

AN ECONOMETRIC MODEL OF A STATE GOVERNMENT SECTOR*

J. R. Barnard, W. T. Dent, and A. P. Reznek**

INTRODUCTION

This paper presents a simultaneous equations model to analyze the effects of State of Iowa government expenditures on the state economy and in turn on the revenues of the state government.[1] The model yields a set of impact multipliers that relate changes in selected state government expenditures to changes in personal income and tax revenues.

The paper is motivated by the interest of governmental decision makers in how tax revenues are affected by such major forces as economic growth, recession, and inflation. State decision makers are also keenly interested in the effects state government expenditures have on the generation of personal income and subsequent revenues of state government. In addition, the decision makers are interested in having an overall picture of what will happen to generate fund revenues and expenditures in future budget periods when a part of expenditures is dictated by allocation formulas and by institutional adjustments based on changes in the Consumer Price Index. And, since many state governments are not permitted to run a deficit budget, they are interested in knowing what effects changes in tax revenues and expenditures will have on a state surplus. The multipliers shown in this paper provide some insight into the above questions by estimating the effects of changes in state government employment on Iowa nonfarm personal income; the effects of changes in personal income, government expenditure, or employment on state tax revenues; and the effects of selected variables on state government expenditures.

The approach of this study is different from other regional econometric modeling efforts. Models by Adams, Brooking and Glickman [1], Glickman [5], and L'Esperance and Nestel [7], are large scale regional models which contain specific equations relevant to estimating regional governmental revenues; however, these models are not primarily concerned with the governmental sector.

STRUCTURE OF THE MODEL AND METHOD OF ESTIMATION

The causal structure of the model runs from state government expenditures to personal income, either directly (e.g., through wages and salaries) or indirectly (e.g., through government purchases of supplies and equipment). Personal income, in turn, affects state revenues through its influence on the size of the bases of many taxes. Finally, some state expenditures (e.g., aid to public schools) are determined by formulas that link expenditures to state revenues. Therefore, revenues do influence expenditures and the model attempts to capture this influence.

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[1] In earlier work (Barnard & Dent [2]) developed models to forecast the major state taxes.

**University of Iowa, Eli Lilly Corp., and U.S. Department of Energy, respectively.

The individual equations are specified so that some of the effects of legislative decisions can be measured. Thus, the modeling takes into account legal changes in tax bases and tax rates, and includes the most important variables that enter into expenditure formulas.

The structure of the model of state government is developed around the major revenue and expenditure categories. The major revenue sources are divided into two categories — general fund and non-general fund revenues. General fund revenues are not earmarked for specific use and include the tax revenues of the state. It is the general fund that state decision makers are most interested in. Non-general fund revenues encompass all funds entering the state special and trust funds. Special fund revenues include most federal aid to state programs such as the unemployment insurance program, federal aid to welfare programs, highway trust funds and state liquor store net income. The sources of funds entering the general and non-general funds for fiscal year 1977 are reported in Table 1.

The objectives of the study required the separation of the available published data for government programs into wages and salaries, administrative expenses, and benefits received by economic agents outside the state government. Seven expenditure categories were identified as relevant and are reported in Table 2.

TABLE 1. Sources of General and Non-General Funds, State of Iowa, Fiscal year of 1979[1].

Source	Amount (million dollars)	Percent
General Fund		
Individual Income Tax	509.4	16.8
Sales Tax	302.9	9.9
Corporate Income Tax	93.6	3.2
Non-Motor Vehicle Use Tax	49.8	1.6
Other General Fund Taxes[2]	190.1	6.3
Total General Fund	1148.5	37.8
Non-General Fund	1887.5	62.2
Total General and Non-General Fund	3036.0	100.0

Source: State of Iowa, Office of State Comptroller, *State Of Iowa Receipts Statement,* Des Moines, Iowa.

[2] Includes alcohol and tobacco tax, chain store tax, franchise tax, inheritance tax, insurance premium tax, and licensing fees.

The econometric model draws on earlier work (Barnard & Dent [2]) on state tax revenue forecasting models for Iowa. In these models it was demonstrated that personal income split into farm and nonfarm components serves well in explaining and forecasting levels of the major tax revenues in Iowa. ARIMA methods (Box & Jenkins [4] and Nelson [8]) are used to forecast the exogenous personal income components that drive the quarterly or annual tax forecasting equations. Methodologically, the approach is along the lines of a closed economy, and this

TABLE 2. State Government Expenditures, Iowa, Fiscal Year 1977.

State Government Expenditures	Amount (million dollars)	Percent
Wages and salaries	519.3	17.5
Aid to public schools	485.5	16.4
State tax credits	194.1	6.5
Welfare expenditures	113.7	3.8
Unemployment insurance	114.1	3.9
Retirement expenditures	56.7	1.9
Other state expenditures	1484.6	50.0
Total	2968.0	100.0

Sources: State of Iowa, Office of the State Comptroller, *Payroll Journal Recap of State Centralized Payroll System*, and *Financial Status Report*, Des Moines, Iowa.

approach is followed in this model.[2] It should be emphasized that this model is specific to Iowa.

