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DECOMPOSING THE PRICE EFFECTS ON THE COST OF LIVING FOR AUSTRALIAN HOUSEHOLDS

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ABSTRACT

In this paper the author demonstrates that the change in cost of living index (CLI) can be decomposed into the contribution that the price change in each good makes to the CLI. A CLI is constructed based upon a demographically scaled version of the Quadratic Almost Ideal demand system. The construction of a CLI in demographic rank-3 framework allows the index to vary across demographics and expenditure level. The parameters of the CLI are recovered by estimating the demand system based upon a pooled cross-section of the Household Expenditure Surveys (HES) and Consumer Price Index (CPI) series from the Australian Bureau of Statistics (ABS) over 1984 to 2003-04. The contribution of price changes in thirteen broad commodity aggregates from 1984 to 2003-04 on the CLI are examined. The variation of the impact is examined across levels of expenditure and the number of children in the household.

Keywords: Cost of Living Index, Price Decomposition, Demographic Demand System

JEL Classification: D1, D6, I3

I. INTRODUCTION

The Consumer Prices Index (CPI) series, constructed by most statistical agencies are weighted averages of retail prices, where the weights are based upon the spending behaviour of a reference household. While not designed to be a measure of purchasing power or the cost of living[1], the CPI is frequently used to adjust welfare payments for inflation, for a range of different households. If spending patterns differ across households then price movements will affect households differently, a single fixed weight index may not be appropriate for such purposes. Before the introduction of the GST, the Australian Treasury claimed that differences in spending patterns were not important and there was no need to account for them in any compensation packages (Treasury 1998a,b). This paper seeks to investigate this question with respect to demographics and total expenditure when attempting to maintain household utility and look at the compensation required for a hypothetical and actual price rises from 1984 to 2003-04.

The CPI constructed by the Australian Bureau of Statistics (ABS) is an important economic indicator, specifically designed as a general measure of price inflation for the household sector. It is constructed as a weighted-average of retail prices, with the weights being based upon the behaviour of the 'CPI population group' taken from the Household Expenditure Survey (HES). Prior to 14th series only those households that received at least three quarters of their income from wages or salaries, excluding the top ten percent in terms of income were included, reducing its usefulness in adjusting the welfare payments of non-working households. The current 15th series CPI population group consists of all metropolitan private households in the six state capitals, Darwin, and Canberra and covers approximately 64% of the population.

Differences in household size and composition, as well as varying expenditure budgets, are likely to result in differences in spending behaviour and in the impact of prices within this CPI population group. For many years prior to 2000, welfare groups requested the ABS to provide price indices for different population groups, that would better capture changes in their cost of living and be more useful in adjusting welfare and other payments.

Since the 2001 the ABS started to publish aggregate price indices for five different household types. These were named "Analytical Cost of Living Indices", but are not true cost of living indices as defined by economists, but rather fixed weight price indices, where the weights are the average budget shares for the specific household types. The price indices constructed were for the following household types: Employee, Age pensioner, Other government transfer recipient, Self-funded retiree and Other households (which includes self employed, income indeterminate and parent supported students). While an improvement the price indices are still rather generic and no allowance is made for differences in income or demographics. Furthermore, fixed weight indices, especially those based on Laspeyres theory (ABS 2000b) such as the CPI are subject to bias, in particular, substitution biases arising from using formulas and levels of aggregation that do not allow for substitution in response to changes in relative prices (Diewert 1996.

According to Boskin et al (1996), Laspeyres indices assume no consumer substitution in response to changes in relative prices. Laspeyres indices adhere to an upper bound, failing to reflect substitution away from a relatively more expensive good to a relatively cheaper good following a price increase. This is clearly unrealistic, and will tend to overstate the effect of price changes compared to a base period. Whilst both Diewert (1996) and Boskin et al (1996) suggested that a superlative index[2] could reduce substitution bias, Deaton (1998)

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[1] The Australian Bureau of Statistics (ABS) indicate that their CPI is not constructed as a cost of living index, ABS (1998, p6).

[2] A superlative index such as the 'trailing Tornqvist' or the Fisher Ideal Index has the desirable properties of being a close approximation to an exact cost of living index assuming homothetic preferences, that is, unit

argued that there is no concrete evidence that such an index would handle substitution bias any better than the Laspeyres index in current use

Whilst there is little argument between economists and statistical agencies that biases exist within CPI's, there is debate regarding the magnitude of the bias, and what can be done to rectify the situation. Boskin et al (1996 & 1998) recommended a movement away from a fixed price index to a cost of living index, allowing for product substitution. Furthermore they and Diewert (1998) recommended increased frequency and timing of fixed weight updates, faster introduction of new goods, and greater sampling of outlets to allow for outlet substitution. It should be noted that the Australian CPI is updated more frequently than its USA counterpart[3], and hence it would be expected, *ceteris paribus*, that any bias arising would be lower than that concluded by the Boskin Report (Boskin et al 1996).

Other recommendations include moving away from using arithmetic means in constructing the sub price indices of the CPI to using the geometric mean. Abraham, Greenlees & Moulton (1998) agreed with the recommendation, pointing out that the use of arithmetic means assumes no substitution between goods. However, geometric means are still not a perfect solution despite "yielding an exact measure of the change in cost of living under the assumption of unitary elasticity of substitution" among items within a category[4] (Abraham et al 1998, p. 29). Both Abraham et al (1998) and Diewert (1998) suggested that the geometric mean offer less bias, although according to Abraham et al (1998) it is only when prices of the different items within an item category diverge that the choice of aggregation formula is of practical significance, and that as scanner data becomes increasingly available, the CPI will reflect less bias using the geometric mean. The Australian CPI has used the

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income elasticities (Boskin et al 1998). This assumption means comparisons over long periods will result in income effects interfering with substitution effects if preferences are nonhomothetic. This can be ameliorated to some degree if nonhomothetic preferences can be represented as a translog function, as superlative indices will then approximate the CLI for an intermediate utility level.

[3] The Australian CPI has its weights reviewed at approximately five year intervals, with timing linked to the availability of Household Expenditure Survey (HES) data (ABS 2000(b)).

geometric mean in the construction of elementary price indices since the 14th series of the CPI (ABS 2000a).

What is clear from the literature surrounding fixed weight price indices, in particular CPI's, is that using the CPI as a welfare policy tool is far from parsimonious, and indeed appears to have many facets that could be improved. There has been pressure on statistical agencies to develop measurements of changes in the cost of living (Boskin et al 1996). Whilst a true cost of living index has been widely rejected, due to it being unobservable and impractical (Abraham et al 1998), the ABS has begun publishing price indices for specific population groups in an attempt to address these concerns. However, these indices suffer many, if not all, of the same problems as the fixed weight Laspeyres CPI.

Cost of living index (CLI) theory began in the 1920's with Konus (1939), who demonstrated clearly that Laspeyres price indices would overstate price increases since they ignore substitution effects. In fact, it is well known that a Laspeyres index is the upper bound of a cost of living index based on reference period tastes, evaluated at the reference period indifference curve (Pollak 1978). A true CLI overcomes this by using the ratio of the minimum expenditures required to attain a particular utility or indifference curve under two different price regimes. However, a true CLI is so difficult in practice to obtain as to make it nearly impossible to estimate (Konus 1939), thus any CLI estimation can only be carried out to produce a sub index of the true CLI. Parameters of the sub index can then be recovered through estimation of a complete system of demand equations (Deaton & Muellbauer 1980).

Cost of living indices (CLIs) are specified as the ratio of the household's utility maximised, cost or expenditure function, in two price regimes. A suitably specified CLI provides a theoretical and practical framework for considering substitution, demographic and

[4] Implying that a constant share of consumer expenditures is devoted to each item when relative prices change (Abraham et al 1998).

income effects of price changes[5]. The principal motivation of this study is to identify the variation in income effects of price movements via the CLI across households with different demographic and total expenditure profiles. To do so it constructs a cost of living index (CLI) based upon a demographically extended version of the Quadratic Almost Ideal Demand System (QAIDS) using an application of Ray's (1983) Price Scaling (PS). The construction of a CLI in a demographic rank-3 framework allows the index to vary across demographics and expenditure level[6]. The parameters of the CLI are recovered by estimating the demand system based upon a pooled cross-section of the Household Expenditure Surveys (HES) and Consumer Price Index (CPI) series from the ABS.

