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Consumer Welfare from Publicly Supplemented Private Goods: Age and Income Effects on Demand for Health Care

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Abstract

In spite major advances in the theoretical, positive and normative, literature analysing the welfare implications of public provision of private goods, empirical investigation is often limited to contingent valuation studies, mainly for environmental goods. In this paper we argue that when a market for a (subsidised or free of charge) publicly provided good exists, a consumer demand approach can be used to construct a money metric of welfare corresponding to the consumption of public provision. We illustrate this approach in investigating age and income effects on household demand for health care in Cyprus, where free public provision is not universal and those entitled to it often resort to private supplementation. Our findings suggest that the money metric of welfare, which consumers attach to free or subsidised access to publicly provided health care, varies substantially with age and to a lesser extent with household income.

Keywords: public provision, demand analysis, consumer welfare,
JEL classification: D1

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1 Introduction

A considerable proportion of public funds is channeled into the provision of private goods, such as health care and education for which, normally there also exist private markets. The design of the public provision scheme often allows the eligible individuals to supplement their consumption with purchases from the private sector. The purpose of this paper is to explore the case where consumer theory can be used in order to construct a money metric of the welfare individuals derive from the consumption of publicly provided private goods, that is estimable by applying demand analysis to accessible data. We use this approach to investigate the extent to which consumer welfare from access to free public health care varies with age and income.

In the literature there are two main strands in analysing the role of public provision of private goods: positive and normative theories. In positive (voting) models, public provision of private goods is a political phenomenon induced by voting (Epple and Romano, 1996; Gouveia, 1996). In normative (welfare) models public provision is introduced to mitigate market imperfections (such as excludability, imperfect information, externalities etc.) and, under certain conditions, is shown to work as a means for income redistribution and efficiency enhancement. Blomquist and Christiansen (1999) combine the positive and normative approaches and establish that efficient public provision of private goods can arise from politically rational voting, under asymmetric information.

Using the example of medical care, Blackorby and Donaldson (1988) prove that under incomplete information and ration or subsidisation/taxation, efficiency and redistribution can be achieved when self-selection constraints are enforced. Besley and Coate (1991) rely also on self-selection to demonstrate that universal public provision of private goods can redistribute income from ‘rich’ to ‘poor’, when public provision is financed by a head tax and its quality matters to the individuals. The redistributive effects of public provision in the presence of a private market, where consumers can pay for extra quality, are also analysed in Ireland (1990). The empirical findings in this paper conform to the theoretical arguments above, in the sense that those who benefit from free access to health care appear to be mostly low income households.

It is worth emphasising that allowing supplementation of public provision with privately purchased quantities of the same good, as we do in this paper, is neither mandatory nor optimal. Besley and Coate (1991), Bergstrom and Blomquist (1996), Blomquist and Christiansen (1995) and Ireland (1990) carry out the analysis for schemes that prohibit supplementation of public provision, whereas the system in Boadway and Marchand (1995) allows supplementing. Blomquist and Christiansen (1998) derive the conditions under which a public provision scheme should allow or not supplementation. Particularly, in the case of health care, the coexistence of public and private provision in relation to redistribution when the quality of health care is represented by waiting time, is analysed by Hoel and Saether (2003) and Marchand and Schroyen (2005). Iversen (1997) investigates the effect of private sector on the waiting time for receiving a treatment in the public sector.

The focus in our analysis is not on how an (optimal) public provision scheme is decided but rather on what such a scheme, once in place, means to potential beneficiaries, the consumers of the publicly provided good. More specifically, we are interested in the welfare implications of public provision as perceived by the individual household and measured empirically from data readily available in household expenditure surveys. To our knowledge, previous empirical analysis in the context of welfare valuation of publicly provided goods is limited to contingent valuation studies (mainly of environmental goods) and econometric modelling of willingness to pay, elicited from contingent valuation surveys (see for example Brookshire and Coursey, 1987; Clinch and Murphy, 2001; Hanemann, 1994) or application of hedonic methods to value air quality (see for example Chay and Greenstone, 2005; Smith and Huang, 1995).

The contribution of this paper lies in the use of an integrable demand system to evaluate utility from a publicly provided private good and investigate age and income effects. We consider the latter effects to be important in view of the escalating public expenditure on health care due to population aging and in the light of arguments for curbing this expenditure by targeting free public provision to those in need. The role of age and income in consumer demand for health care has long been recogised in the literature. Grossman (1972) provides a theoretical justification for the use of age and income in analysing demand for health, whereas Besley et al. (1999) study the probability that an individual owns private health insurance and find that higher household income is associated with greater probability of purchasing private health insurance. They also find that middle-aged individuals have higher probability of owning private insurance than individuals in their 30s and over 65, a result reflecting heavily on our own empirical findings. Other studies demonstrating the importance of income and/or age on health care include Propper (2000) and Atella et al. (2004). These studies examine consumers' behaviour with regard to only one good, health care, hence no welfare implications can be derived.

In our analysis the benefit of the publicly provided private good is introduced in the consumer's optimisation problem as a parameter scaling the market price (price subsidy) of the private good, along the lines first shown by Barten (1964). The scaling, which can vary with consumer characteristics and other variables reflecting the perceived quality of the publicly provided good, gives rise to a measure of the reduction in total expenditure attributed to public provision. This money metric of utility from the publicly provided private good can then be estimated using data from a family expenditure survey and information about the eligibility of households to public provision, often also available in family expenditure surveys. We illustrate our approach in the case of health care in Cyprus, where the public provision scheme is not universal and permits supplementation.

Section 2 considers how free of charge (or at reduced cost) public provision of private goods can be incorporated in a consumer demand system through price scaling. In section 3 an empirical model is specified and compared with a simpler model, where public provision 'translates' consumer demand. Section 4 discusses the estimation results obtained from the two empirical models. Section 5 analyses the welfare implications of the empirical findings for households at different incomes and ages of their head. Section 6 concludes the paper.

2 Consumer demand

We consider utility to be derived from joint consumption of publicly provided and privately purchased goods, as defined by the utility function

$$U(q_{1h} + Q_{1h}, ..., q_{nh} + Q_{nh}) \qquad (i = 1, 2, \ldots, n) \tag{1}$$

where q_{ih} is the quantity of the privately purchased and Q_{ih} the quantity of the publicly provided good consumed by household h. We assume that the consumer perceives q_{ih} and Q_{ih} as the same good, differing only in terms of quality and transforming from one to the other via a linear equation

$$Q_{ih} = \theta_i(z_h)q_{ih} = \theta_{ih}q_{ih},$$

where z_h is a vector of household characteristics and $\theta_{ih} \in (0, \infty)$ a scaling function indicating how household characteristics affect the perceived quality of the publicly provided private good. Among the arguments included in z_h can be household characteristics reflecting the opportunity cost of consuming the good in the public instead of the private sector (e.g. the wage rate) or the level of eligibility and/or take up by household members.

Writing $q^*_{ih} = q_{ih}(1 + \theta_{ih})$ the utility function becomes

$$U(q^*_{1h}, \ldots, q^*_{nh})$$

which is maximised subject to $\sum_{i=1}^{n} p_i q_{ih} \leq y_h$, where p_i is the price of private good i and y_h the total expenditure of household h, or equivalently subject to $\sum_{i=1}^{n} p^*_{ih} q^*_{ih} \leq y_h$, where $p^*_{ih} = p_i/(1 + \theta_{ih})$.[1]

It follows from duality theory that the above utility maximisation problem is equivalent to minimising

$$\sum_{i=1}^{n} p^*_{ih} q^*_{ih}$$

subject to $U(q^*_{1h}, \ldots, q^*_{nh}) \geq u_h$; or minimising the cost function

$$C(p^*_h, u_h) = C(p, \theta_h, u_h)$$

where $p^*_h = (p^*_{1h}, \ldots, p^*_{nh})', p = (p_1, \ldots, p_n)'$ and $\theta_h = (\theta_{1h}, \ldots, \theta_{nh})'$. Thus the utility and cost[2] functions are of the form first given by Barten (1964), where public (free or at reduced charge) supplementation of a private good is introduced as a price subsidy, i.e. a scaling of the price of the corresponding privately purchased amount of the same good. The price scaling in this case is expected to be downwards, indicating that the more a household resorts to free of charge consumption of a particular commodity, the lower is the unit cost of this commodity.

We consider the behavioural and welfare implications of the public provision modelled above assuming that the consumer preferences are described by the Quadratic Logarithmic (QL) cost function (Lewbel, 1990)

$$\ln C(p^*_h, u_h) = a_h(p^*_h) + \frac{b_h(p^*_h)u_h}{1 - l_h(p^*_h)u_h} \qquad (2)$$

[1] The time subscript t that can be attached to the variables in this section is omitted for notational simplicity.