The model of state government expenditures is made up of a system of simultaneous equations. The small sample sizes — 10 annual observations on each variable representing fiscal years 1966-1975 — has serious implications for estimation.[3] The number of observations is less than the total number of exogenous variables, which gives rise to the problem of "undersized samples." The problem is that the 18 observation vectors of exogenous variables cannot be linearly independent in this model. Therefore, system estimators such as Three Stage Least Squares (3SLS) cannot be used, and it turns out that the only appropriate estimation technique is Ordinary Least Squares (OLS).

Theil [9, p. 532-535] shows that the 2SLS estimator can be generalized to fit this situation. Using the Moore-Penrose generalized inverse of a matrix, [9, p. 269-273], he shows that the 2SLS estimator reduces to OLS when the number of observations is less than the number of exogenous variables as in the present model. Therefore, OLS is the estimation method that is used in this study.

Revenue Equations

The revenue equations are made up of three identities and six structural equations covering all state government revenues. Total revenues are expressed as

(1) $R = RG + RN$

[2] The statistical support of the insensitivity of Iowa income to national business cycles is further supported by the analysis of Bretzfelder [3] who ranks Iowa 42nd of 50 states with respect to sensitivity to cyclical swings in national economic behavior.

[3] Quarterly data were available for Iowa personal income and Iowa tax revenues. Therefore, most of Barnard and Dent's single-equations revenue models were quarterly. However, quarterly expenditure data of the type necessary in the current model could not be obtained without prohibitive investments of time. Therefore, annual data were used, which meant that all equations in the system had to be estimated with annual data. In addition, it was not possible to obtain with reasonable effort the correct expenditure data for years prior to 1966.

where

RG = General fund revenues[4]
RN = Non-general fund revenues

General fund revenues can in turn be written as

(2) RG = S + UNM + CYT + PYT + RGO

where

S = Sales tax revenues
UNM = Non-motor vehicle use tax revenues
CYT = Corporate income tax revenues
PYT = Personal income tax revenues
RGO = Other general fund revenues

Sales Tax Revenues (S). Sales tax receipts are related directly to personal income because no satisfactory data set exists on state personal consumption. There is currently a three percent tax on most goods and services, the exception being food and drugs, which were excluded from the tax in July 1974.

$$(3)\quad S = \underset{(23.59)}{14.97} + \beta Y$$

$$R^2 = 0.9724 \qquad DW = 2.08 \qquad RMS = 130.7$$

where

Y = Personal income

The coefficient of Y, represented here by β, is allowed to change in order to account for the change in the tax rate from two to three percent in fiscal 1968 and to account for the exclusion of food and drug items from the tax starting in 1975. This is done by using three Y vectors — one with the observed Y values for 1966 and 1967 and zeros elsewhere, a second with the values for 1968 to 1974, and the third with the values for 1974 and 1975. Thus, the value of β is .009659 for 1966 and 1967, it is .01565 for 1968 through 1974, and it is .01430 for 1975 on. The standard errors for these values of β are .003047, .002038, and .001646 respectively. Only the second β value is used in a later section to compute multiplier values.

The statistics displayed for this equation and for other equations are as follows. Numbers in parentheses are standard errors of the coefficients. F(p,q) is the value of the overall F statistic with p and q degrees of freedom. DW is the Durbin-Watson statistic, SSR is the sum of squared residuals, RMS is the residual mean square, and SE is the standard error of the regression.[5]

[4] All variables are expressed as nominal values. This is done because state budget making and tax revenue forecasting are carried out on a nominal value basis. Also, an appropriate deflator does not exist.

[5] Additional validation was done for each equation using post sample period forecasts. In general, the forecasts were considered satisfactory and provided further evidence of the validity of these specifications. The forecasts are not reported due to the length of the paper. They are available from the authors.

Non-Motor Vehicle Use Tax Revenues (UNM). The nonmotor vehicle use tax is a tax on intermediate manufacturing inputs that do not enter directly into the final product (e.g., chemicals used in cleaning, lubricants, etc.). Since this tax is essentially related to manufacturing and no direct measure of manufacturing inputs is available, two indicators are used: 1) Iowa wages and salaries (as an indicator of state economic activity), and 2) national corporate profits (as an indicator of national corporate activity, which does affect Iowa's manufacturing sector. The exogenous variables are lagged one half-year. The estimated model is[6]

$$(4) \quad UNM = \underset{(2.772)}{-16.96} + \underset{(.0008454)}{.005656 WS_{-1/2}} = \underset{(.00006096)}{.00007062 PI_{-1/2}}$$

$WS_{-1/2}$ = Iowa wages and salaries for previous calendar year
$PI_{-1/2}$ = National corporate profits for previous calendar year

$R^2 = .9728$ SSR = 21.61 $F(2,7) = 125.0$ SE = 11.50 DW = 1.27

Motor vehicle use tax deposits are not modeled separately, but are included in nongeneral revenues.

