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by

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Operational expressions for the marginal cost of indirect taxation when merit arguments matter*

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Abstract

Marginal indirect tax reform analysis evaluates for each commodity (group) the marginal welfare cost (MC) of increasing government revenue by one Euro by raising the indirect tax rate on that commodity. In this paper, I propose an adjustment to the MC expressions to allow for (de)merit good arguments and show how this adjustment can easily be parameterized on the basis of econometric demand analysis.

Keywords: merit goods; marginal indirect tax reform

JEL code: D12, H21

1 Introduction

Marginal indirect tax reform (MITR) analysis is probably one of the most practical applications of public economics. It offers clear-cut guidelines for policy reform and allows empirical implementation using household expenditure data, effective indirect tax rates, estimates of aggregate demand elasticities and a set of welfare weights.[1]

The standard MITR model assumes that the government endorses the sovereignty of households in the economy, fully respecting their decisions regarding the consumption of goods and services. In reality though, through both statements and policy measures, governments reveal a desire to deviate from consumer preferences for commodities like alcohol and tobacco. Not only do governments try to better inform their citizens about the health risks involved, they also attempt to discourage consumption through excise taxes and marketing restrictions. Recently, the World Health Organization has recommended that national governments impose a tax on sugar as an instrument in their battle against obesity. Such arguments are called merit good arguments, and economists have traced out the implications for optimal commodity tax rules. I refer here to Besley (1988), Schroyen (2005) and Blomquist and Micheletto (2006).

In this paper, I investigate how such merit arguments can be incorporated in MITR analysis. In particular, I show how the central expressions for that analysis – the marginal welfare cost of raising an extra Euro by means of the indirect tax rate on good i – need to be amended to allow for merit good arguments and how these expressions can be parameterized in terms of demand elasticities.

At the margin, a merit good argument can be interpreted as the existence of a wedge between the household's willingness to pay for an extra unit of a commodity and that of a planner or government in an otherwise first-best setting. There exist several ways to measure the marginal willingness to pay (MWP) for a commodity. One way is to ask how much of a *numéraire* the household is willing to give up. In a two-good consumption diagram, suppose that $F(x_1, \overline{u})$ is the amount of the *numéraire* required by a household consuming x_1 units of the first good to yield utility level $\overline{u}$. With the *numéraire* measured on the vertical axis, the graph of $F(\cdot, \overline{u})$ is the indifference curve and its slope measures the MWP for good 1. Up to a constant of integration, the total willingness to pay is $F(x_1, \overline{u})$. Schroyen (2005) proposed a transformation of this function to construct the planner's preferences, and then used it to characterize the optimal commodity tax rules.[2]

However, for empirical purposes, and especially for MITR analysis, the *numéraire* function is less convenient because neither the tax code nor empirical demand analysis singles out a particular commodity category as *numéraire*. A more appropriate alternative is then the distance function. This function, which was introduced by Deaton (1979) in the taxation literature, determines the factor by which all quantities have to be scaled down in order to bring the consumer to a certain utility level. As shown by Deaton, the derivative of this function with respect to the quantity of a good gives the demand price for that good (as a fraction of total income). Hence, the function itself can again be considered the total willingness to pay and can be transformed to account for the merit concerns of a planner. That is precisely what I do in the next section of the paper. In section 3, I work out the expression for the marginal welfare cost of indirect taxation, making use of the government's evaluation. This results in equation (21), the central expression of this paper. This equation shows that the merit good argument affects the marginal cost of taxation rules through the consumer's scale elasticities. In section 4, I provide an algorithm to compute such elasticities from information about budget shares, income and Marshallian price elasticities. Section 5 concludes.

2 The model

Households

A representative household has preferences that can be represented by a strongly quasi-concave utility function on n commodities: $u(x_1, ..., x_n)$. Facing a vector of consumer prices $q' = (q_1, ..., q_n)$ and having a disposable income m, it solves the problem

$$\max_x u(x) \text{ s.t. } q'x = m \quad (\lambda). \tag{1}$$

Denoting $\pi \stackrel{\text{def}}{=} \frac{q}{m}$ as the vector of normalized prices, the solution may be written as $x(\pi)$ yielding a utility level $v(\pi)$. Letting subscripts with u denote partial derivatives, the first order conditions for (1) may be written as

$$\frac{u_i(x(\pi))}{\sum_{j=1}^{n} u_j(x(\pi))x_j(\pi)} = \pi_i \ (i = 1, ..., n). \tag{2}$$

For future reference, note that the marginal utility of income, λ, is given by $\frac{\sum_{j=1}^{n} u_j x_j}{m}$.