[2] The relation between p_i and θ_{ih} is dictated by p^*_{ih} hence $C(p, \theta_h, u_h)$ is not any arbitrary function of p and θ_h.

where $a_h(p_h^*) = a_h(p, \theta_h)$, $b_h(p_h^*) = b_h(p, \theta_h)$ and $l_h(p_h^*) = l_h(p, \theta_h)$ are differentiable functions with respect to prices, p_i for all i. Moreover, $a_h(p, \theta_h)$ is homogenous of degree one in prices, whereas $b_h(p, \theta_h)$ and $l_h(p, \theta_h)$ are homogenous of degree zero. u_h is the utility of household h. Note that in (2) the dependency of the cost function on household characteristics can come through two channels: the parameters of the cost function and the household specific price scaling associated with public provision.

Consumer behaviour, as described by the Marshallian budget share for the i-th commodity, is then obtained by differentiation of the log cost function with respect to $\ln p_i$,

$$w_{ih} = \alpha_h^i(p, \theta_h) + \beta_h^i(p, \theta_h)[\ln y_h - a_h(p, \theta_h)] + \lambda_h^i(p, \theta_h)[\ln y_h - a_h(p, \theta_h)]^2 \quad (3)$$

where

$$\alpha_h^i(p, \theta_h) = \partial a_h(p, \theta_h)/\partial \ln p_i, \beta_h^i(p, \theta_h) = b_h^i(p, \theta_h)/b_h(p, \theta_h),$$
$$b_h^i(p, \theta_h) = \partial b_h(p, \theta_h)/\partial \ln p_i, \lambda_h^i(p, \theta_h) = l_h^i(p, \theta_h)/b_h(p, \theta_h)$$

and

$$l_h^i(p, \theta_h) = \partial l_h(p, \theta_h)/\partial \ln p_i.$$

Once the parameters of (3) are known, welfare from free public provision can be computed as the index

$$I_{h0} = C(p_h^*, u_0)/C(p_0^*, u_0) = C(p, \theta_h, u_0)/C(p, \theta_0, u_0) \quad (4)$$

where θ_0 is the price scaling corresponding to the reference household, for instance a household not eligible to free of charge consumption of the publicly provided private good under consideration. In this case (4) shows the compensation required by a household entitled to public provision to give up this entitlement, i.e. attain the same level of utility as a household without entitlement.

Under the quadratic logarithmic form of consumer preferences (4) becomes

$$\ln I_{h0} = a_h(p, \theta_h) - a_h(p, \theta_0) + [\frac{b_h(p, \theta_h)}{1 - l_h(p, \theta_h)u_0} - \frac{b_0(p, \theta_0)}{1 - l_0(p, \theta_0)u_0}]u_0 \quad (5)$$

and, normally, depends on the utility level of the reference household, u_0. This so called 'base dependence' property is well known to hold true for all measures reflecting cost comparisons between households with different characteristics (Lewbel, 1991) and implies that the magnitude of (5) is a function of some arbitrary normalisation (non-decreasing transformation) of u_0, unless $b_h(p, \theta_h) = b_0(p, \theta_0)$ and $l_h(p, \theta_h) = l_0(p, \theta_0)$ for all h.

3 Empirical model

In this section we first specify a rank-3 demand system where public provision enters through the price scalar θ_h, as described above. The effect of public provision in this demand system is rather complicated to determine and interpret. Thus, a simpler model is also considered where public provision is introduced in an *ad hoc* manner, known in the literature as *translating.* It should be noted here that scaling and translating in our analysis refer to the procedure used in modelling potential savings associated with public supplementation of private consumption, rather than the costs incurred by additional household members (Pollak and Wales, 1981).

3.1 Scaling

For the household specific price indices in (2), the functional form corresponding to the QL Almost Ideal demand system (Banks et al., 1997) is used to obtain an empirical rank-3 demand system. In particular,

$$a_h(p_h^*) = \alpha_{0h} + \sum_i \alpha_{ih} \ln p_{ih}^* + 0.5 \sum_i \sum_j \gamma_{ij} \ln p_{ih}^* \ln p_{jh}^* \tag{6}$$

$$b_h(p_h^*) = \prod_i (p_{ih}^*)^{\beta_{ih}} \tag{6a}$$

$$l_h(p_h^*) = \sum_i \lambda_{ih} \ln p_{ih}^*. \tag{6b}$$

Equivalently, expressing (6)-(6b) as functions of p and θ_h,

$$a_h(p_h^*) = a_h(p, \theta_h) = a_h(p) + \overline{a}_h(\theta_h) + g(p, \theta_h) \tag{6c}$$

where $\overline{a}_h(\theta_h) = -\sum_i \alpha_{ih} \ln(1+\theta_{ih}) + 0.5 \sum_i \sum_j \gamma_{ij} \ln(1+\theta_{ih}) \ln(1+\theta_{jh})$ and $g(p, \theta_h) = -0.5 \sum_i \sum_j \gamma_{ij} [\ln p_i \ln(1 + \theta_{jh}) + \ln(1 + \theta_{ih}) \ln p_j]$,

$$b_h(p_h^*) = b_h(p, \theta_h) = b_h(p)/b_h(\theta_h) \tag{6d}$$

$$l_h(p_h^*) = l_h(p, \theta_h) = l_h(p) - l_h(\theta_h), \tag{6e}$$

where $b_h(\theta_h) = \prod_i (1+\theta_{ih})^{\beta_{ih}}$ and $l_h(\theta_h) = \sum_i \lambda_{ih} \ln(1+\theta_{ih})$. Then the Marshallian budget shares take the form

$$\begin{aligned} w_{ih} \;=\; & \alpha_{ih} + \sum_j \gamma_{ij} \ln\left(\frac{p_j}{1+\theta_{jh}}\right) + \beta_{ih}[\ln y_h - a_h(p, \theta_h)] \\ & + \frac{\lambda_{ih} b_h(\theta_h)}{b_h(p)} [\ln y_h - a_h(p, \theta_h)]^2. \end{aligned} \tag{7}$$

Integrability of (7) imposes the following restrictions on the parameters: $\sum_i \alpha_{ih} = 1$ all h, $\sum_i \gamma_{ij} = 0$ all j, $\sum_i \beta_{ih} = \sum_i \lambda_{ih} = 0$ all h for adding up; $\sum_j \gamma_{ij} = 0$, all i for homogeneity; and $\gamma_{ij} = \gamma_{ji}$ all i, j for symmetry.[3]

To retain the linearity of $\sum_j \gamma_{ij} \ln[p_j/(1+\theta_{jh})]$, we define $\theta_{ih} = \exp(\sum_s \xi_{is} N_{sh}) - 1$, where ξ_{is} are parameters capturing the effect of household characteristics N_{sh}, relating to the perceived quality of the publicly provided free good. Furthermore, health care is considered here to be the only publicly supplemented private good in the demand system, denoted by setting $\theta_{ih} = 0$ all i, except $i = M$. Therefore, and to simplify the notation, we drop the i^{th} subscript and write $\theta_h = \exp(\sum_s \xi_s N_{sh}) - 1$. Then, in the absence of price variation, and under the restriction of household invariance for some of the parameters of the cost function, the demand system (7) can be written as

$$w_{ih} = \alpha_{ih} - \gamma_{iM} \sum_s \xi_s N_{sh} + \beta_i [\ln y_h - \alpha_{h0} - \overline{a}_h(\theta_h)] + \lambda_i b(\theta_h) [\ln y_h - \alpha_{h0} - \overline{a}_h(\theta_h)]^2$$

where $b(\theta_h) = [\exp(\sum_s \xi_s N_{sh})]^{\beta_M}$ and $\overline{a}_h(\theta_h) = -\alpha_{Mh} \sum_s \xi_s N_{sh} + 0.5\gamma_{MM} (\sum_s \xi_s N_{sh})^2$.

Given that without price variation the estimation of θ_h relies on the interaction between the level of expenditure, y_h, and the household characteristics N_{sh}, only a few ξ_s parameters can be estimated in the demand system above. For this reason we confine the investigation of the effects of age and income on households behaviour vis-a-vis the free public health care supplementation by defining $\ln(\theta_h + 1) \equiv \phi_h = \sum_{s=1}^{3} \xi_s N_{sh}$ first as

$$N_{1s} = r_h, \quad N_{2s} = z_{1h} r_h, \quad N_{3s} = z_{1h}^2 r_h \tag{7a}$$

where r_h the number of persons in the household entitled to free public health care and z_{1h} the age of household head; and then as

$$N_{1s} = r_h, \quad N_{2s} = \widehat{y}_h r_h, \quad N_{3s} = \widehat{y}_h^2 r_h \tag{7b}$$

where $\widehat{y}_h$ is household's log net income, corrected for various characteristics of the household (number of children, rooms, cars etc) and its head (age, education, employment status etc).[4] The two alternative definitions of θ_h are compared empirically by non-nested methods.

