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Marginal indirect tax reform analysis with merit good arguments and environmental concerns: Norway, 1999*

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Abstract We present a framework to identify and evaluate marginal tax reforms when merit good arguments and environmental concerns are given explicit consideration. It is applied to the Norwegian indirect tax system for 1999. The analysis shows that the reform passed in Parliament in November 2000 had a clear redistributive profile: a lowering of the VAT rate on food items and the introduction of a VAT on services benefits households in the lowest seven deciles while the upper three deciles got worse off. But we also argue that the aggregate demand responses triggered an increase in greenhouse gasses. Next, we show that if the 2000 reform had been complemented with tax rates rate changes on other products, it could have made every decile better off. Finally, we present socially optimal reforms, under different weights on inequality and the environment.

JEL classification: H21, H23.

Keywords: indirect tax reform, merit good arguments, greenhouse gasses

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1 Introduction

In Norway, the indirect tax system is responsible for about one third of total tax revenue. It consists of two parts. On the one hand, a value added tax system that up til 2000 imposed a uniform rate of 23% on most commodities but exempted an important set of services. On the other hand, excise taxes that are imposed on a range of products. These taxes are based on the products' physical properties (% of alcohol content, motor capacity, ...) and are motivated by environmental considerations (petrol, packaging), merit good arguments (spirits and tobacco), or property right arguments (tapes). Excise taxes increase the value of a commodity and therefore the basis for the value added tax on that commodity.

In the Fall of 2000, a proposal to reform the value added tax system was passed in the Norwegian Parliament. The general value added tax rate was to be raised from 23 to 24% from January 2001 onwards, and became applicable as well to most types of services from July 1, 2001 onwards. Also from that date, the VAT rate on food and beverage items was reduced to 12%.

Tax reforms have consequences for the efficiency with which resources in the economy are allocated, for the distribution of welfare over households, and for the environment. 'Large' changes in the indirect tax system, should be evaluated by means of a microeconomic general equilibrium model. For 'small' reforms, however, a limited amount of statistical information suffices to identify directions of reforms that are desirable out of efficiency and/or equity concerns. Such exercises have been performed for a number of developed and developing countries. Examples are Decoster & Schokkaert (1989, 1990) for Belgium, Madden (1995) for Ireland, Ahmad & Stern (1984) for India, Ahmad & Stern (1991) for Pakistan, and Kaplanoglou & Newbery (2003) for Greece.

The above described reform of the Norwegian value added tax system is not a small one. Except for the rise in the rate non-food rate from 23 to 24 %, the nominal rate on many services was raised from 0 to 24%, while the rate on food items was halved. In this paper, we are concerned with an evaluation of the *direction* of this reform by taking the effective indirect tax rate structure of 1999 as our starting point and analysing 'small' or marginal reforms. Methodologically, our framework extends the one used by the authors referred above, by explicitly taking environmental considerations and merit good arguments into account.

In the next section we present the theoretical tools to evaluate marginal reforms. In section 3, we first present the empirical basis for our study, including all the parameter values we use as input for the exercise, some of which are relegated to an appendix. Thereafter we present results of the tax analysis, focusing on the ranking of commodities according to the marginal cost of partial tax increases, and how the ranking changes with the different household deciles and the environment. Furthermore we demonstrate the possibilities of Pareto improving reforms. In section 4 we introduce a social welfare function and demonstrate different types of social welfare improving reforms. Concluding remarks are collected in section 5.

2 A theoretical framework

We consider an economy with H households whose preferences can be represented by the utility functions $u^h(\cdot)$ $(h = 1, ..., H)$ defined over n commodities $(x_i, i = 1, ..., n)$, tradeable on competitive markets. The off-producer prices on these markets are given by the price vector $p = (p_1, ..., p_n)'$. Household h has disposable income m^h that comes from labour earnings, replacement incomes, and capital incomes. The government imposes specific indirect tax rates t_i such that the consumer price for commodity i is $q_i = p_i + t_i$ $(i = 1, ..., n)$. Facing these prices, household h demands $x_i^h(q, m^h)$ units of commodity. For future reference, we denote h's normalised price for good i by $\pi_i^h \overset{\text{def}}{=} \frac{q_i}{m^h}$.

Indirect tax revenue

Aggregate demand for commodity i is given by[1]

$$x_i^T(q) \overset{\text{def}}{=} \sum_h x_i^h(q, m^h),$$

and indirect tax revenue can therefore be written as

$$R(t) \overset{\text{def}}{=} \sum_j t_j x_j^T(p + t).$$

A marginal increase in tax rate i results in extra revenue for the treasury to the amount of

$$r_i \overset{\text{def}}{=} \frac{\partial R}{\partial t_i} = x_i^T + \sum_{j=1}^{n} t_j \frac{\partial x_j^T}{\partial q_i}.$$

[1]Hereafter we ignore the vector of income levels $(m^1, ..., m^H)$ as an argument in commodity demands.

Multiplying this expression through by q_i, we obtain

$$q_i r_i = q_i x_i^T + \sum_{j=1}^{n} t_j^* \varepsilon_{ji} q_j x_j^T, \tag{1}$$

where $\varepsilon_{ji} \overset{\text{def}}{=} \frac{\partial x_j^T}{\partial q_i} \frac{q_i}{x_j^T}$ is the aggregate cross price elasticity and $t_i^* \overset{\text{def}}{=} \frac{t_i}{q_i}$ is the effective tax rate as a fraction of the consumer price.

The government evaluates indirect tax reforms in terms of its effects on household welfare and the environment.

