QUARTERLY TAXATION RELATIONSHIPS FOR NEW ZEALAND

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Research Paper No. 7 October, 1972

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PREFACE

As part of an overall project to construct a quarterly macroeconometric model of the New Zealand economy, some effort has been made to incorporate the central government sector in a realistic manner. This has involved us to date in four research tasks:

(a) The preparation of long-term consistent quarterly data for all government current revenues and expenditures, leading to what is generally known as the "deficit before borrowing" outcome. The statistics derived from a range of published and unpublished sources for these so-called "above the line" transactions were published as *Quarterly Government Accounts: Part I* [14]. In particular, the detailed tax data provided by this analysis are employed in the present Research Paper.

(b) Similarly, *Quarterly Government Accounts: Part II* [7] sets out the results of our endeavours to extract quarterly statistical information on the central government's financing transactions, including a classification of the Public Debt by various institutional and other holders. The availability of detailed figures on these "below the line" transactions and their reconciliation with the official Public Debt series, implies that all major elements of government revenue, both taxation and borrowing, can now be explained endogenously within a quarterly model.

(c) Accordingly, a series of behavioural and empirical relationships has been derived to explain changes in government security holdings of all the major bank and non-bank financial institutions, as well as the private non-financial sector. Because official government security ratio requirements are applied to most institutions, and because these institutions' behaviour is important in its own right, it has also been necessary to develop equations for the relevant asset or deposit series (depending on the way in which the ratios are applied). Furthermore, for the monetary sector (trading and savings banks) full explanations of all major balance sheets items have been derived and presented in [8]. Initial results for security holdings and non-banks are presented in [9], although a separate Research Paper is currently in preparation on this subject.

(d) Current government revenues—predominantly the flows of income and indirect taxation—are discussed in the present Research Paper to round off the analysis of the government sector. Empirical relationships are estimated for a wide range of tax categories, using specially constructed quarterly effective and statutory tax rate variables. At a later stage it is hoped that we shall also be able to study those components of government expenditure which can realistically be treated as endogenous within an econometric model.

The progress of the model project as a whole, and the nature of the equations comprising the framework, are described for an earlier version in [3], for a more recent 95 equation version in [9], and in a non-technical way in [4].

We acknowledge with pleasure the contribution to our work of other members of the Research Section of the Bank's Economic Department. In particular we express our gratitude to M. A. Lumsden who did much of the work involved in extracting long-term quarterly tax data for various groups of income earners (as published in [14]); to D. E. A. Giles who assisted us with various econometric problems; and to A. B. Sturm who solved various computer programming problems for us and who was also primarily responsible for the construction of the Bank's Database system. Other people have offered comments on our work and we have been especially appreciative of the helpful suggestions provided by J. F. Helliwell, R. J. Hurnard and C. J. McKenzie.

On the other hand, the material contained in this paper is our own responsibility and, in particular, the views expressed do not purport to represent those of the Reserve Bank.

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QUARTERLY TAXATION RELATIONSHIPS FOR NEW ZEALAND

(1) THE GOVERNMENT SECTOR

The importance of the government sector within the New Zealand economy is strikingly evident from the fact that total central government expenditure including transfers is now equivalent to about one-third of the country's gross national product. It is thus essential that any macroeconometric model should incorporate this sector in a realistic manner and explain adequately those elements of government's activities which are endogenous in the sense that they are determined largely within the economic system as a whole. This point is clearly applicable, for example, in the case of the bulk of the government's revenue, whether it be in the form of current receipts from taxation or domestic borrowing. Once the exogenous policy and other influences are determined—such as the schedule of income tax rates, the rates of indirect taxes, the government security investment ratios applicable to a wide range of financial institutions and government's overseas borrowing programme—the actual flow of revenue to government will depend on factors linked to economic activity in its broadest sense. These factors include personal and corporate incomes, consumption and other spending, wealth, production, holdings of financial assets and so on. Many of these factors are important endogenous variables in a quarterly econometric model of the New Zealand economy which is currently being developed in the Reserve Bank.

On the other hand, the way in which central government expenditure should be treated is not so readily apparent. Most econometric models, and especially those which fall outside the fairly small group of large models, incorporate government expenditure as largely and simply exogenous. In other words, it is assumed that governments have direct control of their own expenditures and that these are not significantly influenced by factors determined elsewhere within the model. While this may reconcile neatly with the standard elementary text book approach to the determination of gross national product, it conveniently ignores the realities of the situation in which most governments find themselves. For although the latter may endeavour to exert such hypothetical absolute control via their annual budget and other procedures, the fact of the matter is that many areas of government's own spending are dependent upon the size, growth and behaviour of the private sector. Two simple illustrations can be cited: first, social welfare payments, whether they be in respect of unemployment benefits, old age pensions, free medical and hospital services or education, are obviously closely linked to private sector considerations, many of which are not necessarily under any very direct governmental influence; and, secondly, while government expenditure may be fairly accurately predetermined in real terms, the rate of change in domestic prices may play havoc with the budget estimates in money or current value terms. It is easy enough to make a decision to build, for example, a hydro electric dam but, when inflation is rapid, it is much more difficult to know or be able to affect the cost of such a dam. This type of problem was all too readily apparent in New Zealand in 1970-71 when the rate of increase in government expenditure was 18 percent compared with a budgeted increment of just over 9 percent. The New Zealand problem has become particularly acute, of course, since government sector wage and salary rates were linked directly to corresponding private sector movements.

If neither the statistical nor the conceptual framework lend themselves to full integration of government expenditure as endogenous within a model of the New Zealand economy, then at least some components of that spending theoretically require endogenous explanations. A partial solution can be achieved by allowing real government expenditure to be exogenous while its current value counterpart is endogenous as the product of real spending and the model-determined price level (as is done in [9]). But even this simple approach is inhibited in New Zealand by the fact that Budget expenditure is published in money terms only with an implied but publicly unknown official estimate of the likely price increase for the succeeding fiscal year. Alternatively, some components of government's spending could be explained endogenously while others could remain exogenous. It is some mixture of these approaches which is anticipated as the eventual treatment of this item in the Bank's model. In the meantime, however, government expenditure is exogenous in the usual manner.

Reverting to the discussion of the revenue items it can be observed that these are to be handled essentially in two stages. It is the purpose of the present paper to set out a range of equations or empirical relationships covering current taxation receipts for the following major categories: income tax paid by salary and wage earners, other persons and companies; and other tax (mainly classified as indirect tax) including automotive and non-automotive sales tax, beer duty, customs duties, estate duty and highways taxation. The second stage, which is dependent for its formulation on the quarterly analysis of the government's accounts carried out in [7], will explain the central government's domestic borrowing operations. In this case, two basic types of equations will be employed: on the one hand, the simple empirical relationships required to explain the holdings of the "captive" financial institutions as the product of the relevant official government security ratio and the corresponding deposit or other balance sheet aggregate;

and, on the other hand, the behavioural equations based on the modified stock adjustment model which are normally used to account for non-captive holders of bonds. Again, it is hoped that these equations will be the subject of a later paper, although initial results are illustrated in [9].

A satisfactory explanation of government's financial operations within the framework of a quarterly econometric model naturally offers a number of substantial advantages in terms of explaining private sector behaviour. For instance, income tax payments directly influence the community's disposable income and hence their spending and holdings of financial assets. Similarly, via their impact on the price of commodities, indirect taxes can strongly affect private sector expenditure patterns. On the borrowing side, government security investment ratios influence the behaviour of financial institutions while, more generally, the internal deficit/surplus position of government has important effects, not the least of which is the establishment of an adequate linkage between the monetary and government sectors.

(2) THE TAX EQUATIONS

As for the income tax equations, these should ideally be based on a two-stage explanation whereby, first, accruals of tax liabilities would be explained as the product of current income and the appropriate tax rate and, secondly, actual payments of tax would be accounted for by linking these to accruals. Unfortunately, however, this procedure is not feasible in New Zealand because of data limitations which will be outlined shortly. The only practicable alternative thus becomes a one-stage explanation of tax payments as the product of lagged income and the relevant tax rate variable (although this approach is necessarily modified slightly for salary and wage earners who pay tax on a P.A.Y.E., pay-as-you-earn, basis). Theoretically other tax payments, which comprise mainly indirect taxes, should also be treated as the product of the various tax rates and their corresponding tax bases. But, as will be discussed in the detailed commentary, there are a number of complicating factors which impose unavoidable limitations on the specification of most of the individual relationships.

Although the data which are used in the various equations will be discussed in the relevant sections of the paper, it may be useful to make a few general points. As New Zealand has no quarterly national income accounts, there are no quarterly published statistics available for any category of income earners in New Zealand. It is therefore fortuitous from the point of view of the model-builder that the corporate sector and other persons (defined as all non-salary and non-wage earning private individuals) pay their income tax with respect to a March year income aggregate. On the other hand, salary and wage earners pay their tax on a P.A.Y.E. basis, thereby involving their employers in monthly returns to the Inland Revenue Department from which an unpublished quarterly gross income series can be drawn.

Quarterly total income tax receipts into the government's Consolidated Revenue Account are published regularly in the *Gazette,* but no breakdown into the different categories of taxpayers is made. Accordingly, a set of data had to be compiled from the unpublished records of the Inland Revenue Department. This exercise was carried out in sufficient detail to provide quarterly statistics of both gross tax and refunds attributable to the major income-earning groups, thus enabling a reconciliation to be made with the annual Budget totals (although only after some sundry adjustment items had been incorporated). The tax equations employ these gross tax payments as their dependent variables. Refunds, being relatively small, are exogenous in the model.

The tax rate variables employed in the income tax relationships were specially constructed for the paper. Two concepts are used:

(a) Effective tax rates are calculated simply as the ratio of tax paid in a certain fiscal year to income earned for the same year, with appropriate allowance incorporated for any changes in rates during the period. Various definitions are possible (and were tested in the course of the research), depending, for example, on whether the tax data are gross or net of refunds (net if it is desired to explain refunds in a simple endogenous manner), or whether the income statistics are on a national accounts or Inland Revenue assessable income basis. Some of these definitional conflicts must be resolved in a fairly arbitrary manner. For instance, assessable income is undoubtedly preferred conceptually to income in a national accounts sense. But detailed figures on the former may become available only with a time lag of some years, whereas statistics for the latter are more readily available and more easily handled in a model framework. Hence, the national accounts income data are chosen in practice.

(b) Statutory tax rates are computed as the sum of the products of the distribution of income and the corresponding tax rates as drawn from the relevant schedule.[1] In other words, for example, the dis-

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[1] The annual supplement "Income Trends" within the *Monthly Abstract of Statistics* supplies the basic data from which the income distribution is extracted. These data provide a breakdown of the total amount of income earned per income group, as well as the number of income tax returns per income group. From this analysis a distribution of income over a range of income categories (as in the *Abstract*) can be calculated. However, before adjusting the income categories to ensure they correspond with those used in the personal tax schedules allowance must be made for tax exempt income.

From the Statistics Department's publication *Incomes and Income Tax* it is possible to extract the average taxation exemption for salary and wage earners and a similar figure for "other persons". One merely divides the difference between income earned and tax assessable income by the number of returns to get the average tax exemption. This method ensures that unutilized tax exemptions are not included in the tax exempt income. Because of the considerable lag in the publication of the tax exemption tribution of total salary and wage income over a range of income categories is calculated in a manner which ensures that the latter categories correspond with those used in the personal tax schedules. The components of the income distribution are then multiplied by their corresponding tax rates to obtain a series of products which, when summed, provide the statutory tax rate variable. This variable changes from year to year as the annual income distribution pattern varies and may change either between years or within a year as a result of an alteration in the tax schedule. The procedure is illustrated in the table for salary and wage earners for the fiscal year, 1969-70. The use of statutory tax rates offer an obvious advantage over the use of effective tax rates in tax equations in that the policy instrument —the schedule of tax rates—is entered explicitly and can thus be more readily forecast and varied for policy simulations. In addition, it is easier to take account of the changing pattern of income distribution over time, thus allowing more adequately for the progressive nature of income tax.

The tax rate variables employed in the non-income tax equations are discussed in the relevant sections later in the paper. These variables are normally drawn from the appropriate legislation and can either be expressed simply as a percentage rate, such as in the case of sales tax on automobiles, or as an effective tax rate concept not dissimilar from that just mentioned for income tax. An example of the latter procedure is given in the section on estate duty.

As for the other data used in relation to non-income tax payments, the *Gazette* offers some analysis of the statistics. However, in the present instance the data for indirect and other non-income taxes are drawn from the Bank's own breakdown of the government's accounts on a quarterly basis. This exercise, which is described in [14] is being carried out as part of the model project in order to provide a complete set of quarterly accounts covering both current and capital transactions. It is necessary because of the fact that the published quarterly figures do not enable a full reconciliation to be made with the annual Budget. This is essential for a model of course. In particular, the *Gazette* provides insufficient information on borrowing and investment transactions and inadequate detail on some of the current revenue and expenditure items. However, most of the series for other tax are identical to, or easily reconcilable with, the official data.

The ordinary single stage least squares equations in this paper are based on quarterly seasonally unadjusted data. The standard estimation period for the model at present is 1960(2) to 1970(4), a total of 43 observations. While this time period is used wherever it seems suitable for the tax equations, some variations are unavoidable due to data commencing some quarters after 1960(2). On the other hand, in each section the estimation period for the preferred relationship ends in 1970(4) to enable ex post forecasts to be carried out for 1971. Accordingly, where the time period varies from the standard it is expressly noted either in the text or beneath the relevant equations. It should be mentioned that the commencement date of the standard time period was determined solely by data availability while the closing date was chosen to enable ex post forecast tests to be carried out.

In the selection of equations the standard statistical tests are applied by considering, among other things, the coefficient of determination adjusted for degrees of freedom ($\bar{R}^2$), the standard error of the estimate (S.E.E.) and its relationship to the mean of the dependent variable (% S.E.E.), the Durbin-Watson statistic, in one or two cases Durbin's unbiased statistic(2) to detect autocorrelation (D), the t-values of the individual regression coefficients and the pattern of the residuals over the estimation period. Inspection of the latter also assists in determining whether multiplicative seasonal dummy variables are likely to be preferred over the same variables in additive form. The use of seasonal dummies (usually normalised on the fourth calendar quarter) is judged to be preferable to the alternative use of seasonally adjusted data for a number of reasons. In particular, the use of raw data means that the dummy variables should explain only the residual seasonality remaining after that accounted for by the other explanatory variables.

Later sections in the paper consider the ex post forecasting ability of the preferred relationships and compare the root mean square errors (R.M.S.E.) obtained

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data recent tax exemption figures have been obtained by estimation and extrapolation.

The manner in which allowance is made for the tax exempt income is best illustrated by an example. For salary and wage earners during the 1969-70 March year, the average taxation exemption amounted to $600. An adjustment to the income categories was made so that:

the income categories

$ 1 - 199	)	
200 - 399	)	now become "non-taxable"
400 - 599	)	
600 - 799	" "	1 - 199
800 - 999	" "	200 - 399

and so on. The distribution of income is adjusted to correspond with the new income categories, e.g. the income in the "old" income category $600 - 799 is now the income in the "new" income category $1 - 199. Adjusting the income categories for the distribution of income to ensure they correspond to the income brackets used in the personal tax schedules is just a matter of proportioning.

(2) Durbin's unbiased statistic, D, is used in equations containing the lagged dependent variable among the explanatory set.

$$D = (1 - \tfrac{1}{2}\ \text{D.W.}) \left(\frac{n}{1 - nV(bo)}\right)^{\frac{1}{2}}$$

where:

D.W. is the Durbin Watson statistic,
n is the number of observations,
V(bo) is the estimated variance of the ordinary least squares estimate of the coefficient of the lagged dependent variable.