The impact of price movements upon welfare can be analysed by examining their effects on the CLI. For example, a price movement that results in a doubling of the CLI will reduce real welfare by half. This study analyses the impact of hypothetical price changes, in nine broad commodity aggregates, upon real welfare, through the elasticity of CLI with respect to price. The variation of the impact is examined across levels of equivalent expenditure and the number of children in households. The effect of price rises actually experienced by Australian households from 1975-76 to 1998-99 is examined by constructing the implied rates of inflation in the CLI for households with differing levels of equivalent expenditure and demographics. These hypothetical and actual effects of price movements are contrasted with the effects recorded in the CPI for each country.

The plan of this paper is as follows. Section 2.1 presents the standard approach to CLIs and how they can be used with models that include demographics. Section 2.2 demonstrates how CLIs can be decomposed into the contribution that price changes from each good. Section 2.3 specifies the demographically scaled version of QAIDS rank 3 demand

[5] Research into the substitution bias in CPI was ignited by the Boskin Report [Boskin et. al. (1996)], which examined measurement errors in the U.S. CPI.
[6] The 'rank' of demand system is measured by the number of unique price indices in the cost function.

system and section 2.4 develops the CLI and its decomposition for that model. Section 3 describes the data and the commodity, child and expenditure categories used to estimate and illustrate the CLI. Section 4 presents and discusses the results, before the paper concludes with Section 5.

II. THEORETICAL FRAMEWORK

i) Cost of Living Indices (CLI)

The theory of cost of living indices began in the 1920s with Konus (1939). For a thorough examination of CLIs, see Pollak (1989). A cost of living index (CLI), for a household *h* with a given set of preferences, is measured by the ratio of the cost of obtaining a fixed level of reference utility, $\bar{u}$ at current prices, $\mathbf{p}^1$ over the cost of obtaining that same level of utility at initial or base level prices, $\mathbf{p}^0$.

$$CLI_h\left(\mathbf{p}^1, \mathbf{p}^0, \bar{u}\right) = \frac{c_h\left(\bar{u}, \mathbf{p}^1\right)}{c_h\left(\bar{u}, \mathbf{p}^0\right)} \tag{1}$$

where $\mathbf{p}^1$ is a column vectors of n_g current prices for each good *i*

$\mathbf{p}^0$ is a column vectors of n_g initial prices for each good *i*

Such a definition assumes that consumer tastes imbedded in the cost function are constant across time.

CLI typically depend on the reference utility level at which the household cost function is evaluated. The exception is when preferences are homothetic to the origin and the implied demand functions are proportional to total expenditure, see Pollak (1989). Unless this unpalatable restriction is enforced, the cost of living will vary for groups with different levels of utility and expenditure from which it is assumed utility is derived. This allows for the different behaviour of households across total expenditure levels. Richer households are likely to spend a greater proportion of their expenditure on luxuries and less on necessities than poorer households are. If there has been a significant difference in the relative price movements of luxuries and necessities then the CLI will differ significantly between rich and poor households.

The CLI can also vary across demographic groups within the population, when preferences vary according to a household's demographics. Demographic differences in

preferences are captured as variations in the cost functions and associated budget shares across demographic groups. In this case the demographically adjusted CLI can be specified as the ratio of the cost of obtaining a fixed level of reference utility, $\bar{u}$ at current prices, $\mathbf{p}^1$ given a demographic profile **z**, over the cost of obtaining that same level of utility with demographic profile **z** at initial or base level prices, $\mathbf{p}^0$.

$$CLI\left(\mathbf{p}^1,\mathbf{p}^0,\mathbf{z},\bar{u}\right)=\frac{c\left(\mathbf{p}^1,\mathbf{z},\bar{u},\right)}{c\left(\mathbf{p}^0,\mathbf{z},\bar{u},\right)} \tag{2}$$

ii) Decomposition of CLI's

The contribution of the price change of each good to the change CLI can be found by finding the CLI's total differential while holding initial prices ($\mathbf{p}^0$), demographics (**z**), However it is more convenient to work with proportional or log changes in prices and the CLI as we can make use of the fact that first derivative of the log of the cost function with respect to log price gives the compensated budget share.

$$\begin{aligned} d\ln CLI\left(\mathbf{p}^1,\mathbf{p}^0,\mathbf{z},\bar{u}\right)\Big|_{d\mathbf{p}^0=0,\ d\bar{u}=0,\ d\mathbf{z}=0} &= \sum_{i=1}^{n_g}\frac{\partial \ln CLI}{\partial \ln p_i}d\ln p_i \\ &= \sum_{i=1}^{n_g}\left[\frac{\partial \ln c\left(\bar{u},\mathbf{p}^1\right)}{\partial \ln p_i^1}-\frac{\partial \ln c\left(\bar{u},\mathbf{p}^0\right)}{\partial \ln p_i^1}\right]d\ln p_i^1 \\ &= \sum_{i=1}^{n_g}\left[s_i\left(\bar{u},\mathbf{p}^1\right)\right]d\ln p_i^1 \end{aligned} \tag{3}$$

In which case, the change in CLI is equal to sum of the compensated budget share, $s_i\left(\bar{u},\mathbf{p}^1\right)$ multiplied by the change in the log of each price *i*, $d\ln p_i^1$. This allows the contribution of each price to the CLI to be identified.

However rather than the continuous proportionate change in the CLI, $d\ln CLI$, from a very small change in prices, we are more interested in the discrete change in the CLI, between two price vectors, $\mathbf{p}^2$ and $\mathbf{p}^1$ as given below.

$$\Delta\ln CLI=\ln CLI\left(\mathbf{p}^2,\mathbf{p}^0,\mathbf{z},\bar{u}\right)-\ln CLI\left(\mathbf{p}^1,\mathbf{p}^0,\mathbf{z},\bar{u}\right) \tag{4}$$

Equation (3) can be considered the first order approximation to (4). Taylor series expansion of the CLI can be used to obtain second order approximations (and beyond) to the discrete log change in the CLI (see appendix for details) so that $\Delta \ln CLI$ can be written

$$\Delta \ln CLI = \sum_{i=1}^{n_g} \frac{\partial \ln CLI}{\partial \ln p_i} \Delta \ln p_i + \tfrac{1}{2} \sum_{i=1}^{n_g} \sum_{j=1}^{n_g} \frac{\partial \ln CLI}{\partial \ln p_i \partial \ln p_j} \Delta \ln p_i \Delta \ln p_j \tag{5}$$

Making use of the fact that first derivative of the compensated budget share with respect to log price is equal to the compensated budget share multiplied by the compensated cross price elasticity $e_{ij}(\mathbf{p}, \mathbf{z}, u)$ (or the own price elasticity plus one for $i = j$).

$$\Delta \ln CLI = \sum_{i=1}^{n_g} s_i\left(\mathbf{p}^1, \mathbf{z}, \overline{u}\right) \Delta \ln p_i + \tfrac{1}{2} \sum_{i=1}^{n_g} \sum_{j=1}^{n_g} s_i\left(\mathbf{p}^1, \mathbf{z}, \overline{u}\right)\left(e_{ij}\left(\mathbf{p}^1, \mathbf{z}, \overline{u}\right) + \delta\right) \Delta \ln p_i \Delta \ln p_j \tag{6}$$

where δ is the Kronecker-Delta, $\delta = 1$ if $i = j$, $\delta = 0$ if $i \neq j$

iii) A Demographic Rank3 Demand System: PS-QAIDS

The consumer preferences specified in this study for the estimation of cost of living indices, is based upon the QAIDS of Banks, Blundell and Lewbel (1997). The QAIDS is a nonlinear rank-3 model, which allows for Engel curves that are quadratic in log of household expenditure and thus allows goods to change from necessities to luxuries across the expenditure distribution. For the reference household the QAIDS cost function is given in non-demographic form by,

$$x_R = c_R(u, \mathbf{p}) = \exp\left[a(\mathbf{p}) + \frac{b(\mathbf{p})u}{1 - l(\mathbf{p})u} \right] \tag{7}$$

where u is utility, $\mathbf{p}$ denotes the price vector $\mathbf{p} = \left[p_1, ..., p_i, ..., p_{n_g} \right]$ of the n_g goods and

$$a(\mathbf{p}) = \alpha_0 + \sum_i \alpha_i \log p_i + \tfrac{1}{2} \sum_i \sum_j \gamma_{ij} \log p_i \log p_j \tag{8}$$

$$b(\mathbf{p}) = \prod_i p_i^{\beta_i} \tag{9}$$

$$l(\mathbf{p}) = \prod_i p_i^{\lambda_i} \tag{10}$$

the aggregation and homogeneity conditions all require that $\sum_k \alpha_k = 1$, $\sum_k \beta_k = \sum_k \lambda_k = 0$ and $\sum_k \gamma_{ik} = 0$, and symmetry requires that $\gamma_{ij} = \gamma_{ji}$ for all i, j. α_0 is the log of expenditure at the base level prices required for some minimum level of welfare. To provide a positive real expenditure measure for all households α_0 is specified as $\alpha_0 = 0$ [7].