Household welfare

Household welfare is not necessarily perceived in the same way by the government as by the household. The reason for this perception wedge is that the government may be convinced about the beneficial/detrimental properties of some commodities, which households disregard when making their purchasing decisions. The obvious examples here are alcohol and tobacco. In the empirical application, these commodities belong to the same consumption category and we will therefore in the rest of the paper assume that only one commodity has (de)merit properties, viz commodity n. To model merit good arguments in the social evaluation, we follow the approach put forward by one of us (Schroyen, 2005a,b) and take the government's evaluation of household h's consumption bundle as (we drop for the time being the household index)

$$U(x_{-n}, x_n) \overset{\text{def}}{=} u(\frac{x}{1 - \mu x_n}),$$

where x_{-n} is a shorthand for the truncated bundle $(x_1, ..., x_{n-1})$. The parameter μ measures to which extent good n is considered a merit good. It has the dimension of a normalised price (a price in proportion to income), so that μx_n can be interpreted as a virtual budget share for commodity n.[2] Defining now the (uncompensated) consumer's and government's marginal evaluation

[2] If $\pi_i^c(x, \overline{u})$ $(i = 1, ..., n)$ are the compensated inverse demand functions for the household (giving demand prices in proportion to income), the compensated inverse demand functions for the government can be shown to be

$$\begin{aligned} \Pi_i^c(x, \overline{u}) &= \pi_i^c(x, \overline{u}) \quad (i \neq n), \text{ and} \\ \Pi_n^c(x, \overline{u}) &= \pi_n^c(x, \overline{u}) + \mu. \end{aligned}$$

of commodity j, as (subscripts with u and U denote partial derivatives)

$$\pi_j(x) \stackrel{\text{def}}{=} \frac{u_j(x)}{\sum_k u_k(x)x_k} \text{ and } \Pi_j(x) \stackrel{\text{def}}{=} \frac{U_j(x)}{\sum_k U_k(x)x_k},$$

respectively, it can be shown that, to a first approximation,

$$\Pi_j(x) \simeq \pi_j(x)\left[1+\sigma_j w_n \eta\right] \quad (j \neq n), \tag{2a}$$

$$\Pi_n(x) \simeq \pi_n(x)\left[1+\eta+\sigma_n w_n \eta\right], \tag{2b}$$

where σ_j is the scale elasticity for commodity j (the relative change in the demand price of commodity j due to a 1% increase in the Divisia quantity index $\sum_j w_j \mathrm{d}\log x_j$), w_n is the budget share of the merit good, and $\eta \stackrel{\text{def}}{=} \frac{\mu}{\pi_n}$, a dimensionless measure of the merit good argument. Merit considerations regarding good n thus have two effects on the government's demand prices. First, they boost the government's demand price for good n (relative to the household's demand price) with η. But second, and less obviously, the government considers the household to be better off because of all the inframarginal units of n consumed. This has a scale effect on all demand prices whose importance depends on the budget share of n.

Reintroducing the household index h, the effect of a marginal change in t_i on this household's welfare can be shown to be given by

$$-q_i\frac{\partial U^h}{\partial t_i} \simeq (q_i x_i)^h - \eta^h \cdot (q_n x_n)^h \cdot \left(\sum_j w_j^h \sigma_j^h \varepsilon_{ji}^h + \varepsilon_{ni}^h\right) \quad \text{(all } i,h). \tag{3}$$

After dividing (3) by (1), we obtain the marginal cost of rasing one extra krone in tax revenue through rate t_i on household hs welfare (as perceived by the government):

$$MC_i^h \stackrel{\text{def}}{=} \frac{(q_i x_i)^h - \eta^h \cdot (q_n x_n)^h \cdot \left(\sum_j w_j^h \sigma_j^h \varepsilon_{ji}^h + \varepsilon_{ni}^h\right)}{(q_i x_i)^T + \sum_k t_k^* \cdot \varepsilon_{ki} \cdot (q_k x_k)^T} \quad \text{(all } i,h), \tag{4}$$

where the small round brackets indicate that one only needs information on expenditures–not on prices and quantities separately–to compute the MC_i^h.

If $MC_i^h > MC_j^h$, a small decrease in t_i^*, accompanied by a small increase in t_j^* that compensates for the tax revenue loss, leads to a welfare improvement for household h. The reason is simple: per krone that is lost by marginally lowering the tax rate on good i, welfare goes up by more then it goes down by raising the rate on good j to make up for the tax revenue loss.

Environmental concern

Environmental concern is assumed to be focussed on the emission of greenhouse gasses. These gasses are due to the total production, distribution and consumption of goods and services:

$$E(x_1^T, ..., x_n^T).$$

The effect on emissions of a tax rise on commodity i is

$$\frac{\partial E}{\partial t_i} = \sum_k \frac{\partial E}{\partial x_k^T} \frac{\partial x_k^T}{\partial q_i}.$$

Again, multiplying through by q_i allows for a parameterisation in terms of elasticities:

$$q_i \frac{\partial E}{\partial t_i} = \sum_k \omega_k \cdot \varepsilon_{ki}, \tag{5}$$

where $\omega_k \stackrel{\text{def}}{=} \frac{\partial E}{\partial x_k^T} \frac{x_k^T}{E}$, the elasticity of greenhouse gas production w.r.t the consumption of good k. Dividing (5) by (1), we obtain the (probably negative) marginal cost of rasing one extra krone in tax revenue through rate t_i on total emissions:

$$MC_i^E \stackrel{\text{def}}{=} \frac{\sum_k \omega_k \cdot \varepsilon_{ki}}{(q_i x_i)^T + \sum_j t_j^* \cdot \varepsilon_{ji} \cdot (q_j x_j)^T}. \tag{6}$$

Pareto improving tax reforms

Suppose now that $MC_i^h > MC_j^h$ for *all* h, then the above reform may be regarded as Pareto improving for the present generation.[3] Should in addition also $MC_i^E > MC_j^E$, then also future generations, through a cleaner environment, benefit from the reform.

To determine whether a direction of Pareto improving tax reforms exists, we should in principle solve the problem

$$\left.\begin{array}{rc} \max_{\{\mathrm{d}t_i\}} & \sum_i r_i \mathrm{d}t_i \\ \text{s.t. (i)} & \sum_i MC_i^h r_i \mathrm{d}t_i \leq 0 \ \ (\text{all } h) \\ \text{(ii)} & \sum_i MC_i^E r_i \mathrm{d}t_i \leq 0 \end{array}\right\} \tag{P1}$$

[3] 'Pareto improving' should here be understood as 'when evaluated by the government'. It does not necessarily mean that every household would endorse the reform, since its preferences have been distorted by the government.

where the $\mathrm{d}t_i$ are 'small'.

