn from this table. First, the variable used to control for taxes clearly matters, with AFTAX appearing to better capture state tax characteristics. Second, the overall effects of taxes on capital spending decisions, given the characteristics of the states studied in this paper, appear to be dominated by non-tax demographic and economic characteristics.

CONCLUSION

Tax research presupposes that taxes can matter. It is concerned with the circumstances in which taxes do and do not affect decisions, and with the extent to which decisions are altered by tax considerations. Empirical results in any study can be no better than the research design and the data used to measure the effects of taxes. Model specification is determined by the behavioral relationship being tested. Researchers use the most appropriate data available and accurately measure the characteristics of the underlying variable being included in the analysis.

In the case of multijurisdictional tax issues, whether between states or countries, there is always an added empirical difficulty of properly measuring the effects of different tax regimes.

Often, given lack of available data, assumptions must be made in variable construction. Consequently, there is always the possibility that errors in the measurement of variables bias estimates of the significance of a hypothesized relationship.

In this paper we describe and use a measure of taxes across states that is more closely related to the types of variables suggested by economic theory, namely a measure of the after-tax return on investment. From a theoretical standpoint, such a measure is an improvement over simple proxies because it is more comprehensive, although it is also more difficult to construct. We show that after-tax returns on investment vary across states in a much more complex way than statutory rates, just as Klassen and Shackelford (1998) and Goolsbee and Maydew (2000) find that apportionment factors must be carefully measured in each state when considering incentives for the location of sales and employees. In application, our results suggest that state and local taxes, when properly measured, do not appear to have played a statistically significant role in the locational decisions for business investment, in contrast to locational decisions for sales and employees. Given the relatively small influence that taxes exert on rates of return in our sample, other economic and demographic characteristics of a state appear to be the primary factors affecting these choices. Such a result is also consistent with real decisions generally being less responsive to tax changes.

Our results also suggest a number of directions for future research. First, our study was limited, with a focus on the New England states and the likely places where industries common to New England might expand. These results may not extend to other regions, industries, or time periods. Second, this research does not consider recent examples of states targeting particular industries, or companies, with carefully aimed tax benefits or public infrastructure expenditures. Including such actions by states is beyond the scope of this study; such an analysis would require an analysis of the characteristics of a particular firm and the characteristics of competing options, rather than measurement of the general environment created by the tax system.

Table 1
Treatment of State and Local Tax Attributes in the Construction of After-Tax Rates of Return

State and local taxes	· State taxes on corporate profits, capital stock, net worth, and gross receipts · State unemployment insurance taxes · State and local taxes on all property, including real estate, inventories, and both tangible and intangible personal property
Property taxes	· Property tax collections as a percentage of the fair market value of statewide taxable property, reported by state officials or the U.S. Census Bureau
Percentage of each apportionment factor in home state in pre-expansion phase	· 90 percent of property · 90 percent of payroll · 10 percent of sales
Throwback requirements	· Not applicable. Firms assumed to be taxable in every state in which they do business

Source: Tannenwald (1996).

Table 2
Comparison of Tax Measures

State	Maximum Corporate Rate	Five-Industry Average After-Tax Rate of Return
Alabama	6.5	16.0
California	9.3	15.0
Connecticut	11.5	14.5
Florida	5.5	15.5
Georgia	6.0	15.0
Illinois	4.8	15.3
Maine	8.93	15.1
Maryland	7.0	15.7
Massachusetts	9.5	15.2
New Hampshire	8.0	15.3
New Jersey	9.0	15.0
New York	9.0	15.4
North Carolina	7.75	15.0
Ohio	8.9	14.9
Pennsylvania	12.25	14.6
Rhode Island	9.0	15.1
South Carolina	5.0	15.5
Tennessee	6.0	15.3
Texas	n.a.	15.2
Vermont	8.25	14.9
Washington	n.a.	14.8
Wisconsin	7.9	15.0

n.a. - not applicable, state does not tax corporate income. These rates are set to 0.1 in the statistical analyses to allow for log transformations.

Table 3
Summary Statistics

Variable	Mean	Standard Deviation	Minimum	Maximum
new capital expenditures per production worker (NK)	7.24	7.33	0.39	35.44
MAXRATE	7.59	3.187	0.10	12.25
AFTAX	15.15	0.39	14.04	16.02
average wage (AVGWAGE)	10.39	2.74	2.01	19.11
industrial sector cost (ENERGY)	4.223	1.05	2.05	6.2
PRODUCTIVITY	60.71	44.62	14.22	218.34
index of change in production workers (PWINDEX)	85.52	23.39	33.83	149.12
per capita police and fire expenditures (POLFIRE)	191.09	47.18	121.84	271.22
per pupil expenditures in public schools (PUBSCHOOL)	5608.49	530	3314	8439
average daily temperature (TEMP)	55.27	7.54	45.10	72.00

Number of observations is equal to 65 for all variables with the exception of PWINDEX for which there are 63.