A household's preferences may also be represented by the distance function $d(x, \overline{u})$. This function is implicitly defined as

$$u(\frac{x}{d(x, \overline{u})}) = \overline{u} \ \ (\text{all } x, \overline{u}). \tag{3}$$

The 'distance' $d(x, \overline{u})$ is the factor by which the commodity bundle x needs to be scaled down to generate a utility level $\overline{u}$. It can be shown that $\frac{\partial d(x(\pi), v(\pi))}{\partial x_i} = \pi_i$ and hence the derivative provides a measure of the household's marginal willingness to pay for commodity i – see Deaton (1979) on other properties of the distance function. Note that, by definition, the demand prices π_i satisfy the adding-up property

$$\sum_{i=1}^{n} \pi_i x_i = 1. \tag{4}$$

Government

Suppose now that the government considers commodity n as a (de)merit good. Convinced of the (de)merit properties of this commodity, it believes that in order for the consumer to reach utility level $\overline{u}$, all commodities should be scaled down by more (less) than $d(x, \overline{u})$, for instance by the amount

$$D(x, \overline{u}) = d(x, \overline{u}) + \int_0^{x_n} \mu(\chi) \mathrm{d}\chi. \tag{5}$$

In terms of the MWP, we have

$$\frac{\partial D(x, \overline{u})}{\partial x_i} = \frac{\partial d(x, \overline{u})}{\partial x_i} \quad (i \neq n), \text{ and} \tag{6}$$

$$\frac{\partial D(x, \overline{u})}{\partial x_n} = \frac{\partial d(x, \overline{u})}{\partial x_n} + \mu(x_n), \tag{7}$$

so that the government believes that the household should be willing to pay $\mu(x_n)$ extra for an additional unit of good n when consuming a bundle (x_{-n}, x_n) yielding utility level $\overline{u}$. It can be shown that the utility function to which the government subscribes is then given by[3,4]

$$U(x) = u\left(\frac{x}{1 - \int_0^{x_n} \mu(\chi) d\chi}\right) \quad (\text{all } x). \tag{8}$$

Two examples will illustrate. Let n be red wine. Small quantities of wine are tolerated, but quantities in excess of x_n^* are considered harmful: $\mu(\chi) < 0$ if $\chi \geq x_n^*$, zero otherwise. Suppose n is dental care. A regular dental check is regarded as desirable; on any extra dental care the government respects consumer sovereignty: $\mu(\chi) > 0$ if $\chi \leq x_n^*$, zero otherwise.

From now on I assume that $\mu(\chi)$ is zero for $\chi \leq x_n^*$ and takes the constant value μ on the interval $[x_n^*, x_n]$ so that the denominator in (8) becomes $1 - \mu(x_n - x_n^*)$. If $x_n^* = 0$ and $\mu > 0$, we have an instance of the dental care example; the red wine example has $\mu < 0$, $x_n^* > 0$. Letting $\widetilde{x}_i$ be a shorthand for $\frac{x_i}{1-\mu(x_n-x_n^*)}$, the government's interpretation of the marginal utilities is then

$$U_i(x) = \frac{u_i(\widetilde{x})}{1-\mu(x_n-x_n^*)} + \delta_{in} \sum_{j=1}^{n} \frac{u_j(\widetilde{x}) x_j \mu}{[1-\mu(x_n-x_n^*)]^2} \text{ (all } i\text{)}, \tag{9}$$

where $\delta_{in} = 1$ if $i = n$ and 0 otherwise. Normalizing these by dividing through by $\sum_{k=1}^{n} U_k(x)x_k$ $(= \sum_{k=1}^{n} u_k(\widetilde{x})\widetilde{x}_k \frac{1+\mu x_n^*}{1-\mu(x_n-x_n^*)})$ then gives

$$\Pi_i(\widetilde{x}(\mu), \mu) \stackrel{\text{def}}{=} \frac{u_i(\widetilde{x})}{\sum_{k=1}^{n} u_k(\widetilde{x})\widetilde{x}_k} \frac{1}{1+\mu x_n^*} + \delta_{in} \frac{\mu}{1+\mu x_n^*} \text{ (all } i\text{)}. \tag{10}$$

Clearly, if $\mu \to 0$, the government's normalized 'demand prices' coincide with those of the household.

