The Texas State Tax Analysis Modeling Program (Texas-STAMP)

Methodology and Applications

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The Beacon Hill Institute at Suffolk University in Boston, Massachusetts focuses on federal, state and local economic policies as they affect citizens and businesses. The Institute conducts research and educational programs to provide timely, concise and readable analyses that help voters, policymakers and opinion leaders understand today's leading public policy issues.

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Executive Summary

For many years there was a tradition in state government to treat taxes as if they didn't matter. It was presumed that businesses and individuals cared mainly about state and local government services and infrastructure: States could raise taxes without regard to any adverse economic effects.

That tradition is giving way to an economic reality: State taxes do matter. This is especially true in today's competitive economic environment in which firms are able and willing to move from one state to another as tax incentives become available to them.

Assessing the effects of proposed tax-law changes using reliable, credible methods is therefore crucial. In response to this demonstrated need, the Beacon Hill Institute at Suffolk University in Boston developed STAMP, the State Tax Analysis Modeling Program. STAMP permits policymakers, opinion leaders and scholars to determine how a change in state tax law will affect the state economy.

As an "econometric model," STAMP applies economic and statistical methods to state and federal data to determine how state economic indicators vary with changes in state tax law. The economic indicators usually considered by STAMP are the number of jobs, wage rates, the capital stock and tax revenues. The capital stock is the total value of nonresidential capital, including manufacturing facilities, office and warehouse space, business equipment and other items that business uses in production.

STAMP permits its users to "simulate" the effects on these indicators of alternative tax-law changes and combinations of tax-law changes. Using STAMP, we can, for example, estimate the effects on employment of a simultaneous reduction in property taxes and increase in the state sales tax.

States frequently rely on "static" models that attempt to determine the effects of tax-law changes on tax revenues. These models make the simplifying assumption that changes in tax law have no effect on economic activity. For example, in a static model, a rise in the sales tax rate would be assumed to have no effect on sales. A 20% rise in the sales tax rate would be expected to bring about a 20% rise in sales tax revenue.

STAMP is, in contrast, a “dynamic” model. Dynamic models determine the effects of tax-law changes on tax revenues by taking into account how those changes affect economic activity. In a dynamic model, a rise in the sales tax rate would ordinarily be expected to bring about a decrease in sales. Thus a 20% rise in the sales tax rate would bring about a less-than-20% rise in sales tax revenue.

History of STAMP

BHI developed STAMP in 1994 in recognition of a need for a dynamic modeling capability in Massachusetts. The Massachusetts STAMP was first applied to a state ballot initiative that would have replaced the existing flat tax with a graduated income tax. STAMP showed that the proposed graduated income tax would have destroyed about 80,000 jobs and more than $1 billion in wages. The voters overwhelmingly rejected the initiative.

Subsequently, at the request of the Oklahoma Office of State Finance, BHI developed a STAMP for Oklahoma. In 1997, BHI provided evidence supporting the view held by state officials that a cut in income or sales taxes would increase personal income. Also in 1997, BHI built a New Jersey STAMP that showed how recent income tax cuts had resulted in the creation of about 25,000 new jobs and of more than $2 billion in new capital spending.

In January 1998, BHI released the results of an Ohio STAMP showing how a proposed increase in the state sales tax from 5% to 6% would destroy about 100,000 jobs and $3 billion in wages. The governor had proposed the tax hike as a way of raising $1 billion in new revenue to fund education spending. The state legislature rejected the tax hike, as did the voters overwhelmingly in a subsequent referendum.

Other tax analyses performed by BHI include an evaluation, in 1997, of a proposed reduction in the Iowa income tax and, in 1998, of a proposed oil processing tax in Louisiana. The Iowa study figured in a 10% tax cut adopted by the Iowa legislature. The Louisiana study showed that replacing the existing severance tax with a processing tax would slow the state economy by raising refiners’ costs and the price of gasoline.

Texas-STAMP

Texas-STAMP is STAMP applied to the Texas economy. Estimated from Texas and U.S. data for 1970-1996 and for eight sectors of the Texas economy, it is designed to trace the economic effects of Texas tax-law changes. It can be applied to changes in the state sales tax, state unemployment insurance and workers compensation tax rates, property tax rates, and the state franchise tax. It shows how increases in these tax rates exert measurable, negative effects on the state economy.

How does STAMP work?

STAMP works by using certain "coefficients" obtained from the data to show how economic indicators such as jobs vary with changes in tax law. The coefficients are obtained from the data by estimating regression equations that link jobs and the other economic indicators to factors, notably tax rates, that influence those indicators.

Economists sometimes estimate the coefficients that link policy changes to economic changes without specifying the underlying theory on which those coefficients are based. STAMP avoids this error. The regression equations in STAMP are "reduced-form" equations, derived from a set of "structural equations" that lay out explicitly the theoretical underpinnings of the model.

STAMP's theoretical underpinnings are the stuff of standard economics texts: Households demand goods and services. If government raises taxes on the purchase of these goods and services, households will buy less of them. Households also supply labor to firms. If labor services are taxed more heavily, then households will supply less of them.

Firms are assumed to maximize profit, which they do by combining labor and capital in order to produce the goods and services that households demand. In this process, firms supply goods and services. If they have to pay a higher sales tax, then they will charge more for their goods, sell less as a result, and have to reduce production. Firms also pay wages and salaries to their workers. If the cost of hiring their workers rises, for example, because unemployment insurance payments grow, then they will economize on their use of labor by cutting back or finding substitutes.

What are the model's "coefficients?"

Our estimates of the model's reduced form equations are as follows:

Equation 1: Jobs

ln(number of jobs) = -0.1342 ln(government transfers per nonworking adult)
(0.00)
-0.0250 Nonwage labor costs as a percent of the wage
(0.00)
+0.0061 Federal tax rate on labor income
(0.00)
-0.0077 Effective sales tax rate
(0.09)
-0.0306 Cost of capital
(0.00)
+0.6492 ln(working age population)
(0.00)
+ constant terms for each of eight sectors of the economy
+ terms with indices of U.S. output, for each of eight sectors of the economy.

There are six coefficients, each with an associated p-value given below it in parentheses. The p-values measure the statistical significance of the coefficients. We follow the convention whereby a coefficient is deemed statistically significant if its p-value is less than .10. A p-value below 0.10 indicates that there is less than a 10% chance that the true value of the coefficient is zero.

Here the dependent variable is the logarithm of the number of jobs. The first independent variable is the logarithm of government transfers per nonworking adult. The coefficient for this variable reflects the theoretical idea that transfer payments in the form of unemployment and welfare benefits decrease the number of jobs. The negative coefficient indicates that when these payments are larger, employment will be lower, presumably because the transfers will mean that people have less pressure to search for work. Specifically, the coefficient implies that a 1% increase in government transfers decreases jobs by .1342%.

Nonwage labor costs refer to disability and unemployment insurance payments made by employers. These costs have much the same effect as a tax on labor, and the estimated equation shows that when the costs rise, employers will cut back on hiring.

The estimated equation also shows that higher property taxes or sales taxes will reduce employment. The sales tax, as measured here, includes the ordinary sales and use tax and also the state taxes on gasoline, diesel fuel and motor vehicle sales.

A higher cost of capital has the same effect. The cost of capital measures how much employers have to pay to "hire" the capital they use. It is a complex measure, which reflects the size of depreciation, the cost of borrowing (i.e. interest rate), and the numerous taxes that bear on capital (including the state corporate franchise tax, the federal corporate income tax, and federal taxes on dividend income and capital gains).

Equation 2: Wages

ln(wage rate) =
+0.0190 ln(government transfers per nonworking adult)
(0.01)
+0.0094 Nonwage labor costs as a percent of the wage
(0.03)
+0.0021 Federal tax rate on labor income
(0.00)
+0.0175 Effective sales tax rate
(0.00)
-0.0021 Cost of capital
(0.50)
+0.3550 ln(working age population)
(0.00)
+constant terms for each of eight sectors of the economy
+terms with ln(non-Texas wage rate), for each of eight sectors of the economy.

This equation also gives sensible results, but needs to be interpreted with care. It shows that when government transfers are higher, the wage rate will also be higher. A reasonable explanation is that the safety net gives workers an alternative to working at very low wages. At first sight it might seem odd that a higher sales tax, nonwage labor costs, or federal tax rate would *raise* the wage rate. Yet the logic is sound; when these taxes are higher, workers will require higher pre-tax wages in order for it to be worth their while to work. In each case, however, the after-tax wage would be lower than before.

Equation 3: Capital Stock

ln(stock of capital) =
-0.0389 ln(government transfers per nonworking adult)
(0.00)
-0.0133 Nonwage labor costs as a percent of the wage
(0.08)
+0.0018 Federal tax rate on labor income
(0.18)
+0.0088 Effective sales tax rate
(0.18)
-0.0286 Cost of capital
(0.00)
+1.2760 ln(working age population)
(0.00)
+ constant terms for each of eight sectors of the economy
+ term with index of U.S. output.

This equation has no surprises. If capital is more expensive, less will be used. If sales and property taxes are higher, business will refrain from investing in the state.

How does the model simulate the effects of tax changes?

The simulations are done for 1999 and proceed in two steps. First we project what the value of the most import variables - employment, wages, capital stock, and the like - will be in 1999. Then we use the model to measure what happens to these variables when a change is made to the tax system. The 1999 baseline values for the most important variables are summarized below. Further details are provided in the main report.

Baseline Values of Variables Required for Simulations

Variable	Units	1996	1997	1998	1999	Assumptions
Labor	mill. jobs	8.725	9.092	9.401	9.617	Same as growth in nonfarm employment
Capital	$ billion	656	707	758	811	Constant capital/payroll ratio
Wage rate	$/job/yr	27704	28688	29714	31109	Same as growth in personal income net of labor growth
Working age population	thousands	12274	12519	12745	12974	Same as growth of resident population
Welfare payment per nonworking adult	$	1799	1833	1869	1904	Extrapolate using 1993-96 nominal growth rate
Nonwage labor costs as % of wage	%	0.52	0.52	0.52	0.52	Extrapolate using 1992-1996 nominal growth rate
Federal tax on labor income	%	18.4	18.4	18.4	18.4	Constant over time
Tax on industrial & commercial prop.	%	1.38	1.38	1.38	1.38	Constant over time
Sales tax rate	%	6.89	6.54	6.31	6.19	Tx projections; extrapolation for 1999
Cost of capital	%	12.82	12.82	12.82	12.82	Constant over time

Source: From Table 1 in the main report.

Applying the model to current tax issues in Texas

A large number of tax proposals have surfaced in Texas over the past couple of years. Most of these can usefully be analyzed using Texas-STAMP. Five of the most important such proposals are summarized below, followed by a discussion of their economic effects.

Five important tax proposals or changes

Sales tax cut

Governor Bush recently proposed changes in the sales tax that would, according to the Governor Bush Committee, amount to a tax cut of $200 million. Specifically, the change would repeal the current 6.25% sales tax on over-the-counter medicines, diapers and first-aid items; and it would provide a two-week "back to school" sales tax holiday for school clothing and footwear.

