ISSN 0819-2642
ISBN 0 7340 2585 8

THE UNIVERSITY OF MELBOURNE

DEPARTMENT OF ECONOMICS

RESEARCH PAPER NUMBER 929

MARCH 2005

EXCISE TAXATION IN NEW ZEALAND

by

John Creedy
&
Catherine Sleeman

Department of Economics
The University of Melbourne
Melbourne Victoria 3010
Australia.

Excise Taxation in New Zealand[1]

John Creedy and Catherine Sleeman[2]

The University of Melbourne and the
Reserve Bank of New Zealand

Abstract

In New Zealand, excise taxes are levied on three commodity groups: alcohol, tobacco and petrol. The 2001 Tax Review, published by the New Zealand Treasury, argued that excises are inequitable and inefficient, and advised that these taxes should be removed and the revenue replaced by raising the standard rate of GST. This paper provides an empirical examination of these issues. First, the efficiency of New Zealand's current system of indirect taxes is examined. The welfare and redistributive effects resulting from the revenue-neutral removal of excise taxes are then examined. Welfare and redistributive measures are computed for a range of demographic groups and total weekly expenditure levels. While the largest efficiency gains and reductions in inequality are observed for households with at least one smoker, the overall distributional implications of the proposed reforms are found to be small.

.

JEL CLASSIFICATION H21, H23, H31

KEYWORDS Indirect taxation; equivalent variations; excess burdens; inequality; tax reform

[1] Early work on this paper was carried out while the authors were at the New Zealand Treasury, and was supported by a Treasury Post-Graduate Scholarship to Sleeman. However, the views, opinions, findings, and conclusions or recommendations expressed in this paper are strictly those of the authors. They do not necessarily reflect the views of the New Zealand Treasury or Reserve Bank of New Zealand. We should like to thank Seamus Hogan and Alan Woodfield from the University of Canterbury for helpful comments.
[2] Corresponding author: jcreedy@unimelb.edu.au

Excise Taxation in New Zealand

1 Introduction

The indirect tax system in New Zealand consists of a broad-based Goods and Services Tax (GST) imposed at a single rate, plus excise taxes on three broad commodity groups: alcohol, tobacco and petrol.[3] In the Treasury's review of the tax system, McCleod et al. (2001) argued that excise taxes are inefficient at raising tax revenue and inequitable, being regressive in nature. They argued (2001, p.41) that, 'the current excise and duty regime cannot readily be justified on conventional tax policy grounds. As a matter of tax principle the general revenue component of these taxes should be replaced by an increase in GST. At a minimum, the many anomalies in this area of the tax system should be subject to further review'. Their discussion did not include any evidence to support their assertions regarding efficiency or equity. This paper therefore explores the welfare and redistributive effects of excise taxes and the changes that may be expected to result from the revenue-neutral removal of excise taxes in New Zealand.

A standard argument in favour of the higher taxation of the commodity groups that are subject to excise taxes is that they are 'demerit goods' and give rise to substantial external costs. McCleod et al. (2001) questioned these arguments, though information about externalities is extremely hard to obtain.[4] The present paper concentrates on the welfare effects only; these may be compared with independent assessments of external effects.

The analysis proceeds as follows. The welfare effects of the taxes arise as a result of the higher prices imposed on consumers, so it is necessary to evaluate the likely price changes produced by any tax reform. Section 2 describes the existing indirect tax system, and shows how the GST and excise taxes interact to influence final prices. The empirical analysis requires a method of computing the welfare changes and excess burdens, measured here in terms of Hicksian equivalent variations for a variety of demographic groups over a range of total expenditure levels. The method used here follows Creedy (1998a,b) and is applied to New Zealand *Household Economic Survey* (HES) data. The technical details are given briefly in the Appendix, while section 3 provides information about the data and the household groups considered. An important qualification is that the

[3] The annual revenue raised by excise taxes is approximately $4 billion.
[4] For a case study of alcohol, see Barker (2002).

approach is partial equilibrium in nature: any changes to factor prices, and hence incomes, resulting from a tax policy change are ignored.

Section 4 examines the effects of the current tax structure, where the price changes are those resulting from the imposition of the taxes. Two hypothetical reforms are then considered in section 5. In the first, the excise taxes that are currently levied on alcohol and tobacco are removed, but the petrol excise tax is retained. This is because different types of argument relate to these groups. Discussion of the petrol excise tax usually revolves around environmental considerations relating to the over-use of scarce resources, and pollution issues. Alcohol and tobacco excise taxes are usually justified on demerit good and externality grounds. In the second tax reform, the excise taxes on all three commodity groups are removed. For each reform, the standard GST rate that would be required to achieve revenue neutrality is obtained. In computing this GST rate, allowance is made for the consumption changes arising from tax and relative price changes. Welfare measures are reported for representative total expenditure levels within a large number of demographic groups. Measures of inequality are reported in section 6, which provides overall summary indications of the direction and extent of the redistributive effects of the reforms. The sensitivity of the results to adult equivalence scales and the degree of inequality aversion are also considered in section 6. Conclusions are in section 7.

2 The Indirect Tax Structure

The computation of welfare measures requires all existing indirect taxes to be specified in terms of their effective tax-exclusive *ad valorem* rates. [5] This is straightforward for the majority of commodity groups which attract only GST of 12.5 per cent. However, the translation between tax rates and effective *ad valorem* rates is more complex for the three commodity groups subject to excise taxes, since they are expressed in commodity units rather than values, and GST is then imposed on the excise-tax-inclusive price of the commodity.

Let E denote the per unit excise tax, g the GST rate, and P^0 the tax-exclusive price of the good. The total tax paid, T, on a unit of the commodity is defined by:

$$\begin{aligned} T &= \left(P^0 + E\right)g + E \\ T &= P^0 g + E\left(1+g\right) \end{aligned} \qquad (1)$$

[5] The tax-exclusive tax rate is defined as the ratio of tax paid to the tax-exclusive price of the good, while the tax-inclusive tax rate is defined as the ratio of tax paid to the tax-inclusive price of the good.

Assuming that the full amount of the tax is passed forward to consumers, the tax-inclusive price of the good, P^1, is defined as:

$$\begin{aligned} P^1 &= P^0 + P^0 g + E\left(1+g\right) \\ P^1 &= \left(P^0 + E\right)\left(1+g\right) \end{aligned} \tag{2}$$

Hence:

$$P^0 = \frac{P^1}{\left(1+g\right)} - E \tag{3}$$

The effective tax-exclusive *ad valorem* tax rate, $t = T / P^0$, is therefore:

$$t = g + \frac{E}{P^0}\left(1+g\right) \tag{4}$$

For example, in 2001 the petrol excise tax, E, was \$0.343 per litre, and the proportional GST rate, g, was 0.125. Let the consumer price of petrol, P^1, be \$1.08 per litre. Hence, from equation (3) the tax-exclusive price, P^0, was \$0.617, and from equation (4) the effective tax-exclusive *ad valorem* tax rate on petrol, t, was 0.75 cents in the dollar.

Due to estimation requirements it was not possible to retain all the separate and highly detailed commodity groups in the HES. Instead, these were consolidated into 22 commodity groups. Where several HES groups were combined, a weighted average of the tax rates on the HES groups was taken to produce one effective *ad valorem* tax rate.[6] Table 1, based on details given in Young (2002), shows the commodity groups used and the effective tax-exclusive *ad valorem* tax rates for 2001. The group described as 'Petrol' actually combines petrol with diesel, CNG and LPG. Hence the appropriate tax rate for this combination requires a weighted average of petrol and other fuel taxes. The basic (year 2001) rate used for this group is 0.718, which is correspondingly lower than the effective rate of 0.75 on petrol discussed above.

Two commodity groups do not attract any form of indirect tax. Overseas Travel (Group 1) is zero rated and therefore attracts a GST rate of zero per cent, while Rent (Group 2) is exempt from GST. Recreational Vehicles (Group 3) and Vehicle Purchases (Group 4) do attract GST but for both groups, the HES includes expenditures on second-hand vehicles, which are exempt. The majority of commodity groups attract the standard GST rate of 12.5 per cent. Alcohol, Petrol and Tobacco (Groups 20 to 22) all attract excise taxes in addition to GST. The excise rates are clearly substantial, with the effective *ad valorem* tax rate on tobacco falling just short of 240 per cent.