I now propose to approximate $\Pi_i(\widetilde{x}(\mu), \mu)$ by a first order Taylor expansion around $\Pi_i(\widetilde{x}(0), 0) = \pi_i$. This gives

$$\Pi_i(\widetilde{x}(\mu), \mu) \simeq \pi_i(1-\mu x_n) + \delta_{in}\mu + \left[\left(\sum_{k=1}^{n} \frac{\partial \pi_i}{\partial x_k} x_k \right) + \pi_i \right] (x_n - x_n^*)\mu \text{ (all } i\text{)}. \tag{11}$$

The big round bracket term denotes a pure scale effect, i.e., the effect of an equi-proportional increase in all quantities on the normalized demand price for a commodity (viz. $\frac{\partial \pi_i(\alpha x)}{\partial \alpha}|_{\alpha=1}$). I denote this effect as g_i $(i = 1, ..., n)$ and write (11) as

$$\Pi_i(\widetilde{x}(\mu), \mu) \simeq \pi_i(1-\mu x_n) + \delta_{in}\mu + (g_i + \pi_i)(x_n - x_n^*)\mu \text{ (all } i\text{)}. \tag{12}$$

Because scale effects satisfy the condition $\sum_{i=1}^{n} g_i x_i = -1$ (see Barten and

Bettendorf, 1989, p 1512), it may be checked that the Π_i $(i = 1, ..., n)$ also satisfy the adding-up requirement (4): $\sum_{i=1}^{n} \Pi_i x_i = 1$.

Suppose first that $x_n = x_n^*$, meaning that the government's evaluation coincides with that of the household for all but the last unit consumed of good n. Then (12) reduces to $\Pi_i(\widetilde{x}(\mu), \mu) \simeq \delta_{in}\mu + \pi_i(1 - \mu x_n)$. Merit considerations thus affect MWP in two ways. First, the government corrects the household's MWP for the merit good (n) with factor μ. Second, *all* demand prices are scaled down by factor μx_n to restore adding-up. Consequently, the demand price for commodity n becomes $\pi_n + \mu(1 - \pi_n x_n)$.

Consider next the opposite extreme where the government disapproves of the consumption of good n from the first unit onwards: $x_n^* = 0, \mu < 0$. Now (12) reduces to $\Pi_i(\widetilde{x}(\mu), \mu) \simeq \delta_{in}\mu + \pi_i(1 - \mu x_n) + (g_i + \pi_i)x_n\mu$. The last term is the correction for the consumption of all the infra-marginal units of the demerit good. Demerit considerations make the government regard the household as worse off than it is aware of itself, because of all the infra-marginal units of good n consumed. This has a scale effect that, for all normal goods ($g_i < 0$), increases the MWP. Again, to secure adding-up, the MWPs are scaled down in proportion to the π_i. The government's MWP thus becomes

$$\Pi_i(\widetilde{x}(\mu), \mu) \simeq \pi_i + \delta_{in}\mu + g_i x_n \mu. \tag{13}$$

In the remainder of the paper, I will derive the marginal cost expressions for this last case ($x_n^* = 0, \mu < 0$).

3 Marginal cost expressions

MITR asks about the marginal cost in terms of social welfare, W, of raising government revenue, R, by one Euro when using the tax on commodity i $(i = 1, ..., n)$:

$$MC_i = -\frac{\partial W/\partial t_i}{\partial R/\partial t_i} \ \ (i = 1, ..., n). \tag{14}$$

If $MC_i > MC_j$, welfare can be increased by lowering the indirect tax rate on commodity i and raising that on commodity j in a budgetary neutral fashion.