Business R&D tax credit

Texas is one of only five states that does not give businesses a tax credit for research and development (R&D) or for capital investments. Intel Corporation leads a coalition that is lobbying for an investment tax credit. Telecommunications firms, heavily concentrated in the North Dallas area, favor an R&D tax credit. The budget office estimates that a tax credit would cost about $250 million in lost revenue over a two-year period, which means an annual cost of $125 million. The R&D credit has the backing of Governor Bush.

Raise the homestead exemption by $10,000

In early 1997, Governor Bush proposed that the homestead exemption, then at $5,000 per residence, be raised by $20,000 for the purposes of computing school maintenance and operation (M&O) property tax. The intention of the proposal was to reduce the fiscal pressure on homeowners, who had seen their property tax payments rise rapidly over the previous decade. The direct effect of the larger exemption would be to lower tax revenue (to school districts) by $981 million, making this a sizeable tax cut. The legislature ultimately raised the exemption by $10,000, which is the policy change whose effects are simulated in this study.

Reduce the property tax rate by 13¢ per $100

As part of the 1998 package of property tax relief proposals, Governor Bush has proposed reducing the school M&O property tax by 13¢ per $100 (i.e. 0.13 percentage points), from its average of about $1.24 per $100 of valuation. The change would apply to property tax levied on residential as well as commercial and industrial property. The direct revenue effect would be to lower takings by $1.11 billion.

Exempt certain businesses from the franchise tax

The business franchise tax is levied on corporate income and/or capital, depending on which method yields the most. The tax is particularly onerous on small businesses, which sometimes incur hundreds of dollars in expenses in order to calculate tax bills that may be as low as $100. In order to reduce the burden on small firms, Governor Bush has proposed exempting from the franchise tax all firms with a turnover under $100,000 annually. The direct effect would be to lower revenues by $28.6 million per year.

The economic effects of these tax changes are summarized in the next table. Some additional comments on the findings are in order.

The cut in the *sales tax* would lead to 10,953 more jobs. While this is a large number, it represents an increase of just 0.11% in the number of jobs in Texas. The "static" effect of this tax change would be to reduce state revenue by $200 million. However this would be offset to some degree by additional revenues that would result from the fact that more people would be working, and there would be more capital to subject to property tax. The net effect would be to reduce tax revenue (at the state and local levels together) by just $182 million.

Summary Effects of Tax Changes

	A Cut sales tax by $200m		B Business R&D tax credit of $125m Mean response		B Business R&D tax credit of $125m 95% Range
		%		%	
Economic effects					
Number of jobs	+10,953	0.11	+136	0.001	92-180
Capital stock ($ million)	+900	0.11	+11	0.001	7-14
Wage rate ($/job/year)	-31	-0.10	0	0	
Working age population	+11,288	0.09	0	0	
Payroll ($ million)	+44	0.02	+4	0.001	3-6
Revenue effects ($ million):					
"Static"					
Sales tax	-200				
Franchise tax			-125		-125
Property tax (business)					
Property tax (residential)					
"Dynamic"					
Sales tax	+3		+.2		0.16-0.30
Franchise tax	+2				
Property tax (business)	+13		+.2		0.10-0.20
Therefore					
Net effect on tax revenue	-182	-0.89	-125	-0.61	-124.5 to -124.7
Memo items:					
Total state tax revenue	20,564				
Revenue from sales tax	12,248				

	C Cut residential property tax via extra $10,000 exemption		D Cut property tax via rate reduction of 13¢/$100		E Exempt businesses with gross receipts of $100,000 or less from franchise tax	
		%		%		%
Economic effects						
Number of jobs	+25,449	0.265	+39,710	+0.41	+31	0.0003
Capital stock ($ million)	+4,220	0.520	+5,059	+0.62	+2	0.0003
Wage rate ($/job/year)	+45	0.145	-5	-0.02	0	0.0000
Working age population	+52,990	0.408	+60,868	+0.47	0	0.0000
Payroll ($ million)	+1,226	0.410	+1,186	+0.40	+1	0.0003
Revenue effects ($ million):						
"Static"						
Sales tax						
Franchise tax					-28.6	
Property tax (business)			-547			
Property tax (residential)	-491		-563			
"Dynamic"						
Sales tax	+67		+66		+.05	
Franchise tax	+10		+12		+.01	
Property tax (business)	+58		+70		+.03	
Therefore						
Net effect on tax revenue	-355	-1.726	-962	-4.68	-28.5	-0.14
Memo items:						
Total state tax revenue						
Revenue from sales tax						

Source: From simulations using the Texas-STAMP model.
Rounding may occur in the numbers.

The *business tax credit* would have a surprisingly small economic effect - creating no more than about 180 jobs overall - but there is a clear and logical explanation for this. First, the tax cut is relatively small; it represents just 0.6% of state revenue, and would cut the cost of capital to Texas firms by a mere 0.05%. Second, the tax credit leaves corporations with more profit after tax, but over a third of this windfall goes immediately to the federal government, as the higher profit triggers higher payments of corporation income tax. Third, as the fast-diminishing windfall is paid to owners as dividends (or accrues as capital gains), it is subject to federal taxes on personal income, which will again reduce the amount left for owners. The net effect is to lower the after-tax rental cost of capital from 14.21% to 14.20%. It is not surprising that such a small change in the cost of capital will have almost negligible economic effects.

It is sometimes argued that if the business tax credit takes the form of an *R&D tax credit,* this would ultimately have additional "downstream effects." This reasoning is based on the idea that when firms locate their R&D in Texas, then manufacturing and other facilities will tend to follow. It is not at all evident that R&D leads and manufacturing follows; an equally plausible case can be made that manufacturing facilities lead and R&D follows, in which case the argument for providing tax credits for R&D (rather than for other forms of investment) is greatly weakened. The Texas-STAMP model treats all tax credits equally, and is not designed to measure the possible differential effects of different forms of tax credits.

On the other hand, these estimates are based on the assumption that the tax credit for R&D done in Texas is significantly offset by higher tax payments to the federal government. However, firms undertaking new R&D in Texas would benefit not only from the Texas tax credit, but also from the federal R&D incentive. The net effect is to lower the cost of R&D quite substantially, leading to new R&D expenditures for which we do not attempt to account. Thus our estimates of the effects of the Texas R&D should be thought of as lower bounds.

The effect of the *$10,000 extra property tax exemption*, according to the Texas-STAMP model, is to increase the number of jobs by 25,449 (+0.265%) and the capital stock by $4.2 billion (+0.520%). The increased exemption will add $1.2 billion to state payrolls and induce almost 53,000 working-age adults to enter the state.

The Texas-STAMP model shows that *a 13¢ per $100 cut in the property tax rate* would have a substantial economic effect: employment would rise by 39,710 and the capital stock by $5.1 billion. While the direct ("static") loss of tax revenue would be $1,110 million, the additional economic activity triggered by this change would lead to $148 million in extra tax revenue (the "dynamic" effect), for a net revenue loss of $962 million.

Exempting businesses with gross receipts not exceeding $100,000 from the franchise tax would have almost no effect on the economy: The effects on jobs and capital spending, and therefore also tax revenue, would be negligible. However the main purpose of this tax cut is to reduce the burden of paperwork for small firms, an effect that the Texas-STAMP model is not designed to measure.

These simulation exercises illustrate the manner in which the Texas-STAMP model can shed light on the economic effects of changes in the system of state taxes in Texas. As with any modeling, the results should be taken as indicative of the orders of magnitude involved, since it is not possible to predict the effects of tax changes with great precision.

The Texas State Tax Analysis Modeling Program
Methodology and Applications

1. Introduction

Changes in tax rates have measurable effects on taxable activities. The weight of evidence shows that state-level tax increases have significant negative effects on state economic activity.[1] Yet it is not easy to quantify these effects, and the job can only be done satisfactorily with the help of a complete tax model.

This report quantifies the economic effects of eight proposals that have been made over the past two years, by Governor Bush and by others, to change the structure of taxes in Texas. The economic effects are simulated using a tax model that was build to fit Texan conditions, and was estimated using data for the state for the period 1970-1996.

The results of the simulations are set out in Chapter 2, along with explanations of the effects. Readers interested in the underlying model should turn to Chapter 3, where the theoretical underpinnings are described and the estimating equations derived. The sources of data, and methods used to construct the variables, are the focuses of Chapter 4. The equation estimates are presented and evaluated in Chapter 5.

[1] Timothy J. Bartik, *Who Benefits from State and Local Economic Development Policies?* (Kalamazoo, Michigan: W.E. Upjohn Institute for Employment Research, 1991).

2. Simulating the Effects of Tax Changes in Texas

The structure and levels of taxes are subject to heated debate in all states, and Texas is no exception. Over the past two years, several serious tax changes have been proposed, including lowering property taxes, replacing the business franchise tax with a business tax, and altering the sales tax rate. In this chapter we identify six important proposals, and quantify their effects on the number of jobs, the size of the stock of capital, and wage rates in Texas.

In each case the basic approach is first to establish baseline values of the variables of interest (number of workers, wage rate, capital stock, working age population, tax revenue) without the tax change. Then we use the Texas-STAMP model to determine the values of these variables in the presence of the tax change. It is then straightforward to isolate the effects of the tax change itself. Fortunately the results are not particularly sensitive to the choice of the baseline.

We have established baseline values for all the main variables for 1999, to serve as our points of reference. These are shown in Table 1, along with the assumptions used to derive them. We now consider each of the tax proposals in more detail; a summary of the various proposals is given in Table 2.

A. A $200 Million Consumer Tax Cut

Governor Bush recently proposed changes in the sales tax that would, according to the Governor Bush Committee, amount to a tax cut of $200 million. Specifically, the change would repeal the current 6.25% sales tax on over-the-counter medicines, diapers and first-aid items; and it would provide a two-week "back to school" sales tax holiday for school clothing and footwear.

In tracing the effects of this proposed tax change, it is assumed that the change is fully in effect in 1999. The effective sales tax rate is expected to be 6.191% in the absence of any tax change. The “effective” sales tax refers to the sales and use tax as well as the motor vehicle sales tax and state excises on gasoline and diesel fuel. The proposed change would reduce the effective tax rate by 0.074 percentage points to 6.117%. This in turn would increase the amount of labor by 0.114%, or by 10,953 jobs. Similar calculations show that the capital stock would rise by

$900 and payroll payments by $44 million. The wage rate would drop by $31 per job per year, offsetting part of the tax cut.

Table 1
Baseline Values of Variables Required for Simulations

Variable	Unit	1996	1997	1998	1999	Assumptions
Labor	mill/jobs	8.725	9.092	9.401	9.617	Same as growth in nonfarm employment.*
Capital	$ billion	656	707	758	811	Constant capital/payroll ratio.
Wage rate	$/job	27704	28688	29714	31109	Same as growth in personal income net of labor growth.*
Working age population	'000	12274	12519	12745	12974	Same as growth of resident population.
Welfare payment per nonworking adult	$	1799	1833	1869	1904	Extrapolate using 1993-96 nominal growth rate.
Nonwage labor costs as % of wage	%	0.52	0.52	0.52	0.52	Extrapolate using 1992-1996 nominal growth rate.
Federal tax on labor income	%	18.4	18.4	18.4	18.4	Constant over time.
Tax on industrial & commercial prop.	%	1.38	1.38	1.38	1.38	Constant over time.
Tax on res. property	%	1.24	1.24	1.24	1.24	Constant over time.
Sales tax rate	%	6.89	6.54	6.31	6.19	Tx projections; extrapolation for 1999.*
Retail sales	$ billion	216	234	253	269	Tx projections.*
Corporate profit	$ million	60361	66069	67322	69910	Tx projections of revenue; assume constant rate.
Franchise tax rate	%	2.72	2.72	2.72	2.72	Constant over time.
Property value: industrial & commercial	$ billion	350	378	405	433	Same growth as nominal personal income.
Property value: residential	$ billion	340	367	396	421	Same growth as nominal personal income.
Cost of capital	%	12.82	12.82	12.82	12.82	Constant over time.
Revenue, all sales taxes	$ million	10756	11315	11775	12248	Tx projections.*
All tax revenue	$ million		19383	19482	20564	Tx projections.*

* Projections from Texas Comptroller's Office, December 1998.

