Food expenditure and GST in New Zealand
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This paper investigates the welfare effects on New Zealand households of zero-rating food in a goods and services tax (GST). The detailed effects, for a range of household types, are investigated using Household Economic Survey data. Demand responses to consumer price changes are estimated and welfare changes, in terms of equivalent variations, are obtained. Comparisons are also made across clusters, consisting of groups of households with similar characteristics. A tax change is found to produce a very small amount of progressivity in the GST. Redistribution is from households without children and with high total expenditure to households with children and low total expenditure, and towards older households.

Keywords: goods and services tax; tax progressivity; budget shares; welfare changes

JEL Classifications: H31, I3, D11

1. Introduction

The aim of this paper is to investigate the detailed welfare effects on households of a change to the indirect tax structure in New Zealand involving the zero-rating of food from goods and services tax (GST), except for meals consumed outside the home.1 A feature of the present paper is that demand responses to consumer price changes are obtained, using a result established by Frisch (1959) for directly additive utility functions. This relates own- and cross-price elasticities to total expenditure elasticities, budget shares and the elasticity of the marginal utility of income (the so-called ‘Frisch parameter’).

The New Zealand GST is unusual in having a very broad base, which includes food.2 This is usually defended on grounds of efficiency: the broad base makes it possible to keep the GST rate relatively low. This keeps the excess burden low, in view of the well-known approximation that the excess burden increases with the square of the tax rate. In an optimal tax framework there is no presumption in favour of uniformity because the conditions under which the maximisation of a social welfare function gives rise to uniform indirect taxes are strong and unlikely to hold.3 However, faced with the enormous difficulty of computing a set of optimal taxes, there is often a presumption in favour of uniformity on the grounds of the large administrative and compliance costs of differentiation. These arguments are combined with the important point that equity objectives can be met using the nonlinear structure of income taxes and transfers.

Nevertheless, other countries have used the zero-rating of food and other goods, along with differential rates, for redistributive reasons.4 It is sometimes suggested that if the GST rate becomes much higher than its current level in New Zealand, there is likely to be
further pressure, on equity grounds, for the exemption of some goods. Hence, despite the limitations of any analysis devoted to only one part of the complete tax and transfer system (since it is the overall effect of all taxes combined that matters), a separate analysis of GST is warranted.

The question then arises, when looking at only one tax, of how to measure tax progressivity. Although in popular discussions, tax payments in relation to gross (pre-tax) income are often examined, the approach adopted here is to look at tax payments and welfare changes in relation to the relevant tax base, in this case total expenditure, for each household. Indeed, it can be shown that spurious results can be obtained if a different tax base, such as income, is used. The difference between bases is affected by income taxation and benefit payments as well as savings and, where relevant, dissavings. A change in the effective marginal income tax rate schedule can misleadingly suggest a change in the progressivity of indirect taxes. A complication is of course raised, in a short-period framework, by differential saving rates. However, savings are ultimately spent and they are best ignored when using annual data. These issues are treated in detail in Creedy (1998a, 2001). In what follows, and bearing in mind that one tax is being considered in isolation, where a denominator is required all measures refer to tax or welfare changes in terms of expenditure. Importantly, in the present context, no attempt is made to produce an overall progressivity measure, since the focus is on welfare changes, for different household types, arising from a change to the tax structure.

Following this approach, a consumption tax imposed at a uniform rate on all goods and services has no redistributive effect since all prices change by the same proportion and there are no excess burdens. A consumption tax is most progressive, or inequality reducing, when it taxes most heavily those goods which form a systematically higher proportion of the budgets of high-expenditure households: the precise condition is established formally in Section 2. This lies behind the argument that food should be exempt from a general consumption tax, given the long-established empirical relationship (referred to as Engel’s law) of a declining budget share for food as total expenditure increases. But there is a cost of such redistribution because, to raise the same revenue, the tax rate imposed on other goods must be higher than in the uniform structure. Rational debate requires information about both the costs and benefits of such differentiation. Section 2 also compares, in a simplified structure, the redistributive ability of an exemption for food with an adjustment to a universal benefit payment. This highlights the poor targeting of a policy of zero-rating food — even though a benefit is received by everyone.