Rather than searching for 'small' $\mathrm{d}t_i$s, Ahmad & Stern (1984) suggest to look instead for a set of δ_i $(i = 1, ..., n)$ where δ_i is the extra revenue raised from increasing the tax on good i; these revenue changes are then constrained to be smaller than one in absolute value. For this purpose, we define δ_i as $r_i \mathrm{d}t_i$ (all i) and checking the existence of a Pareto improving tax reform is thus equivalent to solving

$$\left.\begin{array}{ll} \max_{\{\delta_i\}} & \sum_i \delta_i \\ \text{s.t. (i)} & \sum_i MC_i^h \delta_i \leq 0 \quad (\text{all } h) \\ \text{(ii)} & \sum_i MC_i^E \delta_i \leq 0 \\ \text{(iii)} & -1 \leq \delta_i \leq 1 \quad (\text{all } i) \end{array}\right\} \tag{P2}$$

If the solution to this problem is $\delta_i = 0$ (all i), we can apply Farkas-Minkowski's lemma and solve the inverse problem, that is search for a set of $H + 1$ non-negative welfare judgements $(\beta^1, ..., \beta^H, \beta^E)$, such that

$$\sum_{h=1}^{H} \beta^h MC_i^h + \beta^E MC_i^E = 1 \quad (\text{all } i). \tag{7}$$

This expression says that for an optimal tax vector, the social marginal cost of increasing every tax rate to raise an extra krone in tax revenue should equal that krone.

In the empirical part, this problem will not concern us as there is room for Pareto improvements. Christiansen & Jansen (1978) have solved the 'inverse problem' for the Norwegian indirect tax system of 1975. Their approach, however, is slightly different in that they constrain the social welfare parameters β^h to be monotonically declining according to the exponential function $\beta^h = \beta^1 \cdot (\frac{m^h}{m^1})^{-e}$, where $e \in [0, \infty)$ is an inequality aversion parameter (this function was introduced by Stern, 1977). Implicitly, they thus assumed that the 1975 system does not allow for Pareto improvements.

3 Empirical analysis

The theory above is now applied to analyse marginal indirect tax reforms in the Norwegian economy as of 1999, and use the result to evaluate the direction of the reform which was passed in Parliament in November 2000. We start out by presenting the empirical basis of our tax analysis, in terms of price, income and scale elasticities, tax rates, emission rates, and expenditure patterns of ten representative consumers. Next we present the results of our tax reform analysis, by proceeding in three stages. First we ignore merit good considerations and the effects on the environment, second we introduce the merit good argument, and finally we also take environmental externalities into account. According the MC_i^h expression (4) we need price and scale elasticities at the individual level. Since we we lack this information, we replace them with the respective aggregate elasticities.

3.1 Empirical basis

All the empirical parameters needed in our analysis of tax reforms are presented in table 1 below and in tables A1-A2 in the appendix. These parameters are taken from a comprehensive system of statistics, econometric studies and simulation models, including both micro and macro data, compiled and carried out by Statistics Norway.

The budget shares, Engel elasticities and direct Cournot elasticities presented in Table 1, stem from a complete demand system for a representative household in Norway 1999, generating macro demands by multiplying with the number of households. The cross price Cournot elasticities are presented in table A2 in the appendix. They fulfil all restrictions following from adding-up, homogeneity, symmetry and negativity. The macro demands can be generated from a Gorman polar cost function with linear demographics. Under absence of corner solutions, these macro demands can also be generated by exact aggregation from a population of households with corresponding demand functions (cf Aasness, Bye and Mysen, 1996, pp. 339-341).[4]

[4] An earlier and more simple version of the model is described in Aasness, Bye and Mysen (1996) and the references therein. The model we used to generate tables 1 and A2 is documented in Nygard and Aasness (2003) and the references therein. Each household in the population is assumed to have a utility function in terms of a utility tree with 55 commodities and 34 branches, at each branch the preferences can be described by a translated CES utility function, where the "necessity quantities" are linear functions of the number of children and adults in the household. The demand system is calibrated using data from household expenditure surveys and national accounts. The elasticities are aggregated to the 14 commodities in this paper using Hicksian aggregation. The aggregation is partly across branches of the underlying utility tree.

Table 1. Budget shares, income, own (uncompensated) price and scale elasticities, effective tax rates and emission shares. Average household. Norway 1999.

i	Commodity group	Budget share	Income elasticity	Own price elasticity	Scale elasticity	Effective tax rate	Emission share
1	Food and non-alcoholic drinks	.143	0.31	-0.21	-4.36	.21	.320
2	Alcohol and tobacco	.046	0.94	-0.75	-0.44	.69	.020
3	Clothing and footwear	.055	1.16	-0.51	-0.15	.19	.020
4	Gross rents	.155	1.13	-0.61	-0.19	.02	.018
5	Electricity	.028	0.42	-0.26	-3.98	.28	.022
6	Fuels	.005	0.18	-0.48	-5.10	.23	.084
7	Health	.026	0.74	-0.32	-1.35	.08	.011
8	Private transport	.094	1.39	-0.84	0.04	.42	.294
9	Public local transport	.017	0.87	-0.66	-0.50	.00	.037
10	Public distant transport	.010	1.77	-1.65	0.13	.05	.016
11	Post and telecommunication	.022	0.31	-0.28	-2.76	.18	.006
12	Other goods	.151	1.03	-0.53	-0.40	.17	.094
13	Other services	.181	1.20	-0.62	-0.08	.11	.057
14	Direct purchases abroad	.067	1.52	-0.92	-0.12	.00	0
	Sum (weighted)	1	1		-1		1

The price elasticities for the representative household in tables 1 and A1 are our estimates of the ε_{ji} in the formulae of section 2. Since we analyse *marginal* tax reforms, the expenditures for the different households $(q_i x_i^h)$ in the year 1999 suffice to calculate the effects on the standard of living. In order to make the analysis transparent, and comparable with similar studies for European countries, we have constructed ten households to represent the Norwegian population of households in 1999. The expenditure patterns of these ten representative households are presented in table A2 in the appendix. Household expenditures are derived from a microsimulation model which is calibrated to the same 1999 consumption data as the macro model, so that the aggregation restrictions presented at the start of section 2 are fulfilled in our marginal tax analysis.

The fourth column of table 1 gives the scale elasticity for each commodity. These elasticities were obtained by inverting the direct demand system (see Schroyen, 2005b, on the algorithm). Their interpretation is the percent change in the demand price of a commodity for a 1% increase in the Divisia quantity index $(\sum_j w_j \mathrm{dlog}\, x_j)$.