The cut in the sales tax makes it more profitable for firms to produce, so they expand their hiring. Capital spending also becomes more worthwhile and rises too. At the same time, consumers find that they face lower prices, so the money they earn stretches further. This increases the supply of labor, which is what pushes the wage rate down. The lower wage rate further encourages firms to hire labor.

The economic effects of the change are summarized in Table 3, along with those of all the other tax simulations. Also shown in this table are the revenue effects of the change. The "static" effect of the tax change would be to reduce state revenue by $200 million. However this would be offset to some degree by additional revenues that would result from the fact that more people would be working, and there would be more capital to subject to property tax. The net effect would be to reduce tax revenue (at the state and local levels together) by $182 million.

Table 2
Summary of Tax Proposals Evaluated

	Proposals	Annual direct revenue effects, $million	Comments
A	Cut sales tax revenue by repealing tax on over-the-counter medicines, plus two-week back to school tax holiday for school clothing and footwear	-200	Source: Governor Bush Committee: *1998 Tax Cut and Economic Development Proposals* (undated).
B	Business R&D tax credit	-125	Source: *Wall Street Journal Interactive Edition*, 2 Dec. 1998. Credit under consideration might be for R&D or for investment.
C	Abolish "business inventory" tax	-663	Source: Governor Bush Committee: *Cutting Texas Taxes* (29 Jan. 1997). This tax is the maintenance and operation part of the school property tax.
D	Increase homestead exemption by $10,000	-491	Source: As in C. Covers the M&O portion of school taxes only.
E	Lower property tax rate by 13¢ per $100	-1,110	Source: As in A. Covers school tax rates only.
F	Abolish the franchise tax for small business	-29	Source: As in C.

B. A Business Tax Credit of $125 Million

Texas is one of only five states that does not give businesses a tax credit for research and development (R&D) or for capital investments. Intel Corp. leads a coalition that is lobbying for an investment tax credit. Telecommunications firms, heavily concentrated in the North Dallas area, favor an R&D tax credit, and this is the option that has the backing of Governor Bush. The budget office estimates that a tax credit would cost about $250 million in lost revenue over a two-year period, which means an annual cost of $125 million.

Table 3
Summary Effects of Tax Changes

	A Cut sales tax by $200m		B Business R&D tax credit of $125m		
			Mean response		95% Range
		%		%	
Economic effects					
Number of jobs	+10,953	0.11	+136	0.001	92-180
Capital stock ($ million)	+900	0.11	+11	0.001	7-14
Wage rate ($/job/year)	-31	-0.10	0	0	
Working age population	+11,288	0.09	0	0	
Payroll ($ million)	+44	0.02	+4	0.001	3-6
Revenue effects ($ million):					
"Static"					
Sales tax	-200				
Franchise tax			-125		-125
Property tax (business)					
Property tax (residential)					
"Dynamic"					
Sales tax	+3		+.2		0.16-0.30
Franchise tax	+2				
Property tax (business)	+13		+.2		0.10-0.20
Therefore					
Net effect on tax revenue	-182	-0.89	-125	-0.61	-124.5 to -124.7
Memo items:					
Total state tax revenue	20,564				
Revenue from sales tax	12,248				

	C Cut residential property tax via extra $10,000 exemption		D Cut property tax via rate reduction of 13¢/$100		E Exempt businesses with gross receipts of $100,000 or less from franchise tax	
		%		%		%
Economic effects						
Number of jobs	+25,449	0.265	+39,710	+0.41	+31	0.0003
Capital stock ($ million)	+4,220	0.520	+5,059	+0.62	+2	0.0003
Wage rate ($/job/year)	+45	0.145	-5	-0.02	0	0.0000
Working age population	+52,990	0.408	+60,868	+0.47	0	0.0000
Payroll ($ million)	+1,226	0.410	+1,186	+0.40	+1	0.0003
Revenue effects ($ million):						
"Static"						
Sales tax						
Franchise tax					-28.6	
Property tax (business)			-547			
Property tax (residential)	-491		-563			
"Dynamic"						
Sales tax	+67		+66		+.05	
Franchise tax	+10		+12		+.01	
Property tax (business)	+58		+70		+.03	
Therefore						
Net effect on tax revenue	-355	-1.726	-962	-4.68	-28.5	-0.14
Memo items:						
Total state tax revenue						
Revenue from sales tax						

Source: From simulations using the Texas-STAMP model.
Rounding may occur in the numbers.

This tax cut would have the same effect as reducing the franchise tax rate from 2.72% to 2.54%, or by 0.18 percentage points. The economic effects of this change, using the Texas-

STAMP model, are shown in Table 3. Most striking about these results is how small the economic effects are, adding $11 million to the stock of capital and creating just 136 jobs. This is our best estimate of the effect. Given the imprecision that is inherent in any modeling, one might prefer to express the effect as a range: there is a 95% probability that the number of jobs created would be between 92 and 180.

The small size of the effects is easy to explain. First, the tax cut is relatively small; it represents just 0.6% of state revenue, and would cut the cost of capital to Texas firms by a mere 0.05%. Second, the tax credit leaves corporations with more profit after tax, but over a third of this windfall goes immediately to the federal government, as the higher profit triggers higher payments of corporation income tax. Third, as the fast-diminishing windfall is paid to owners as dividends (or accrues as capital gains), it is subject to federal taxes on personal income, which will again reduce the amount left for owners. The net effect is to lower the after-tax rental cost of capital from 14.21% to 14.20%. It is not surprising that such a small change in the cost of capital will have almost negligible economic effects.

It is sometimes argued that if the business tax credit takes the form of an *R&D tax credit,* this would ultimately have additional "downstream effects." This reasoning is based on the idea that when firms locate their R&D in Texas, then manufacturing and other facilities will tend to follow. It is not at all evident that R&D leads and manufacturing follows; an equally plausible case can be made that manufacturing facilities lead and R&D follows, in which case the argument for providing tax credits for R&D (rather than for other forms of investment) is greatly weakened. The Texas-STAMP model treats all tax credits equally, and is not designed to measure the possible differential effects of different forms of tax credits.

C. Raise the Homestead Exemption by $10,000

In early 1997, the state legislature increased the homestead exemption, then at $5,000 per residence, to $15,000 for the purposes of computing school maintenance and operation (M&O) property tax. A constitutional change approved by the voters in the same year limited increases in property valuations to no more than 10% per year.

The intention of the proposal was to reduce the fiscal pressure on homeowners, who had seen their property tax payments rise rapidly over the previous decade. The direct effect of the larger exemption is to lower tax revenue (to school districts) by $491 million, making this a sizeable tax cut.

The effect of the higher exemption, according to the Texas-STAMP model, is to increase the number of jobs by 25,449 (+0.265%) and the capital stock by $4.2 billion (+1.520%). The lower property tax will encourage migration into Texas, and the greater pool of available labor will permit employers to hire more people. This would be facilitated by the additional spending that households would do as a result of the annual windfall of $280 from the tax cut.

The large size of the economic effects generated by this tax needs to be treated cautiously, as it is one of the less robust parts of the model. Over the past two decades the property tax (on residential as well as on commercial and industrial property) has risen rapidly, as has the number of jobs in Texas. It is difficult to identify the direction or strength of causality in such cases.

D. Reduce the Property Tax Rate

Governor Bush is currently considering reducing the school M&O property tax by 13 cents per $100 (i.e. 0.13 percentage points), from its average of about $1.24 per $100 of valuation.

The Texas-STAMP model shows that the 13¢ per $100 cut in the property tax rate would have a substantial economic effect: employment would rise by 39,710 and the capital stock by $5.1 billion. While the direct ("static") loss of tax revenue would be $1,110 million, the additional economic activity triggered by this change would lead to $148 million in extra tax revenue (the "dynamic" effect), for a net revenue loss of $962 million.

E. Exempt More Small Businesses from Franchise Tax

One of the proposals by Governor Bush would exempt all businesses with gross receipts of $100,000 or less from the franchise tax. The Comptroller's Office estimates that this would reduce revenue by $57.2 million over a two-year period, or by $28.6 million annually. The main purpose of the exemption proposal is to reduce the nuisance factor, by relieving small firms of the necessity of filing tax returns for small amounts of money. The economic effects of the cut would be very small, partly because this represents a minor tax cut (little more than a dollar per Texas resident per year), and partly because much of the franchise tax that firms would save as a result of this change would be paid to the federal government instead.

F. Eliminate the "Internet Tax"

A proposal has also been made to eliminate the "Internet Tax." This tax is actually the 6.25% sales and use tax, applied to Internet access. At most it yields about $30 million, assuming that about 1.5 million computers pay $25 per month for Internet access. Its abolition would lead to 1,643 more jobs and $135 million in additional capital stock. These figures are plausible, reflecting the effects of the growth in this vigorous sector that might be expected if it faced a lower tax rate.

3. The Structure of the Texas-STAMP Model

A. The Essentials of the Model

Many attempts to model state tax-law changes proceed directly from "reduced-form" estimates that leave unanswered the question of the theoretical underpinnings on what those estimates are based.[2]

The Texas State Tax Analysis Modeling Program, Texas-STAMP for short, is a structural model, in that it is rooted in the optimizing behavior of households and firms. The wellbeing of households comes from the goods and services they consume, as well as the leisure time they enjoy. There is a tradeoff between the two, because by working more, the household earns the wherewithal to buy more goods and services, but now has less leisure time. The structure of taxes affects this tradeoff; thus, for instance, a higher tax on labor income will discourage some households from working.

The goods and services that households buy come from businesses. These firms need inputs of capital and labor, which they employ in such a way as to maximize their profits. The precise amount of capital and labor hired will depend, to some degree, on the level and structure of taxes faced by firms and their owners. A high property tax on commercial and industrial property, for instance, would discourage investment and lead to less employment and lower wages.

A strength of the STAMP family of tax models is that they measure tax rates in a theoretically appropriate way. We may think of households and firms as making decisions at the margin: Should I work an extra hour? Should I hire the services of an extra machine? Thus it is necessary to measure the weight of taxes at the margin too. The calculation of these marginal tax rates is difficult and time-consuming, which is why it is rarely done.

The two sectors, households/consumers and firms/producers, interact to determine equilibrium employment, wage rates and the stock of capital in the economy. Consider again the

[2] See, for example, Bartik.

example of a higher state tax on labor income. As some households work less, employers will now face a lower supply of labor, and so the (pre-tax) wage rate will rise somewhat. This would result in a decrease in the equilibrium amount of labor employed in the market.

