The Built-in Flexibility of Income and Consumption Taxes in New Zealand

John Creedy and Norman Gemmell

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AUTHOR/S

John Creedy
New Zealand Treasury
1 The Terrace
Wellington
NZ]

Email John.creedy@treasury.govt.nz

Telephone 61-4-471-5009

Fax 61-4-473-1151

Norman Gemmell
University of Nottingham
Univeristy Park
Nottingham
UK

Email Norman.Gemmell@nottingham.ac.uk

Telephone

Fax

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NZ TREASURY

New Zealand Treasury
PO Box 3724
Wellington 6008
NEW ZEALAND

Email information@treasury.govt.nz

Telephone 64-4-472 2733

Website www.treasury.govt.nz

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Abstract

This paper provides estimates of individual and aggregate revenue elasticities of income and consumption taxes in New Zealand, based on the 2001 tax structure and expenditure patterns. Using analytical expressions for revenue elasticities at the individual and aggregate levels, together with a simulated income distribution, values for New Zealand were obtained. Results using equi-proportional income changes suggest that the aggregate income and consumption tax revenue elasticities are both fairly constant as mean income increases, at around 1.3 and 0.95 respectively. This latter estimate assumes that increases in disposable income are accompanied by approximately proportional increases in total expenditure. If there is a tendency for the savings proportion to increase as disposable income increases, a somewhat lower total consumption tax revenue elasticity, of around 0.9, is obtained for 2001 income levels. However, non-equiproportional income changes are more realistic. Allowing for regression towards the geometric mean income reduces these elasticities, giving an elasticity for income and consumption taxes combined that is only slightly above unity. Examination of the tax-share weighted expenditure elasticities for various goods also revealed that, despite the adoption of a broad based GST at a uniform rate in New Zealand, the persistence of various excises has an important effect on the overall consumption tax revenue elasticity, especially for individuals at relatively low income levels.

JEL CLASSIFICATION H60
H71

KEYWORDS Tax Revenue; Elasticity; Budget Shares

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The Built-in Flexibility of Income and Consumption Taxes in New Zealand

1 Introduction

This paper provides estimates of the built-in flexibility, or revenue elasticity, of income and consumption taxes (GST and excise taxes) in New Zealand. It is important for the design of tax policy to be able to measure reliably the income elasticity of tax revenues both for a tax system and its component taxes. For example, given some revenue target, the need for discretionary changes tax rates and thresholds depends on the expected automatic revenue growth generated by the system's built-in flexibility. The extent to which the aggregate effective tax rate changes when total income changes depends on a range of factors, including consumption patterns and the distribution of individual relative income changes associated with the aggregate change. Furthermore, elasticity and progressivity are closely related, so that tax changes designed to affect progressivity may have unforeseen consequences for elasticity, and vice versa.

Elasticity values at individual and aggregate levels are reported. These are obtained using convenient analytical expressions which have the advantage that they can be evaluated readily from relatively little information about the tax structure, income distribution and budget shares. Furthermore, the main factors affecting the size of the elasticities can be identified, using meaningful and easily interpreted decompositions of the revenue elasticities.[1]

Detailed official forecasts of tax revenues in New Zealand are of course frequently made, though for various reasons these do not always involve the explicit calculation of revenue elasticities. Few independent estimates for New Zealand appear to have been published; however, various elasticities are given by van den Noord (2000) for OECD countries.

This neglect may reflect the perception that, in the presence of lower rates of inflation in recent years, a flattening of the income tax structure, and a broad based consumption tax, fiscal drag is no longer significant. However, as the analysis below shows, the issue is more complex than this simple view would suggest. It is also useful to identify the various influences on the size of New Zealand tax revenue elasticities.

[1] The approach, involving explicit modelling of the tax structure, contrasts with the use of regression analyses, of time series data on tax revenues and income, which are sometimes used to produce aggregate elasticities. Some comparisons of aggregate income tax revenue elasticities based both on regressions and on tax-share weighted individual values are given in Giorno *et al.* (1995), although they do not include New Zealand.

Section 2 sets out the relevant conceptual expressions for income and consumption tax revenue elasticities at the individual level; subsection 2 provides some estimates based on the 2001 tax structure. Section 3 defines aggregate revenue elasticity expressions, with empirical estimates in subsection 2. These estimates use the standard assumption that all incomes increase by the same proportion from year to year. Subsection 3 models the more realistic case of non-equiproportional income changes, and allows for a simple process of regression towards the geometric mean income.

In producing aggregate values directly from individual values, the question arises of the level of disaggregation to be used, particularly regarding the budget shares. The estimates reported here are based on an overall distribution of taxable income and use published budget shares for all households combined, rather than considering different household types separately; however, the methods could be applied to more disagreggated data. Section 4 draws some conclusions.

2 Individual revenue elasticities

This section examines tax revenue elasticities for individuals. The variation in individual elasticities with income provides a useful independent indication of the local progressivity of the tax structure, and of course the individual elasticities provide the basic components on which aggregate values are based. The appropriate formulae are given in subsection 1, and empirical estimates for the 2001 tax structure in New Zealand are reported in subsection 2.

2.1 Elasticity formulae

Suppose T_{y_i} denotes the income tax paid by individual i with a nominal income of y_i. Changes in nominal income with respect to nominal tax allowances affect built-in flexibility.[2] The revenue elasticity of the income tax with respect to a change in individual income, η_{T_y,y_i}, is defined as:

$$\eta_{T_y,y_i} = \frac{dT(y_i)/dy_i}{T(y_i)/y_i} = \frac{mtr_i}{atr_i} \tag{1}$$

where mtr_i is the marginal tax rate and atr_i is the average tax rate faced by i. Here, the first subscript of the revenue elasticity, η, refers to the type of tax revenue considered (so that in the present case of the individual elasticity, the i subscript is dropped for convenience) and the second subscript refers to the income (or tax base) that is considered to change. In a progressive tax structure, $mtr_i > atr_i$ for all i, so that $\eta_{T_y,y_i} > 1$. This elasticity is also a local measure of progressivity: it is the concept of liability progression defined by Musgrave and Thin (1948).