[6] The weights were computed using expenditure data on each commodity.

Table 1 – Commodity Groups and Effective *Ad Valorem* Tax Rates

No.	Commodity Group	Tax Rate (%)	No.	Commodity Group	Tax Rate (%)
1	Overseas Travel	0	12	Household Services	12.5
2	Rent	0	13	Adult's Clothing	12.5
			14	Children's Clothing	12.5
3	Recreational Vehicles	6.3	15	Public Transport in NZ	12.5
4	Vehicle Purchases	7.1	16	Vehicle Supplies, Parts etc	12.5
			17	Medical, Cosmetic etc	12.5
5	Food	12.5	18	Services	12.5
6	Food Outside Home	12.5	19	Other Expenditure	12.5
7	Pay to Local Authorities	12.5			
8	House Maintenance	12.5			
9	Domestic Fuel and Power	12.5	**20**	**Alcohol**	**46.8**
10	Household Equipment	12.5	**21**	**Petrol**	**71.8**
11	Furnishings	12.5	**22**	**Tobacco**	**239.8**

Changes in effective rates must be translated into proportionate price changes. In general, suppose that the tax-exclusive *ad valorem* tax rate imposed on good i is denoted t_i, which is equivalent to a tax-inclusive rate of $t_i/(1+t_i)$. The revenue, R_i, from this indirect tax is equal to expenditure multiplied by the tax-inclusive rate. If t_i is increased by the proportional rate, $\dot{t}_i$, the resulting proportionate increase in the price of the ith good, $\dot{p}_i$, is given by:

$$\dot{p}_i = \dot{t}_i \left(\frac{t_i}{1+t_i} \right) \tag{5}$$

The price changes can then be used to obtain the required welfare changes. In the case of the existing tax structure, the 'initial' tax rate is obviously zero, so the proportional price change is the actual tax rate.

3 Household Expenditure Data

The welfare and redistributive measures were computed using data collected from households participating in the 1995, 1996, 1997, 1998 and 2001 *Household Economic Surveys* (HES).[7] The data set consists of the reported weekly expenditure on each commodity group for each household, from which the budget shares were computed. The expenditure data were adjusted to 2001 prices using the consumer price index (CPI).

[7] Surveys have only been conducted tri-annually since 1998.

There were very few changes in indirect tax rates over this period. The surveys were then pooled to form one large database, providing approximately 13,500 households.

Each household was placed into one of the eighteen household groups shown in Table 2.[8] The groups were further sub-divided into smoking and non-smoking households. A positive weekly expenditure on tobacco was sufficient for a household to be designated as a smoking household. The division into smoking and non-smoking households was found to improve substantially the fit of the estimated budget share relationships discussed in the appendix. Table 2 shows the number of households in each group together with their mean level of total weekly expenditure. As explained in the appendix, welfare measures are derived from the Linear Expenditure System. The preferences of each household are unique to the household's total expenditure level and demographic group.

Table 2 – Household Groups

No.	Household Group	Number of Households		Mean Total Expenditure ($)	
		Smoking	Non-Smoking	Smoking	Non-Smoking
1	65+ Single	16	1282	267	274
2	65+ Couple	224	1191	498	540
3	Single Adult & No Children	384	1098	406	437
4	Single Adult & 1 Child	148	239	400	403
5	Single Adult & 2 Children	148	181	428	438
6	Single Adult & 3 Children	59	75	468	475
7	Single Adult & 4+ Children	33	39	501	539
8	Adult Couple & No Children	966	2036	690	766
9	Adult Couple & 1 Child	381	643	668	763
10	Adult Couple & 2 Children	435	916	707	896
11	Adult Couple & 3 Children	207	458	805	844
12	Adult Couple & 4+ Children	98	195	673	822
13	3 Adults & No Children	319	456	975	992
14	3 Adults & 1 Child	122	157	898	1038
15	3 Adults & 2+ Children	117	134	826	920
16	4+ Adults & No Children	179	192	1311	1282
17	4+ Adults & 1 Child	65	60	1110	1129
18	4+ Adults & 2+ Children	47	47	1070	925
	Total	4093	9399		

[8] For the second group, the age refers to that of the 'head of the household'.

4 Welfare Effects of Existing Indirect Taxes

This section examines the welfare effects of New Zealand's current indirect tax system. The starting point was an economy with no indirect taxes. The current schedule, as shown in Table 1, was then imposed and the resulting welfare changes analysed. This was accomplished by moving in the opposite direction and imposing a set of proportional price reductions, equal to the current set of tax rates. The required equivalent variation resulting from the tax structure was therefore the negative of the compensating variation produced by the set of price reductions.

In addition to equivalent variations, EV, it is useful to examine the welfare costs of the indirect tax system.[9] Welfare cost, WC, provides a measure of efficiency loss and is defined as the excess burden per dollar of tax raised, or:

$$WC = \frac{EV - Tax}{Tax} \tag{6}$$

Further, the ratio of equivalent variation to total expenditure, EV/m, can be used to examine the proportionate change in the money metric measure of utility when pre change prices are used as the reference set of prices. Therefore, the relationship between the ratio, EV/m, and m within each household group can be used to gauge the disproportionality of the welfare impact from imposing the current indirect tax system. The system is described as progressive when EV/m rises with m, and regressive when it falls with m.

For each household group, measures of welfare change were computed for a range of total expenditure levels. The tax system was found to be regressive for multi-adult smoking households. However among single adult smoking households, the system is progressive. Furthermore, the rate at which EV/m rises with total expenditure increases with the number of children in the household.

Among the non-smoking households the effect of the current system was found to be ambiguous in terms of the behaviour of EV/m. The tax system is generally regressive over lower levels of total expenditure, but becomes increasingly progressive over higher levels, particularly among single adult households and those with multiple children. Hence, when examining separate demographic groups, there is no strong evidence of a

[9] The equivalent variation is used here as it simplifies the computation of efficiency measures: the excess burden based on the compensating variation would need to evaluate the tax change allowing for compensation. Furthermore, as mentioned below, the ratio of the equivalent variation to total expenditure is the proportional change in money metric utility, where the latter is based on pre-reform prices.

regressive effect of indirect taxes: a more detailed analysis thus requires overall summary measures of inequality, as given in section 6 below.

Summary welfare measures were computed for each household group, based on its arithmetic mean total expenditure level, $\bar{m}$. The latter gives a representative indication of the likely welfare costs faced by each household group, and enables between-group comparisons to be made more easily. These results are reported in Table 3, where Tax describes the weekly amount of indirect tax paid by each household group based on $\bar{m}$.

The equivalent variation, as a ratio of $\bar{m}$, varies among demographic groups. The range is from about 8 to 16 per cent. The ratio is in fact similar for most household groups, yet is notably smaller for single adult household groups with children and higher for pensioner households (Groups 1 and 2) who smoke. The ratio $EV / \bar{m}$ is higher among smoking households in comparison with non-smoking households, with large differences in some cases (in particular, between smoking and non-smoking pensioners).

For the majority of household groups, the welfare costs per dollar of tax raised are small, suggesting that the indirect tax system as a whole is relatively efficient at raising revenue. These welfare cost values are substantially lower than figures generally suggested for income tax revenue, for example, where there is an increasing marginal rate structure. However, as shown in Figures 1 and 2, smoking household groups do incur relatively higher welfare costs than their non-smoking counterparts. For every dollar of indirect tax paid, the efficiency losses incurred by smoking household groups range between about 2 and 8 cents, while for non-smoking households, these losses range between only about 1 and 4 cents.

Furthermore, there is a strong negative correlation between the welfare costs incurred by smoking household groups and their mean total expenditure levels. Accordingly, pensioners and single adult household groups who have the lowest mean total expenditure levels incur the largest welfare costs. This correlation reflects the effects of the excise tax on tobacco, towards which poorer household groups devote larger fractions of their total weekly budget. This correlation is not observed among the non-smoking household groups.