If D lies in the interval [—1.96, 1.96] the hypothesis of serial independence of the error term is accepted with a 5% level of significance. See Durbin [10] and Malinvaud [17, p. 562].

from these forecasts for the four quarters of 1971 with predictions derived from some naïve models. Some additional statistical tests are also introduced for the preferred equations in section 8 to help provide some indication of the existence or otherwise of multicollinearity, fourth-order autocorrelation, and structural instability. The nature of these tests are described in some detail in the relevant section.

To assist further with the interpretation of the results, and to provide a convenient summary of the ability of the equations to track out the past in a realistic manner, graphs for the preferred equations are presented at the end of the paper. The graphs show both the pattern of residuals over the estimation period and a comparison of the actual and estimated values for the dependent variables as computed by ordinary least squares. It is hoped that the 51 behavioural equations included in the overall 95 equation model described in [9] will be re-estimated in the near future using an instrumental variables procedure. This re-estimation will include the taxation relationships.

SAMPLE CALCULATION OF STATUTORY TAX RATE FOR SALARY AND WAGE EARNERS FOR 1969-1970

Taxable Income Group $	*Tax Rate*	*Amount of Income in Taxable Income Group $m.*	*Fraction of Total Income*		*Tax Rate × Fraction of Total Income*
Non-taxable*	—	642.5*	.2522		—
0 - 650	.0785	600.4	.2357		.0185
650 - 1,700	.210	714.4	.2805		.0589
1,700 - 2,000	.245	132.4	.0520		.0127
2,000 - 2,500	.275	156.0	.0612		.0168
2,500 - 3,000	.330	92.0	.0361		.0119
3,000 - 3,500	.340	57.3	.0225		.0076
3,500 - 4,000	.370	38.1	.0150		.0056
4,000 - 4,500	.400	24.8	.0097		.0039
4,500 - 5,000	.430	17.5	.0069		.0030
5,000 - 5,500	.450	13.0	.0051		.0023
5,500 - 6,000	.490	9.4	.0036		.0018
6,000 - 6,500	.500	6.4	.0025		.0013
6,500 - 7,000	.540	5.1	.0020		.0011
7,000 - 7,500	.600	4.2	.0016		.0010
7,500 - 8,000	.650	3.5	.0014		.0009
8,000 - 10,000	.660	8.5	.0033		.0022
10,000 - 12,000	.670	3.0	.0012		.0008
12,000 +	.675	18.8	.0074		.0050
		2,547.3	1.0000	*Statutory Tax Rate:*	0.1553

* This represents the tax exempt income. From the Statistics Department's publication *Incomes and Income Tax* it is possible to extract the average taxation exemption for salary and wage earners and a similar figure for "other persons". For the calculation of the above statutory tax rate an average tax exemption of $600 was used. The average taxation exemption figures do not include unutilized exemptions. Also, for the years prior to 1969-70 allowance has been made for the income that is exempt from income tax but not exempt from social security tax. Because of the considerable lag in the publication of the tax exemption data recent tax exemption figures have been obtained by extrapolation. See text for further details.

(3) NOTATION

The following notation is used in the paper:

ICA	Imports, c.i.f., excluding aircraft, ships, railway equipment and arms of war, \$m.
KAR	Automotive stocks, real, depreciated at 4 per-cent per quarter, \$m.
QB	Beer production, gallons, 000's.
RA	Wholesale automotive sales, motor vehicles parts and accessories, \$m.
RAA	Wholesale sales (RA) excluding parts and accessories adjusted to give a pre-tax concept, \$m.
RAR	Wholesale sales (RA) deflated by private transport price index, \$m.
RT	Retail turnover, total, \$m.
RTF	Retail turnover, food, \$m.
S_i	Seasonal dummy variable; takes the value 1 in calendar quarter i, zero elsewhere.
TIA	Total indirect and other tax, i.e. other than income and payroll tax, \$m.
TIB	Indirect tax, beer duty, \$m.
TIC	Indirect tax, customs duty, \$m.
TIE	Indirect tax, estate duty, \$m.
TIH	Indirect tax, highways tax, \$m.
TISA	Indirect tax, automotive sales tax, \$m.
TISN	Indirect tax, sales tax other than for the automotive group, \$m.
TRA	Rate of sales tax on automobiles, e.g. 40 per-cent is expressed as 0.40.
TRCE	Effective annual tax rate on company income.
TRE	Effective tax rate, estate duty.
TROE	Effective annual tax rate on other persons' income.
TRSE	Effective annual tax rate for salary and wage earners.
TSRO	Statutory tax rate for other persons.
TSRS	Statutory tax rate for salary and wage earners.
TYCG	Gross direct income tax, companies, \$m.
TYOG	Gross direct income tax, other persons, \$m.
TYSD	Gross P.A.Y.E. income tax (deductions from pay), salary and wage earners, \$m.
TYSP	Gross P.A.Y.E. income tax (payments into the public account), salary and wage earners, \$m.
YC	Company income adjusted for tax exemptions, quarterly interpolations of annual national accounts data, \$m.
YCA	Company annual income, national accounts basis (with an adjustment for payroll tax), March year, \$m.
YCEA	Company annual income tax exemptions and special depreciation allowances, March year, \$m.
YD1	Aggregate domestic expenditure, excluding change in farm stocks, \$m.
YD3	Aggregate domestic expenditure, excluding change in all stocks, \$m.
YO	Other persons' income, excluding company dividends, quarterly interpolations of annual national accounts data, \$m.
YOA	Other persons' annual income, excluding company dividends, national accounts basis, March year, \$m.
YS	Total gross salary and wage income, \$m.
ZT1	Dummy variable to account for changes in the proportion of provisional tax payable; takes the value 1 in March quarters up to and including 1964(1), 1.33 in succeeding March quarters, and zero elsewhere.
ZT2	Dummy variable to account for changes in the proportion of provisional tax payable; takes the value 1 in September quarters up to 1963(3), 0.67 in succeeding September quarters, and zero in all other quarters.
ZT3	Dummy linear time trend on successive March quarters; starts as 0 in 1965(1).
Note:	The sub-script —1 on a variable implies a lag of one quarter. The sub-script —1A in the company and other persons' income tax equations means that the income variable relates to the immediately preceding annual March year aggregate.

(4) INCOME TAX RESULTS

(a) Salary and wage earners

In New Zealand, tax deductions for salary and wage earners (TYSD) are made on a P.A.Y.E., pay-as-you-earn, basis. Accordingly, employers' deductions can be expressed as the product of the relevant tax rate variable and the current quarter's income (YS). In its simplest form, using linear seasonal dummy variables and an effective tax rate index (TRSE), equation (1) can be obtained for the period 1960(2) to 1970(4).[3] The September seasonal, S_3, is dropped as its coefficient proved to be not significantly different from zero.

$$TYSD = \underset{(79.41)}{0.9537}\,(YS * TRSE) + \underset{(2.37)}{1.7393}\,S_1 - \underset{(2.91)}{2.0553}\,S_2 + 2.6744$$

$\bar{R}^2$ 0.994, S.E.E. 1.909, % S.E.E. 2.905, D.W. 1.77 (1)

Over time there has been some increase in the degree of seasonal fluctuation in P.A.Y.E. tax deductions for salary and wage earners. However, an equation incorporating the seasonal dummy variables in multiplicative rather than additive fashion yields only a marginally better fit, a point illustrated by estimate (2).

(3) This 43 quarter time period is used for all salary and wage earners' tax equations.

$$\text{TYSD} = \underset{(84.48)}{0.9556}\,(\text{YS} * \text{TRSE}) + \underset{(2.90)}{0.0041}\,(S_1 * \text{YS}) - \underset{(3.32)}{0.0046}\,(S_2 * \text{YS}) + 2.5225$$

$\bar{R}^2$ 0.994, S.E.E. 1.807, % S.E.E. 2.750, D.W. 1.77 (2)

Because the schedule of tax rates for private individuals is a progressive one, with the percentage of income flowing to the government in the form of tax revenue rising as the income level increases, it is of some interest to compare these formulations with a relationship employing logarithmic functions.[4] This is done in equation (3).

$$\text{Log TYSD} = \underset{(24.69)}{1.0505}\,\text{Log YS} + \underset{(8.32)}{0.8082}\,\text{Log TRSE} + \underset{(3.71)}{0.0280}\,S_1 - \underset{(3.25)}{0.0251}\,S_2 - 0.7015$$

$\bar{R}^2$ 0.997, S.E.E. 0.020, % S.E.E. 0.477, D.W. 2.20 (3)

In a practical model-building situation it is desirable to be able to incorporate both changes in the schedule of tax rates and variations in the pattern of income distribution over time. This facilitates easier forecasting and is likely to permit more adequate simulation of alternative policy changes. Accordingly, equations (4) to (7) incorporate a statutory tax rate variable (TSRS) in substitution for the effective rate concept. Equations (4) to (6) correspond conceptually with estimates (1) to (3) respectively. The results using TSRS are slightly inferior in a statistical sense to those employing TRSE but, on the other hand, they have the important conceptual advantages just mentioned.

For the quarterly macroeconometric model, equation (7) is preferred on the grounds that it provides a satisfactory statistical result with an appropriate underlying theoretical basis. If the tax base—the product of income and the derived tax rate variable—is accurately measured, it would be expected to attract a coefficient close to unity. It must be recognised that data deficiencies may result in some deviation from 1.0, but it would obviously be unsatisfactory for this departure to be too great. Clearly, for example, equation (6) gives an unrealistic estimate of the elasticity of tax deductions with respect to not only changes in tax rates but also income, with the former deficiency being probably the more substantial of the two. On the other hand, equations (4) and (5) have tax base coefficients of the anticipated size but are judged inferior to estimate (7) because they provide ex post forecasts which are considerably poorer than those of equation (7). This is illustrated by the following data:

EX POST FORECASTS ERRORS[5]

$ million	*Equation 5*	*Equation 7*
1971(1)	8.7	1.3
1971(2)	3.0	—3.0
1971(3)	6.4	—0.9
1971(4)	6.6	—0.1

Data and possible specification deficiencies thus imply that some compromise is necessary in the selection of a preferred relationship, for although equation (7) forecasts well its tax base coefficient at 1.15 is rather high. In policy simulation exercises, such an equation could be expected to give over-estimates of the response to a change in the schedule of tax rates, all other things being equal. Nevertheless, this compromise seems reasonably realistic. It should be noted that suppression of the constant term yields inferior results.

$$\text{TYSD} = \underset{(63.99)}{1.0182}\,(\text{YS} * \text{TSRS}) + \underset{(2.10)}{1.9038}\,S_1 - \underset{(1.34)}{1.1742}\,S_2 - 8.9303$$

$\bar{R}^2$ 0.990, S.E.E. 2.365, % S.E.E. 3.599, D.W. 1.39 (4)

$$\text{TYSD} = \underset{(65.61)}{1.0178}\,(\text{YS} * \text{TSRS}) + \underset{(2.45)}{0.0297}\,(S_1 * \text{YS} * \text{TSRS}) - \underset{(1.43)}{0.0163}\,(S_2 * \text{YS} * \text{TSRS}) - 8.9470$$

$\bar{R}^2$ 0.990, S.E.E. 2.317, % S.E.E. 3.525, D.W. 1.38 (5)

$$\text{Log TYSD} = \underset{(35.91)}{1.3147}\,\text{Log YS} + \underset{(2.45)}{0.3982}\,\text{Log TSRS} + \underset{(3.55)}{0.0396}\,S_1 + \underset{(2.08)}{0.0225}\,S_3 - 3.2132$$

$\bar{R}^2$ 0.993, S.E.E. 0.029, % S.E.E. 0.703, D.W. 1.76 (6)

(4) It should be noted that a logarithmic equation's adjusted coefficient of determination ($\bar{R}^2$), and its standard error of estimate (S.E.E.) together with its relationship to the mean of the dependent variable (% S.E.E.), are not directly comparable with those of a non-logarithmic equation.

(5) For actual data for TYSD, see section (6) of this paper on ex post forecasts. Data have been converted from log to ordinary level form.

$$\text{Log TYSD} = \underset{(59.96)}{1.1541} \text{ Log (YS * TSRS)}$$

$$+ \underset{(2.37)}{0.0078} [S_1 * \text{Log (YS * TSRS)}]$$

$$- \underset{(1.28)}{0.0041} [S_2 * \text{Log (YS * TSRS)}]$$

$$- 0.7800$$

$\bar{R}^2$ 0.989, S.E.E. 0.036, % S.E.E. 0.880, D.W. 1.22 (7)

The second stage in estimating the government's receipts of this form of P.A.Y.E. taxation is to link the flow of payments into the Public Account (TYSP) to the deductions made by employers (TYSD). For the private sector the institutional arrangements are quite simple, involving a lag of approximately one month. Deductions for one calendar month should be paid to the Inland Revenue Department by the 20th of the immediately following month. For the government sector, the flow of payments is unfortunately rather more complicated than can be assumed in a model which makes use of quarterly data only and, at least at this stage, does not distinguish between payments of tax by private and government sector employees. Although some government payments are recorded in the month in which they are paid, other imprest payments do not appear to be recorded in a consistent fashion. In an aggregate quarterly equation some compromise is thus inevitable.

Three alternative approaches are offered in equations (8) to (10). The simplest method and, as it turns out, the one originally preferred for inclusion in the overall model,(6) is to link payments directly to deductions. This is done in estimate (8). A slight improvement on this result is obtained if an apportioning exercise is carried out under which the major explanatory variable becomes the sum of two-thirds current TYSD and one-third lagged TYSD (the lag being of one-quarter). This represents a crude attempt to allow for the one month lag in a more satisfactory manner (see equation (9)). Finally, estimate (10) offers an alternative to the preferred two stage procedure by eliminating the equation for tax deductions and instead explaining payments, TYSP, directly as the product of income and the statutory tax rate variable. The errors obtained in equation (10) can only be compared, of course, with the sum of the errors resulting from the two stage procedure. However, since the latter is obviously more acceptable on conceptual grounds, estimate (9) would be the preferred relationship for inclusion in an overall model. Equation (10) is simply an illustration of an alternative empirical approach.

$$\text{TYSP} = \underset{(88.98)}{0.8978} \text{ TYSD} + \underset{(17.84)}{0.1653} (S_1 * \text{TYSD})$$

$$+ \underset{(6.37)}{0.0581} (S_2 * \text{TYSD})$$

$$+ \underset{(8.38)}{0.0735} (S_3 * \text{TYSD}) + 1.2205$$

$\bar{R}^2$ 0.996, S.E.E. 1.483, % S.E.E. 2.289, D.W. 2.57 (8)

$$\text{TYSP} = \underset{(96.42)}{0.9535} (0.67 \text{ TYSD} + 0.33 \text{ TYSD}_{-1})$$

$$+ \underset{(14.22)}{0.1225} [S_1 * (0.67 \text{ TYSD} + 0.33 \text{ TYSD}_{-1})]$$

$$+ \underset{(3.30)}{0.0283} [S_2 * (0.67 \text{ TYSD} + 0.33 \text{ TYSD}_{-1})]$$

$$+ \underset{(6.71)}{0.0559} [S_3 * (0.67 \text{ TYSD} + 0.33 \text{ TYSD}_{-1})]$$

$$- 0.2138$$

$\bar{R}^2$ 0.996, S.E.E. 1.372, % S.E.E. 2.117, D.W. 3.02 (9)

$$\text{TYSP} = \underset{(46.73)}{0.9260} (\text{YS * TSRS}) + \underset{(10.71)}{0.0277} (S_1 * \text{YS})$$

$$+ \underset{(2.61)}{0.0066} (S_2 * \text{YS}) + \underset{(4.69)}{0.0116} (S_3 * \text{YS})$$

$$- 8.1378$$

$\bar{R}^2$ 0.983, S.E.E. 2.929, % S.E.E. 4.519, D.W. 1.43 (10)

(b) Other persons

The self-employed, being mainly farmers and professional persons, and individuals who receive (in excess of the tax exemption) dividends, rents and interest, pay tax which comes under the "other persons" category. These taxpayers pay their tax in two instalments, the first of which is payable on 7 September and the second on 7 March of each fiscal year. Up to the 1963-64 March year these instalments were of equal proportions, but since 1964-65 one-third of the tax liability has been due on 7 September and two-thirds on 7 March. As in the case of company taxation, it is assumed that the income base for provisional tax is the previous year's income (YOA_{-1A}). This procedure is consistent with the fact that official income data for other persons are available only on an annual March year basis. Throughout this section linear relationships are tested, as logarithmic formulations gave inferior results.

