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Many-Person Ramsey Rule and Nonlinear Income Taxation*

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Abstract

We provide a necessary condition for optimal commodity taxes when agents differ according to labor skill and consumption tastes and when the government can also use a general nonlinear tax on labor income. The discouragement index of commodities is shown to be the sum of (1) the distributive factors over the different income classes and (2) the excess demand of mimickers. The first component arises whenever there is taste heterogeneity within income classes. The second one arises whenever there is taste heterogeneity between income classes. In an empirical application from Canadian microdata we delineate groups of households with homogeneous tastes based on nonviolation of revealed preferences. Assuming that indirect taxes are set optimally, we identify the relevant incentive constraints and provide estimates for social values of the different groups. Redistribution from indirect taxes favors households living in rural Quebec.

JEL classification numbers: H21, D12, D82

Keywords: taste heterogeneity, commodity taxes, income taxation, redistribution, empirical tests for asymmetric information, social weights.

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1 Introduction

In order to ease the fiscal burden on those in need the common practice is to exempt necessities or to tax them at a lower rate than luxuries. Whether commodity taxes should contribute to the progressivity of the overall tax system is however a continued debate in public finance. In a first-best environment indirect taxes are useless and one can conciliate efficiency and equity considerations by appealing to personalized lump-sum income transfers only. It is nevertheless difficult to think about any circumstances where the tax authority could actually use such income transfers. More plausibly the demanding informational requirements of the first-best instead will be not met. In the absence of a general nonlinear income tax the second-best consists to set commodity taxes according to the many-person Ramsey rule derived by Diamond and Mirrlees [15]. This rule recommends to discourage less heavily the demand for the goods preferred by less well-off persons. Its appeal is profoundly affected by the possibility to use a general nonlinear income tax. Atkinson and Stiglitz [2] and Mirrlees [23] and [24] have indeed found that the only role of commodity taxation then amounts to relax incentive constraints. Consider for instance a redistribution from high to low labor skill persons. When labor skill is private information a high tax on necessities that would discourage high skill workers to reduce labor effort may be socially desirable. In fact this happens whenever high skill workers who provide low labor effort consume more necessities than the low skilled. Of course low skilled suffer from the high tax burden but they also gain from a greater scope for redistribution of income. There is suspicion that this narrow role for commodity taxes relates to the fact that labor skill is the only dimension in which agents differ, and that consumption taste heterogeneity on top of labor skill could save some version of the many-person Ramsey rule. The purpose of our paper is to discuss the respective roles of direct nonlinear income taxation and indirect linear uniform commodity taxation when agents differ according to both labor skill and consumption tastes.

Much effort has been done in the recent literature to examine the optimal shape of commodity taxes when individuals differ along two dimensions that are private information to the agents. See especially Cremer, Pestieau and Rochet [9], Cremer, Pestieau and Rochet [10], Saez [25], Diamond [13], Blomquist and Christiansen [4], Kaplow [19], Diamond and Spinnewijn [16] and Golosov, Troshkin, Tsyvinski and Weinzierl [21]. This literature shows that the role of commodity taxes identified by Atkinson and Stiglitz [2] and Mirrlees [24] is still at work in this more general framework. So far there is therefore no clear justification for an heavy taxation of luxuries.

The closest papers to ours are Cremer, Pestieau and Rochet [9] and Diamond and Spinnewijn [16]. Using a Lagrangian approach Cremer, Pestieau and Rochet [9] derive an optimal rule where commodity taxes only depend on the 'incremental net demand of mimickers' defined as the difference between the consumption of mimickers and mimicked agents. As in Atkinson and Stiglitz [2] and Mirrlees [24] the demand for a given commodity should be discouraged when the mimickers consume more of this commodity than the mimicked persons. For instance groceries should be taxed when the richest display a strong enough preference for this category of goods: even with a lower income these persons would still have a relatively high consumption of groceries. In order to study the role of heterogeneity of tastes at a given earning level and to provide a detailed analysis of the relevant incentive constraints, Diamond and Spinnewijn [16] consider an occupation setup where labor income is determined by the occupation independently of consumption tastes. Assuming that high income earners who have high discount rate are ready to imitate low income earners, the 'incremental net demand of mimickers' device recommends to subsidy savings of low income earners. A particular feature of the optimal tax system in Diamond and Spinnewijn [16] is to involve a tax on savings of high income earners that complements this subsidy on the less well-off agents. Diamond and Spinnewijn [16] interpret this additional tax as a second manner to relax incentive constraints. Indeed a tax on savings of the richest redistributes welfare from the richest patient to the richest impatient agents, and so raises the welfare of the potential mimickers (the richest impatient agents) if they do not relax labor effort.

Our paper shows that this tax on savings of the richest in fact is part of a many-person Ramsey rule. The intuition is simple. When there is a limited number of occupations relatively to the total number of different types, some agents with different tastes must be clustered within the same income class. The income tax can only be used to handle with heterogeneity between income classes, but it is useless for achieving a finer redistribution within income classes. This is a role devoted to commodity taxation. Within a given income class or occupation, or equivalently in the presence of bunching where different types of agents have after-tax income, incentive problems become irrelevant: commodity taxes depend on the relationship between the individual consumption and the social valuation of the consumers.

We use a method closely related to Cremer, Pestieau and Rochet [9] in an occupation setup that generalizes Diamond and Spinnewijn [16]. Unlike Cremer, Pestieau and Rochet [9] we solve for a dual program allowing for a separate treatment of commodity taxes and occupation and labor decisions, as in Laroque [20] and Gauthier and Laroque [18]. The program yields a necessary condition for indirect taxes to be optimal given any arbitrary distribution of before-tax income. This condition can be written in two alternative ways. The first writing coincides with the standard many-person Ramsey rule provided that agents' social weights are suitably redefined. Following Diamond [12] the social weight of an agent usually equals the change in social welfare that would result from an income transfer toward this agent in the absence of incentive considerations. In our setup this weight also integrates a component related to incentives. Indeed an income transfer makes more difficult to discourage all the agents who are initially tempted by the allocation designed for those benefiting from the transfer. From an incentive viewpoint it would instead be better to lower income transfers to envied (mimicked) agents. The relevant weight in the many-person Ramsey rule is the sum of the 'intrinsic' social weight used by Diamond [12] and a negative component due to incentive issues. This 'consolidated' social weight is therefore below the intrinsic one when incentive considerations matter. It might even be negative, as is sometimes found in the empirical literature estimating these weights from many-person Ramsey rules (see, e.g., Ahmad and Stern [1]).

The second writing follows from a decomposition of these two parts. This gives a new formulation for the optimal rule of indirect taxation that mixes a many-person Ramsey rule over the usual Diamond [12] intrinsic social weights, and an incentive component function of the incremental net demand of mimickers. This formulation shows that the usefulness of indirect taxes relates to taste heterogeneity in two different ways. On the one hand, indirect taxes are shaped by a many-person Ramsey rule when agents within the same income class have different consumption tastes. On the other hand, indirect taxes are also useful when agents in different income classes have also different tastes: indirect taxes then allow to relax incentive constraints. In view of the many-person Ramsey rule component the consumption of those who have low intrinsic weights can be discouraged, even in the presence of a general nonlinear income tax. Commodity taxation then reinforces the progressivity of the tax system by managing within income class taste heterogeneity, while the income tax is concerned by between class income (cross-sectional) heterogeneity.

In an empirical illustration from Canadian consumption microdata we identify groups of agents who have the same preferences for consumption by appealing to Crawford and Pendakur [8]. They provide a method that clusters household observations consistent with the Generalized Axiom of Revealed Preferences. We find that taste heterogeneity matters but that few groups are enough to give an account of most of the data.

Assuming that the Federal Good and Services Tax (GST) is optimally set is then used to give estimates for the social weights of the different groups based on the rules derived in our theoretical model. We provide evidence that consolidated social weights vary with taste groups. They are negative for low levels of education childless or single parent rural families living in West Canada.