Corporate Income Tax Revenues (CYT). No state corporate income series is available directly. Hence, it was necessary to construct the series using the reciprocal of the corporate tax rate applied to corporate income tax collections. Taxable corporate income estimates are made using local and national indicators of corporate activity. The local indicator is Iowa nonagricultural wage and salary employment and the national indicator is national corporate profits before taxes. Dummy variables are used in the equation to represent significant changes in reporting requirements on taxable corporate income in fiscal 1968 and 1972.

Taxable corporate income is modeled by

$$(5) \quad CY = \underset{(173.0)}{-686.69} + \underset{(.0006736)}{.007046 PI_{-1/2}} + \underset{(.2734)}{.4484 NN_{-1/2}} + \underset{(25.27)}{100.49 D_2} + \underset{(17.18)}{15.70 D_3}$$

where

$PI_{-1/2}$ = National corporate profits for previous calendar year
$NN_{-1/2}$ = Nonagricultural wage and salary employment for previous calendar year
D_2, D_3 = Dummy variables corresponding to changes in tax rates and legal reporting requirements in fiscal 1968 and 1972

$R^2 = .9965$ SSR = 1186.15 $F(4,5) = 360.5$ SE = 15.40 DW = 2.14

The current corporate income tax rate is 8 percent. Thus corporate income taxes are estimated as

$$(6) \quad CYT = .08 CY$$

[6] This equation and some others contain variables whose coefficients would not be significantly different from zero if subjected to the standard t-tests. The inclusion of these variables makes sense from a theoretical point of view, and further, when one turns out insignificant, it may be premature to exclude it on statistical grounds alone because the number of observations is small. The equations shown in this paper are those that best balance parsimony in the number of parameters with explanatory and forecasting power.

Personal Income Tax Revenues (PYT). Personal income taxes depend directly on personal income. The influence of farm and nonfarm personal incomes can be separated so that the effect of each on income tax revenues can be measured. Iowa's highest marginal tax rate prior to January, 1975 was 7 percent; at that time it was increased to 13 percent. The equation for personal income is

$$(7)\quad PYT = \underset{(31.25)}{-224.06} + \underset{(.004978)}{.03838YN} + \underset{(.02249)}{.03958YF}$$

where

YN = Nonfarm income
YF = Farm income

$R^2 = .9673$ SSR = 3632.15 F(2,7) = 103.7 SE = 22.78 DW = 1.38

The coefficients in this equation can be thought of as estimates of the effective tax rates on farm and nonfarm personal income. As would be expected under a specification with no income distribution measure, the rates on farm and nonfarm income are approximately equal.

Other General Fund Revenues (RGO). Other general fund revenues includes such taxes as tobacco and liquor taxes, the inheritance tax, the insurance premium tax, and licensing fees of many types. These revenues follow relatively stable growth paths. Two exogenous variables (population and nonfarm income) are used to explain the general level of growth in other general fund revenues. The estimated equation is

$$(8)\quad RGO = \underset{(176.0)}{-855.38} + \underset{(.06599)}{.3299POP} + \underset{(.001281)}{.005125YN}$$

where

POP = State population
YN = Nonfarm personal income

$R^2 = .9767$ SSR = 153.34 F(2,7) = 146.7 SE = 4.68 DW = 2.43

Non-General Fund Revenues (RN). Non-general fund revenues include intergovernmental transfers of funds from the federal government to state government, trust funds (including unemployment insurance funds), and public employee retirement funds. Two exogenous variables are used to explain nongeneral fund revenues — the Iowa Unemployment rate and the Consumer Price Index. The unemployment rate reflects the need for federal government transfers and the Consumer Price Index reflects changes in cost of living adjustments on transfer payments. The estimated equation is

$$(9)\quad RN = \underset{(63.70)}{-660.59} + \underset{(17.50)}{6.303UR} + \underset{(.7713)}{13.56CPI}$$

$R^2 = .9899$ SSR = 6089.85 F(2,7) = 342.2 SE = 29.50 DW = 1.76

where

UR = Iowa unemployment rate
CPI = Consumer Price Index

Expenditure Equations

There are seven structural equations and one identity covering state expenditures. Total expenditures is the sum of the seven major expenditure categories:

(10) $E = EW + ES + ET + EWL + EUI + ER + EO$

where

EW = State government wages and salaries
ES = State aid to public schools
ET = State tax credits
EWL = State welfare expenditures
EUI = State unemployment insurance expenditures
ER = State retirement expenditures (IPERS program only)
EO = Other state expenditures

State Government Wages and Salaries (EW). Government wages and salaries depend on the number of state government employees and adjustments made for changes in the cost of living based on the consumer price index. Wages and salaries are estimated by