The QAIDS model is demographically extended by an application of Ray's (1983) Price Scaling (PS) technique to provide the PS-QAIDS model. Price scaling involves multiplying the non-demographic cost function of the reference household, $c_R(u, \mathbf{p})$, given by (7), by an equivalence scale, $m(\mathbf{p}, \mathbf{z})$, dependent on prices and household characteristics.

$$c_h(u, \mathbf{p}, \mathbf{z}) = c_R(u, \mathbf{p}) m_h(\mathbf{p}, \mathbf{z}) \tag{11}$$

The majority of household equivalence scales are based on household size and composition of its members. This study follows that tradition specifying the demographic vector as $\mathbf{z} = [n_a \;\; n_{k1} \;\; n_{k2} \;\; n_{k3}]$ containing n_a, n_{k1}, n_{k2}, n_{k3}, n_k, which denote, respectively, the number of adults, infants, children, older dependants and total dependants living in the household. See Table A1 in the appendix, for definitions of infants, children and older dependants constructed from the HES data and used in estimation.

The specification of the equivalence scale $m(\mathbf{p}, \mathbf{z})$ [8] chosen in this study is

$$m_h(\mathbf{p}, \mathbf{z}) = \left(n_a + \kappa_1 n_{k1} + \kappa_2 n_{k2} + \kappa_3 n_{k3}\right)^{(1-\theta)} \prod_{g=1}^{n_g} p_g^{\nu_g n_k} \tag{12}$$

where the κ's represent the constant utility cost of infants, children and older dependants, as

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[7] In reference price regime $a(\mathbf{p}) = \alpha_0$ and if real expenditure is to be positive then $\alpha_0 < \ln(x_{MIN})$. Many households from the HES and FES report very low or negative expenditure. While such observations are frequently removed, in this case they have been included and given a value of \$1, allowing them to be included in the estimation. This imposes an upper bound of zero on α_0 and is specified as zero in line with previous studies, for example Lancaster and Ray (1996).

[8] Note that the *h* subscripts denoting each household, have been omitted from the vectors ***p, z*** and their elements for notational convenience.

a proportion of an adult and θ reflects the economies of scale in household size, $\theta = 0$ indicating that there are no economies of scale in household expenditure. If all household expenditure is on household public goods that can be simultaneously enjoyed by all household members, then $\theta = 1$ and the scale gives unscaled 'per household' measures of welfare. The ν_g are the price elasticities of the equivalence scale with $\sum_g \nu_g = 0$.

The equivalence scale (12) used in this study, can be considered the product of a two terms. The first term $\left(n_a + \kappa_1 n_{k1} + \kappa_2 n_{k2} + \kappa_3 n_{k3}\right)^{(1-\theta)}$ captures the effect of household size and composition in scaling total household expenditure or the "general demographic effect". It incorporates the relative "cost" of children of different ages and the economies of scale enjoyed by large households. This is similar to Banks and Johnson's (1994) specification, but with differing costs allowed for different aged dependants and the θ is specified as one minus the elasticity of household expenditure with respect to an adult. It is specified to have a base of a single adult living alone in the base price period such that the scale measures the number of adult 'equivalent persons' living alone.

The second term $\prod_{g=1}^{n_g} p_g^{\nu_g n_k}$ captures the effect that household composition has in altering the relative demand for goods or the "relative demographic effect". It captures the interaction effect between household composition and prices. Most of the composition effects of the relative cost of adults and different aged dependants has been captured in their size effects from the "general demographic effect" on demand. Thus, the remaining relative effect from the size of the household (including the relative cost of children) is small and can not always be captured well. In light of this, the relative effect is based purely upon the total number of dependants in the household. An application of Shephard's Lemma shows that the ν_g have the effect of shifting the budget share demands for good *g* by ν_g for every dependent present. Note that in the reference period when all prices are unity there is no "relative demographic

effect" and prices do not affect the household equivalence scale.

Minimising the household's cost function subject to reaching a certain level of utility, allows the PS-QAIDS budget shares for the $i = 1$ to n_g goods to be written,

$$s_i = \eta_i n_k + \alpha_i + \sum_g \gamma_{ig} \log p_g + \beta_i \log \tilde{x} + \lambda_i \prod_g p_g^{\lambda_g - \beta_g} \log \tilde{x}^2 \tag{13}$$

where

$$\log \tilde{x} = \log x - a(\mathbf{p}) - \log\left(n_a + \kappa_1 n_{k1} + \kappa_2 n_{k2} + \kappa_3 n_{k3}\right)^{(1-\theta)} - n_k \sum v_g \log p_g \tag{14}$$

iv) The PS-QAIDS Cost of Living Index

Using the definition of a CLI in (2) and the PS-QAIDS model specified in this paper in (7) - (10), (11) and (12) is given by

$$CLI\left(\mathbf{p}^1, \mathbf{p}^0, \mathbf{z}, \bar{u}\right) = \exp\left[a(\mathbf{p}^1) - a(\mathbf{p}^0) + \frac{b(\mathbf{p}^1)\bar{u}}{1 - l(\mathbf{p}^1)\bar{u}} - \frac{b(\mathbf{p}^0)\bar{u}}{1 - l(\mathbf{p}^0)\bar{u}} \right] \times \prod_{g=1}^{n_g} \left(\frac{p_g^1}{p_g^0} \right)^{v_g n_k} \tag{15}$$

and varies across levels of utility and the demographic profile of the household. The reference level of utility $\bar{u}$ can be obtained as a function of prices, demographics and expenditure by using the PS-QAIDS indirect utility function.

$$\bar{u} = v\left(\bar{\tilde{x}}, \bar{\boldsymbol{p}}\right) = \frac{\log \bar{\tilde{x}}}{b\left(\bar{\boldsymbol{p}}\right) + \lambda\left(\bar{\boldsymbol{p}}\right) \log \bar{\tilde{x}}} \tag{16}$$

where $\tilde{x}_0$ is the household's real adult equivalent expenditure in the reference period as specified in (14). The CLI in (15) can be simplified by specifying in log form and normalising initial prices to unity so that $a(\mathbf{p}^0) = 0$, $b(\mathbf{p}^0) = 1$ and $l(\mathbf{p}^0) = 1$, and that the log of the CLI is

$$\ln CLI = a(\mathbf{p}^1) + \frac{b(\mathbf{p}^1)\bar{u}}{1 - l(\mathbf{p}^1)\bar{u}} - \frac{\bar{u}}{1 - \bar{u}} + n_k \sum_g \delta_g \log p_g^1 \tag{17}$$

The compensated budget shares used in the decomposition of the change in the log of the CLI for the PS-QAIDS model specified in this paper are

$$s_i\left(\mathbf{p}^1,\mathbf{z},u\right)=\alpha_i+\sum\gamma_{ij}\ln p_j+\frac{\beta_i b(\mathbf{p}^1)\overline{u}}{1-l(\mathbf{p}^1)\overline{u}}+\frac{\lambda_i l(\mathbf{p}^1)b(\mathbf{p}^1)\overline{u}^2}{\left[1-l(\mathbf{p}^1)\overline{u}\right]^2}+\delta_i n_k \tag{18}$$

III. DATA, ESTIMATION AND METHODOLOGY

The data used to estimate the PS-QAIDS for Australia is based on a pooled cross-section of the 1984, 1988-89, 1993-94, 1998-99 and 2003-04 Household Expenditure Survey (HES) to provide 29,463 observations on household expenditure and demographic data. This data was combined with broad level price indices by state/territory, derived from the ABS's quarterly CPI series[9]. The price indices were scaled to be unity in the reference period 1988-89 for each state/territory's expenditure category. 1988-89 was chosen as the reference period because the state/territory of residence was not released for the 1988-89 HES. The variation in prices across the data set allows the cross-price elasticity effects to be estimated and the demographic-price interaction effects to be examined.