The fifth column of table 1 lists the effective tax rates for all 14 categories. These rates are the sum of the value added tax, ad valorem tax and volume tax as a fraction of the final consumer price for the year 1999.[5]

The final column gives the emission shares. Emissions include both direct emissions from the consumers and emissions from the producers of the consumer goods, including the emissions from the production of the intermediate goods used in the production of the consumer goods, applying input-output techniques. The emission estimates are taken from Indahl, Sommervoll and Aasness (2001, table 1, last column), updated to 1999 and aggregated to the commodity groups used in this paper.

3.2 Results ignoring merit goods and emission effects

When presenting our results, we proceed in three stages. First we ignore merit good considerations and the effects on the environment. Next, we introduce the merit good argument, and finally we also take the negative environmental externalities into account.

The marginal costs for the ten representative households when setting $\eta^h = 0$ are reported in table A3 of the appendix. But as we discussed earlier, to identify the effect of reform on household hs well-being, it suffices to compare the ranking of the different MC_i^h. The rankings are depicted in figure 1.

First notice how a marginal tax changes may have very different effects on the well-being of different households. While the lower deciles would approve of a reduction in the tax rate on **food** or **fuel** and an increase in that on **private transport** or **public distant transport**, exactly the opposite is true for the upper deciles. A similar finding was reported by Decoster & Schokkaert (1989) for Belgium and Kaplanoglou & Newbery (2002) for Greece. This should not come as a surprise since the budget share for food falls from more than 25% for the lowest decile down to 9% for the highest decile (cf table A2). Private and public distant transport, on the other hand increase from less than 4% (taken together) up to almost 13%. Much less variation is there in the budget share for public local transport: from 1.9% for $h = 1$ to 1.6% for $h = 10$.

Figure 1 also shows that the type of reform passed in the Norwegian parliament in the Fall of 2000–a reduction in the VAT rate on food items,

[5] These are calculated for 1999 by the input-output model integrated in the Norwegian national accounts and large scale general equilibrium models of Statistics Norway. See e.g. Holmøy et al (1994, 2.17.1-5)

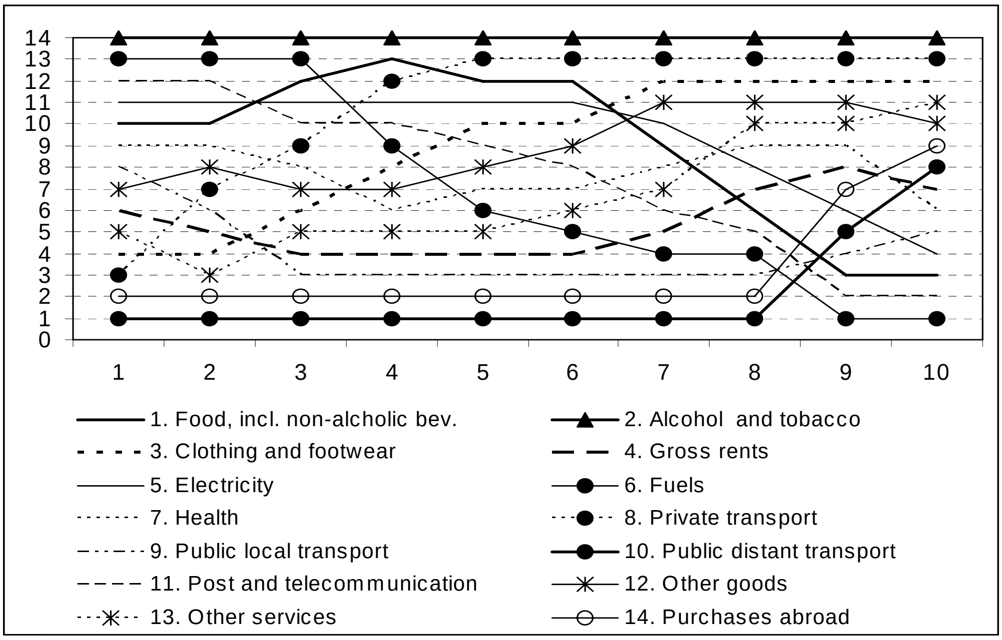

Figure 1: Rankings of MC_i^h $(\eta = 0)$.

and introduction of VAT on services–is benefiting the first seven deciles and making the last three deciles worse off.

Except for the first decile, all other deciles would also agree on a reduction in the tax on **private transport** (excise taxes on gasoline and on cars) if this was financed by more expensive **public local transport**.

Another observation is that all ten representative households would endorse lower excise taxes on **alcohol and tobacco** no matter how financed through other commodity taxes (even that on **health** services!).

Many observers are likely to utter scepticism about these last policy proposals, arguing that the high level of excise taxes on alcoholic beverages and tobacco serve to contain consumption patterns that put health at risk, and that excise taxes on private transport play a Pigouvian role. In a next stage, we therefore introduce the merit good argument and environmental concerns.

3.3 Introducing a merit good and environmental concerns

We single out the category **alcohol and tobacco** as a demerit good whose consumption is depreciated by the government with a factor $\eta < 0$ common for all deciles. An important question is then what value η should take. In recent years, public opinion is unambiguously converging on the idea that smoking is detrimental for people's health.[6] Regarding alcohol, the sale of beverages with an alcohol content of more than 5% is restricted in Norway to *Vinmonopolet*, the stated owned wine monopoly.[7]

As seen earlier, a zero value for η makes it possible to make all deciles better off by lowering taxes on **alcohol and tobacco**, and raising the tax on **health care**. From table A3, it transpires that $MC^h_{alc\&tob} - MC^h_{health}$ is lowest for households in the lowest decile. It turns out that $-.67$ is the highest value for η such that $MC^h_{alc\&tob} \geq MC^h_{health}$ (all h) (the inequality being binding for the lowest decile). On the other hand, for any value of η below $-.784$, we have that $MC^h_{bev\&tob} \leq MC^h_{health}$ (all h) so that every decile's well-being could be improved by taxing **beverages and tobacco** heavier and making **health care** products and services cheaper. We therefore fix η at $-.70$ in the remainder of the paper. This means that the government's marginal willingness to pay for **alcohol and tobacco** lies about 68.6% below that of the consumer.[8] For this parameter value, the ranking of the different MC^h_i are given in the first ten columns of figure 2 (based on table A4).

From this figure, it transpires that the government could still increase the well-being of every decile by at least two reforms: lowering taxes on **private transport**, **clothes and footwear**, **other services** and raising them on **public distant transport**; and lowering taxes on **alcohol and tobacco** and rasing them on **gross rents**. But are such reforms also to the benefit of the environment?