Using multiplicative seasonals, an effective tax rate index (TROE), and the full estimation period 1960(2)

(6) See, for example, Deane [3].

to 1970(4), estimate (11) is obtained for other persons' gross taxation (TYOG).[7]

$$TYOG = \underset{(36.14)}{0.5637} (S_1 * YOA_{-1A} * TROE) + \underset{(1.56)}{0.0235} (S_2 * YOA_{-1A} * TROE) + \underset{(19.21)}{0.2892} (S_3 * YOA_{-1A} * TROE) + \underset{(0.96)}{0.0495} (YOA_{-1A} * TROE) - 2.5564$$

$\bar{R}^2$ 0.976, S.E.E. 6.028, % S.E.E. 14.604, D.W. 2.03 (11)

Alternatively, when a statutory tax rate variable (TSRO) is used, the result is somewhat poorer, as illustrated by equation (12).

$$TYOG = \underset{(34.73)}{0.6539} (S_1 * YOA_{-1A} * TSRO) + \underset{(1.49)}{0.0270} (S_2 * YOA_{-1A} * TSRO) + \underset{(18.42)}{0.3344} (S_3 * YOA_{-1A} * TSRO) + \underset{(0.49)}{0.0303} (YOA_{-1A} * TSRO) + 1.4569$$

$\bar{R}^2$ 0.974, S.E.E. 6.270, % S.E.E. 15.190, D.W. 1.91 (12)

The rather low t-values for the June and December quarters in these equations reflect the relatively small and variable taxation payments made in these quarters. Furthermore, the overall standard of fit of the equations is clearly inadequate for this type of relationship. A study of the pattern of residuals, and knowledge of the institutional-type change which occurred in 1964-65 with respect to the proportions of tax payments attributable to the March and September quarters, suggests the need to incorporate an adjustment factor. Accordingly, two time trend variables, ZT1 and ZT2, are introduced into the equivalent of equations (11) and (12) to provide estimates (13) and (14) respectively. It will be recalled that these variables are defined as follows: ZT1 takes the value 1 in March quarters up to and including 1964(1), 1.33 in succeeding March quarters, and zero elsewhere; ZT2 is 1 in September quarters up to 1963(3), 0.67 in all later September quarters, and zero in all other periods. Although some improvement in the fit is evident, the results remain unsatisfactory.

$$TYOG = \underset{(60.50)}{0.4530} (ZT1 * YOA_{-1A} * TROE) + \underset{(1.99)}{0.0179} (S_2 * YOA_{-1A} * TROE) + \underset{(32.02)}{0.3680} (ZT2 * YOA_{-1A} * TROE) + \underset{(1.45)}{0.0448} (YOA_{-1A} * TROE) - 0.7796$$

$\bar{R}^2$ 0.991, S.E.E. 3.630, % S.E.E. 8.795, D.W. 1.92 (13)

$$TYOG = \underset{(47.17)}{0.5230} (ZT1 * YOA_{-1A} * TSRO) + \underset{(1.50)}{0.0199} (S_2 * YOA_{-1A} * TSRO) + \underset{(24.89)}{0.4252} (ZT2 * YOA_{-1A} * TSRO) + \underset{(0.38)}{0.0172} (YOA_{-1A} * TSRO) + 4.4515$$

$\bar{R}^2$ .986, S.E.E. 4.645, % S.E.E. 11.253, D.W. 1.78 (14)

The alternative to employing time trend variables such as ZT1 and ZT2 is to use a shorter sample period in order to eliminate the problem caused by the institutional change which occurred in 1964-65. When the sample period commences in the March quarter, 1965, and using the effective tax rate index, estimate (15) is obtained for other persons' gross tax payments.

$$TYOG = \underset{(71.53)}{0.6022} (S_1 * YOA_{-1A} * TROE) + \underset{(2.64)}{0.0213} (S_2 * YOA_{-1A} * TROE) + \underset{(32.93)}{0.2659} (S_3 * YOA_{-1A} * TROE) + \underset{(2.92)}{0.1838} (YOA_{-1A} * TROE) - 27.6613$$

$\bar{R}^2$ 0.997, S.E.E. 2.584, % S.E.E. 5.592, D.W. 2.20 (15)
(Period 1965(1) to 1970(4); 24 observations)

It is clear that this procedure is markedly superior to using the longer sample period in that the percentage standard error has been reduced from 8.8 percent in equation (13) to 5.6 percent in equation (15). However, for conceptual and forecasting reasons, it is more desirable to employ a statutory tax rate variable rather than the effective rate index. Equation (16) illustrates the effect of substituting TSRO for TROE although the standard error of the estimate still remains rather high. Closer inspection of the basic data and the residuals pattern suggests a progressive divergence between the various series being employed in equation (16).

---

(7) It should be recalled that TYOG is a quarterly series, whereas YOA is an annual series with the −1A subscript implying that the income variable relates to the immediately preceding annual March year aggregate. This presentation is one of convenience only, and the re-writing of the relationships in full quarterly format is a simple if space-consuming procedure. This is illustrated by the appropriate re-arrangement of the preferred equation, number 18, re-written as 18A.

$$\text{TYOG} = \underset{(41.91)}{0.6909}\ (S_1 * \text{YOA}_{-1A} * \text{TSRO}) + \underset{(1.55)}{0.0249}\ (S_2 * \text{YOA}_{-1A} * \text{TSRO}) + \underset{(19.32)}{0.3094}\ (S_3 * \text{YOA}_{-1A} * \text{TSRO}) + \underset{(1.45)}{0.2275}\ (\text{YOA}_{-1A} * \text{TSRO}) - 29.8257$$

$\bar{R}^2$ 0.990, S.E.E. 4.402, % S.E.E. 9.528, D.W. 1.78 (16)
(Period 1965(1) to 1970(4); 24 observations)

A simple but effective way to overcome this problem is to introduce a linear time trend on the March quarters where this problem appears most acute. Accordingly ZT3 takes the values 0, 1, 2 . . . in the March quarters 1965, 1966, 1967 . . . and zero in all other periods. Adding this variable to equation (16) provides a more satisfactory result.

$$\text{TYOG} = \underset{(48.67)}{0.6263}\ (S_1 * \text{YOA}_{-1A} * \text{TSRO}) + \underset{(2.89)}{0.0249}\ (S_2 * \text{YOA}_{-1A} * \text{TSRO}) + \underset{(35.96)}{0.3094}\ (S_3 * \text{YOA}_{-1A} * \text{TSRO}) + \underset{(2.21)}{0.1864}\ (\text{YOA}_{-1A} * \text{TSRO}) + \underset{(6.92)}{3.9517}\ \text{ZT3} - 23.2914$$

$\bar{R}^2$ 0.997, S.E.E. 2.365, % S.E.E. 5.119, D.W. 2.31 (17)
(Period 1965(1) to 1970(4); 24 observations)

Re-estimation of estimate (17) with the constant term suppressed yields an equation of slightly inferior fit but one with more desirable conceptual qualities and, in particular, the sum of the coefficients on the (YOA_{-1A} * TSRO) variables, representing the tax base, more closely approximate unity in equation (18).

$$\text{TYOG} = \underset{(6.21)}{0.0397}\ (\text{YOA}_{-1A} * \text{TSRO}) + \underset{(46.75)}{0.6222}\ (S_1 * \text{YOA}_{-1A} * \text{TSRO}) + \underset{(2.75)}{0.0249}\ (S_2 * \text{YOA}_{-1A} * \text{TSRO}) + \underset{(34.18)}{0.3094}\ (S_3 * \text{YOA}_{-1A} * \text{TSRO}) + \underset{(6.71)}{4.0220}\ \text{ZT3}$$

$\bar{R}^2$ 0.997, S.E.E. 2.488, % S.E.E. 5.385, D.W. 2.10 (18)

This preferred relationship, as with all the other equations in this section, can be re-written for use in a quarterly econometric model using quarterly rather than annual income data, as illustrated in equation (18A). The quarterly "other persons' " and company income data used in this paper are derived by interpolation of the relevant national accounts annual series, given the unavailability of genuine quarterly series.

Probably the most serious deficiency of these equations for other persons' taxation (TYOG), and one which it has not yet proved possible to overcome in a satisfactory manner, is the fact that adequate allowance is not made for tax on company dividends paid by "other persons". No published quarterly information appears to be available on the proportion of TYOG which is attributable to dividends and, furthermore, in the past company dividends attracted a maximum rate of income tax which was less than that on other personal income. The income series used in this section, YOA and YO, do not include company dividends in order to preserve comparability with the statutory tax rate variable, TSRO, which itself does not include allowance for the different maximum rates just mentioned. This is simply because of the practical problems involved in this area, including data shortcomings. In order to help ease the problem, company dividends were included as a separate variable in the other persons' tax equation but this yielded quite unsatisfactory results and this procedure was rejected.

$$\text{TYOG} = \underset{(2.75)}{0.0646}\ [S_2 * \text{TSRO}\ (\text{YO}_{-1} + \text{YO}_{-2} + \text{YO}_{-3} + \text{YO}_{-4})] + \underset{(34.18)}{0.3491}\ [S_3 * \text{TSRO}\ (\text{YO}_{-2} + \text{YO}_{-3} + \text{YO}_{-4} + \text{YO}_{-5})] + \underset{(6.21)}{0.0397}\ [S_4 * \text{TSRO}\ (\text{YO}_{-3} + \text{YO}_{-4} + \text{YO}_{-5} + \text{YO}_{-6})] + \underset{(46.75)}{0.6619}\ [S_1 * \text{TSRO}\ (\text{YO}_{-4} + \text{YO}_{-5} + \text{YO}_{-6} + \text{YO}_{-7})] + \underset{(6.71)}{4.0220}\ \text{ZT3}$$

$\bar{R}^2$ .997, S.E.E. 2.49, % S.E.E. 5.390, D.W. 2.10 (18A)
(Period 1965(1) - 1970(4); 24 observations)

The significance of the deficiency is uncertain in that it is not known what proportion of company dividends represents income for the "other persons' " category.[8] In 1970-71 dividends totalled $108 million, compared with other persons' income excluding dividends of $802 million. Although recent tax changes, which make dividends generally assessable in a similar manner to other personal income, will make the situation more straight forward in the future, the period after the change occurred may create problems. It is, however, encouraging to note the satisfactory ex post forecasts provided by equation 18 (see the later section (6)).

(c) Company tax

For New Zealand taxation purposes companies are divided into two classes, those which pay tax on a provisional basis and those which are termed subsisting companies. Any company incorporated after 25 July 1957 is obliged to pay provisional tax which effectively implies a pay-as-you-earn basis along similar lines to that used for salary and wage earners. The main difference, of course, is that tax payments are due only twice yearly (presumably as a matter of administrative and political convenience[9]) rather than monthly as is the case with salary and wage earners. There is also a provision in the Land and Income Tax Act which states that any company incorporated on or before 25 July 1957 may elect to become a provisional taxpayer. All other private and public companies pay their tax on a subsisting basis, which means that current tax payments relate to the immediately preceding fiscal year rather than to an estimate of current income. As far as a company tax equation is concerned, the two categories can be conveniently treated as one aggregate in that the provisional taxpayers are permitted to use their own estimated income base for computing their payments of tax, so long as this base is judged to give a fair and reasonable guide as to the income which the company expects to earn in the current year. For this purpose most companies use the previous year's income as their base, which brings provisional tax payments conceptually into line with those for subsisting companies. In addition, it is not possible to obtain income data broken down into the two major categories, so an aggregate approach is necessary on purely statistical grounds. Although there are no official estimates of quarterly company income, a fact which is inconvenient from the point of view of an econometric model as a whole, this is not a serious problem in respect of company tax payments where these are based on annual data. A similar situation applies with respect to other persons' income.

Using multiplicative seasonal dummy variables and an effective tax rate index (TRCE), estimate (19) is obtained for gross company tax payments (TYCG). The full time period 1960(2) to 1970(4) is used.

$$
\begin{aligned}
TYCG = {} & \underset{(199.80)}{0.8778}\,[S_1 * (YCA - YCEA)_{-1A} * TRCE] \\
& + \underset{(2.35)}{0.0097}\,[S_2 * (YCA - YCEA)_{-1A} * TRCE] \\
& + \underset{(5.62)}{0.0233}\,[S_3 * (YCA - YCEA)_{-1A} * TRCE] \\
& + \underset{(4.19)}{0.0294}\,[(YCA - YCEA)_{-1A} * TRCE] \\
& - 1.2264 \qquad (19)
\end{aligned}
$$

$\bar{R}^2$ 0.999. S.E.E. 1.964, % S.E.E. 4.426, D.W. 2.45

The standard error of this estimate is relatively low and the other statistical features of the equation appear satisfactory. Unfortunately detailed information on the distribution of company income over different income categories is only available with a time lag of several years. As a result, no attempt is made to construct a statutory tax rate index. This shortcoming is less serious than it may appear on first sight because corporate tax rates progress to the maximum marginal rate quite rapidly, reaching the maximum at a relatively low assessable income.[10] On the other hand, the question of explaining the corporate effective tax rate variable endogenously within the model was examined by regressing this variable against a number of indicators which it was thought may account for changes resulting from influences such as investment incentives and export incentives. Variables employed as explanatory factors included building permits issued, imports of plant and machinery, and total exports. Although the statistical results were not particularly satisfactory, the nature of the relationships between these variables and the effective tax rate in terms of the signs on the coefficients were as would be expected from a conceptual point of view. This work is proceeding.

As in the case of the other persons' tax estimate, equation (19) for company tax can be re-written for inclusion in a quarterly model in a manner illustrated in equation (19A). This relationship employs an income

(8) For example, some dividends would be attributable to companies themselves, both domestic and foreign-owned, including major institutional investors such as insurance companies, and some would be received by non-corporate non-personal organisations.

(9) In recent years some representations have been made to government to introduce quarterly tax payments for non-salary and non-wage earners and companies, mainly on the grounds that quarterly payments would help ease the extreme seasonal liquidity fluctuations which occur in New Zealand under the present arrangements. For example, such a recommendation with respect to company tax was made by the Monetary and Economic Council in [18]. However, the present government seems reluctant to make any change in this direction, although it was announced in the 1972 Budget that subsisting companies would be required to pay one-third of their tax in September and the remainder in March. This change applies to income derived during the March 1973 fiscal year.