Consider an individual with gross income of y_i and facing a multi-step income tax function, such that if $0 < y_i \le a_1$, the tax paid is $T_{y_i} = t_0 y_i$; if $a_1 < y_i \le a_2$, tax paid is $T_{y_i} = t_0 a_1 + t_1 (y_i - a_1)$; if $a_2 < y_i \le a_3$, tax paid is

[2] The exception is where the tax function is homogeneous of degree one in income and allowances, and both are indexed similarly.

$T_{y_i} = t_0 a_1 + t_1 (a_2 - a_1) + t_2 (y_i - a_2) = t_2 y_i - a_1 (t_1 - t_0) - a_2 (t_2 - t_1)$, and so on. Hence if y_i falls into the k th tax bracket, so that $a_k < y_i \leq a_{k+1}$, and $a_0 = 0$, income tax can be expressed for $k \geq 1$ as:

$$T_{y_i} = t_k y_i - \sum_{j=1}^{k} a_j \left(t_j - t_{j-1} \right)$$

$$= t_k \left(y_i - a_k' \right) \tag{2}$$

where $a_k' = \sum_{j=1}^{k} a_j \left(t_j - t_{j-1} \right) / t_k$. Hence the tax paid under a multi-step function is equivalent to that paid with a single-step tax structure having a marginal rate, t_k, imposed on the individual's income in excess of an effective threshold of a_k'.

Creedy and Gemmell (2003) show that, for this tax function, the individual elasticity, η_{T_y, y_i}, is:

$$\eta_{T_y, y_i} = 1 + \left(\frac{a_k'}{y_i - a_k'} \right) \left(1 - \eta_{a_k', y_i} \right) \tag{3}$$

This indicates the potentially important role of the elasticity of effective allowances, η_{a_k', y_i}. The individual revenue elasticity must exceed unity if $\eta_{a_k', y_i} < 1$. A positive value of η_{a_k', y_i} can be expected where allowances are income-related, for example when there is tax relief for mortage interest payments or pension contributions.[3]

To derive the individual revenue elasticity for consumption taxes, define z_i as individual i's net income, so that:

$$z_i = a_k' t_k + y_i (1 - t_k) \tag{4}$$

Suppose a proportion, γ_i, of z_i is consumed, so that total consumption expenditure, m_i, is $\gamma_i z_i$. In general, γ_i can vary with z_i and hence with y_i, and can exceed unity over some ranges of z_i, as discussed below.

If the tax-exclusive *ad valorem* indirect tax rate imposed on the ℓ th good (for $\ell = 1, ..., n$) is v_ℓ, the equivalent tax-inclusive rate is $v_\ell' = v_\ell / (1 + v_\ell)$. Define $w_{i\ell}$ as person i's budget share of the ℓ th good. The consumption tax paid by person i on good ℓ can be written as:

$$T_{v_\ell, i} = v_\ell' w_{i\ell} m_i = v_\ell' w_{i\ell} \gamma_i z_i \tag{5}$$

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[3]For example, Creedy and Gemmell (2003) found that η_{a_k', y_i} takes values around 0.4 for the UK, but varies significantly over time in response to changes in the tax deductability of various income-related reliefs such as those for families, pensions and mortgages. The value of η_{a_k', y_i} is of course unlikely to exceed unity.

It is required to obtain the consumption tax revenue elasticity for each good, that is, $\eta_{T_{v_\ell},y_i}$. Writing $m_{i\ell} = w_{i\ell}m_i$ as expenditure on the i th good, first note that:

$$m_{i\ell} = w_{i\ell}m_i \text{ implies: } \eta_{m_{i\ell},m} = 1+\eta_{w_{i\ell},m_i}$$

$$m_i = \gamma_i z_i \quad \text{ implies: } \eta_{m_i,z_i} = 1+\eta_{\gamma_i,z_i}$$

$$T_{v_{i\ell}} = v_\ell^{'} m_{i\ell} \text{ implies: } \eta_{T_{v_{i\ell}},m_{i\ell}} = 1 \tag{6}$$

Differentiating (5) with respect to income, y_i, and using the relationships in (6), it can be shown that:

$$\eta_{T_{v_\ell},y_i} = \left(1+\eta_{w_{i\ell},m_i}\right)\left(1+\eta_{\gamma_i,z_i}\right)\eta_{z_i,y_i} \tag{7}$$

where η_{z_i,y_i} is the elasticity of disposable income, z_i, with respect to y_i. The second term in (7) can be expressed in terms of $e_{i\ell}$, the total expenditure elasticity of demand for the ℓ th good by person i, whereby:

$$\left(1+\eta_{w_{i\ell},m_i}\right) = e_{i\ell} \tag{8}$$

The last term in (7), η_{z_i,y_i}, is determined by the progressivity of the income tax, such that:

$$\eta_{z_i,y_i} = \eta_{(y_i-T_{y_i}),y_i} = \frac{1-mtr_i}{1-atr_i} \tag{9}$$

In fact, η_{z_i,y_i} is the familiar measure of residual progression. Combining (7), (8) and (9) it follows that:

$$\eta_{T_{v_\ell^{'}},y_i} = e_{i\ell}\left(1+\eta_{\gamma_i,z_i}\right)\left(\frac{1-mtr_i}{1-atr_i}\right) \tag{10}$$

Equation (10) demonstrates that the consumption tax revenue elasticity for good ℓ can be decomposed into three terms, reflecting the total expenditure elasticity for good ℓ, the way in which the proportion of disposable income consumed by i changes with income, and the degree of residual progression determined by individual i's marginal and average income tax rates.

The consumption tax revenue elasticity for all goods combined, for person i, η_{T_v,y_i}, can be obtained directly from the expression for the consumption tax paid on all goods, T_{v_i}. Aggregating (5) over n goods gives:

$$T_{v_i} = \sum_{\ell=1}^{n} T_{v_{\ell,i}}$$

$$= m_i \sum_{\ell=1}^{n} v'_\ell w_{i\ell} \tag{11}$$

Differentiation of (11) then reveals that η_{T_v,y_i} is given by:

$$\eta_{T_v,y_i} = \left(1+\eta_{\gamma_i,z_i}\right)\left(\frac{1-mtr_i}{1-atr_i}\right)\left\{\sum_{\ell=1}^{n}\left(\frac{T_{i\ell}}{T_{v_i}}\right)e_{i\ell}\right\} \tag{12}$$

This result shows that, compared with the revenue elasticity for a single good in (10), the tax-share weighted expenditure elasticity appears in (12). To calculate the weighted elasticity, it is necessary to distinguish only between goods facing different *ad valorum* tax rates.