That question can be addressed by looking at the last ranking in figure

[6] Since June 2004, smoking is no longer allowed in Norwegian cafés and restaurants.

[7] *Vinmonopolet* was established in 1922 after a general referendum in 1919 where more than 60% of the electorate voted in favour of a ban on the sale of spirits and liquor. Several years later, this ban was abolished and *Vinmonopolet* got the sole right to sell spirits and liquor.

[8] Using (2b), we get that

$$\frac{\Pi_2(x) - \pi_2(x)}{\pi_2(x)} \simeq (1 + \sigma_2 w_2)\ \eta = [1 + (-.441)(.0464)]\ (.7) = -.686$$

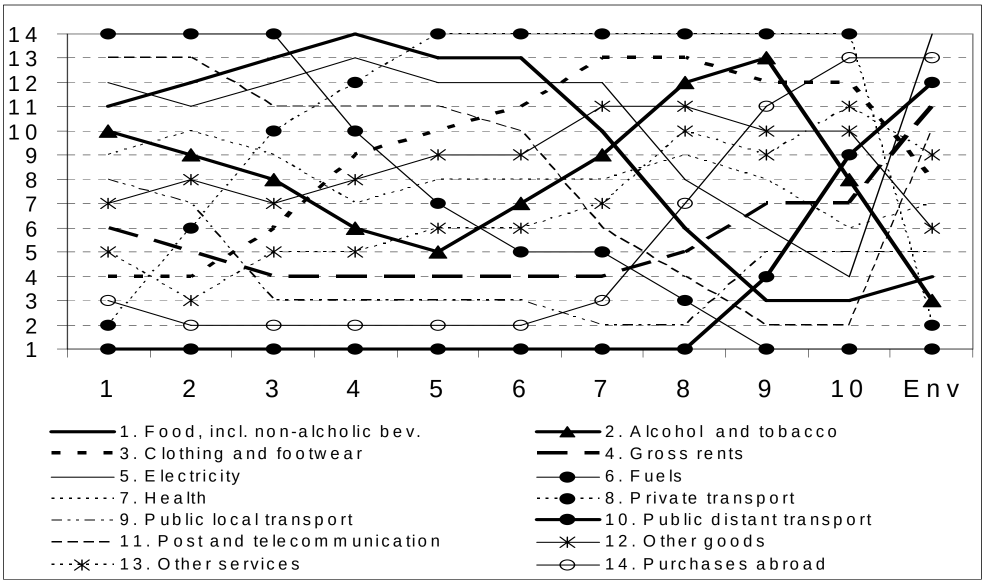

Figure 2: Rankings of MC_i^h and MC_i^E ($\eta = -.7$).

2, indicated as 'Env'. This column depicts the ranking of the marginal costs for the environment, MC_i^E. As explained in section 2, the cost for the environment comes in the form of greenhouse gas emissions related to the consumption, production and distribution activities of the 14 commodities (except for **purchases abroad**).

For each decile h we have computed the rank correlation coefficient between the MC_i^h and MC_i^E. These are reported in table 2. For most deciles, these correlations are insignificant. But it transpires that pleasing deciles 2, 3 or 4 *and* the environment poses a challenge. Interestingly, the rank correlation becomes less negative (and even positive) when considering the upper deciles.

Table 2. Rank correlation coefficient between MC_i^h and MC_i^E

Decile	1	2	3	4	5	6	7	8	9	10
rankcorr(MC_i^h, MC_i^E)	-.26	-.43	-.46	-.34	-.29	-.28	-.29	-.24	-.08	+.13

The impact of the 2000 reform on the environment can be readily read off from the final column in figure 2: $MC_{food}^E < MC_{oth\ serv}^E$ indicates that greenhouse gas emissions will have increased following this reform. The explanation is that consumption of food items entails production and distribution activities which are heavy contributors to greenhouse gas emission (an emission share of 29%). Services, on the other hand, pollute far less (3.6% emission share). The reduced demand for services due to the introduction of a VAT, does not compensate for the extra CO_2 emissions following the increased consumption of food items.

Notice also that the relative ranking for **private transport/clothing and footwear/other services** relative to **public distant transport** now switches: the environment is made worse off when reducing taxes on one of the former category and raising them on the latter to neutralise the effect on revenue. The same can be said about the second reform that was earlier identified as Pareto improving. Taxing (imputed) **gross rents** heavier while cutting on the tax on **alcohol and tobacco** goes at the cost of more CO_2-pollution. However, this does not mean that Pareto improving reforms are non-existent. In table 3, we show the solution to problem (P2) (with $\eta = -.7$).

Table 3. A Pareto improving reform securing maximal revenue ($\eta = -.7$).

i	*Category*	δ_i
1	Food & Beverages	1
2	Alcohol & Tobacco	−1
3	Clothing & Footwear	−.28
4	Gross Rents	1
5	Electricity	−1
6	Fuels	.22
7	Health	1
8	Private transport	−1
9	Public local transport	1
10	Public distant transport	1
11	Post & telecommunication	−.31
12	Other goods	−1
13	Other services	1
14	Purchases abroad[a]	0
	Sum	0.9317

[a] δ_{14} was constrained to zero

This reform produces a maximal revenue increase of 0.93 kroner. It keeps emissions constant and makes all deciles, except for the 1st, 9th and 10th strictly better off. This reform is striking in several respects. First, **private transport** features among those commodities that can be taxed more leniently while **public local transport** should be taxed heavier. **Fuels** and

other services are categories that should be taxed more heavily, but so is **food** (unlike what the 2000 reform did). And strikingly, the tax on **alcohol and tobacco** should be reduced, while that on **health care** should be raised–and this despite the fact the government already discounts the former category at a rate of 70% (since $\eta = -.70$).

4 Social welfare improving reforms

Above, it was established that there is room for a reform of the Norwegian indirect tax system that makes every decile better off and reduces CO_2-emissions. Two qualifications should be kept in mind. First, that 'better off' means as perceived by the government. Second, that we only looked at the welfare of the representative agent in each decile: all persons in a decile were treated identically. Should we increase the number of representative agents, e.g. to 100, then the likelihood of finding a tax reform that furthers the welfare of every agent would be close to zero. One can then no longer avoid comparing the losses of some agents with the gains experienced by others.

