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

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I. INTRODUCTION

► Consumer Prices Index (CPI) series are not designed to be a measure of the cost of living, but are frequently used to adjust welfare payments for inflation, for a range of different households.

► Two problems:

- o spending patterns differ across households
- o substitution effects are ignored

► 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.

I. INTRODUCTION

Differing Spending Patterns

► If spending patterns differ across households then price movements will affect households differently, and a fixed weight index based upon a single set of weights would be in appropriate.

► The ABS's current 15th series CPI takes its weights from the spending behaviour 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.

I. INTRODUCTION

Differing Spending Patterns

► 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.

► While named “Analytical Cost of Living Indices”, they are rather fixed weight Laspeyres price indices, where the weights are the average budget shares for the specific household types.

I. INTRODUCTION

Substitution Effects

► Konus (1939) demonstrated that Laspeyres price indices overstate price increases since they ignore substitution effects.

► The Boskin Report, Boskin et al (1996), reported that substitution and other problems with the US CPI had resulted in inflation being overstated by 1.1% p.a.

I. INTRODUCTION

Substitution Effects

- ► Boskin et al (1996) and Diewert (1998) called for
  - o faster introduction of new goods,
  - o greater sampling of outlets to allow for outlet substitution,
  - o using the geometric mean (unit elastic) for sub price indices {also Abraham et al (1998)}
  - o to account for substitution either
    - ▪ a cost of living index or
    - ▪ at minimum increased frequency that the weights are updated.

- ► The Australian CPI weights are updated more frequently than its USA counterpart (5 compared to 7 years).

- ► The Australian CPI has used the geometric mean in the construction of elementary price indices since the 14th series of the CPI (ABS 2000a).

I. INTRODUCTION

Cost of Living Indices

► The theory of cost of living indices began in the 1920s with Konus (1939). For a thorough examination of CLIs, see Pollak (1989).

► 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 income effects of price changes.

I. INTRODUCTION

Aim and Motivation

► To construct the CLI for households with different levels of total expenditure and different demographic profiles.

► To compare the effects that prices rises have had on the cost of living for these groups. Have prices changes had a greater impact on a particular group?

► To decompose the change in the CLI into the parts that each price change is responsible.

II. THEORETICAL FRAMEWORK

ia) Traditional Cost of Living Indices (CLI)

► A cost of living index (CLI), is 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, $\mathbf{p}^0$.

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

where $\mathbf{p}^1$ and $\mathbf{p}^0$ are column vectors of n_g current and initial prices, respectively for each good.

II. THEORETICAL FRAMEWORK

ia) Traditional Cost of Living Indices (CLI)

► Only if preferences are homothetic see Pollak (1989) will the CLI be independent of base utility (IB). Homothetic preferences are a rather unpalatable as they result in demand functions that are proportional to total expenditure.

► If IB then the CLI is independent of utility and so also income and therefore the same for all households.

► If not IB then CLI is dependent of utility and so also income

► Therefore the CLI varies across income. Impact would depend on the relative price movements of luxuries and necessities.

II. THEORETICAL FRAMEWORK

ib) Demographically Adjusted Cost of Living Indices (CLI)

► 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 utility and cost functions and associated budget shares across demographic groups.

► In this case the CLI that varies across different demographic profiles is

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

where **z** is a vector of demographic variables

II. THEORETICAL FRAMEWORK

ii) Decomposition of CLI's

► Total differential of log CLI while holding initial prices ($\mathbf{p}^0$), demographics (**z)**

$$d\ln CLI\left(\mathbf{p}^1,\mathbf{p}^0,\mathbf{z},\bar{u}\right)\Big|_{d\mathbf{p}^0=0,\ d\bar{u}=0,\ d\mathbf{z}=0} = \sum_{i=1}^{n_g}\frac{\partial \ln CLI}{\partial \ln p_i}d\ln p_i$$

$$= \sum_{i=1}^{n_g}\left[\frac{\partial \ln c\left(\bar{u},\mathbf{p}^1\right)}{\partial \ln p_i^1} - \frac{\partial \ln c\left(\bar{u},\mathbf{p}^0\right)}{\partial \ln p_i^1}\right]d\ln p_i^1 \qquad (3)$$

$$= \sum_{i=1}^{n_g}\left[s_i\left(\bar{u},\mathbf{p}^1\right)\right]d\ln p_i^1$$

► However rather than the continuous proportionate change in the CLI, $d\ln CLI$, we are more interested in the discrete change in the CLI

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

II. THEORETICAL FRAMEWORK

ii) Decomposition of CLI's

► Equation (3) can be considered the first order approximation to (4).