The structural model cannot be estimated directly. Instead it is rearranged as a set of reduced form equations, where the variables of interest to us (employment, the stock of capital, and the wage rate) are expressed as a function of the relevant policy variables, including tax rates.

The formal structure of the model is described in detail below, where the reduced form equations are also derived. Readers interested in other aspects of the model may turn directly to the discussion of the data that is given in Chapter 4, to the estimation results in Chapter 5, or to the applications in Chapter 2.

B. Labor Supply by Households

Households with a fixed labor endowment of $\bar{L}$ choose how to divide $\bar{L}$ between work (L) and leisure ($l = \bar{L} - L$) based on the maximization of a utility function subject to a budget constraint. The household budget is the sum of the value of labor endowments (whether sold or retained as leisure) and unearned income. The household consumes goods and leisure, where the price of leisure is the after-tax wage rate. Assuming a Cobb-Douglas utility function, the household choice problem is then specified as:

$$\text{(3.1)} \quad \text{Max}U = AC^{\theta} l^{1-\theta},$$

or alternatively

$$\text{(3.2)} \quad \text{Max}U = AC^{\theta} (\bar{L} - L)^{1-\theta},$$

subject to

$$\text{(3.3)} \quad C = \left\{ wL\left(1 - t_{fl}\right)\left(1 - t_{sl}\right) + G_{tr} + \mu\gamma rK \right\}\left(1 - t_{sa}\right) + \left(1 - \mu\right)\gamma rK.$$

Equation (3.3) shows that consumption spending comes from after-tax earnings, transfer payments from the federal government, and income from capital. A fraction γ of the capital income (rK) generated in Texas accrues to residents of Texas. Of this, a proportion μ is spent in the state, and so has to face sales tax; the remainder is spent outside the state, and so escapes the sales tax. The variables in equation (3.3) are:

C = the consumption of goods and services;
L = the amount of time spent working;
w = the wage rate;
t_{fl} = the federal tax rate on labor income;
t_{sl} = the state tax rate on labor income;
G_{tr} = government transfer payments;
γ = the fraction of capital income generated in Texas that accrues to Texas residents;
μ = the proportion of locally-accruing capital income that is spent in Texas;
r = the rental cost of capital;
K = the stock of capital used in the state; and
t_{sa} = the sales tax rate on goods sold in the state.

The problem in (3.2) can be rewritten as:

$$(3.4) \quad \text{Max}\Psi = AC^{\theta}\left(\bar{L}-L\right)^{1-\theta} + \lambda\left[C - \left\{wL\left(1-t_{fl}\right)\left(1-t_{sl}\right) + G_{tr} + \mu\gamma rK\right\}\left(1-t_{sa}\right) - \left(1-\mu\right)\gamma rK\right].$$

Maximizing Ψ with respect to C and L, and rearranging yields

$$(3.5) \quad C = \frac{\theta\left(\bar{L}-L\right)\left\{w\left(1-t_{fl}\right)\left(1-t_{sl}\right)\left(1-t_{sa}\right)\right\}}{1-\theta}$$

and substitution back into (3.3) gives

$$(3.6) \quad \frac{\theta}{1-\theta}\left(\bar{L}-L\right)w\left(1-t_{fl}\right)\left(1-t_{sl}\right)\left(1-t_{sa}\right)$$
$$= \left(1-t_{sa}\right)wL\left(1-t_{fl}\right)\left(1-t_{sl}\right) + G_{tr}\left(1-t_{sa}\right) + \mu\gamma rK\left(1-t_{sa}\right) + \left(1-\mu\right)\gamma rK.$$

Further manipulation gives the individual supply of labor, L_i^s, as:

$$(3.7) \quad L_i^s = \theta\bar{L} - \left(1-\theta\right)\left\{\frac{G_{tr}}{w\left(1-t_{fl}\right)\left(1-t_{sl}\right)} + \frac{\left(1-\mu t_{sa}\right)\gamma rK}{w\left(1-t_{fl}\right)\left(1-t_{sl}\right)\left(1-t_{sa}\right)}\right\}.$$

Then, the aggregate supply of labor for the state, L^s, is specified as the state's working age population, PW, times the individual supply of labor:

$$(3.8) \quad L^s = \left(PW\right) \times \left[\theta\bar{L} - \left(1-\theta\right)\left\{\frac{G_{tr}}{w\left(1-t_{fl}\right)\left(1-t_{sl}\right)} + \frac{\left(1-\mu t_{sa}\right)\gamma rK}{w\left(1-t_{fl}\right)\left(1-t_{sl}\right)\left(1-t_{sa}\right)}\right\}\right].$$

A log-linear approximation of (3.8) gives:

$$(3.9) \quad \ln L^{s} \approx a_0 + a_1\ln(PW) + a_2\ln(G_{tr}) + a_3 t_{fl} + a_4 t_{sl} + a_5 \ln w + a_6 t_{sa} + a_7\ln(r) + a_8\ln(K),$$

where a_0 is a constant and all the other coefficients are negative, except for a_1 and a_5.[3]

C. *Labor and Capital Demand by Producers*

Producers use two primary production factors, labor (*L)* and capital (*K)*. They are assumed to maximize profit, given a production function and factor costs. The gross factor cost of labor (w^*) is the pretax wage rate (w) plus nonwage costs such as unemployment insurance and workers compensation. We treat these nonwage costs (v) as an ad valorem tax on the use of labor services, and measure it by the sum of the unemployment insurance tax rate and the workers compensation insurance rate paid, expressed as a percentage of total payroll. Formally this yields $w^*=w(1+v)$.

The gross factor cost of capital to producers, r, is derived from the equilibrium condition whereby the present value of the future income stream to the owners of capital (i.e., households) is equal to the price of capital. The cost of capital incorporates the cost of borrowing, along with the taxes on corporate profits and on capital income. One of the more important components of the cost of capital in the Texas context is the local tax rate on commercial and industrial property.[4]

The labor market in a state is influenced by national economic trends. To capture this, the model assumes that producers reflect nationwide economic conditions in their production decisions, i.e., other things being equal, they increase production when the national economy is strong. This effect is picked up by a variable q, that could be instrumented by the national unemployment rate or by an index of nonstate economic activity. We assume a Cobb-Douglas production function taking the following form:

$$(3.10) \quad Q = HqL^{\alpha}K^{\beta}$$

where q is the U.S. economic indicator, $0<\alpha, \beta<1$, and H is a parameter. The profit-maximizing problem may be written as:

[3] A detailed derivation, which also gives the signs of the coefficients, is available upon request.
[4] A full derivation of cost of capital appears in Appendix 3.

(3.11) Max. $\Pi = HqL^{\alpha}K^{\beta} - w^{*}L - rK$.

Maximizing Π with respect to *L* and *K* gives the demand for labor as:

(3.12) $\ln L^{d} = \lambda_0 + \lambda_q \ln q + \lambda_w \ln w^{*} + \lambda_r \ln r$

where $\lambda_q > 0$, λ_w, $\lambda_r < 0$. Similarly the demand for capital is given by

(3.13) $\ln K^{d} = \kappa_0 + \kappa_q \ln q + \kappa_w \ln w^{*} + \kappa_r \ln r$

where $\kappa_q > 0$ and κ_w, $\kappa_r < 0$.

D. Equilibrium in the Labor Market

By solving the system of structural equations (3.9), (3.12) and (3.13) simultaneously we arrive at a set of *reduced form equations* that express employment, the wage rate, and the stock of capital as functions of the remaining set of exogenous variables. These reduced form equations can then be estimated econometrically.

In equilibrium the labor market clears, which implies that labor supply (equation 3.9) equals labor demand (equation 3.12). Setting these equal and solving for $\ln(w^{*})$ gives

(3.14) $\ln w^{*} = \omega_0 + \omega_{PW} \ln PW + \omega_q \ln q + \omega_v v + \omega_r \ln r + \omega_g \ln G_{tr}$

$+ \omega_f t_{fl} + \omega_s t_{sl} + \omega_{sa} t_{sa}$

where $\omega_{PW} < 0$, ω_r has an ambiguous sign, and all the other coefficients are positive (although $\omega_v < 1$). Substituting (3.14) into (3.12) gives the reduced-form equation for equilibrium labor:

(3.15) $\ln L = \eta_0 + \eta_{PW} \ln PW + \eta_q \ln q + \eta_v v + \eta_r \ln r + \eta_g \ln G_{tr}$

$+ \eta_f t_{fl} + \eta_s t_{sl} + \eta_{sa} t_{sa}$.

Most of the coefficients in this equation are negative, although $\eta_{PW} > 0$, η_q has an ambiguous sign but is probably positive, and the sign of η_r cannot be predicted on theoretical grounds. Finally, substituting (3.14) into (3.13) gives the reduced-form equation for capital:

(3.16) $\ln K = \gamma_0 + \gamma_{PW} \ln PW + \gamma_q \ln q + \gamma_v v + \gamma_r \ln r + \gamma_g \ln G_{tr}$

$+ \gamma_f t_{fl} + \gamma_s t_{sl} + \gamma_{sa} t_{sa}$

where $\gamma_{PW} > 0$, γ_q is probably (but not necessarily) positive, the sign of γ_r is indeterminate, and all the other coefficients are expected to be negative.

E. Determination of Working Age Population

We postulate that migration into a state, and thus its population, is determined by job market conditions as well as the attractiveness of its living and working environment relative to that of other states. We consider that nonwage labor costs as a proportion of wage costs (v), the local residential property tax rate (t_{pr},) and the state sales tax (t_{sa}) are policy variables that attract or deter people from moving into or out of the state. Then, the variable of working age population is specified as:

$$(3.17) \quad \ln PW = \pi_0 + \pi_1 \ln(PW_{-1}) + \pi_v v + \pi_{pr} t_{pr} + \pi_{sa} t_{sa} + \pi_{fl} t_{fl}$$

where $\pi_1 > 0$, $\pi_v < 0$, $\pi_{sa} < 0$, and $\pi_{pr} < 0$.

4. Data Considerations

The estimates of the Texas-STAMP model are based on a set of the equations shown in (3.14)-(3.17). A full list of the variables used in the estimation, the way they are defined, and the sources of the information on which they are based, are given in Table 1. A value for each variable was constructed for each year from 1970 through 1996. All the dependent variables and some independent variables are for each of eight sectors of the economy.[5] Some of the variables, including the measures of employment, wages, and the state tax rate on labor income, are straightforward. However several of them are difficult to construct. This is the most challenging and time-consuming part of the modeling exercise, and so a few further comments are warranted on the methods used. Further details are presented in Appendices 1-3.

A. Average Marginal Tax Rates

The federal tax rates on labor, and the tax rates that are included in the cost of capital - the federal taxes on capital income (dividends, capital gains) and the federal and state taxes on corporate income (including the Texas franchise tax) - are *effective average marginal tax rates*. That is, they aim to measure the average of the marginal tax rates actually facing taxpayers.

For the personal income tax, information is available for a number of income brackets on the number of taxpayers, their adjusted gross incomes, and their actual tax liabilities. From this information it is possible to infer the extra tax liability which would be incurred as a taxpayer moves from one income class to the next, i.e. the marginal tax rate. The average marginal tax rate is then calculated as a weighted average of these marginal rates:

- for the average marginal tax rate on *labor* income, the weights are the proportion of wages and salaries falling within each income class; and
- for the average marginal tax rate on *capital* income, the weights are the proportion of dividend and capital gains income falling within each income class.