Recovering the intrinsic social weights requires identifying the relevant incentive constraints. The existing empirical literature offers several several tests for the presence of asymmetric information. These tests usually rely on the comparison between market outcomes with and without asymmetric information (see Chiappori and Salanié [7] and Finkelstein and McGarry [17]). We need however a much more precise information about the pattern of incentives. We use a simple new argument for identifying the binding incentive constraints, based on a direct measure of the Lagrange multipliers associated with these constraints. We find that incentive problems are mostly concentrated on households whose consolidated social weights are negative. The negative consolidated social weights found for these categories thus underestimate their intrinsic weights. The bias appears large enough for all the intrinsic weights to be actually positive. In general redistribution implied by the GST favors the poorest households within each taste group, while redistribution between taste groups favors households living in rural Quebec.

2 General setup

We consider a population of agents varying in labor skill i ($i = 1, \ldots, I$) and consumption tastes j ($j = 1, \ldots, J$). There are n_{ij} type ij agents and the total population size is normalized to 1. The preferences of a ij agent are represented by the utility function $U_i(V_j(x), y)$ where x is a bundle of N commodities and y is a nonnegative real number which stands for before-tax labor income. Preferences embody separability between labor income and consumption, which allows for a clear distinction between labor skill and consumption tastes. There is heterogeneity in consumption tastes when the subutility V_j varies with j. The functions U_i and V_j have standard monotony and convexity properties.

The government observes individual income and aggregate consumption for every good. Labor skill i and consumption tastes j are private information to the agent. The tax tools available to the government consist of a nonlinear income taxes and a set of linear consumption taxes. Consumption goods are produced from labor according to a linear technology associated with a given vector of N producer prices p. The vector of N consumption taxes is $q - p$ where q is the vector of consumer prices. An agent with before-tax labor income y earns $R(y)$ as after-tax labor income.

Following Diamond [14] and Diamond and Spinnewijn [16] income heterogeneity proceeds through the existence of occupations (or jobs) indexed by k ($k = 1, \ldots, K$). All the agents in occupation k earn the same before-tax income y_k and are subject to the same earnings tax rate, with $R_k = R(y_k)$ as after-tax income. The standard taxation setup obtains when $K = IJ$, i.e., there are as many possible occupations as individual types. In the sequel we assume that $K \leq IJ$.

Given (y, R) a ij agent chooses a consumption bundle maximizing $V_j(x)$ subject to the budget constraint $q \cdot x \leq R$. The solution to this problem is a bundle $\xi_j(q, R)$ yielding (conditional) indirect subutility $V_j(\xi_j(q, R)) \equiv V_j(q, R)$ from consumption, with a slight abuse of notation.

A ij agent in occupation k has therefore utility $U_i(V_j(q, R_k), y_k)$. She self-selects into occupation k if and only if

$$U_i(V_j(q, R_k), y_k) \geq U_i(V_j(q, R_{k'}), y_{k'}) \tag{1}$$

for all k'.

A tax system is defined by a vector q consisting of N consumer prices, an income tax profile (y_k, R_k) for $k = 1, \ldots, K$, and an allocation rule assigning every type of agent to some occupation. The allocation rule is defined as a profile (μ_{ijk}) where μ_{ijk} is 1 if ij agents are assigned to occupation k, and is 0 otherwise.

A tax system is feasible if

$$\sum_{ijk} n_{ij}\mu_{ijk}\left[(q-p)\cdot\xi_j(q,R_k)+(y_k-R_k)\right]\geq 0.$$

It satisfies incentive compatibility if (1) holds for each type ij and each pair of occupations k and k' such that $\mu_{ijk}=1$.

3 A dual program

Consider some reference tax system $((\bar{\mu}_{ijk}),\bar{q},(\bar{y}_k,\bar{R}_k))$ satisfying incentive compatibility (1) and feasibility requirements (2). This section derives a necessary condition for $\bar{q}$ and $(\bar{R}_k)$ to be optimal, given $(\bar{\mu}_{ijk})$ and $(\bar{y}_k)$. For convenience, let $\bar{V}_{jk}\equiv V_j(\bar{q},\bar{R}_k)$ be the subutility that a type ij agent obtains when facing the reference tax system. Let also

$$n_{jk}\equiv\sum_i n_{ij}\bar{\mu}_{ijk}$$

be the number of taste j agents in occupation k.

Suppose that the economy is locally nonsatiated when facing the reference tax system: some additional resources could be used to achieve a Pareto improvement without violating incentive compatibility requirements. Given the assignment $(\bar{\mu}_{ijk})$ and before-tax income levels $(\bar{y}_k)$, the tax tools $(q,(R_k))=(\bar{q},(\bar{R}_k))$ must locally solve the program $\mathcal{P}$ that consists to maximize the total amount of collected resources

$$\sum_{jk} n_{jk}\left[(q-p)\cdot\xi_j(q,R_k)+(\bar{y}_k-R_k)\right]$$

subject to

$$V_j(q,R_k)\geq\bar{V}_{jk}\tag{2}$$

for all ijk such that $\bar{\mu}_{ijk}=1$, and

$$V_j(q,R_k)\leq\bar{V}_{jk}\tag{3}$$

for all ijk $U_i(\bar{V}_{jk},\bar{y}_k)=U_i(\bar{V}_{jk'},\bar{y}_{k'})$ and $\bar{\mu}_{ijk'}=1$ for some $k'\neq k$.

If there were some $(q,(R_k))$ different from $(\bar{q},(\bar{R}_k))$ solution to $\mathcal{P}$, there would exist another tax system satisfying incentive constraints and yielding a higher amount of collected tax. The nonsatiation hypothesis would imply suboptimality of $(\bar{q},(\bar{R}_k))$.

The JK constraints (2) ensure that not agent suffers from the implementation of the new taxes $(q,(R_k))$. The constraints (3) maintain local incentive compatibility. Consider indeed a ij agent allocated to some occupation k' different from k who contemplates switching to occupation k. It follows from (2) that her welfare when she remains in her own occupation

k' is greater when she faces the new taxes $(q,(R_k))$ than the reference taxes $(\bar{q},(\bar{R}_k))$. The constraints (3) therefore ensure that the deviation cannot be made profitable. Of course as soon as some type ij agent assigned to occupation k' is ready to switch to occupation k in the reference situation, both (2) and (3) have to hold simultaneously for tastes j and occupation k: the subutility obtained by a type ij agent assigned to occupation k then cannot change, $V_j(q,(R_k)) = V_j(\bar{q},(\bar{R}_k))$.

Note that the constraints (3) only involve types ij and occupations corresponding to active incentive constraints in the reference situation: if no taste j agent contemplates deviating to occupation k, $V_j(q,R_k)$ could be set below $\bar{V}_{jk}$ without violating incentive constraints.

Remark 1. The program $\mathcal{P}$ assumes that all the agents with the same type are assigned to the same occupation. If agents with the same type were assigned to different occupations, then both (2) and (3) should hold for this type.

Remark 2. Suppose that in the reference situation agents are bunched into $K' < K$ income classes. Since $(\bar{y}_k)$ and $(\bar{\mu}_{ijk})$ are given in $\mathcal{P}$, all the agents with the same before-tax income must have the same after-tax income (otherwise incentive constraints would be violated). Hence the government in fact can use at most K' different after-tax income levels and there is no loss to set $K = K'$. This shows that an occupation can be thought of as an income class.

We solve $\mathcal{P}$ by appealing to Lagrangian methods. This requires qualification of the (active) constraints in the reference situation (Simon and Blume [26]).

Assumption 1. *The constraints of program $\mathcal{P}$ active at $(\bar{q},(\bar{R}_k))$ are qualified: the $JK \times (N+K)$ Jacobian matrix whose jkth row is $\nabla V_j(\bar{q},(\bar{R}_k))$ has rank JK.*

Assumption 1 requires that $(J-1)K \leq N$, i.e., a large enough number of taxable goods relatively to agents' heterogeneity. Under this assumption there are nonnegative Lagrange multipliers λ_{jk} and γ_{jk} associated with (2) and (3) such that a solution to $\mathcal{P}$ is a local extremum of

$$\sum_{jk} n_{jk}\left(t\cdot\xi_j(q,R_k) - R_k\right) + \sum_{jk} n_{jk}\lambda_{jk}\left[V_j(q,R_k) - \bar{V}_{jk}\right] + \sum_{jk} \tilde{n}_{jk}\gamma_{jk}\left[\bar{V}_{jk} - V_j(q,R_k)\right],$$

where

$$n_j \equiv \sum_k n_{jk} \quad \text{and } \tilde{n}_{jk} \equiv \sum_i \sum_{k'\neq k} n_{ij}\bar{\mu}_{ijk'}\mathbb{1}\left[U_i(\bar{V}_{jk'},\bar{y}_{k'}) = U_i(\bar{V}_{jk},\bar{y}_k)\right]$$

are respectively the number of taste j agents in the economy and the number of taste j agents assigned to occupation $k' \neq k$ who contemplate switching to occupation k.