Sources: U.S. Census Bureau (1989, 1990, 1991, 1994), U.S. Advisory Commission on Intergovernmental Relations (1994), S.H. Brooks (1993), Papke (1991), Horner (1992).

Table 4
Tax Measures and Capital Spending: Model Estimates

Dependent variable: new capital expenditures per production worker. All variables in logarithmic form. Standard errors are heteroskedastic-consistent (White 1984). Significance levels: *5 percent, **1 percent.

	(1)	(2)	(3)	(4)	(5)	(6)
MAXRATE	-0.135		-0.089		-0.077	
	(0.134)		(0.096)		(0.068)	
AFTAX		13.004*		8.472**		-0.107
		(5.925)		(2.936)		(2.662)
AVGWAGE			0.281	0.059	0.074	0.105
			(0.319)	(0.278)	(0.137)	(0.154)
ENERGY			0.351	-0.241	-0.229	-0.574
			(0.578)	(0.420)	(0.438)	(0.391)
PRODUCTIVITY			1.404**	1.442**	1.160**	1.188**
			(0.172)	(0.163)	(0.165)	(0.164)
PWINDEX			1.004**	0.968**	0.277	0.285
			(0.354)	(0.332)	(0.275)	(0.291)
POLFIRE			0.779*	0.475	0.537*	0.624**
			(0.343)	(0.308)	(0.220)	(0.221)
PUBSCHOOL			-0.250	0.295	0.071	0.086
			(0.523)	(0.499)	(0.333)	(0.396)
TEMP			0.035	-0.299	0.697	0.701
			(0.816)	(0.771)	(0.523)	(0.551)
SIC 232					-0.943**	-0.899**
Apparel					(0.218)	(0.226)
SIC 342					-0.217	-0.221
Fabricated Metals					(0.167)	(0.166)
SIC 357					-0.200	-0.189
Computers					(0.222)	(0.230)
SIC 367					0.521**	0.552**
Electronic components					(0.140)	(0.146)
Constant	1.694**	-33.872*	-11.438	-35.013**	-10.087*	-10.273
	(0.285)	(16.123)	(7.150)	(10.481)	(4.268)	(9.368)
Observations	65	65	63	63	63	63
F	1.02	4.82*	37.76**	40.62**	45.71**	53.01**
Adjusted R^2	0.01	0.07	0.73	0.76	0.87	0.87

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ENDNOTES

[1] Analysts also differ on the appropriate models to be employed in analyzing the impact of taxes on firms' location. For recent surveys of the literature on the impact of interstate tax differentials on location and economic growth, see Bartik (1991), Wasylenko (1991, 1997), Tannenwald (1993), and Lynch (1995).

[2] See Lynch (1995) for a summary.

[3] Tannenwald (1993) reports that in interviewing location consultants, none "identified state and local tax differentials as being an important factor in locational choice," with one stating that they "enter the locational decision 'after the fact'" (p. 28).

[4] See Lester et al. (1995); Massachusetts Taxpayers Foundation (1995); and DRI/McGraw Hill (1995).

[5] Omer (1997) provides the example of New Jersey, which reports a 9 percent business tax rate and a 7.5 percent rate on income not taxed at 9 percent.

[6] See Goolsbee and Maydew (2000) for a study of the effects of changes in the payroll weight in apportionment formulas and employment.

[7] Klassen and Shackelford (1998) present a more refined use of the statutory tax rate by focusing on the rate and the apportionment factors related to sales. However, such a measure is still far short of capturing the full effects of a state tax system, and ignores the possible opposite direction of causality: If sales are an important element of firms' characteristics in a state, this may lead to a reduction in the rate to accommodate them.

[8] A similar need for a more comprehensive measure of taxes in an international setting is demonstrated by Babcock (2000), who shows that, in addition to the rate of tax levied by a country, the country's imputation system will also influence tax planning.

[9] See Tannenwald (1993), Appendix Table D-2.

[10] For example, over the course of 1992, nationwide personal income grew by 8 percent, while corporate profits grew by 22 percent.