There is nothing that prevents us to carry out such a welfare analysis by calculating and comparing $\sum_{h=1}^{10} \beta^h MC_i^h$ (all i). For this purpose, we use the iso-elastic specification for the social marginal utility of income,

$$\beta^h = \beta^1 \cdot (\frac{m^h}{m^1})^{-e} \cdot (\frac{n^h}{n^1}), \;\; e \in [0, \infty),$$

normalise β^1 to 1, where m^h is taken as total consumption expenditure per equivalent adult (i.e. standard of living in table A2) and n^h is the average number of persons in a household of decile h (thus giving one welfare vote to each person in the underlying population).[9] The parameter e is the inequality aversion parameter with $e = 0$ reflecting efficiency with no distributional concerns while $e \to \infty$ puts zero weight on all but the lowest decile (Rawls). For practical purposes, this last case can be studied by taking $e = 10$. We do not add the environment/future generations in the computation of the MC_i since this would require the selection of a β^E. We call $\sum_h \beta^h MC_i^h$ therefore the short term social marginal cost of category i.

Figure 3 presents the rankings of the short term MCs for seven different values of e. Thus **private transport** and **public local transport** change

[9] The average household size in each of the ten deciles are as follows: 1.70 (lowest decile), 1.71, 2.22, 2.44, 2.54, 2.40, 2.27, 2.14, 2.01, 2.01 (highest decile).

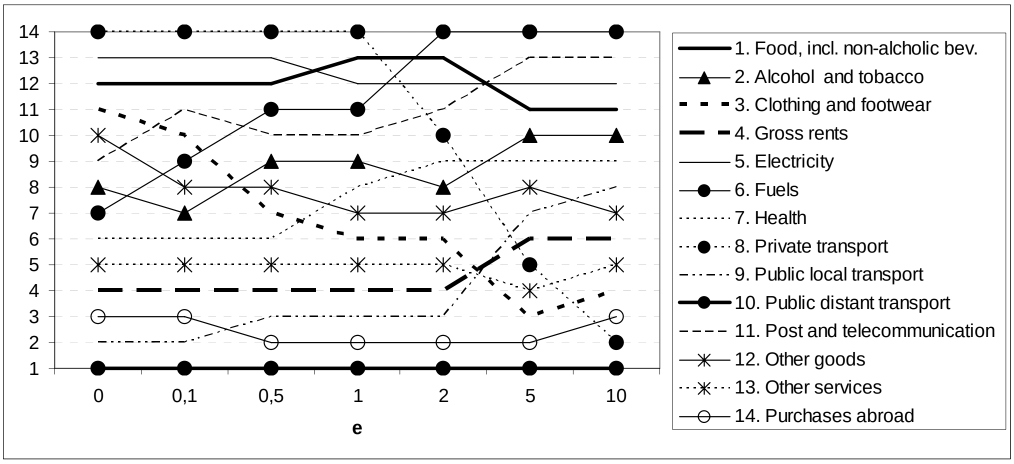

Figure 3: Short term social marginal cost rankings for different e values.

from resp. a bad and good candidate for a tax increase to a good and bad one, as inequality aversion grows. **Public distant transport** should be made more expensive for any value of e. The marginal cost for **food** exceeds that for **other services** for all values of e. Earlier, it was mentioned that the first seven deciles benefit from the 2000 reform, while the upper three deciles loose. Figure 3 ($e = 0$) thus establishes that the winners' gain outweighs the losers' loss.

We now inquire which δ_i $(i = 1, ..., n)$ should be chosen in order to minimise the $\sum_{h=1}^{10} \sum_{i=1}^{14} \beta^h MC_i^h \delta_i$, without deteriorating public revenue and without increasing emissions:

$$\left.\begin{array}{rc} \min_{\{\delta_i\}} & \sum_{h=1}^{10} \beta^h \sum_{i=1}^{14} MC_i^h \delta_i \\ \text{s.t. (i)} & \sum_{i=1}^{14} MC_i^E \delta_i \leq 0 \\ \text{(ii)} & \sum_{i=1}^{14} \delta_i \geq 0 \\ \text{(iii)} & -1 \leq \delta_i \leq 1 \quad (\text{all } i) \end{array}\right\} \qquad \text{(P3)}$$

Column a of table 4 gives the results for the efficiency criterion. Interestingly, the recommended policy includes a lowering of the tax on private transport and an increase in the tax on public local and distant transport and this benefits the environment (the constraint (i) is slack). Thus, there is no conflict between a utilitarian perspective and concerns for the environment. This is no longer the case when we take a maximin perspective. Column b of table 4 presents the solution to (P3) when the weights to all but the lowest decile are set to zero and when constraint (i) is ignored. W.r.t. the efficiency solution, tax policy recommendations now change for more than half of the commodity groups. In particular, the tax on **fuels** is now reduced rather than increased. Since **fuels** have an extremely high marginal environmental cost (cf last column of table A4), the consequence is a deterioration of the environment. Imposing constraint (i) and re-optimising results in column *c* of table 4. The main changes in policy recommendation are a smaller tax reduction for **fuels** and a tax increase for **public local transport** (rather than a *status quo*).

Table 4. Optimal δ_i values ($\eta = -.7$, Lagrange multipliers with (i) and (ii) in brackets).

i	*Category*	^{a} Efficiency	^{b} Rawls	^{c} Rawls+env.
1	Food and non-alc. bev.	-1	-1	-1
2	Alcohol and tobacco	0	-1	-1
3	Clothing and footwear	-1	1	1
4	Gross Rents	1	1	1
5	Electricity	-1	-1	-1
6	Fuels	1	-1	$-.27$
7	Health	1	-1	-1
8	Private transport	-1	1	1
9	Public local transport	1	0	1
10	Public distant transport	1	1	1
11	Post and telecommunication	-1	-1	-1
12	Other goods	-1	1	$-.73$
13	Other services	1	1	1
14	Purchases abroad[a]	0	0	0
	Sum	0 (1.53)	0 (.04)	0 (.03)
	$\sum_h \beta^h \sum_i MC_i^h \delta_i$	-1.66	$-.32$	$-.26$
	$\sum_i MC_i^E \delta_i$	-2.61	2.73	0 ($-.021$)

[a] δ_{14} was constrained to zero

5 Conclusion

We have presented a framework to identify and evaluate marginal tax reforms when merit good arguments and environmental concerns matter. We next applied the analysis on the Norwegian indirect tax system for 1999. Our analysis showed that the reform passed in Parliament in November 2000 had a clear redistributive profile: a lowering of the VAT rate on food items, and the introduction of VAT on services benefited households in the lowest seven deciles while the upper three deciles got worse off. But we also argued that an increase in greenhouse gasses has resulted from the aggregate demand responses.