4 A many-person Ramsey rule

Let $\xi^h_{jk} \equiv \xi^h_j(\bar{q}, \bar{R}_k)$ be the demand for good h by a ij agent in occupation k in the reference situation. The tax system $((\bar{\mu}_{ijk}), \bar{q}, (\bar{y}_k, \bar{R}_k))$ is optimal only if the first-order condition in the consumer price q^h of good h,

$$\sum_{jk} n_{jk} \left(\xi^h_{jk} + \sum_\ell t^\ell \frac{\partial \xi^\ell_{jk}}{\partial q^h} \right) - \sum_{jk} n_{jk} \lambda_{jk} \alpha_{jk} \xi^h_{jk} + \sum_{jk} \tilde{n}_{jk} \gamma_{jk} \alpha_{jk} \xi^h_{jk} = 0,$$

is satisfied.

The value of a one unit of income transfer toward a taste j agent assigned to occupation k is

$$\beta_{jk} = \sum_\ell t^\ell \frac{\partial \xi^\ell_{jk}}{\partial R} + \lambda_{jk} \alpha_{jk}. \tag{4}$$

The value of β_{jk} measures the 'intrinsic' social weight of a taste j agent assigned to occupation k. This is the marginal social valuation of an income transfer in the absence of any incentive problems involving this agent.

The value of the same transfer, designed to a taste j agent in occupation k, but that would also benefit to a taste j agent allocated to some other occupation $k' \neq k$ when she switches to occupation k is

$$\tilde{\beta}_{jk} = \gamma_{jk} \alpha_{jk}. \tag{5}$$

It follows that the total social value of a one unit of income transfer toward each taste j agent in occupation k is

$$b_{jk} = n_{jk} \beta_{jk} - \tilde{n}_{jk} \tilde{\beta}_{jk}. \tag{6}$$

This 'consolidated' social weight b_{jk} equals the 'intrinsic' social weight net of the incentive correction $\tilde{\beta}_{jk}$.

Appealing to the Slutsky properties, the first-order condition in q^h can be written

$$\sum_\ell t^\ell \frac{\partial \hat{\xi}^h}{\partial q^\ell} = -\xi^h + \sum_{jk} b_{jk} \xi^h_{jk} \tag{7}$$

where

$$\xi^h \equiv \sum_{jk} n_{jk} \xi^h_{jk}$$

represents the aggregate demand for good h, and $\hat{\xi}^h$ is the aggregate compensated demand for this good. Using the first-order condition in the after-tax income chosen for occupation k,

$$\sum_j b_{jk} = \sum_j n_{jk} \equiv n_k, \tag{8}$$

the first-order condition in q^h finally yields a first necessary condition for optimal commodity taxes.

Proposition 1. *Suppose that Assumption 1 is satisfied. Consider some assignment* $(\bar{\mu}_{ijk})$*, a vector of consumer prices* $\bar{q}$ *and an income tax schedule* $(\bar{y}_k, \bar{R}_k)$ *satisfying incentive compatibility and feasibility requirements. Then, given* $(\bar{\mu}_{ijk})$ *and* $(\bar{y}_k)$*, the optimal indirect taxes must satisfy*

$$\sum_\ell t^\ell \frac{\partial \hat{\xi}^h}{\partial q^\ell} = \sum_k n_k \Phi_k^h \tag{9}$$

where

$$\Phi_k^h \equiv \sum_j \frac{b_{jk}}{n_k}\xi_{jk}^h - \sum_j \frac{n_{jk}}{n_k}\xi_{jk}^h = \operatorname{cov}\left(\frac{b_{jk}}{n_{jk}}, \xi_{jk}^h\right).$$

The covariance Φ_k^h is positive when agents in occupation k who have a high consolidated social weight like good h. The rule (9) fits a many-person Ramsey rule formulation. In the standard many-person Ramsey rule the intrinsic replace the consolidated social weights. Here social values are adjusted downward because an income transfer toward agents in occupation k makes this occupation more desirable to the other agents, and so tightens incentive constraints. This might contribute to explain why the social values recovered from the many-person Ramsey rule are sometimes found to be negative in the empirical literature. In our illustration in section 5 consolidated social values are negative for some groups of agents.

The above formulation possibly involves hypothetical consumption levels of mimickers. One can however isolate the own impact of effective consumption heterogeneity on commodity taxes. This requires to disentangle the positive impact of an income transfer toward agents in occupation k (whose welfare increases) and the negative impact coming from a tightening of incentive constraints. To this aim we exploit the linearity properties of the covariance operator to the expression of b_{jk} given in (6):

$$\Phi_k^h = \operatorname{cov}\left(\beta_{jk}, \xi_{jk}^h\right) - \operatorname{cov}\left(\frac{\tilde{n}_{jk}}{n_{jk}}\tilde{\beta}_{jk}, \xi_{jk}^h\right),$$

where

$$\operatorname{cov}\left(\beta_{jk}, \xi_{jk}^h\right) \equiv \phi_k^h = \sum_j \frac{n_{jk}}{n_k}\beta_{jk}\xi_{jk}^h - \sum_j \frac{n_{jk}}{n_k}\beta_{jk}\sum_j \frac{n_{jk}}{n_k}\xi_{jk}^h \tag{10}$$

is the distributive factor of good h advocated by Diamond [12], here computed within occupation k. Similarly,

$$\operatorname{cov}\left(\frac{\tilde{n}_{jk}}{n_{jk}}\tilde{\beta}_{jk}, \xi_{jk}^h\right) = \sum_j \frac{\tilde{n}_{jk}}{n_k}\tilde{\beta}_{jk}\left(\xi_{jk}^h - \xi_k^h\right)$$

where

$$\xi_k^h \equiv \sum_j \frac{n_{jk}}{n_k} \xi_{jk}^h$$

is the average (actual) demand for good h within occupation k. Recall that $\tilde{n}_{jk}\tilde{\beta}_{jk}$ is 0 when no taste j agent in occupation $k' \neq k$ contemplates switching to occupation k in the reference situation. A type ij in occupation k' would get the subutility $V_j(q, R_k)$ in occupation k and thus would have the same consumption ξ_{jk}^h as a taste j agent initially assigned to occupation k. The covariance in (4) thus appears as a weighted sum of the differences between the fictitious consumption of good h from agents who contemplate switching to job k and the actual consumption of this same good by agents allocated to job k in the reference situation. This is the 'incremental demand of the mimickers' used by Cremer, Pestieau and Rochet [9].

Proposition 1 can then be rewritten in the following way:

Proposition 2. *Suppose that Assumption 1 is satisfied. Consider some assignment $(\bar{\mu}_{ijk})$, a vector of consumer prices $\bar{q}$ and an income tax schedule $(\bar{y}_k, \bar{R}_k)$ satisfying incentive compatibility and feasibility requirements. Then, given $(\bar{\mu}_{ijk})$ and $(\bar{y}_k)$, the optimal indirect taxes must satisfy*

$$\sum_\ell t^\ell \frac{\partial \hat{\xi}^h}{\partial q^\ell} = \sum_k n_k \phi_k^h - \sum_{jk} \tilde{n}_{jk}\tilde{\beta}_{jk} \left(\xi_{jk}^h - \xi_k^h\right), \tag{11}$$

where ϕ_k^h is the within occupation k distributive factor for good h.