[11] Tannenwald (1993), Appendix Table D-2, provides an example of the large changes in rank orderings of this measure versus the others. Massachusetts, the focus of his study, ranked 7th and 10th in the nation using the statutory tax rate and state and local income taxes per $1000 of personal income, respectively, as the measure of tax burden. After property taxes were included, the state's rank fell to 31st.

[12] Studies utilizing this approach include S. H. Brooks Co. (1993), Commonwealth of Massachusetts (1987), Papke (1987, 1991), Papke and Papke (1984, 1986), Connecticut Task Force on State Tax Revenue (1991), KPMG Peat Marwick (1994), and DeSeve and Vasquez (1977).

[13] The calculation of AFTAX is itself dependent on a set of assumptions about the representative firm and its financial characteristics. However, as Tannenwald and Kendrick (1995) point out, with the exception of "throwback" provisions, after-tax returns are primarily driven by non-tax factors. Our estimate of AFTAX assumes nexus in all states in the study.

[14] A description of the methodology, as well as the tax rates used in this paper, can be found in Tannenwald (1996). Also, see Appendix.

[15] Competing states were identified based upon a survey of Massachusetts companies by an industry group, as described by Tannenwald (1993).

[16] Capital expenditures are divided by the number of production workers in order to scale for the size of the industry in the state. As Papke (1987) points out, this variable should not be interpreted as an indicator of the industry/state's capital intensity. Such a measure would have capital stock, not capital spending, in the numerator.

[17] One would also expect an upward simultaneity bias, in that capital spending per capita raises worker productivity, which in turn raises their wages.

[18] Indeed, one would expect an estimate of the relationship between the dependent variable, capital spending per production worker, and labor productivity, defined as value added per production worker, to be simultaneously determined.

[19] The effects of a firm being in "scientific instruments" are included in the intercept.

Appendix to "Measuring the Incentive Effects of State Tax Policies Toward Capital Investment"

EXPLANATION OF MODEL USED TO COMPUTE AFTAX

The model begins with a hypothetical but representative corporation in a single industry, operating at sites throughout the 22 states included in the sample. The model computes the after-tax cash flow that firm would receive for the next 60 years if its geographic allocation of operations were to remain constant and it were to undertake no expansion during this period. This scenario is the baseline against which expansion scenarios are compared.

The representative firm then expands in one of the 22 states. The expansion requires the firm to invest in additional equipment, structures, inventories, financial assets, and the like, and to hire more workers. As a result of these new facilities, the firm will make larger profits and pay higher taxes than in the baseline scenario. Comparing the after-tax cash flow of the firm after the expansion with its pre-expansion cash flow provides an estimate of the net rate of return to the expansion. By assumption, all non-tax characteristics of the firm are assumed to be constant across all locations. Differences across expansion locations in after-tax rates of return to the new facility reflect only differences in tax environments. The exercise is repeated for the firm representing each industry and for each possible expansion state.

The model consists of six blocks. Each block computes values for several variables for each year, for the hypothetical firm representing each industry, under both pre- and post-expansion scenarios, and under different assumptions concerning each firm's home state and expansion state. The first block computes the asset mix and the amount of investment in each asset type needed to maintain that mix. The second block computes net profits, gross profits, and before-tax profits. The third block uses the output of the first two blocks to compute liabilities for each state and local tax. The fourth tax computes federal corporate income tax liability. The fifth block computes after-tax cash flow. The sixth block computes the internal rate of return generated by the new investment stream.

Block I: Computation of Capital Stocks and Investment Streams

This computation requires values for four exogenous variables: 1) the level and mix of assets in the time period just before the firm expands; 2) the rate of inflation for each asset type (asset deflators); 3) the service lives of each type of depreciable asset (equipment and structures); and 4) the percent by which existing capital stocks grow as a result of the expansion. It is assumed that each firm has $100 million in total assets, which are classified as working or non-working. Working assets include cash, net receivables, inventories, land, structures, and equipment. The asset mix for each of the five firms used in the study is provided in Appendix Table 1. The table also includes estimates of other firm characteristics—rent, net worth, gross receipts, and employment-to-capital ratio—that are used to estimate liabilities for various state and local business taxes.

The average service lives for structures and equipment for 1991 are assumed to be 32 years and 12 years. Each expansion is assumed to entail a proportional increase in all assets and employment of 10 percent, so that the new facility comprising the expansion is a one-tenth miniature of the whole firm in the baseline scenario. Asset prices are assumed to be stable throughout each 60-year scenario.