The treatment of consumers’ behaviour makes it possible to estimate money measures of welfare changes arising from tax changes. The welfare changes are obtained using the linear expenditure system (LES), a special case of an additive utility function. There are well-known limitations of the use of additivity; for example, it does not allow for complements. However, the problems are minimised when using very broad commodity groups, as here. Nevertheless, in view of the strong assumptions, the results must be treated with caution. The alternative is to make the unrealistic assumption that demand patterns are fixed when prices change. Contrasts between results obtained using the present approach and an assumption of fixed demands are obtained below, showing substantial differences.

The approach involves a set of price elasticities being computed for each of a range of total expenditure groups for several household types, following the general approach suggested in Creedy (1998b). Instead of using a single set of parameters, estimates of the
LES are obtained for each household type for each of a number of total expenditure
groups. Households within each group are assumed to have the same preferences, but
these are allowed to vary between groups.† Hence many elasticities are computed. The
approach is discussed further in Appendix A. The welfare changes arising from the cur-
rent system and a reform involving the zero-rating of food are reported in Section 3. Com-
parison of welfare effects are made for a range of household types. In Section 4,
comparisons are made across ‘clusters’, consisting of groups of households with similar
characteristics. Section 5 briefly concludes.

2. Budget shares and tax structures
This section examines some of the basic considerations to take into account when
attempting to use exemptions to achieve distributional objectives.

2.1. Elasticities and liability progression
The argument, mentioned in the introduction, relating to indirect tax progressivity and
variations in budget shares with total expenditure can be restated more formally as fol-
lows. Let \( t_i \) denote the tax-inclusive \textit{ad valorem} consumption tax rate on good \( i \), for \( i = 1, \ldots, n \) goods. This is related to the tax-exclusive consumption tax rate, \( t_i \), by
\[ t_i = t_i / (1 + t_i). \]
The price and consumption of good \( i \) are respectively \( p_i \) and \( x_i \), and the
budget share of \( i \) is \( w_i = p_i x_i / \sum_{i=1}^{n} p_i x_i = p_i x_i / z \). The total consumption tax, \( T(z) \), paid
by an individual with total expenditure of \( z \) is
\[ T(z) = z \sum_{i=1}^{n} t_i w_i \] (1)

One local measure of the progressivity of a tax system is the elasticity of revenue, \( T(z) \),
with respect to the tax base, in this case total expenditure, \( z \). This elasticity is also the ratio
of the marginal tax rate to the average tax rate. It is in fact the Musgrave–Thin measure
of liability progression, and is given by
\[ \eta = 1 + \sum_{i=1}^{n} \left( \frac{\tau_i w_i}{\sum_{i=1}^{n} \tau_i w_i} \right) \left( \frac{d w_i}{d z} \frac{z}{w_i} \right) \] (2)

Let \( e_i = 1 + \frac{d w_i}{d z} \frac{z}{w_i} \), for \( i = 1, \ldots, n \), denote the total expenditure elasticities, and define
\( \theta_i = \tau_i w_i / \sum_{i=1}^{n} \tau_i w_i \) as the proportion of tax resulting from good \( i \). Then
\[ \eta = 1 + \sum_{i=1}^{n} \theta_i (e_i - 1) \] (3)

Hence \( \eta \) is a tax-share weighted average of the \( e_i - 1 \).

An increasing budget share is equivalent to \( e_i > 1 \), and since \( \eta > 1 \) for a progressive
tax structure, Equation (3) indicates that goods with total expenditure elasticities greater
than 1 should be taxed most heavily in order to obtain the greatest progressivity. How-
ever, some progressivity can be obtained even if taxes are imposed on some goods for
which \( e_i < 1 \) at some total expenditure levels. Furthermore, the elasticities vary with \( z \).
Indeed, it is often the case that for goods with \( e_i > 1 \) at all levels of \( z \), the elasticity
declines as $z$ increases.\textsuperscript{8} This again provides a constraint on the progressivity of an indirect tax structure, since the tax rate has to be set independently of individuals’ total expenditure levels.

