Revenue-Stabilizing Tax Rates Over the Business Cycle: Implications for States

Carl E. Enomoto*
New Mexico State University

Christopher A. Erickson
New Mexico State University

Soumendra N. Ghosh
New Mexico State University

Abstract

This paper formulates a model of private and government sector behavior to derive a time path for tax rates. These tax rates minimize variation in state revenue about a predetermined level. Although the methodology is general, the paper concentrates on gross receipts (sales) tax rates because gross receipts typically are the most important source of government revenue at the state level. The results indicate that in choosing a particular tax policy, four factors must be considered: the effect of the business cycle on the state economy; the effect of taxes on personal income and gross receipts; the number of years in which taxes will be set at a fixed level and the costs involved in changing those taxes; and the timing of surpluses and deficits. It also is found that balancing the budget annually increases the variability of personal income, causing the state to suffer a more severe business cycle.

Introduction

The timing of tax collections over the business cycle is an important issue for policy makers at the state level because state authorities often face political and legal constraints that limit fiscal flexibility. For example, 39 states have constitutions that include some kind of balanced budget provision. Although tax collections not always are required to cover all expenditures, these provisions often limit deficit financing to capital projects that are preapproved by popular vote. Even when state constitutions do not proscribe deficits, political circumstances often do. Large budget surpluses are also politically undesirable. Large surpluses imply tax rates and associated deadweight losses that are greater than necessary. Political opponents can point to surpluses as evidence of poor management.

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Political and constitutional balanced budget requirements can limit the ability of states to finance government operations over the business cycle. Because sales tax revenues are generated by taxing economic activity, they tend to be procyclical. Even small declines in tax revenues during periods of slow or negative growth can force state governments to curtail or eliminate programs, disrupting service flows. Unusually large levels of collections during business upturns may be difficult to justify when tax rates could have been reduced. In fact, variable cash flows are just as much a problem for governments as they are for firms. A reduction in state government cash flow variability can be viewed as one way of reducing risk.

Despite the importance of business cycles to state government finances, only limited work has been done in this area.[1] The purpose of this paper is to help fill this gap in the literature. A model of private and government sector behavior is formulated and used to derive a time path for tax rates that minimizes variation in state revenue about a predetermined level. Although the methodology is general, this research concentrates on gross receipts (sales) tax rates because gross receipts typically are the most important source of government revenue at the state level.

Changing tax rates each year to balance the budget may be impractical. Tax rate changes often are associated with intense lobbying efforts. Constituent pressure on legislators, especially not to raise taxes, may be intense. It is unlikely that legislators are willing to enact rate changes frequently. Therefore, the optimal tax path is derived not only for the case when the budget is balanced annually, but also for when the budget is balanced over two, three, four, and five years. The five year case is particularly interesting because this corresponds to balancing the budget over a typical business cycle.

Although the main purpose of this paper is to derive a revenue-stabilzing tax time path, the results also shed light on the effects of the business cycle on state economies. In particular, the model can be applied to any state to show how changes in Gross National Product (GNP) and tax rates affect personal income and taxable gross receipts. It is found that balancing the budget annually increases the variability of state personal income, causing the state to suffer a more severe business cycle.

The concept of optimal tax rates has been discussed widely in the literature. (See, for example, Diamond and Mirrlees, 1977a, 1977b; Mirrlees, 1976; Sandmo, 1976; Sadka, 1977; Garfinkel, Moreland, and Sadka, 1986.) The methodology used typically has been to choose taxes to maximize a social wel-

[1]Much of the work that has been done deals with choosing a single tax rate and tax base to achieve a more stable path for revenues from a particular source. For example, Pollock and Suyderhoud (1986) use simulation to look at the time path of so-called rainy day funds over the business cycle. See also Vasche and Williamson (1987) and Wolkoff (1987).

fare function subject to a production and government revenue constraint. Such an approach is subject to criticism to the extent that a social welfare function is not well defined. Apart from these theoretical considerations, optimal tax theory has been difficult to apply because data necessary about preferences are not available.

Another trend in the tax policy literature has been to use simulation models to determine the effect of alternate tax policies (Salathe, *et al.*, 1985; Westcott, 1986; Christensen and Hallberg, 1983; Fallert *et al.*, 1987; Pollock and Suyderhoud, 1986; Garfinkel, Moreland, and Sadka, 1986). These models typically estimate a set of either reduced form or structural equations where government policies are exogenous variables. Simulations are based on different projections of exogenous policies and result in alternative scenarios for the economy. It is this second approach that is used here. Specifically, a model of consumer, producer, and government behavior is developed. The model is simulated using data from New Mexico.