We then showed that if the 2000 reform had been complemented with tax rates rate changes on other products (as specified in table 3), it could have made every decile better off. We have also studied social welfare improving reforms by computing an inequality averse weighted average of the marginal welfare costs of the ten deciles and arrived at similar conclusions.

It is important to stress the limitations of our analysis. First, we have been concerned with *marginal* tax reforms—changes in the indirect tax rates in a neighbourhood of the existing–1999–indirect tax structure. To evaluate finite changes in the tax structure, it no longer suffices to have 'local' information about behavioural responses of economic agents in the form of price elasticities. An explicit system of demand equations for each decile is then required to trace out the responses.

Second, we have included only ten deciles of household groups, in order to obtain transparency and comparability to other studies. In reality there are more than 2 million households in the Norwegian economy, heterogenous in many dimensions. A full scale microsimulation model might reflect this heterogeneity in a more appropriate way, and could in principle be used in our type of analysis. A testable conjecture is that our ten household deciles will capture an essential part of the heterogeneity, in such a way that our results on social welfare improving reforms are robust. Another testable conjecture is that Pareto improving reforms would not exist in such a model with a large degree of heterogeneity. However, our results on Pareto improving reforms in our 10 household model would still seem to give some insight in the welfare effects of marginal tax reform in Norway 1999.

Finally, the empirical basis used and presented in the present paper, may of course have weaknesses of different kinds. Without doubt, improved data and painstaking econometric work would improve this basis. But since the main policy conclusions are based on ordinal rather than cardinal comparisons of marginal costs, we expect our model to be fairly robust to minor improvements of the empirical basis.

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Appendix

This appendix presents the econometric estimates of the demand responses (Table A1), the expenditure patterns for the different household deciles (Table A2), and the computations of the marginal welfare costs (Tables A3 and A4).

The ten representative households are constructed from a micro simulation model with 26 825 individuals forming 9 964 households with weights such that this micro population is in many dimensions a good representation of the Norwegian population in the year 1999 (see Aasness,1997, and Aasness, Benedictow and Hussein, 2002, and references therein for information on this model). The households are ranked according to their standard of living, defined as their estimated latent total consumption expenditure in the year 1999 divided by the number of equivalent adults (using the OECD scale), assuming that each person in the same household has the same standard of living. The households are grouped in ten deciles such that the weighted number of households is the same in each decile. The number of persons per household varies between 1 and 13 in the micro data and between 1.70 and 2.54 among the deciles. This implies that the number of persons differ between the different deciles. The group All in table A2 gives the expenditures of the average household in the micro population, which is equal to the mean of the expenditures in the deciles. Thus the expenditures in group All in table A2 multiplied by the total number of households (2 064 574) in Norway 1999 are the macro expenditures according to the micro model. The corresponding budget shares are equal to the macro budget shares in table 1 and A1. This is so since we have calibrated both the macro model (behind table 1 and A1) and the microsimulation model (behind table A2) to fit the same macro data in 1999. Otherwise the empirical basis for our marginal tax analysis would not be consistent with the basic theory in section 2.

Table A1. Budget shares, income elasticities and uncompensated price elasticities. Norway 1999.

	budget	income	uncompensated price elasticities													
Commodity group	share	elast.	p_1	p_2	p_3	p_4	p_5	p_6	p_7	p_8	p_9	p_{10}	p_{11}	p_{12}	p_{13}	p_{14}
1 Food and non-alcoh. drinks	0.143	0.306	-0.212	-0.006	-0.008	-0.022	-0.007	-0.001	-0.005	-0.010	-0.003	0.000	-0.006	-0.023	-0.024	0.020
2 Alcohol and tobacco	0.046	0.935	-0.108	-0.749	-0.023	-0.066	-0.021	-0.004	-0.016	-0.029	-0.009	-0.001	-0.018	-0.072	-0.072	0.253
3 Clothing and footwear	0.055	1.156	-0.141	-0.030	-0.511	-0.082	-0.026	-0.005	-0.023	-0.036	-0.011	-0.002	-0.022	-0.104	-0.127	-0.036
4 Gross rents	0.155	1.130	-0.138	-0.029	-0.028	-0.614	-0.027	-0.005	-0.019	-0.035	-0.011	-0.002	-0.021	-0.093	-0.087	-0.021
5 Electricity	0.028	0.418	-0.051	-0.011	-0.010	-0.036	-0.261	0.064	-0.007	-0.013	-0.004	-0.001	-0.008	-0.040	-0.032	-0.008
6 Fuels	0.005	0.175	-0.021	-0.004	-0.004	-0.015	0.398	-0.483	-0.003	-0.005	-0.002	0.000	-0.003	-0.014	-0.014	-0.003
7 Health	0.026	0.738	-0.090	-0.019	-0.025	-0.052	-0.017	-0.003	-0.316	-0.023	-0.007	-0.001	-0.014	-0.066	-0.081	-0.023
8 Private transport	0.094	1.387	-0.169	-0.035	-0.034	-0.098	-0.032	-0.006	-0.023	-0.841	0.025	0.070	-0.006	-0.106	-0.107	-0.025
9 Public local transport	0.017	0.867	-0.106	-0.022	-0.021	-0.061	-0.020	-0.004	-0.015	0.192	-0.662	0.010	-0.009	-0.066	-0.067	-0.016
10 Public distant tranport	0.010	1.771	-0.216	-0.045	-0.043	-0.126	-0.040	-0.008	-0.030	0.646	0.002	-1.648	0.041	-0.136	-0.136	-0.032
11 Post and telecommunication	0.022	0.311	-0.038	-0.008	-0.008	-0.022	-0.007	-0.001	-0.005	0.074	0.002	0.032	-0.277	-0.024	-0.024	-0.006
12 Other goods	0.151	1.025	-0.125	-0.026	-0.031	-0.080	-0.025	-0.004	-0.019	-0.032	-0.010	-0.001	-0.019	-0.528	-0.098	-0.026
13 Other services	0.181	1.197	-0.146	-0.031	-0.041	-0.085	-0.027	-0.005	-0.024	-0.037	-0.012	-0.002	-0.023	-0.107	-0.620	-0.038
14 Purchases abroad	0.067	1.519	-0.130	-0.147	-0.050	-0.108	-0.035	-0.006	-0.029	-0.048	-0.015	-0.002	-0.029	-0.133	-0.159	-0.923
Scale elasticities			-4.358	-0.441	-0.151	-0.188	-3.977	-5.098	-1.349	0.036	-0.501	0.125	-2.764	-0.396	-0.078	-0.120

Table A2. Arithmetic means of household expenditures per decile. Norway 1999.