Furthermore, there is substantial population heterogeneity. The budget share devoted to food decreases systematically \textit{on average} as total expenditure rises, but there is considerable variation within any total expenditure group. This implies a certain amount of ‘reranking’ if differential rates are used: the rank ordering of households by after-tax total expenditure is not the same as the ordering by pre-tax expenditure. This reranking reduces the degree of systematic redistribution that can be achieved by zero-rating food.\textsuperscript{9} It is thus necessary to consider the empirical orders of magnitude in detail. First, it is useful to consider some simple comparisons which give rise to unambiguous results, achieved by assuming that budget shares are not affected by indirect taxes and using a simple relationship between total expenditure and budget shares.

### 2.2. Some simple comparisons

Some simple comparisons between alternative structures can be made. Consider a broad-based GST where $\tau$ is the common tax-inclusive rate applied to all expenditure. In terms of the tax base, this is thus neutral from a progressivity point of view since the average tax rate, $\text{ATR}$, is $\tau$ for all $z$ values. Suppose that food is then zero-rated, but the same rate is applied to all other goods. If the budget share devoted to food declines as total expenditure increases, according to

\[ w = \alpha + \frac{\gamma}{z} \]  

The average tax rate, $\text{ATR}_E$, faced by someone with total expenditure of $z$ is thus

\[ \text{ATR}_E = \tau (1 - w) = \tau \left( 1 - \alpha - \frac{\gamma}{z} \right) \]  

and the consumption tax is progressive because $\text{ATR}_E$ clearly increases as $z$ increases. With a population size of $P$, total tax revenue per person, $T_E$, is, again ignoring individual subscripts, equal to $T_E = \frac{\tau}{P} \sum z(1 - w)$. Hence

\[ T_E = \tau \left( \bar{z} - (\gamma + \alpha \bar{z}) \right) \]  

Instead of zero-rating food, suppose that the tax raised from food is used to finance a transfer payment or benefit. Thus the indirect tax system becomes effectively a combined tax and transfer system, such that the same \textit{net} amount of tax revenue is collected as when food is zero-rated, but there is a universal transfer payment of $b$, financed from the tax rate of $\tau$ applied to all goods. The transfer is not subject to income taxation, but of course the expenditure arising from $b$ is taxed at the standard GST rate. This does not
specifically target low total expenditure groups. The government budget constraint, since \( T_E \) must be obtained net of the transfer, is thus given by

\[
\tau(z + b) - b = T_E \tag{7}
\]

and the transfer is

\[
b = \frac{\tau z - T_E}{1 - \tau} \tag{8}
\]

or

\[
b = \frac{\tau(y + \alpha z)}{1 - \tau} \tag{9}
\]

The average tax rate in this structure, \( ATR_B \), is thus found to be

\[
ATR_B = \frac{\tau(z + b) - b}{z} = \tau - \frac{b}{z}(1 - \tau) \tag{10}
\]

Substituting for \( b \) gives

\[
ATR_B = \tau \left\{ 1 - \frac{y + \alpha z}{z} \right\} \tag{11}
\]

Comparison of the average tax rates in the two alternatives gives

\[
ATR_B - ATR_E = \alpha \tau \left( 1 - \frac{z}{\bar{z}} \right) \tag{12}
\]

and \( ATR_B - ATR_E > 0 \) for \( z > \bar{z} \), and \( < 0 \) for \( z < \bar{z} \). Hence, redistribution takes place from those above the arithmetic mean to those below the mean total expenditure. Furthermore, the average tax rate increases more rapidly with the transfer than with exemptions over the whole range of total expenditures, since

\[
\frac{dATR_B}{dz} = \frac{\tau(y + \alpha z)}{z^2} > \frac{dATR_E}{dz} = \frac{y \tau}{z^2} \tag{13}
\]

for all \( z \). Even though the transfer is universal, and thus received by those with high and low total expenditures, it is more redistributive than a system that exempts food.

3. Welfare effects of GST changes

The welfare effects reported here are for two policy changes. The first change simply eliminates GST on food, so that total tax revenue falls and welfare increases for all households.\(^{10}\) The second policy involves the zero-rating of food while at the same time keeping total GST revenue constant by raising the GST rate imposed on all other goods. The measure of welfare change reported is the equivalent variation (EV), defined as the maximum amount an individual would be prepared to pay (after the tax policy change) to return to the old prices. Hence a negative value of EV indicates a welfare gain rather than a loss. The method of calculation is described in Appendix A.
For comparisons among households with differing compositions, parametric adult equivalent scales are used such that the adult equivalent size, $s$, of a household with $n_a$ adults and $n_c$ children is given by $s = (n_a + \theta n_c)^\alpha$, with $\theta = 0.6$ and $\alpha = 0.8$. The latter reflects the assumed extent of economies of scale within the household. The data used are obtained from the Household Economic Survey for 2010.