Table 3 – Welfare Effects of the Current Indirect Tax System

		Smoking Households				Non-Smoking Households			
No.	Household Group	$\bar{m}$	Tax	$EV/\bar{m}$	WC	$\bar{m}$	Tax	$EV/\bar{m}$	WC
1	65+ Single	267	42.23	0.1709	0.0805	274	29.49	0.1092	0.0142
2	65+ Couple	498	78.68	0.1656	0.0483	540	62.73	0.1181	0.0171
3	Single Adult & No Children	406	60.14	0.1567	0.0582	437	46.94	0.1092	0.0166
4	Single Adult & 1 Child	400	44.58	0.1165	0.0455	403	37.12	0.0938	0.0189
5	Single Adult & 2 Children	428	48.44	0.1195	0.0562	438	38.37	0.0896	0.0232
6	Single Adult & 3 Children	468	47.29	0.1096	0.0848	475	42.62	0.0914	0.0188
7	Single Adult & 4+ Children	501	51.82	0.1086	0.0498	539	45.17	0.0853	0.0177
8	Adult Couple & No Children	690	100.57	0.1509	0.0356	766	86.46	0.1145	0.0142
9	Adult Couple & 1 Child	668	92.52	0.1448	0.0452	763	85.17	0.1131	0.0128
10	Adult Couple & 2 Children	707	94.33	0.1361	0.0197	896	102.44	0.1157	0.0118
11	Adult Couple & 3 Children	805	106.71	0.1355	0.0223	844	96.12	0.1149	0.0091
12	Adult Couple & 4+ Children	673	92.90	0.1432	0.0375	822	90.84	0.1141	0.0326
13	3 Adults & No Children	975	139.50	0.1468	0.0262	992	114.24	0.1169	0.0154
14	3 Adults & 1 Child	898	127.99	0.1464	0.0270	1038	121.04	0.1182	0.0132
15	3 Adults & 2+ Children	826	116.38	0.1496	0.0620	920	102.96	0.1162	0.0381
16	4+ Adults & No Children	1311	173.93	0.1349	0.0167	1282	147.83	0.1172	0.0162
17	4+ Adults & 1 Child	1110	168.93	0.1574	0.0345	1129	130.73	0.1207	0.0428
18	4+ Adults & 2+ Children	1070	145.72	0.1412	0.0371	925	105.96	0.1158	0.0109

Figure 1 – Welfare Costs of the Current Indirect Tax System for Smoking Households

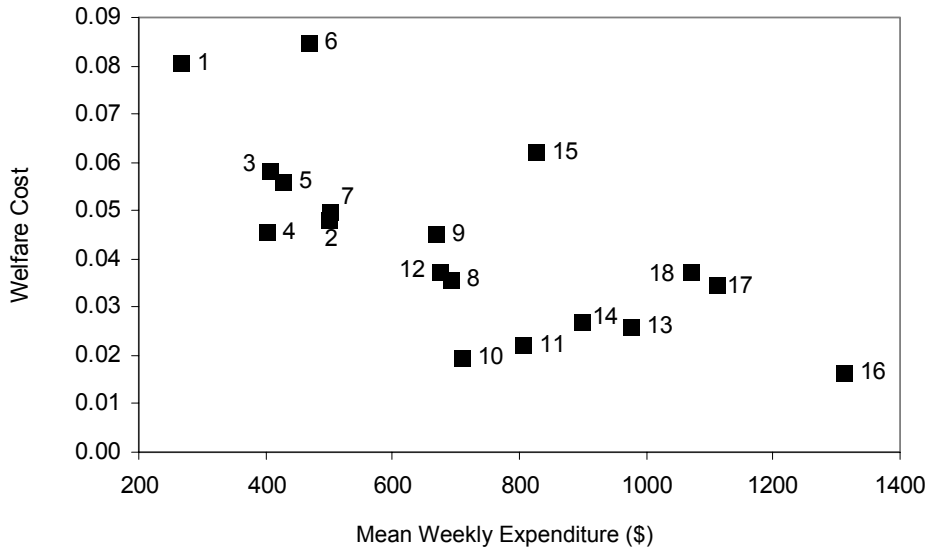
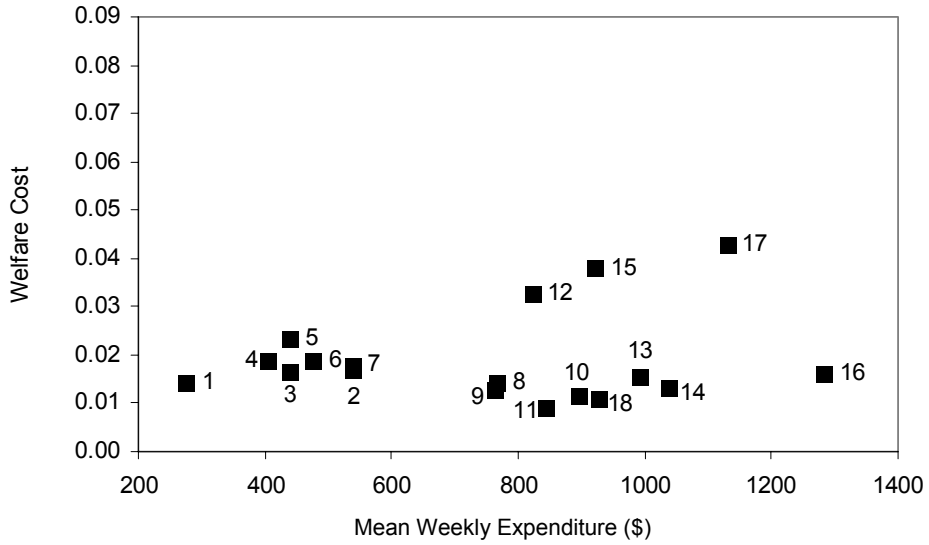


Figure 2 – Welfare Costs of the Current Indirect Tax System for Non-Smoking Households



5 Revenue-Neutral Tax Reforms

This section examines the welfare and redistributive effects of the revenue-neutral removal of excise taxes in New Zealand. For comparative purposes, two reforms are considered, both of which involve the removal of the alcohol and tobacco excise taxes. The petrol excise tax is retained in the first reform but removed in the second. Subsection 5.1 provides the schedule of adjusted GST rates which are required to achieve revenue neutrality for each reform. The marginal welfare implications for each household group are analysed in subsection 5.2.

5.1 Revenue Neutrality

For each reform the standard GST rate was raised to ensure that the total amount of indirect tax paid by households remained constant, allowing for the changes in demands following the relative price changes. This involved the use of an iterative search procedure. It was found that to support the revenue-neutral removal of the alcohol and tobacco excise taxes, the standard GST rate would need to rise from 12.5 to 14.4 per cent. The corresponding rates on Recreational Vehicles and Vehicle Purchases (groups 3 and 4 in Table 1) increase to 8.1 and 8.9 per cent respectively, while by assumption the

effective rate of petrol tax was fixed at 71.8 per cent.[10] When in addition, the petrol excise tax is removed the required GST rate rises to 15.9 per cent (with the rates on commodity groups 3 and 4 increasing to 9.7 and 10.5 per cent respectively).

5.2 Welfare Results

Measures of welfare change were computed for a range of total expenditure levels for each household type. When examining tax reforms, the appropriate concept is the marginal excess burdens, MEB, defined as:

$$MEB = EV - \Delta T \tag{7}$$

where ΔT is the change in the amount of indirect tax paid. The closely related measure of marginal welfare cost, MWC, is obtained by scaling the marginal excess burden by the absolute value of the change in tax paid, ΔT:

$$MWC = \frac{MEB}{|\Delta T|} \tag{8}$$

In cases where households pay less tax as a result of a reform and are better off, the equivalent variation is negative and the efficiency gain is that remaining after (hypothetically) returning the tax 'rebate'. As marginal welfare cost measures the gain per dollar of (reduced) revenue, the marginal excess burden must be divided by the absolute tax change. Thus a negative value for MWC denotes an efficiency gain.