Table 4
Description of Variables and Their Sources

	Description	Measurement	Source
L	Labor by sector	Number of jobs (employees & self-employed) by sector, in thousands	BEA
w	Wage rate by sector	Total payroll divided by number of jobs.	BEA
K	Capital stock by sector	See Appendix 2.	Census & other sources
PW	Working age population	Population of age 16-64.	Census
q	Index of U.S. economic activity.	Measures used include: U.S. unemployment rate (in %); index of real sectoral output; non-Texas real wages rates by sector.	Economic Report of the President; BEA
G_{tr}	Real government transfer payments per nonworking adult aged 16-64	Federal income maintenance transfers and unemployment insurance.	BEA, BLS and Census
v	State tax rate on use of labor services	Sum of unemployment insurance tax rate and the workers compensation insurance rate.	BLS and WCRI
r	Cost of capital by sector	See Appendix 3. Also, see Appendix 1 for measurement of the components of *r*.	BEA, IRS and other sources
t_{sa}	Sales tax rate	Revenue from general and motor vehicle sales tax , plus revenue from gasoline and diesel taxes, divided by sales of these goods.	TCO, BEA, and U.S. Dept. of Energy
t_{fl}	Average marginal federal tax rate on labor income applied to Texas residents	See Appendix 1.	SOI
t_{pc}	Local tax rate on commercial and industrial property	Average tax rate. See Appendix 1.	TCO
t_{pr}	Local tax rate on residential property	Average tax rate. See Appendix 1.	TCO

Sources

BEA	Bureau of Economic Analysis, U.S. Department of Commerce
BLS	Bureau of Labor Statistics, U.S. Department of Labor
TCO	Texas Comptroller's Office
IRS	Internal Revenue Service
SOI	Statistics on Income

A similar procedure is followed for the federal corporation income tax. This is possible because for each of the eight main sectors of the economy – agriculture, mining, construction, FIRE (finance, insurance and real estate), manufacturing, services, trade, and TPU (transport and public utilities) – information on the number of returns, net income, taxable income, and tax liability is available for each of several size classes of business receipts. From this it is possible to infer the marginal tax rates faced by corporations as they expand their net income.

Full details of these procedures are described in Appendix 1.

[5] These sectors are agriculture, mining, construction, manufacturing, trade, services, TPU

B. The State Capital Stock

It was necessary to construct a measure of the net stock of fixed nonresidential private capital, by industry, for Texas for each year from 1970 through 1996. The Bureau of Economic Analysis publishes national, but not state-level, estimates of private capital, broken down into a number of categories such as depreciable assets for construction, for manufacturing, trucks, gas pipelines, and so on.

In order to estimate Texas's share of national capital, in each category, we applied a series of proxies. For instance we took the state's share of capital in the communications sector to be proportional to the state's share of miles of wire in cable. Or again, for capital used in the retail and wholesale trades, we took the Texas share to be in proportion to the state's share of sales in these categories. The complete details are given in Appendix 2.

C. The Cost of Capital

Businesses make decisions about investment based, in part at least, on the rental cost of capital (r), which is the total rental charge for capital (including tax costs and a provision for depreciation) divided by the value of capital. It can be shown (Appendix 3, equations (A3.17) and A3.18)) that

$$r = \frac{(\rho + d)(1 - t_{ck} \sum_{t=1}^{DL} \frac{\alpha_t}{(1+\rho)^t})}{(1 - t_{ck})} + \beta .$$

This equation shows that the rental cost of capital depends on the discount rate (ρ), the capital consumption rate (d), the average marginal tax rate on capital (t_{ck}), the recovery allowance percentage that is allowed under the tax laws (α_t), the depreciable life of the asset (DL), and the tax rate on corporate property (β). The systems of depreciation permitted for tax purposes have changed over time, with the sum of the year's digits system in place from 1954 through 1980, an accelerated cost recovery system from 1981 through 1985, and a modified accelerated cost recovery system since then. The average marginal tax on capital is derived from the state and federal taxes on corporate income and on dividends and capital gains. A detailed description of how r was constructed is given in Appendix 3.

(transport and public utilities) and FIRE (finance, insurance and real estate).

5. Estimation Results

The results of estimating the reduced form of the model, i.e. equations (3.14)-(3.17), are shown in Tables 4 and 5.

A. Technical Details

Technically, we estimated the equations using the pooled cross-section time-series data, for the eight main sectors of the economy for the period 1970-1996. We first regressed all of the variables against a time trend (and also the trend squared and, where appropriate, the cube of the trend), in order to detrend the data. We then used the detrended numbers in the regressions. In all cases we adjusted for first-order autocorrelation. We estimated the equations with fixed effects, which means that there is a separate intercept term in each equation for each of the eight sectors. An adjustment was made to handle the effects of contemporaneous correlation, which occurs when a random shock that affects one sector in a given year is likely to affect other sectors at the same time. Finally, we computed the standard errors after taking the possibility of heteroscedasticity (of a general form) into account.

B. Comments on the Estimates

The estimates are very satisfactory, and provide strong support for our initial proposition, which is that state tax rates do have an important influence on economic activity.

From the *labor/jobs equation* (3.14) it is clear that:

- Higher taxes on industrial property, sales or corporate income significantly reduce the number of jobs;
- When the nonlabor costs of hiring are higher, there will be fewer jobs; and
- When government transfer payments are higher, there will also be fewer jobs, presumably because the incentive to look for work is diminished.

The one unexpected result is that a higher federal income tax rate is associated with slightly more jobs. A possible explanation is that an increase in this rate may deter employers even more in other states, making Texas *relatively* less unattractive.

Table 5
Results of Estimating the Employment, Wage and Capital Stock Equations

	Employment equation		Wage equation		Capital equation	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Dependent variable	ln(number of jobs)		ln(wage rate)		ln(capital stock)	
Independent variables						
ln(government transfers per nonworking adult)	-0.1342	0.00	0.0190	0.01	-0.0389	0.00
Nonwage labor costs as % of wage	-0.0250	0.00	0.0094	0.03	-0.0133	0.08
Federal tax rate on labor income	0.0061	0.00	0.0021	0.00	0.0018	0.18
Effective sales tax rate	-0.0077	0.09	0.0175	0.00	0.0088	0.18
Cost of capital	-0.0306	0.00	-0.0021	0.50	-0.0286	0.00
Working age population	0.6492	0.00	0.3550	0.00	1.2760	0.00
Other	ln(Index of U.S. output), by sector		ln(Non-Texas wage rate), by sector		ln(Index of U.S. output)	

Notes: p-value below 0.1 indicates coefficient is statistically significant at the 10% level or better. For full definitions of variables, see Table 1 and text. The coefficients for the intercept terms, and for the measures of U.S. economic activity, are not shown here. All variables were differenced before the estimation was done.

The estimates of the coefficients in the *wage equation*, where they are statistically significant, all have the expected signs, but need to be interpreted with care. Wages as defined here include the nonwage costs of unemployment insurance tax and payments for workers compensation insurance. When these costs rise, then so will gross wages (but employees will take home less pay). When the sales tax rises, the gross wage tax also *rises*, as workers in effect seek higher pay to compensate for the higher tax. A higher level of government transfer payments leads to a higher wage rate, because it discourages would-be employees from looking, in effect raising their reservation wage.

The *capital equation* (3.16) shows broadly similar results to the labor equation. Here too, higher tax rates appear to lead to a smaller stock of (nonresidential) capital, as do higher transfer payments and nonwage labor costs.

The equations fit relatively well, and the most important coefficients are robust, so that they do not change much if the equations are specified and estimated slightly differently.

Table 6
Results of Estimating the State Working Age Population Equation

	Coefficient	p-value
Dependent variable	ln(working age population)	
Independent variables		
Nonwage labor costs as % of wage	-0.0037	0.22
Federal tax rate on labor income	0.0005	0.10
Tax rate on residential property	-0.0361	0.00
Effective sales tax rate	-0.0117	0.00
Lagged value of ln(working age population)	0.4818	0.00

Notes: p-value below 0.1 indicates coefficient is statistically significant at the 10% level or better. For full definitions of variables, see Table 1 and text. All variables were differenced prior to estimation. Constant term not shown.

APPENDIX 1: CALCULATION OF TAX RATES

The STAMP model includes a number of tax rates, either as independent variables in the reduced-form estimating equations, or as components of the cost of capital (see Appendix 3 for more details about the latter). The tax rates used as regressors in the estimating equations are

(a) the federal tax rate on labor income applied to Texas residents,

(b) the state tax rates on the use of labor service – unemployment insurance tax rate and workers compensation tax rate combined,

(c) the local tax rates on commercial/industrial property and residential property, and

(d) the state sales tax.

The tax rates that we include as the components of the cost of capital are

(e) the corporate income tax rate for Texas corporation (taken here to mean the franchise tax),

(f) the federal tax rate on corporate income by sector, and

(g) the federal tax rate on capital income applied to all U.S. residents.

In the following sections we explain how these tax rates were computed for the purposes of the Texas-STAMP model.

We use *average marginal tax rates* wherever the data needed to calculate them are available. These are calculated, in general, as the average of the marginal tax rates facing individuals (or businesses). A recognized weakness in other state-level tax models is that they typically use measures of average tax rates, with the drawback that these do not summarize the tax rates that face an individual who is trying, at the margin, to decide whether to work more, or a firm wondering whether it should invest more.[6]

The calculation of average marginal tax rates is somewhat complicated, so the procedures followed are described in this Appendix. Our methodology is based on the approach taken by John Seater.[7]

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[6] Timothy Bartik. 1991. *Who Benefits from State and Local Economic Development Policies?*, W.E. Upjohn Institute for Employment Research, Kalamazoo, MI. This report surveys the relevant literature.

[7] John Seater, "Marginal Federal Personal and Corporate Income Tax Rates in the US, 1909-1975," *Journal of Monetary Economics* (1982).

(1.) Average Marginal Federal Tax Rate on Labor Income for Texas Residents

We used data obtained from the *Statistics of Income* publication. This publication reports, for each Adjusted Gross Income (AGI) group, the number of returns, total AGI, total wages and salaries, and total tax liability. Given these data, we compute the marginal federal tax rate for AGI group i, $t_{fpy,i}$, as the change in tax liability per change in gross income. The marginal federal tax rate for income group i is then written as:

$$t_{fpy,i} = \frac{T_{fpy,i} - T_{fpy,i-1}}{Y_{fy,i} - Y_{fy,i-1}}$$

where $T_{fpy,i}$ = average federal tax liability for AGI group i, calculated by dividing the total tax liability by the number of returns for AGI group i, and
$Y_{fy,i}$ = average gross income for AGI group i, calculated by dividing the total gross income by the number of returns for AGI group i.

Then, the Average Marginal Federal Tax Rate on Labor Income for Texas, t_{fl} , is calculated by multiplying wages and salaries in each AGI class by the marginal tax rate for that class, then dividing by the total wages and salaries.

$$t_{fl} = \frac{\sum_i (Y_{fl,i}) * (t_{fpy,i})}{\sum_i (Y_{fl,i})}$$

where $Y_{fl,i}$ = total wages and salaries for income group i.