Expressions of this kind have been discussed in detail by Ahmad and Stern (1984), who show that a neat parameterization is obtained by multiplying numerator and denominator by the respective after-tax price q_i. The denominator is then given by

$$\begin{aligned} q_i \frac{\partial R}{\partial t_i} &= q_i x_i + \textstyle\sum_{j=1}^n t_j \frac{\partial x_j}{\partial q_i} q_i \\ &= q_i x_i + \textstyle\sum_{j=1}^n t_j^* q_j x_j \varepsilon_{ji}, \end{aligned} \tag{15}$$

where ε_{ji} is the (aggregate) Marshallian elasticity of the demand for good j with respect to the price of good i, and t_j^* is the tax on commodity j expressed as a fraction of the consumer price $(\frac{t_j}{q_j})$.

Turning now to the numerator, the obvious measure of social welfare is $U(x(\pi))$. The effect of a marginal change in the excise tax rate on commodity

i $(i = 1, ..., n)$ on social welfare is then

$$-\frac{\partial W}{\partial t_i} = -\sum_{j=1}^{n} U_j \frac{\partial x_j}{\partial \pi_i}\frac{1}{m} = -\left(\frac{\sum_{k=1}^{n} U_k x_k}{m}\right)\sum_{j=1}^{n}\frac{U_j}{\sum_{k=1}^{n} U_k x_k}\frac{\partial x_j}{\partial \pi_i}. \quad (16)$$

The round bracket term can be interpreted as the government's evaluation of the consumer's marginal utility of income. This can be seen as follows. Since

$$\sum_{k=1}^{n} U_k x_k = \sum_{k=1}^{n} u_k(\widetilde{x})\widetilde{x}_k \frac{1}{1-\mu x_n}, \quad (17)$$

approximating the *rhs* with a first order Taylor expansion around $\mu = 0$, yields

$$\frac{\sum_{k=1}^{n} U_k x_k}{m} \simeq \frac{\sum_{k=1}^{n} u_k(x) x_k}{m}\left[1 + (2 - (-\frac{x' u_{xx} x}{x' u_x})\mu x_n\right]. \quad (18)$$

In (18), the term $\frac{\sum_{k=1}^{n} u_k(x)x_k}{m}$ is the household's marginal utility of income, λ, to which $\frac{\sum_{k=1}^{n} U_k x_k}{m}$ converges as $\mu \to 0$. The expression $-\frac{x' u_{xx} x}{x' u_x}$ is a scalar measure of the curvature of the household's utility function.[5]

Denoting $\frac{\sum_{k=1}^{n} U_k x_k}{m}$ by Λ, the *rhs* of (16) may then be written as $-\Lambda \sum_{j=1}^{n} \Pi_j(\widetilde{x}(\mu), \mu)\frac{\partial x_j}{\partial \pi_i}$ and upon using the approximating expression (13) we get[6]

$$-\frac{\partial W}{\partial t_i} \simeq \Lambda\left[x_i - \sum_{j=1}^{n} g_j \frac{\partial x_j}{\partial \pi_i}\mu x_n - \mu \frac{\partial x_n}{\partial \pi_i}\right]. \quad (19)$$

Multiplying through by the consumer price q_i then gives

$$-q_i \frac{\partial W}{\partial t_i} \simeq \Lambda \left[q_i x_i - m\mu x_n \left(\sum_{j=1}^{n} \sigma_j w_j \varepsilon_{ji} + \varepsilon_{ni} \right) \right], \tag{20}$$

where $\sigma_j \stackrel{\text{def}}{=} \frac{g_j}{\pi_j}$ is the scale elasticity of good j, and $w_j \stackrel{\text{def}}{=} \pi_j x_j$ is the budget share of good j. In section 4, I explain the algorithm to retrieve the scale elasticities σ_j from the more standard ones.

The term in front of the big round brackets may be written as $\frac{m\mu}{q_n} q_n x_n$. Since μ has the dimension of a normalized price, $m\mu$ has the dimension of a price and $\frac{m\mu}{q_n}$ is the wedge between the government's MWP and that of the consumer, expressed as a fraction of the latter. Denoting this relative wedge as $\theta \stackrel{\text{def}}{=} \frac{m\mu}{q_n}$, the reduction of the consumer's welfare – as perceived by the government and measured in Euro – is then

$$-q_i \frac{\partial W}{\partial t_i} \simeq \Lambda \left[(q_i x_i) - \theta \left(q_n x_n \right) \left(\sum_{j=1}^{n} \sigma_j w_j \, \varepsilon_{ji} + \varepsilon_{ni} \right) \right]. \tag{21}$$

Household welfare goes down to the extent that it spends disposable income on commodity i. However, the increase in the consumer price q_i has the additional effect of changing the consumption pattern for all goods and, to the extent (θ) that merit good considerations drive a wedge between the consumer's and the government's MWP, this needs to be accounted for – hence the big round bracket term.