In terms of the equity effects of the reforms, it was found that with the alcohol and tobacco excise taxes removed, the ratio of EV/m increased with total expenditure within all smoking household groups. This suggests that the reform is progressive for smoking households. In contrast, the reform produced profiles of the ratio that appeared non-monotonic for the majority of non-smoking households, for whom the ratio of EV/m showed no systematic rise or fall with total expenditure. The additional removal of the petrol excise tax caused no substantial changes in the progressivity of the reform for smoking households. However, for non-smoking households, the removal of the petrol excise tax prompted substantial increases in EV/m with total expenditure within each group. This led the reform to appear progressive for the majority of non-smoking household groups. Further analysis of equity effects is provided in section 6.

The present section therefore concentrates on comparisons between demographic groups, so that welfare measures were again computed based on each group's arithmetic mean total expenditure level, $\bar{m}$. The use of the mean expenditure levels provides more representative indications as to the likely levels of welfare change faced by each

[10] The excise tax on petrol was considered to be lowered sufficiently to counter the rise in the standard GST

household type. Tables 4 and 5 report the summary welfare measures for the first and second reforms respectively.

For both reforms, all smoking household types experience reductions in the amount of weekly indirect tax paid, with the largest reductions obtained by households with three or more adults. The smallest reductions are gained by household groups with single adults. Although all non-smoking household groups incur increases in tax paid, these are generally small in size. The absolute differences in tax for the smoking and non-smoking households is explained by the fact that there are many more of the latter groups of household. The revenue-neutral removal of the alcohol and tobacco excise taxes generates increases in tax paid for non-smoking households that rise with the number of adults in the household. However, the removal of all excise taxes leads household groups with three or more adults to experience smaller increases in tax paid relative to other groups.

Figures 3 and 4 plot the indirect tax paid under the current schedule of indirect taxes (Table 3) against the changes in tax paid which result from the revenue-neutral removal of the alcohol and tobacco excise taxes for smoking and non-smoking household groups respectively. Among smoking household groups, those currently paying the largest amounts of indirect tax stand to experience the greatest reductions in tax paid. However as Figure 4 shows, these reductions are funded primarily by the non-smoking household groups which already pay the largest amounts of indirect tax under the current schedule.

The welfare gains experienced by smoking household groups were similar for both reforms and lay primarily between two and six per cent of the groups' mean weekly expenditure level. Household groups containing one and two adults with no children enjoyed the largest welfare gains as a fraction of their mean total expenditure. The welfare losses which were incurred by all non-smoking household groups were trivial in size, typically forming less than one per cent.

rate to ensure the effective *ad valorem* tax rate on petrol remained constant.

Table 4 – Marginal Welfare Changes from the Revenue-Neutral Removal of the Alcohol and Tobacco Excise Taxes

		Smoking Households				Non-Smoking Households			
No.	Household Group	$\bar{m}$	ΔT	$EV/\bar{m}$	MWC	$\bar{m}$	ΔT	$EV/\bar{m}$	MWC
1	65+ Single	267	-12.02	-0.0673	-0.4950	274	2.91	0.0116	0.0928
2	65+ Couple	498	-15.99	-0.0445	-0.3859	540	4.76	0.0095	0.0735
3	Single Adult & No Children	406	-15.32	-0.0519	-0.3760	437	3.41	0.0083	0.0587
4	Single Adult & 1 Child	400	-6.47	-0.0203	-0.2566	403	3.48	0.0093	0.0718
5	Single Adult & 2 Children	428	-6.74	-0.0216	-0.3694	438	3.80	0.0095	0.0921
6	Single Adult & 3 Children	468	-5.38	-0.0190	-0.6561	475	4.46	0.0103	0.0987
7	Single Adult & 4+ Children	501	-2.65	-0.0096	-0.8226	539	4.35	0.0088	0.0943
8	Adult Couple & No Children	690	-17.88	-0.0339	-0.3082	766	5.43	0.0074	0.0460
9	Adult Couple & 1 Child	668	-14.91	-0.0310	-0.3870	763	6.94	0.0098	0.0749
10	Adult Couple & 2 Children	707	-11.05	-0.0217	-0.3910	896	8.57	0.0103	0.0817
11	Adult Couple & 3 Children	805	-9.94	-0.0163	-0.3189	844	8.45	0.0109	0.0899
12	Adult Couple & 4+ Children	673	-10.87	-0.0227	-0.4039	822	9.59	0.0131	0.1251
13	3 Adults & No Children	975	-18.97	-0.0250	-0.2826	992	7.10	0.0074	0.0352
14	3 Adults & 1 Child	898	-16.89	-0.0246	-0.3073	1038	9.62	0.0101	0.0852
15	3 Adults & 2+ Children	826	-13.57	-0.0236	-0.4363	920	9.30	0.0113	0.1161
16	4+ Adults & No Children	1311	-19.37	-0.0177	-0.1982	1282	8.55	0.0068	0.0199
17	4+ Adults & 1 Child	1110	-23.87	-0.0254	-0.1789	1129	10.61	0.0103	0.1008
18	4+ Adults & 2+ Children	1070	-16.99	-0.0222	-0.3949	925	9.64	0.0116	0.1089

Table 5 – Marginal Welfare Changes from the Revenue-Neutral Removal of the Alcohol, Tobacco and Petrol Excise Taxes

		Smoking Households				Non-Smoking Households			
No.	Household Group	$\bar{m}$	ΔT	$EV/\bar{m}$	MWC	$\bar{m}$	ΔT	$EV/\bar{m}$	MWC
1	65+ Single	267	-11.04	-0.0640	-0.5480	274	3.95	0.0151	0.0456
2	65+ Couple	498	-16.47	-0.0471	-0.4250	540	4.91	0.0088	-0.0285
3	Single Adult & No Children	406	-16.02	-0.0556	-0.4101	437	2.86	0.0060	-0.0874
4	Single Adult & 1 Child	400	-7.44	-0.0244	-0.3132	403	2.82	0.0066	-0.0532
5	Single Adult & 2 Children	428	-7.97	-0.0265	-0.4228	438	3.65	0.0081	-0.0219
6	Single Adult & 3 Children	468	-5.56	-0.0210	-0.7644	475	4.76	0.0100	-0.0063
7	Single Adult & 4+ Children	501	-2.27	-0.0110	-1.4361	539	2.75	0.0053	0.0473
8	Adult Couple & No Children	690	-19.74	-0.0381	-0.3303	766	4.58	0.0055	-0.0852
9	Adult Couple & 1 Child	668	-17.24	-0.0366	-0.4182	763	6.50	0.0083	-0.0231
10	Adult Couple & 2 Children	707	-12.54	-0.0252	-0.4211	896	8.85	0.0101	0.0260
11	Adult Couple & 3 Children	805	-11.51	-0.0192	-0.3440	844	8.76	0.0108	0.0445
12	Adult Couple & 4+ Children	673	-14.35	-0.0301	-0.4105	822	9.76	0.0129	0.0861
13	3 Adults & No Children	975	-22.12	-0.0297	-0.3092	992	4.58	0.0038	-0.1659
14	3 Adults & 1 Child	898	-19.23	-0.0285	-0.3323	1038	7.59	0.0073	0.0040
15	3 Adults & 2+ Children	826	-18.47	-0.0325	-0.4543	920	7.83	0.0085	-0.0051
16	4+ Adults & No Children	1311	-24.84	-0.0229	-0.2093	1282	5.37	0.0031	-0.2551
17	4+ Adults & 1 Child	1110	-33.18	-0.0363	-0.2140	1129	6.99	0.0057	-0.0858
18	4+ Adults & 2+ Children	1070	-22.62	-0.0296	-0.4010	925	5.58	0.0056	-0.0627