To aid in the estimation of demand systems goods need to be aggregated into broad expenditure categories. In this study total household expenditure has been divided amongst thirteen HES broad expenditure categories of 1) Current housing costs, 2) Domestic fuel and power, 3) Food and non-alcoholic beverages, 4) Alcoholic beverages, 5) Tobacco products, 6) Clothing and footwear, 7) Household furnishings and equipment, 8) Household services and operation, 9) Medical care and health expenses, 10) Transport, 11) Recreation, 12) Personal care, and 13) Miscellaneous goods and services. It has implicitly been assumed that within each broad commodity group, spending behaviour is the same for households with given total expenditure and household demographics.

Obviously, this broad level of commodity aggregation limits the degree of substitution that the CLI can record. The amount of substitution between goods that can be captured in a CLI is limited by the growth in the parameters required to estimate a demand system at a detailed commodity level. For example this 13 good demographic rank 3 demand system has 225 parameters, of which 130 must be estimated. This makes it difficult to allow for any

detailed disaggregation in the CLI. More product substitution is likely to occur within goods of a similar nature, such as between different types of food than between broad commodity groups such as food and recreation. Thus the estimation of a CLI from broad commodity groups, as in this study, will only pick up the smaller broad-level product substitution effects. If the fine-level substitution effects have been adequately captured by the ABS when constructing their more detailed price indices, which form the broader price indices, then there is no need to attempt to capture them in the model. For this reason the substitution effects of price rises are not the focus of this paper and if the omitted substitution effects are relatively constant across households and over time, then results of this study will not be seriously affected.

The system of equations is estimated by Full Information Maximum Likelihood (FIML) estimation using the SAS 9.1 system for windows[10]. While the residuals are non-normally distributed the Seemingly Unrelated Regressions (SUR) estimates are almost identical to the FIML results. No observations were removed and each household measure was weighted by its survey weigh. The estimated PS-QAIDS parameters are presented in the Appendix A2 in Tables A2.1 and A2.2. Engel Curves for the 13 goods are provided in Appendix A2 in Figures A2.1 and A2.2.

This paper examines variation of the price elasticity of the CLI and hence measures of welfare when deflated by it using five levels of base period expenditure, from the 2003-04 HES. The five expenditure classes are defined in terms of the mean and standard deviation of the logarithm of the real equivalent expenditure per week in Table 1. Since the distribution of expenditure is skewed and approximately log-normal, the categories may be interpreted as their percentiles from the normal distribution.

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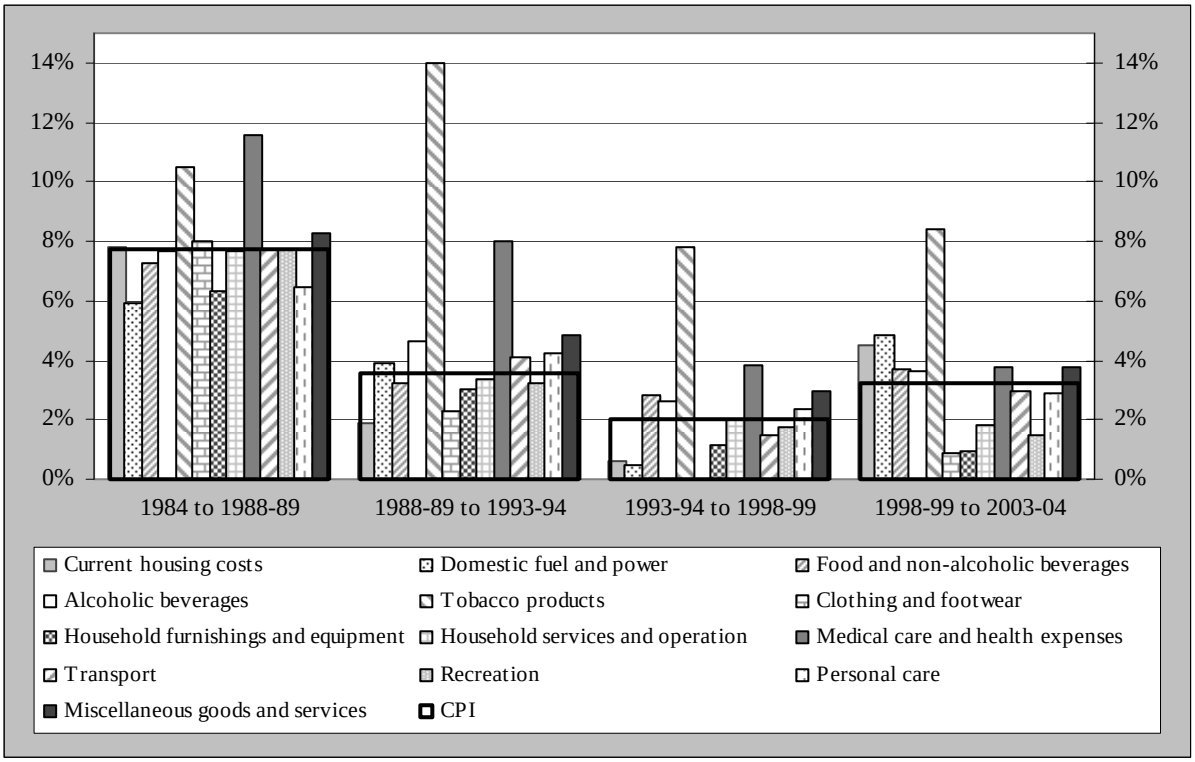
[9] In some instances, particularly for the early HES, price indices that are more detailed were used to so align the HES broad expenditure categories to the ABS price categories.

Table 3.2 Demographic Classes

Adults	Children aged 5-14 years	PS-QAIDS (1989-99) Equivalence Scale	PS-QAIDS (2003-04) Equivalence Scale	Real (1989-99) Weekly Expenditure	Nominal (2003-04) Weekly Expenditure
1	0	1.000	1.000	$320.30	$478.69
1	1	1.352	1.350	$433.16	$646.01
1	2	1.635	1.628	$523.71	$779.44
1	3	1.879	1.867	$601.69	$893.65
2	0	1.435	1.435	$459.50	$686.73
2	1	1.705	1.701	$546.01	$814.33
2	2	1.940	1.932	$621.41	$924.85
2	3	2.152	2.138	$689.18	$1,023.59
2	4	2.346	2.326	$751.31	$1,113.55

Note: The equivalence scales provide the ratio and $weekly expenditure required by each demographic class to reach the same utility level as a single adult household with a nominal weekly spend of $478.69 in 2003-04.

Chart 3.1 Annualised Rates of Inflation of the 13 HES Goods 1984 to 2003-04



Note: Compiled from ABS Broad and Detailed Consumer Price Indices in ABS6401.09 Consumer Price Index, Australia.

IV. RESULTS

Table 4.1 on the following page provide the estimates of the PS-QAIDS Cost of Living Index (CLI) for households with different levels of total expenditure and also the ABS's Consumer Price Index (CPI) for reference. The upper half of the table provides the indices , while the lower half provides the annualised rates of inflation, based on the change in the index between the HES.

Table 4.1 CLI for Different Expenditure Groups

Income Class:	Very Low	Low	Average	High	Very High	CPI
Nominal Equivalent Weekly Expenditure: 2003-04	$144.01	$262.56	$478.69	$872.74	$1,591.17	
CLI						
1984	0.716	0.715	0.715	0.716	0.718	0.715
1988-89	1.000	1.000	1.000	1.000	1.000	1.000
1993-94	1.200	1.202	1.202	1.200	1.195	1.192
1998-99	1.329	1.331	1.328	1.320	1.306	1.315
2003-04	1.575	1.562	1.544	1.520	1.492	1.544
Annualised Rates of Inflation in the CLI						
1984 to 1988-89	7.71%	7.74%	7.75%	7.72%	7.66%	7.75%
1988-89 to 1993-94	3.71%	3.75%	3.75%	3.71%	3.63%	3.57%
1993-94 to 1998-99	2.06%	2.06%	2.01%	1.92%	1.79%	1.99%
1998-99 to 2003-04	3.46%	3.25%	3.05%	2.87%	2.69%	3.26%
1984 to 2003-04	**4.13%**	**4.09%**	**4.03%**	**3.94%**	**3.83%**	**4.03%**

The table shows that change in prices from 1984 to 2003-04 has had a greater impact on poorer households, but only by a small margin. The difference is quite small, with the annualised rate of CLI inflation for the poorest households being only 0.5% higher than for the richest households. In fact the change in the CLI for households with average levels of log expenditure align very closely with the CPI. It may appear inconsistent that the CLI which allows for substitution between goods is larger for the CPI from 1988-89 to 1993-94 (and to a lesser extent 1993-94 to 1998-99). However this period saw households substitute towards goods who's price was rising, suggesting that there was change in preferences over

the period.