The elasticity of the consumption proportion with respect to income in (10), η_{γ_i,z_i}, also varies with incomes if saving rates vary across disposable income levels. While a non-proportional relationship is generally accepted for cross-sectional income differences and, to a lesser extent, for time-series changes over the short-term, changes in the consumption proportion over the long-run are probably best regarded as proportional.

Creedy and Gemmell (2003) allow for the possibility of a non-proportional relationship by using the specification:[4]

$$m_i = a\left(z_i + b\right) \tag{13}$$

For this case, it can be shown that $1+\eta_{\gamma_i,z_i}$ in (12) is equal to $z/\left(z+b\right)$. Hence for a proportional consumption function (including zero savings, where $a=1$), $b=0$, $1+\eta_{\gamma_i,z_i}=1$. The elasticity therefore depends on the three terms as follows:

$$\eta_{T_v,y_i} = \left(\frac{z}{z+b}\right)\left(\frac{1-mtr_i}{1-atr_i}\right)\left\{\sum_{\ell=1}^{n}\left(\frac{T_{i\ell}}{T_{v_i}}\right)e_{i\ell}\right\} \tag{14}$$

The first two bracketed terms of equation (14) are less than or equal to unity, but the third component, shown in curly brackets, may exceed unity for some income levels and tax structures. However, η_{T_v,y_i} tends towards unity as income increases.[5]

2.2 Estimates of individual revenue elasticities

Individual elasticities can identify those taxpayers likely to experience the greatest change in tax liabilities as their incomes, or fiscal parameters, change. They therefore also provide local measures of tax progressivity. This subsection shows how individual revenue elasticities can be expected to vary across income levels in New Zealand.

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[4]The over-spending at very low income levels can be viewed in terms of the existence of transfer payments and consumption out of savings.

[5]This is because all expenditure elasticities converge towards unity, although the convergence may not be monotonic, along with the first two terms in (14). Creedy and Gemmell (2003a) illustrate this decomposition for the UK.

Using information on the New Zealand income tax structure in 2001 to calculate effective allowances, $a_k^{'}$, estimates of the income tax revenue elasticity in (3) can readily be obtained for a range of individual income levels. Income tax rates of 0.15, 0.21, 0.33, 0.39 between income thresholds of (NZ$) 0, 9500, 38000, and 60000 were used. These are the effective rates and thresholds, allowing for the existence of the Low-Income Rebate. For New Zealand, with no initial tax-free allowance and virtually no deductions, tax thresholds do not change with individuals' incomes, so it is reasonable to assume $\eta_{a_k^{'},y_i} = 0$ in (3). This simplifies income tax revenue elasticity calculations.

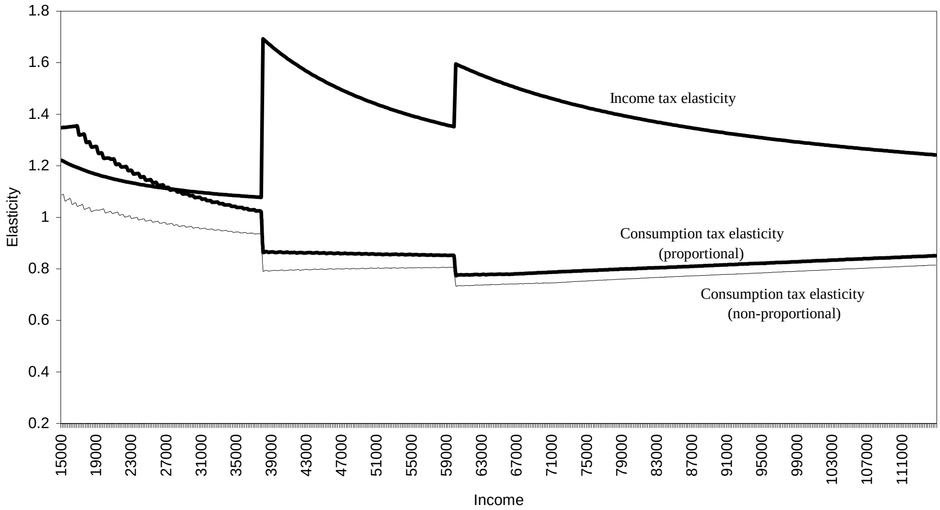
Consumption tax revenue elasticity calculations require estimates of the *ad valorum*-equivalent indirect tax rates. Most goods are taxed at the 12.5 per cent GST rate. However some expenditures are exempt from GST (for example, rent and overseas travel) while a number of excises produce very different effective tax rates on goods such as fuel, alcohol and tobacco. The consumption tax rates used are given in the Appendix.

It is necessary to have total expenditure elasticities of goods taxed at different rates. For this reason it is not possible, even if separate income unit data from budget studies were available, to produce precise individual values since estimates must be based on the cross-sectional variation in budget shares as total expenditure varies within specified groups (defined say by location or demographic characteristics). The estimates reported here are based on total expenditure elasticities for all households combined, and were obtained from published average expenditures from the 2000-2001 Household Expenditure Survey; further details of the method used are discussed in the Appendix.

Finally, consumption function parameters, a and b in (13) are required. In view of the considerable difficulty in obtaining reliable information about savings functions, three consumption function cases were examined. These are: the no savings case, $a = 1$, $b = 0$; the proportional savings case, $a = 0.95$, $b = 0$; and the non-proportional case, $a = 0.85$, $b = 3000$. The proportional case assumes that 95 per cent of disposable income is spent, while the non-proportional case implies an average propensity to consume of 0.95 at NZ$30,000, which is around the arithmetic mean income level.

Figure 1 shows how the income and consumption tax revenue elasticity (all goods) varies across income levels. The income tax elasticity generally declines as income rises, with discrete jumps taking place as individuals cross the tax thresholds, reflecting the sharp increase in the marginal rate of income tax.