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[3] The form of the budget share shows that even if the parameters of the cost function are restricted to be free of h, violation of 'independence of base' can occur through θ_h appearing in the coefficient of the quadratic term (Pashardes, 1995).

[4] Alternative functional forms of ϕ_h, in z_{1h}, such as the linear and expontential were employed but were statistically dominated by the quadratic in nested and non-nested tests, respectively.

The share equations are then given by

$$\begin{aligned} w_{ih} &= \alpha_{ih} - \gamma_{iM}\phi_h + \beta_i[\ln y_h - \alpha_{0h} + \alpha_{Mh}\phi_h - 0.5\gamma_{MM}\phi_h^2] \\ &\quad + \lambda_i \exp(\beta_M \phi_h)[\ln y_h - \alpha_{0h} + \alpha_{Mh}\phi_h - 0.5\gamma_{MM}\phi_h^2]^2 \end{aligned} \tag{8}$$

and estimated for the specifications of ϕ_h given by (7a) and (7b).

Following standard practice in estimating demand systems from individual household data (e.g. Blundell et al., 1993), the household specific intercepts of the budget share equations in (8) are defined as linear functions of observed characteristics of the household, $\alpha_{ih} = \alpha_i + \sum_{k=0}^{K} \alpha_{ik} z_{kh}$ where z_k, $k = 0....K$, are the characteristics of the household (such as the number of children, size of house, central heating, availability of durables like cars) and its members (such as age, education, economic position and employment status). The parameter capturing the *subsistence* (zero utility) expenditure is defined as $\alpha_{0h} = \alpha_0 + \alpha_{01} z_{0h}$, where z_{0h} denotes the number of children in the (two adult) household.[5]

The interaction of parameters γ_{iM} and ξ_s, $s = 1, 2, 3$ captures commodity substitution due to access to the publicly supplemented private good. The household specific parameters $\alpha_{Mh}\xi_s$ and $\gamma_{MM}\xi_s\xi_l$, $l = 1, 2, 3$, show the income effect of this supplementation through scaled (Barten-type) prices.

Model estimation is conducted using nonlinear SUR under integrability restrictions, which in the case of system (8) become $\sum_i \alpha_{ih} = 1$, all h, $\sum_i \gamma_{iM} = 0$ and $\sum_i \beta_i = \sum_i \lambda_i = 0$. Furthermore, the restriction $\gamma_{iM} = \gamma$ for all $i \neq M$ is imposed in estimation.

3.2 Translating

When public provision is introduced by translating the demand system, the quadratic logarithmic cost function takes the form

$$\ln C^T(p, N_h, u_h) = a_h(p) + f(p, N_h) + \frac{b_h(p)u_h}{1 - l_h(p)u_h} \tag{9}$$

where $a_h(), b_h()$ and $l_h()$ are as defined in subsection 3.1, $N_h = [N_{1h,} \ldots, N_{Sh}]$ is a vector of household characteristics, relating to public provision, as in the previous

[5] The parameter α_0 is set equal to the log expenditure of the poorest 1% household in the sample. Also, the fact that the data used in the empirical analysis come from surveys conducted in two different years (1997, 2003) is taken into account by introducing a dummy variable in α_{ih} and α_{0h}. The coefficient of the dummy variable in α_{0h} is set to 0.2, which is approximately the cost of living increase between 1997 and 2003.

section, and $f(p, N_h)$ is a linear, differentiable and homogenous (of degree one) function in prices. By differentiating (9) with respect to $\ln p_i$ we obtain the budget share for commodity i

$$w_{ih}^T = \alpha_{ih} + \sum_i \gamma_{ij} \ln p_j + \phi^i(p, N_h) + \beta_{ih}[\ln y_h - a_h(p) - f(p, N_h)] + \frac{\lambda_{ih}}{b_h(p)}[\ln y_h - a_h(p) - f(p, N_h)]^2 \quad (10)$$

where $\phi^i(p, N_h) = \partial f(p, N_h)/\partial \ln p_i$. The superscript T appearing in the cost function and budget share denotes the case of translating the demand system (cost function).

To see how translating the demand system relates to scaling the commodity prices, we combine (2) with (6c)-(6e) and use $\theta_{ih} = \exp(\sum_s \xi_{is} N_{sh}) - 1$ to write the cost function as

$$\ln C(p, N_h, u_h) = a_h(p) + \overline{a}_h(N_h) + g(p, N_h) + \frac{b_h(p)u_h}{b_h(N_h)[1 - l_h(p)u_h - l_h(N_h)u_h]} \quad (11)$$

where

$$b_h(N_h) = \prod_i \exp(\beta_{ih} \sum_s \xi_{is} N_{sh}), \quad l_h(N_h) = \sum_i \lambda_{ih} \sum_s \xi_{is} N_{sh}$$

$$\overline{a}_h(N_h) = -\sum_i \alpha_{ih} \sum_s \xi_{is} N_{sh} + 0.5 \sum_i \sum_j \gamma_{ij} \sum_s \xi_{is} N_{sh} \sum_s \xi_{js} N_{sh}$$

and

$$g(p, N_h) = -0.5 \sum_i \sum_j \gamma_{ij} (\ln p_i \sum_s \xi_{js} N_{sh} + \sum_s \xi_{is} N_{sh} \ln p_j).$$

The corresponding budget share equations are then given by

$$w_{ih} = \alpha_{ih} + \sum_j \gamma_{ij}(\ln p_j - \sum_s \xi_{js} N_{sh}) + \beta_{ih}[\ln y_h - a_h(p, N_h)] + \frac{\lambda_{ih} b_h(N_h)}{b_h(p)}[\ln y_h - a_h(p, N_h)]^2 \quad (12)$$

where $a_h(p, N_h) = a_h(p) + \overline{a}_h(N_h) + g(p, N_h)$.

In order to relate the (translated) cost function (9) with (11) let

$$f(p, N_h) = \sum_s A_s N_{sh} + \sum_i \sum_s E_{is} \ln p_i N_{sh} + 0.5 \sum_s \sum_l A_{sl} N_{sh} N_{lh} \quad (13)$$

with $A_{sl} = A_{ls}$ for all s and l. Assuming that $\beta_{ih} = \beta_i$ and $\lambda_{ih} = \lambda_i$ and that $\alpha_{ih} = \alpha_i + \sum_{k=0}^{K} \alpha_{ik} z_{kh}$, as in the previous section, the functional form of the cost function resulting from scaling is identical to that from translating if

$$\sum_i \beta_i \xi_{is} = 0, \text{ all } s \quad (14)$$

$$\sum_i \lambda_i \xi_{is} = 0, \text{ all } s \tag{14a}$$

$$-\sum_i \alpha_i \xi_{is} = A_s, \text{ all } s \text{ and } -\alpha_{ik}\xi_{is} = 0, \text{ all } i, k \text{ and } s \tag{14b}$$

$$-\sum_i \sum_j \gamma_{ij} \xi_{is} \xi_{jl} = A_{sl}, \text{ all } s \text{ and } l \tag{14c}$$

$$\sum_j \gamma_{ji} \xi_{jl} = E_{is}, \text{ all } i \text{ and } s. \tag{14d}$$

Imposing the restrictions (14)-(14d) on the scaled budget share equations (12) we obtain the translated ones in (10) for the form of $f(p, N_h)$ defined by (13).[6]

In the absence of price variation and with health care ($i = M$) being the only publicly provided private good in the system the share equation is given by

$$\begin{aligned} w_{ih}^T &= \alpha_{ih} + \sum_s E_{is} N_{sh} + \beta_{ih}[\ln y_h - \alpha_{0h} - f_h] \\ &\quad + \lambda_{ih}[\ln y_h - \alpha_{0h} - f_h]^2. \end{aligned} \tag{15}$$

where $f_h = \sum_s A_s N_{sh} + 0.5 \sum_s \sum_l A_{sl} N_{sh} N_{lh}$.