The Theoretical Model

It is assumed that state governments seek to raise funds in order to finance the production of public goods and income or in-kind transfers. Given this, the determination of a revenue-stabilizing time path of taxes can be thought of as a two step procedure. In the first step, the desired level of government expenditures is determined through the political process. Rather than explicitly modeling this process,[2] the level of government expenditure in each year will be treated as exogenous. The second step is to determine the time path of tax rates necessary to raise sufficient revenue to finance desired public expenditures. Because gross receipts taxes usually account for the majority of revenues at the state level, these taxes are the focus of this paper.[3]

The effect of changes in the gross receipts tax rates on the state economy is derived. It is assumed that production is carried out by profit-maximizing firms operating in competitive product and factor markets. Because gross receipts tax rates affect net product prices received by producers, they are arguments in the profit maximization problem solved by firms.

It is assumed, in particular, that each firm j (j = 1, 2, 3, ... , k) faces a net product price (net of tax) for its output, which is denoted p_j^n. These prices are a function of z, a measure of overall economic activity, and τ, the gross receipts tax rate. Each firm j has a standard production function, $Y_j(X)$, where X is a

[2]The level of government expenditures can be thought of as being derived through a democratic choice rule or some other similar selection procedure.

[3]This research uses a partial equilibrium approach. It implicitly is assumed that the feedback between gross receipt taxes and other tax revenue is small.

vector of inputs used by the firm. Let r_i be the price of the ith factor and X_i ($i = 1, 2, 3, \ldots, m$) be the quantity of the ith input utilized by the firm. The typical firm's profit maximization problem is:

$$(1)\ \max \pi_j = p_j^n(z,\tau)Y_j(X) - \sum_{i=1}^{m} r_i X_i.$$

The solution to this problem yields the input demands, $X_i = \tilde{X}_i(z, \tau, r)$, where r is a vector of input prices. When the input demands are substituted into the production function, the firm's supply function is:

$$Y_j = Y_j[X(z, \tau, r)] \equiv \tilde{Y}_j(z, \tau, r).$$

The expression for taxable gross receipts, denoted by GR, can be derived by summing the gross receipts for each of the k firms:

$$(2)\ GR = \psi(y, \tau, r) \equiv \sum_{j=1}^{k} p_j^n(z,\tau)\tilde{Y}_j(z, \tau, r)).$$

Given this specification of the gross receipts function, the analysis now turns to the problem confronting state government.

The state is assumed to choose taxes to minimize losses from deviations of collected revenue (R) from the desired level (R*) in each period. It is assumed that the preferences of policy makers can be represented by a quadratic loss function.[4] The revenue-stabilizing tax rates must be chosen subject to the effect of tax rates on gross receipts, the government revenue identity, and the values of the predetermined variables. The state's problem is given by:

$$(3)\ \min_{\{\tau_t\}} \sum_{t=1}^{N} (R_t - R_t^*)^2$$

subject to:

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[4]It is assumed that positive and negative deviations from desired revenue are equally undesirable. That is, the cost of unnecessarily high taxes is the same as the cost of deficits. Alternatively, the loss function could be specified in a manner that would place different weights on positive and negative deviations. In particular:

$\text{loss} = \alpha(R - R^*)$ if $R > R^*$, and $\text{loss} = \beta(R - R^*)$ if $R < R^*$.

The objective function in the text assumes that $\alpha = \beta$.

(i) $R_t = GR_t \times \tau_t$;

and

(ii) $GR_t = \psi(y_t, \tau_t, r_t)$.

Thus, the state minimizes variation in cash flows by choosing τ each period. The predetermined variables in equation (3) are r_t (factor prices) and z_t. It is through z_t that business cycles are introduced. In the next section, overall state, z, economic activity is measured by personal income. Thus, variation in state personal income (i.e., a business cycle) leads to variation in tax revenues.

Data and Results

To operationalize the model, data were used for the State of New Mexico over the sample period 1982:I to 1988:IV. Although the model is applicable to any state, using New Mexico data has several advantages. First, New Mexico is one of the few states with a comprehensive gross receipts tax. The gross receipts tax differs from the sales tax in that services typically are not taxed with a sales tax but are taxed under a gross receipts tax. Because gross receipt taxes are more comprehensive, using New Mexico data minimizes the confounding influence of changes in relative prices.