Figure 3 – Current Tax Paid and Changes in Tax Paid: Smoking Households

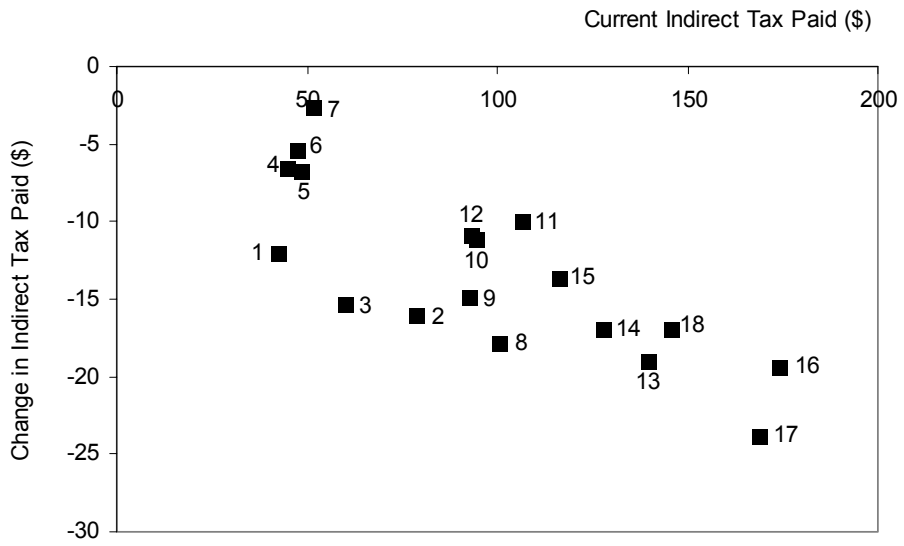
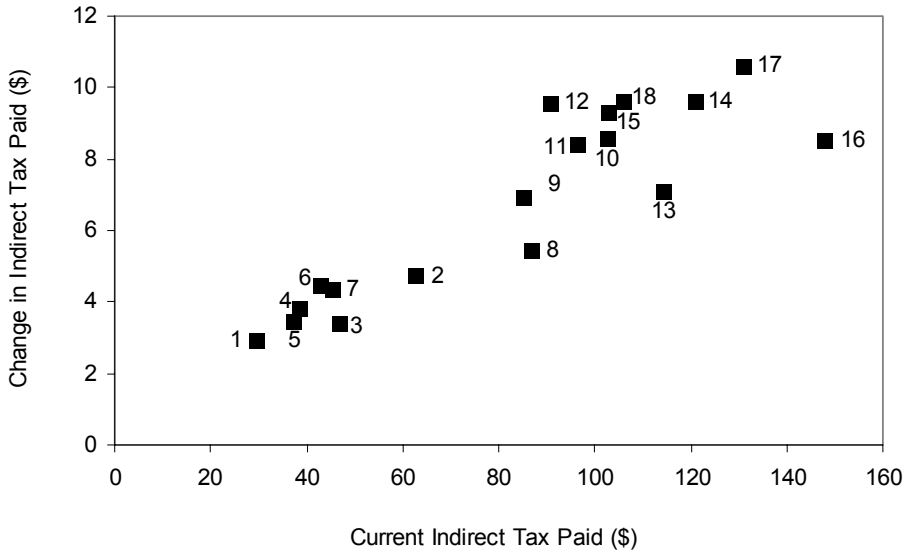


Figure 4 – Current Tax Paid and Changes in Tax Paid: Non-Smoking Households



Tables 4 and 5 also provide the marginal welfare costs of both reforms. Excise taxes create efficiency losses by distorting the prices of the affected commodities relative to other commodity prices. The elimination of all excise taxes reduces these distortions, which lead the majority of household groups to experience marginal welfare benefits. However, both reforms also entail raising the rate of GST to achieve revenue neutrality. As the rate of GST rises, the commodities groups Rent and Overseas Travel (Groups 1 and 2 in Table 1) remain, respectively, exempt and zero rated. Hence, the reforms enlarge

the distortions between the prices of these commodities relative to those which attract GST. This counters the efficiency gains which stem from the removal of the excise taxes and leads some non-smoking household groups to incur marginal welfare costs or efficiency losses. This is particularly true of the first reform, in which the petrol excise tax is retained.

For both reforms, all smoking household groups experience substantial marginal welfare benefits. For every dollar reduction in tax paid, the revenue-neutral removal of all excise taxes leads smoking households groups to experience efficiency gains ranging between about 20 and 50 cents. However, for single adult households with three or more children these are much higher, despite the fact that they devote the smallest budget shares to alcohol, tobacco and petrol. This counterintuitive result may be explained by the resulting small reduction in tax paid by these household groups, so that the denominator is close to zero (the MWC expression has a singularity when there is no change in tax paid).[11]

The revenue-neutral removal of the alcohol and tobacco excise taxes leads all non-smoking household groups to incur marginal welfare costs. However, these costs are of a trivial size. Furthermore, the removal of the petrol excise tax leads two thirds of all non-smoking household groups to acquire small gains in efficiency. Thus, these household groups experience increases in efficiency despite paying more tax. In contrast to smoking household groups, non-smoking household groups with no children incur the smallest marginal welfare costs and largest marginal welfare benefits from the first and second reforms respectively. Non-smoking household groups with multiple children feared worst, sustaining the largest efficiency losses. No significant correlations were found between the budget shares which non-smoking household groups devote to the excise commodities and either the groups' changes in tax paid or their marginal welfare costs. The marginal changes in welfare are more varied across the smoking household groups than the non-smoking household groups.

6 Indirect Taxes and Inequality

It was found in the previous section that the analysis of ratios of equivalent variations to total expenditure does not generally give an unambiguous indication of the overall progressivity or otherwise of excise tax reforms.[12] This section therefore considers the equity effects of the excise tax reforms by examining overall measures of inequality, both within demographic groups and over all households combined. When examining

[11] For both reforms, the efficiency gains of smoking household groups typically rise with the number of children, while at the same time the reductions in tax paid fall.

households with differing demographic compositions, it is necessary to use some kind of adult equivalence scale. In measuring inequality, it is clearly not appropriate simply to use a measure of total expenditure net of indirect taxes, since these do not accurately reflect welfare changes. Furthermore, a measure of inequality must be chosen. These issues are considered in subsection 6.1, and results are reported in subsection 6.2. Sensitivity analyses are undertaken in subsection 6.3.

6.1 Money Metric Measures and Equivalence Scales

The analysis here uses a money metric measure of each household's utility to measure 'wellbeing'. The money metric, m_e, is defined as the level of total expenditure that, at a set of reference prices, gives the same utility as the actual total expenditure. This money metric ensures that alternative situations are evaluated using a common set of reference prices, and it is invariant with respect to monotonic transformations of utility. When the vector of pre-reform prices, p^0, is used as the reference set of prices, the pre-reform and post-reform money metric measures are:[13]

$$m_e^{\,0} = m \tag{9}$$

$$m_e^{\,1} = m - EV \tag{10}$$

Measures of inequality are designed for populations that are demographically homogenous. However, populations are comprised of households that have a variety of different demographic structures. Achieving the required homogeneity to compute the inequality measures involves creating, as Ebert (1997, p.235) aptly put it, 'an (artificial) income distribution for a fictitious population'. The artificial income distribution is created by scaling the money metric measure of utility by an adult equivalence scale, h. The resulting distribution, $z = m_e / h$, provides a measure of 'wellbeing' that is comparable across all individuals in a population.[14] The present analysis uses the two-parameter equivalence scale, which takes the form:

$$h = \left(n_a + \theta n_c\right)^{\alpha} \tag{11}$$

where n_a and n_c are the number of adults and children in the household respectively. The parameter θ measures the size of children relative to adults, and the term α reflects economies of scale in consumption. On the use of this form, see Jenkins and Cowell

[12] The ratio EV/m gives only a local measure of progressivity.

[13] The proportionate change in money metric utility is conveniently the ratio of the equivalent variation to total expenditure – which provides a rationale for the earlier discussion of local progressivity in terms of the variation in this ratio with total expenditure.

[14] For within-group inequality, the equivalence scale chosen only affects the calculations for household groups: 7, 12 and 15-18 (see Table 1) which do not contain a homogenous number of adults and children.