1. Incentive considerations are irrelevant when there is only one occupation $k = K = 1$. We have $\tilde{\beta}_{jk} = 0$ for all jk. The income tax degenerates to a uniform lump-sum tax and the optimal rule for indirect taxation given in Proposition 2 simplifies as

   $$\sum_\ell t^\ell \frac{\partial \hat{\xi}^h}{\partial q^\ell} = \sum_k n_k \phi_k^h = \phi_1^h.$$

   This is the familiar many-person Ramsey rule. The discouragement of compensated demand for good h should equal to the distributive factor of this good. Indirect taxation is useful as far as there is taste heterogeneity within the (unique) income class.

2. When there are IJ occupations, each type ij can be viewed as assigned to occupation $k = ij$. We have then $\phi_k^h = 0$ for all h and k, and the optimal rule for indirect taxation given in (11) becomes

   $$\sum_\ell t^\ell \frac{\partial \hat{\xi}^h}{\partial q^\ell} = -\sum_{jk} \tilde{n}_{jk}\tilde{\beta}_{jk} \left(\xi_{jk}^h - \xi_k^h\right). \tag{12}$$

The discouragement only relies on the incremental net demand of the mimickers, as in Mirrlees [24], Guesnerie [22], Cremer, Pestieau and Rochet [9] and [10]. The formula (11) also applies when tastes are perfectly correlated with skill, as in Golosov, Troshkin, Tsyvinski and Weinzierl [21]. Indirect taxation is useless when no agent contemplates switching to another occupation in the reference situation ($\tilde{\beta}_{jk} = 0$ for all jk). It is also useless in the homogeneous taste case, i.e., $V_j(x) = V(x)$, so that $\xi^h_{jk} = \xi^h_k$, which yields the Atkinson and Stiglitz [2] theorem. The role of indirect taxes in (12) is bound to relax incentive constraints. This is possible when agents in different income classes have also different consumption tastes. When $\tilde{\beta}_{jk} > 0$ for some jk, consumption of a given good h should be discouraged when agents who contemplate switching to occupation k have a higher consumption of this good than agents in occupation k.

The considerations coming from these two polar cases mix together in a surprisingly simple manner in the more general configuration where $1 \leq K \leq IJ$. The optimal discouragement should then equal the sum of distributive factors over the different income classes and the measure of the excess consumption of mimickers.

In each configuration nonlinear income taxes handle with heterogeneity of agents between occupations. Proposition 2 highlights that (nonuniform) indirect taxes are useful in two kinds of circumstances. First they contribute to deal with equity when individuals allocated to the same income class have different consumption tastes. Then they allow the tax authority to manage within income class heterogeneity through a many-person Ramsey-like rule. Second, they ensure relaxation of incentive constraints when individuals allocated to different income classes have different tastes, i.e., in the presence of cross-sectional taste heterogeneity.

Proposition 2 makes clear that indirect taxes should be partly designed to reinforce the progressivity of the tax system. However one cannot expect that luxuries be more heavily taxed than necessities, even if agents who like luxuries have lower intrinsic weights, because the impact of taste heterogeneity between income classes may overcome taste heterogeneity within income classes.

5 An empirical illustration

We use Canadian consumption microdata to delineate groups of agents who have similar consumption tastes and to estimate the consolidated social values (b_{jk}). We provide a simple method to identify the relevant incentive constraints. This yields separate estimates for the incentive corrections ($\tilde{\beta}_{jk}$) and the intrinsic social weights (β_{jk}).

5.1 Data, consumption and taxes

The data comes from the Survey of Family Spending (for years 1992, 1996, 1997, and 1998) and the Survey of Household Spending (for every year from 1999 to 2008) collected by Statistics Canada.[1] Annual surveys comprise from 8,624 to 16,461 observations, yielding a 14 year pooled sample of 183,971 observations at the household level. One observation gives the amounts spent by an household on 13 aggregate COICOP categories of goods (Food expenditures, Alcoholic beverages, Clothing, Housing, Furnishings and equipment, Health care, Public and Private Transportation, Communication, Education, Recreation, Restaurants, and a Miscellaneous Goods and Services category).[2] Price indices are drawn from Statistics Canada's Consumer Price Index. They are harmonized across provinces using the 2008 Inter-city Indexes of Consumer Price Levels. They are computed at the category × province × year level.

Canada appeals to both a federal Goods and Services Tax (GST) and local commodity taxes. Some provinces set local taxes in accordance with the GST within the framework of an Harmonized Sales Tax (HST). Others may have provincial or retail sales tax on top of the GST. In this illustration we mostly focus our attention on the federal redistributive stance, taking as given local taxes. We thus ignore possible vertical interactions between different levels of governments. The GST was enacted in 1991 at a rate of 7% through legislative arrangements promoted by Brian Mulroney and part of the Progressive Conservative party, but disapproved by other right-wing Members of Parliament, as well as the Liberal party and most of the population. The Conservative Party subsequently lowered the GST rate to 6% in 2006 and to 5% in 2008.

The GST applies to the supply of most goods and services, except basic groceries such as milk, bread, vegetables, meat, agricultural or fishery products, and also most of health and education related expenditures. In this illustration, we consider that all goods are subject to GST, except the whole Food, Health and Education categories that are assumed tax-free. It is likely that the available aggregate categories in fact include both taxed and zero-rated or exempted items.

5.2 Revealed preferences taste groups

The identification of the groups of households who have the same consumption tastes uses the revealed preference based methodology used by Crawford and Pendakur [8]. We use the `revealedPrefs` algorithm developed by Boelaert [6] to perform Crawford and Pendakur

[1] Details about the database and cleaning procedure can be found in Boelaert [5].

[2] The United Nations Statistics Division provides details about the different categories available online at `http://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=5Lg=1`. The 02 Alcoholic beverages category also comprises Tobacco and Narcotics. Water supply, electricity, gas and other fuels are included into the 04 Housing category. The 07 Transport category is splitted into Private and Public transportation. The latter corresponds to the 07.3 Transport services COICOP subcategory.

clustering of the data. This yields groups of households who do not violate the Generalized Axiom of Revealed Preferences. Households from the same group have the same preferences and the same demand functions. The algorithm is computationally demanding. For this reason we have worked with a random sub-sample of 100,000 observations from our initial sample. We find that taste heterogeneity does matter but that a limited number of groups is enough to rationalize the data.[3] The three groups with most observations comprise about one-third of the sample. In the sequel we only consider these three taste groups.

There are $12,756$ observations in taste group 1, $8,573$ in taste group 2, and $6,880$ in taste group 3. Detailed characteristics about these groups are given in Appendix A and B. Taste 1 group comprises households whose consumption pattern is similar to the one of a household with intermediate education, and living in rural areas in Quebec. Households in this group have relatively large spending on the Furnishings and equipment and Recreation categories. Taste 2 group consists of tenants or mortgaged owners, with high education, living in urban areas of Ontario. This is the richest group of our sample. A larger income share is devoted to Housing and Restaurants categories. Finally, in taste 3 group, one finds households with low education, living in urban areas of British Columbia or Prairies regions. These are the poorest households of our sample. They consume relatively more Private transport, Alcohol and education categories.

5.3 Social weight estimates

Assuming that the GST rates are set optimally, the best estimates for the profile of social weights (b_{jk}) must satisfy the first-order conditions (6) and (7). The first-order condition (7) associated with category h can be rewritten

$$\sum_{\ell} \frac{t^{\ell}}{q^{\ell}} \hat{\varepsilon}^{h\ell} = -1 + \sum_{jk} b_{jk} \frac{\xi^h_{jk}}{\xi^h},$$

where

$$\hat{\varepsilon}^{h\ell} = \sum_{jk} n_{jk} \frac{\xi^h_{jk}}{\xi^h} \hat{\varepsilon}^{h\ell}_{jk} \tag{13}$$

is the price elasticity of compensated aggregate demand for category h with respect to consumer price q_ℓ, and

$$\hat{\varepsilon}^{h\ell}_{jk} = \frac{q_\ell}{\xi^h_{jk}} \frac{\partial \hat{\xi}^h_{jk}}{\partial q_\ell}.$$

In addition, from (6), we have

$$b_{1k} = \sum_{j} n_{jk} - \sum_{j\geq 2} b_{jk} \equiv n_k - \sum_{j \geq 2} b_{jk} \tag{14}$$

[3] We find that 77 taste groups rationalize the whole 100,000 observations dataset: only 8 groups are enough to rationalize 50% of the data, 18 for 75% of the data, and 32 for 90% of the data.

for all income class k. The best estimates (b^*_{jk}) for consolidated social weights of taste groups $j \geq 2$ is a profile (b_{jk}) minimizing

$$\left(\sum_{\ell} \frac{t^\ell}{q^\ell} \left(\sum_{jk} n_{jk} \frac{q^h \xi^h_{jk}}{q^h \xi^h} \hat{\varepsilon}^{h\ell}_{jk} \right) + 1 - \sum_{k} n_k \frac{q^h \xi^h_{1k}}{q^h \xi^h} - \sum_{k} \sum_{j \geq 2} b_{jk} \frac{q^h \xi^h_{jk} - q^h \xi^h_{1k}}{q^h \xi^h} \right)^2 . \tag{15}$$

The estimate (b^*_{1k}) for consolidated social weights of taste group 1 then obtain from (14).