(2.) Statewide Average Local Property Tax Rate

The data used to calculate the average school property tax rate for Texas were obtained from John Sharp (Comptroller of Public Accounts), *Annual Property Tax Report*, for every year from 1981 through 1996. These reports provide information on the value of property assessments for all 1,037 school districts, and a breakdown of statewide school property tax revenue for some (but not all) of the years. Where data were missing we interpolated the revenue. For 1970-1981 we used the mean rates for 1981-88. The school tax generates about 60% of all property tax revenues. It was levied at an average rate of $1.389 per $100 of value in 1996, of which $1.237 was for maintenance and operations (M&O) and the remaining $0.152 for interest costs and a sinking fund. State law limits the M&O tax rate to $1.50 or lower.

(3.) Texas Sales Tax

The most important source of state revenue in Texas is the *sales and use tax*, which accounted for 35% of all tax revenues in 1972. By 1990 this proportion had risen to 55% and has stayed at about this level since then. Three other important taxes have the characteristics of a sales tax:

A. the motor vehicle sales and use tax (8.7% of state tax revenue in FY1997),
B. the gasoline tax (9.2% of tax revenue), and
C. the diesel fuel tax (2.1% of tax revenue).

Collectively these taxes accounted for 73.4% of state taxes collected in FY1997.

We have created a broad-based sales tax variable that is defined as

$$t_s = \frac{\text{Revenue from sales and use tax, motor vehicle sales and use tax, gasoline tax and diesel fuel tax}}{\text{Total retail sales}}.$$

The data on revenue come from John Sharp (Comptroller of Public Accounts), *Sources of Revenue Growth*, July 1998. Information on retail sales come from a file entitled "Texas Economic Detail: Calendar Years 1970-2020)," available through the Web site of the Texas Comptroller's office.[8]

(4.) Average Income Tax Rate for Texas Corporations

We created a state corporate income tax rate for Texas, called *tsca*, by applying the following formula:

$$t_{sca} = \frac{\text{franchise tax collections}}{\text{Texas taxable base}}$$

where the taxable base consists of net corporate income.

Note that this treats the franchise tax as if it were a tax on corporate net income. This is a defensible procedure, but simplifies the situation somewhat. Prior to 1991 the tax was levied on the taxable capital of corporations, and so was akin to a corporation property tax. Since 1991 the

[8] The Web address is www.cpa.state.tx.us.

tax has been levied at a lower basic rate ($2.50 per $1,000 of taxable capital) "plus the amount, if any, by which a tax of 4.5% on earned surplus exceeds the tax on capital."[9] This has moved the tax more clearly toward a corporate income tax, which is how we treat it for purposes of the tax model.

The information on franchise tax collections comes from John Sharp (Texas Comptroller of Public Accounts), *Sources of Revenue Growth*, July 1998. The data refer to the fiscal year (September 1 through August 31), and they were converted to calendar year figures in order to be consistent with other data used in this calculation.[10]

To estimate the total Texas taxable base, we first calculated the taxable base for the combined primary sectors (i.e. agriculture, construction, manufacturing, trade, transportation and public utilities (TPU), finance, insurance and real state (FIRE), mining, and services) by multiplying the U.S. corporate net income reported in the *Corporation Income Tax Returns,* an IRS publication, by the Texas (TX) apportionment ratio as:

$$TB = ar * Y$$

where *TB, ar,* and *Y* are taxable base, apportionment ratio and U.S. corporation net income, respectively. The apportionment ratio was obtained using the following formula:

$$ar_i = 0.5 * \frac{\text{TXsales}}{\text{US sales}} + 0.25 * \frac{\text{TXassets}}{\text{USassets}} + 0.25 * \frac{\text{TXpayroll}}{\text{USpayroll}}.$$

The payroll ratios were computed using data on payroll for the state and for the United States, which were obtained from the Bureau of Economic Analysis (BEA). We calculated the asset ratios using data on U.S. nonresidential capital stock published by BEA and the state capital stock data estimated by BHI.[11] Sales data are, in principle, available based on censuses undertaken every fifth year. However the data for Texas are incomplete, and do not provide a breakdown for all the eight sectors of the economy. Therefore we used the ratio of Texas Gross State Product to U.S. Gross Domestic Product as a proxy for the sales ratio.

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[9] John Sharp (Texas Comptroller of Public Accounts), *Sources of Revenue Growth*, July 1998, p. 56.
[10] For instance the number for calendar year 1990 was calculated as 2/3 times the FY1990 value plus 1/3 times the FY1991 value.

Once all the ratios (sales, asset and payroll ratios) in the apportionment formula were estimated or calculated, we multiplied the apportionment ratio by U.S. corporate net income to get the taxable base for each sector. Then the total state taxable base was obtained by adding the taxable base for all sectors: $TB_{state} = \Sigma_i TB_i$. The last step in the calculation of t_{sca} was to divide state franchise tax collections by the total state taxable base.

(5.) Average Marginal Federal Tax Rate on Corporate Income

In order to calculate the average marginal federal tax rate on corporate income we used data for firms of all states, as published by the IRS in *Corporation Returns*. This publication reports, for each of the eight sectors of the economy (agriculture, construction, FIRE, manufacturing, mining, service, TPU, and trade) and for each different size of business (as measured by receipts), the number of returns, net income, income subject to tax, and income tax. Given these data, we calculated the marginal federal tax rate for business receipts group *i*, $t_{fc,i}$, as the change in corporate tax liability per change in corporate taxable income.[12] Hence, $t_{fc,i}$ is written as:

$$t_{fc,i} = \frac{T_{fc,i} - T_{fc,i-1}}{TY_{fc,i} - TY_{fc,i-1}}$$

where $T_{fc,i}$ = average corporate tax liability for group *i,* calculated by dividing the total corporate tax liability by the number of returns for business receipts group *i,* and

$TY_{fc,i}$ = average taxable corporate net income (less deficits) for business receipts group *i,* calculated by dividing the total corporate taxable income by the number of returns for business receipts group *i.*

Then the average marginal tax rate on corporate income, t_{fc} , is calculated by multiplying corporate net income in each business receipt group by the marginal tax rate for that class, and dividing by the total corporate net income, to give

$$t_{fc} = \frac{\sum_i (TY_{fc,i}) * (t_{fc,i})}{\sum_i TY_{fc,i}}.$$

[11] See later in this section for a detailed description of the state capital stock estimation.

[12] The average tax rate on corporate income was used for the first business receipts income group. The marginal tax rate on corporate income was used on the remaining income groups, with the exception of negative or erroneous results, in which case the average tax rate on corporate income was used.

(6.) Average Marginal Federal Tax Rate on Capital Income Applied to All U.S. Residents

To compute this tax we used data from federal tax returns for all U.S. residents published in *Statistics of Income Bulletin.*[13] This publication reports, for each AGI class, the number of returns, total AGI less deficit, tax liability, taxable income, dividends, and net capital gains. First, we defined the marginal federal tax rate for AGI group i, $t_{fy,i}$, as the change in tax liability per change in taxable income. Then, $t_{fy,i}$, is written as:

$$t_{fy,i} = \frac{T_{fy,i} - T_{fy,i-1}}{TY_i - TY_{i-1}}$$

where $T_{fy,i}$ = average federal tax liability for AGI group i, calculated by dividing the total tax liability by the number of returns for AGI group i, and
TY_i = average taxable income for AGI group i, calculated by dividing the taxable income by the number of returns for AGI group i.

(a) *Average Marginal Federal Tax Rate on Dividend Income.* The average marginal tax rate on dividend income for all states, t^d_{fk} , is then calculated by multiplying dividend income in each AGI class, D_i, by the marginal tax rate for that class, and dividing by total dividend income. Thus

$$t^d_{fk} = \frac{\sum_i (t_{fy,i}) * (D_i)}{\sum_i D_i},$$

where D_i = the total dividend income for income group i.

As shown, t^d_{fk} is the weighted average of the individual AGI group marginal federal tax rates, the weight being the fraction of total dividends that fall within each income class.

(b) *Average Marginal Federal Tax Rate on Capital Gains.* The average marginal tax rate on capital gains income for all states, t^g_{fk} , is calculated by multiplying *actually realized* capital gains income in each AGI class, G_i , by the marginal tax rate for that class, then dividing by total capital gains income. The *SOI* reports only those capital gains included in the AGI, G_i^A . Since some of the capital gains were tax deductible at the federal level until the year 1986, realized capital gains are greater than the reported capital gains for that period. We calculate G_i by multiplying G_i^A by the ratio of the total realized capital gains to the total reported capital gains for each year. The Office of Tax Analysis of the Internal Revenue Service reports this ratio. Then t_{fk}^g is calculated as:

$$t_{fk}^g = \frac{\sum_i (t_{fy,i}) * (G_i)}{\sum_i G_i}.$$

Here again, t_{fk}^g is the weighted average of the individual AGI group marginal federal tax rates, with the weight being the fraction of total capital gains that fall within each income class.

[13] See section of Selected Historical and Other Data, Individual Income and Tax Data by State and Size of Adjusted Gross Income for the U.S.

APPENDIX 2: ESTIMATION OF THE TEXAS CAPITAL STOCK

The Basic Approach

Since no state-by-state data are available on the stock of private capital, it was necessary to develop a method for allocating capital stock between states from the national totals published by the Bureau of Economic Analysis (BEA). The capital stock series selected was the current-cost net stock of fixed private capital, nonresidential, by industry, for the years 1970-1996. Net stock is calculated as the cumulative value of past gross investment less the cumulative value of past depreciation.[14] The approach taken was to apportion for each year from 1970 to 1996, the BEA national total for private capital on the basis of various measures of economic activity in Texas in the eight major sectors of the economy: agriculture, forestry, and fishing (AFF); construction; manufacturing; transportation and public utilities (TPU); wholesale and retail trade (Trade); finance, insurance, and real estate (FIRE); mining; and services. Adopting a procedure similar to the one outlined by Munnell,[15] we used a number of proxies to determine what share of the national capital stock (as estimated by the BEA) could be attributed to Texas. The calculation of these proxies is described below.

We obtained most of the data used as proxies from the economic censuses, which take place every fifth year. We also acquired proxies for several sectors using data from sources other than the economic censuses. The state's share of the proxy in a census year (the *base year*), or other years for which the state's share of the proxy was available, were used to distribute the BEA national capital stock for that year. Thus, the state capital stock for a base year, for each sector, K_τ, is:

$$K_\tau = \rho_\tau * K_{US,\tau}$$

where ρ_τ = apportionment rate for base year τ, and
$K_{US,\tau}$ = U.S. capital stock for base year τ.

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[14] In 1997 BEA revised the U.S. capital stock data based on a new methodology for calculating depreciation charges. For a given year, the depreciation charges are obtained by multiplying the prior year's charge by one minus the annual depreciation rate. Net stocks are estimated by subtracting cumulative depreciation from cumulative gross investment.

[15] Alicia M. Munnell, with Leah Cook. "How Does Public Infrastructure Affect Regional Economic Performance?" *New England Economic Review*, Sept./Oct. 1990, pp. 11-32.