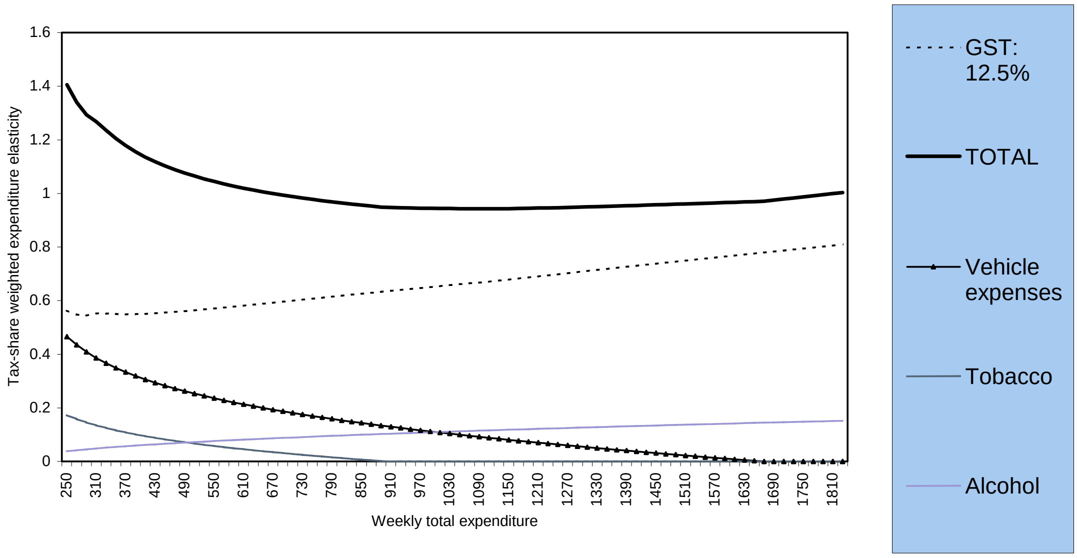
Figure 1 – Individual tax revenue elasticities



For the consumption tax elasticity, two examples of the proportional and non-proportional cases are shown. As shown in subsection 1, the shapes of these profiles reflect the three combined effects of the progressivity of the income tax, saving habits and differing expenditure elasticities across goods (combined with their associated *ad valorem* rates). Income tax progressivity tends to induce a 'mirror image' effect in the consumption tax profile via changes in disposable incomes. For example, discrete declines are evident in the consumption tax elasticity profiles in Figure 1 at the income tax thresholds and, at higher income levels, elasticities tend to rise.

However, at lower income levels consumption tax revenue elasticities also decline, rather than showing a mirror image of the decline in the income tax elasticity. This arises because of the dominant effect of declines in the tax-share weighted expenditure elasticities. For example, examination of these elasticities in Figure 2 reveals substantial declines in tax-share weighted expenditure elasticities for vehicles (mainly fuel) and tobacco as incomes increase from relatively low levels. Since these expenditures face especially high tax rates, changes in these tax-share weighted elasticities dominate changes in the weighted average at low income levels. Figure 1 also reveals that the elasticities produced by the non-proportional consumption function relationship are generally slightly lower, by about 0.1 - 0.2 percentage points, than the proportional equivalents.

__Figure 2 – Tax-share weighted total expenditure elasticities__



3 Aggregate revenue elasticities

This section examines aggregate tax revenue elasticities, which are the most relevant from the point of view of tax forecasting and planning, and possible automatic stabilisation properties of the tax structure. Subsection 1 presents the basic formulae required and subsection 2 reports results for New Zealand in the case of equiproportional income changes. The implications of non-equiproportional income changes are examined in subsection 3.

3.1 Elasticity formulae

Aggregate revenue elasticities can readily be expressed as a tax-weighted sum of the individual elasticities. Letting T_Y and Y denote respectively total income tax revenue and total income, the aggregate income tax revenue elasticity is:

$$\eta_{T_Y,Y} = \sum_{i=1}^{N} \left(\frac{T_{y_i}}{T_Y} \right) \eta_{T_y,y_i} \eta_{y_i,Y} \tag{15}$$

Evaluation of the aggregate elasticity therefore requires, in addition to information about the income distribution (for computation of the income tax shares T_{y_i}/T_Y), knowledge of the extent to which individuals' incomes change when aggregate income changes, reflected in the term $\eta_{y_i,Y}$, where the condition $\frac{1}{N}\sum_{i=1}^{N} \eta_{y_i,Y} = 1$ must hold. A typical simplifying assumption is that all incomes increase by the same proportion, so that $\eta_{y_i,Y} = 1$ and the aggregate income rax revenue elasticity is a simple tax-share weighted average of individual values.

The aggregate consumption tax elasticity can be calculated, following (15), using:

$$\eta_{T_V,Y} = \sum_{i=1}^{N} \left(\frac{T_{v_i}}{T_V} \right) \eta_{T_v,y_i} \eta_{y_i,Y} \tag{16}$$

where T_V is aggregate consumption tax revenue. Furthermore, since total revenue is $T = T_Y + T_V$, the elasticity of total revenue with respect to aggregate income can be found as a tax-share weighted average of the income and consumption tax revenue elasticities.

3.2 Estimates of aggregate revenue elasticities

This subsection uses the analytical expressions in subsection 1, along with the assumption of equiproportional income changes, to examine how aggregate revenue elasticities vary with aggregate income levels in New Zealand.

One approach would be to use detailed information, in the form of a large data set containing data on individual taxable incomes.[6] However, the method used here (since such individual data are available only to a highly restricted group of users in New Zealand) is to parameterise the distribution, based on grouped income distribution data, and then to produce a simulated distribution of incomes by taking random draws from the fitted distribution.

Figure 5 in the appendix shows the New Zealand grouped income distribution in 2001, and discusses the application of a lognormal distribution to summarise the data.[7] It was found that a mean and variance of the logarithms of incomes of $\mu = 9.85$ and $\sigma^2 = 0.7$ provide a reasonable approximation to parameterise a lognormal income distribution. These values imply an arithmetic mean income of $26,903.[8] Each aggregate revenue elasticity is obtained using a simulated population of 20,000 individuals, drawn at random from the distribution. As the results reported here assume that all incomes increase by the same proportion, the relative dispersion of incomes remains constant as incomes change over time.