The empirical results are presented in Table 1 for deciles of the distribution of household expenditure per adult equivalent person. Consider first the section of the table for deciles of household expenditure per adult equivalent person. The final column shows the average budget share for food within each decile. This decreases systematically as total expenditure increases, consistent with Engel’s law. The first policy change considered is the simple zero-rating of food. With a GST-exclusive rate of 0.125, or 12.5% (consistent with the use of the 2009/10 Household Expenditure Survey), this implies a reduction in the price of food, while the prices of other goods remain constant in this partial equilibrium setting.

Hence it is expected that all households are better off as a result of this change, as indicated by the fact that all values of EV in the second column of the table are negative: the convention in the public finance literature that a welfare loss is indicated by a positive EV is followed here. Although all households gain, it is clear that those in the top expenditure decile (decile 10) gain considerably more than those in the lower decile in absolute terms. This reflects the poor ‘target efficiency’ of this kind of policy change where it is intended to generate greater equality: it is impossible to exempt food from indirect taxation for only those in specific categories defined by personal characteristics. Nevertheless, in relative terms, the lower total expenditure deciles gain relatively more than the higher deciles: the ratio $EV/z$ declines systematically as $z$ increases, from $-2.69$ in the first decile to $-1.04$ in the top decile.

As stressed above, this kind of tax policy change is not revenue neutral. In practice it would be necessary to raise tax revenue in other ways or reduce expenditure, in order to avoid debt increases. Suppose that the extra revenue (in aggregate) is obtained by increasing the GST rate applied to taxed goods and services. The new rate can be found only by a numerical iterative process, and it is found that the GST rate would need to increase by 2 percentage points. This is the rate obtained after all households adjust their consumption pattern as a result of the relative price change between taxed and untaxed goods.

| Decile  | EV    | EV/z  | Decile  | EV    | EV/z  | Food share (%) |
|---------|-------|-------|---------|-------|-------|----------------|
| 1       | -472  | -2.69 | 1       | -206  | -1.18 | 24.16          |
| 2       | -619  | -2.38 | 2       | -216  | -0.83 | 20.09          |
| 3       | -620  | -1.95 | 3       | -108  | -0.34 | 17.12          |
| 4       | -759  | -1.99 | 4       | -147  | -0.38 | 16.79          |
| 5       | -796  | -1.78 | 5       | -65   | -0.15 | 15.47          |
| 6       | -899  | -1.74 | 6       | -52   | -0.10 | 15.39          |
| 7       | -966  | -1.59 | 7       | 40    | 0.07  | 13.45          |
| 8       | -998  | -1.52 | 8       | 99    | 0.15  | 12.66          |
| 9       | -1003 | -1.32 | 9       | 292   | 0.38  | 11.19          |
| 10      | -1188 | -1.04 | 10      | 803   | 0.70  | 7.87           |

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The effects of this revenue neutral change are shown in the two columns under the heading ‘Revenue neutral’ in the table. For the first six decile groups the EV is still negative, reflective of a welfare gain, but for the higher decile groups there is a welfare loss. When converting to the ratio, \( EV/z \), the revenue neutral policy change is progressive in that the absolute value of the ratio, \( EV/z \), decreases as \( z \) increases. However, the relative gains to the lower decile groups are much smaller than with the first (revenue decreasing) policy change.

Table 2 shows results for various other groups distinguished by age, household structure and housing tenure. In particular it is seen that, with the groups classified by household structure, those with children are generally the only ones to experience welfare gains from the revenue neutral policy change. Consistent with this finding, the age group 35–44 – the prime child-rearing age bracket – experiences welfare gains from the revenue neutral change. Again, not surprisingly, those in the age group 65 and over also gain, on average, from the revenue neutral policy.