(10) Full details are provided in an Appendix to the paper.

$$TYCG = \underset{(2.35)}{0.03914} [S_2 * TRCE\ (YC_{-1} + YC_{-2} + YC_{-3} + YC_{-4})]$$

$$+ \underset{(5.62)}{0.05274} [S_3 * TRCE\ (YC_{-2} + YC_{-3} + YC_{-4} + YC_{-5})]$$

$$+ \underset{(4.19)}{0.02940} [S_4 * TRCE\ (YC_{-3} + YC_{-4} + YC_{-5} + YC_{-6})]$$

$$+ \underset{(119.80)}{0.90721} [S_1 * TRCE\ (YC_{-4} + YC_{-5} + YC_{-6} + YC_{-7})] - 1.2264$$

$\bar{R}^2$ .999, S.E.E. 1.964, % S.E.E. 4.426, D.W. 2.45 (19A)
(Period 1960(2) - 1970(4); 43 observations)

variable obtained through quarterly interpolation of the annual national accounts series. In each case the tax base excludes special exemptions (see the notation in section (3) of the paper). The coefficients on the tax base variables in equation (19A) sum approximately to unity, which is as expected. Thus, for example, a 10 percent tax rate change would lead to a corresponding 10 percent change in income tax receipts for government in the first instance (ignoring at this stage secondary effects which would obviously accrue both in the real world and in model simulation).

(5) OTHER TAX RESULTS

The present attempts to estimate central government receipts of indirect and other taxation are heavily constrained by a desire to use as tax bases variables which are endogenous to the quarterly macroeconomic model which is currently being constructed within the Bank. It will be seen from the following detailed results that bases which are more appropriate than those determined within the model have been tried successfully in one or two cases. For example, the production of beer clearly provides a better tax base for beer tax than the retail turnover aggregate which is preferred as far as the model is concerned. Unfortunately beer production is neither easy to forecast, given the range of explanatory variables available, nor does it fit into the present overall model framework in an adequate manner. As it happens, this type of problem is probably least acute for the tax categories which yield the largest amounts of revenue.

It will be noticed that tax rate variables do not appear in most of the following estimates. This is not because they have not been tested. Where seemingly relevant, tax rates have been tried, but often without success. The principal explanation for this is that in those cases where rates have been changed significantly, as for example in the case of sales tax on new motor vehicles, the tax base itself effectively incorporates the change. Using the same illustration, the tax base (automotive turnover) has risen when the tax rate has been increased, as higher taxes appear to have been passed on in the form of higher prices. But in the really important categories, the absence of a tax rate variable is explained not by statistical difficulties but simply by the fact that no significant changes in rates have been made over the period (e.g. non-automotive sales tax), or that where variations have occurred, they are exceedingly difficult to represent empirically as part of a single tax rate variable (e.g. customs duties). These explanations imply that the indirect and other tax equations may be quite useful for forecasting purposes, but are likely to be of more limited applicability in assessing the probable impact of changes in rates of indirect taxation. The individual relationships are explained briefly in the following sections of the paper.

(a) Sales tax (other than automotive)

In New Zealand there is a basic sales tax rate of 20 percent on the value of commodities, this tax being payable at the stage where goods pass to the retailer. As is usual with taxes of this type, certain commodities are classified as exempt, such as many basic primary foodstuffs, machinery for use in manufacturing, tobacco and beer. It should be noted that these last two commodities are subject to excise duty and are thus treated separately.[11] Because the tax rate levied on new motor vehicles is substantially higher than the general sales tax rate of 20 percent, and because motor vehicles are an important category of consumption and tax revenue in their own right, automotive sales tax is excluded from the definition of sales tax employed in this section. Although this procedure seems to be the most acceptable from a conceptual point of view, it has the significant disadvantage of shortening the estimation period for the sales tax equations. Although statistical data are available on sales tax as an aggregate including the automotive category for the full estimation period of the model (that is, from 1960(2) to 1970(4)), this is not the case with respect to the unpublished series for automotive sales tax which was obtained through the generosity of

(11) Beer duty is considered as a separate item in part (c) of the present section of the paper. Tobacco duty represents part of customs duty, which is the subject of part (e) of this section.

the Customs Department. The latter series can only be segregated from total sales tax from 1963 to date. Accordingly the following equations for TISN cover the time period 1963(2) to 1970(4), a total of 31 observations. The closing date of the estimation period is chosen in order to allow ex post forecasts to be carried out for 1971, for which period actual statistics for all the tax categories are readily available.

The most appropriate major explanatory variable for the non-automotive sales tax equations appears to be total retail trade turnover. If additive seasonal dummy variables are employed in addition to RT, estimate (20) is obtained.

$$\underset{(5.89)}{TISN = 0.0221\ RT} + \underset{(7.10)}{4.5582\ S_1} - \underset{(9.34)}{5.6679\ S_2} + 1.4685$$

$\bar{R}^2$ 0.890, S.E.E. 1.374, % S.E.E. 13.418,
D.W. 2.63 (20)
(Period 1963(2) to 1970(4); 31 observations)

However, as is shown by equation (21), the use of multiplicative seasonal dummies gives superior results. The third quarter seasonal is omitted because it lacks statistical significance.

$$TISN = \underset{(7.63)}{0.0239\ RT} + \underset{(8.73)}{0.0119\ (S_1 * RT)}$$

$$- \underset{(11.30)}{0.0141\ (S_2 * RT)} + 0.6980$$

$\bar{R}^2$ 0.919, S.E.E. 1.174, % S.E.E. 11.463,
D.W. 2.49 (21)
(Period 1963(2) to 1970(4); 31 observations)

Because a range of primary foodstuffs are exempt from sales tax, it was thought useful to compare the above results with an equation using total retail trade turnover, excluding the food categories, as the major explanatory factor. However, the result shown in equation (22) is marginally inferior to that of equation (21).

$$TISN = \underset{(7.90)}{0.0258\ (RT - RTF)}$$

$$+ \underset{(8.68)}{0.0278\ [S_1 * (RT - RTF)]}$$

$$- \underset{(10.83)}{0.0303\ [S_2 * (RT - RTF)]} + 5.6760$$

$\bar{R}^2$ 0.910, S.E.E. 1.237, % S.E.E. 12.079,
D.W. 2.29 (22)
(Period 1963(2) to 1970 (4); 31 observations)

Finally, it should be noted that as the sales tax rate remained unchanged throughout the estimation period, it is not statistically necessary to incorporate a tax rate variable in the direct estimation process. On the other hand, these equations could be rewritten if desired to incorporate such a variable if the appropriate adjustment was made to the retail trade turnover figures in order to obtain a pre-tax concept.

(b) Automotive sales tax

For sales tax purposes the automotive trade is defined as including new motor vehicles (cars and lorries), parts and accessories. The only independent variable which is available in quarterly form and which seems to provide a suitable base for estimating automotive sales tax is the automotive group within the wholesale turnover series published by the Government Statistician. A tax rate variable, TRA, was constructed on the basis of changes in the rate of sales tax on motor vehicles which occurred during the estimation period. In the early part of the period the rate was 33.3 percent (having been reduced from 40 percent to this value in July 1960). The rate was increased to 40 percent in May 1967, as part of a package of restrictive measures adopted to cope with the balance of payments crisis at that time. The 40 percent rate has not been changed since 1967. Although TRA was incorporated in the automotive sales tax equations, it did not prove significant unless a suitable adjustment was made to the automotive turnover series, RA, to gain a pre-tax concept. For example, using additive seasonal dummies and an unadjusted version of RA, and making due allowance for the time lag between automotive sales and payments of the relevant tax through the incorporation of TISA lagged one period in the equation, estimate (23) is obtained.

$$TISA = \underset{(4.38)}{0.0713\ RA} + \underset{(4.65)}{0.5825\ TISA_{-1}} - \underset{(6.15)}{2.4600\ S_1}$$

$$+ \underset{(1.02)}{0.4828\ S_2} - \underset{(1.24)}{0.4607\ S_3} + 0.3026$$

$\bar{R}^2$ 0.934, S.E.E. 0.729, % S.E.E. 6.953,
D.W. 1.89, D. 0.43 (23)
(Period 1963(3) to 1970(4); 30 observations)

If the automotive turnover variable lagged one period is dropped from the equation, there is a marked deterioration in the goodness of fit. As an alternative to the above procedure the value of quarterly production of motor assembly plants, multiplied by the sales tax rate variable, was used as the major explanatory factor, although it should be noted that at the present time this value of production variable is not included in the overall model. The statistical results obtained from this approach were relatively poor.

$$TISA = \underset{(6.46)}{0.4563\ (TRA * RAA)}$$

$$- \underset{(7.00)}{0.2719\ (S_1 * TRA * RAA)}$$

$$- \underset{(1.98)}{0.0602\ (S_3 * TRA * RAA)}$$

$$+ \underset{(5.58)}{0.5465\ TISA_{-1}} + 0.9256$$

$\bar{R}^2$ 0.923, S.E.E. 0.787, % S.E.E. 6.005,
D.W. 1.85, D. 0.48 (24)
(Period 1963(3) to 1970(4); 30 observations)

It is possible to illustrate the manner in which an equation such as that just outlined for TISA can be presented in a theoretically more appropriate manner by adjusting the tax base variable to gain a pre-tax concept. In equation (24), RAA is simply the original RA adjusted in two ways: first, to exclude an estimate of sales of parts and accessories (Census of Distribution data suggesting that these represent about 43 percent of total RA) and, secondly, to gain a pre-tax version of this adjusted RA.

(c) Beer duty

Since June 1958, the rate of excise duty on beer has remained unchanged at 60 cents a gallon, advancing by 1.67 cents for every unit of specific gravity in excess of 1,036. Unfortunately, there are no statistics available on the volumes of beer brewed at different levels of specific gravity, so it is necessary to assume that all beer attracts the same (average) rate of excise duty. Consequently the excise tax rate for beer does not need to be used in the equations estimated in this section. As has been mentioned previously, production of beer is not an endogenous variable within the quarterly econometric model of which these tax equations form part. For this reason equations have also been tested in which it is assumed that sales of beer move in a similar way to aggregate retail trade turnover. The inclusion of the lagged dependent variable among the explanatory set is justified on the grounds of lags between the sales of beer and the receipt of duties into the Public Account. Equation (25) is preferred for inclusion in the overall model.

$$\begin{aligned} TIB = {} & \underset{(10.90)}{0.0082\ RT} + \underset{(2.46)}{0.1348\ TIB_{-1}} - \underset{(14.07)}{1.9675\ S_2} \\ & - \underset{(11.50)}{1.6252\ S_3} + 4.9970 \end{aligned}$$

$\bar{R}^2$ 0.928, S.E.E. 0.352, % S.E.E. 4.232, D.W. 1.80, D. 0.70 (25)
(Period 1960(2) to 1970(4); 43 observations)

Alternatively, it is possible to assume that beer sales may follow food turnover more closely than total retail trade sales. The lagged dependent variable did not enter equation (26) at an acceptable level of significance.

$$TIB = \underset{(14.39)}{0.0228\ RTF} - \underset{(15.07)}{1.8741\ S_2} - \underset{(15.32)}{1.8942\ S_3} + 6.2935$$

$\bar{R}^2$ 0.936, S.E.E. 0.332, % S.E.E. 3.989, D.W. 1.82 (26)
(Period 1960(2) to 1970(4); 43 observations)

Equations using multiplicative seasonal dummies proved inferior to those in which additive seasonals were used, such as in the preceding cases. When quarterly production of beer is substituted for retail trade turnover, a somewhat better overall fit is obtained. In addition, of course, equation (27) provides a better conceptual framework, even though it lacks convenience as far as the model is concerned. The beer production statistics are published regularly on a quarterly basis in the *Monthly Abstract of Statistics.*

$$TIB = \underset{(17.90)}{0.0005\ QB} + \underset{(12.74)}{1.3394\ S_1} - \underset{(1.87)}{0.1982\ S_2} + 0.3638$$

$\bar{R}^2$ 0.958, S.E.E. 0.269, % S.E.E. 3.236, D.W. 1.94 (27)
(Period 1960(2) - 1970(4); 43 observations)

Because the preferred equations for sales tax, other than with respect to automobiles and beer duty, have similar explanatory variables within the model, it is of some interest to compare the disaggregated results with an estimate in which the dependent variable is the sum of non-automotive sales tax plus beer duty. Equation (28) illustrates this approach.

$$\begin{aligned} TIB + TISN = {} & \underset{(10.29)}{0.0346\ RT} + \underset{(8.08)}{0.0128\ (S_1 * RT)} \\ & - \underset{(12.30)}{0.0178\ (S_2 * RT)} \\ & - \underset{(3.08)}{0.0045\ (S_3 * RT)} + 5.6640 \end{aligned}$$

$\bar{R}^2$ 0.943, S.E.E. 1.178, % S.E.E. 6.157, D.W. 2.50 (28)
(Period 1963(3) to 1970(4); 30 observations)

(d) Estate duty

There are severe difficulties inherent in determining a quarterly relationship to explain central government receipts in the form of estate duty. Although quarterly tax data are available for the full period for which detailed accounts of the government sector have been compiled (see Grindell and Deane [14]), the same is not true in respect of the explanatory variables which are normally used in this sort of equation. In particular, the value of estates assessable for duty purposes is only available in the form of an annual series and unfortunately there are fairly long lags in these figures becoming available. For example, at the time of writing (October 1972), the latest available valuation of estates is in respect of the year ended March 1971. Apart from this, any attempt to interpolate quarterly data on the basis of the annual statistics runs the risk of achieving a poor representation of reality because of the problem of determining an appropriate seasonal pattern. The major guide in this respect is the series for number of deaths, which shows a strong peak in the winter months. To obtain a reasonably accurate estimate of estate duty receipts by government it would be necessary to interpolate the seasonal factor with some degree of precision if a sensible relationship is to be obtained between receipts and the corresponding value of estates (including reasonable estimates of the distributed lag that would probably be involved).

For the sake of the record, it can be observed that attempts were made to use the series for value of estates declared for death duty purposes as an explanatory factor, but the standard of statistical fit was poor. This presumably reflects, at least in part, the nature of the statistical difficulties just mentioned. Accordingly, the following equation represents a compromise position and essentially amounts to an ad hoc model designed to facilitate forecasts of estate duty without meeting the normal conceptual standards which might be expected in this area. An effective tax rate variable was constructed by computing the ratio of total estate duty paid to government to the total value of estates declared for death duty purposes. To account for the increase over time in the value of dutiable estates, at least in a crude way, an aggregate domestic expenditure series is also used in the equations. This series, YD3, comprises the sum of expenditures in the following sectors: consumption, investment and government. Within the overall model, an aggregate national expenditure series fulfils the role of a gross national product variable (there being no official quarterly G.N.P. figures available in New Zealand). The standard of the fit of equation (29) is not particularly satisfactory and various experiments with other variables, such as the number of deaths, failed to yield any improvement.

$$\begin{aligned} TIE = {} & \underset{(5.86)}{0.0033\ YD3} - \underset{(4.50)}{0.0009\ (S_2 * YD3)} \\ & + \underset{(4.28)}{39.3778\ TRE} + \underset{(1.80)}{0.2032\ TIE_{-1}} - 2.9335 \end{aligned}$$

$\bar{R}^2$ 0.671, S.E.E. 0.501, % S.E.E. 9.168,
D.W. 2.48, D. —2.07 (29)
(Period 1961(3) to 1970(4); 38 observations)

(e) Customs duty

Customs revenue is derived from the tariffs levied on goods which are imported into New Zealand. The tariff rates depend not only on the type of commodity that is imported but also on the country of origin. For example, during the estimation period there were three major categories of tariffs applicable in this country: British preferential, most favoured nation and the general tariff. Because of the nature of the tariff structure and the changing pattern of trade over time, it was decided that the compilation of an index of tariff rates would be a long and difficult task. As a result, the equations which explain customs duties use actual c.i.f. imports as the independent variable. This excludes certain items which are exogenous to the model as a whole because of their random lumpy nature, such as imports of ships, aircraft, railway and defence equipment, a considerable proportion of which are government imports and thus do not attract an important amount of customs duty. The inclusion of the lagged dependent variable among the explanatory set is justified on the grounds of lags between the arrival of imports and the receipt of duties into the Public Account. Other formulations, including non-linear relationships and alternative lag structures, were tested without further success.