In estimation we use $E_{is} = 0$ except for $s = 1$ and $f_h = \sum_{s=1}^{3} A_s N_{sh}$, thus

$$w_{ih}^T = \alpha_{ih} + E_{i1} N_{1h} + \beta_i [\ln y_h - \alpha_{0h} - f_h] + \lambda_i [\ln y_h - \alpha_{0h} - f_h]^2 \tag{16}$$

where $\beta_{ih} = \beta_i$, $\lambda_{ih} = \lambda_i$ and f_h is given by the two alternative definitions of N_{1h}, N_{2h} and N_{3h} given in (7a) and (7b). The system (16) is estimated by nonlinear SUR under integrability restriction and the restriction $E_{i1} = E$ for all i except $i = M$.

Clearly, translating results in a simpler empirical specification than scaling, as no second order effects of public supplementation ($A_{sl} = 0$, all s and l) are included in the estimated budget share equations.[7]

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[6] Note that while the scaled and translated demand systems are observationally equivalent, as implied by the reparameterisations (14)-(14d), they do not necessarily intergate to the same cost function implying that the two specifications can have different welfare implications.

[7] As in the scaling model, the parameter α_{01} is set to 0.3 and α_0 is set equal to the log expenditure of the household at the lowest 1% in the sample. The translating model is estimated under the restriction that the demographic substitution effect of r_h is the same for all commodity groups, except for health care.

4 Empirical results

We calculate the effects of free of charge public provision of health care and how these vary with the age of household head and the level of household income[8] using data drawn from the Cyprus Household Budget Surveys of 1997 and 2003. Cyprus, like many non-western countries, does not have a universal National Health Service, although a large proportion of the population has free access to public health care.[9] Nevertheless, public health services are poorly organised and of low quality (especially at primary level) so that most (if not all) households in the country supplement to a lesser or greater extent the freely available public with paid out of pocket private health care services. As a consequence the private health care sector in Cyprus is 'fully developed' at all levels (primary, secondary and tertiary) and accounts for around 60% of total health care expenditure in the country.

A demand system consisting of six commodity groups (food, clothing-footwear, health care, electricity-fuel, water-communication-other services, other non-durable goods) is estimated. The sample consists of two-adult households whose age of head is between 20 and 60, not self-employed or employer and either does not have any or has only public/government medical cover (ditto for head's spouse). This selection of the sample is made in order to achieve sufficient homogeneity in terms of household composition while maintaining variation in terms of access to the publicly provided health care.

Below we present results obtained from SUR estimation of the scaling (8) and translating (16) empirical specifications when the effects of public supplementation depend on the age of household head and the level of household income. In each case we report selected parameters estimates, together with some parameter and system diagnostics. The remaining parameter estimates of the four models are shown in the Appendix (Tables A1-A4).

[8] Income (net of tax) consists of net salary and pension income, social security income (such as unemployment, sickness, child etc benefits), net income from rent, dividends and interest, income in kind, houshold own-consumption, imputed rent and pecuniary transfers from other households. Pecuniary transfers to other households are deducted.

[9] Entitlement to publicly provided free medical care in Cyprus is to a great extent means-tested. Free medical care is also provided to civil servants and their families.

4.1 Age effects

Table 1 reports selected parameter estimates (t-ratios in parentheses) obtained from the scaling model when the effects of public supplementation of health care depend on head's age. The linear log expenditure effects are significant at 5% significance level, for all commodity groups, except for services. The significance of the quadratic log expenditure coefficient can be inferred from a test of $\lambda_i = 0$ and t-ratios show that the quadratic expenditure term is significant only for electricity-fuel and services.

Table 1: Selected parameter estimates and system statistics; head's age

	Scaling	Translating
A_1	-	-0.5767 (-2.91)
A_2	-	0.0303 (3.10)
A_3	-	-0.0004 (-3.15)
β_i		
Food	-0.0988 (-5.19)	-0.0995 (-5.43)
Clothing-footwear	0.0356 (2.98)	0.0354 (3.07)
Health care	0.0410 (3.14)	0.0485 (3.70)
Electricity-fuel	-0.0377 (-4.52)	-0.0380 (-4.71)
Services	0.0147 (0.78)	0.0112 (0.60)
λ_i		
Food	-0.0065 (-0.67)	-0.0061 (-0.63)
Clothing-footwear	-0.0012 (-0.19)	-0.0016 (-0.27)
Health care	-0.0064 (-0.96)	-0.0081 (-1.18)
Electricity-fuel	-0.0083 (-1.95)	-0.0084 (-1.99)
Services	0.0237 (2.47)	0.0253 (2.58)
ξ_1	7.8901 (2.43)	-
ξ_2	-0.4127 (-2.44)	-
ξ_3	0.0052 (2.43)	-
γ_{iM}, all i except $i = M$	0.0019 (1.75)	-
γ_{MM}	-0.0097 (-1.75)	-
Root MSE		
Food	0.1077	0.1074
Clothing-footwear	0.0678	0.0674
Health care	0.0744	0.0753
Electricity-fuel	0.0470	0.0470
Services	0.1074	0.1073
Number of observations (N)	711	711
Number of parameters	104	104
Objective*N	3463	3458

The estimates of the scaling parameters (ξ_1, ξ_2, ξ_3) are individually significant at 5% level (Table 1) and jointly significant at 1% level (Table 2). The interactions of the scaling parameters with the coefficient of log expenditure in the health care share equation (β_M) are also jointly significant at 1% level, indicating rejection of the independence of base hypothesis - the coefficient of the quadratic log expenditure term is not household invariant (Pashardes, 1995).

The estimates of γ_{iM}, the substitution effects in the health care equation from changes in the number of household members entitled to free public medical care, is negative for ages 33-46 and positive otherwise, giving rise to a negative effect on average. This means that privately purchased and free public health care are substitutes for age groups at the middle and complements for households at the low and high ends of the age range 20-60.

The overall savings due to access to free public health care is more complicated to calculate as it involves the interaction of several parameters. However the significance of ξ_s ($s = 1, 2, 3$), α_{Mk} ($k = 1, \ldots, K$) and $\gamma_{MM}\xi_s$ ($s = 1, 2, 3$) suggests that this effect is also significant. We shall return to this point in the next section.[10]

Table 2: Likelihood ratio tests; head's age

Scaling	
Null hypothesis	LR statistic and p-value
$\xi_s = 0,\ s = 1, 2, 3$	22.84 (<0.0001)
$\beta_M \xi_s = 0,\ s = 1, 2, 3$	8.85 (0.0029)
$\alpha_{Mk} = 0,\ k = 1, \ldots K$	33.68 (0.0092)
Translating	
Null hypothesis	LR statistic and p-value
$A_s = 0,\ s = 1, 2, 3$	9.70 (0.0213)

We next turn to the interpretation of the parameter estimates from the translating model for the specification relating to head's age. As in the scaling model, the linear log expenditure parameters (β_i) are significant (at 1% level) for all commodity groups except for services. The quadratic log expenditure effect in the translating model is given by a single parameter, λ_i, which (in contrast to the scaling model) is the same for all households. The quadratic log expenditure effects are found to be significant only in electricity-fuel and services equations.

[10]The estimates of the parameters showing the effect of household and head characteristics on the intercept of the share equations are shown in the Appendix (Table A1). For example an additional child in the household increases the share of expenditure on clothing-footwear and health care by 0.0140 and 0.0106 respectively, and decreases the shares of food and electricity-fuel by 0.0091 and 0.0155, respectively.

In the translating model the effect of access to free public health care on household cost enters the model directly, through the parameter A_1, while the parameters A_2 and A_3 reflect the interaction of this effect with head's age and age squared. The negative sign and statistical significance of A_1 suggest that the number of people in the household entitled to free public health care reduce household cost in a statistically significant manner. The parameters A_2 and A_3 are also significant (at 1% level) and their positive and negative signs, respectively, imply that the cost reduction (or, equivalently, the savings from access to free public health care) is greater for households with heads whose age lies at the tails of the age range 20-60. Additionally, the parameters A_1, A_2 and A_3 are jointly significant at 5% level (Table 2). The size and statistical significance of this cost reduction/increase is further investigated in the next sub-section.

The substitution effect of the number of household members with free access to public health care is insignificant for all commodity groups[11] (Table A2). Estimates of the effects of characteristics on the intercepts of share equations are also shown in the Appendix (Table A2).

4.2 Income effects

The interpretation of the estimates in Table 3 (t-ratios in parentheses) from the scaling and translating models, for the specification depending on household income, is very similar to that for Table 1. Moreover, the magnitude and significance of the estimated β_i and λ_i on Table 3 is very close to those of the corresponding estimates for the scaling and translating models in Table 1.