The first step in block 1 is to determine how much annual investment is required in the steady state to maintain one dollar's worth of each asset type shown in Appendix Table 1. For non-depreciable assets—all but structures and equipment—the answer is simple: one dollar. For a depreciable asset, the amount depends on the asset's service lifetime. Appendix Table 2 displays the amount of steady state investment flow required to maintain a stock of one constant dollar for assets with alternative service lifetimes. For a 12-year asset, the assumed average useful lifetime of equipment, annual constant-dollar investment of approximately 15.1 cents is required. For a 32-year asset, the assumed useful lifetime of structures, the comparable figure is approximately 6.1 cents. Appendix Table 3 shows how the 0.3333 steady state investment flow for a 5-year asset is derived.

The next step in the block is to determine the value of the capital stock after the expansion, which simply equals 110 percent of the value before expansion. The final and most difficult step is the calculation of the new investment stream (post-expansion) in each year for both depreciable asset types. The "multiplier" linking investment to the capital stock is a function of the rate of economic depreciation. The model inverts that relationship to calculate the new investment stream needed to maintain the new capital stock determined above. It takes several years for the investment stream to reach a new steady state. Once it does, the values cited in Appendix Table 2 hold. For example, after expansion the prototypical men's and boys' clothing manufacturer has approximately $9.2 million in equipment. In the steady state, the annual amount of investment needed to maintain this stock of equipment is approximately 0.153 x $9.2 million, or $1.4 million.

Block II: Calculation of Net, Gross, and Before-Tax Profits

In this block, values for the endogenous variables computed in the first block are used to calculate three categories of profits: gross, net, and before-tax. Each is created for both the old and the new investment series.

Net profits equal the firm's capital stock times 0.25, the assumed uniform rate of return on all assets. The capital stock is equal to a moving average consisting of the current year's and the preceding year's end-of-period capital stocks.   Economic depreciation is then added to net profits to obtain gross profits. For each asset type, economic depreciation D in year t is calculated as investment minus the difference between the capital stock in period t and in t-1:

$$I_t – (K_t – K_{t-1})$$

Before-tax profits equal the difference between gross profits and tax depreciation. Tax depreciation for equipment is calculated according to the double-declining balance methods, while structures are depreciated according to the straight-line method. In this version of pre-tax book profits, unemployment insurance taxes are not subtracted out.

Block III. **Calculation of State and Local Taxes**

This block computes the state and local taxes on business specific to each state. Taxes that the model takes into account include property, unemployment insurance, corporate income, net worth, and capital stock taxes, among others. All features of each of these taxes, including the way in which they interact with federal taxation, are taken into account. Sales taxes on business inputs are not taken into account.

In computing tax liabilities, the authors attempt to take into account as many of the features of taxes as the underlying data allow, including exemptions, exclusions, apportionment formulas, and tax credits.   Complete details of the tax calculations are available from the authors on request. Following is a brief discussion of some key assumptions used in calculating some of the taxes where computation of tax liability was not straightforward.

Property taxes. The property tax burden on each representative firm equals the statewide average ratio of nonresidential property tax receipts to the fair market value of nonresidential property.   Data were obtained from state tax officials in each of the states in the study. For the few states that have not disaggregated equalized values and property tax receipts into residential and nonresidential components, the authors use the ratio of total property tax receipts to the estimated equalized value of all property, both residential and nonresidential.

Unemployment insurance taxes. The unemployment insurance taxes per taxpaying firm were computed as the per capita liability that the average firm would owe if the firm were taxed at the “new employer’s” tax rate and each new employee earned at least the minimum threshold amount of taxable payroll. The tax liability is adjusted for inflation. The tax per worker is an average for the states in which the firm operates, weighted by the portion of the firm’s employment in each state. The number of workers in each firm is determined by the employment-to-capital ratio of the industry in question (see Appendix Table 1). As noted in the text of the article, in the pre-expansion phase, 10 percent of employment is assumed to be located in the 21 states in the sample where the firm is not headquartered. This “out-of-headquarters” employment is allocated among the 21 states in proportion to their personal income.

Corporate income taxes. As noted in the text, in the pre-expansion phase 90 percent of sales and 10 percent of property and payroll are assumed to be located in the 21 states in the sample other than the state in which the firm’s headquarters is located. Among these 21 states, these 10 percent fractions are allocated according to these states’ personal income.