Figure 3 shows aggregate elasticity profiles for income and all consumption taxes, and for total tax revenues, as incomes increase over a range of average income levels.[9] The consumption tax profile shown is for the non-proportional consumption case. These profiles are approximately linear with the income and consumption tax elasticities at slightly below 1.3 and 0.9 respectively. However, the income tax elasticity reveals a tendency to rise slightly and then decline at higher average income levels. This decline occurs when a large proportion of the income distribution faces the highest marginal income tax rate.[10]

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[6]Some studies use an entirely numerical approach, by imposing small income increases on each individual in the data set and examining the resulting tax changes, rather than using explicit formulae such as those given above.

[7]In Giorno *et al.* (1995), aggregate income tax revenue elasticities were obtained by fitting lognormal distributions, using information for each country about only the ratios of the first and ninth deciles to the median income. Values of individual elasticities were computed at 16 points on the income distribution. An aggregate elasticity was obtained as the ratio of average (income weighted) marginal rates to that of average (income weighted) average tax rates. (The weights were obtained from the first moment distribution of the associated lognormal distribution). Unfortunately the ratio of averages is not equivalent to the average of ratios, which is the required measure.

[8]In the lognormal case, the arithmetic mean income is derived as $\bar{y} = \exp\{\mu + \sigma^2/2\}$.

[9]The 20k values were selected randomly from an initial distribution with a lower mean of logarithms than the 2001 distribution. The average income increase, with a fixed variance of logarithms of income, was achieved simply by increasing all incomes by a fixed proportion each year. The non-equiproportional case involves a more complex process of income change, as shown below.

[10]For the highest average income shown, about one quarter of taxpayers are above the top threshold.

Figure 3 – Aggregate tax revenue elasticities

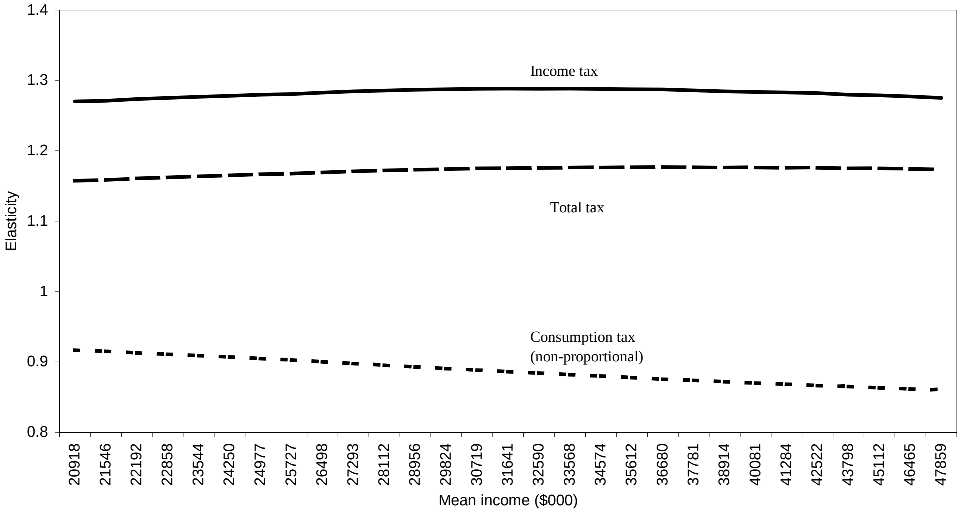
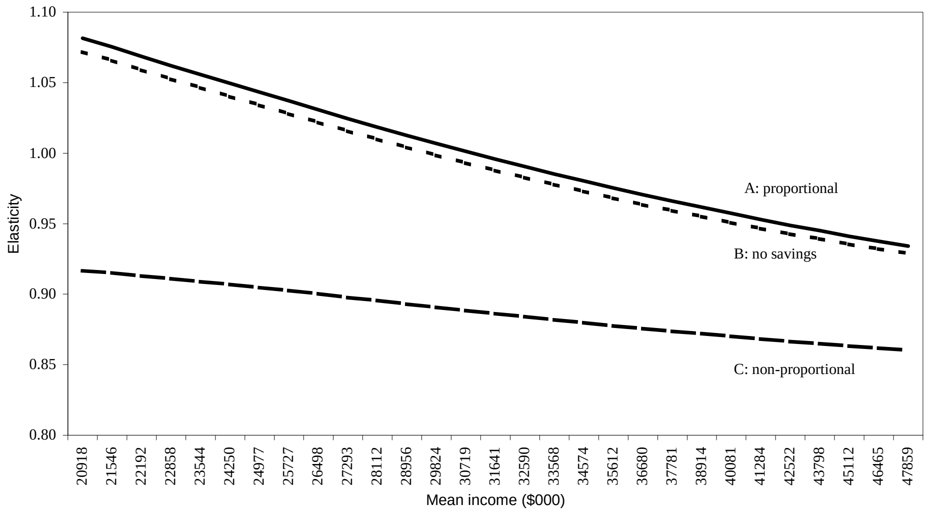


Figure 4 shows how consumption tax elasticities depend on assumed saving behaviour. Revenue elasticity estimates are noticeably higher for the proportional consumption and 'no savings' cases (profiles A and B), but decline more rapidly as income rises, compared to the non-proportional case in profile C. For example, at mean income levels of around $30,000, elasticities of about 1.0 and slightly below 0.9 are obtained from profiles A and C respectively. Figure 4 also suggests that the effect on the revenue elasticity of ignoring savings is not substantial provided, when income increases, the proportion of income consumed remains approximately constant.

Figure 4 – Aggregate consumption tax revenue elasticities



3.3 Non-equiproportional income changes

This subsection relaxes the assumption of equiproportionate income changes, used in the previous subsection and in the vast majority of studies. In line with the present approach of using parametric specifications at a fairly high level of aggregation, subsection 1 presents a function to describe the systematic variation in $\eta_{y_i,Y}$ with y_i. Subsection 2 presents revised aggregate elasticities based on estimates of the dynamic specification.