In (15) the *ad valorem* taxes t^ℓ/q^ℓ are set to the mean GST rate over time for all taxed categories, and is 0 for untaxed categories (Food, Health, and Education). For simplicity we consider $K = 2$ income classes comprising households whose income (total expenditure) is below or above the median Canadian income. Annual income is between 133 and $36,260$ CAD in the lower class, and between $36,260$ and $354,206$ CAD in the upper class. There are therefore 6 different groups characterized by their consumption tastes $j = 1, 2, 3$ and their income class $k = 1, 2$.

We have a system of $13 + 2 = 15$ equations (there are 13 categories of good and 2 income classes) to recover the 6 consolidated social weights (b_{jk}). In the sequel, however, we disregard the first-order condition (7) associated with Alcohol, since taxes on alcohol depend not only on efficiency/equity matters, but also on e.g., public health considerations.

The data gives the amount $(q^h \xi^h_{jk})$ spent on every category h (in CAD) for every group jk. We obtain the price elasticities of compensated demand from the estimation of an Almost Ideal Demand System. Table 1 reports for every jk the ratio b^*_{jk}/n_{jk} that minimizes (15) subject to (14).[4] This ratio measures the gross social value (in CAD) of a transfer of 1 CAD to one individual in the jk group. It is greater than 1 when it is socially profitable to transfer 1 dollar to one such individual. The first row of Table 1 gives the social values estimated from the whole sample. Tastes of group 1 appear socially favored while tastes of group 3 are socially penalized. The society seems to be about neutral regarding taste group 2.

In the second and third rows of Table 1 the tax rate is set to the mean GST rate over the years where the Prime Minister is from the Conservative Party (1993, 2006, 2007, and 2008) and from the Liberal Party (1992, and every year from 1996 to 2005), respectively. The same general pattern as in the whole sample continues to hold in the two sub-samples. Conservative Party possibly puts less weight than the Liberal Party on low income earners of taste group 2 and more weight on those of taste group 3.

[4]The value of (15) at (b^*_{jk}) is 0.46. This represents only 9.5% of the average value of (15) obtained from $50,000$ random draws with (b_{jk}) between -1 and 2. The algorithm thus performs well. Table 6 in the appendix provides a decomposition of the total residual per category. Most of the residual in fact concerns Education: equity and efficiency considerations are not enough to justify exemption of Education from the GST base.

Table 1: CONSOLIDATED SOCIAL WEIGHTS

	b^*_{jk}/n_{jk} (in Canadian Dollars)					
Taste group j	1		2		3	
Income class k	Lower	Upper	Lower	Upper	Lower	Upper
Whole sample	1.93	1.65	0.96	0.94	−0.67	−0.12
Conservative Party	2.04	1.67	0.31	0.87	0.10	−0.09
Liberal Party	2.02	1.84	0.75	0.63	−0.67	−0.07

5.4 Incentive pattern and intrinsic social values

Intrinsic social weights (measured by β_{jk}) equal b_{jk}/n_{jk} if and only if group jk is not envied by another group ($\tilde{n}_{jk}$ is 0 in (6)). When $\tilde{n}_{jk} > 0$, intrinsic social weights are blurred by incentive considerations. In this section we appeal to Assumption 1 to isolate the intrinsic component. Suppose that $\tilde{n}_{jk}\gamma_{jk} > 0$. By Assumption 1 it must be that (2) is inactive for taste j agents in occupation k. Indeed both (2) and (3) cannot be active without violating qualification. We have therefore:

IDENTIFYING ASSUMPTION. Under Assumption 1, $\tilde{n}_{jk}\gamma_{jk} > 0 \Rightarrow \lambda_{jk} = 0$.

We now proceed by contradiction in order to identify the pattern of relevant incentive constraints. Assume that agents of group jk are envied:

$$\tilde{n}_{jk}\gamma_{jk} > 0. \tag{16}$$

It follows that $\lambda_{jk} = 0$ and by (4) the intrinsic social weight of an agent of group jk is

$$\beta_{jk} = \sum_{\ell} t^{\ell} \frac{\partial \xi^h_{jk}}{\partial R^k}. \tag{17}$$

Using (6) then yields

$$\tilde{n}_{jk}\gamma_{jk} = n_{jk} \sum_{\ell} t^{\ell} \frac{\partial \xi^h_{jk}}{\partial R^k} - b_{jk}. \tag{18}$$

Table 2 reports the values of $\tilde{n}_{jk}\gamma_{jk}$ for every jk obtained from (18) with (b_{jk}) replaced by the estimates (b^*_{jk}) given in Table 1, computing the income effect consistent with an AIDS formulation. When the value is found negative, the assumption that jk is envied is falsified and the incentive constraints involving group jk must be slack ($\tilde{n}_{jk}\gamma_{jk} = 0$).

Table 2 shows that incentive considerations do not matter within taste group 1. The estimated social weights b^*_{1k} reported in Table 1 thus give estimates for the intrinsic social

Table 2: INCENTIVE CORRECTION

	$\tilde{n}_{jk}\tilde{\beta}_{jk}$ (in Canadian Dollars)					
Taste group j	1		2		3	
Income class k	Lower	Upper	Lower	Upper	Lower	Upper
Whole sample	-0.29	-0.21	-0.04	-0.04	0.18	0.09
Conservative Party	-0.24	-0.31	0.03	-0.06	0.06	0.10
Liberal Party	-0.33	-0.23	0.001	0.01	0.18	0.08

values β_{1k}/n_{1k} for the two income classes. To some extent this also applies to taste group 2 (the values for $\tilde{n}_{2k}\tilde{\beta}_{2k}$ stand very close to 0). Incentives clearly do matter within taste group 3.

When incentive constraints bind for a group jk, the intrinsic social weight must be computed from (17). The corrected weights are given in Table 3.

Table 3: INTRINSIC SOCIAL WEIGHTS

	β_{jk} (in Canadian Dollars)					
Taste group j	1		2		3	
Income class k	Lower	Upper	Lower	Upper	Lower	Upper
Whole sample	1.93	1.65	0.96	0.94	0.73	0.67
Conservative Party	2.04	1.67	0.61	0.87	0.61	0.56
Liberal Party	2.02	1.84	0.75	0.70	0.76	0.69

The intrinsic social weights are consistent with a Paretian social welfare function ($\beta_{jk} > 0$ for all jk). A group is socially favored when $\beta_{jk} > 1$ and socially penalized otherwise. Redistribution revealed from federal GST rates shows that taste group 1 is socially favored while taste groups 2 and 3 are socially penalized. In general the social value is greater for low income earners than high income earners in a given taste group, and redistribution toward the less well off households is magnified under the Liberals.[5]

REMARK 3. We have considered that the federal level takes local taxes as given. If one assumes instead that the federal stance takes into account the change in local commodity

[5]The results are about unaffected if the reference is an adult equivalent instead of an household. Appendix E provides estimated social weights for renormalized consumption expenditures using standard equivalent scales.

taxes that results from an adjustment in the GST rate, for instance through the (HST) harmonization settlement, then the sum of the federal and provincial tax rates is better suited for the analysis. Reproducing the same analysis with the GST rate replaced by the total (federal and provincial) tax rate yields intrinsic social weights given in Table 4. The pattern of relevant incentive constraints is unchanged (see Tables 9 in Appendix D), with incentive difficulties still concentrated within taste group 3. Taste groups 2 and 3 still have lower social values than taste group 1, but, absent from incentive issues, indirect taxes now would make income transfers socially desirable for every group.