Special modeling challenges were posed by states that permit corporations to deduct their taxable corporate income from federal corporate income tax payments and corporate income tax liabilities incurred in other states. In situations involving states that allow a deduction for federal tax payments, the authors were required to make some assumption about the firm’s estimated tax payment strategy. The authors assumed that total federal tax payments during year t equal the firm's federal tax liability in year t-1.

That some states permit a deduction against corporate taxable income for state income taxes paid to other states creates the potential for an iterative loop. For example, consider a corporation with operations in two states, A and B. The corporation's headquarters are in state A, and it expands in B. As a result of the expansion, taxes owed to state B rise, increasing the deduction for taxes paid to other states provided for by state A. This lowers the corporation's apportionable taxable income, which lowers tax liability in both A and B, which lowers the deduction that the firm can take against taxable income in state B for taxes paid in state A, which raises taxes paid in state B, which raises the corporation's apportionable income, which raises taxes paid to both states, and so on. Fortunately, the iterative loop converges to a stable solution. The authors used the values for tax liability in each state in which the firm operates that were obtained after two iterations.

Net operating loss carryovers and carrybacks are not modeled because, by assumption, each firm is profitable in every year of its existence. Investment tax credits and employment tax credits are modeled, but, given the absence of necessary data, research and development credits are not.

Blocks IV through VI: Calculation of Federal Taxes, After-Tax Cash Flow, and Internal Rate of Return

In order to calculate federal taxes, the firm's total state and local taxes are deducted from before-tax book profits and are taxed at the federal statutory tax rates in effect in 1991. Then the model calculates the after-tax cash flow streams under the old and new investment paths by subtracting the sum of federal, state, and local taxes (including unemployment insurance taxes) from gross before-tax profits. Finally, the model calculates the internal rate of return of the new investment stream. It takes, as input, the annual returns from the expansion project and its cost. The returns are calculated as the difference between the new and old after-tax cash flows. The costs are calculated as the difference between the new and old investment paths.

Appendix Table 1

Estimated Asset Mix and Selected Other Variables, by Industry
(millions of dollars, unless otherwise noted)

Concept	Men's and Boy's Furnishings	Cutlery, Hand Tools and Hardware	Office, Computing, Accounting Machine	Electronic Components and Accessories	Scientific Instruments, Measuring Devices
Total Assets	100.0	100.0	100.0	100.0	100.0
Working Assets	50.4	40.4	54.3	62.0	64.0
Cash	2.3	2.2	3.3	7.0	6.5
Net Receivables	6.9	9.2	14.5	14.4	15.3
Inventories	25.5	13.0	12.9	19.5	19.0
Land	0.5	0.9	0.8	1.1	1.6
Structures	6.8	5.1	8.2	6.4	9.9
Equipment	8.4	10.0	14.6	13.6	11.7
Non-Working Assets	49.6	59.6	45.7	38.0	36.0
Rent	1.5	0.9	1.5	1.5	1.5
Gross Receipts	136.8	94.9	96.9	126.9	139.0
Net Worth	25.2	38.3	37.7	40.2	41.7
Employment Ratio[a]	113.7	23.0	20.5	19.6	24.9

Sources: U.S. Internal Revenue Service, *1988 Corporation Source Book of Statistics of Income*; U.S. Bureau of the Census, *1991 Annual Survey of Manufacturers*; U.S. Bureau of Economic Analysis, *National Income and Product Accounts*.

Notes: Information on employment-capital ratios was taken from detail at the two-digit level.

[a] Employment ratio is workers per million dollars of depreciable property.

Appendix Table 2

Steady-State Investment Flow
Required to Maintain Stock of $1
(constant dollars, alternative service lives)

Service Life (years)	Investment (dollars)
5	0.333
10	0.182
12	0.151
15	0.125
20	0.095
25	0.077
30	0.065
32	0.061

Appendix Table 3

Example Demonstrating Why Steady-State Investment Flow Required to Maintain a Stock of $1 is $.333 When Service Life of Asset is 5 Years

Year	1	2	3	4	5	6	7
Vintage:							
1	$1	$0.800	$0.600	$ 0.40	$ 0.200	$ -	
2		$0.333	$ 0.264	$ 0.200	$ 0.133	$ 0.067	
3			$0.333	$ 0.264	$ 0.200	$ 0.133	$ 0.067
4				$ 0.333	$ 0.264	$ 0.200	$ 0.133
5					$ 0.333	$ 0.264	$ 0.200
6						$ 0.333	$ 0.264
7							$ 0.333
Total	$1	$1.13	$1.197	$1.197	$ 1.130	$ 0.997	$ 0.997