For the scaling model only ξ_1 and ξ_2 are marginally significant at 10% level, but all scaling parameters are jointly significant at 5% (Table 4). The joint significance though for the income specification is weaker than that for the age specification. There is evidence that the coefficient of log expenditure squared depends on household income and the number of household members entitled to free public health care, as $\beta_M \xi_s$, $s = 1, 2, 3$, are jointly significant (Table 4), invalidating the independence of base property.

The interaction terms $\gamma_{iM} \xi_s$, $s = 1, 2, 3$, give the substitution effect for the

[11] As a result of the parameter restriction on γ_{iM}'s and E_{iM}'s, for the scaling and translating models respectively, and the adding up restriction, the absolute value of t-ratio for the parameters relating to the substitution effect of r_h is the same in all share equations.

commodity group i from changes in the number of household members entitled to free medical care. For the health care share equation these terms are jointly significant (Appendix, Table A6) and the effect depends on household income. This suggests that privately purchased and free public health care are substitutes for age groups in the middle and complements for households in the (low and high) ends of the age range 20-60.

Table 3: Selected parameter estimates and system statistics; household income

	Scaling	Translating
A_1	-	-0.2967 (-2.98)
A_2	-	0.4594 (2.94)
A_3	-	-0.1512 (-2.39)
β_i		
Food	-0.0958 (-4.72)	-0.0883 (-4.56)
Clothing-footwear	0.0398 (3.11)	0.0419 (3.43)
Health care	0.0396 (2.75)	0.0399 (2.90)
Electricity-fuel	-0.0347 (-3.83)	-0.0341 (-3.97)
Services	0.0092 (0.45)	-0.0006 (-0.03)
λ_i		
Food	-0.0087 (-0.81)	-0.0124 (-1.17)
Clothing-footwear	-0.0037 (-0.55)	-0.0055 (-0.83)
Health care	-0.0057 (-0.75)	-0.0039 (-0.53)
Electricity-fuel	-0.0105 (-2.19)	-0.0109 (-2.33)
Services	0.0280 (2.62)	0.0331 (3.10)
ξ_1	2.2893 (1.73)	-
ξ_2	-3.3779 (-1.67)	-
ξ_3	1.1427 (1.50)	-
γ_{iM}, all i except $i = M$	0.0022 (1.17)	-
γ_{MM}	-0.0109 (-1.17)	-
Root MSE		
Food	0.1078	0.1076
Clothing-footwear	0.0677	0.0674
Health care	0.0750	0.0755
Electricity-fuel	0.0471	0.0470
Services	0.1074	0.1072
Number of observations (N)	711	711
Number of parameters	104	
Objective*N	3452	3453

The parameters A_1, A_2 and A_3 show the reduction in household expenditure from the entitlement of household members to the free (or reduced rate) use of the publicly provided good and its interaction with household income and income squared. The parameter estimates point to a cost reduction from public provision for very low and very high income households, more precisely, for households belonging to the lowest three and the highest deciles of net income distribution. Again, a more extensive exploration of the income effect follows in the next section.

Table 4: Likelihood ratio tests; household income

Null hypothesis	LR statistic and p-value
Scaling	
$\xi_s = 0,\ s = 1,2,3$	9.73 (0.0210)
$\beta_M \xi_s = 0,\ s = 1,2,3$	7.04 (0.0080)
$\alpha_{Mk} = 0,\ k = 1,\dots K$	21.39 (0.2094)
Translating	
$A_s = 0,\ s = 1,2,3$	8.73 (0.0332)

4.3 Choosing between alternative specifications

To test which variable, head's age or household income is more informative in modelling public provision of private goods, models that include both variables are estimated and the significance of the two alternative sets of variables is tested. In particular the scaling model is estimated for $\phi_h = \xi_1 r_h + \xi_2 r_h z_{1h} + \xi_3 r_h z_{1h}^2 + \xi_4 r_h \widehat{y}_h + \xi_5 r_h \widehat{y}_h^2$ and the translating model for $f_h = A_1 r_h + A_2 r_h z_{1h} + A_3 r_h z_{1h}^2 + A_4 r_h \widehat{y}_h + A_5 r_h \widehat{y}_h^2$. The significance of head's age (household income) and its square, as they appear in the expressions above, is tested both in the scaling and translating model. The results of likelihood ratio tests are shown on Table 5.

Table 5: Likelihood ratio tests, head's age vs household income

Null hypothesis	LR statistic and p-value
Scaling	
$\xi_s = 0,\ s = 2,3$	17.11 (0.0002)
$\xi_s = 0,\ s = 4,5$	4.98 (0.0831)
Translating	
$A_s = 0,\ s = 2,3$	7.99 (0.0184)
$A_s = 0,\ s = 4,5$	6.94 (0.0311)

In the scaling model the hypothesis that the cost reduction from access to free public health care does not vary with age (the effects of age and age square) is clearly rejected. In the translating model the same hypothesis is rejected at 5% level but not at 1% level. On the contrary, the hypothesis that the cost reduction from access to free public health care does not vary with income (the effects of income and income square) is not rejected in the scaling model at 5%. The translating model gives somehow more ambiguous results as both hypotheses can be rejected at 5% level, but neither can be rejected at 1%. Tests results give overall lower values for the likelihood ratio statistic (higher p-values), when the coefficients of household income and its square are tested against zero, in both the scaling and the translating models. This can be loosely interpreted as evidence in favour of the specification allowing the cost reduction from access to free public health care to vary with age rather than income.

Since scaling and translating the original demand system results in two non-nested models it is investigated which model, is more favoured by the data using a non-nested test (Davidson and MacKinnon, 1982; Manera and McAleer, 2005). As the empirical evidence in favour of/against the age or income variables is not very clear, non-nested tests are conducted for models that include either the age or income variables. The results of the tests are shown on Table 6.

Table 6: Non-nested tests

	Age variables		Income variables	
Null hypothesis	Wald statistic (p-value)	t-statistic (p-value)	Wald statistic (p-value)	t-statistic (p-value)
Scaling	0.01	0.00	0.01	0.00
	(1.0000)	(0.2210)	1.0000	(0.5123)
Translating	0.19	0.42	0.03	0.00
	(0.9999)	(0.6736)	1.0000	0.5828

The null hypothesis that corresponds to the scaling (translating) model corresponds to the restriction that the coefficients of the fitted values from the translating (scaling) model are all zero in all share equations estimated using the scaling (translating) model. In one instance the coefficients of the fitted values are allowed to differ in each share equation thus a Wald statistic for their joint significance is computed. Alternatively a single coefficient is estimated, the same for all share equations hence a t-statistic is reported to test for its significance. Test results from both Wald and t-tests are inconclusive, as neither model can be rejected against the other. One possibility is that both models fit the data equally well, since they are very similar and essentially differ only in higher order terms. Another possibility is that the particular data set does not provide enough information in choosing between the two models.

5 Welfare implications

The empirical results discussed in the previous section, have found entitlement to free public health care in a household to have an age or income dependant effect on consumer behaviour. To evaluate the welfare implications of these empirical findings in the case of the scaling model we compute the expenditure required by a household (with at least one member) entitled to free public medical care to reach the same level of utility as the (reference) household whose members are not entitled to free public health care. At $u_0 = 0$, this expenditure index is given by

$$\ln I_{h0}^S = \alpha_{0h} + \overline{a}_h(\theta_h) - \alpha_{00} - \overline{a}_0(\theta_0) = -\alpha_{Nh}\phi_h + 0.5\gamma_{MM}\phi_h^2. \qquad (13)$$

This index can be seen as a measure of the compensation required by household h so that its members forego entitlement to free public health care.

For the model where public provision is introduced via translating, the corresponding expenditure index is given by

$$\ln I_{h0}^T = \alpha_{0h} + f_h - \alpha_{00} - f_0 = \alpha_{0h} + f_h. \qquad (14)$$

Both indices, I_{h0}^S and I_{h0}^T, are computed for the definitions of N_{sh} variables given in (7a) and (7b), yielding results where the welfare implications vary with age and income.

5.1 Variation with age

Figures 1 and 2 show the log cost (expenditure) reduction from access to free or at reduced charge public medical care by one household member, as estimated from the scaling and translating model respectively. The estimated indices[12] reported in Figures 1 and 2, whose corresponding functional forms are given in equations (13) and (14), are estimated for every head's age in the range 20-60. The upper and lower endpoints of 90% confidence intervals are also shown, indicating the ages for which the log expenditure reduction is statistically different from zero.

It can be seen from Figure 1 that log cost reduction is significantly different from zero (at 10% level) for head's age 20-27, whereas for the remaining ages

[12] The index in Figure 1 is computed at the sample averages of the variables in α_{Mh} (except for head's age) for the case where one household member is entitled to free or at reduced charge public health care, i.e. he/she possesses government medical cover.