(11) $$EW = \underset{(29.10)}{-440.9} + \underset{(1.415)}{10.71}NG + \underset{(.2762)}{2.312}CPI$$

where

NG = Number of state government employees
CPI = Consumer Price Index

$R^2 = .9964$ SSR = 210.4 $F(2,7) = 981.6$ SE = 5.48 DW = 1.54

State Aid to Public Schools (ES). State aid to public schools is a program to equalize the burden and promote equality in the state elementary and secondary school system. Funds are allocated to local school districts by formula based on growth in the general fund and property tax valuation. The estimated equation is

(12) $$ES = \underset{(175.2)}{-187.5} + \underset{(.1626)}{.4245}RG_{-1} + \underset{(.03632)}{.02626}PVL$$

where

RG_{-1} = General fund revenue lagged one year
PVL_{-1} = 27% of statewide assessed property tax valuation, lagged one year

$R^2 = .9649$ SSR = 3778.55 $F(2,7) = 96.3$ SE = 23.23 DW = 2.09

Tax Credits (ET). Tax credits are payments made by state government to local governments with the expressed purpose of shifting some of the burden of payment for local services to the state. Accordingly, tax credits are a function of the property tax valuation lagged one year. The estimated equation is

$$(13)\quad ET = \underset{(24.01)}{-70.58} + \underset{(.003436)}{.0233}PVL_{-1}$$

where

PVL_{-1} = 27% of statewide assessed property tax valuation, lagged one year

$R^2 = .8518$ SSR = 676.2 $F(1,8) = 46.0$ SE = 9.19 DW = 1.52

Welfare Expenditures (EWL). Welfare expenditures are determined by three variables: number of recipients of old age assistance, the unemployment rate, and adjustments from the general price level as measured by the Consumer Price Index. The estimated equation is

$$(14)\quad EWL = \underset{(25.55)}{-144.59} + \underset{(.3356)}{2.329}NOAGE + \underset{(2.042)}{8.22}UR + \underset{(.2089)}{1.27}CPI$$

where

NOAGE = Number of recipients of old age assistance
UR = Iowa unemployment rate
CPI = Consumer Price Index

$R^2 = .9885$ SSR = 24.32 $F(3,6) = 171.56$ SE = 2.01 DW = 2.71

Unemployment Insurance Expenditures (EUI). Unemployment insurance expenditures are determined by the number of recipients and the maximum weekly unemployment insurance benefit. The estimated equation is

$$(15)\quad EUI = \underset{(5.331)}{-22.55} + \underset{(.2700)}{3.556}NUI + \underset{(.1167)}{.2942}UIMAX$$

where

NUI = Number of recipients of unemployment insurance
UIMAX = Maximum weekly unemployment insurance benefit

$R^2 = .9903$ SSR = 38.87 $F(2,7) = 358.1$ SE = 2.10 DW = 2.31

To explain and predict the number of recipients of unemployment insurance, the following equation is used:

$$(16)\quad NUI = \underset{(2.004)}{-6.755} + \underset{(.6283)}{5.209}UR$$

where

UR = Iowa unemployment rate

$R^2 = .8958$ SSR = 19.27 F(1,8) = 68.79 SE = 1.55 DW = .6531

Retirement Expenditures (ER). Retirement expenditure for the Iowa Public Employees Retirement System is dependent on the number of IPERS recipients and the Consumer Price Index. The estimated equation is

$$(17)\quad ER = \underset{(6.830)}{-9.699} + \underset{(.3203)}{.7526NIPERS} + \underset{(.09883)}{.169CPI}$$

where

NIPERS = Number of IPERS recipients
CPI = Consumer Price Index

$R^2 = .9805$ SSR = 10.00 F(2,7) = 175.7 SE = 1.195 DW = 2.76

Other State Expenditures (EO). Other government expenditures accounted for the remaining 50 percent of total expenditures in fiscal 1977. The bulk of expenditures in this category go for state government purchases of goods and services, and as such their effect is on the private nonfarm business sector. Department of Transportation (DOT) transfers to cities and counties for road construction and maintenance are also included here.

State government investment expenditures are included in the "Other Expenditures" category. While it would be very valuable to have an investment sector in the model, lack of relevant data prevents its inclusion. There is no reliable data available on the capital stock of the state government or of the state as a whole. Construction expenditures could possibly be used as an approximation to investment, but their use is ruled out by the fact that the state accounting system does not collect them separately from other capital expenditures.