Another important reason for choosing New Mexico is that the New Mexico economy was unusually stable over the sample period. For example, no major new state programs were initiated during the sample period. In fact, a possible objection to the procedure used below is the Lucas (1975) critique, which argues that regime changes can render structural models unidentified. Because the New Mexico economy was characterized by a stable policy regime over the sample period, the Lucas critique is not applicable to this study.

The first step in the procedure is to estimate equation (2). As indicated above, state personal income (PI) is used to represent the measure of overall economic activity. This variable is chosen because it is the broadest measure of income available at the state level on a quarterly basis. Two factor prices are included. The AAA corporate bond rate is selected as a proxy for the user price of capital. Labor costs are proxied by dividing total state earnings by total state employment. The data were obtained from the National Income Accounts, the U.S. Bureau of Economic Analysis, Federal Reserve Bulletins, and the New Mexico Taxation and Revenue Department. All variables are in nominal terms. It is assumed that the gross receipt function is linear in its arguments.

To account for the possibility of simultaneity between gross receipts and personal income, instrumental variables are used to estimate equation (2). The instruments chosen for state personal income include state personal income lagged one quarter (LPI),[5] Gross National Product (GNP), the tax rate (τ), the AAA corporate bond rate (AAA), and annualized state wages (WAGE).[6] The results of the first stage estimation are:

$$\text{(4) } PI = \underset{(-.531)}{-742} + \underset{(5.92)}{.613}\, LPI + \underset{(2.95)}{1.14}\, GNP + \underset{(0.22)}{5.84}\, AAA + \underset{(2.12)}{154.87}\, WAGE - \underset{(-1.48)}{146.38}\tau$$

$$\begin{aligned} \overline{R^2} &= .899 \\ DW &= 2.399 \\ Q(1) &= 1.184 \end{aligned}$$

where t-statistics are given in parentheses.[7] Because gross receipts are a function of personal income and personal income is a function of GNP, gross receipts are also a function of GNP. Thus, it is through personal income in the model that the national business cycle affects gross receipts.

Using equation (4) to generate $\hat{PI}$, the gross receipts function is estimated to be:

$$\text{(5) } GR = \underset{(1.02)}{1861335} + \underset{(5.05)}{437.7}\hat{PI} + \underset{(1.64)}{56263}AAA - \underset{(-1.71)}{22163.34}WAGE - \underset{(-2.61)}{308024}\tau$$

$$\begin{aligned} \overline{R^2} &= .8544 \\ DW &= 2.052 \\ Q(1) &= 1.027 \end{aligned}$$

where t-statistics appear in parentheses. The results indicate that gross receipts are related positively to state personal income and related inversely to the tax

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[5]The results were robust to different specifications of the PI lag structure.

[6]Although it could be argued that state wages should be treated as endogenous, this paper treats wages as exogenous for several reasons. First, approximately 17 percent of New Mexico's labor force is paid the federally mandated minimum wage, compared to only 4.4 percent nationally. Second, federal government employment accounts for 6 percent of New Mexico jobs compared to only 3 percent nationally. Finally, the wages paid many other New Mexican workers either are tied to minimum wage or are determined in national labor markets (New Mexico Department of Labor.

[7]Because equation (4) contains a lagged dependent variable as an independent variable, the DW statistic is biased toward two and must be interpreted with care. Q(1), which is distributed $\chi^2(1)$, provides an alternative test for first order serial correlation. The formula for Q(1) is

$$Q(1) = \frac{n(n+2)}{(n-1)} r^2$$

where r is the estimated first order autocorrelation coefficient. There is no indication of autocorelation.

rate, as was expected. Both coefficients are significant at the 5 percent level. Neither of the two input prices have a significant effect on gross receipts. Recalling that both wages and the AAA rate are used as instruments for personal income, this last result may be due to multicollinearity between the two input prices and $\hat{PI}$.

Equations (4) and (5) now can be used to solve the constrained optimization problem in equation (3). The model is simulated over 20 quarters, the average length of the U.S. business cycle in the postwar period. The final sample observation (1988:IV) is used as the initial value for each exogenous variable. Interest rates and annual state wages both are assumed to remain constant at 9.56 percent and \$20,684, respectively. This assumption is made to focus attention on the effect of business cycles on the state economy. The targeted level of revenue, R*, is held constant at its final sample value (\$182,832,000) over the entire simulation period. The initial value of LPI (lagged personal income) was \$17,091 million.