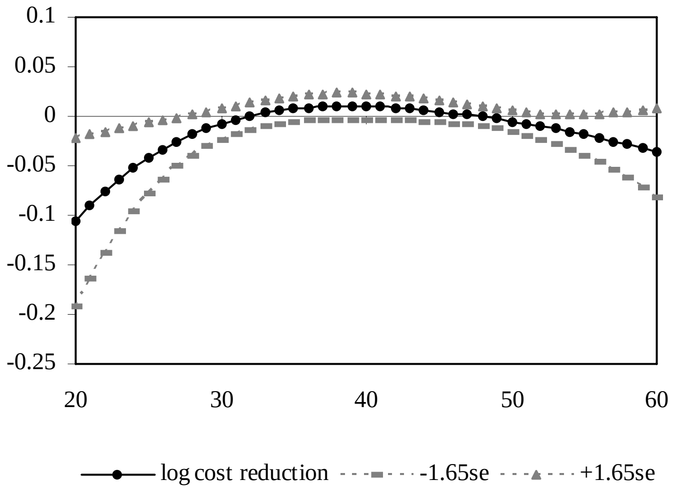

Figure 1: Log cost reduction by age of household head; scaling

cost reduction is not so different. For example, a household whose head is 20 years old and one of its members has access to free public health care, has a log cost reduction equal to 0.1, which means that the household faces 10% lower expenditure than a household with the same characteristics except for the free access to the publicly provided private good. For ages 32-47 entitlement to free public medical care appears to be associated with higher expenditure (compared to household without such entitlement), however, this rather odd finding can be dismissed as statistically insignificant and can be attributed to the quadratic modelling (inverted U-shape) of the age effect. From Figure 1 it can be inferred that for households with heads aged 28-31 and 48-60 the benefit from their entitlement to free public health care is also insignificant, whereas for households with heads aged 20-27 this benefit is significant.

Figure 2 follows a similar pattern to Figure 1, showing that cost reduction from entitlement to free public health care is experienced by households whose head's age lies in the tails of the age range 20-60. In particular the log cost reduction is statistically different from zero (at 10% level) for households with heads aged 20-23 and 59-60. For example, a household with one member entitled to free public health care and whose head is 20 years old has about 13% lower expenditure than a household with the same characteristics except for the entitlement to free public medical care. For ages 31-50 the model estimates an increase in expenditure, which is not significantly different from zero. For ages 24-30 and 51-58 there appears to

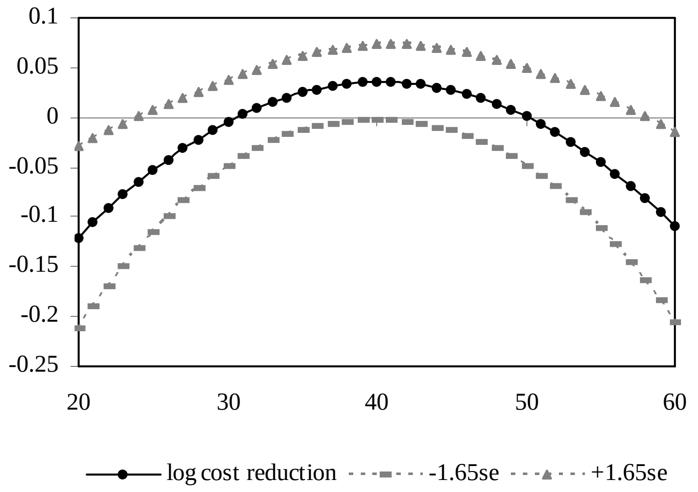

Figure 2: Log cost reduction by age of household head; translating

be a small cost reduction (benefit) from entitlement to free public medical care, nevertheless not statistically different from zero.

From Figures 1 and 2 we can conclude that the two models[13] give similar results namely that households with very young heads benefit significantly from entitlement to free medical care. The translating model results into more extreme values for cost reduction than the scaling model, therefore larger benefit for households with younger and also for older heads. The average log cost reduction (over all ages) estimated from the two models is 0.016 and 0.017 for the scaling and translating model respectively. Hence, the empirical finding from both models converge to the conclusion that for each member entitled to free public health care households enjoy, on average, a reduction of around 1.5% to 2% in their total consumption expenditure.

[13]Both scaling and translating models were also estimated using three stage least squares (3SLS) to account for possible endogeneity of total expenditure. In the case of the translating model the results from 3SLS estimation are similar to those from SUR estimation. In the case of the scaling model the marginally significant λ's for electricity-fuel and services obtained from SUR estimation become insignificant when 3SLS estimation is applied, thus giving less precise estimates of the demographic costs (Pashardes, 1995) and consequently insignificant estimates for the cost reduction from access to free public health care. The pattern however, where benefit appears to be larger for households with heads whose age lies closer to the end points of the age interval 20-60, is maintained. The results of 3SLS estimation are available on request.

5.2 Variation with income

Below it is investigated whether variation with age, of cost reduction from the entitlement to free public health care might simply be capturing the effect of income, as income tends to be lower for households with very young or older (mainly pensioners) heads, therefore such households are expected to benefit more from public provision. Thus we use definition (7b) in calculating the log cost indices (13) and (14).

Figures 3 and 4 show the log cost reduction estimated using (13)[14] and (14), respectively, from the entitlement to the free access to public health care services by one household member, for different deciles of household net income. The deciles are shown on the graphs in ascending order, thus 1 and 10 corresponds to the 10% of households in the sample with the lowest and highest average $\widehat{y}_h$, respectively; and (13) and (14) are computed at the average $\widehat{y}_h$ in each decile. To indicate the deciles for which log cost reduction is statistically different from zero, the upper and lower endpoints of 90% confidence intervals are also presented in the graphs.

Figure 3 shows that for all deciles log cost reduction is not statistically different from zero even though it tends to be larger for the lower (1st and 2nd) and higher (9th and 10th) deciles. On the other hand Figure 4 shows that there is, to some extent, variation of the benefit from free access to public health care services with net income, as cost reduction is statistically different from zero for the lowest deciles (1st and 2nd) of net income. For example, for the poorest households (i.e. those belonging in the 1st decile), entitlement to free public medical care by one member of the household reduces cost by 13%, compared to a household belonging to the same decile but without such entitlement. Households in higher deciles (7th, 8th and 9th) seem to experience a small increase in total expenditure due to entitlement to free use of public health care services, a paradoxical result even though statistically significant only at 10% level.

From Figures 1-4 and the tests' outcomes of Table 5, it emerges that the age of household head seems to be a more appropriate characteristic associated with variation in the welfare effects of free access to public health care among households in Cyprus.

[14] Analogously to the index in Figure 1, the index in Figure 3 is computed at the sample averages of the variables in α_{Mh} (except for $\widehat{y}_h$) for the case where one household member is entitled to free or at reduced charge public health care.

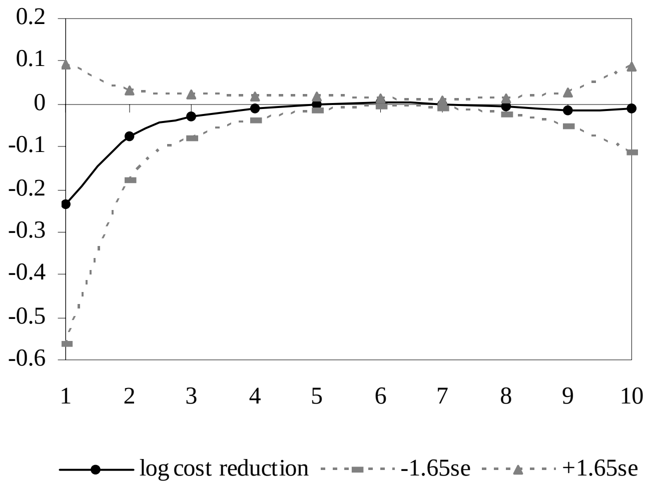

Figure 3: Log cost reduction by decile of household net income; scaling

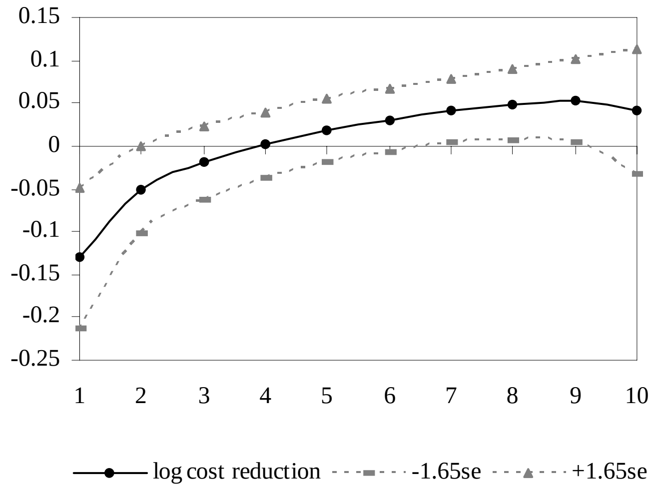

Figure 4: Log cost reduction by decile of household net income; translating

6 Summary and conclusion

The techniques for evaluating the welfare effects of public (minimarket) goods are well-developed in the literature and include both revealed (e.g. hedonic models) and stated (e.g. contingent valuation) preference methods. This paper proposes a revealed preference approach to estimating consumer welfare from free access to publicly provided private goods, using demand analysis and readily available data.