Since other state expenditures are an aggregation of several types of expenditures, there are several factors which combine to determine its magnitude. Administrative purchases of goods and services vary with the size of the government itself and with the price level. DOT transfers to lower level governments are largely determined by construction activity by the lower level governments. All these factors are considered in the development of the model. The model is

$$(18)\quad EO = \underset{(282.8)}{-545.76} + \underset{(13.74)}{4.520NG} + \underset{(2.680)}{9.328CPI}$$

where

NG = Number of state government employees
CPI = Consumer Price Index

$R^2 = .9424$ SSR = 19820.6 F(2,7) = 57.27 SE = 53.21 DW = 1.43

Personal Income Equation

There are two identities for Iowa personal income (Y). The first identity is

(19) $Y = YN + YF$

where

YN = Nonfarm personal income
YF = Farm personal income

The second identity breaks YN down into its components:

(20) $YN = EW + WON + YOL + YPN + DIR + EWL + EUI + ER + TRO - SI$

where

EW = State government wages and salaries
WON = Other nonfarm wages and salaries
YOL = Other labor income
YPN = Nonfarm proprietors' income
DIR = Dividends, interest, and rent
EWL = Welfare expenditures
EUI = Unemployment insurance benefits
ER = Retirement expenditures (IPERS only)
TRO = Other transfer payments
SI = Personal contributions for social insurance

The endogenous variables in equation (20) are EW, WON, EWL, EUI, ER, and TRO. EW, EWL, EUI, and ER are modeled in equations (11), (14), (15), and (17), respectively. The models for WON and TRO are presented in the next two sections.

Other Nonfarm Wages and Salaries (WON).

(21) $$WON = \underset{(634.3)}{-6520.77} + \underset{(1.391)}{7.846}NON + \underset{(5.058)}{46.33}CPI$$

where

NON = NN − NG
NN = Nonagricultural wage and salary employment
NG = Number of state governmental employees
CPI = Consumer Price Index

$R^2 = .9978$ SSR = 3880.2 $F(2,7) = 1562.31$ SE = 74.75 DW = 1.96

Other Transfer Payments (TRO)

(22) $$TRO = \underset{(66.85)}{-1292.88} + \underset{(.6062)}{20.10}CPI$$

$R^2 = .9928$ SSR = 9236.55 $F(1,8) = 1099.50$ SE = 33.98 DW = 1.65

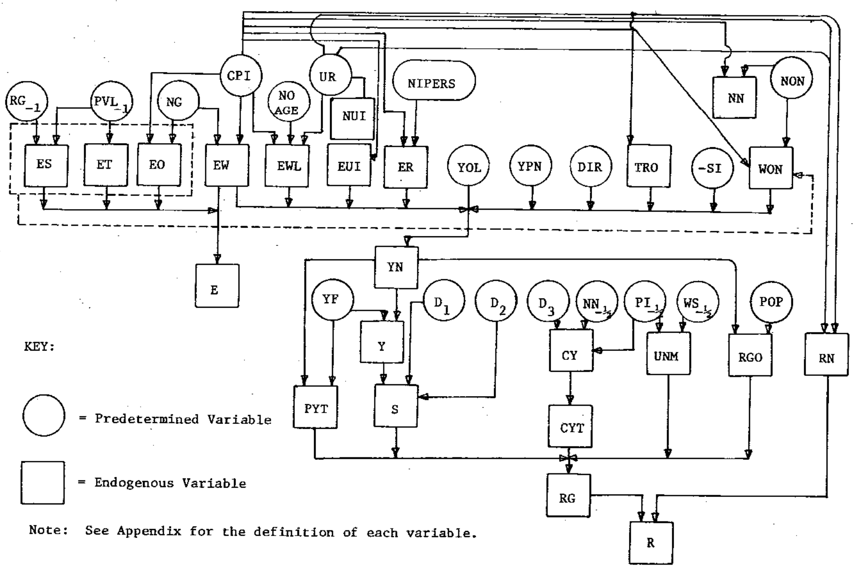
MULTIPLIER ANALYSIS

This section explains the estimates of the effects of state government expenditures on the generation of Iowa personal income and the influence of personal income on state governmental revenues. The determination of these effects provides insight into how state government expenditures can affect state revenues.

Multiplier Theory

The tool used in this section is multiplier analysis. In introducing this tool, Theil [9, pp. 464-465] notes that there are three forms for the same economic model. The first form consists of the structural equations which describe the economic relations in their elementary form. The structural form of the model is depicted graphically in Figure 1. Predetermined variables are represented by circles, and endogenous variables by boxes. Lines of causality are shown by the directions of the arrows. The dotted box around ES (state aid to public schools), ET (state tax credits), and EO (other state expenditures), and the dotted arrow leading from that box to WON (other nonfarm wages and salaries) are included to highlight the *absence* of a relationship between the first three variables and WON.

Figure 1. The Structure of the Main Model



Note: See Appendix for the definition of each variable.

The second form is the reduced form, which describes the current endogenous variables as functions of lagged endogenous variables, current and lagged exogenous variables, and disturbances. The final form is obtained by repeatedly eliminating all lagged endogenous variables from the reduced form. When the system contains no lagged endogenous variables, the reduced and final forms are identical, but this is not true in general and it is not true here due to the inclusion of lagged general fund revenues (RG_{-1}) in equation (12).