Expression (21) is for a representative household economy. To account for heterogeneous households, I add household superscripts h ($h = 1, ..., H$)

and attach a social weight γ^h to household h. This gives

$$-q_i \frac{\partial W}{\partial t_i} \simeq \sum_{h=1}^{H} [\gamma^h \Lambda^h] \left[(q_i x_i)^h - \theta \, (q_n x_n)^h \left(\sum_{j=1}^{n} \sigma_j^h \, w_j^h \, \varepsilon_{ji}^h + \varepsilon_{ni}^h \right) \right]. \qquad (22)$$

The small round bracket terms denote expenditure levels, and are available from household survey data, while the scale and price elasticities can in principle be estimated using a household expenditure panel data. A second-best solution is to use estimates based on aggregate expenditure time series data. For a given set of welfare weights $(\gamma^h \Lambda^h)$ and merit parameter (θ), it is then possible to calculate the expressions for (14) and rank them.

A final issue is the choice of welfare weights $\gamma^h \Lambda^h$. From (18), we have

$$\Lambda^h \simeq \lambda^h \left[1 + \theta \left(2 - (-\frac{x' u_{xx} x}{x' u_x})^h \right) (q_n x_n)^h \right]. \qquad (23)$$

As a first approximation, one could just ignore the square bracket term and choose the Stern (1977) specification for $\gamma^h \Lambda^h$, viz. $(\frac{m^h}{m^0})^{-\nu}$ where $\nu (> 0)$ is an inequality aversion parameter and m^0 is the income of the lowest household income group. Alternatively, one could approximate $(-\frac{x' u_{xx} x}{x' u_x})$ by an estimate of the coefficient of relative risk aversion, ρ, and use as welfare weights

$$\gamma^h \Lambda^h = \left(\frac{m^h \left[1 + \theta \, (2 - \rho) \, (q_n x_n)^h \right]^{-1}}{m^0 \left[1 + \theta \, (2 - \rho) \, (q_n x_n)^0 \right]^{-1}} \right)^{-\nu}. \qquad (24)$$

4 Retrieving scale elasticities from regular estimation results

In this section, I briefly show how estimates for Marshallian price elasticities (ε_{ji}) and Engel income elasticities (η_i) together with average budget shares (w_i) can be used to construct the corresponding scale elasticities (σ_i).

Let $w = (w_i), E = (\varepsilon_{ij}), \eta = (\eta_i)$ and denote the diagonal matrix of budget shares as $\hat{w}$. The matrix of compensated price elasticities is then given by $E^c = E + \eta w'$. Now define $S \stackrel{\text{def}}{=} \hat{w}E^c$ and $b \stackrel{\text{def}}{=} \hat{w}\eta$. This matrix and vector are the Rotterdam parameterization of the regular demand system in differential form, i.e.

$$\hat{w}\mathrm{d}\log x = b[-w'\mathrm{d}\log \pi] + S\mathrm{d}\log \pi. \tag{25}$$

If ι denotes the vector of units, then $\iota' b = 1, S = S', S\iota = 0$, and $y\prime Sy < 0$ (all $y \neq \alpha\iota$, α real scalar) (see Theil, 1976).

Following Salvas-Bronsard *et al.* (1977), consider, next, the bordered matrix $\binom{S \;\; w}{w' \;\; 0}$. This matrix has rank $n+1$, and is invertible into $\binom{T \;\; \iota}{\iota' \;\; 0}$. The matrix T has the properties (i) $TS = I - \iota w'$, (ii) $Tw = 0$, (iii) $T = T'$, and (iv) $y'Ty < 0$ (all $y \neq \alpha w$, α real scalar). Pre-multiplying (25) through by T, making use of (i) and rearranging then gives

$$\mathrm{d}\log \pi = T\hat{w}\mathrm{d}\log x - (Tb + \iota)w'\mathrm{d}\log x, \tag{26}$$

where I used the fact that $-w'\mathrm{dlog}\,\pi = w'\mathrm{dlog}\,x$. The vector of scale elasticities σ is therefore given by $-(Tb + \iota)$ with the property $w'\sigma = -1$.