These results demonstrate clearly that the absolute and relative gains and losses from a revenue neutral policy of zero-rating food in a GST are small relative to total expenditure, despite the fact that the policy can achieve some progressivity. Such exemptions are a ‘poor redistributive instrument’. As demonstrated above using a simple illustration, a policy of raising transfer payments — even where these are received by everyone — is capable of producing more progressivity.

The above results may be compared briefly with those obtained by a simple comparison of tax payments in relation to total expenditure, with no allowance for demand responses to price changes, instead of using equivalent variations. Table 3 shows the ratio of the reduction in GST to the equivalent variation, for the revenue neutral policy change which, as explained above, involves an increase in GST of 2 percentage points. Where this ratio has a positive sign, the tax changes and welfare changes are in the same

| Age         | No GST on food | Revenue neutral | Food share (%) |
|-------------|----------------|-----------------|----------------|
|             | EV  | EV/z | EV   | EV/z |                  |
| < 25        | −720| −1.45| 133  | 0.27 | 11.56            |
| 25–34       | −852| −1.55| 79   | 0.14 | 13.01            |
| 35–44       | −977| −1.71| −21  | −0.04| 13.56            |
| 45–54       | −1011| −1.55| 101  | 0.15 | 12.77            |
| 55–64       | −850| −1.50| 116  | 0.20 | 12.61            |
| 65+         | −622| −1.98| −109 | −0.35| 16.21            |
| Household structure |      |      |      |      |                  |
| Single      | −409| −1.53| 43   | 0.16 | 12.07            |
| Single with children | −693| −1.77| −46  | −0.12| 14.64            |
| Couple only | −912| −1.54| 89   | 0.15 | 12.66            |
| Couple with children | −1222| −1.78| −89  | −0.13| 14.33            |
| Housing tenure |      |      |      |      |                  |
| Mortgage    | −892| −1.61| 45   | 0.08 | 13.12            |
| Renting     | −737| −1.66| 8    | 0.02 | 13.79            |
| Other       | −1020| −1.61| 47   | 0.08 | 13.13            |
direction. A negative sign indicates that the use of tax changes, with no demand responses, suggests a change in the opposite direction from that of the welfare change. In all the cases where there is a negative sign, the use of tax changes indicates a gain, whereas the use of equivalent variations indicates a welfare loss. Even where the two measures agree about the direction of change, it is clear that there are substantial differences in relative orders of magnitude.\textsuperscript{16}

4. The use of clusters
This section compares the above results with those obtained using an alternative method of grouping households. Ball and Ryan (2014) identified 12 representative types, referred to as clusters, for New Zealand households. The clusters were formed by grouping together households found to be similar on a range of economic and demographic dimensions, including the age of highest income earner, number of children, qualification,
home ownership status (mortgage holder or renter) and household disposable income. Additional dimensions are the proportions of income that comes from the following sources: government transfers (excluding working for families); private and public pensions; investments and private sources (excluding private pension and investments).

Table 4 provides key income and demographic information about the clusters. Clusters A and B are renting young low-income households. Furthermore, B has the highest number of children on average of any cluster (3.0) which, coupled with their relatively low income, means they have the highest food budget share of any cluster. In terms of explaining the differences in food budget shares for the two middle aged mortgage holding clusters, I and J, the average number of children is important. Cluster I has higher average wage and salary income than J, but has more children and hence a lower disposable income per adult equivalent, and a higher food budget share of 14.05 compared with 12.31 for cluster J.

Clusters E, H and K are the older households. Cluster E contains those who are fully retired and receive New Zealand Superannuation (NZS). Those in H work part-time in retirement while receiving NZS. Cluster K contains full-time workers receiving NZS or those still working but nearing the age of eligibility for NZS. Of these clusters, E has the highest food budget share (and the second highest of any cluster) reflecting their lower income. Those in K, who are working full-time and hence have the highest disposable income, have the lowest food budget share of the three older clusters. There are two young highly qualified clusters, C and G. Cluster G is characterised as being a cluster of young well-paid professionals, with relatively high salary earnings and a low average number of children; households in cluster C, although similarly qualified as G, differ from G insomuch as they receive lower wage and salary income. Reflecting their high income and lack of children, cluster G has a relatively low budget share of food (the second lowest of any cluster), while cluster C’s budget share is low relative to other clusters, reflecting their lack of children, but slightly higher than G’s reflecting their lower income. The inverse relationship between income and food budget share holds in the clusters with average age 50–60 as well. Members of L, mid-life highly qualified high earners with