Multipliers are obtained from the coefficients of the final form. Impact multipliers measure the effects on the current period of exogenous changes in the system; interim multipliers measure the effects of these changes during later periods, and total multipliers measure the total effects of the changes.

Many of the multipliers obtained for the present system do not fit into the above three types, all of which measure the response of an endogenous variable to some exogenous change. In many cases, however, interest in this model centers on the impact of an endogenous change on other endogenous variables. Examples include the effects of changes in welfare expenditures on personal income or on sales tax revenues.

There are two reasons for examining multipliers of this type. First, state decision makers want to know the effects of changes in expenditures on revenues. They often are not concerned with the cause of the expenditure changes. Thus, if a legislator asks for the effect of a million-dollar increase in state government wages and salaries on state income tax revenues, he or she is not necessarily interested in whether the increase in wages is due to a cost-of-living pay increase or to an increase in the number of state government employees.

Second, the examination of final multipliers might be misleading in some cases for the model presented here because all of the economic relationships within the state economy are not captured by the model. For example, an increase in the state unemployment rate would have (at least) two effects on the generation of personal income in the state. It would cause an increase in the levels of transfer payments such as welfare and unemployment insurance, and at the same time it would tend to decrease the growth rate of the number of private sector employees. The increase in transfer payments would tend to cause an increase in state sales tax revenues, but the slowdown in the growth rate of private sector employment would tend to retard the growth rate of sales tax deposits. The first effect is captured directly by the present model, because there is a link in the model between the unemployment rate and transfer payments. But there is no link between the unemployment rate and private sector employment, so the second effect on sales tax revenues is not captured.[7]

The multipliers used in this section might be termed "incomplete" multipliers, for two reasons. First, a multiplier which measures the effect of an endogenous change on another endogenous variable does not attempt to explain the cause of the first endogenous change. This cause may have other effects on the system, but these effects are not captured by the incomplete multipliers. Second, some of the links between the various sectors of the Iowa economy do not appear in this model. As such, some of the multipliers from this model are incomplete descriptions of the effects of exogenous changes on the economy. Therefore, it is necessary in some cases to consider instead the effects of endogenous changes on other endogenous variables.

Multiplier Estimates

An extensive set of multipliers has been estimated with the model presented in the preceding section; however, only selected multipliers are reported here in the interest of avoiding excessive length. Three sets of multipliers are presented: 1)

Note that because of this problem, we did not compute a multiplier effect of the unemployment rate on transfer payments. For the multipliers reported in this paper, we believe that the lack of completeness in the model has a very small effect.

the nonfarm personal income multiplier from increasing state government employment, 2) selected sales, personal income tax, and general fund multipliers from increases in personal income, government expenditure, or employment components, and 3) multiplier effects on state government expenditures from selected variables.

The influence on personal income of changes in levels of governmental expenditures does not carry over in this model from one year to the next. Expenditures affect personal income and personal income affects state revenues, but revenues affect expenditures in the next year only in the case of state aid to public schools (ES). Since there is no link in the model between state aid to public schools (ES) and personal income, it follows that the impact multipliers of changes in expenditures are the same as the total multipliers. Therefore, the multiplier effects of all state government wages and salaries, welfare expenditures, unemployment insurance expenditures, and retirement expenditures are all unity — a $1 million increase in the level of any one of these expenditure categories causes an equal increase in the level of personal income in the same fiscal year, and none in following years.

An example of some of the multiplier effects on nonfarm personal income from changes in selected variables such as the number of state government employees is obtained by substituting equations (11), (14), (15), (17), (21), and (22) into equation (20) and combining terms, yielding

$$(23)\quad YN = -8365.25 + 10.71NG + 7.84NON + .7526NIPERS + 68.91CPI + EWL + EUI + YOL + YPN + DIR - SI$$

Multipliers showing the effect of *ceteris paribus* changes in state government employment (NG), other nonagricultural wage and salary employment (NON), and number of IPERS recipients (NIPERS) on nonfarm income are shown in Table 3.

TABLE 3. Selected Multiplier Effects on Nonfarm Personal Income

Variable	Multiplier
Number of state government employees (NG)	10.71
Other nonagricultural wage and salary employment (NON)	7.846
Number of Iowa public employee's retirement system recipients (NIPERS)	.7526

The multipliers in Table 3 indicate that an increase of 1000 in the number of state governmental employees (NG) causes a $10,710,000 increase in the level of personal income *ceteris paribus.* Similarly, an increase of 1000 in the number of Iowa Public Employees Retirement System (IPERS) recipients gives rise to a $752,600 increase in personal income. The same increase in the number of other nonfarm employees causes a $7,856,000 rise in nonfarm income.