5 Conclusion

Marginal indirect tax reform (MITR) exercises have been performed for many countries, both developed and developing. However, the computation of high marginal costs for commodities such as tobacco and alcohol, and the ensuing policy recommendations that these goods should be taxed more leniently, has often made researchers make qualifying statements about the usefulness of such exercises for this type of goods.

In this paper, I have developed a methodology to account for (de)merit good arguments in MITR. It consists in constructing government marginal willingness to pay functions and linearizing these around the MWPs of the household. The MWP wedges turn out to depend on the scale elasticities of the different commodities. I have also shown how these elasticities can be retrieved from the standard Marshallian price and income elasticities. In Schroyen and Aasness (2006), this methodology is applied to a vector of 14 indirect effective tax rates prevailing in Norway.

Notes

[1]See Ahmad and Stern (1984, 1991) for India and Pakistan, Decoster and Schokkaert (1989) for Belgium, Madden (1995) for Ireland, Kaplanoglou and Newbery (2003) for Greece, Schroyen and Aasness (2006) for Norway. A broader perspective on these reform rules is provided in Drèze and Stern (1990) and Coady and Drèze (2002).

[2]Besley (1988) considers good i a (de)merit good by defining the government's utility function as $U(x) \stackrel{\text{def}}{=} u(x_{-i}, \alpha x_i)$ where $u(\cdot)$ is the household's utility function and α is a constant above (below) unity. Schroyen (2005) showed that this formulation leads to counter-intuitive policy recommendations for goods with a price elasticity below unity. Blomquist and Micheletto (2006) say a (de)merit good argument for commodity i exists when the planner would like to compensate a household more (less) for a marginal increase in the price of good i than the household itself requires. It can be shown that a merit good argument for good i defined in terms of the willingness to pay (as in this paper) implies a merit good argument in the Blomquist–Micheletto sense, not only for commodity i but for any Hicksian complement to good i (and any Hicksian substitute to i is a demerit good).

[3]Define $U(\cdot)$ as $U(\frac{x}{D(x,\overline{u})}) = \overline{u}$ (all $x, \overline{u}$), then $U(x) = \overline{u}$ if $D(x, \overline{u}) = 1$. From (3) and (5)

$$u\left(\frac{x}{D(x,\overline{u}) - \int_0^{x_n} \mu(\chi) d\chi}\right) = \overline{u} \;\; (\text{all } x, \overline{u}),$$

so that

$$U(\frac{x}{D(x,\overline{u})}) = u\left(\frac{x}{D(x,\overline{u}) - \int_0^{x_n} \mu(\chi)\mathrm{d}\chi}\right) \;\; (\text{all } x, \overline{u}).$$

Evaluating this at $D(x, \overline{u}) = 1$ finally gives (8). Notice that $\int_0^{x_n} \mu(\chi)\mathrm{d}\chi = \mu(\widetilde{\chi})x_n$ (some $\widetilde{\chi} \in [0, x_n]$) and therefore that it has the dimension of a budget share (since μ has the dimension of a normalized price).

[4]Extending this framework to more than one (de)merit good is straightforward. If, e.g., $n - 1$ is also a (de)merit good, one can add $\int_0^{x_{n-1}} \mu_{n-1}(\chi)\mathrm{d}\chi$ to the *rhs* of (5) and subtract it from the denominator in (8).

[5]With a single commodity, it is clear that $-\frac{x' u_{xx} x}{x' u_x}$ coincides with the coefficient of relative risk aversion. In the multicommodity case, the relative risk aversion coefficient

for the indirect utility function $v(q,m)$ is given by $-\frac{v_{mm}}{v_m}m$, which can be shown to equal $-\frac{x_m' u_{xx} x_m}{x' u_x}m$. This equals $-\frac{x' u_{xx} x}{x' u_x}$ with homothetic preferences.

[6] Use is also made of $\sum_{j=1}^{n} \pi_j \frac{\partial x_j}{\partial \pi_i} = -x_i$ (which follows from differentiating the budget constraint by π_i).

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