Although equation (30) is illustrated in the graphs and is used in table 1, the table of ex post forecasts, it provides results which are little different from those of estimate (31). The latter provides a marginally better fit at the expense of a slightly higher Durbin-Watson statistic. The only structural difference between equations (30) and (31) is, of course, in their treatment of the multiplicative variables to account for seasonality.

$$\begin{aligned} TIC = {} & \underset{(6.09)}{0.0731\ ICA} - \underset{(5.48)}{0.0266\ (S_1 * ICA)} \\ & - \underset{(7.40)}{0.0303\ (S_2 * ICA)} - \underset{(3.21)}{0.0146\ (S_3 * ICA)} \\ & + \underset{(4.07)}{0.4957\ TIC_{-1}} + 1.9176 \end{aligned}$$

$\bar{R}^2$ 0.874, S.E.E. 1.755, % S.E.E. 7.516,
D.W. 2.32, D. —1.30 (30)
(Period 1960(1) to 1970(4); 44 observations)

$$\begin{aligned} TIC = {} & \underset{(4.90)}{0.0566\ ICA} + \underset{(5.20)}{0.6332\ TIC_{-1}} \\ & - \underset{(5.99)}{0.1985\ (S_1 * TIC_{-1})} - \underset{(7.70)}{0.2442\ (S_2 * TIC_{-1})} \\ & - \underset{(2.74)}{0.1097\ (S_3 * TIC_{-1})} + 1.7709 \end{aligned}$$

$\bar{R}^2$ 0.881, S.E.E. 1.705, % S.E.E. 7.301,
D.W. 2.44, D. —2.47 (31)
(Period 1960(1) to 1970(4); 44 observations)

(f) Highways tax

Highways taxation is made up largely of revenue from motor spirits and registration fees. Accordingly, it can be expected that TIH, the dependent variable in these equations, could be explained by factors such as the stock of automobiles and some measure of the likely usage of this stock. As far as usage is concerned, a simple assumption can be made to the effect that usage of automobiles tends to vary in a manner similar to wholesale turnover of automobiles and parts and accessories. This latter series, RA, is also used in the equations for automotive sales tax. However, in the present instance a constant price series, RAR, is the more appropriate conceptual version. A series for the stock of vehicles has been constructed by Deane and Grindell [6] as part of a wider study on the question of wealth series for New Zealand. For automobiles, the assumed depreciation rate built into the stock variable, KAR, is 4 percent per quarter. Equation (32) is the preferred estimate.

$$\text{TIH} = \underset{(4.00)}{0.1345\ \text{RAR}} + \underset{(2.87)}{0.0028}\ (\text{KAR} + \text{KAR}_{-1})$$

$$+ \underset{(6.48)}{3.9566}\ S_1 - \underset{(4.79)}{2.7031}\ S_2 + \underset{(4.67)}{2.6383}\ S_3 + 2.3606$$

$\bar{R}^2$ 0.897, S.E.E. 1.319, % S.E.E. 8.598, D.W. 2.21 (32)
(Period 1960(2) to 1970(4); 43 observations)

(g) Total indirect and other tax

An alternative to the disaggregated approach adopted above, where separate equations are developed for each category of non-income tax, is to establish one equation for total indirect and other tax receipts by government. Although this procedure provides less detail, it is certainly simpler as far as generating forecasts is concerned. The broadly defined aggregate domestic expenditure series, YD1, is used as the major independent variable and gives reasonably satisfactory results. It should be noted that the dependent variable, TIA, excludes payroll tax at this stage but includes some minor categories of tax for which separate equations are not developed in the preceding set of disaggregated estimates. An attempt to obtain an equation with these minor items treated as one category gave poor results.

$$\text{TIA} = \underset{(10.67)}{0.0685}\ \text{YD1} + \underset{(1.93)}{0.0044}\ (S_1 * \text{YD1})$$

$$- \underset{(10.37)}{0.0202}\ (S_2 * \text{YD1}) + \underset{(1.26)}{0.1116}\ \text{TIA}_{-1}$$

$$+ 10.8844$$

$\bar{R}^2$ 0.954, S.E.E. 3.790, % S.E.E. 4.613, D.W. 1.76, D. 0.89 (33)
(Period 1961(3) to 1970(4); 38 observations)

(6) EX POST FORECASTS

Ideally the forecasting performance of equations such as those contained in this paper can only be fully assessed after intensive use in an applied situation over a reasonable period of time. It is certainly hoped that the Bank's econometric model will be put to such a test in the near future. In the shorter run, however, a compromise assessment may be carried out on the basis of ex post rather than genuine ex ante forecasts. As far as ex post forecasts are concerned, two procedures are available: first, the individual sector equations may be put together in the form of a model, thus enabling dynamic simulation experiments to be conducted with the model as a whole, along the lines illustrated in [3] and [9]; or, secondly, ex post forecasts can be computed on an individual equation basis with all the independent variables being treated as exogenous.

The second approach is that adopted in table 1, the table of ex post forecasts, presented in this paper. For the preferred equations, the estimation period ends in 1970(4). Thus, given the limitations on current data availability, four quarters are available for ex post forecasts: 1971(1) to 1971(4). It can be seen from the table of forecasts that some equations perform better than others. In the case of the income tax estimates, the root mean square errors[12] for the four forecast quarters are as follows:

	% R.M.S.E.
Salary and wage earners' tax deductions	1.1
Salary and wage earners' tax payments	2.0
Other persons' tax	3.1
Company tax	4.8

Given the rapid rise in incomes generally and the substantial rate of inflation recorded during 1971, these ex post forecast errors do not seem unreasonable. There are some difficulties inherent in obtaining low percentage errors for the quarters which because of seasonal/institutional arrangements usually record low absolute values for flows of other persons' and company income taxation. The flows in these quarters are at times subject to rather unpredictable fluctuations, at least within the context of generalised equations which are primarily concerned with explaining the relatively more important quarters where the major proportion of these flows are recorded. Table 1 makes it clear that the forecasts for these important quarters are quite satisfactory for 1971. Furthermore, the percentage root mean square errors (% R.M.S.E.) obtained from the forecasts are in each case either reasonably close to the percentage standard error of estimate derived from the estimation period or, as in the case of other persons' tax, are somewhat lower. This type of information is summarised in table 3.

As far as the indirect tax equations are concerned, it can be observed that the disaggregated results are rather mixed and it seems likely that an aggregate non-income tax equation may well be preferred over the set of estimates for individual categories for forecasting purposes. In some instances the % R.M.S.E. are disturbingly high and exceed the sample period standard errors. Non-automotive sales tax, beer duty and estate duty are particularly acute examples of this type of problem. On the other hand, the equations for customs duty, highways taxation, and especially aggregate indirect tax, give rather more satisfactory results. Again, the detailed statistics are provided in table 1.

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(12) The root mean square error (R.M.S.E.) measure is derived from the following formula:

$$\text{R.M.S.E.} = \left(\sum_{t=1}^{n} (A_t - P_t)^2\right)^{\frac{1}{2}} \Big/ \left(\sum_{t=1}^{n} A_t^2\right)^{\frac{1}{2}}$$

where:
A_t is the actual value of the dependent variable in period t.
P_t is the predicted value calculated by the equation in period t.
This ratio measure is converted to percentage terms simply by multiplying by 100.

TABLE 1

EX POST FORECASTS FROM PREFERRED EQUATIONS

$ million

		1971(1)	*1971(2)*	*1971(3)*	*1971(4)*	*% R.M.S.E.*
Income Tax						
P.A.Y.E. (tax deductions)	Actual *	160.9	154.5	157.3	168.6	
(equation 7)	Estimate *	159.6	157.5	158.2	168.7	1.1*
	Difference	1.3	—3.0	—0.9	—0.1	
P.A.Y.E. (flow into P/A)	Actual	162.2	156.1	157.7	161.3	
(equation 9)	Estimate	166.0	153.4	157.4	156.8	2.0
	Difference	—3.8	2.7	0.3	4.5	
Other Persons	Actual	139.4	12.1	69.4	7.5	
(equation 18)	Estimate	140.6	12.0	64.7	7.4	3.1
	Difference	—1.2	0.1	4.7	0.1	
Company	Actual	251.0	17.8	20.0	9.1	
(equation 19)	Estimate	258.9	10.5	14.6	7.6	4.8
	Difference	—7.9	7.3	5.4	1.5	
Indirect and Other Tax						
Sales Tax	Actual	23.8	5.3	14.1	18.0	
(equation 21)	Estimate	19.0	6.1	14.1	16.3	15.4
	Difference	4.8	—0.8	0.0	1.7	
Automotive Sales Tax	Actual	15.4	17.4	20.3	23.8	
(equation 23)	Estimate	15.7	17.4	17.9	21.4	8.7
	Difference	—0.3	0.0	2.4	2.4	
Beer Duty	Actual	11.5	9.1	7.5	13.4	
(equation 25)	Estimate	10.6	8.9	9.1	11.5	12.4
	Difference	0.9	0.2	—1.6	1.9	
Beer Duty plus Sales Tax	Actual	35.3	14.4	21.6	31.4	
(equation 28)	Estimate	29.8	14.9	22.5	28.2	12.0
	Difference	5.5	—0.5	—0.9	3.2	
Estate Duty	Actual	7.3	5.0	6.0	5.7	
(equation 29)	Estimate	6.8	5.7	6.8	7.5	17.8
	Difference	0.5	—0.7	—0.8	—1.8	
Customs Duty	Actual	36.1	34.6	38.1	45.3	
(equation 30)	Estimate	35.0	31.8	37.6	42.2	5.6
	Difference	1.1	2.8	0.5	3.1	
Highways Tax	Actual	24.6	17.8	21.3	24.1	
(equation 32)	Estimate	22.9	16.8	22.5	21.5	7.9
	Difference	1.7	1.0	—1.2	2.6	
Total Indirect Tax	Actual	131.4	97.9	122.4	146.6	
(equation 33)	Estimate	126.3	95.5	127.4	140.3	3.9
	Difference	5.1	2.4	—5.0	6.3	

* log form converted to level form.

Generally speaking, the income tax results are more pleasing than the indirect tax estimates, a situation which could well be at least partly related to the better data and hence superior tax bases available for the former category as compared with the latter group. Undoubtedly, the disaggregated non-income tax equations suffer from the unfortunately unavoidable use of over-generalised tax base data. It is thus not too surprising that an aggregate estimate provides a better statistical result in this area.

In the context of a dynamic simulation of the model as a whole, as reported on in [3] and [9], earlier versions of the tax equations gave generally quite satisfactory results over both the estimation period and the ex post forecast period, although the errors in the latter case were somewhat higher than those recorded during the estimation period for some of the equations, especially the indirect tax relationships. Because some of the preferred equations reported in this paper differ from those used to date in whole-model simulations, detailed simulation results are not discussed here. However, they will be the subject of later Research Papers.

(7) NAIVE PREDICTORS

To help judge the forecasting ability of the preferred econometric equations, the ex post forecasts obtained in the preceding section of the paper can be compared with the predictions obtained from various naive models. The test is admittedly a simple one, but is thought to be nevertheless useful in the absence of any other satisfactory benchmark for comparison. The forecast period being considered is again 1971(1) to 1971(4), the four quarters immediately following the end of the equations' estimation periods. In order to take account of both the absolute value and the variance of the forecast errors in each case, the root mean squared error statistic, in percentage form, is used in table 2, the table of comparative results.

Basically two naive predictors are used:

(a) $Y_t = Y_{t-1}$

(b) $Y_t = Y_{t-1}^2/Y_{t-2}$
where Y_t is the actual value of the dependent variable in period t, Y_{t-1} the value in period t—1, etc.

Model (b) incorporates a rate of change concept, as can be easily demonstrated:[13]

If:

$$(Y - Y_{t-1})/Y_{t-1} = (Y_{t-1} - Y_{t-2})/Y_{t-2}$$

then:

$$(Y_t * Y_{t-2}) - (Y_{t-1} * Y_{t-2}) = Y_{t-1}^2 - (Y_{t-1} * Y_{t-2})$$

or:

$$Y_t * Y_{t-2} = Y_{t-1}^2$$

and thus:

$$Y_t = Y_{t-1}^2/Y_{t-2}$$

Where there is a distinct seasonal pattern:

model (a) is replaced by $Y_t = Y_{t-4}$

model (b) is replaced by $Y_t = Y_{t-4}^2/Y_{t-8}$

If there is some doubt about the impact of seasonal patterns, both types of model are tried. Specific details on a variable by variable basis are provided in the table. Where applicable, empirical relationships are used, such as:

$$TYSD = YS * TSRS$$

It should be noted that the change in the tax rate schedules for individuals between the March years 1970-71 and 1971-72, allied with the tax surcharge on individuals,[14] unfortunately casts doubt on the usefulness of some of the models in the case of personal income tax payments. However, models 1.3 and 2.3 in table 2 avoid this complication, and model 3.2 has also been adjusted to take specific account of the surcharge.

In essence, the naive predictors suggest that for the category of tax payments under consideration, either—

(a) The current quarter's value will be equal to the preceding quarter's value (or the value of the same quarter in the previous year, as appropriate), or

(b) The rate of change in the current quarter's value will be equal to the rate of change in the previous quarter (or in the same quarter of the previous year, as appropriate).

Table 2 shows quite clearly that in every case the econometric approach yields lower forecast errors than those obtained from these particular naive predictors. This is true even where the equation predictions are relatively poor. Although these results obviously have limitations, and say nothing about alternative forecasting procedures, they are at least suggestive of the potential offered by econometric techniques in this area.

(13) A bar signifies division; an asterisk multiplication.

(14) See the Appendix for details.

TABLE 2

COMPARISON OF NAIVE AND ECONOMETRIC PREDICTORS

(Forecast period 1971(1) to 1971(4))

Naive Model	*Naive Model % R.M.S.E.*	*Preferred Equation % R.M.S.E.*
INCOME TAX		
1. *P.A.Y.E. (tax deductions)*		
1.1 $TYSD = TYSD_{-1}$	7.2	1.1
1.2 $TYSD = \frac{TYSD_{-1}^2}{TYSD_{-2}}$	10.4	1.1
1.3 $TYSD = YS * TSRS$	2.8	1.1
2. *P.A.Y.E. (flow to Public Account)*		
2.1 $TYSP = TYSP_{-1}$	11.3	2.0
2.2 $TYSP = \frac{TYSP_{-1}^2}{TYSP_{-2}}$	17.0	2.0
2.3 $TYSP = 2/3\ TYSD + 1/3\ TYSD$	2.7	2.0
3. *Other Persons*		
3.1 $TYOG = TYOG_{-4}$	9.2	3.1
3.2 $TYOG = TYOG_{-4}$ plus adjustment for tax surcharge[1]	7.8	3.1
3.3 $TYOG = \frac{TYOG_{-4}^2}{TYOG_{-8}}$	11.6	3.1
4. *Company*		
4.1 $TYCG = TYCG_{-4}$	15.1	4.8
4.2 $TYCG = \frac{TYCG_{-4}^2}{TYCG_{-8}}$	5.2	4.8
INDIRECT AND OTHER TAX		
5. *Sales Tax*		
5.1 $TISN = TISN_{-1}$	66.3	15.4
5.2 $TISN = TISN_{-4}$	19.4	15.4
5.3 $TISN = \frac{TISN_{-4}^2}{TISN_{-8}}$	17.5	15.4
6. *Automotive Sales Tax*		
6.1 $TISA = TISA_{-1}$	15.3	8.7
6.2 $TISA = \frac{TISA_{-1}^2}{TISA_{-2}}$	17.3	8.7

(1) See Appendix for details of tax surcharge.