To determine the effect of business cycles on tax rates, three cases are examined. In the base case, personal income is held fixed at \$17,091 million, the final value from the data set. The other two simulation induce a business cycle by assuming that real GNP follows a sine wave. In particular, real GNP is assumed to be generated by:[8]

(6) $GNP = 4056 - \gamma \times \sin[(\pi/10) \times t]$

where:

$\pi/10$ = The number of radians per quarter such that a business cycle is completed in five years (20 quarters);

t = Time, with values of 1 to 20 over the simulated cycle.

The constant term in equation (6) was chosen in order to calibrate the initial value of GNP to its final in-sample value (\$4,056 billion).

The model is simulated for two different business cycles. In the moderate cycle case, real GNP was allowed to change 5.06 percent from peak to trough by setting γ equal to 100. This case corresponds to the average cycle experienced by the U.S. economy during the postwar period through 1989. To determine the sensitivity of the results to the severity of the business cycle, a severe business cycle model also was simulated. For the severe cycle case, real GNP was allowed to change 10.4 percent from peak to trough by setting γ equal to 200. Finally,

[8]The particular form of the business cycle used here is for simulation purposes. Policy makers would use forecasted values of GNP. These are available from sources such as Blue Chip Indicators, Data Resources, Inc., and Fairmodel.

to calculate nominal GNP from the real GNP generated by equation (6), inflation was assumed to be 4 percent.

The Gauss-Seidel method (Fair, 1984) is used to find numerical solutions to the policy makers' optimization problem given in equation (3). This technique involves the selection of initial values for the endogenous variables: the tax rate (τ) and gross receipts (GR). These values then are used in an iterative manner to generate subsequent values of the endogenous variables. In the model, the problem reduces to two equations. Specifically, combining the constraints with the objective function in equation (3) and rearranging gives:

(i') $GR = \psi(x, \tau, r)$;

and

(ii') $\tau = \dfrac{R^*}{GR}$.

These equations show that the tax rate and gross receipts must not only be consistent with each other, equation (i'), but also must be consistent with target revenue (R^*), equation (ii'). To start the process, initial values must be chosen for each of the variables in equations (i') and (ii'). The values for the final in-sample observation (i.e., the values for 1988:IV) were used for the initial values. When these values were substituted into the right side of these two equations, a new set of estimates was derived which then was substituted into equations (i') and (ii'). This process continued until convergence within a given tolerance occurred.[9]

The results are given in Tables 1 through 3. Tax rates are expressed as percentages, personal income is measured in millions of dollars, and gross receipts and tax revenue are measured in thousands of dollars and are quarterly averages for the year. The results for the base case (i.e., the no business cycle case) are reported in Table 1. The revenue-stabilizing tax rate for this case is 4.8 percent. This rate yields the desired revenue and results in constant personal income and gross receipt figures of \$17,091 million and \$3,809 million, respectively.

The results for the moderate and severe cycle cases are reported in Tables 2 and 3, respectively. Changing tax rates each year will not be practical under most circumstances. For example, such changes would make planning in the private sector difficult. To determine the consequences of balancing budgets over several years, the model was solved for those tax rates that would stabilize revenue over

[9]Convergence was assumed when the values of the variables did not change by more than 10^{-6}. There are many programs available, including Minos and Gauss, that could be used to replicate the results.

two, three, and four year periods. Revenue-stabilizing tax rates also are solved for a five year period. This last simulation corresponds to balancing the budget over the full business cycle.

There are several interesting results apparent from the study. When the budget is balanced annually, tax rates start at a high level and then decrease over the first four years of the business cycle. They increase only in the fifth year. This in part occurs due to the way the business cycle is modeled in equation (6). In particular, the economy is assumed to enter a five quarter recession in the first quarter of the simulation. GNP then expands for the next ten quarters and finally declines the last five quarters. The time paths of taxes for both the moderate and severe cycles are similar, although the variability of tax rates is greater for the severe business cycle case.

Given the particular cycle assumed here, tax rates will be high initially to offset the initial decline in gross receipts caused by the drop in GNP and resulting decline in state personal income. As GNP recovers, tax rates begin to fall. As GNP decreases again, tax rates start to increase. Note that tax rates are not perfectly synchronized with turning points in the business cycle because of the lagged effect of personal income on itself and subsequently on gross receipts.