Table 4: Intrinsic social weights from federal and provincial taxes

	β_{jk} (in Canadian Dollars)					
Taste group j	1		2		3	
Income class k	Lower	Upper	Lower	Upper	Lower	Upper
Whole sample	1.84	1.47	1.33	1.40	1.30	1.20
Conservative Party	2.09	1.52	1.17	1.22	1.18	1.09
Liberal Party	1.91	1.75	1.32	1.24	1.33	1.23

5.5 Discouragement and incentives

The impact of incentive constraints on Canadian indirect taxes depends on incentives through the demand of taste group 3 mimickers. If their consumption is close to the average consumption, then indirect taxes is shaped by the many-person Ramsey rule and Tables 3 and 4 imply that demand for the goods preferred by taste group 1 should be less discouraged. Figures 1 and 2 however show that consumption of taste group 3 differ from the consumption of other groups.

Figure 1 gives the ratio of the individual consumption of a lower income class taste group 1 household (in blue), 2 (in red) and 3 (in black) to the mean (over all possible tastes) consumption of the lower income class, i.e., ξ^h_{jk}/ξ^h for $k = 1$ and all j and h. These consumptions coincide with the fictitious consumption of the upper income class from taste group 1 (resp., 2 and 3) who would mimic a lower income class from this same taste group 1 (resp., 2 and 3). Figure 1 also reports the income share devoted to each category by a low income earner is reported into brackets. Individual expenditures by group and discouragement indices are given in Table 6 in Appendix C. Taste group 3 consumption significantly departs from the average pattern. In particular this group consumes much more Private transportation, which this is the most heavily discouraged category. Similarly, Clothing is less consumed by taste group 3 and its discouragement index is about 0. On the other hand, Health is relatively preferred by taste groups 1 and 3 and the demand for this category is encouraged by the tax system: Ramsey considerations then overcome incentive considerations.

Figure 2 reproduces the same exercise for the upper income class and provides similar insights. The large positive excess consumption of Private transportation by taste group 3 would call for a further discouragement by the GST.

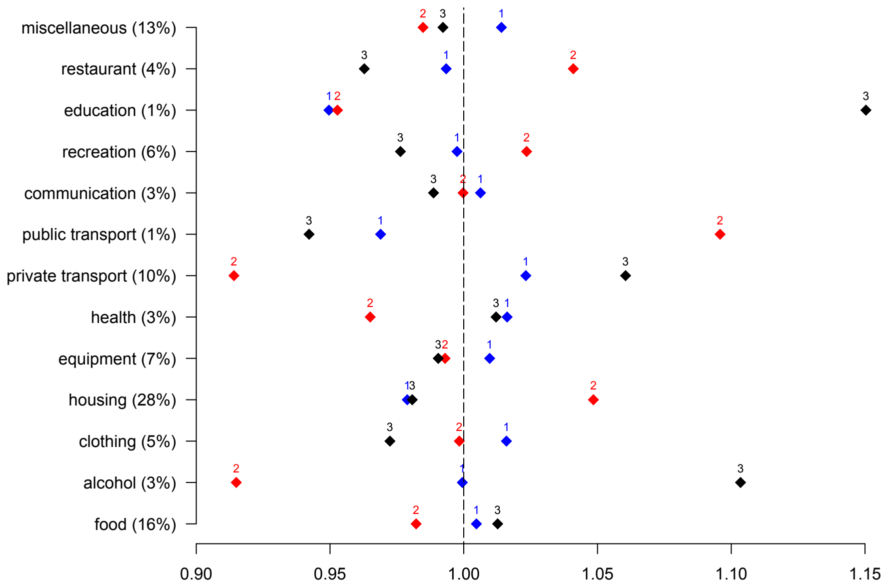

Figure 1: Lower class consumption

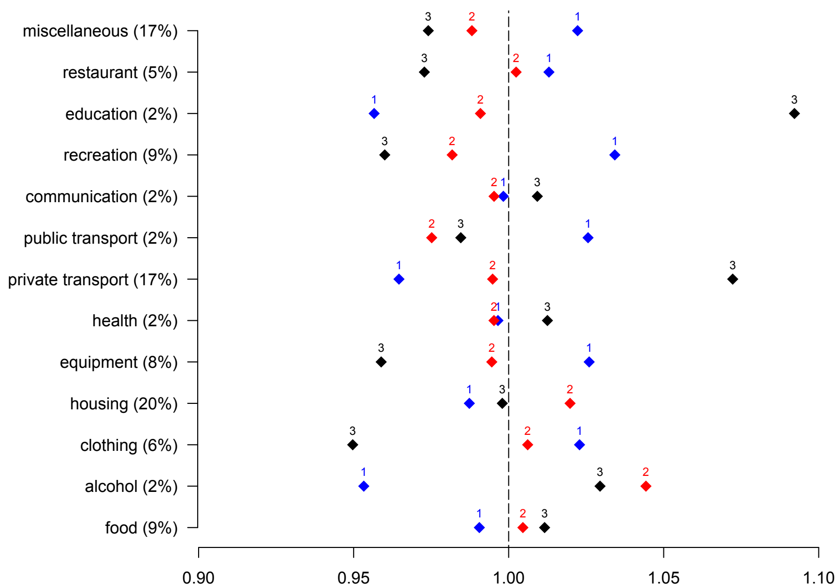

Figure 2: Upper class consumption

References

[1] Ahmad, E. and N. Stern, 1984, The theory of reform and Indian indirect taxes, Journal of Public Economics 25, 259-298.

[2] Atkinson, A. and J. Stiglitz, 1976, The design of tax structure: Direct versus indirect taxation, Journal of Public Economics 6, 55-75.

[3] Atkinson, A. and J. Stiglitz, 1980, Lectures on Public Economics, McGraw-Hill.

[4] Blomquist, S. and V. Christiansen, 2008, Taxation and heterogeneous preferences, Finanz Archiv 64, 218-244.

[5] Boelaert, J., 2013, Is one demand function enough? An inquiry on preference stability using discrete mixtures of neural networks, CES working papers, University Paris 1 Panthéon-Sorbonne.

[6] Boelaert, J., 2015, revealedPrefs: revealed preferences and microeconomic rationality, R package available at `http://cran.r-project.org/web/packages/revealedPrefs`.

[7] Chiappori, P.A. and B. Salanié, 2000, Testing for asymmetric information in insurance markets, The Journal of Political Economy 108, 56-78.

[8] Crawford, I. and K. Pendakur, 2013, How many types are there?, The Economic Journal 123, 77-95.

[9] Cremer, H., P. Pestieau and J.C. Rochet, 2001, Direct versus indirect taxation : the design of the tax structure revisited International Economic Review 42, 781-799.

[10] Cremer, H., P. Pestieau and J.C. Rochet, 2003, Capital income taxation when inherited wealth is not observable, Journal of Public Economics 87, 2475-2490.

[11] Deaton, A. and J. Muellbauer, 1980, An Almost Ideal Demand System, American Economic Review 70, 312-326.

[12] Diamond, P., 1975, A many-person Ramsey tax rule, Journal of Public Economics 4,335-342.

[13] Diamond, P., 2005, Taxation, Incomplete Markets and Social Security, Munich Lectures in Economics, MIT press.

[14] Diamond, P., 2006, Optimal tax treatment of private contributions for public goods with and without warm glow preferences, Journal of Public Economics 90, 897-919.

[15] Diamond, P. and J. Mirrlees, 1971, Optimal taxation and public production II: tax rules, American Economic Review 61, 261-78.

[16] Diamond, P. and J. Spinnewijn, 2011, Capital income taxes with heterogeneous discount rates, American Economic Journal: Economic Policy 3, 52-76.

[17] Finkelstein, A. and K. McGarry, 2006, Multiple dimensions of private information: evidence from the long-term care insurance market, American Economic Review 96, 938-958.

[18] Gauthier, S. and G. Laroque, 2009, Separability and public finance, Journal of Public Economics 93, 1168-1174.