Then we estimated the Texas capital stock for nonbase years using the base year apportionment ratios and the annual growth rates of the U.S. capital stock.[16] Using the state capital stock for two base years as reference points, the estimate for the years between the two base years is generated in accordance with the growth rate of the national capital stock as follows:

$$K_t = K_{t-1} * \exp[(\ln K_b - \ln K_a) * (g_t / \sum_{t=a+1}^{b} g_t), \quad a < t \leq b$$

where K_t = state capital stock for year t,
K_a = state capital stock for the preceding base year,
K_b = state capital stock for the following base year, and
g_t = growth rate of U.S. capital stock for year t.

Methodology for Nonresidential Assets

We apportioned the BEA estimate of assets in *agriculture* according to the state's share of the value of farmland, buildings and equipment taken from the *Census of Agriculture* 1969, 1974, 1978, 1982, 1987 and 1992.[17] We estimated assets for 1970 by applying the 1969 ratio; assets for 1971-1973 with data from the 1969 and 1974 *Censuses*; assets for 1975-1977 with data from the 1974 and 1978 *Censuses*; assets for 1979-1981 with data from the 1978 and 1982 *Censuses*; assets for 1983-1986 with data from 1982 and 1987 *Censuses*; assets for 1988-1991 with data from 1987 and 1992 *Censuses*; and assets for 1993-1996 were obtained by applying the 1992 ratio.

Texas' Share of U.S. Value of Farm Land, Buildings and Equipment

Year	1969	1974	1978	1982	1987	1992
%	8.53	9.04	7.92	8.87	11.08	9.10

Source: U.S. Bureau of the Census. *Census of Agriculture,* 1969, 1974, 1978, 1982, 1987 and 1992.

[16] Munnell (1990) used the base year apportionment ratios to distribute the BEA national capital stock for preceding years and following years. Thus, she used data from the 1972 *Census* to estimate the capital stock apportionment ratios for each state for 1969 to 1974; data from 1977 to estimates for 1975 to 1979; 1982 *Census* data to estimate shares for the 1980 to 1984 stock estimates; and data from 1987 *Census* to estimate shares for 1985 to 1989. The resulting series, however, sometimes show significant divergence of annual growth rates from the growth rates of the U.S. capital stock. To avoid this problem we used the smoothing method described in the text.
[17] The ratio obtained from the 1969 Census was applied to 1970, which is the first year of the series.

We apportioned the BEA estimate of assets in *construction* according to the state's share of the gross book value of depreciable assets taken from the *Census of Construction* for 1972, 1977, 1982, 1987 and 1992. We estimated assets for 1970 and 1971 by applying the 1972 ratio; assets for 1973-1976 with data from the 1972 and 1977 *Censuses*; assets for 1978-1981 with data from the 1977 and 1982 *Censuses*; assets for 1983-1986 with data from the 1982 and 1987 *Censuses*; assets for 1988-1991 with data from 1987 and 1992 *Censuses*; and assets for 1993-1996 were obtained by applying the 1992 ratio.

Texas' Share of U. S. Gross Book Value of Depreciable Assets for Construction

Year	1972	1977	1982	1987	1992
%	7.01	8.21	10.19	7.44	6.87

Source: U.S. Bureau of the Census, *Census of Construction*, 1972, 1977, 1982, 1987 and 1992.

We apportioned the BEA estimate of assets in *manufacturing* according to the state's share of the gross book value of depreciable assets taken from the 1970 and 1971 *Annual Survey of Manufactures* and from the *Censuses of Manufactures* for 1977, 1982, 1987 and 1992. The data from the 1971 *Annual Survey* and the 1977 *Census* were used to estimate capital stock for 1972-1976; assets for 1978-1981 were estimated with data from the 1977 and 1982 *Censuses*; and so on.

Texas' Share of U. S. Gross Book Value of Depreciable Assets for Manufacturing

Year	1970	1971	1977	1982	1987	1992
%	6.40	6.66	8.25	9.32	8.12	8.60

Source: US Bureau of the Census. *Annual Survey of Manufactures*, 1971 and *Census of Manufactures,* 1977, 1982, 1987, and 1992.

We employed several procedures to distribute assets in the *transportation and public utilities (TPU)* sector. This sector was divided into three sub-sectors: transportation; communications; and electricity, gas and sanitary services. We began with the transportation sub-sector for which three additional sub-sectors were considered: railroad; trucking and warehousing; and air transportation. We distributed the BEA estimate for railroad transportation according to the state's share of railroad mileage in 1980, 1982, 1985, 1986, 1990, 1991, 1993, 1994 and 1996. We obtained this data from *Railroad Facts*. We estimated assets from 1970 to

1979 by applying the 1980 ratio;[18] assets for 1983 and 1984 with data from the 1982 and 1985; assets for 1987 to 1989 with data from the 1986 and 1990; and so on.

Texas' Share of U. S. Railroad Mileage

Year	1980	1982	1985	1986	1990	1994	1996
%	7.27	7.60	8.07	8.28	8.69	8.50	9.74

Source: Association of American Railroads. *Railroad Facts*. Washington, 1983, 1985, 1988, 1993, 1995 and 1997.

We estimated the state's assets in trucking and warehousing according to the state's share of trucks. We collected these data for 1971, 1972, 1977, 1981, 1982, 1987 and 1992 from the *Census of Transportation*.

Texas' Share of U.S. Trucks

Year	1971	1972	1977	1981	1982	1987	1992
%	8.19	8.18	8.12	9.37	9.52	8.87	7.39

Source: U.S. Bureau of the Census. *Census of Transportation,* 1972, 1977, 1982, 1987 and 1992.

We apportioned the state's assets in air transportation by estimating the state's share of registered aircraft. We obtained these data from the *Census of U.S. Civil Aircraft*, a publication of the Federal Aviation Administration.

Texas' Share of U.S. Aircraft

Year	1972	1977	1982	1987	1992	1993
%	7.37	7.56	8.85	8.06	7.66	7.60

Source: U.S. Federal Aviation Administration. *Census of U.S. Civil Aircraft*, 1972, 1977, 1982, 1987, 1992 and 1993 Washington, DC: Government Printing Office.

We were unable to obtain sufficient proxies for other sub-sectors of transportation so we apportioned the weighted average of the shares of railroad, trucking and warehousing, and air transportation to total transportation. These three sectors accounted for 80% of the U.S. capital stock in transportation in 1996.

[18] We were unable to find the state's share of U.S. road mileage for early years, so we assume that the apportionment ratio remain constant before 1980 at that year ratio.

The next sub-sector is the communication sector. We apportioned the national estimate of the capital stock in this sub-sector according to the state's share of miles of wire in cable. We collected these data from the *Statistics of Communications Common Carriers*, a publication of the Federal Communication Commission, for 1972, 1977, 1980, 1986 and 1987. However, we had to estimate the 1993 and 1996 ratios according to the state's share of total pre-subscribed lines, also located in *Statistics of Communications Common Carriers,* since the previously used data set, *Miles of Wire and Cable,* is not published anymore.

Texas' Share of U.S. Miles of Wire in Cable

Year	1972	1977	1980	1986	1987	1993	1996
%	6.37	6.71	7.36	7.98	8.00	6.61	6.78

Source: U.S. Federal Communications Commission. Statistics *of Communications Common Carriers*, 1972, 1977, 1980, 1986, 1987, 1993 and 1996. Washington, DC: Government Printing Office.

The final sub-sectors of TPU are electricity, gas and sanitary services. We distributed assets in the electric service sector based on the state's share of installed capacity of electric energy (for 1970 to 1989) and net summer capability (for 1990 to 1996).[19] These data were obtained from the *Statistical Abstract of the United States*, 1975, 1985, 1990, 1993, 1995 and 1997. We estimated assets for 1971 to 1973 using data from the years 1970 and 1974; assets for 1977 to 1979 with data from the years 1976 and 1980; assets for 1987 with data from the years 1986 and 1988; and so on.

Texas' Share of U.S. Installed Capacity of Electric Energy

Year	1970	1975	1980	1985	1988	1991	1993	1995
%	7.88	8.52	8.69	8.45	8.69	8.98	9.13	9.12

Source: U.S. Bureau of the Census. *Statistical Abstract of the United States,* 1975, 1985, 1990, 1993, 1995 and 1996. Washington, DC: Government Printing Office.

We estimated assets in the gas service sector based on Texas' share of miles of pipeline and gas mains. We collected these data from *Gas Facts*, a publication of the American Gas Association, for 1970, 1975, 1978-1980, 1985, and 1989-1996. We estimated assets for 1971 to 1974 with data from the years 1970 and 1975; assets for 1976 and 1977 with data from the years 1975 and 1978; assets for 1981 to 1984 with data from the years 1980 and 1985; and so on. We

[19] Data for installed capacity are not available after 1989. They are replaced with net summer capability.

could not find a good proxy for the sanitary service sector, so we apportioned the weighted average of the shares of electric and gas to the total of electric, gas, and sanitary services.[20]

Texas' Share of U.S. Miles of Pipeline and Gas Main

Year	1975	1980	1985	1990	1992	1993	1994	1995
%	10.79	11.34	11.62	10.65	11.13	10.39	9.99	9.79

Source: American Gas Association, *Gas Facts*, 1975,1980, 1985, 1980, 1992, 1993, 1994, 1995 and 1996.

We distributed assets in finance, insurance, and real estate (FIRE) according to the state's share of gross production in the FIRE sector for each year.[21] We obtained annual data on gross state product in the FIRE sector, for both the U.S. and Texas, from the Bureau of Economic Analysis (BEA).

We based the Texas share of the national capital stock in the mining sector on the state's share of the value of national output of oil and natural gas. The wellhead value of natural gas production came from the Energy Information Administration (EIA), *Historical Natural Gas Annual: 1930 Through 1997*, Table 7. Oil production numbers for Texas were found in the Texas Railroad Commission publication *Oil production and Well Counts (1935-1997)*; for the U.S. as a whole them came from the EIA's *Annual Energy Review 1996*, Table 5.2. The wellhead price of crude oil for Texas is from the EIA's *Petroleum Marketing Annual 1997*, Table 21, and the national price is found in the EIA's *Annual Energy Review 1996*, chapter 3.

We apportioned BEA estimates capital in the *retail and wholesale trade* and *service* sectors according to the state's share of sales in each category. We obtained sales data from the *Census of Retail Trade*, 1972, 1977, 1982, 1987 and 1992; the *Census of Wholesale Trade*, 1972, 1977, 1982, 1987, and 1992; and the *Census of Service Industries*, 1972, 1977, 1982, 1987, and 1992. The shares of Texas's sales in the retail industry for the years 1986 and 1990-1995 were obtained from different editions of the *Statistical Abstract of the United States* (1993, 1996 and 1997).

[20] The sanitary service sector is small: In 1996 it accounted for just 9.3% of the capital stock in electricity, gas, and sanitary services.
[21] Munnell (1990) used the state's share of commercial bank deposits in the U.S. However, the fraction of banks' capital stock in FIRE is relatively small (e.g., it was 20% in 1993) and thus the deposit share may

Texas's Share of U.S. Sales in Retail Trade, Wholesale Trade, and Service Industries

Year	1972 %	1977 %	1982 %	1987 %	1990 %	1991 %	1992 %	1994 %	1995 %
Retail	5.63	6.34	7.72	6.51	6.67	6.93	6.99	6.84	7.03
Wholesale	6.07	6.97	10.26	7.61	N/A	N/A	8.48	N/A	N/A
Service	5.02	6.35	7.50	6.60	N/A	N/A	7.05	N/A	N/A

Sources: U.S. Bureau of the Census. *Census of Wholesale Trade,* 1972, 1977, 1982, 1987 and 1992. *Census of Retail Trade*, 1972, 1977, 1982, 1987, 1992 and 1994. *Statistical Abstract of the United States*, 1996. *Census of Service Industries*, 1972, 1977, 1982, 1987 and 1992.

not be a good measure for the whole FIRE sector. For this reason, we used the state share of gross production for which data are available for each year.