3.3.1 A specification

It is convenient to specify a functional form for the variation in $\eta_{y_i,Y}$ with y_i. A suitable form, involving just one parameter, is:

$$\eta_{y_i,Y} = 1-(1-\beta)(\log y_i - \mu) \tag{17}$$

where μ is the mean of logarithms of income (the logarithm of geometric mean income).[11] This means that if $\beta < 1$ and y_i is less than geometric mean income, the elasticity, $\eta_{y_i,Y}$, is greater than unity, and *vice versa*, so that (17) involves equalising changes. If $\beta > 1$, income changes are disequalising. This specification can thus be used to examine the sensitivity of aggregate revenue elasticity measures to variations in the standard assumption of $\eta_{y_i,Y} = 1$.[12]

In examining non-equiproportionate changes, according to equation (17), it is also useful, when increasing the 20,000 simulated incomes from one year to the next, to impose random proportionate income changes, in addition to the systematic equalising or disequalising tendency reflected in β. Without such changes, annual income inequality changes too rapidly. The specification in (17) is consistent with the following dynamic process. Let y_{it} denote individual i's income in period t, and let μ_t denote the mean of logarithms in period t, with $m_t = \exp(\mu_t)$ as the geometric mean. The generating process can be written as:

$$y_{i2} = \left(\frac{y_{i1}}{m_1}\right)^{\beta} \exp(\mu_2 + u_i) \tag{18}$$

where u_i is $N(0, \sigma_u^2)$. Equation (18) can be rewritten as:

$$(\log y_{i2} - \mu_2) = \beta(\log y_{i1} - \mu_1) + u_i \tag{19}$$

Hence the variance of logarithms of income in period 2, σ_2^2 , is given by

$$\sigma_2^2 = \beta^2\sigma_1^2 + \sigma_u^2 \tag{20}$$

The variance of logarithms is therefore constant when $\sigma_u^2 = \sigma_1^2(1-\beta^2)$.[13]

3.3.2 Aggregate elasticities

Estimation of equation (19) was carried out for a range of pairs of consecutive years during the 1990s, using information from large samples of IR5 and IR3 filers. The results

[11]In the case of lognormal income distributions, this is also the median income.

[12]For non-equiproportional changes, the aggregate revenue elasticity can now be less than 1; for example it is zero if the only incomes which increase are below a tax-free threshold and none crosses the threshold.

[13]In general, the variance of logarithms of income increases if the regression coefficient, β, exceeds the correlation between log-incomes in the two periods. If $\beta < 1$, the variance of logarithms of incomes eventually becomes stable at $\sigma_u^2/(1-\beta^2)$. On dynamic income specifications, see Creedy (1985).

suggest a relatively stable value of β of around 0.85. This reflects a substantial degree of regression towards the (geometric) mean; indeed, with no random component of income change this would have the effect of halving income inequality in as little as three years. If $\beta = 0.85$ is combined with $\sigma_u^2 = 0.194$, the variance of logarithms of income remains constant over time.[14] These values produce an aggregate income tax revenue elasticity, at 2001 mean income, of about 1.11. For the proportional and non-proportional consumption functions respectively, the aggregate consumption tax revenue elasticities are 0.93 and 0.83, giving corresponding total tax revenue elasticities of 1.05 and 1.03 respectively.

Regression towards the geometric mean therefore reduces the aggregate revenue elasticities. This arises because, for those above the geometric mean income, the value of $\eta_{T_y, y_i}\eta_{y_i, Y}$ is reduced, and *vice versa* for those below the geometric mean. The aggregate elasticity, from (15), is a tax-share weighted average of these terms, and in view of the fact that T_{y_i}/T_Y increases as y increases, the lower values of $\eta_{T_y, y_i}\eta_{y_i, Y}$ at the upper income levels dominate.

To give some idea of the sensitivity of results to the variation in β, consider a value of $\beta = 0.9$, which requires $\sigma_u^2 = 0.133$ for a stable degree of income inequality. The aggregate income tax elasticity, again at 2001 mean income, is now 1.17, while the consumption tax elasticities are 0.96 and 0.85 for proportional and non-proportional consumption functions (giving total revenue elasticities of 1.11 and 1.07).

4 Conclusions

This paper has examined the revenue responsiveness properties of New Zealand income and consumption taxes, based on the 2001 tax structure and expenditure patterns. Using analytical expressions for revenue elasticities at the individual and aggregate levels, together with a simulated income distribution, values for New Zealand were obtained. Treating income growth as equiproportionate, these suggest that the aggregate income and consumption tax revenue elasticities are both fairly constant as mean income increases, at around 1.3 and 1.0 respectively. This latter estimate assumes that increases in disposable income are accompanied by approximately proportional increases in total expenditure. Allowing for non-equiproportionate income growth reduces revenue elasticities to around 1.1 (income tax) and 0.93 (consumption taxes). If there is a tendency for the savings proportion to increase as disposable income increases, a somewhat lower total consumption tax revenue elasticity, of around 0.85 - 0.90, is obtained at mean income levels which approximate current levels in New Zealand. These elasticities are relatively low by international standards. Examination of the tax-share weighted expenditure elasticities for various goods also revealed that, despite the adoption of a broad based GST at a uniform rate in New Zealand, the persistence of various excises has an important effect on the overall consumption tax revenue elasticity, especially for individuals at relatively low income levels.

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[14] This value is in fact similar to that estimated for IR3 filers, though the values obtained for IR5 filers were lower, at about 0.1. Given that these samples do not constitute all taxpayers, and in practice inequality is relatively stable, it is appropriate here to model a stable variance of logarithms.

Appendix: Further details of the elasticity computations

Expenditure elasticities

Expenditure elasticities were obtained using the published summary table of average expenditures over a range of income groups in the 2001 NZ Household Economic Survey (HES), obtained from http://www.stats.govt.nz/. This table divides all households in the sample into $K = 11$ income groups. Within each group the budget shares for each of $n = 58$ commodity groups were obtained (by dividing average expenditure in each category by average total expenditure).[15] Denote the arithmetic mean total expenditure of the k th group by $m_k \left(k = 1, ..., K\right)$ and the budget share of the i th commodity group and k th total expenditure group by $w_{ki} \left(i = 1, ..., n\right)$.