(1994, p.894). The results reported here use the values $\theta = 0.65$ and $\alpha = 0.75$. These values are roughly 'mid-range' values of a large number of scales used and examined in Creedy and Sleeman (2004). However, sensitivity results are also reported below.

The fictitious population is created by selecting a unit of analysis for which the inequality measures are calculated. Possible units include the household, the equivalent adult and the individual. The present analysis uses the individual. The inequality measure reported is the Atkinson measure of inequality.[15] This is based on the social welfare function, W, defined as:

$$W = \frac{1}{\sum_{i=1}^{N} n_i} \sum_{i=1}^{N} n_i V(z_i) \tag{12}$$

where n_i is the number of individuals in the ith household $(i = 1, \ldots, N)$ and $V(z)$ is increasing and concave. Most commonly, V takes the form:

$$V(z) = \frac{z^{1-\varepsilon}}{1-\varepsilon} \tag{13}$$

for $\varepsilon \neq 1$, and $V(z) = \log z$ when $\varepsilon = 1$. The parameter ε reflects the policymaker's aversion to inequality. The following subsection reports results for ε of 1.2, which represents substantial aversion to inequality, though sensitivity analyses are also discussed. The equally distributed equivalent, $\tilde{z}$, is the money metric which, if received by every individual, would give the same level of social welfare, W, as the actual distribution. The Atkinson measure of inequality is the proportional difference between the arithmetic mean, $\bar{z}$, and the equally distributed equivalent, $\tilde{z}$, and is thus:

$$A(\varepsilon) = \frac{\bar{z} - \tilde{z}}{\bar{z}} \tag{14}$$

Pre-reform and post-reform measures of inequality are generated for each household group and for all households combined. The percentage difference between the pre and post-reform measures provides an indication of the redistributive effect of the tax reforms.

6.2 Tax Reforms and Inequality

Tables 6 and 7 report the pre-reform and post-reform values of the Atkinson inequality measure for the first and second reforms respectively. For both reforms, all smoking

[15] A range of extended Gini measures were also computed, but gave similar results.

household groups experience reductions in inequality. For the revenue-neutral removal of all excise taxes, these reductions range from 0.1 to 8.6 per cent. Smoking household groups with two or more adults have greater reductions in inequality from the second as opposed to the first reform. These household groups were found to devote the largest budget shares to petrol. In contrast, smoking household groups with one adult, which devote smaller budget shares to petrol, generally experience larger reductions in inequality from the revenue-neutral removal of just the alcohol and tobacco excise taxes.

Among the non-smoking household groups, the removal of the alcohol and tobacco excise taxes causes the majority to incur a slight increase in inequality. However, the additional removal of the petrol excise tax leads to all but one non-smoking household group experiencing a reduction in inequality. As with the welfare results, the percentage changes in inequality for the smoking household groups exhibit greater variation than those for the non-smoking household groups.

The overall reductions in inequality are small, as these are dominated by the non-smoking households, which incur some of the smallest reductions and in some cases increases in inequality from the reforms. However, the overall reduction in inequality approximately doubles when the petrol excise tax is removed.

Table 6 - Atkinson Inequality Measures for the Revenue-Neutral Removal of the Alcohol and Tobacco Excise Taxes

No.	Household Group	Atkinson Inequality Measure ($\varepsilon = 1.2$)					
		Smoking Households			Non-Smoking Households		
		Pre:	Post:	%Δ:	Pre:	Post:	%Δ:
1	65+ Single	0.1567	0.1502	-4.1481	0.1695	0.1700	0.2950
2	65+ Couple	0.1044	0.1001	-4.1188	0.1733	0.1736	0.1731
3	Single Adult & No Children	0.1804	0.1728	-4.2129	0.1928	0.1929	0.0519
4	Single Adult & 1 Child	0.0876	0.0849	-3.0822	0.1310	0.1313	0.2290
5	Single Adult & 2 Children	0.1027	0.1001	-2.5316	0.1318	0.1315	-0.2276
6	Single Adult & 3 Children	0.1140	0.1131	-0.7895	0.1270	0.1267	-0.2362
7	Single Adult & 4+ Children	0.0722	0.0708	-1.9391	0.1162	0.1158	-0.3442
8	Adult Couple & No Children	0.1285	0.1230	-4.2802	0.1670	0.1671	0.0599
9	Adult Couple & 1 Child	0.1237	0.1189	-3.8804	0.1658	0.1659	0.0603
10	Adult Couple & 2 Children	0.1072	0.1039	-3.0784	0.1749	0.1749	0.0000
11	Adult Couple & 3 Children	0.1656	0.1592	-3.8647	0.1463	0.1462	-0.0684
12	Adult Couple & 4+ Children	0.1236	0.1206	-2.4272	0.1411	0.1409	-0.1417
13	3 Adults & No Children	0.1354	0.1305	-3.6189	0.1387	0.1392	0.3605
14	3 Adults & 1 Child	0.1284	0.1231	-4.1277	0.1387	0.1385	-0.1442
15	3 Adults & 2+ Children	0.1269	0.1226	-3.3885	0.1474	0.1473	-0.0678
16	4+ Adults & No Children	0.1120	0.1085	-3.1250	0.1122	0.1127	0.4456
17	4+ Adults & 1 Child	0.1120	0.1047	-6.5179	0.2092	0.2098	0.2868
18	4+ Adults & 2+ Children	0.1675	0.1619	-3.3433	0.1748	0.1743	-0.2860
	Overall	Pre: 0.1739		Post: 0.1724		%Δ: -0.8626	

Table 7 - Atkinson Inequality Measures for the Revenue-Neutral Removal of the Alcohol, Tobacco and Petrol Excise Taxes

No.	Household Group	Atkinson Inequality Measure ($\varepsilon = 1.2$)					
		Smoking Households			Non-Smoking Households		
		Pre:	Post:	%Δ:	Pre:	Post:	%Δ:
1	65+ Single	0.1567	0.1510	-3.6375	0.1695	0.1701	0.3540
2	65+ Couple	0.1044	0.1001	-4.1188	0.1733	0.1728	-0.2885
3	Single Adult & No Children	0.1804	0.1731	-4.0466	0.1928	0.1914	-0.7261
4	Single Adult & 1 Child	0.0876	0.0847	-3.3105	0.1310	0.1298	-0.9160
5	Single Adult & 2 Children	0.1027	0.1005	-2.1422	0.1318	0.1316	-0.1517
6	Single Adult & 3 Children	0.1140	0.1137	-0.2632	0.1270	0.1265	-0.3937
7	Single Adult & 4+ Children	0.0722	0.0721	-0.1385	0.1162	0.1140	-1.8933
8	Adult Couple & No Children	0.1285	0.1217	-5.2918	0.1670	0.1652	-1.0778
9	Adult Couple & 1 Child	0.1237	0.1184	-4.2846	0.1658	0.1640	-1.0856
10	Adult Couple & 2 Children	0.1072	0.1027	-4.1978	0.1749	0.1725	-1.3722
11	Adult Couple & 3 Children	0.1656	0.1562	-5.6763	0.1463	0.1442	-1.4354
12	Adult Couple & 4+ Children	0.1236	0.1197	-3.1553	0.1411	0.1392	-1.3466
13	3 Adults & No Children	0.1354	0.1287	-4.9483	0.1387	0.1373	-1.0094
14	3 Adults & 1 Child	0.1284	0.1210	-5.7632	0.1387	0.1360	-1.9466
15	3 Adults & 2+ Children	0.1269	0.1217	-4.0977	0.1474	0.1461	-0.8820
16	4+ Adults & No Children	0.1120	0.1063	-5.0893	0.1122	0.1113	-0.8021
17	4+ Adults & 1 Child	0.1120	0.1024	-8.5714	0.2092	0.2084	-0.3824
18	4+ Adults & 2+ Children	0.1675	0.1600	-4.4776	0.1748	0.1717	-1.7735
	Overall	Pre: 0.1739		Post: 0.1710		%Δ: -1.6676	

6.3 Sensitivity Analyses

This subsection analyses the sensitivity of the Atkinson measure of inequality to the parameters of the equivalence scale, θ and α, along with the degree of inequality aversion. The sensitivity analysis is based on the percentage reduction in the overall measure of inequality that results from the revenue-neutral removal of all three excise taxes. Figure 5 shows the sensitivity of the reductions in overall inequality to the weight attached to children, θ, while the economies of scale parameter, α, is held fixed at 0.75. Conversely, figure 6 shows the sensitivity to the economies of scale parameter, α, holding θ fixed at 0.65. In both figures, inequality measures are given for three levels of aversion to inequality, $\varepsilon = 0.2, 0.6, 1.2$.[16]

All values of the parameters continued to produce reductions in the overall level of Atkinson inequality. However, the magnitudes of these reductions varied greatly. Figure 5 shows that the percentage reduction in overall inequality falls as the weight attached to children increases. In contrast, figure 6 shows that the relationship between the percentage reduction in inequality and the economies of scale parameter is a relatively flat U-shape. Increases from the $\alpha = 0.75$ used earlier lead to smaller percentage reductions in inequality, while reductions in α, below about 0.4, also lead to smaller reductions in inequality.