Table 4. Cluster 2010 demographic and income information.

|       | HH disp income per AE | Wage and salary income | Population (000s) | Age of HH head | No of children | Food share |
|-------|-----------------------|------------------------|-------------------|----------------|---------------|------------|
| A     | 21,909                | 23,229                 | 156               | 33             | 0.7           | 13.82      |
| B     | 22,977                | 33,986                 | 104               | 38             | 3.0           | 19.38      |
| C     | 25,838                | 33,076                 | 132               | 34             | 0.6           | 12.27      |
| D     | 16,200                | 10,296                 | 103               | 57             | 0.1           | 15.94      |
| E     | 20,938                | 2266                   | 172               | 75             | 0.0           | 17.62      |
| F     | 33,168                | 37,952                 | 138               | 52             | 0.2           | 12.73      |
| G     | 60,640                | 101,020                | 159               | 30             | 0.3           | 11.13      |
| H     | 27,455                | 6315                   | 115               | 72             | 0.0           | 16.18      |
| I     | 45,461                | 88,866                 | 138               | 42             | 2.5           | 14.05      |
| J     | 52,247                | 84,086                 | 163               | 47             | 0.6           | 12.31      |
| K     | 71,284                | 53,794                 | 87                | 63             | 0.2           | 13.71      |
| L     | 72,624                | 108,176                | 158               | 53             | 0.3           | 10.99      |
high investment income, have a higher relative budget share on luxury items, such as international air travel, audio-visual and computing equipment and major cultural and recreational equipment but the lowest budget share of any cluster on food (11%). Households in Cluster F, on average, are roughly the same age as L, slightly less qualified and on lower incomes, and have a food budget share of 12.73% compared with 10.99%. The lowest income cluster of these, D, is a beneficiary cluster, with relatively large average payments of unemployment, invalid and sickness benefit, relatively low wage and salary income, and a food budget share of 15.94%.

Table 5 reports welfare changes for the clusters, whose characteristics are summarised in Table 4. All groups gain from the aggregate revenue-reducing policy of simply zero-rating food. Those with the largest gains from this policy, clusters A, B, D, E, H and I, continue to gain from the revenue-neutral policy. However, as before, their relative gains are much lower. Clusters D and E are the older households with few, if any, children and low average incomes, with relatively large food budget shares. Clusters B and I are households with relatively more children and, as expected, relatively high budget shares for food. The biggest losers from the revenue-neutral policy are clusters G and L, consisting of high-income households with few children and hence lower food budget shares.

5. Conclusions
This paper has investigated the detailed welfare effects on households of a change to the indirect tax structure in New Zealand involving the zero-rating of food in the GST. Such a policy is motivated in all other countries having a GST or value added tax system by a desire to introduce some progressivity into the GST structure, in view of the well-established property that the share of household expenditure devoted to food declines as household total expenditure increases. As mentioned in the introduction, it is sometimes argued that the case for zero-rating becomes stronger when the uniform GST rate is high. However, households with high total expenditure benefit more in absolute terms, so that such
a policy has poor targeting properties. This was illustrated using a simple model where the revenue lost from zero-rating food is instead devoted to a universal transfer payment, with a larger effect on progressivity.

The detailed effects of zero-rating food were then investigated for a range of household types, using Household Economic Survey data. Demand responses to consumer price changes were estimated and welfare changes, in terms of equivalent variations, were obtained. Comparisons were made for households in total expenditure decile and age groups. A revenue neutral reform was seen to produce a very small amount of progressivity in the GST, with welfare losses for higher decile groups and welfare gains for the lower deciles. Furthermore, redistribution is from high total expenditure households without children to lower total expenditure households with children, and older households. It was also shown that the use of tax changes, with an assumption of no responses to price changes, somewhat overstates the degree of progressivity achieved. The analysis supports earlier studies suggesting that the use of zero-rating in an indirect tax structure provides a poor redistributive instrument compared with direct taxes and transfers.