The raw values of these budget shares cannot be used to obtain elasticities because sampling variations (particularly for low and high income groups) give rise to negative elasticities. Regressions were carried out of the form:

$$w_{ki} = a_{ik} + b_{ik} \log\left(m_k\right) + \frac{c_{ik}}{m_k} \tag{21}$$

for each commodity group, i. In addition to generally providing a good fit, this specification has the advantage that weights based on the estimated parameters add to unity.[16] The smoothed budget shares were then used to calculate the total expenditure elasticities.

Differentiating (21), and dropping the k subscript, gives:

$$\frac{dw_i}{dm} = \frac{b_i y - c_i}{m^2} \tag{22}$$

so that w_i unequivocally falls as m rises if $b_i < 0$ and $c_i > 0$; or if $c_i < 0$, so long as $m > c_i / b_i$. Alternatively, the share rises as income rises (that is, the income elasticity exceeds 1) if $b_i > 0$ and $c_i < 0$; or if $c_i > 0$, so long as $m > c_i / b_i$.

The coefficient estimates are reported in Appendix Tables 1 and 2. The required expenditure elasticities were obtained using:

$$e_{ki} = 1 + \frac{dw_{ki}}{dm_k} \frac{m_k}{w_{ki}} \tag{23}$$

with dw/dm taken from differentiation of (21).

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[15] Several commodity groups were excluded on the grounds that they more closely represented savings rather than expenditure. The ratio of averages is of course not the same as the average budget share (though earlier experiments using data for individual households showed that the differences were minor).

[16] However, it does not guarantee that the predicted weights always lie in the range $0 < w < 1$, though in practice this was not a serious problem; a few negative values at low total expenditure levels for some goods were set to zero and the other shares were adjusted accordingly to maintain the adding-up requirement.

Appendix Table 1 – Budget share regressions

	a	b	c	R-squared
Fruit	-0.00829	0.002749	2.087083	0.26022
Vegetables	0.054475	-0.00579	-1.37903	0.794889
Meat	0.225018	-0.02806	-13.3021	0.732829
Poultry	0.052294	-0.00617	-3.62406	0.302579
Fish	0.001745	0.000182	0.429412	0.195002
Farm products, fats, oils	0.126825	-0.0152	-4.4229	0.869153
Cereals, cereal products	0.135981	-0.01589	-5.7208	0.887933
Sweet products, beverages	0.139186	-0.01627	-7.28867	0.713447
Other foodstuffs	0.152218	-0.01774	-8.35408	0.381223
Meals away from home	-0.16374	0.03029	4.718327	0.971466
Rent	0.622274	-0.08312	-1.83007	0.928584
Payments to local authorities	-0.0882	0.013836	15.20095	0.950052
Property maintenance goods	0.081228	-0.0069	-8.63439	0.718421
Property maintenance	-0.68323	0.100973	43.35151	0.787053
Housing expenses n.e.c.	-0.03517	0.004634	3.377435	0.741892
Domestic fuel and power	0.196174	-0.02413	-0.94521	0.976625
Home appliances	-0.00112	0.003079	2.134009	0.024083
Household equipment	-0.00563	0.001527	0.727346	0.041477
Furniture	-0.10488	0.017014	6.453542	0.741345
Furnishings	-0.00076	0.000831	-0.64299	0.451658
Floor coverings	-0.06074	0.008517	4.952152	0.461902
Household textiles	-0.01107	0.002411	0.852601	0.124718
Household supplies	0.078421	-0.00923	-4.4682	0.502538
Household services	-0.08467	0.015257	16.66589	0.919618
Men's clothing	-0.0772	0.01134	5.588882	0.523455
Women's clothing	-0.17633	0.025524	13.84376	0.742386
Children's clothing	-0.00054	0.000862	0.267848	0.027241
Other Clothing	0.029442	-0.00308	-3.3534	0.867552
Clothing supplies & services	-0.00295	0.000601	0.434927	0.015415
Men's footwear	-0.02062	0.003132	1.23944	0.597497
Women's footwear	-0.06346	0.008629	5.976196	0.878226
Children's footwear	0.002005	-8.35E-05	-0.35364	0.250285
Other Footwear	0.010164	-1.05E-03	-1.32814	0.780407
Footwear supplies & services	0.003267	-3.81E-04	-0.3558	0.337931
Public transport within NZ	-0.06172	0.009624	5.100902	0.503206

Appendix Table 2 – Budget share regressions

	a	b	c	R-squared
Overseas travel	-0.47099	0.07091	28.55522	0.787953
Road vehicles	0.291782	-0.02883	-31.0849	0.652508
Vehicle ownership expenses	0.625611	-0.0743	-42.9299	0.569541
Private transport costs n.e.c	-0.01354	0.002442	1.589636	0.058705
Tobacco products	0.166991	-0.0214	-8.79842	0.620878
Alcohol	-0.12924	0.021882	7.49086	0.629366
Medical goods	-0.02832	0.004974	3.036628	0.105698
Toiletries and cosmetics	0.00956	0.000191	-0.92042	0.395319
Personal goods	0.032463	-0.00257	-3.42718	0.58933
Pets, racehorses and livestock	0.120291	-0.01498	-7.75913	0.470165
Stationery and office equip	0.070482	-0.00593	-5.10796	0.308231
Leisure goods	0.019047	0.000662	-4.02311	0.757771
Recreational vehicles	0.011469	-0.00076	-2.11383	0.635397
Goods n.e.c.	-0.0119	0.002321	0.9711	0.140835
Health services	-0.12371	0.020146	11.10986	0.545345
Personal services	-0.10878	0.015507	9.209476	0.352852
Educational and tuition	0.026106	-0.00101	1.068944	0.17518
Accommodation services	-0.07752	0.011855	4.266511	0.679455
Fin, insurance and legal	0.097855	-0.00857	-2.83561	0.185043
Vocational services	-0.00239	0.000818	-0.75566	0.896757
Leisure services	-0.03519	0.009307	0.15564	0.86498
Services n.e.c.	0.061889	-0.00639	-7.72831	0.46135
Outgoings n.e.c.	0.207629	-0.02421	-17.3681	0.078868