Both figures show that the pattern of inequality reductions is similar for different degrees of inequality aversion, though the absolute levels change. A lower aversion to inequality is associated with a larger percentage reduction in inequality. The lower aversion also increases the sensitivity of the Atkinson inequality measure to changes in the upper ranges of the distribution.

[16] The lower value of 0.2 corresponds to that found among economics students by Amiel et al. (1999) using surveys. The higher value represents substantial aversion, in terms of the tolerance of a 'leaky bucket' in making transfers from rich to poor (for example, in taking $1 from one person and transferring it to someone with half the income, an aversion coefficient of 2 implies that a leak of 75 cents is tolerated).

Figure 5 – Sensitivity of Atkinson Inequality to the Weight Attached to Children

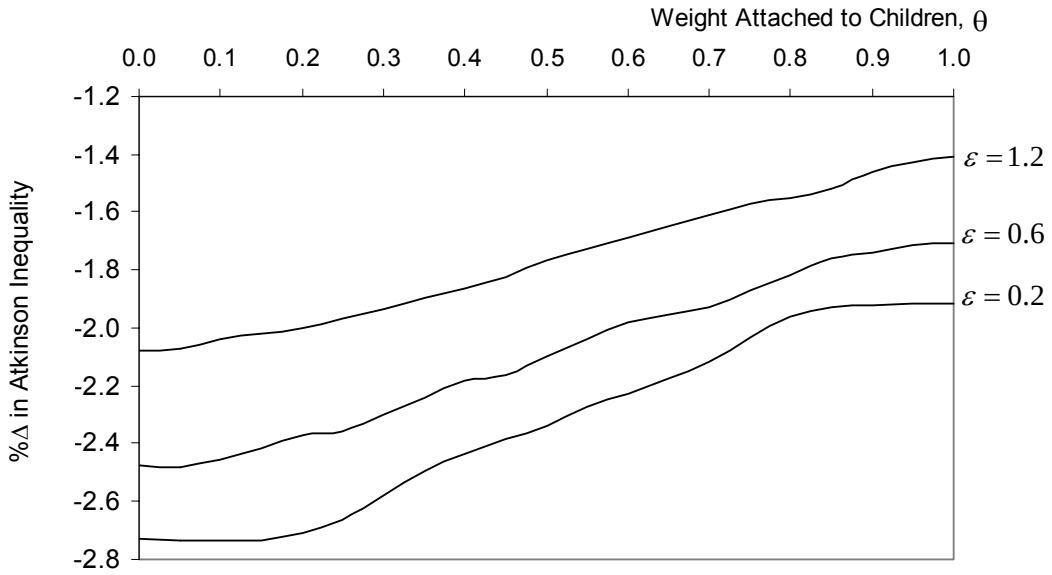
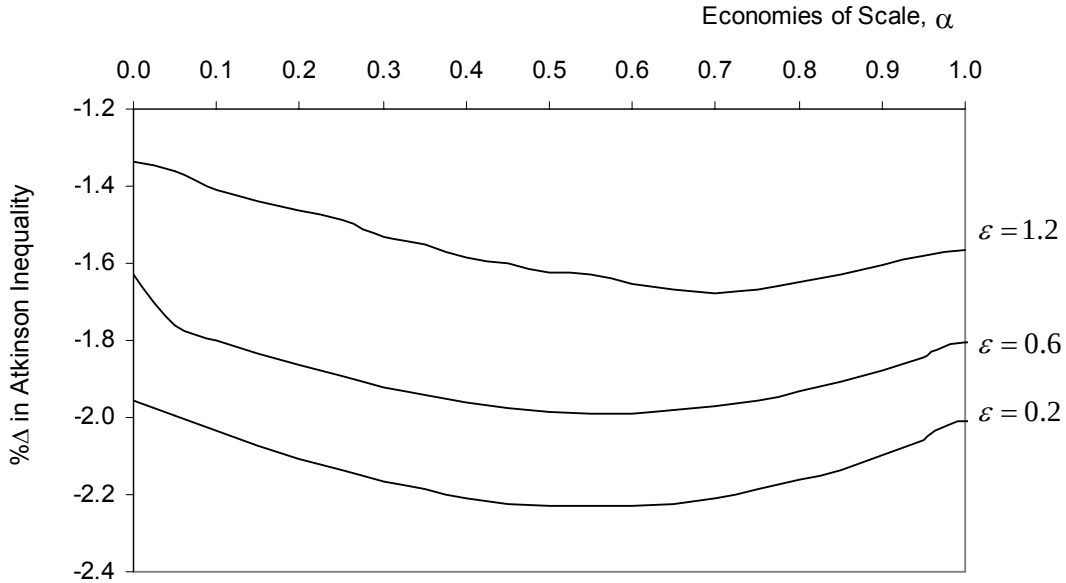


Figure 6 – Sensitivity of Atkinson Inequality to the Economies of Scale



7 Conclusions

Following a recommendation of McCleod et al (2001), this paper has analysed the welfare and redistributive effects of the revenue-neutral removal of excise taxes in New Zealand. Welfare and redistributive measures were computed for thirty-six demographic groups, using the Linear Expenditure System and data pooled from several *Household Economic*

Surveys. By enabling parameters to vary with total household expenditure levels, this approach allowed for considerable preference heterogeneity.

New Zealand's current system of indirect taxes was found to be relatively efficient at raising tax revenue, having generally low marginal welfare costs per dollar of revenue raised. However, smoking household groups incur larger welfare costs than their non-smoking counterparts, reflecting the high effective tax rate on tobacco. The standard GST rate required to support the revenue-neutral removal of the alcohol and tobacco excise taxes was found to be 14.4 per cent. If in addition the petrol excise tax is removed, the required GST rate rises to 15.9 per cent. The direction and magnitude of the welfare and redistributive effects of the reforms was found to vary substantially among household groups. Smoking households experienced relatively larger efficiency gains and greater reductions in inequality than non-smoking households. The increases in the standard GST rate required to achieve revenue neutrality enlarged the distortions between the prices of the commodity groups which attract GST relative to the two commodity groups which do not attract GST. These countered the efficiency gains generated by the removal of the excise taxes and led some non-smoking household groups to incur efficiency losses from the reforms. For both reforms, the large reductions in tax paid that were acquired by smoking household groups were found to be primarily funded by those non-smoking household groups who already pay the largest amounts of indirect tax under the current schedule.

McCleod et al. (2001) argued that excise taxes were both inequitable and inefficient. Dismissing other arguments widely used to justify these taxes, they recommended their abolition. The present paper has found marginal welfare gains for such a reform to be of the order of about 40 cents per dollar of (reduced) tax revenue for smoking households, and only 5 cents per dollar of tax revenue for non-smoking households. Comparable estimates for other taxes are not available, and it would be interesting to compare these welfare effects, particularly for smoking households, with those arising from income taxation. In terms of equity, the overall reduction in inequality (of money metric utility per adult equivalent) resulting from the proposed reform was found to be around the range of 1.5 to 2.5 per cent, depending on the degree of inequality aversion and the parameters used in the adult equivalence scale. However, these overall results conceal larger variations within particular household groups. Any policy decision in this context must of course balance these findings against perceived advantages, including environmental and health considerations. Policy views must inevitably depend on value judgements, but it is hoped that the findings of this paper can contribute towards rational debate on the subject, rather than relying on guesswork.