The choice of the period over which the budget is to be balanced has an effect on the timing of surpluses and deficits. For the moderate business cycle, when the budget is balanced over two and three years, deficits incurred in the initial year are followed by surpluses. When the budget is balanced over four and five years, however, a surplus occurs in the initial year. A similar pattern also holds for the severe cycle case. Thus, the choice of whether to change rates often or to select one rate has a direct effect on the timing of surpluses and deficits. This result has important implications for policy makers who have a need to generate immediate surpluses to carry over to later deficit years. Moreover, state government administrations and legislatures may have two, four, or eight year time horizons, depending on the occurrence of state elections. The response, therefore, of state government to a business cycle could depend on the stage of the election cycle.

Not only does tax policy affect the timing of surpluses and deficits, but the time path of state personal income also is affected. For example, when the budget is balanced annually, higher initial tax rates reduce personal income for the first two years. As GNP recovers, lower rates increase personal income figures in the third and fourth year compared to when the budget is balanced over a longer period. This pattern holds for both the moderate and severe business cycle cases. Thus, balancing the budget annually increases the variability of personal income, causing the state to suffer a more severe business cycle. This result must be interpreted with care, however, given the small t-statistic associated with taxes in equation (4). Nevertheless, this result suggests that balanced budget amendments are counterproductive if minimizing the effect of business cycles on a state economy is one goal. This is an especially interesting result given the recent recession experience in the United States during which a typical response by states to budget deficits has been to raise tax rates.

The most important difference between the moderate and severe business cycle cases, not surprisingly, is the variability of tax rates. This difference becomes less important, however, as the time over which the budget is balanced is increased. When the budget is balanced annually, tax rates vary by only 35 basis point (7.5 percent of τ) for the moderate business cycle but vary by 90 basis points (18.8 percent of τ) with the severe cycle. When the budget is balanced over the full cycle, the tax rate for both the moderate and severe cycle cases converge to the tax rate for the base case—4.8 percent.

Summary and Conclusions

The business cycle is an important determinant of tax revenues at the state level. Often political and constitutional constraints limit the ability of state governments to run deficits and surpluses over the business cycle. Tax rates may need to be adjusted to finance desired government expenditures. Despite the need to balance budgets in response to the business cycle, little work has been done in this area. This paper is an attempt to reduce this gap in the literature. A dynamic model of a state economy is derived that links tax rates and economic activity at the state and national levels. The model was applied to the State of New Mexico.

The study has shown that in determining the gross receipt tax rate, several factors must be examined:

- The effect of the business cycle on the state economy;
- The effect of taxes on personal income and gross receipts;
- The time over which the budget is to be balanced; and
- The desired timing of surpluses and deficits.

Simulating the effect of a specific business cycle on a state economy shows that when a budget is balanced over the entire cycle, tax rates are lower in the early years compared to tax rates adjusted annually. The different tax time paths that result from different tax policies give rise to different patterns of surpluses and deficits. Further, the time path of state personal income is affected by tax policy. When policy makers are designing tax policy, they should consider not only what the rates will be, but for how long they will be set and over what phase of the business cycle. Attempting to balance the budget annually would result in greater variability in personal income.

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Table 1
Base Case
Revenue-Stabilizing Gross Receipts Tax Rates
When State Personal Income Is Held Constant at 1988 Level

Year	Tax Rate[a]	Personal Income[b] ($ Millions)	Gross Receipts[c] ($ Thousands)	Revenue[d] ($ Thousands)	Surplus (+) or Deficit (-)
For Each of Five Years	4.8	17,091	3,809,000	182,832	0

Notes:
a: Tax rate maximizes gross receipt while satisfying target revenue constraint, calculated using Gauss-Seidel technique
b: Personal income generated using regression equation (4)
c: Gross receipts generated using regression equation (5)
d: Number shown is revenue generated. Target revenue (R^*) is $182,832,000
Source: Authors' calculations using regressions reported in text

Table 2
Moderate Business Cycle Case
The Effect on Revenue-Stabilizing Gross Receipts Tax Rates
When GNP[a] is Allowed to Vary by 5.06 Percent From Peak to Trough