The lack of variation may appear somewhat surprising, particularly from 1988-89 onwards when the prices of the 13 HES goods did not rise in unison. Since 1988-89 there have been large relative increases in the price of Tobacco products, Medical care and health expenses and Miscellaneous goods and services. The price of Food and non-alcoholic beverages has risen sharply since 1993-94 as has the price of Domestic fuel and power since 1998-99. On the other hand there the price of Clothing and footwear, Household furnishings and equipment, Household services and operation and Recreation has risen very slowly since 1993-94.

Engel Curves from the PS-QAIDS estimates in the figures 4.1 and 4.2 below illustrate that of those goods with prices rises larger than the CPI, are a mix of luxuries (Miscellaneous goods and service) and necessities (Tobacco products, Medical care and health expenses). The HES goods for which prices have risen slower than the CPI are also a mix of expenditure neutral (Clothing and footwear and Household furnishings and equipment), a necessity (Household services and operation) and a luxury (Recreation). So in general the price rises have been felt equally by low and high expenditure households as there has been a mix of both luxuries and necessities who prices have risen faster and slower than the CPI.

The more resent increases in the price of Food and non-alcoholic beverages and Domestic fuel and power, both necessities with declining Engel Curves, is the primary reason for the divergence in inflation rates between low and high expenditure households from 1998-99 to 2003-04.

Figure 4.1: Engel Curves from PS-QAIDS Estimates (Goods 1 to 7)

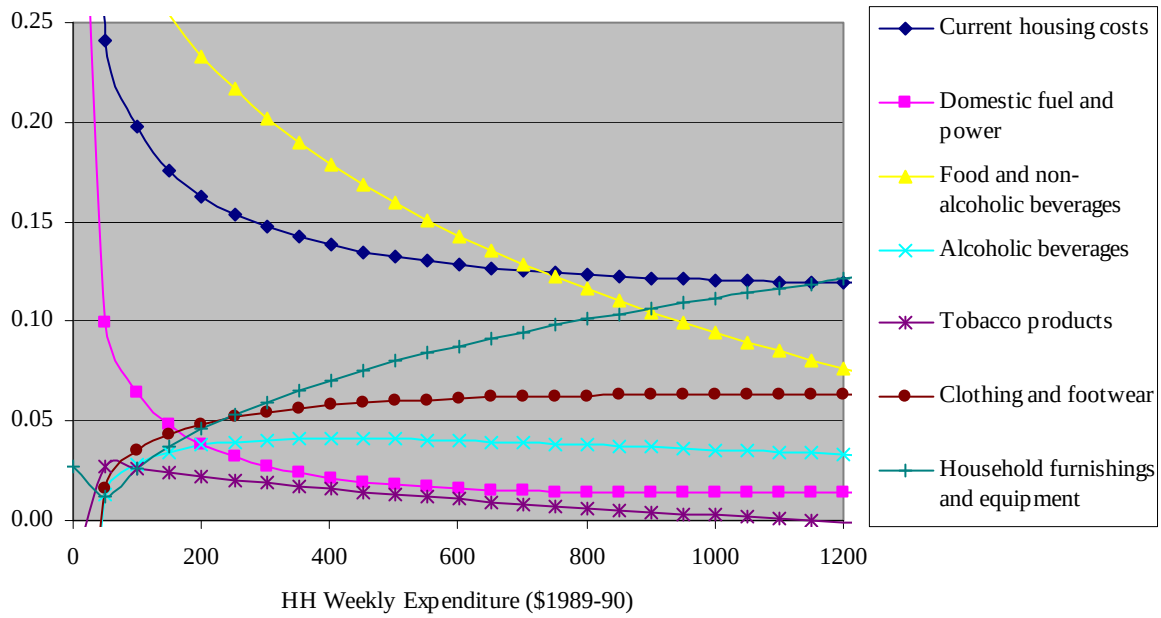


Figure 4.2: Engel Curves from PS-QAIDS Estimates (Goods 8 to 13)

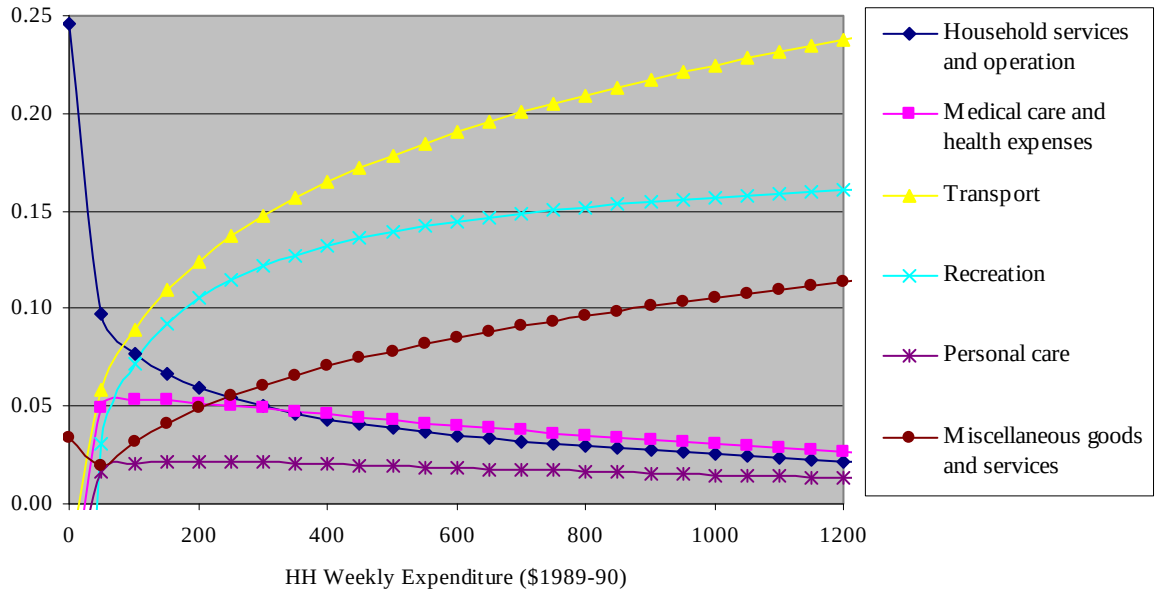


Table 4.2 on the following page provides the estimates of the PS-QAIDS CLI for households with different numbers of adults and children, for household with average log expenditure (adjusted for family size). The change in prices over this period has had very similar effect across households with these varying demographic compositions. The rise in the CLI of households with children is very slightly less than for those without. This is most

noticeable from 1988-89 to 1993-94, when the difference in the annualised rate of CLI inflation was 0.12% higher for those households without children. Thus the prices of HES goods more intensively purchased by households with children have not risen as fast as those HES goods more intensively purchased by childless households.