Multipliers are obtained showing the effects on sales tax revenues of changes in selected components of personal income, employment, and number of Iowa public employees retirement system (IPERS) recipients by successively substituting identity (19) and equation (23) into equation (3) to give an intermediate equation and then the following:

$$(24)\quad S = -115.95 + .1676NG + .1228NON + 1.078CPI + .01178NIPERS + .01565(YF + EWL + EUI + YPN + DIR - SI).$$

Using the intermediate equation and equation (24), the multipliers in Table 4 are obtained. It is noted that the multipliers for all components of nonfarm income are equal because the consumers do not differentiate whether the money comes from wage income, interest income, or transfer payments. The multipliers for farm and nonfarm income are equal because the two income streams are not separated in equation (3). The multipliers of Table 4 show that a one million dollar increase in personal income, or one of the personal income components, generates an increase in sales tax revenues of about $15,650. Recall Iowa's three percent sales tax rate with food and drug exclusions. The effective sales tax on personal income is approximately 1.5 percent after deducting income taxes, savings and drug exclusions. An increase in state government employment of 1000 would increase sales tax revenues by $167,600.

TABLE 4. Selected Multiplier Effects on Sales Tax Revenues

Variable	Multiplier
Iowa nonfarm income (YN)	.01565
State government wage & salaries expenditures (EW)	.01565
Other nonfarm wages & salaries (WON)	.01565
State welfare expenditures (EWL)	.01565
State unemployment insurance benefits (EUI)	.01565
Retirement expenditures (ER)	.01565
Other transfer payments (TRO)	.01565
Farm personal income (YF)	.01565
Number of state government employees (NG)	.1676
Other nonagricultural wage & salary employment (NON)	.1228
Number of Iowa public employee retirement recipients (NIPERS)	.01178

The multiplier effects for personal income tax revenues are obtained by substituting equations (11), (21), and (23) into (7). The last substitution yields

$$(25)\quad PYT = -491.25 + .4110NG + .3011NON + 1.867CPI + .03838(ER + EWL + EUI + YOL + YPN + DIR - SI) + .03958YF$$

The multipliers in Table 5 can be interpreted as the effective tax rates on nonfarm income, farm income, state government wages and salaries, and other nonfarm wages and salaries.[8] The multipliers indicate a one million dollar increase in per-

[8] The Iowa individual income tax schedule is shown below.

Taxable Income	Rate (Percent)	Taxable Income	Rate (Percent)
$ 0 - 1,000	.05	$15,000 - 20,000	8.00
1,000 - 2,000	1.25	20,000 - 25,000	9.00
2,000 - 3,000	2.75	25,000 - 30,000	10.00
3,000 - 4,000	3.50	30,000 - 40,000	11.00
4,000 - 7,000	5.00	40,000 - 75,000	12.00
7,000 - 9,000	6.00	75,000 & over	13.00
9,000 - 15,000	7.00		

Source: Iowa Department of Revenue, Summary of Revisions in Iowa Tax Laws enacted 1968-1978, Des Moines, Iowa, 1978.

sonal income generates an increase in personal income tax revenues of about \$38,000. The last multiplier indicates that when the state hires an additional 1000 workers, it can expect to receive an additional \$411,000 *ceteris paribus.*

TABLE 5. Selected Multiplier Effects on Personal Income Tax Revenues

Variable	Multiplier
Iowa nonfarm personal oncome (YN)	.03838
Farm Personal income (YF)	.03958
State government wage & salary expenditures (EW)	.03838
Other nonfarm wages & salaries (WON)	.03838
Other nonagricultural wage & salary employment (NON)	.3011
Number of state government employees (NG)	.4110

General fund revenues are the sum total of all general tax revenue collections. Accordingly, the multipliers for the general fund are of larger magnitude than specific taxes such as sales or personal income taxes. The multiplier effects on the general fund revenues are obtained by substituting equations (3) through (8) into identity (2) to yield

$$(26)\quad RG = -1136.37 + .05916YN + .05223YF + .0006342PI_{-1/2} + .005656WS_{-1/2} + .03587NN_{-1/2} + .3299POP + 8.039D_1 + 1.256D_3$$

In addition, substituting identity (20) and equations (22) and (21) into (26) yields the multipliers for NG, NON, EW, and WON, which are reported in Table 6.

The final set of multipliers reported is for general fund expenditures. Substituting equations (11) through (17) into identity (10) yields

$$(27)\quad E = -1445.60 + 15.23NG + 13.09CPI + .045956PVL_{-1} + .4245RG_{-1} + .04956PVL_{-1} + 26.75UR + .2942UIMAX + .7526NIPERS$$

TABLE 6. Selected Multiplier Effects on General Fund Revenues

Variable	Multiplier
Iowa nonfarm personal income (YN)	.05916
Farm personal income (YF)	.05223
National corporate profits (calendar year) (PI-½)	.0006342
Wages and salaries (calendar year) (WS-½)	.005656
Nonagricultural wage & salary employment (calendar year) (NN-½)	.03587
State population (POP)	.3299
Number of state government employees (NG)	.6336
Other nonagricultural wage & salary employment (NON)	.4642
State government eage & salary expenditures (EW)	.05916
Other nonfarm wages & salaries (WON)	.05916

In addition, substituting identity (2) into (27) gives the multipliers for other variables reported in Table 7.