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Notes

1. A distinction needs to be made between exemptions from GST and zero-rating. With zero-rating, registered firms can claim tax credits on inputs purchased. With exemptions, such credits cannot be claimed. For a detailed analysis of zero-rating of food from a legal and administrative point of view, see van Klink (2012).
2. For international comparisons, using the concept of ‘C-efficiency’ (reflecting departure from a uniform system), see Keen (2013). He decomposes the efficiency measure into a ‘policy gap’ and a ‘compliance gap’.
3. Indeed, the configuration of tax rates is irrelevant only if judges are indifferent to the distribution of welfare and, in addition, if all own-price and cross-price elasticities of demand are zero. This is essentially a second-best problem in view of the impossibility of taxing endowments. For example, with identical preferences, a fixed wage rate distribution and a linear income tax, uniformity is optimal if Engel curves are linear and the marginal rate of substitution between goods is independent of leisure; see Stern (1990).
4. An argument for zero-rating certain food items considered to be healthy has been made, but the emphasis here is on the general redistributive case made in all countries where food is exempt (though the question of what constitutes food is not always clear, and problems arise in defining food consumed outside the home).
5. Although only the single tax is being examined rather than a tax and transfer system, the term ‘redistribution’ is used here, following the public finance convention.
6. If all households have identical tastes, additivity implies that optimal indirect tax rates are uniform. However, this does not arise in the present context because of the allowance for heterogeneity of expenditure patterns between groups.
7. On the revenue elasticity of indirect taxes in New Zealand, see Creedy and Gemmell (2004).
8. This is consistent with the elasticities converging towards unity, though the convergence may not be uniform. The budget shares are also affected by the tax structure, since
\[ w_i = \tau_i + \sum e_{i,r} \tau_r, \] where \( e_{i,r} \) is the cross-price elasticity of demand for good \( i \) with respect to a change in the price of good \( r \).

9. On reranking arising from indirect taxes in Australia, see Creedy (2002).

10. This policy effectively ignores any consequences arising from increased debt or reduced government expenditure as a result of the revenue reduction.

11. The unit is the household: that is, 10% of households are in the lower decile of household expenditure per adult equivalent.

12. All values reported are averages within the designated groups, obtained as weighted averages using the Household Economic Survey sample weights used to aggregate to population values. In the case of the budget shares, these are obtained as the ratio of the (weighted) average household expenditure on food, divided by weighted average total expenditure. This is in line with Statistics New Zealand calculations of budget shares (though of course the ratio of averages is not the same as the average of ratios).

13. It could be argued that, since food may enter as an intermediate input into some goods and services which are still subject to GST, those other goods will not have constant prices. This kind of effect cannot be considered here but can reasonably be expected to be small.

14. There is an exception in that the average ratio for decile 4 is slightly higher than that for decile 3.

15. Values for ‘Other households’ are omitted from the table. These two groups (with and without children) are extremely heterogeneous, and in the case of those without children the EV is negligible, making the ratio of the change in tax to the equivalent variation extremely high.

16. The larger values of \( \Delta \text{Tax}/\text{EV} \) observed for expenditure decile number 6 and renting households arise because the equivalent variations for these groups are in fact very small.

17. Since \( \tau_i = p_0/(1 + \tilde{p}_i) \), and defining \( \tilde{s}_i = p_0 \gamma_i/\sum p_0 \gamma_i \), it can be shown that \( A_1/A_0 = 1 + \sum \tilde{s}_i \tilde{p}_i \) and \( B_1/B_0 = \Pi (1 + \tilde{p}_i)^{\tilde{s}_i} \).

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Appendix A. Utility, demand elasticities and welfare

This appendix describes the method used to obtain demand elasticities and welfare changes using the linear expenditure system (LES), applied separately for a range of demographic groups (though the following notation generally omits the additional subscript).

The first stage is to obtain, for each household type, a set of average budget shares, \( w_{ki} \), for each consumption category, \( i \), and a range of total expenditure groups, \( k \). The total expenditure elasticities are obtained using the variations in budget shares for each commodity group. However, the
observed variability in budget shares gives rise to some negative total expenditure elasticities. This can be overcome by smoothing the data. The approach used was first to carry out a series of ordinary least squares regressions of the form:

\[ w_{ki} = a_i + b_i \log z_k + c_i(1/z_k) \]  

for each commodity group (and household type), where the values of \( z_k \) correspond to the arithmetic mean values of total expenditure in each group, \( k \). The form in Equation (A.1) provides a reasonably good fit for most groups and ensures that the predicted weights add to unity.