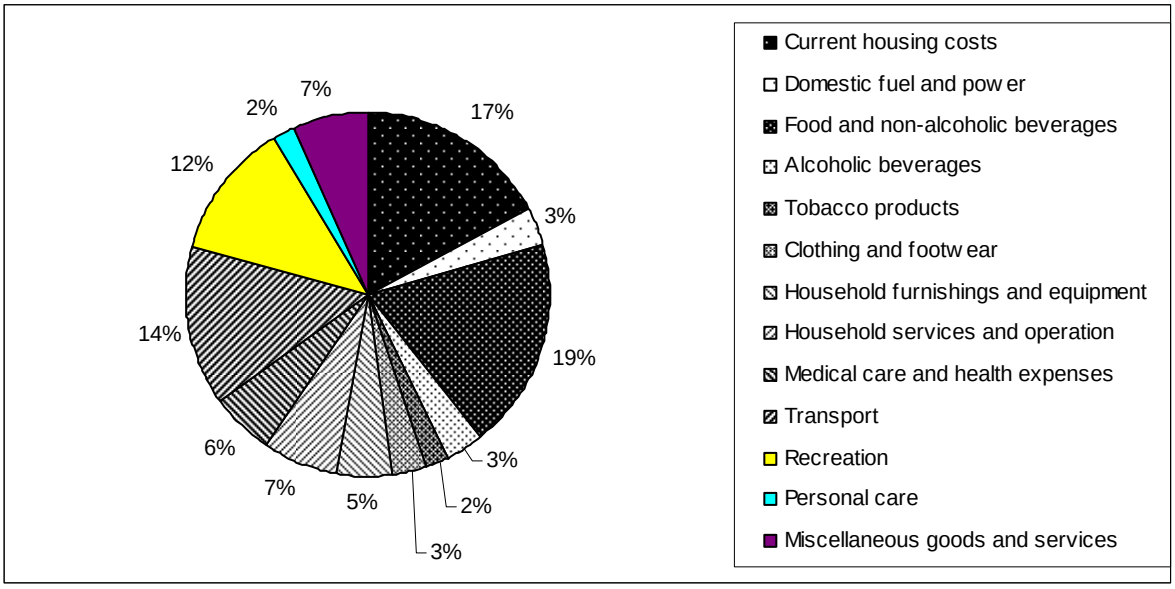
Table 4.2 CLI for Different Demographic Groups

Adults:	**1**	**1**	**1**	**1**	**2**	**2**	**2**	**2**	**2**
Children:	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**4**
					CLI				
1984	0.715	0.715	0.716	0.716	0.715	0.715	0.716	0.716	0.716
1988-89	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1993-94	1.202	1.201	1.199	1.197	1.202	1.201	1.199	1.197	1.195
1998-99	1.328	1.326	1.323	1.321	1.328	1.326	1.323	1.321	1.318
2003-04	1.544	1.540	1.537	1.534	1.544	1.540	1.537	1.534	1.531
					Annualised Rates of Inflation in the CLI				
1984 to 1988-89	7.75%	7.73%	7.72%	7.71%	7.75%	7.73%	7.72%	7.71%	7.70%
1988-89 to 1993-94	3.75%	3.72%	3.69%	3.66%	3.75%	3.72%	3.69%	3.66%	3.63%
1993-94 to 1998-99	2.01%	2.00%	1.99%	1.98%	2.01%	2.00%	1.99%	1.98%	1.98%
1998-99 to 2003-04	3.05%	3.05%	3.05%	3.04%	3.05%	3.05%	3.05%	3.04%	3.04%
1984 to 2003-04	**4.03%**	**4.01%**	**4.00%**	**3.99%**	**4.03%**	**4.01%**	**4.00%**	**3.99%**	**3.97%**

Table 4.3 Contribution to the ΔCLI for each HES good for Average Log Equivalent Expenditure

	Broad HES Commodity	1984 to 1988-89	1988-89 to 1993-94	1993-94 to 1998-99	1998-99 to 2003-04	**1984 to 2003-04**
1	Current housing costs	15%	8%	5%	24%	**14%**
2	Domestic fuel and power	2%	3%	1%	5%	**3%**
3	Food and non-alcoholic beverages	18%	16%	28%	21%	**20%**
4	Alcoholic beverages	4%	4%	5%	4%	**4%**
5	Tobacco products	2%	7%	7%	5%	**5%**
6	Clothing and footwear	6%	3%	0%	1%	**3%**
7	Household furnishings and equipment	5%	5%	3%	1%	**4%**
8	Household services and operation	5%	5%	6%	4%	**5%**
9	Medical care and health expenses	7%	11%	10%	7%	**8%**
10	Transport	15%	16%	11%	13%	**14%**
11	Recreation	12%	11%	12%	6%	**11%**
12	Personal care	2%	2%	3%	2%	**2%**
13	Miscellaneous goods and services	7%	8%	10%	8%	**8%**
	All Goods – Higher Order Effects	0%	0%	3%	-5%	-1%

Figure 4-4 Budget Share for Log Average Equivalent Expenditure 2003-04



V. CONCLUSIONS

The change in prices from 1984 to 2003-04 has had a greater impact on poorer households, however the difference is quite small, with the annualised rate of CLI inflation for the poorest households being 0.5% higher than for the richest households. The change in prices over this period has had very similar effect across households with varying demographic compositions. The annualised rate of CLI inflation for single adult households was only 0.06% higher than two adult, four children households.

Rises in the price of Food and non-alcoholic beverages accounts for one fifth of the change in the rise in the CLI from 1984 to 2003-04. While housing costs and transports account for just under 30% of the CLI's rise. The price of Recreation was contributing almost 12% prior to 1998-99, but declines in its price have seen the effect of this item half. Other notable contributors to the rise in the cost of living are Health (8%) and Miscellaneous (8%), which includes education and credit charges.

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APPENDIX

Appendix A1 – Demographic and Expenditure Classes

Table A.1 contains the child/dependent age categories constructed from the HES data which is used in the specification and estimation of the demographically scaled QAIDS.

Table A.1 Child/Dependent Categories

Child/Dependent Categories		
Infants	n_{k1}	children under 5 years
Children	n_{k2}	children 5 to 14 years
Older Dependants (Students)	n_{k3}	dependants 15 to 24 years
Total Dependants	$n_k = n_{k1} + n_{k2} + n_{k3}$	dependants aged under 25 years

Table A.2 Expenditure Classes

Expenditure Class	Definition	Percentile if $\log \tilde{x} \sim N$	Real (1989-99) Equivalent Weekly Expenditure	Nominal Equivalent Weekly Expenditure 2003-04
Very Low	$mean(\log \tilde{x}) - 2std.dev(\log \tilde{x})$	2.5%	$96.41	$144.01
Low	$mean(\log \tilde{x}) - 1std.dev(\log \tilde{x})$	16%	$175.77	$262.56
Average	$mean(\log \tilde{x})$	50%	$320.46	$478.69
High	$mean(\log \tilde{x}) + 1std.dev(\log \tilde{x})$	84%	$584.26	$872.74
Very High	$mean(\log \tilde{x}) + 2std.dev(\log \tilde{x})$	97.5%	$1,065.22	$1,591.17

Source: Australia: 2003-04 HES

Note: Prices have risen by approximately XX% for Australia from 2003-04 to 2009. Thus the mean of log Australian equivalent expenditure in 2003-04 in nominal 2003-04 Australian dollars is approximately $XXX per week.

Appendix A2 – PS-QAIDS Demand System Estimates

Table A2.1 PS-QAIDS Demand System Estimates (of Budget Shares)

Good Number	Intercepts α	Slopes β	Curvatures λ	Demographics δ
1	0.6819 **	-0.1527	0.0103	-0.0006
2	0.4819 **	-0.1363 **	0.0099 **	-0.0008 **
3	0.4012 **	0.0103	-0.0079 **	0.0060 **
4	-0.1971 **	0.0794 **	-0.0066 **	-0.0053 **
5	-0.0256 **	0.0255 **	-0.0031 **	-0.0013 **
6	-0.1748 **	0.0674 **	-0.0048 **	0.0039 **
7	0.0272	-0.0254 **	0.0055 **	-0.0011 *
8	0.2460 **	-0.0458 **	0.0020 **	0.0003
9	-0.0607 **	0.0476 **	-0.0050 **	-0.0041 **
10	-0.0274	0.0026	0.0049 **	-0.0011
11	-0.3330 **	0.1212 **	-0.0073 **	-0.0040 **
12	-0.0533 **	0.0282 **	-0.0027 **	-0.0011 **
13	0.0337	-0.0220 **	0.0047 **	0.0091 **

Notes: ** denotes estimates are significant at the 1% level, * denotes estimates are significant at the 5% level