TABLE 2 (continued)

COMPARISON OF NAIVE AND ECONOMETRIC PREDICTORS

(Forecast period 1971(1) to 1971(4))

Naive Model	*Naive Model % R.M.S.E.*	*Preferred Equation % R.M.S.E.*
7. *Beer Duty*		
7.1 $TIB = TIB_{-1}$	31.2	12.4
7.2 $TIB = TIB_{-4}$	16.1	12.4
7.3 $TIB = \frac{TIB_{-4}^2}{TIB_{-8}}$	20.6	12.4
7.4 $TIB = 0.6 * QB$	16.6	12.4
(basic duty on beer is $0.60 per gallon)		
8. *Estate Duty*		
8.1 $TIE = TIE_{-1}$	20.9	17.8
8.2 $TIE = \frac{TIE_{-1}^2}{TIE_{-2}}$	32.1	17.8
9. *Customs Duty*		
9.1 $TIC = TIC_{-1}$	12.1	5.6
9.2 $TIC = \frac{TIC_{-1}^2}{TIC_{-2}}$	19.2	5.6
9.3 $TIC = TIC_{-4}$	15.3	5.6
9.4 $TIC = \frac{TIC_{-4}^2}{TIC_{-8}}$	9.7	5.6
10. *Highways Tax*		
10.1 $TIH = TIH_{-4}$	8.7	7.9
10.2 $TIH = \frac{TIH_{-4}^2}{TIH_{-8}}$	14.8	7.9
11. *Total Indirect Tax*		
11.1 $TIA = TIA_{-1}$	19.2	3.9
11.2 $TIA = \frac{TIA_{-1}^2}{TIA_{-2}}$	25.2	3.9
11.3 $TIA = TIA_{-4}$	12.0	3.9
11.4 $TIA = \frac{TIA_{-4}^2}{TIA_{-8}}$	9.3	3.9

(8) STRUCTURAL STABILITY

To assist further with the assessment of the preferred equations, this section of the paper provides a table, table 3, which sets out in some detail the range of test statistics applicable to the preferred equations for both—

(a) The normal estimation periods used in the results section; and

(b) This period plus four additional quarters to illustrate the effect of updating the equations to *include* the ex post forecast quarters in the estimation period.

Apart from the normal range of tests already mentioned at the start of the paper, and employed throughout the results section—such as $\bar{R}^2$, S.E.E., % S.E.E., D.W. and D—several new statistical measures are introduced here:[15] an index of multicollinearity, M.C., a sign reversal test for fourth order autocorrelation, S.R., and a Chow test statistic, C, to facilitate assessment of the structural stability of the equations. The nature of these measures can be summarized as follows:

(a) Multicollinearity

An index of multicollinearity is derived from the formula:

$$M.C. = -\ (n - \tfrac{1}{3}b - {}^{11}\!/_{6})\ \log |X'X|$$

where n is the number of observations.

b the number of regression degrees of freedom.

X is the matrix of correlation coefficients for the explanatory variables.

This index is distributed approximately as a Chi-square distribution with $\tfrac{1}{2}b\ (b - 1)$ degrees of freedom. Further details are provided by Farrar and Glauber [11] (and see also Bartlett [1]).

(b) Fourth-order autocorrelation

Although the usual Durbin-Watson statistic is used to test for first order autocorrelation, there is some likelihood that fourth-order autocorrelation may be present when quarterly data are employed, i.e. there may be a relationship between the residuals of corresponding quarters in successive years, apart from any relationship over successive quarters. The "sign reversal test" (S.R.) used in table 3 is the approximate Chi-square test for the presence of fourth-order autocorrelation suggested by Thomas and Wallis [20]. This test is distributed approximately as a Chi-square distribution with one degree of freedom.

(c) Structural stability

The Chow test statistic [2] used here is derived from the formula:

$$C = [(A - B)/m]/[B(n - p)]$$

where p is the number of parameters in the equation to be tested, including the constant.

n is the number of observations.

m is the number of additional observations where $m \leqslant p$.

A is the sum of the squares of the residuals from a regression over the $(n + m)$ observations.

B is the sum of the squares of the residuals from a regression over the n observations.

This statistic takes an F-distribution with $(m, n - p)$ degrees of freedom. The null hypothesis is that the additional m data are generated by the same model as the original n observations. In essence, the C statistic can be used to provide some indication of the structural stability of the equation on updating to cover additional quarters. However, some care is necessary in interpreting individual results for, as pointed out by Giles [13], "The fact that the relationship is judged unstable by this test does not preclude the possibility that the statistical features of the equation may improve. It may be that the equation *is* in fact correctly specified, and that the new sample of observations simply strengthens the case for retaining the formulation." In other words, the full range of usual tests should be applied in addition to the Chow test to assist interpretation of the latter.

The eleven Chow tests performed are set out in table 3. A sufficiently large value of C leads to the rejection, at a prespecified significance level, of the null hypothesis mentioned above. A double asterisk denotes rejection at the 1 percent level; a single asterisk at the 5 percent level. Otherwise the hypothesis is accepted.

It is interesting to note that of the 12 out of 51 equations discussed by Giles [13] in analysing the structural stability of all the equations in the Reserve Bank's latest model, 6 were tax relationships. These warrant some specific comments:

(i) Despite a significant C value for the company tax (TYCG) equation, all but one of the individual regression coefficients improve in significance for the longer time period and other changes are only minor.

(ii) The other equation with a relatively high C value, that for beer duty (TIB), shows a marked deterioration in fit over the extended period and the lagged dependent variable loses statistical significance. The Chow test indicates the need for re-examination of this equation on updating.

(15) Although specific acknowledgements of the sources of these test statistics are noted below, we are grateful to D. E. A. Giles for initiating their use in the Bank's Database programs and for advising on aspects of interpretation. The relevant computer programming was carried out by A. B. Sturm and Miss M. G. Griffin. Similar tests applied to another area of the model, the consumption sector, are illustrated in [5] and [12].

TABLE 3
SUMMARISED TEST STATISTICS FOR PREFERRED TAX EQUATIONS

Dependent Variable	Equation Number	Time Period	Statistical Tests Results								Chow Test			
			$\bar{R}^2$	S.E.E.	% S.E.E.	M.C.	D.W.	S.R.	D.	% R.M.S.E.(3)	n	m	p	C(4)
Log TYSD	7	1960(2) - 1970(4)	0.989	0.036	0.880	4.533	2.217	0.222	—(2)	1.1	43	4	4	0.075
		1960(2) - 1971(4)	0.993	0.035	0.826	4.808	1.295	0.220	—					
TYSP	9	1960(2) - 1970(4)	0.996	1.372	2.117	30.517	3.016	1.249	—	2.0	43	4	5	3.588*
		1960(2) - 1971(4)	0.998	1.532	2.103	34.458	2.799	0.206	—					
TYOG	18	1965(1) - 1970(4)	0.997	2.488	5.385	n.a.(1)	2.101	n.a.	—	3.1	24	4	5	0.776
		1965(1) - 1971(4)	0.997	2.439	5.107	n.a.	2.193	n.a.	—					
TYCG	19	1960(2) - 1970(4)	0.999	1.964	4.426	21.696	2.447	0.626	—	4.8	43	4	5	7.780**
		1960(2) - 1971(4)	0.999	2.520	5.368	24.289	2.340	0.467	—					
TISN	21	1963(2) - 1970(4)	0.919	1.174	11.463	3.742	2.486	3.240	—	15.4	31	4	4	3.577*
		1963(2) - 1971(4)	0.920	1.355	12.527	3.800	2.333	0.111	—					
TISA	23	1963(3) - 1970(4)	0.934	0.729	6.953	57.579	1.885	3.846	0.433	8.7	30	4	6	3.430*
		1963(3) - 1971(4)	0.957	0.846	7.348	77.634	1.671	1.833	0.662					
TIB	25	1960(2) - 1970(4)	0.928	0.352	4.232	25.948	1.802	0.039	0.697	12.4	43	4	5	13.439**
		1960(2) - 1971(4)	0.885	0.520	6.125	28.143	2.264	0.034	—1.043					
TIE	29	1961(3) - 1970(4)	0.671	0.501	9.168	23.919	2.482	1.074	—2.068	17.8	38	4	5	3.190*
		1961(3) - 1971(4)	0.603	0.557	10.100	32.482	2.098	2.922	—0.471					
TIC	30	1960(1) - 1970(4)	0.874	1.755	7.516	76.616	2.319	6.352	—1.798	5.6	44	4	6	0.794
		1960(1) - 1971(4)	0.928	1.739	7.063	102.142	2.488	1.455	—2.405					
TIH	32	1960(2) - 1970(4)	0.897	1.319	8.599	84.555	2.206	0.649	—	7.9	43	4	6	1.455
		1960(2) - 1971(4)	0.907	1.348	8.477	100.272	2.144	0.183	—					
TIA	33	1961(3) - 1970(4)	0.954	3.790	4.613	64.358	1.758	0.424	0.891	3.9	38	4	5	1.334
		1961(3) - 1971(4)	0.968	3.858	4.476	85.764	1.965	0.095	0.137					

Note: (1) n.a. not available.
(2) — not applicable.
(3) % R.M.S.E. for four ex post forecast quarters 1971(1) to 1971(4).
(4) * C significant at 5 percent level.
** C significant at 1 percent level.

(iii) Of the remaining 4 relationships which recorded C values which were significant, all at the 5 percent level, none appear to call for a change in the underlying models. The significance attributed to the C value seems to be related to a variety of factors within the preferred equations, such as variations in individual coefficients, their significance, and overall fit. Movements in the latter can be assessed from table 3.

(iv) Although the Chow test suggests stable relationships for customs duty (TIC) and total indirect tax (TIA), it should be observed that the coefficients of the lagged dependent variables in these equations change from 0.50 and 0.11 to 0.58 and 0.17 respectively on updating. Again, however, no change in the model seems called for.

(9) CONCLUSION

The tax relationships outlined in this paper appear to provide a reasonable forecasting framework for the bulk of government's current revenue. This is the case in spite of the need to employ proxy variables in the role of tax bases in quite a number of the equations. Although the reasons why tax rate indexes cannot be built into some of the indirect tax relationships are clear enough, this problem in principle probably renders these equations rather less useful than those relating to income tax in so far as policy analysis is concerned. In fact, it seems likely that an aggregate non-income tax equation would give just as satisfactory forecasting results as the combined outcome from the series of disaggregated indirect and other tax estimates. On the other hand, the income tax equations and in particular those involving statutory tax rate variables, may well provide the basis for some interesting simulation exercises within the framework of the quarterly model as a whole. In particular, it will be possible to examine the hypothetical impact of changes in both the official schedules of tax rates and the pattern of income distribution on the flows of tax and hence also on expenditures, holdings of financial assets and so on. Such experiments will, hopefully, be the subject of a later paper.

In the future, consideration will also need to be given to the posibility of incorporating the pattern of income distribution in an endogenous manner, so that only the schedule of personal income tax rates will remain exogenous within the statutory tax rate variables. At present, of course, in handling these latter variables in a forecasting situation it is necessary to make exogenous assumptions about the relationship between the level of income and the pattern of its distribution (although an iterative process can ensure a reasonable degree of consistency between the respective endogenous and exogenous elements).

The basic aim of the work on the government sector, of which this paper is just one part, is to provide a comprehensive series of quarterly data on the government's accounts, including both current and capital transactions, allied with econometric explanations of the flows of tax revenue and borrowed funds from the private sector to government. In time, it may also be possible to treat some components of government expenditure as endogenous to the model. The work has now progressed to the stage where the current revenue/expenditure data are in satisfactory form [14], the capital or financing transactions series are complete [7], while the tax revenue is explained in the present study. Satisfactory progress has also been made on the government security equations (e.g. as in [9]). The government sector has now been adequately integrated within the model as a whole and, in particular, the linkages between this sector and the financial system are now much improved over the position which prevailed prior to the range of new data becoming available. Simulation research is well under way, involving examination of the properties of the model, accompanied by the generation of regular forecasts and policy analysis exercises.

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APPENDIX

A. Basic tax rates for individuals in effect between 1 April 1960 and 31 March 1969.*

Taxable Balances Between $ $	*Tax Percent*
1 to 1,000	22.50
1,000 to 1,200	25.00
1,200 to 1,400	27.50
1,400 to 1,600	30.00
1,600 to 1,800	32.50
1,800 to 2,000	33.75
2,000 to 2,200	35.00
2,200 to 2,400	36.25
2,400 to 2,600	37.50
2,600 to 2,800	38.75
2,800 to 3,000	40.00
3,000 to 3,200	41.25
3,200 to 3,400	42.50
3,400 to 3,600	43.75
3,600 to 3,800	45.00
3,800 to 4,000	46.25
4,000 to 4,200	47.50
4,200 to 4,400	48.75
4,400 to 4,600	50.00
4,600 to 4,800	51.25
4,800 to 5,000	52.50
5,000 to 5,200	53.75
5,200 to 5,400	55.00
5,400 to 5,600	56.25
5,600 to 5,800	57.50
5,800 to 6,000	58.75
6,000 to 6,200	60.00
6,200 to 6,400	61.25
6,400 to 6,600	62.50
6,600 to 6,800	63.75
6,800 to 7,000	65.00
7,000 to 7,200	66.25
7,200 and over	67.50

* From 1 April 1969 social security tax was merged with ordinary income tax (see Land and Income Tax Act). For consistency social security tax and ordinary income tax were combined in the above table.

B. Basic tax rates for individuals, in effect between 1 April 1969 and 31 March 1971.

Taxable Balances Between $ $	*Tax Percent*
1 to 650	7.85
650 to 1,700	21.00
1,700 to 2,000	24.50
2,000 to 2,500	27.50
2,500 to 3,000	33.00
3,000 to 3,500	34.00
3,500 to 4,000	37.00
4,000 to 4,500	40.00
4,500 to 5,000	43.00
5,000 to 5,500	45.00
5,500 to 6,000	49.00
6,000 to 6,500	50.00
6,500 to 7,000	54.00
7,000 to 7,500	60.00
7,500 to 8,000	65.00
8,000 to 10,000	66.00
10,000 to 12,000	67.00
12,000 and over	67.50

C. Basic tax rates for individuals, in effect from 1 April 1971.

Taxable Balances Between $ $	*Tax Percent*
1 to 650	7.85
650 to 1,700	21.00
1,700 to 2,000	24.50
2,000 to 2,500	27.50
2,500 to 3,000	30.50
3,000 to 3,500	34.50
3,500 to 4,000	37.00
4,000 to 4,500	39.00
4,500 to 5,000	41.00
5,000 to 5,500	43.00
5,500 to 6,000	45.00
6,000 to 7,000	46.00
7,000 to 8,000	47.00
8,000 to 10,000	48.00
10,000 to 12,000	49.00
12,000 and over	50.00

D. Company tax rates.

The following notes summarize *major* aspects of company tax over the past decade. Full details are available elsewhere, such as in Staples [19].