APPENDIX 3: DERIVATION OF COST OF CAPITAL

The gross-of-factor cost of capital that producers are required to pay, *r*, is determined by the equilibrium condition where the present value of the future income stream to the owner of capital (i.e., household, HH) is equal to the price of capital. In other words, HH investors would be willing to give up one dollar of current consumption in order to hold one dollar of capital only if the present value of the income stream (i.e., net of taxes and net of depreciation return of capital) is at least one dollar. Let:

K = price of capital (e.g., cost of new machine or equipment);

R = rental charge for capital including tax costs, i.e., rental cost to firms; and

R_n = net of tax rental income to capital owner.

Then, in equilibrium, the following must hold:[22]

(A3.1) $$K = \int_0^{SL} R_n e^{-(\rho+d)t} dt$$

where

SL = service life of capital asset
ρ = real discount rate, and
d = capital consumption rate or replacement rate.

Investors who own corporate shares deduct corporation income tax liability from their portion of the corporation's net income before taxes; the investors then pay personal income tax on capital gains and on any dividends paid out to them by the corporation. Then, R_n is obtained as:

(A3.2) $$R_n = R\text{-}(T_p + T_c + T_k)$$

where T_p is the tax on corporate property,

$T_c = T_{fc}+T_{sc}$ is the sum of federal and state corporate income tax,[23] and

$T_k = T_{fk}+T_{sk}$ is the sum of federal and state personal income tax on capital income.

Also, T_{fc} and T_{sc} are calculated as:

(A3.3) $$T_{sc} = t_{sc}(R\text{-}T_p\text{ -}D)$$

[22] See Hall and Jorgenson (1968). The result only holds in the limit, when proportion *d* of the capital stock is consumed every year, and $SL\rightarrow\infty$.

[23] The Texas franchise tax is assumed to have the same effects as a state corporate income tax, in the context of the Texas-STAMP model.

(A3.4) $T_{fc} = t_{fc}(R\text{-}T_p\text{-}D\text{-}T_{sc})$

where t_{sc} = state tax rate on corporate income;
t_{fc} = federal tax rate on corporate income; and
D = depreciation allowed for tax purposes.[24]

Then T_c is obtained from (A3.3) and (A3.4) as:

(A3.5) $T_c = (t_{fc}+t_{sc})(R\text{-}T_p\text{-}D)\text{-}t_{fc}*t_{sc}(R\text{ -}T_p\text{-}D) = \tau_c(R\text{ -}T_p\text{-}D)$

where:

(A3.6) $\tau_c = t_{fc}+t_{sc}\text{-}t_{fc}*t_{sc.}$

After-tax corporate profits are distributed to the investors who own corporate shares in the form of dividend income and/or capital gains. They then pay personal income tax on dividends and capital gains. Now T_k is calculated as follows:

(A3.7) $T_k = T_{fk.}$

because there is no state tax on personal income in Texas. Here T_{fk} is given by

(A3.8) $T_{fk} = t_{fk}(R\text{-}T_p\text{-}D\text{-}T_c) = t_{fk}(R\text{-}T_p\text{-}D\text{-}T_c)$

where t_{fk} = federal tax rate on individual capital income.[25] Hence

(A3.9) $T_k = t_{fk}(R\text{-}T_p\text{ -}D\text{-}T_c)$.

Assuming that individual capital income takes the form of dividends and capital gains, t_{fk} is calculated as:

(A3.10) $t_{fk} = t^d_{fk}\ p + t^g_{fk}\ (1\text{-}p)$

where t^d_{fk} = federal tax rate on dividend income;
t^g_{fk} = federal tax rates on capital gains; and
p = the ratio of dividend income to the total of dividend income and capital gains.

Now substitute (A3.5) and (A3.9) into (A3.2) to rewrite R_n as:

(A3.11) $R_n = R\text{-}T_p\text{-}(T_c+T_k)$

[24] We assume that the depreciation allowed for federal tax purposes is the same for state tax purposes.

$$= R\text{-}T_p\text{-}[(R\text{-}T_p\text{-}D)t_{fk}\text{-}T_c t_{fk}+T_c]$$

$$= R\text{-}T_p\text{-}[t_{fk}(R\text{-}T_p\text{-}D)+(1\text{-}t_{fk})\tau_c(R\text{-}T_p\text{-}D)]$$

$$= R\text{-}T_p\text{-}(R\text{-}T_p\text{-}D)(t_{fk}+(1\text{-}t_{fk})\tau_c)$$

$$= (1\text{-}t_{ck})(R\text{-}T_p)+ t_{ck}D$$

where :

(A3.12) $t_{ck} = \tau_c + t_{fk} - t_{fk} * \tau_c.$

Now substitute (A3.11) into (A3.1) to get:

(A3.13) $$K = \int_0^{SL} [(R\text{-}T_p)(1\text{-}t_{ck})]\, e^{-(\rho+d)t}dt + \int_0^{SL} t_{ck}De^{-(\rho+d)t}dt$$

$$= \frac{-(R-T_p)(1-t_{ck})(e^{-(\rho+d)SL}-1)}{(\rho+d)} + t_{ck}\int_0^{SL} (De^{-(\rho+d)t})dt$$

$$= \frac{(R-T_p)(1-t_{ck})}{(\rho+d)} + t_{ck}\int_0^{SL} (De^{-(\rho+d)t})dt\ ,$$

for $e^{-(\rho+d)SL}\approx 0$, which will be true for $SL\rightarrow\infty$.

The implicit rental *rate* of capital (or the cost of capital to producers), r, is then defined as the ratio of R to K,

(A3.14) $r \equiv R/K.$

As shown in (A3.13) and (A3.14), the structure of federal and state taxes and the depreciation method affect r. To get the closed form solution for r, the depreciation that is a function of K and t needs to be specified.

The second term on the right hand side of (A3.13) is the present value of the tax benefits of depreciation allowances (TBD), expressed in continuous time. It may be rewritten as

$$TBD = t_{ck}\int_0^{SL} (De^{-dt})e^{-\rho t}dt \equiv t_{ck}\int_0^{SL} Ae^{-\rho t},$$

where De^{-dt} measures the depreciation allowed in any given time period and $e^{-\rho t}$ discounts this allowance to the present. In discrete form this gives

$$TBD = t_{ck}\sum_0^{DL}\frac{A_t}{(1+\rho)^t},$$

[25] Since we assume that the supply of capital is perfectly elastic due to perfect capital mobility in the U.S., t_{fk} is the tax rate on capital income applied to all U.S. residents.

where A_t is the depreciation allowed for tax purposes by the federal government for recovery year t. Note that the depreciation allowance is summed up over DL years, reflecting the tax depreciation life of the asset.

Federal tax law stipulates the depreciable life for various types of capital and the recovery allowance percentages for each recovery year. Assuming that the depreciable basis is equal to the value of capital, the depreciation allowed for year t, A_t, is:

$$A_t = \alpha_t K \quad \text{for } 1 \le t \le DL \text{; otherwise, } 0 \tag{A3.15}$$

where α_t is the recovery allowance percentage for recovery year t. With these changes, equation (A3.13) is modified to give

$$K = \frac{(R - T_p)(1 - t_{ck})}{(\rho + d)} + \text{t}_{\text{ck}} \sum_{t=1}^{DL} \frac{\alpha_t K}{(1+\rho)^t}. \tag{A3.16}$$

The tax on business property is given by $T_p = \beta K$. Substituting this into (A3.16), and solving for r ($=R/K$) yields

$$r = \frac{R}{K} = \frac{(\rho + d)(1 - t_{ck} C)}{(1 - t_{ck})} + \beta, \tag{A3.17}$$

where $C = \sum_{t=1}^{DL} \frac{\alpha_t}{(1+\rho)^t}$ and $C<1$. As indicated in (A3.17), r is affected by the structure of the various federal and state taxes and the depreciation method.

Numerical Example of Calculation of C

The depreciation for federal tax purposes is currently based on the Modified Accelerated Cost Recovery System (MACRS). Under MACRS, the depreciable life is seven years for most industrial equipment, office furniture and fixtures, and the recovery allowance percentages, α, are as follows:

Recovery Allowance Percentages under MACRS

Recovery Year	1	2	3	4	5	6	7	8
Recovery allowance percentages, α, in %	14	25	17	13	9	9	9	4

Suppose that the discount rate (ρ) is 10%, and the depreciation method is based on MACRS with a depreciable life of seven years. Then, we get:

$$(A3.18) \qquad C = \sum_{t=1}^{DL} \frac{\alpha_t}{(1+\rho)^t}$$

$$= \frac{.14}{(1+.1)} + \frac{.25}{(1+.1)^2} + \frac{.17}{(1+.1)^3} + \frac{.13}{(1+.1)^4} + ... + \frac{.04}{(1+.1)^8} = 0.722.$$

Data on α. The recovery allowance percentages, α, vary depending on the depreciation method specified in the tax laws, as follows.

Depreciation Methods for Federal Tax Purposes

Years	Method
1986-present	Modified Accelerated Cost Recovery System (MACRS)
1981-1985	Accelerated Cost Recovery System (ACRS)
1954-1980	Accelerated method (sum-of-years'-digits, SYD)

MACRS. Under MACRS, a sample of the depreciation life allowed for tax purposes is:

DL=3 years for certain special manufacturing tools,
DL=5 years for automobiles, computers, certain manufacturing equipment,
DL=7 years for most industrial equipment, office furniture and fixtures,
DL=10 years for certain longer-lived types of equipment.

The Recovery Allowance Percentages are:

Recovery year	Class of investment		
	3-year %	5-year %	7-year %
1	33	20	14
2	45	32	25
3	15	19	17
4	7	12	13
5		11	9
6		6	9
7			9
8			4

ACRS. Under ACRS, a sample of the depreciation life allowed for tax purposes is:

DL=3 years for autos, research and experimental equipment and certain special tools,

DL=5 years for all other machinery and equipment,

DL=10 years for certain public utility property, residential manufactured homes.

The Recovery Allowance Percentages are:

Recovery year	Class of investment		
	3-year %	5-year %	10-year %
1	25	15	8
2	38	22	14
3	37	21	12
4		21	10
5		21	10
6			10
7-10			9

SYD Method. The Internal Revenue Code of 1954, which authorized taxpayers to use the SYD method, does not specify the depreciation life allowed for tax purposes for different property classes; the SYD method does not provide any guidelines regarding different recovery periods. The depreciation percentages by ownership years under SYD are:

Ownership Year	Class of investment			
	3-yr %	5-yr %	7-yr %	10-yr %
1	50.00	33.33	25.00	18.18
2	33.33	26.67	21.43	16.36
3	16.67	20.00	17.86	14.55
4		13.33	14.29	12.73
5		6.67	10.71	10.91
6			7.14	9.09
7			3.57	7.27
8				5.45
9				3.64
10				1.82