[19] Kaplow, L., 2008, Optimal policy with heterogeneous preferences, B. E. J. Econ. Analysis and Policy 8, Article 40, 1-28.

[20] Laroque, G., 2005, Indirect taxation is superfluous under separability and taste homogeneity: A simple proof, Economics Letters 87, 141-144.

[21] Golosov, M., M. Troshkin, A. Tsyvinski, and M. Weinzierl, 2013, Preference heterogeneity and optimal commodity taxation, Journal of Public Economics 97, 160-175.

[22] Guesnerie, R., 1995, A Contribution to the Pure Theory of Taxation, Econometric Society Monographs, Cambridge University Press.

[23] Mirrlees, J., 1975, Optimal taxation in a two-class economy, Journal of Public Economics 4, 27-33.

[24] Mirrlees, J., 1976. Optimal tax theory: a synthesis, Journal of Public Economics 6, 327-358.

[25] Saez, E., 2002, The desirability of commodity taxation under non-linear income taxation and heterogeneous tastes, Journal of Public Economics 83, 217-230.

[26] Simon, C. and L. Blume, 1994, Mathematics for Economists, Norton & Company.

A Crawford-Pendakur taste groups

Table 5: Crawford-Pendakur taste groups

(ref: Taste group 1)	Taste group 2	Taste group 3
Age	0.0001	0.001
	(−0.003, 0.003)	(−0.002, 0.004)
Urban (ref: rural)	0.056	0.059
	(−0.037, 0.149)	(−0.038, 0.156)
Housing tenure (ref: tenancy)		
Mortgaged owner occupancy	0.082	0.032
	(−0.015, 0.180)	(−0.072, 0.136)
Outright owner occupancy	-0.146^{**}	−0.066
	(−0.249, −0.044)	(−0.174, 0.041)
Type of family (ref: Single)		
Childless Family	−0.028	0.106
	(−0.130, 0.074)	(−0.001, 0.214)
Single Parent Family	-0.162^{*}	0.129
	(−0.308, −0.015)	(−0.020, 0.279)
Couple with children	-0.115^{*}	−0.022
	(−0.223, −0.007)	(−0.138, 0.095)
Other extended family	−0.014	0.024
	(−0.155, 0.127)	(−0.128, 0.177)
Education (ref: Primary education)		
Secondary education	0.009	−0.099
	(−0.100, 0.117)	(−0.211, 0.014)
Partial post-secondary education	0.030	−0.015
	(−0.107, 0.167)	(−0.156, 0.127)
Complete post-secondary education	0.012	−0.093
	(−0.111, 0.134)	(−0.221, 0.035)
University	0.091	-0.153^{**}
	(−0.024, 0.206)	(−0.275, −0.032)
Region (Ref: Ontario)		
Atlantic Canada[1]	-0.247^{***}	0.024
	(−0.369, −0.125)	(−0.109, 0.157)
British Columbia	0.112	0.110
	(−0.030, 0.255)	(−0.049, 0.269)
Canadian Prairies[2]	-0.191^{***}	0.097
	(−0.307, −0.075)	(−0.031, 0.224)
Quebec	-0.196^{**}	-0.178^{*}
	(−0.337, −0.054)	(−0.337, −0.020)
Constant	-0.245^{*}	-0.650^{***}
	(−0.473, −0.017)	(−0.894, −0.406)
Akaike Inf. Crit.	26,098.470	26,098.470

Notes: *p<0.1; **p<0.05; ***p<0.01; Confidence intervals at the 10% level

1. New Brunswick, Newfoundland and Labrador, Prince Edward Island, and Nova Scotia
2. Alberta, Manitoba, Saskatchewan, Yukon, Nunavut, and Northwest Territories

B Consumption patterns

Consumption patterns of the three taste groups are represented in Figure B. A more detailed description is given in Table 6. In Figure B consumption of taste group 1 is chosen as reference. The vertical axis reports the ratio between (1) the sales share of a given product out of total expenditure per household of group 2 and (2) the same share per household of the reference group 1. The horizontal axis has a similar interpretation, but it applies to group 3 rather than group 2. A point located in the 45-degree line therefore indicates that (the share of) consumption of a given category is the same for groups 2 and 3. The horizontal (resp. vertical) line at 1 indicates that the consumption is identical for groups 1 and 3 (resp. 2). The largest differences between groups 2 and 3 concern Private transport and Education. Group 2 consumes much more Housing than group 1, and much less Durables and Leisure services. Finally, group 3 consumes much more Education and Private transport than group 1, and much less Durables, Clothing and Leisure services.

The red point in Figure B gives the relative incomes (total net expenditures) of the three sub-populations: Group 2 is the richest and group 3 the poorest sub-population.

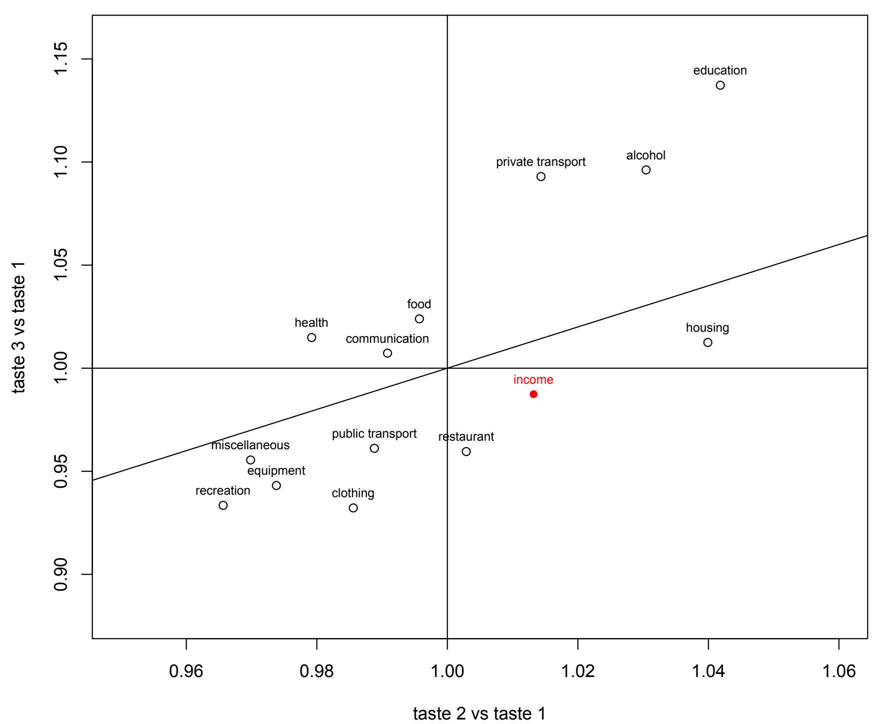

Figure 3: Consumption by taste group

Table 6: ANNUAL EXPENDITURES PER HOUSEHOLD

		Food	Alc	Cloth	Hous	Equip	Health	PrivT	PubT	Com	Rec	Educ	Rest	Misc	Total
Whole sample															
Expenditures (in CAD)		4754	988	2345	9602	3262	972	6790	648	1126	3751	596	2008	7111	43952
budget share (in %)		10.8	2.2	5.3	21.8	7.4	2.2	15.4	1.5	2.6	8.5	1.4	4.6	16.2	100
Discouragement (in %)		20.9		−1.1	−1.8	0.2	21.5	−11.3	0.8	−6.7	−3.1	55.7	−8.2	−2.7	
Residual (in %)[1]		9.97		0.23	0.33	0.09	9.94	0.58	0.04	1.1	0.07	77.65	2.19	0.3	100
Subsample Decomposition															
Expenditures (in CAD)	n_{jk}														
Taste group 1															
Low income	23%	3123	623	926	5485	1344	592	2076	268	698	1289	103	770	2738	20036
High income	22%	6470	1316	3984	13748	5486	1389	11520	1077	1590	6626	1076	3383	12141	69805
Taste group 2															
Low income	15%	3053	571	910	5874	1322	562	1855	304	694	1323	103	807	2659	20036
High income	15%	6509	1430	3887	14087	5276	1376	11786	1016	1573	6240	1105	3321	11643	69249
Taste group 3															
Low income	13%	3272	716	921	5713	1371	613	2238	271	714	1312	130	776	2786	20833
High income	12%	6415	1380	3591	13492	4978	1370	12433	1004	1561	5972	1192	3155	11233	67776

Note: Food (Food); Alc (Alcohol); Cloth (Clothing); Hous (Housing); Equip (Equipment); Health (Health); PrivT (Private Transport); PubT (Public Transport); Com (Communication); Rec (Recreation); Educ (Education); Rest (Restaurants); Misc (Miscellaneous).