(1) *Resident Companies*

For the March income years 1962 to 1971 (inclusive) resident company tax rates were as follows: where the taxable income did not exceed $7,200 the basic rate was 20 cents increased by 1/48,000 of a dollar for every dollar of taxable income. On so much of the taxable income as exceeded $7,200, income tax was $2,520 on the first $7,200 and 50 cents per dollar on the excess over $7,200. For the March years 1958 to 1961 (inclusive) resident company tax rates for income between $7,200 and $15,300 varied a little from the preceding rates.

For income derived after 31 March 1971 resident company tax rates have been as follows: where the taxable income does not exceed $6,250 the basic rate is 20 cents in the dollar increased by 0.002 cents in the dollar for every dollar of taxable income. Income in excess of $6,250 attracts a tax rate of 45 cents in the dollar.

(2) *Non-resident Companies*

The basic non-resident company tax rate is the same as that for resident companies except that from the March income year 1964 onwards, non-resident companies have paid an additional 5 cents in the dollar.

Note:

(i) The above company tax rates up to the March 1969 income year are composite ones, i.e. social security tax is combined with income tax. From 1 April 1969, social security tax has been officially merged with income tax.

(ii) The recent tax changes were announced in December 1971 and consequently some adjustments would have been involved, e.g. with respect to timing of payments provisional company taxpayers would have paid their September 1971 instalment at the old rates and hence an adjustment would have been made to the March 1972 instalment.

(iii) The Company tax cuts announced in December 1971 provided instant tax relief for the provisional company taxpayers but not for the subsisting company taxpayers. To rectify this, subsisting company taxpayers were allowed to postpone 10 percent of their March 1972 instalments until September 1972.

E. Tax exemptions and tax rebates for individuals.

The following notes summarize some of the more important changes since 1960 to date in tax exemptions and tax rebates for individuals in New Zealand. Although these notes include reference to major changes which were incorporated in the statutory tax rate variables constructed for and used in this Research Paper—those for salary and wage earners, TSRS, and other persons, TSRO—it is not claimed that the notes provide a full coverage of significant changes. Full details of this type are available in Staples [19].

Effective Date

from 1-4-60 The exemption for life insurance premiums and superannuation contributions was increased from $350 to $500, or 20 percent of assessable income, whichever is the lesser. Other exemptions at this date were:

Personal exemption	—	$936
Wife	—	$312
Housekeeper	—	$312
Child	—	$156

from 1-4-61 The interest exemption was raised from $24 to $60.

from 1-4-62 Ordinary income tax was reduced by 5 percent subject to a maximum of $100 for any one taxpayer. The exemption of $208 of income from social security tax (applicable to people on low incomes previously) was extended to all individuals. Charitable donations and private school fees up to $50 were made deductible.

from 1-4-63 The 5 percent rebate on individual income tax was increased to 10 percent from 1-10-63, with a maximum reduction of $200. For the whole of the 1963/64 financial year this represented a rebate of 7½ percent with a maximum of $150.

An additional $50 became deductible for private school fees.

from 1-4-64 The 10 percent rebate on income tax introduced on 1-10-63 was continued. The maximum rebate was $200. The exemption for life insurance premiums and superannuation contributions paid by the self-employed was raised by $150 to $650.

from 1-4-65 Housekeeper exemption was extended. The 10 percent rebate on ordinary income tax with a maximum of $200 was continued.

from 1-4-66 The 10 percent rebate and $200 maximum was continued. Subscriptions, fees and levies paid by a salary or wage-earner which relate directly to his employment were made deductible. These included trade union fees and subscriptions to professional bodies, up to a limit of $20 per year.

Premiums on life policies on the lives of a taxpayer's wife and children could be claimed as deductions. A special exemption of $156 was allowed to separated and divorced persons with dependent children who were not entitled to claim the housekeeper exemption.

from 1-4-67 The 10 percent rebate and $200 maximum was continued.

from 1-4-68 Salary and wage earners were permitted to deduct certain items of expenditure related directly to their trade or occupation from their assessable income.
The 10 percent rebate with a maximum of $200 was continued.

from 1-4-69 The government introduced a new tax rate and exemption structure for individuals operating from 1-4-69. The broad effects of the new rate and exemption structure were:

(a) The merging of the ordinary and social security taxes into one composite tax.

(b) The adoption of lower special exemptions applying to the composite tax which were:

Personal exemption	$275
Wife exemption	$240
Child exemption for each of the first four children	$135
For each child after the fourth	$140

The exemption from having to pay provisional tax was increased from $100 to $200.

The $60 personal exemption of interest and investment society dividends was increased to $100.

For married couples when both were earning income, a special exemption of up to $240 a year was allowed for the income of a wife in cases where a housekeeper was employed to care for the married couple's dependent children while the wife was at work. The exemption also applied with respect to fees paid to day nurseries.

Up to the March 1969 financial year company dividends in the hands of individuals were treated for taxation purposes as ordinary income with a proviso that the maximum overall rate of tax was limited to 35 cents in the dollar (note that no social security tax was paid on company dividends). From 1-4-69 company dividends were still treated for taxation purposes as ordinary income however a rebate was introduced to ensure that the maximum tax payable on dividend income did not exceed 32.5 cents in the dollar.

from 1-4-70 Wife and housekeeper exemptions were increased to $275.
For taxpayers who were members of subsidised superannuation funds the insurance/superannuation exemption was increased from $500 to $700; for taxpayers who were not members of such funds the exemption was increased from $650 to $950.

from 1-12-70 During the last four months of the March 1971 financial year a 10 percent income tax surcharge was imposed on salary and wage earners, terminal tax payments were adjusted so that for the 1970/71 year there was an effective surcharge of 3⅓ percent. The surcharge of 3⅓ percent for the 1970/71 year applied to all individuals.

from 1-4-71 For the first four months of the March 1972 financial year a 10 percent income tax surcharge was imposed on salary and wage earners, terminal tax payments were adjusted so that for the 1971/72 year there was an effective surcharge of 3⅓ percent. The surcharge of 3⅓ percent for the 1971/1972 year applied to all individuals.
The rebate on taxable dividends in force up to 31 March 1971 was abolished and replaced with a rebate of 10 percent of taxable dividends with a ceiling of $200 at a taxable income of $2,000. The maximum rebate was reduced by $1 for every $10 by which taxable income exceeded $2,000 so that it would disappear when the taxable income was in excess of $4,000.

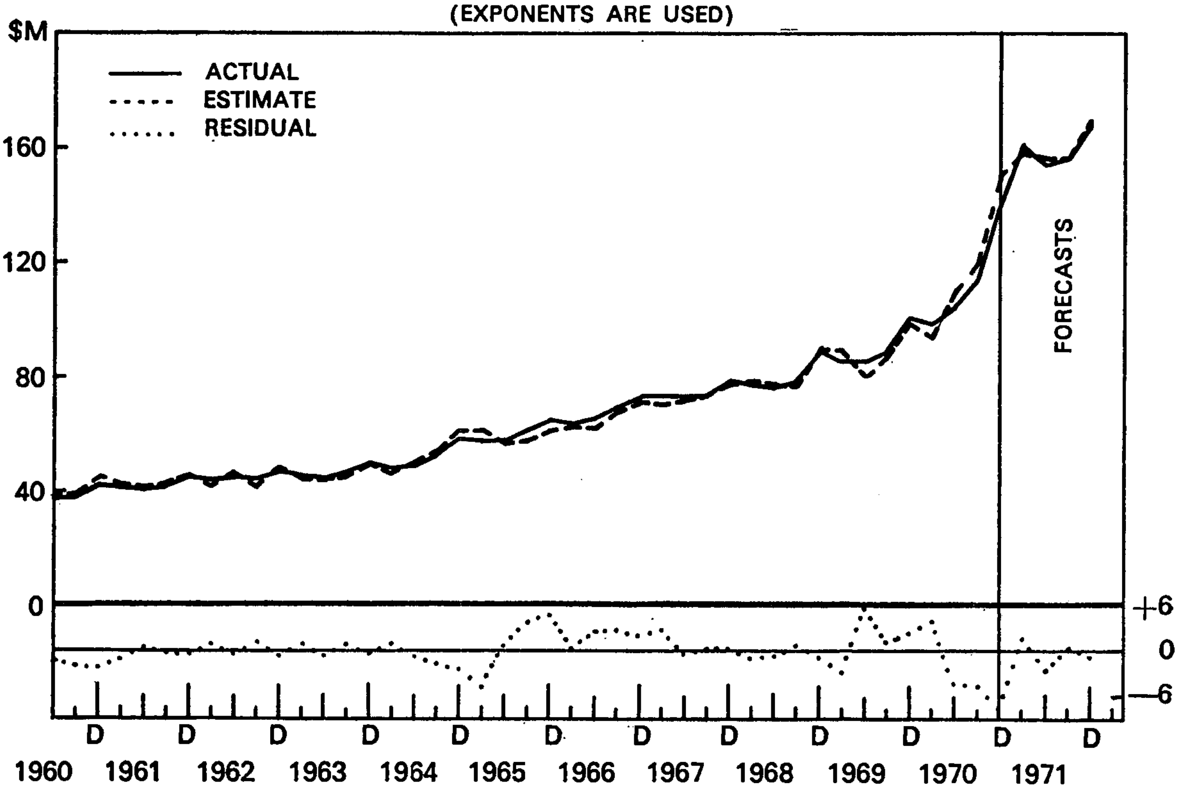
from 1-4-72 The dividend rebate was extended. The rebate was 10 percent of taxable dividends with a ceiling of $400 at a taxable income of $4,000. The maximum rebate was reduced by $1 for every $10 by which taxable income exceeded $4,000 so that it would disappear when the taxable income was in excess of $8,000.

from 1-7-72 Salary and wage earners received a 10 percent tax rebate, equivalent to 7½ percent for the year ended March 1973. Other taxpayers also received a 7½ percent rebate for the same year.

GRAPH 1: PAYE INCOME TAX(DEDUCTIONS FROM PAY)

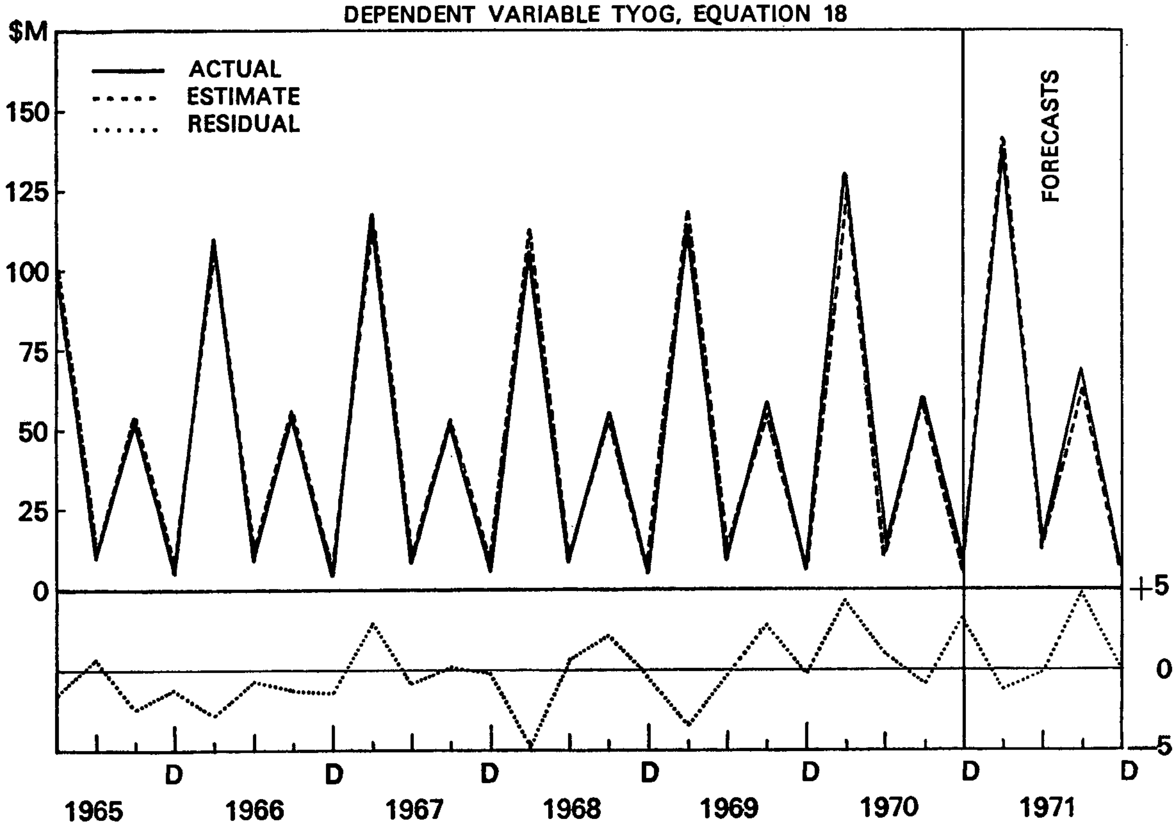
DEPENDENT VARIABLE TYSD, EQUATION 7

(EXPONENTS ARE USED)