Table A2.2 PS-QAIDS Demand System Estimates (of Budget Shares) *continued….*

	Cross-Price Parameters												
$\gamma_{i\,j}$	1	2	3	4	5	6	7	8	9	10	11	12	13
1	-0.0013	-0.0899**	-0.0493**	0.065**	0.0252**	0.0187*	-0.0409**	-0.0298**	0.0296**	0.0134	0.0356**	0.0155**	0.0081
2		0.0057**	0.0125**	0.0284**	0.0169**	0.0299**	-0.0002	-0.0382**	0.0341**	-0.0190**	0.0617**	0.0078**	-0.0495**
3			0.0805**	0.0101	-0.0178**	-0.0106	0.0013	0.0279*	-0.0239**	0.0154	-0.0083	-0.0127*	-0.0252
4				-0.0188	-0.0068*	0.0223*	-0.0098	0.0089	-0.0004	-0.0642**	-0.0297*	0.016**	-0.0210
5					-0.0001	-0.0202**	0.0090**	0.0077*	-0.0001	0.0039	0.0020	-0.0069**	-0.0128*
6						-0.0095	0.0311**	-0.0404**	-0.0119*	0.0051	0.0265	-0.0327**	-0.0082
7							0.0200*	-0.0258**	-0.0233**	0.0125	0.0111	0.0146**	0.0003
8								-0.0789	0.0115**	0.0419*	0.1243*	0.0130	-0.0218
9									-0.0094*	-0.0060	-0.0105	-0.0020	0.0122
10										-0.0341	-0.0132	0.0140	0.0291
11											-0.1698**	-0.0033	-0.0299
12												-0.0169**	-0.0064
13													0.1252

Notes: ** denotes estimates are significant at the 1% level, * denotes estimates are significant at the 5% level

Figure A2.1: Engel Curves from PS-QAIDS Estimates (Goods 1 to 7)

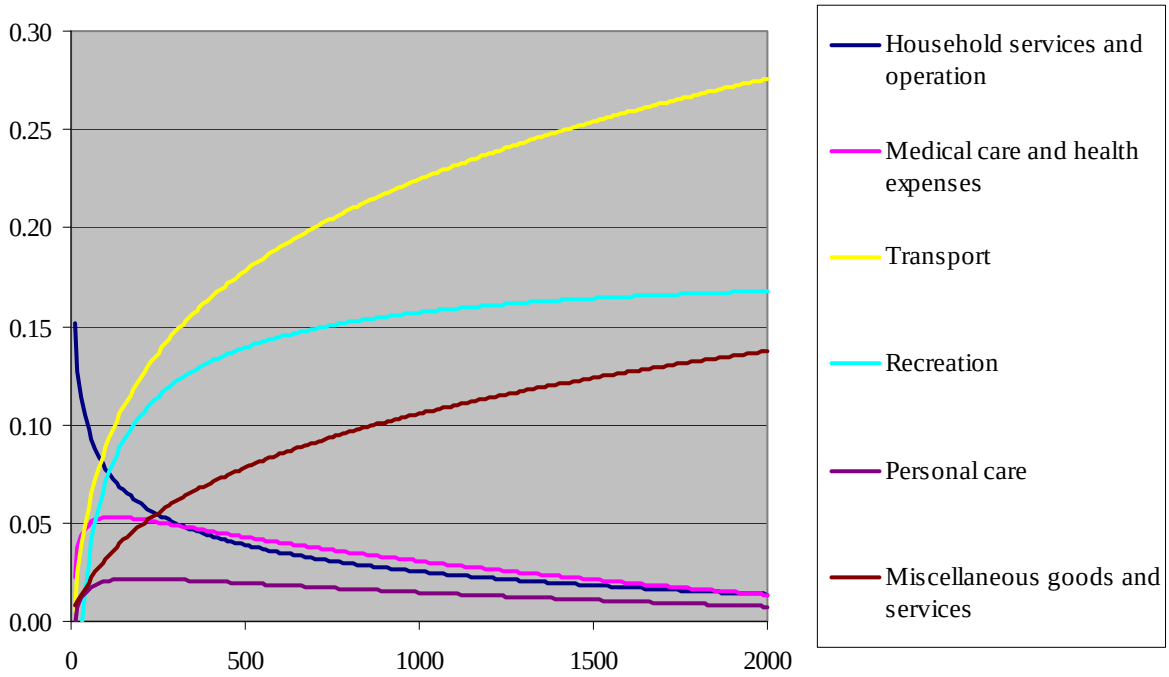
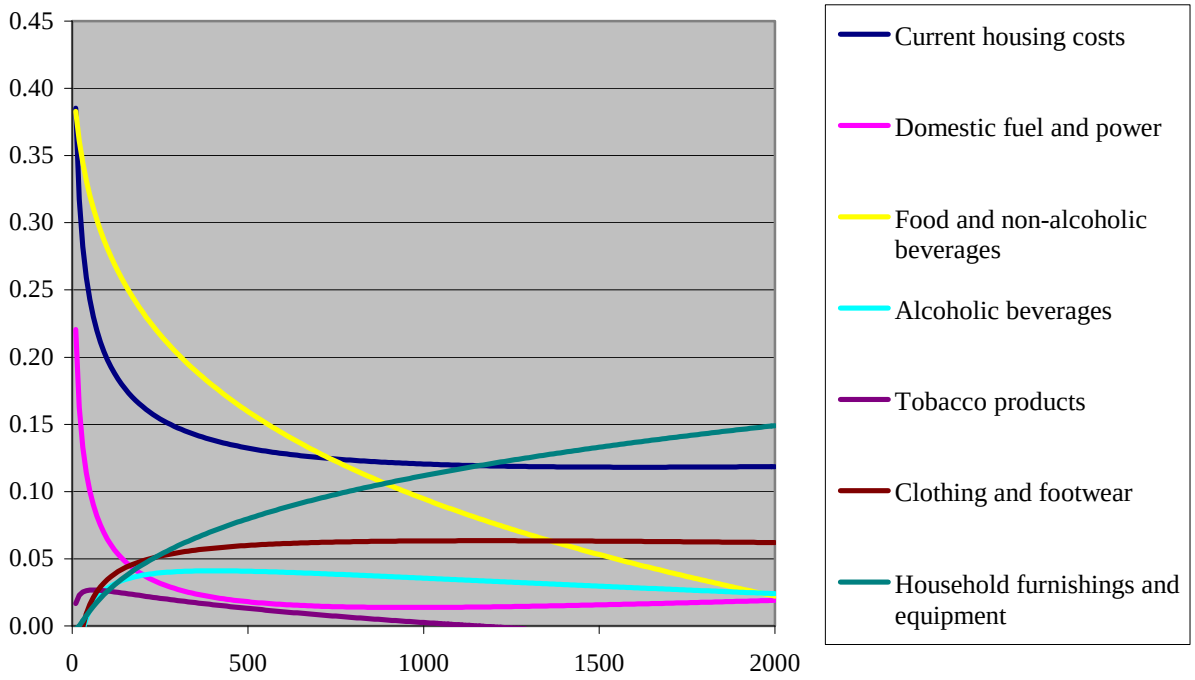


Figure A2.2: Engel Curves from PS-QAIDS Estimates (Goods 8 to 13)



Appendix A.3 - Taylor Series Expansion of the CLI

$$CLI\left(\mathbf{p}^0,u\right) \approx CLI\left(\mathbf{p},u\right)\Big|_{\mathbf{p}=\mathbf{p}^1} + \left(\mathbf{p}^0-\mathbf{p}^1\right)CLI'\left(\mathbf{p},u\right)\Big|_{\mathbf{p}=\mathbf{p}^1} + \tfrac{1}{2}\left(\mathbf{p}^0-\mathbf{p}^1\right)^T CLI''\left(\mathbf{p},u\right)\Big|_{\mathbf{p}=\mathbf{p}^1}\left(\mathbf{p}^0-\mathbf{p}^1\right)$$

$$CLI\left(\mathbf{p}^0,u\right) \approx CLI\left(\mathbf{p}^1,u\right) - \left(\mathbf{p}^1-\mathbf{p}^0\right)CLI'\left(\mathbf{p},u\right)\Big|_{\mathbf{p}=\mathbf{p}^1} + \tfrac{1}{2}\left(\mathbf{p}^1-\mathbf{p}^0\right)^T CLI''\left(\mathbf{p},u\right)\Big|_{\mathbf{p}=\mathbf{p}^1}\left(\mathbf{p}^1-\mathbf{p}^0\right)$$

$$CLI\left(\mathbf{p}^1,u\right) - CLI\left(\mathbf{p}^0,u\right) \approx \Delta\mathbf{p}CLI'\left(\mathbf{p},u\right)\Big|_{\mathbf{p}=\mathbf{p}^1} - \tfrac{1}{2}\Delta\mathbf{p}^T CLI''\left(\mathbf{p},u\right)\Big|_{\mathbf{p}=\mathbf{p}^1}\Delta\mathbf{p}$$