1. Per category residual of (15) evaluated at b^*_{jk} given in the first row of Table 1.

C AIDS demand

Demand is assumed to fit the Almost Ideal Demand System specification used by Deaton and Muellbauer [11] (see eq. (8) and (9) in Deaton and Muellbauer [11]). It is estimated using the functions `aidsEst` and `aidsElas` from R package `micEconAids`. This Appendix provides the matrix of estimated price elasticity of aggregate compensated demand used in (13) and the income effects for each group used in (18).

Table 7: Price elasticity of compensated aggregate demand

Price	Food	Alc	Cloth	Hous	Equip	Health	PrivT	PubT	Com	Rec	Educ	Rest	Misc
Quantity													
Food	−2.96	0.01	0.15	0.27	−0.11	0.19	1.51	0.08	0.16	0.22	−0.34	0.55	0.27
Alc	0.08	−4.23	−0.54	1.28	0.60	0.48	1.59	−0.27	0.21	−0.63	0.51	−0.74	1.67
Cloth	0.32	−0.23	−1.84	0.23	0.52	−0.04	1.11	−0.00	−0.58	−0.21	−0.12	0.31	0.54
Hous	0.13	0.13	0.05	−1.89	0.13	0.11	0.55	0.08	0.01	0.33	0.02	0.22	0.15
Equip	−0.17	0.18	0.36	0.39	−3.99	−0.16	0.38	0.19	−0.11	0.31	0.30	0.18	2.13
Health	0.95	0.47	−0.09	1.11	−0.52	−4.86	1.45	−0.61	0.33	0.23	0.70	−0.41	1.25
PrivT	1.14	0.24	0.38	0.82	0.19	0.22	−5.96	0.42	0.09	0.38	0.32	0.52	1.24
PubT	0.63	−0.43	−0.00	1.19	1.00	−0.99	4.50	−4.07	0.64	0.22	0.24	−1.23	−1.70
Com	0.67	0.17	−1.14	0.04	−0.30	0.28	0.52	0.34	−1.89	1.70	0.05	−0.32	−0.13
Rec	0.30	−0.17	−0.13	0.88	0.28	0.06	0.67	0.04	0.54	−3.32	0.10	0.14	0.61
Educ	−3.19	0.96	−0.52	0.32	1.85	1.34	4.06	0.26	0.12	0.71	−6.45	0.17	0.37
Rest	1.38	−0.37	0.36	1.09	0.31	−0.21	1.75	−0.39	−0.19	0.26	0.05	−3.90	−0.13
Misc	0.20	0.23	0.18	0.21	0.99	0.18	1.15	−0.15	−0.02	0.31	0.03	−0.04	−3.27

Table 8: Income elasticity by group

	Food	Alc	Cloth	Hous	Equip	Health	PrivT	PubT	Com	Rec	Educ	Rest	Misc
Quantity													
Taste group 1													
Low income	0.84	0.82	1.11	0.71	1.02	1.10	1.54	0.63	0.79	1.11	1.46	1.20	1.38
High income	0.57	0.68	1.12	0.84	1.11	0.70	1.37	1.32	0.56	1.21	1.99	1.02	0.91
Taste group 2													
Low income	0.74	0.71	1.20	0.75	1.04	1.03	1.52	0.84	0.75	1.18	1.75	1.29	1.41
High income	0.52	0.43	1.19	0.81	1.16	0.70	1.32	1.23	0.59	1.27	2.01	1.09	0.95
Taste group 3													
Low income	0.71	1.11	1.10	0.66	1.10	1.04	1.62	0.59	0.70	1.21	2.00	1.31	1.41
High income	0.54	0.59	1.10	0.71	1.04	0.56	1.55	1.24	0.54	1.16	1.91	1.04	0.95

D Total federal and provincial tax rates

The total commodity tax rate is the GST rate in Alberta and in Yukon, Northwest Territories, and Nunavut; the sum of the GST and a Provincial rate (PST) in British Columbia, Manitoba and Saskatchewan; the sum of the GST and Quebec Sales Tax (QST) in Quebec; while the Harmonized Sales Tax (HST) applies in other provinces.[6] The current total tax

[6] Detailed information can be obtained at `http://www.taxtips.ca/salestaxes/salestaxrates.htm`.

rates range from 5% (in provinces and territories where only the GST applies) to 14.975% in Quebec and 15% in Nova Scotia. Tables 4 and 9 apply the (time) average total tax rate to the tax base given in the main text.

Table 9: Total federal and provincial taxes

Taste group j	1		2		3	
Income class k	Lower	Upper	Lower	Upper	Lower	Upper
consolidated social weights b^*_{jk}/n_{jk} (in Canadian Dollars)						
Whole sample	1.84	1.47	1.34	1.40	−0.95	−0.39
Conservative Party	2.09	1.52	0.21	1.22	0.13	−0.28
Liberal Party	1.91	1.75	1.09	0.98	−0.89	−0.34
Incentive correction $\tilde{n}_{jk}\tilde{\beta}_{jk}$ (in Canadian Dollars)						
Whole sample	−0.14	−0.05	−0.01	−0.03	0.29	0.19
Conservative Party	−0.16	−0.12	0.10	−0.02	0.12	0.20
Liberal Party	−0.16	−0.10	0.04	0.04	0.29	0.17

E Equivalent scales adjustment

In the paper the social weights have been estimated at the household level without any adjustment for family size. Families of each taste group comprise 1.5 consumption units in average. However family size may differ across income classes. This happens in particular within taste group 1. In this group rich households have more children than the low income class households. Table 10 provides social weight estimates applying an equivalent scale adjustment to family expenditures. They are obtained from the whole 14 year sample, with tax rates set equal to the sum of federal and provincial rates (as in Remark 3). We have considered two alternative procedures. In both procedures expenditures are divided by the number of consumption units in the household.[7]

In the first procedure (option 1) demand functions are reestimated maintaining the composition of the 6 groups unchanged. The results can consequently be directly compared to those given in (the first row of) Table 4.

This procedure is not entirely satisfactory since the equivalent scale correction implies changes in income classes within each taste group. An household with two income earners may for instance be classified in the upper income class in the absence of equivalent scale

[7]Statistics Canada refers to the Low Income Measure (LIM) equivalence scale where the oldest person in the family receives a factor of 1, all other members aged 16 and over each receive a factor of 0.4, and those under age 16 receive a factor of 0.3.

adjustment, while it belongs to an adult equivalent low income class. The second procedure (option 2) takes into account the actual adult equivalent income classes and reestimates demand functions for these new groups. The resulting estimates cannot be compared to those given in Table 4.

Table 10: Equivalent scale correction

Taste group j	1		2		3	
Income class k	Lower	Upper	Lower	Upper	Lower	Upper
Option 1						
consolidated weight	2.41	1.21	−0.85	2.15	0.62	−0.88
Incentive correction	−0.27	0.01	0.33	−0.13	0.09	0.25
Intrinsic weight	2.41	1.27	1.30	2.15	1.32	1.25
Option 2						
consolidated weight	2.53	1.18	−0.84	1.91	0.33	−0.49
Incentive correction	−0.31	0.02	0.32	−0.10	0.12	0.20
Intrinsic weight	2.53	1.25	1.28	1.91	1.29	1.22

Notes: Estimates are from the whole 14 year sample, using total (federal and provincial) taxes. consolidated and intrinsic weights coincide when the incentive correction is negative.

The lower income class of taste group 1 still appears as socially favored. The equivalent scale adjustment yields a higher weight for the low size poor households in taste group 1. There is no significant changes otherwise, except a higher weight put of the high income earners of taste group 2. Incentive issues still concern taste group 3. Indirect taxes are detrimental to this last taste group.