Public provision of private goods is studied in the context of an integrable rank-3 demand system where publicly provided private goods (such as health care) are simultaneously available at the private market and eligible households can consume either the publicly provided good, buy it from the private sector or consume a combination of the two, assuming that the public provision scheme (e.g. health care system) allows supplementation.

Access to publicly provided private goods is introduced in the demand system as a scaling in the price of the corresponding private good, with the scaling parameter being a function of income or the age of household head. Thus, scaling allows public supplementation to operate as a price subsidy for the private good. This relationship arises from the assumption that the publicly provided private good is an affine transformation of the private good. We examine the welfare implications of free access to a publicly provided private good by comparing the cost required to attain the same utility level by households without and with such access. The welfare measure used in this paper does not include the positive externalities associated with the free access to public health care.

An empirical investigation is provided for the case of health care services in Cyprus, where free public provision is not universal and also those entitled to it often supplement their consumption with purchases from the private health sector. The price scaling associated with free access to public health services is modelled as a function of the age of head and income of the household. Furthermore, in the empirical analysis the effect of free public provision on household cost is also investigated using an alternative empirical specification known in the literature as translating. Although not having a meaningful theoretical interpretation in the context of our analysis, translating can be a useful benchmark for comparison with scaling because the two models are observationally very close to each other.

The results of our empirical analysis show that the entitlement to free public health care benefits mostly households with younger heads (less than 27 years old) and, to a lesser extent, households with heads aged 28-31 and 48-60 face reductions of much smaller magnitude. Some evidence associating access to free public health care provision with reduction in cost is found for households with low income. On average the benefit from the entitlement of one household member to free public medical care is estimated to be around 2% of total household expenditure.

The conclusion emerging from our analysis is that among households entitled to free access to public health care services only those with very young or older head and/or low income benefit from it. This probably reflects the low quality of the public health care services in Cyprus, including queuing and bureaucratic inconvenience. While this conclusion is somewhat confounded by inadequacy in the number of observations and other data limitations (e.g. lack of price variation) we believe that the modelling approach proposed in this paper can be useful in investigating behavioural and welfare implications of free public health care. The same approach can also be used in investigating behavioural and welfare effects of education, day care and other publicly provided private goods.

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Appendix

Table A1: Scaling; head's age

Variable	Food	Cloth.	Health	Electr.	Serv.
Constant	0.4525	0.0631	0.1368	0.1522	0.0894
	(7.39)	(1.62)	(3.30)	(5.52)	(1.42)
Survey	-0.0240	-0.0144	0.0063	0.0339	-0.0017
	(-2.83)	(-2.70)	(1.02)	(8.97)	(-0.20)
Household characteristics					
Number of children	-0.0091	0.0140	0.0106	-0.0155	-0.0084
	(-1.69)	(4.20)	(2.70)	(-6.48)	(-1.59)
Number of rooms	-0.0010	-0.0014	-0.0019	0.0031	-0.0003
	(-0.30)	(-0.64)	(-0.81)	(2.06)	(-0.08)
Number of cars	-0.0309	-0.0038	-0.0044	0.0211	0.0256
	(-3.97)	(-0.77)	(-0.83)	(6.16)	(3.25)
Central heating	0.0050	0.0025	-0.0065	0.0153	-0.0129
	(0.49)	(0.39)	(-0.94)	(3.45)	(-1.28)
Head's characteristics					
Age	0.0033	-0.0004	-0.0011	-0.0003	-0.0004
	(6.37)	(-1.13)	(-2.31)	(-1.38)	(-0.79)
Private sector employee	0.0083	-0.0114	0.0103	-0.0094	0.0159
	(0.80)	(-1.75)	(1.44)	(-2.07)	(1.53)
Elementary education-not completed	-0.0611	-0.0021	-0.0395	-0.0114	0.1263
	(-1.16)	(-0.06)	(-1.16)	(-0.48)	(2.30)
Elementary education	-0.0897	0.0119	-0.0306	-0.0155	0.1405
	(-1.82)	(0.37)	(-0.96)	(-0.70)	(2.72)
Lower secondary education	-0.0986	0.0130	-0.0306	-0.0180	0.1572
	(-1.94)	(0.40)	(-1.09)	(-0.78)	(2.96)
Upper secondary education	-0.1188	0.0164	-0.0469	-0.0200	0.1741
	(-2.38)	(0.51)	(-1.45)	(-0.88)	(3.33)
College	-0.0976	0.0183	-0.0532	-0.0180	0.1620
	(-1.89)	(0.55)	(-1.58)	(-0.77)	(3.01)
University	-0.1346	0.0121	-0.0499	-0.0252	0.2009
	(-2.64)	(0.37)	(-1.50)	(-1.09)	(3.77)
Employed	-0.0324	0.0312	0.0186	-0.0016	0.0017
	(-1.86)	(2.80)	(1.58)	(-0.21)	(0.10)
Unemployed	-0.0160	0.0223	-0.0219	0.0049	0.0130
	(-0.64)	(1.41)	(-1.30)	(0.45)	(0.52)
Housewife	-0.0112	0.0279	-0.0232	0.0089	-0.0245
	(-0.30)	(1.17)	(-0.91)	(0.54)	(-0.65)
Chronically ill/disable	-0.0078	0.0151	0.0177	-0.0308	-0.0044
	(-0.30)	(0.91)	(1.02)	(-2.69)	(-0.17)

Table A2: Translating; head's age

Variable	Food	Cloth.	Health	Electr.	Serv.
Constant	0.4363	0.0620	0.1565	0.1416	0.0968
	(7.01)	(1.61)	(3.63)	(5.16)	(1.57)
Survey	-0.0229	-0.0152	0.0074	0.0341	-0.0023
	(-2.59)	(-2.74)	(1.11)	(8.66)	(-0.24)
Household characteristics					
Number of children	-0.0099	0.0158	0.0065	-0.0153	-0.0071
	(-1.80)	(4.59)	(1.63)	(-6.28)	(-1.26)
Public medical cover (no. of members)	-0.0004	-0.0004	0.0018	-0.0004	-0.0004
	(-0.72)	(-0.72)	(0.72)	(-0.72)	(-0.72)
Number of rooms	-0.0011	-0.0016	-0.0013	0.0031	-0.0005
	(-0.31)	(-0.73)	(-0.53)	(2.06)	(-0.15)
Number of cars	-0.0306	-0.0032	-0.0073	0.0215	0.0262
	(-3.92)	(-0.65)	(-1.33)	(6.28)	(3.36)
Central heating	0.0052	0.0025	-0.0074	0.0152	-0.0125
	(0.52)	(0.40)	(-1.04)	(3.44)	(-1.23)
Head's characteristics					
Age	0.0034	-0.0004	-0.0009	-0.0003	-0.0005
	(5.64)	(-1.27)	(-2.50)	(-1.25)	(-0.90)
Private sector employee	0.0083	-0.0119	0.0122	-0.0092	0.0149
	(0.80)	(-1.82)	(1.65)	(-2.00)	(1.41)
Elementary education-not completed	-0.0450	-0.0006	-0.0638	-0.0027	0.1236
	(0.85)	(-0.02)	(-1.72)	(-0.11)	(2.33)
Elementary education	-0.0754	0.0148	-0.0566	-0.0070	0.1387
	(-1.52)	(0.47)	(-1.63)	(-0.32)	(2.79)
Lower secondary education	-0.0844	0.0151	-0.0597	-0.0094	0.1545
	(-1.65)	(0.47)	(-1.67)	(-0.42)	(3.01)
Upper secondary education	-0.1041	0.0187	-0.0715	-0.0110	0.1713
	(-2.08)	(0.59)	(-2.03)	(-0.50)	(3.41)
College	-0.0825	0.0207	-0.0789	-0.0088	0.1593
	(-1.59)	(0.64)	(-2.18)	(-0.39)	(3.07)
University	-0.1198	0.0152	-0.0776	-0.0160	0.1990
	(-2.34)	(0.47)	(-2.16)	(-0.71)	(3.88)
Employed	-0.0336	0.0320	-0.0193	-0.0013	0.0017
	(-1.91)	(2.90)	(-1.57)	(-0.17)	(0.09)
Unemployed	-0.0168	0.0230	-0.0222	0.0055	0.0122
	(-0.67)	(1.47)	(-1.27)	(0.50)	(0.49)
Housewife	-0.0123	0.0289	-0.0245	0.0101	-0.0254
	(-0.33)	(1.22)	(-0.93)	(0.61)	(-0.67)
Chronically ill/disable	-0.0133	0.0174	0.0172	-0.0335	-0.0009
	(-0.51)	(1.06)	(0.94)	(-2.92)	(-0.03)