Appendix Table 3 – Grouped distribution of taxable income: New Zealand

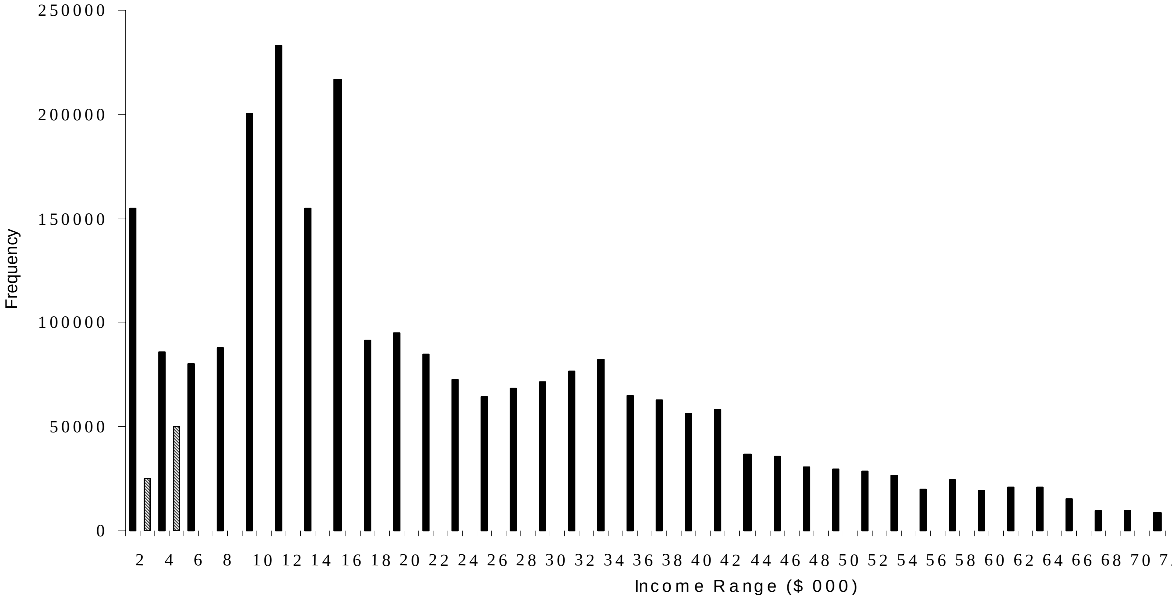
Range (OOOs)	no.	Average Income	Range (OOOs)	no.	Average Income
-1	93,213	409.83	30 -31	41,890	30,414.00
1 -2	61,912	1,452.57	31 -32	34,770	31,507.18
2 -3	41,329	2,521.56	32 -33	44,251	32,477.18
3 -4	44,486	3,544.49	33 -34	38,084	33,533.93
4 -5	36,385	4,552.98	34 -35	33,849	34,534.91
5 -6	43,644	5,437.80	35 -36	30,837	35,526.43
6 -7	32,442	6,580.17	36 -37	27,936	36,512.18
7 -8	55,677	7,495.72	37 -38	34,878	37,548.02
8 -9	67,115	8,371.65	38 -39	31,082	38,498.93
9 - 9.5	66,408	9,267.31	39 -40	25,273	39,483.37
9.5 - 10	42,052	9,707.22	40 -41	27,987	40,563.92
10 - 11	143,426	10,669.95	41 -42	30,355	41,480.31
11 - 12	89,621	11,513.70	42 -43	17,037	42,551.03
12 - 13	74,977	12,571.58	43 -44	19,855	43,478.16
13 - 14	80,137	13,429.31	44 -45	20,373	44,647.87
14 - 15	163,260	14,396.08	45 -46	15,506	45,453.50
15 - 16	53,649	15,422.00	46 -47	15,027	46,560.53
16 - 17	52,664	16,568.82	47 -48	15,720	47,510.66
17 - 18	38,984	17,472.11	48 -49	17,132	48,471.26
18 - 19	48,558	18,469.33	49 -50	12,519	49,700.59
19 - 20	46,773	19,566.15	50 -52	28,862	51,011.51
20 - 21	47,134	20,556.02	52 -54	26,642	52,891.96
21 - 22	37,598	21,524.06	54 -56	19,947	54,980.98
22 - 23	37,181	22,572.31	56 -58	24,379	56,876.89
23 - 24	35,388	23,539.56	58 -60	19,203	59,208.08
24 - 25	32,699	24,518.45	60 -65	52,194	62,407.42
25 - 26	31,564	25,449.60	65 -70	24,748	67,319.34
26 - 27	30,796	26,333.18	70 -80	43,913	74,481.48
27 - 28	37,842	27,465.45	80 -90	22,783	85,128.34
28 - 29	35,810	28,586.43	90 100	19,963	94,708.39
29 - 30	35,872	29,622.28	Over 100	47,218	182,074.25

Income distribution

The grouped frequency distribution of taxable income in New Zealand for 2000-2001 is given in Appendix Table 3. This distribution is for income from all sources, and covers employed and self employed individuals. A histogram of this distribution is shown in Appendix Figure 1. The second mode at the bottom of the distribution raises a problem when using the standard two-parameter lognormal distribution. The pragmatic solution was adopted of adjusting the frequencies at the bottom of the distribution, as shown by smaller marked blocks for the two lowest income classes. It has in fact been found that New Zealand bimodal distributions can be modelled using a mixture distribution comprising a weighted average of lognormal and exponential distributions; see Bakker and Creedy (1999)

The resulting values were then used to obtain the mean and variance of logarithms reported above. The implied arithmetic mean value (using the properties of the lognormal mentioned above) was found to be close to the arithmetic mean calculated directly from the distribution.

Appendix Figure 1 – Income distribution



Tax rates

Ad valorem tax-exclusive indirect tax rates are required for the same commodity groups as listed in Appendix Tables 1 and 2. In most cases the appropriate rate is simply the GST rate of 0.125. For rent and overseas travel, the rate is zero. In other cases, particularly where excises are involved, the computation of an effective *ad valorem* rate is complicated by the use of unit taxes, in combination with GST, and by the need to consolidate a wide variety of goods into a single category. The non-zero rates differing from the standard GST rate are as follows: road vehicles 0.07054; vehicle ownership expenses 0.58642; tobacco products 2.39845; alcohol 0.46819; recreational vehicles 0.0625; financial, insurance and legal services 0.0625; and expenditure not elsewhere included 0.23. For details on the computation of these rates, see Young (2002).

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