Commodity group	*All*	*Decile 1*	*Decile 2*	*Decile 3*	*Decile 4*	*Decile 5*	*Decile 6*	*Decile 7*	*Decile 8*	*Decile 9*	*Decile 10*
1 Food and non-alcoh. drinks	39824	26154	31668	35733	40010	42920	42532	42266	42069	42422	52472
2 Alcohol and tobacco	12937	6071	7685	8733	10112	11525	12663	13841	15151	16889	26700
3 Clothing and footwear	15350	3512	6873	9854	12864	15300	16067	16981	18059	19849	34136
4 Gross rents	43278	14360	21949	28168	34469	40136	43259	46743	50723	56591	95882
5 Electricity	7938	5321	6214	6853	7536	8070	8192	8338	8513	8822	11521
6 Fuels	1289	1209	1223	1210	1204	1214	1253	1292	1334	1383	1565
7 Health	7295	3406	4523	5209	6176	7037	7485	7940	8448	9146	13581
8 Private transport	26176	3633	9189	13832	19245	24077	26637	29380	32486	36946	66331
9 Public local transport	4657	1917	2644	3068	3719	4331	4718	5106	5536	6103	9426
10 Public distant transport	2695	198	632	940	1481	2068	2555	3048	3593	4299	8135
11 Post and telecommunication	6214	4537	5138	5526	5976	6327	6405	6493	6598	6778	8367
12 Other goods	42033	13778	21881	28330	35110	40841	43209	45887	48980	53757	88562
13 Other services	50517	13306	23529	32112	40635	47975	51332	55176	59615	66436	115054
14 Purchases abroad	18841	4337	6892	8694	11581	14759	17691	20696	24020	28329	51410
Total expenditure	2790474	101748	150040	188261	230115	266580	283998	303187	325124	357749	583143
Standard of living	161028	71370	95163	109653	123915	138296	152969	169468	189155	215893	344401

Table A3. MC_i^h $(h = 1, ..., 10; i = 1, ..., 14)$ for $\eta = 0$. Norway 1999.

	Decile 1	Decile 2	Decile 3	Decile 4	Decile 5	Decile 6	Decile 7	Decile 8	Decile 9	Decile 10
1 Food and non-alcoh. beverages	.080	.097	.109	.122	.131	.130	.129	.128	.129	.160
2 Alcohol and tobacco	.114	.145	.164	.190	.217	.238	.260	.285	.318	.502
3 Clothing and footwear	.028	.054	.077	.101	.120	.126	.133	.142	.156	.268
4 Gross rents	.036	.056	.071	.087	.102	.110	.119	.129	.143	.243
5 Electricity	.083	.097	.107	.117	.125	.127	.130	.132	.137	.179
6 Fuels	.110	.111	.110	.110	.111	.114	.118	.122	.126	.143
7 Health	.054	.072	.083	.098	.112	.119	.126	.134	.145	.216
8 Private transport	.023	.057	.086	.119	.149	.165	.182	.201	.229	.411
9 Public local transport	.041	.057	.066	.080	.093	.102	.110	.119	.131	.203
10 Public distant transport	.006	.019	.029	.046	.064	.079	.094	.111	.132	.250
11 Post and telecommunication	.086	.098	.105	.114	.120	.122	.123	.125	.129	.159
12 Other goods	.039	.062	.081	.100	.116	.123	.131	.139	.153	.252
13 Other services	.030	.054	.073	.093	.109	.117	.126	.136	.152	.262
14 Purchases abroad	.021	.034	.043	.057	.072	.087	.101	.118	.139	.252
$MC^h_{\text{alc\&tobacco}} - MC^h_{\text{health}}$	.060	.073	.082	.092	.105	.119	.134	.158	.172	.286

Table A4. MC_i^h ($h = 1, ..., 10; i = 1, ..., 14$) for $\eta = -.7$, and $MC_i^E(\times 1000000)$ ($i = 1, ..., 14$). Norway 1999.

	Decile 1	*Decile 2*	*Decile 3*	*Decile 4*	*Decile 5*	*Decile 6*	*Decile 7*	*Decile 8*	*Decile 9*	*Decile 10*	*Environm.*
1 Food and non-alcoh. beverages	.082	.098	.111	.124	.133	.131	.130	.130	.130	.160	-.477
2 Alcohol and tobacco	.057	.072	.081	.094	.107	.117	.128	.140	.156	.246	-.659
3 Clothing and footwear	.028	.054	.077	.101	.120	.126	.133	.141	.155	.267	-.245
4 Gross rents	.036	.056	.071	.087	.101	.109	.118	.128	.143	.242	-.176
5 Electricity	.084	.098	.108	.118	.127	.129	.131	.133	.138	.179	.144
6 Fuels	.116	.115	.113	.111	.112	.115	.119	.123	.127	.141	-3.881
7 Health	.055	.072	.083	.098	.112	.119	.126	.135	.146	.216	-.281
8 Private transport	.022	.056	.085	.118	.148	.164	.181	.200	.227	.408	-1.491
9 Public local transport	.042	.057	.066	.080	.093	.102	.110	.119	.131	.203	-.440
10 Public distant transport	.005	.019	.028	.045	.063	.077	.092	.109	.131	.248	-.175
11 Post and telecommunication	.088	.100	.107	.115	.122	.123	.125	.126	.130	.159	-.189
12 Other goods	.039	.062	.081	.100	.116	.123	.130	.139	.153	.251	-.305
13 Other services	.030	.053	.073	.092	.109	.117	.125	.135	.151	.261	-.220
14 Purchases abroad	.026	.040	.050	.065	.082	.097	.113	.131	.153	.275	-.016