The multipliers indicate that an increase of 1000 in state government employment implies an increase in total state government expenditures of \$15,230,000.

TABLE 7. Selected Multiplier Effects on Total State Government Expenditures

Variable	Multiplier
Number of state governmental employees (NG)	15.23
Consumer price index (CPI)	13.09
General fund revenue lagged one year (RG_{-1})	.4245
Sales tax revenues lagged one year (S_{-1})	.4245
Nonmotor vehicle tax revenues lagged one year (UNM_{-1})	.4245
Corporate income tax revenues lagged one year (CYT_{-1})	.4245
Personal income tax revenues lagged one year (PYT_{-1})	.4245
Other general fund revenues lagged one year (RGO_{-1})	.4245
27% of statewide assessed property tax valuation lagged one year (PVL_{-1})	.04956
Iowa unemployment rate (UR)	26.75
Maximum weekly unemployment insurance benefit (UIMAX)	.2942
Number of Iowa public employee retirement recipients (NIPERS)	.7526

Estimates of the impacts of lagged tax revenues (sales (S_{-1}), personal income (PYT_{-1}), etc.) on state government expenditures are all equal (.4245) because they are not differentiated in the state government expenditure process. The multiplier indicates that given an increase of one million dollars in the previous year of any one of the taxes, state government expenditures would increase in the current year by $424,500. Similarly, a one percentage point increase in the unemployment rate (UR) will increase state government expenditures by $26,750,000.

SUMMARY

In this paper, we have developed a model of the state government revenue and expenditure process and demonstrated that useful and meaningful results can be obtained from a simple simultaneous equations model. The model assumes that state government expenditures affect Iowa personal income, which in turn influences the level of state government revenues. Multipliers are obtained from the estimated model to determine such quantities as the additional revenue the state will receive in the form of sales, income, or other taxes when state government wage and salary payments rise. Similarly, estimates are made of the effects that changes in selected variables (such as the unemployment rate) will have on state government expenditures.

APPENDIX. The Variables In The Main Model

Symbol	Exogenous Variables (18)	Units of Measurement
CPI	Consumer Price Index	Index (1967 = 100)
D_1	Dummy representing change in Corporate Income Tax rate in 1968.	
D_3	Dummy representing change in Corporate Income Tax rate and reporting requirements in 1972	
DIR	Dividends, Interest, and Rent	$ Millions
NG	Number of State Government Employees	Thousands

NIPERS	Number of IPERS recipients	Thousands
$NN_{-1/2}$	Nonagricultural Wage & Salary Employment (calendar year)	Thousands
NOAGE	Number of Recipients of Old-Age Assistance	Thousands
$PI_{-1/2}$	National Corporate Profits (calendar year)	$ Millions
POP	State Population	Thousands
PVL_{-1}	27% of Statewide Property Tax Valuation, lagged one year	$ Millions
SI	Personal Contributions to Social Insurance	$ Millions
UIMAX	Maximum Weekly Unemployment Insurance Benefit	Dollars
UR	Iowa Unemployment Rate	Percent
$WS_{-1/2}$	Iowa Wages and Salaries (calendar year)	$ Millions
YF	Farm Personal Income	$ Millions
YOL	Other Labor Income	$ Millions
YPN	Nonfarm Proprietors' Income	$ Millions

Endogenous Variables (23)

CY	Iowa Taxable Corporate Income	$ Millions
CYT	Corporate Income Tax Revenues	$ Millions
E	State Governmental Expenditures	$ Millions
EO	Other State Expenditures	$ Millions
ER	Retirement Expenditures (IPERS only)	$ Millions
ES	State Aid to Public Schools	$ Millions
ET	State Tax Credits	$ Millions
EW	State Government Wage and Salary Expenditures	$ Millions
EWL	State Welfare Expenditures	$ Millions
EUI	State Unemployment Insurance Benefits	$ Millions
NON	Other Nonagricultural Wage and Salary Employment	Thousands
NUI	Number of Recipients of Unemployment Insurance	Thousands
PYT	Personal Income Tax Revenues	$ Millions
R	State Government Revenues	$ Millions
RG	General Fund Revenues	$ Millions
RGO	Other General Fund Revenues	$ Millions
RN	Non General Fund Revenues	$ Millions
S	Sales Tax Revenues	$ Millions
TRO	Other Transfer Payments	$ Millions

UNM	Non Motor Vehicle Use Tax Revenues	$ Millions
WON	Other Nonfarm Wages and Salaries	$ Millions
Y	Iowa Personal Income	$ Millions
YN	Iowa Nonfarm Personal Income	$ Millions

Lagged Endogenous Variables (1)

RG_{-1}	Lagged General Fund Revenues	$ Millions

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