Year	Tax Rate[b]	Personal Income[c] ($ Millions)	Gross Receipts[d] ($ Thousands)	Revenue[e] ($ Thousands)	Surplus (+) or Deficit (-)
		Rates Adjusted Annually			
1	5.03	16,818	3,635,902	182,832	0
2	4.95	16,909	3,692,995	182,832	0
3	5.00	17,250	3,908,646	182,832	0
4	4.68	17,367	3,981,149	182,832	0
5	4.79	17,102	3,817,453	182,832	0
		Rates Adjusted Every Second Year			
1	4.83	16,937	3,730,744	180,195	-
2	4.83	17,137	3,818,002	184,410	+
3	4.71	17,283	3,919,432	184,605	+
4	4.71	17,169	3,869,835	182,269	-
5	4.90	16,931	3,708,405	181,712	-
					-
		Rates Adjusted Every Third Year			
1	4.74	17,090	3,825,465	181,327	-
2	4.74	17,231	3,887,086	184,248	+
3	4.74	17,157	3,854,584	182,707	-
4	4.85	17,011	3,758,347	182,280	-
5	4.85	16,964	3,737,857	181,286	-
		Rates Adjusted Every Fourth Year			
1	4.79	17,202	3,858,876	184,840	+
2	4.79	17,159	3,840,248	183,948	+
3	4.79	17,021	3,779,545	181,040	-
4	4.79	16,979	3,761,172	180,160	-
5	4.77	17,095	3,819,006	182,167	-
		Rates Adjusted Every Fifth Year			
1	4.80	17,147	3,834,061	184,035	+
2	4.80	17,007	3,772,890	181,099	-
3	4.80	17,040	3,787,224	181,787	-
4	4.80	17,178	3,847,830	184,696	+
5	4.80	17,144	3,833,012	183,985	+

Notes:
a: GNP generated using equation (6) with γ set at 100
b: Tax rate minimizing personal income while satisfying target revenue constraint, calculated using Gauss-Seidel technique
c: Personal income generated using regression equation (4)
d: Gross receipts generated using regression equation (5)
e: Number shown is revenue generated. Target revenue (R^*) is $182,832,000
Source: Authors' calculations using regressions reported in text

Table 3
Severe Business Cycle Case
The Effect on Revenue-Stabilizing Gross Receipts Tax Rates
When GNP[a] is Allowed to Vary by 10.4 Percent From Peak to Trough

Year	Tax Rate[b]	Personal Income[c] ($ Millions)	Gross Receipts[d] ($ Thousands)	Revenue[e] ($ Thousands)	Surplus (+) or Deficit (-)
		Rates Adjusted Annually			
1	5.31	16,536	3,448,135	182,832	0
2	5.12	16,718	3,568,216	182,832	0
3	4.57	17,405	4,003,994	182,832	0
4	4.41	17,638	4,145,283	182,832	0
5	4.78	17,111	3,824,306	182,832	0
		Rates Adjusted Every Second Year			
1	4.87	16,783	3,651,455	177,825	-
2	4.87	17,182	3,826,158	186,333	+
3	4.63	17,474	4,028,948	186,540	+
4	4.63	17,247	3,929,758	181,947	-
5	5.02	16,778	3,604,880	180,965	-
		Rates Adjusted Every Third Year			
1	4.69	17,087	3,840,039	180,097	-
2	4.69	17,370	3,963,637	185,894	+
3	4.69	17,222	3,898,816	182,854	+
4	4.90	16,931	3,707,004	181,643	-
5	4.90	16,837	3,666,156	179,641	-
		Rates Adjusted Every Fourth Year			
1	4.79	17,310	3,907,846	187,186	+
2	4.79	17,227	3,871,133	185,427	+
3	4.79	16,950	3,750,060	179,628	-
4	4.79	16,867	3,713,516	177,877	-
5	4.75	17,100	3,828,740	181,865	-
		Rates Adjusted Every Fifth Year			
1	4.79	17,268	3,889,287	186,296	+
2	4.79	17,200	3,857,922	184,794	+
3	4.79	16,921	3,735,974	178,953	-
4	4.79	16,987	3,764,886	180,338	-
5	4.79	17,265	3,886,249	186,151	+

Notes:
a: GNP generated using equation (6) with γ set at 200
b: Tax rate minimizing personal income while satisfying target revenue constraint, calculated using Gauss-Seidel technique
c: Personal income generated using regression equation (4)
d: Gross receipts generated using regression equation (5)
e: Number shown is revenue generated. Target revenue (R^*) is $182,832,000
Source: Authors' calculations using regressions reported in text