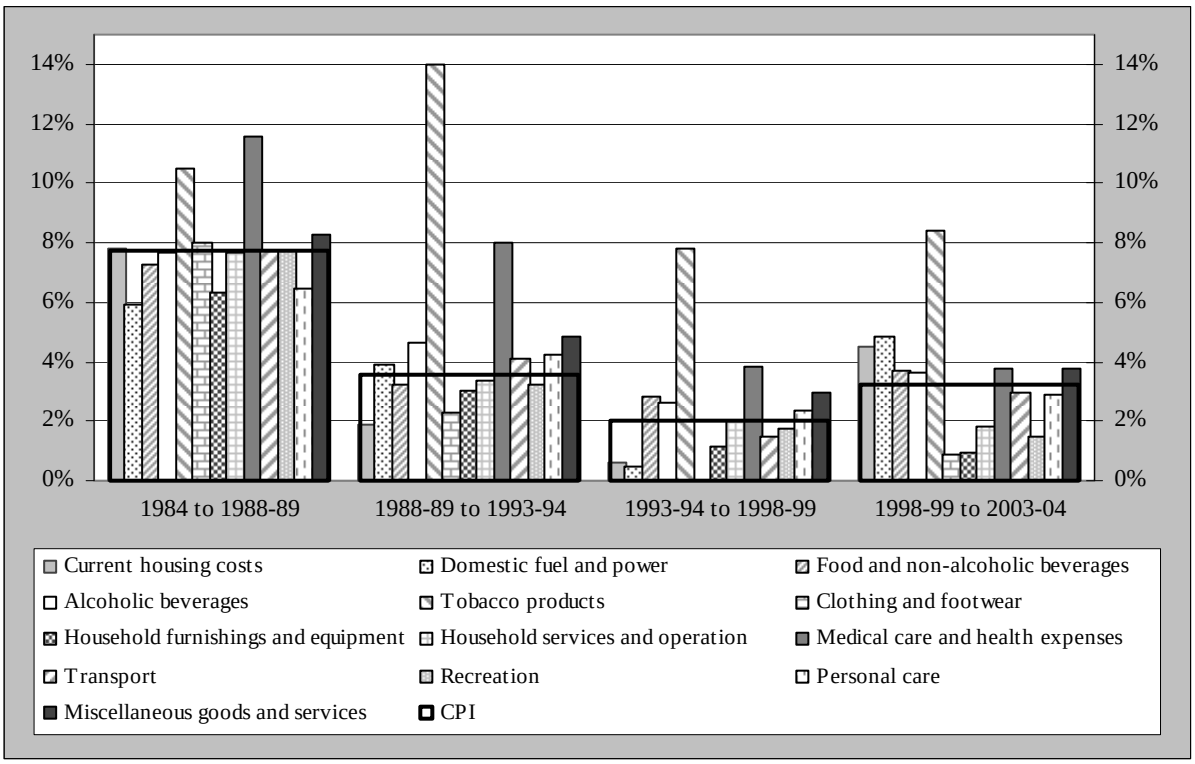
$$\Delta CLI\left(\mathbf{p},u\right) \approx \Delta\mathbf{p}CLI'\left(\mathbf{p},u\right)\Big|_{\mathbf{p}=\mathbf{p}^0} - \tfrac{1}{2}\Delta\mathbf{p}^T CLI''\left(\mathbf{p},u\right)\Big|_{\mathbf{p}=\mathbf{p}^1}\Delta\mathbf{p}$$

$$CLI\left(\mathbf{p}^1,u\right) \approx CLI\left(\mathbf{p},u\right)\Big|_{\mathbf{p}=\mathbf{p}^0} + \left(\mathbf{p}^1-\mathbf{p}^0\right)CLI'\left(\mathbf{p},u\right)\Big|_{\mathbf{p}=\mathbf{p}^0} + \tfrac{1}{2}\left(\mathbf{p}^1-\mathbf{p}^0\right)^T CLI''\left(\mathbf{p},u\right)\Big|_{\mathbf{p}=\mathbf{p}^0}\left(\mathbf{p}^1-\mathbf{p}^0\right)$$

$$CLI\left(\mathbf{p}^1,u\right) - CLI\left(\mathbf{p}^0,u\right) \approx \Delta\mathbf{p}CLI'\left(\mathbf{p},u\right)\Big|_{\mathbf{p}=\mathbf{p}^0} + \tfrac{1}{2}\Delta\mathbf{p}^T CLI''\left(\mathbf{p},u\right)\Big|_{\mathbf{p}=\mathbf{p}^0}\Delta\mathbf{p}$$

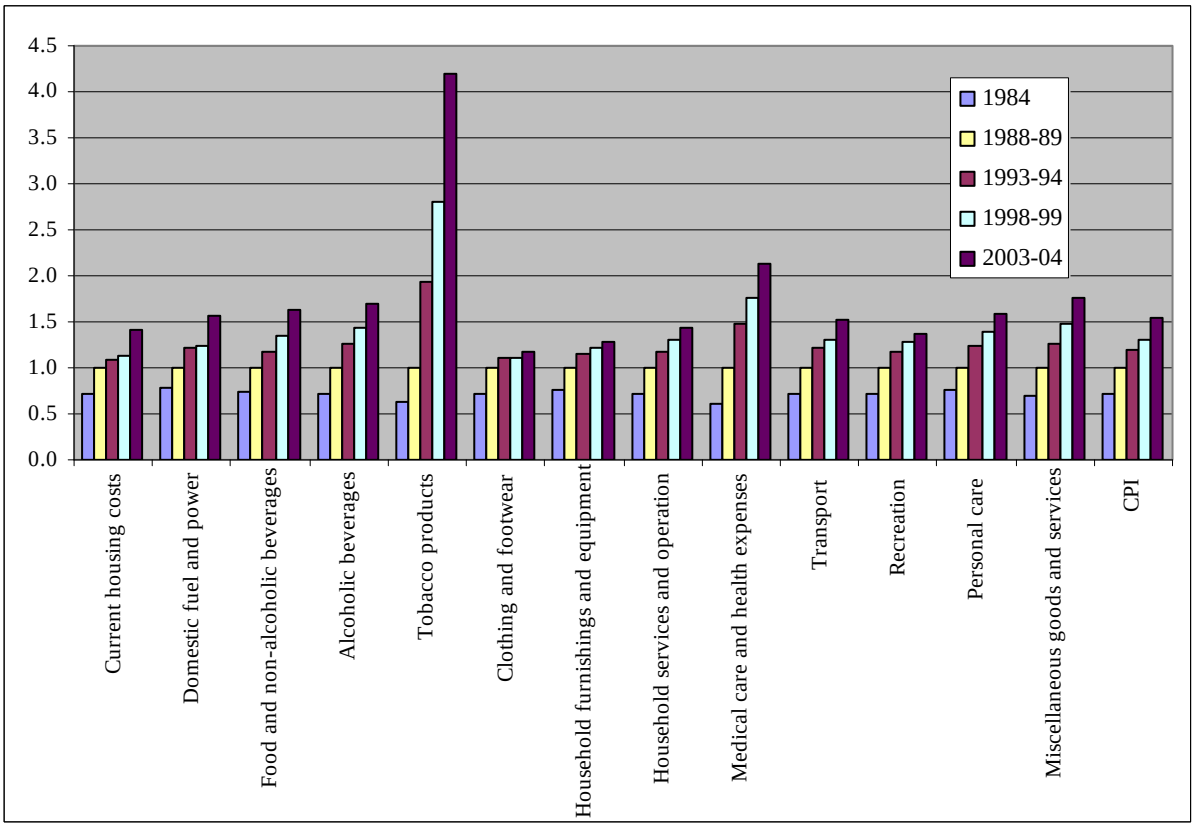
$$\Delta CLI\left(\mathbf{p},u\right) \approx \Delta\mathbf{p}CLI'\left(\mathbf{p},u\right)\Big|_{\mathbf{p}=\mathbf{p}^0} + \tfrac{1}{2}\Delta\mathbf{p}^T CLI''\left(\mathbf{p},u\right)\Big|_{\mathbf{p}=\mathbf{p}^0}\Delta\mathbf{p}$$

Chart 3.1 Annualised Rates of Inflation of the 13 HES Goods 1984 to 2003-04



Note: Compiled from ABS Broad and Detailed Consumer Price Indices in ABS6401.09 Consumer Price Index, Australia.

Chart 3.1 Price of the 13 HES Goods 1984 to 2003-04



Note: Compiled from ABS Broad and Detailed Consumer Price Indices in ABS6401.09 Consumer Price Index, Australia.

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