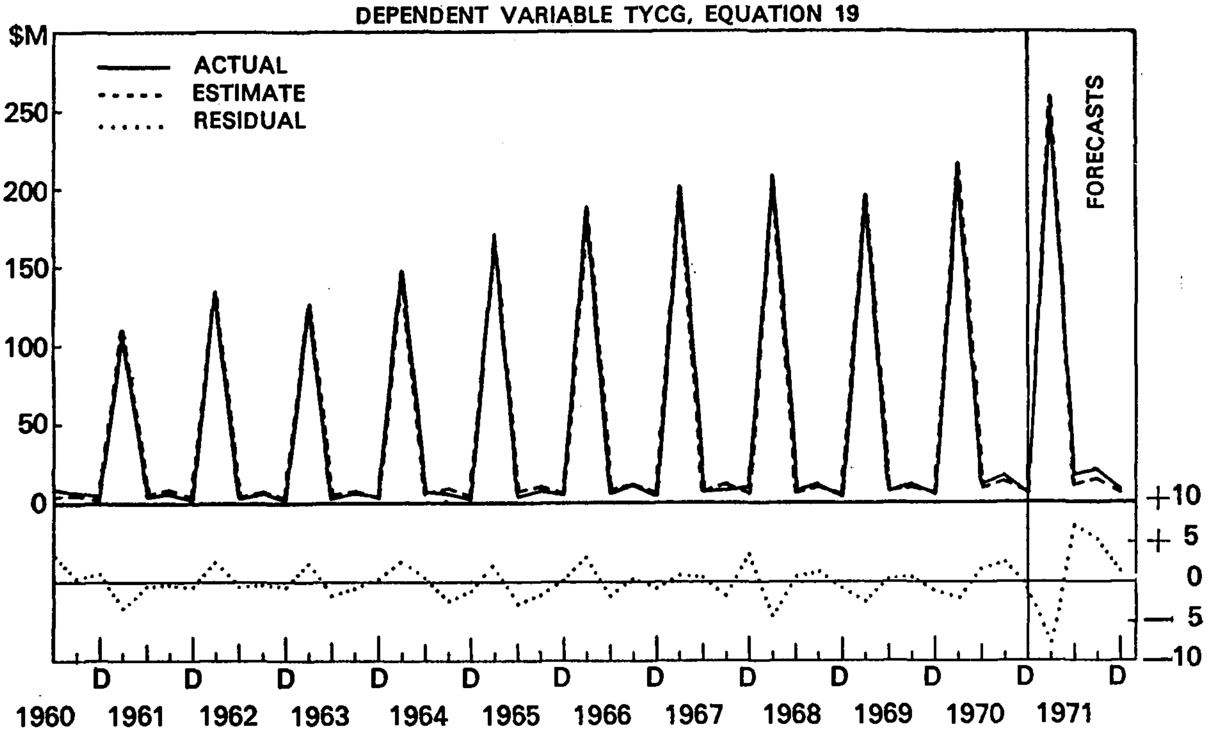
GRAPH 2: OTHER PERSONS' INCOME TAX

DEPENDENT VARIABLE TYOG, EQUATION 18



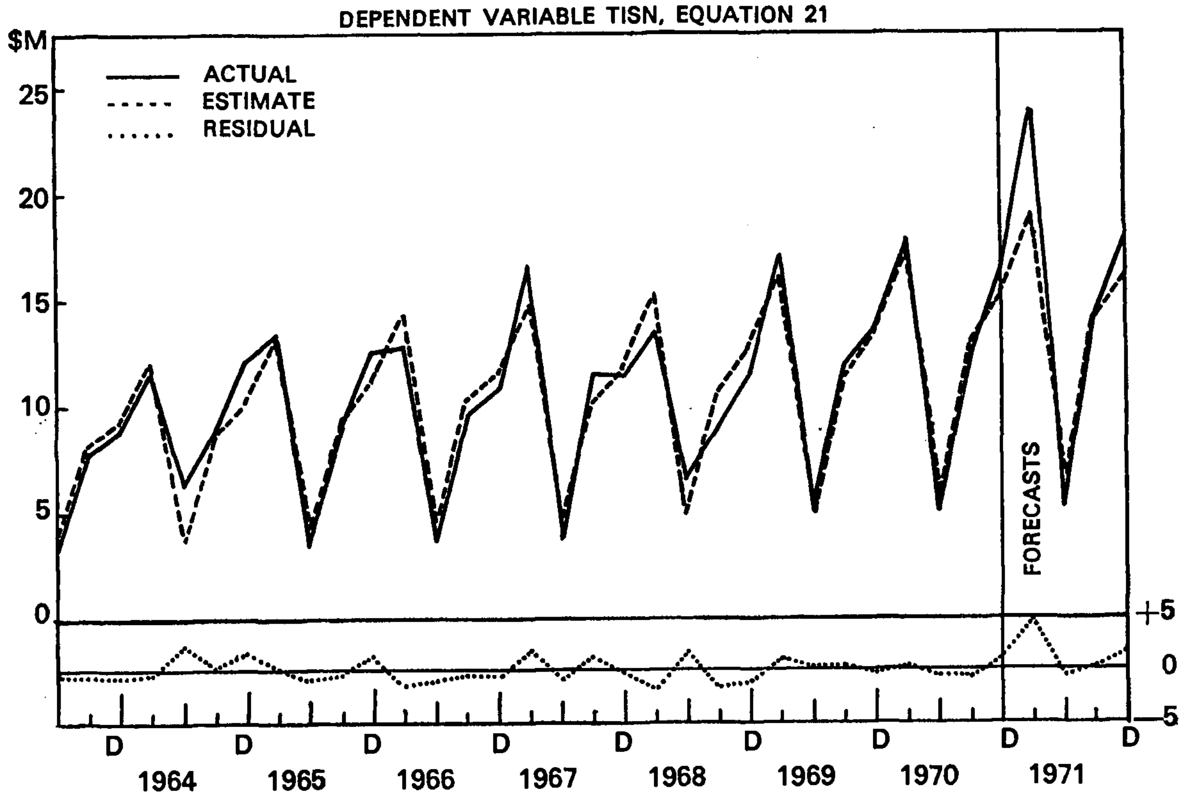
GRAPH 3: COMPANY INCOME TAX

DEPENDENT VARIABLE TYCG, EQUATION 19



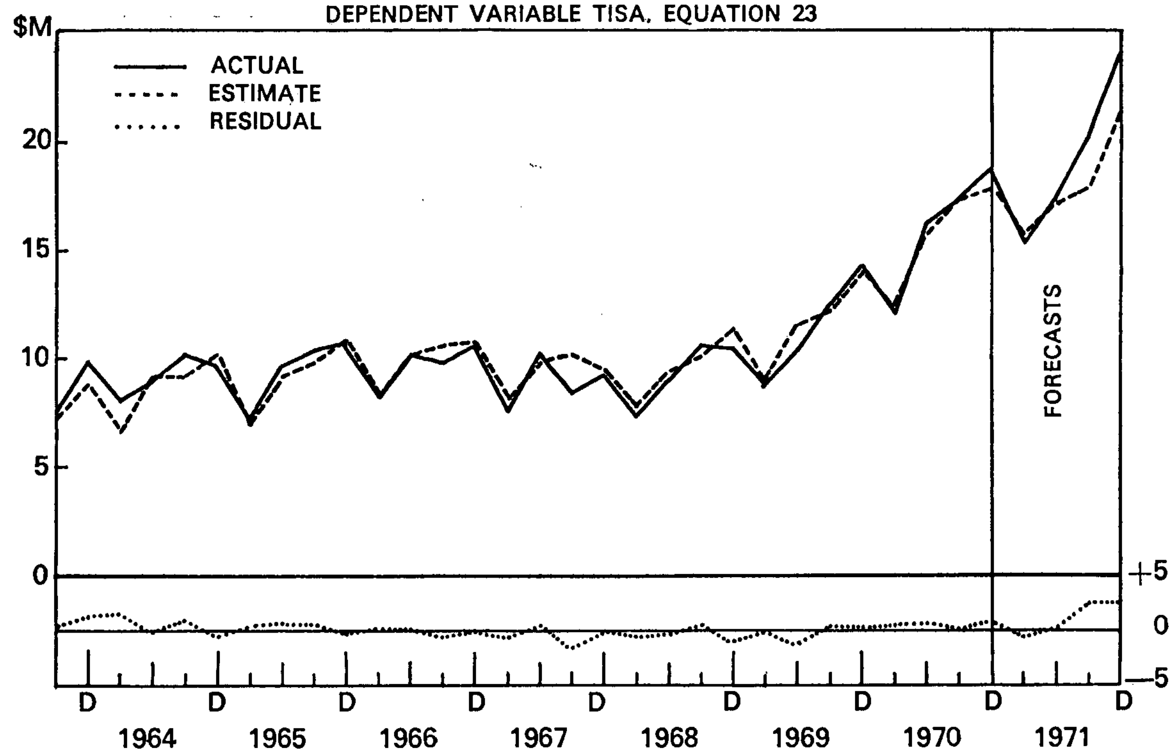
GRAPH 4: SALES TAX (OTHER THAN AUTOMOTIVE)

DEPENDENT VARIABLE TISN, EQUATION 21



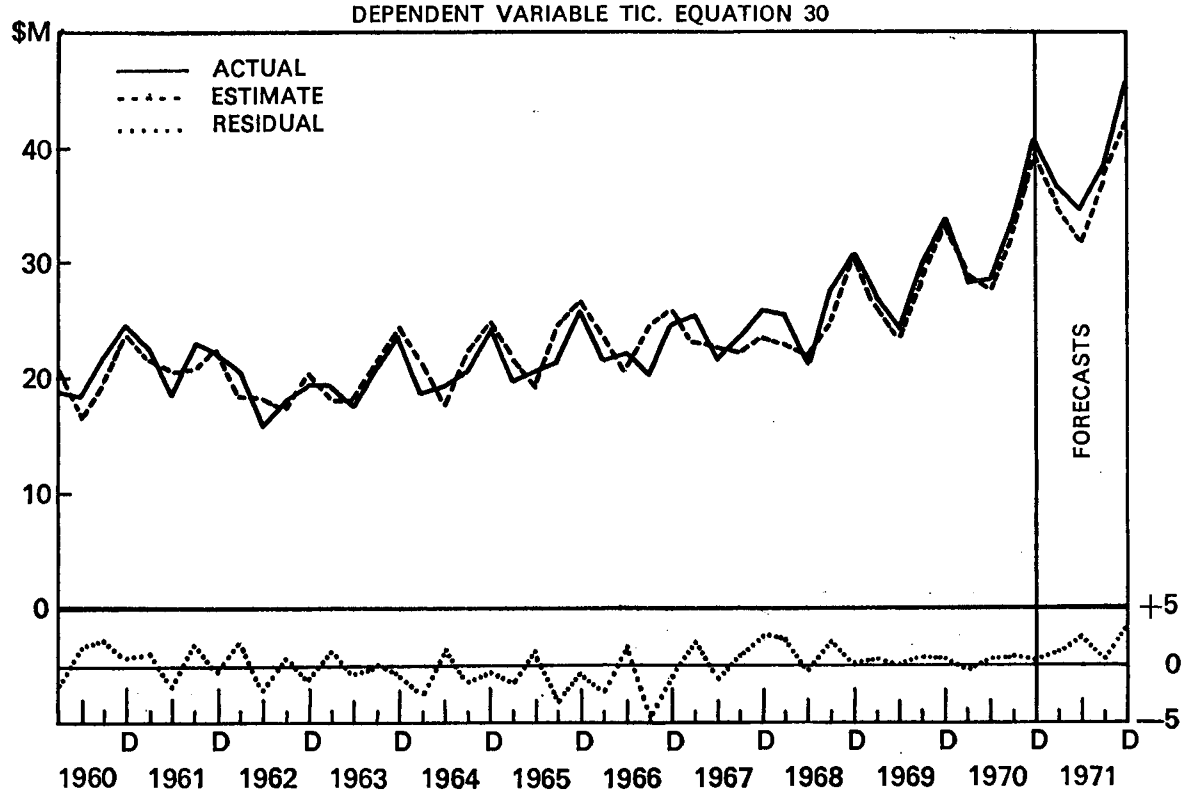
GRAPH 5: AUTOMOTIVE SALES TAX

DEPENDENT VARIABLE TISA. EQUATION 23



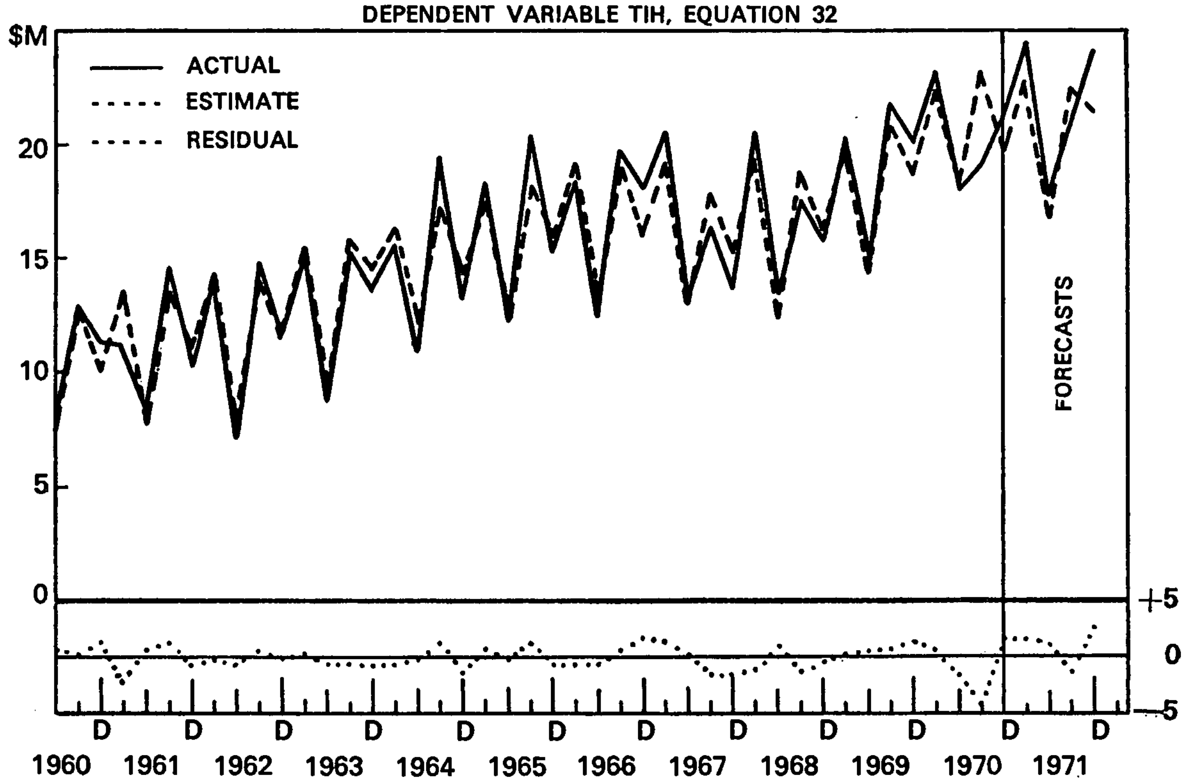
GRAPH 6: CUSTOMS DUTY

DEPENDENT VARIABLE TIC. EQUATION 30



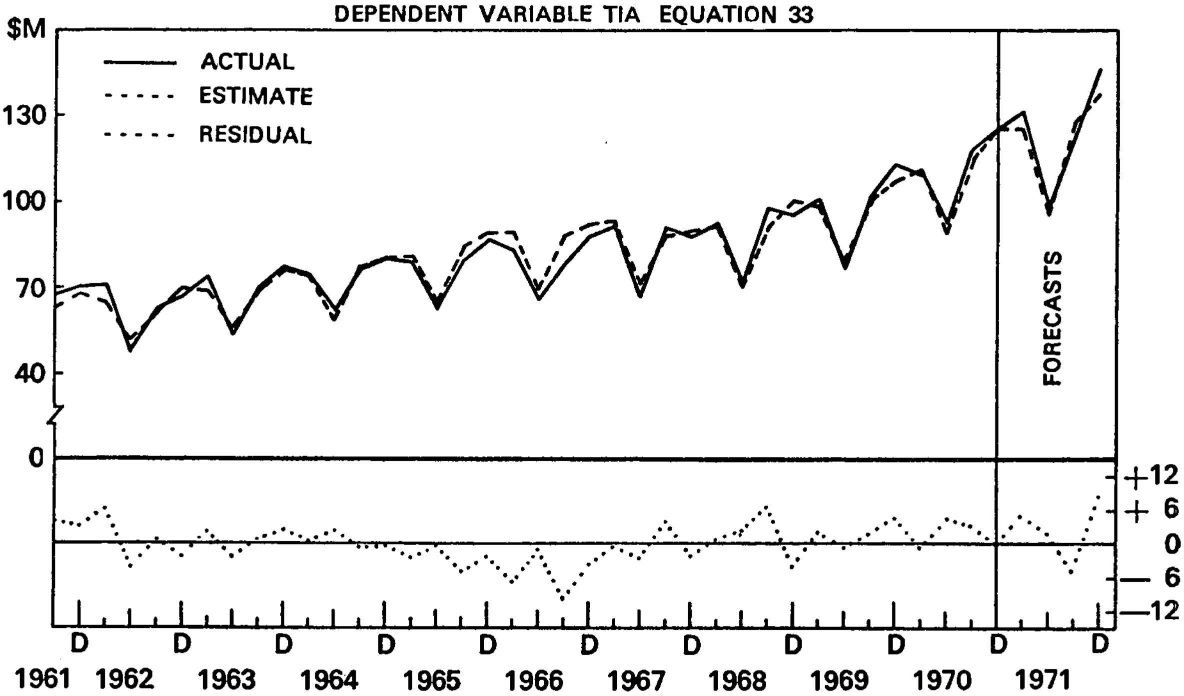
GRAPH 7: HIGHWAYS TAX

DEPENDENT VARIABLE TIH, EQUATION 32



GRAPH 8: TOTAL INDIRECT AND OTHER TAX

DEPENDENT VARIABLE TIA EQUATION 33



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