The second stage is to compute own- and cross-price elasticities, \( e_{ii} \) and \( e_{ij} \), (again for each total expenditure group and household type) using Frisch’s (1959) results for additive demand systems. The expressions require the use of the elasticity of the marginal utility of total expenditure with respect to total expenditure, \( \xi \), often referred to as the ‘Frisch parameter’. If \( \delta_{ij} \) denotes the Kronecker delta, such that \( \delta_{ij} = 0 \) when \( i \neq j \), and \( \delta_{ij} = 1 \) when \( i = j \), Frisch showed that the elasticities can be written as

\[ e_{ij} = -e_i w_j \left( 1 + \frac{e_j}{\xi} \right) + \frac{e_i \delta_{ij}}{\xi} \]  

(A.2)

It is necessary to make use of extraneous information about the way in which the Frisch parameter varies with total expenditure. In view of the role played by the Frisch parameter and the lack of a really firm foundation for the values used, it is important to carry out a range of sensitivity analyses.

The third stage involves obtaining parameters of the LES direct utility function (again for each total expenditure group and household type):

\[ U = \prod_i (x_i - \gamma_i)^{\beta_i} \]  

(A.3)

with \( 0 \leq \beta_i \leq 1 \); \( \gamma_i \) is the committed consumption of good \( i \), and \( \sum \beta_i = 1 \). The own-price elasticity, \( e_{ii} \), is given by

\[ e_{ii} = \frac{\gamma_i(1 - \beta_i)}{x_i} - 1 \]  

(A.4)

The total expenditure elasticity of good \( i, e_i \), is

\[ e_i = \frac{\beta_i z}{p_i x_i} \]  

(A.5)

Having obtained the total expenditure elasticities from the smoothed budget shares, the corresponding values of \( \beta_i \) at each total expenditure level were obtained using Equation (A.5), whereby \( \beta_i = e_i w_i \). Using the values of own-price elasticities as described in the second stage above, Equation (A.4) can be used to solve for \( p_i \gamma_i \), the committed expenditures for each good.

As before, the various parameters vary with \( z \), but the additional subscript is suppressed for convenience. Defining the terms \( A \) and \( B \) respectively as \( \sum p_i \gamma_i \) and \( \prod (p_i/\beta_i)^{\beta_i} \), the indirect utility function for the LES, \( V(p, z) \), is

\[ V = (z - A)/B \]  

(A.6)

The expenditure function, \( E(p, U) \), the minimum expenditure required to achieve \( U \) at prices \( p \), is found by inverting Equation (A.6) and substituting \( E \) for \( z \) to get

\[ E(p, U) = A + BU \]  

(A.7)
If the vector of prices changes from \( p_0 \) to \( p_1 \), the equivalent variation, \( EV \), is 
\[
EV = E(p_1, U_1) - E(p_0, U_1).
\]
Substituting for \( E \) using Equation (A.7) gives
\[
EV = z - (A_0 + B_0 U_1) \quad (A.8)
\]
Substituting for \( U_1 \), using Equation (A.6) into Equation (A.8) and rearranging gives
\[
EV = z - A_0 \left[ 1 + \frac{B_0}{B_1} \left( \frac{z}{A_0} - \frac{A_1}{A_0} \right) \right] \quad (A.9)
\]
The term \( A_1/A_0 \) is a Laspeyres type of price index, using \( \gamma_i \)'s as weights. The term \( B_1/B_0 \) simplifies to \( \prod (p_{1i}/p_{0i})^{\gamma_i} \), which is a weighted geometric mean of price relatives. These two terms can be expressed in terms of the \( \gamma_i \)s. \(^{17}\) If all prices change by the same proportion, \( \hat{p}_i = \hat{p} \) for all \( i \), and Equation (A.9) becomes 
\[
EV/z = (1 - B_0/B_1) + (A_0/z)(B_0/B_1)(A_1/A_0 - 1), \quad \text{with } B_1/B_0 = A_1/A_0 = 1 + \hat{p}.
\]