Table A3: Scaling; household income

Variable	Food	Cloth.	Health	Electr.	Serv.
Constant	0.3751	0.0592	0.0599	0.1332	0.2818
	(7.15)	(1.76)	(1.58)	(5.57)	(5.24)
Survey	-0.0191	-0.0135	0.0132	0.0358	-0.0176
	(-1.69)	(-1.89)	(1.55)	(6.88)	(-1.54)
Household characteristics					
Number of children	-0.0005	0.0148	0.0083	-0.0114	-0.0208
	(-0.07)	(3.12)	(1.62)	(-3.31)	(-2.70)
Number of rooms	0.0200	0.0013	0.0220	0.0114	-0.0619
	(0.70)	(0.07)	(1.14)	(0.86)	(-2.08)
Number of cars	0.0184	0.0024	0.0453	0.0404	-0.1119
	(0.29)	(0.06)	(1.08)	(1.39)	(-1.70)
Central heating	0.0569	0.0092	0.0488	0.0356	-0.1613
	(0.83)	(0.21)	(1.06)	(1.13)	(-2.27)
Household net income	-0.2592	-0.0330	-0.2541	-0.1032	0.7176
	(-0.79)	(-0.16)	(-1.16)	(-0.68)	(2.11)
Head's characteristics					
Age	0.0034	-0.0004	-0.0008	-0.0003	-0.0008
	(6.84)	(-1.19)	(-2.22)	(-1.35)	(-1.55)
Private sector employee	-0.0212	-0.0153	-0.0226	-0.0207	0.1015
	(-0.53)	(-0.60)	(-0.83)	(-1.12)	(2.43)
Elementary education	-0.0285	0.0150	0.0049	-0.0023	0.0152
	(-1.26)	(1.03)	(0.31)	(-0.23)	(0.65)
Lower secondary education	-0.0194	0.0180	0.0254	0.0021	-0.0258
	(-0.46)	(0.37)	(0.89)	(0.11)	(-0.60)
Upper secondary education	-0.0220	0.0239	0.0339	0.0071	-0.0604
	(-0.36)	(0.61)	(0.81)	(0.25)	(-0.95)
College	0.0098	0.0267	0.0328	0.0135	-0.0956
	(0.14)	(0.57)	(0.67)	(0.40)	(-1.27)
University	0.0284	0.0281	0.0857	0.0290	-0.2067
	(0.20)	(0.32)	(0.92)	(0.45)	(-1.43)
Employed	0.0430	0.0406	0.0684	0.0280	-0.2202
	(0.43)	(0.63)	(1.03)	(0.61)	(-2.11)
Unemployed	0.0161	0.0263	0.0123	0.0180	-0.0789
	(0.35)	(0.88)	(0.39)	(0.84)	(-1.62)
Housewife	0.0025	0.0300	-0.0182	0.0165	-0.0561
	(0.06)	(1.18)	(-0.67)	(0.93)	(-1.39)
Chronically ill/disable	-0.0186	0.0132	-0.0166	-0.0335	-0.0496
	(-0.51)	(0.56)	(-0.66)	(-2.02)	(-1.31)

Table A4: Translating; household income

Variable	Food	Cloth.	Health	Electr.	Serv.
Constant	0.3843	0.0553	0.0511	0.1365	0.2858
	(7.04)	(1.62)	(1.30)	(5.62)	(5.15)
Survey	-0.0175	-0.0151	0.0177	0.0362	-0.0210
	(-1.47)	(-2.01)	(1.94)	(6.74)	(-1.65)
Household characteristics					
Number of children	-0.0016	0.0144	0.0116	-0.0120	-0.0214
	(-0.21)	(3.06)	(2.20)	(-3.59)	(-2.84)
Public medical cover (no. of members)	-0.0005	-0.0005	0.0025	-0.0005	-0.0005
	(-1.00)	(-1.00)	(1.00)	(-1.00)	(-1.00)
Number of rooms	0.0185	-0.0018	0.0351	0.0102	-0.0664
	(0.64)	(-0.10)	(1.69)	(0.79)	(-2.25)
Number of cars	0.0131	-0.0037	-0.0739	0.0372	-0.1207
	(0.20)	(-0.09)	(1.62)	(1.31)	(-1.86)
Central heating	0.0530	0.0019	0.0800	0.0326	-0.1718
	(0.76)	(0.04)	(1.61)	(1.05)	(-2.44)
Household net income	-0.2491	0.0087	-0.4152	-0.0914	0.7760
	(-0.75)	(0.04)	(-1.75)	(-0.62)	(2.30)
Head's characteristics					
Age	0.0035	-0.0004	-0.0007	-0.0003	-0.0007
	(6.92)	(-1.35)	(-1.99)	(-1.25)	(-1.70)
Private sector employee	-0.0179	-0.0119	-0.0378	-0.0184	0.1049
	(-0.44)	(-0.47)	(-1.31)	(-1.01)	(2.55)
Elementary education	-0.0316	0.0153	0.0085	-0.0032	0.0148
	(-1.37)	(1.06)	(0.52)	(-0.32)	(0.64)
Lower secondary education	-0.0248	0.0162	0.0399	-0.0008	-0.0299
	(-0.58)	(0.60)	(1.31)	(-0.00)	(-0.69)
Upper secondary education	-0.0288	0.0201	0.0585	0.0039	-0.0680
	(-0.46)	(0.51)	(1.30)	(0.14)	(-1.07)
College	0.0025	0.0207	0.0638	0.0097	-0.1047
	(0.03)	(0.45)	(1.21)	(0.29)	(-1.40)
University	0.0199	0.0135	0.1510	0.0230	-0.2296
	(0.14)	(0.15)	(1.49)	(0.37)	(-1.60)
Employed	0.0345	0.0313	0.1104	0.0226	-0.2324
	(0.34)	(0.50)	(1.52)	(0.50)	(-2.25)
Unemployed	0.0117	0.0230	0.0307	0.0157	-0.0844
	(0.25)	(0.77)	(0.90)	(0.74)	(-1.75)
Housewife	0.0037	0.0269	-0.0087	0.0172	-0.0613
	(0.09)	(1.07)	(-0.31)	(0.97)	(-1.52)
Chronically ill/disable	-0.0155	0.0123	-0.0206	-0.0330	0.0522
	(-0.41)	(0.52)	(-0.76)	(-1.97)	(1.37)

Table A5: Likelihood ratio tests (Scaling; head's age)

Hypothesis	LR statistic and p-value
$\gamma_{MM}\xi_s = 0,\ s = 1, 2, 3$	22.84 (<0.0001)
$\gamma_{MM}\xi_1 = 0$	20.86 (<0.0001)
$\gamma_{MM}\xi_2 = 0$	22.19 (<0.0001)
$\gamma_{MM}\xi_3 = 0$	22.40 (<0.0001)

Note: the inference about $\gamma_{iM}\xi_s = 0,\ s = 1, 2, 3,\ i \neq M$ follows from the outcomes in the table as the model is estimated under the restriction $\gamma_{MM} = -5\gamma_{iM}$.

Table A6: Likelihood ratio tests (Scaling; household income)

Hypothesis	LR statistic and p-value
$\gamma_{MM}\xi_s = 0,\ s = 1, 2, 3$	9.68 (0.0215)
$\gamma_{MM}\xi_1 = 0$	8.59 (0.0034)
$\gamma_{MM}\xi_2 = 0$	5.29 (0.0215)
$\gamma_{MM}\xi_3 = 0$	2.27 (0.1313)

Note: the inference about $\gamma_{iM}\xi_s = 0,\ s = 1, 2, 3,\ i \neq M$ follows from the outcomes in the table as the model is estimated under the restriction $\gamma_{MM} = -5\gamma_{iM}$.