Appendix: Demands and Welfare Changes

This appendix outlines the approach taken to evaluate the welfare and redistributive effects of the proposed indirect-tax reforms.[17] The demand responses of households to price changes are modelled using the Linear Expenditure System (LES), which has direct utility functions of the form:[18]

$$U = \prod_{i=1}^{n} (x_i - \gamma_i)^{\beta_i} \tag{1}$$

where x_i denotes consumption of the ith good and γ_i is committed consumption with $x_i > \gamma_i, 0 \le \beta_i \le 1, \sum_{i=1}^{n} \beta_i = 1$. The budget constraint is $m = \sum_{i=1}^{n} p_i x_i$, where m denotes total expenditure and p_i denotes the price of good i. The indirect utility function takes the form:

$$V(p, m) = \frac{(m - C)}{B} \tag{2}$$

where p denotes the vector of commodity prices, $C = \sum_{i=1}^{n} p_i \gamma_i$ and $B = \prod_{i=1}^{n} \left(\frac{p_i}{\beta_i} \right)^{\beta_i}$. Hence, the expenditure function is $E(p, U) = C + BU$.

Consider a change in the vector of prices from p^0 to p^1 resulting from an indirect-tax reform. The equivalent variation, $EV = m - E(p^0, U^1)$, is thus $EV = m - \left(C^0 + B^0 U^1 \right)$ and substituting for U^1 gives:

$$EV = m - C^0 \left[1 + \frac{B^0}{B^1} \left(\frac{m}{C^0} - \frac{C^1}{C^0} \right) \right] \tag{3}$$

If $\dot{p}_i$ denotes the change in the effective *ad valorem* tax rate on the ith good, then $p_i^1 = p_i^0 (1 + \dot{p}_i)$, so that:

$$\frac{C^1}{C^0} = 1 + \sum_{i=1}^{n} s_i \dot{p}_i \tag{4}$$

[17] This section summarises the approach described in Creedy (1998a and 1998b).
[18] Given data limitations, the LES enables the desired commodity and demographic disaggregation to be used here.

where $s_i = \dfrac{{p_i}^0 \gamma_i}{\sum_{i=1}^{n} {p_i}^0 \gamma_i}$. Furthermore:

$$\frac{B^1}{B^0} = \prod_{i=1}^{n} \left(1 + \dot{p}_i\right)^{\beta_i} \tag{5}$$

The computation of the welfare measures thus requires expressions for both the parameter, β_i and committed expenditure, $p_i\gamma_i$.

For the LES, $\beta_i = e_i w_i$, where e_i denotes the total expenditure elasticity and w_i is the budget share for the ith good, $w_i = \left(p_i x_i\right)/m$. Reported budget shares that are obtained from sample surveys have too much sampling variability to be used directly and commonly give rise to spurious negative total expenditure elasticities. A flexible specification that has been found to provide a good fit is:[19]

$$w_i = \delta_{1i} + \delta_{2i} \log m + \frac{\delta_{3i}}{m} \tag{6}$$

The parameters, δ_{1i}, δ_{2i} and δ_{3i} are estimated using equation (6), which has the convenient property that, if the parameters are estimated using ordinary least squares, the 'adding-up' condition, $\sum_{i=1}^{n} w_i = 1$, holds for the predicted budget shares. The total expenditure elasticity is $e_i = 1 + \dfrac{dw_i}{dm}\dfrac{m}{w_i}$, which can be expressed using equation (6) as:

$$e_i = 1 + \frac{\left(m/\delta_{3i}\right)\delta_{2i} - 1}{\left(m/\delta_{3i}\right)\left(\delta_{1i} + \delta_{2i}\log m\right) + 1} \tag{7}$$

Committed expenditure in the LES can be written as:

$$p_i\gamma_i = \frac{m w_i \left(1 + \eta_{ii}\right)}{1 - \beta_i} \tag{8}$$

where η_{ii} denotes the own-price elasticity of demand for good i. Using a result established by Frisch (1959), the required set of own-price elasticities are evaluated using:

$$\eta_{ii} = e_i \left\{ \frac{1}{\xi} - w_i \left(1 + \frac{e_i}{\xi} \right) \right\} \tag{9}$$

[19] A total of 792 regressions were carried out (for 36 household types and 22 commodity groups), so the results cannot be presented here. Good fits have also been found using Australian data; see Creedy (1998b). The budget share relationship used here is an extension of that behind the AIDS model, which omits the term in the reciprocal of total expenditure.

where ξ denotes the Frisch parameter, defined as the elasticity of the marginal utility of total expenditure with respect to total expenditure. The Frisch parameter cannot be calculated within the model and instead must be determined from extraneous information. The analysis was conducted using a fixed Frisch parameter of -1.9. Experiments with varying Frisch parameters, allowing the absolute Frisch to fall as total expenditure rises, showed that the results were not sensitive. Hence only the constant case is reported here. Tulpule and Powell (1978) used a value of $\xi = -1.82$ when calculating elasticities at average income for Australia, based on the work of Williams (1978), and this value was adopted by Dixon *et al.* (1982) in calibrating a general equilibrium model. The slightly higher absolute value was used here to avoid some negative committed expenditures.

The budget shares allocated by each household group to a given commodity were regressed on the set of total weekly expenditure levels for that group using the HES data. This was repeated for each of the 22 commodity groups. Hence, a total of 792 (22x18x2) budget share regressions were performed. For any given household, the parameters of their direct utility function (β and γ) are unique to both the household's total expenditure level as well as their demographic make-up. This approach enables considerable preference heterogeneity that is not found in representative agent frameworks.

References

Amiel, Y., Creedy, J. and Hurn, S. (1999) Measuring attitudes towards inequality. *Scandinavian Journal of Economics*, 101, pp. 83-96.

Barker, F. (2002) Consumption externalities and the role of government: the case of alcohol. *New Zealand Treasury Working Paper*, no. 02/25.

Creedy, J. (1998a) Measuring the welfare effects of price changes: a convenient parametric approach. *Australian Economic Papers*, 37, pp. 137-151.

Creedy, J. (1998b) *Measuring Welfare Changes and Tax Burdens.* Cheltenham: Edward Elgar.

Creedy, J. and Sleeman, C. (2004) Adult equivalence scales, inequality and poverty in New Zealand. *New Zealand Treasury Working Paper*, no 04/21.

Dixon, P., Parmenter, B. R., Sutton, J. and Vincent, D. P. (1982) *ORANI: A Multisectoral Model of the Australian Economy.* Amsterdam: North Holland Publishing Company.

Ebert, U. (1997) Social welfare when needs differ: an axiomatic approach. *Economica*, 64, pp. 233-244.

Frisch, R. (1959) A Complete Scheme for Computing All Direct and Cross Demand Elasticities in a Model With Many Sectors. *Econometrica*, 27, pp. 177-196.

Jenkins, S. P. and Cowell, F. A. (1994) Parametric equivalence scales and scale relativities, *Economic Journal*, 104, pp. 891-900.

McLeod, R., Chatterjee, S., Jones, S., Patterson, D. and Sieper, T. (2001) Final Report, 2001 Tax Review. New Zealand Treasury.

Tulpule, A. and Powell, A. A. (1978) *Estimates of Household Demand Elasticities for the Orani Model.* IMPACT Project Preliminary Working Paper, OP-22.

Williams, R. A. (1978) The Use of Disaggregated Cross-Section Data in Explaining Shifts in Australian Consumer Demand Patterns Over Time. *Impact Project Research Paper*, SP-13.

Young, L. (2002) *Ad valorem* indirect tax rates in New Zealand. New Zealand Treasury Internal Paper (#435217).