► Taylor series expansion of the CLI can be used (see appendix) to obtain second order approximations (and beyond) to the discrete log change in the CLI so that $\Delta \ln CLI$ can be written

$$\Delta \ln CLI = \sum_{i=1}^{n_g} \frac{\partial \ln CLI}{\partial \ln p_i^1} \Delta \ln p_i^1 - \tfrac{1}{2} \sum_{i=1}^{n_g} \sum_{j=1}^{n_g} \frac{\partial^2 \ln CLI}{\partial \ln p_i^1 \partial \ln p_j^1} \Delta \ln p_i^1 \Delta \ln p_j^1 \qquad (5)$$

II. THEORETICAL FRAMEWORK

ii) Decomposition of CLI's

► Given $e_{ij} = \frac{1}{s_i}\left(\frac{\partial s_i}{\partial \ln p_i}\right) - \delta$ where δ is the Kronecker-Delta, $\delta = 1$ if $i = j$, $\delta = 0$ if $i \neq j$

► and $$\frac{\partial^2 \ln CLI}{\partial \ln p_i \partial \ln p_j} = \frac{\partial s_i\left(\mathbf{p}^1, \mathbf{z}, \bar{u}\right)}{\partial \ln p_j}$$

► The CLI can be decomposed as

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

II. THEORETICAL FRAMEWORK

iii) A Demographic Rank3 Demand System: PS-QAIDS

► For this study the QAIDS of Banks, Blundell and Lewbel (1997).

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

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

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

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

► Aggregation and homogeneity conditions 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.

II. THEORETICAL FRAMEWORK

iii) A Demographic Rank3 Demand System: PS-QAIDS

► The QAIDS model is demographically extended by an application of Ray's (1983) Price Scaling (PS) technique to provide the PS-QAIDS model.

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

where equivalence scale, $m(\mathbf{p},\mathbf{z})$, dependent on prices and household characteristics.

This study specifies 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.

II. THEORETICAL FRAMEWORK

iii) A Demographic Rank3 Demand System: PS-QAIDS

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

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

where the

- κ's represent the constant utility cost of infants, children and older dependants, as 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 then $\theta = 1$.

► The ν_g are the price elasticities of the equivalence scale with $\sum_g \nu_g = 0$.

II. THEORETICAL FRAMEWORK

iii) A Demographic Rank3 Demand System: PS-QAIDS

► The PS-QAIDS budget shares for the i = 1 to n_g goods are,

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

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

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

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

► 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.

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

where $\tilde{x}_0$ is the household's real adult equivalent expenditure in the reference period as specified previously in (14).

iv) The PS-QAIDS Cost of Living Index

► 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 $I(\mathbf{p}^0)=1$, and that the log of the CLI is

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

► 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

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

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 33,955 observations on household expenditure and demographics.

► This data was combined with broad level price indices by state/territory, derived from the ABS's quarterly CPI series.

► The price indices were scaled to be unity in the reference period 1988-89 for each state/territory's expenditure category.

III. DATA, ESTIMATION AND METHODOLOGY

► 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
13 Miscellaneous goods and services

► This 13 good demographic rank-3 demand system has 225 parameters, of which 130 must be estimated.

III. DATA, ESTIMATION AND METHODOLOGY

► The CLI attempts to capture only the substitution between these broad categories that are modelled.

► Substitution between goods within each category is ignored.

► The ABS attempt to account for fine-level substitution effects when constructing their more detailed price indices, which form the broader price indices.

III. DATA, ESTIMATION AND METHODOLOGY

- The system of equations is estimated by Full Information Maximum Likelihood (FIML) and Seemingly Unrelated Regressions (SUR) estimation using the SAS 9.1 system for windows.

- While the errors appear non-normal there is very little difference between the FIML and SUR results.

- No observations were removed and each household was weighted by its survey weight in the estimation.

- The estimated PS-QAIDS parameters and their standard errors are presented in the Appendix in Tables A1, A2 and A3. A log-likelihood ratio test of restricting the QAIDS model to AIDS is clearly rejected.

III. DATA, ESTIMATION AND METHODOLOGY

Chart 3-1 Price of the 13 HES Goods 1984 to 2003-04

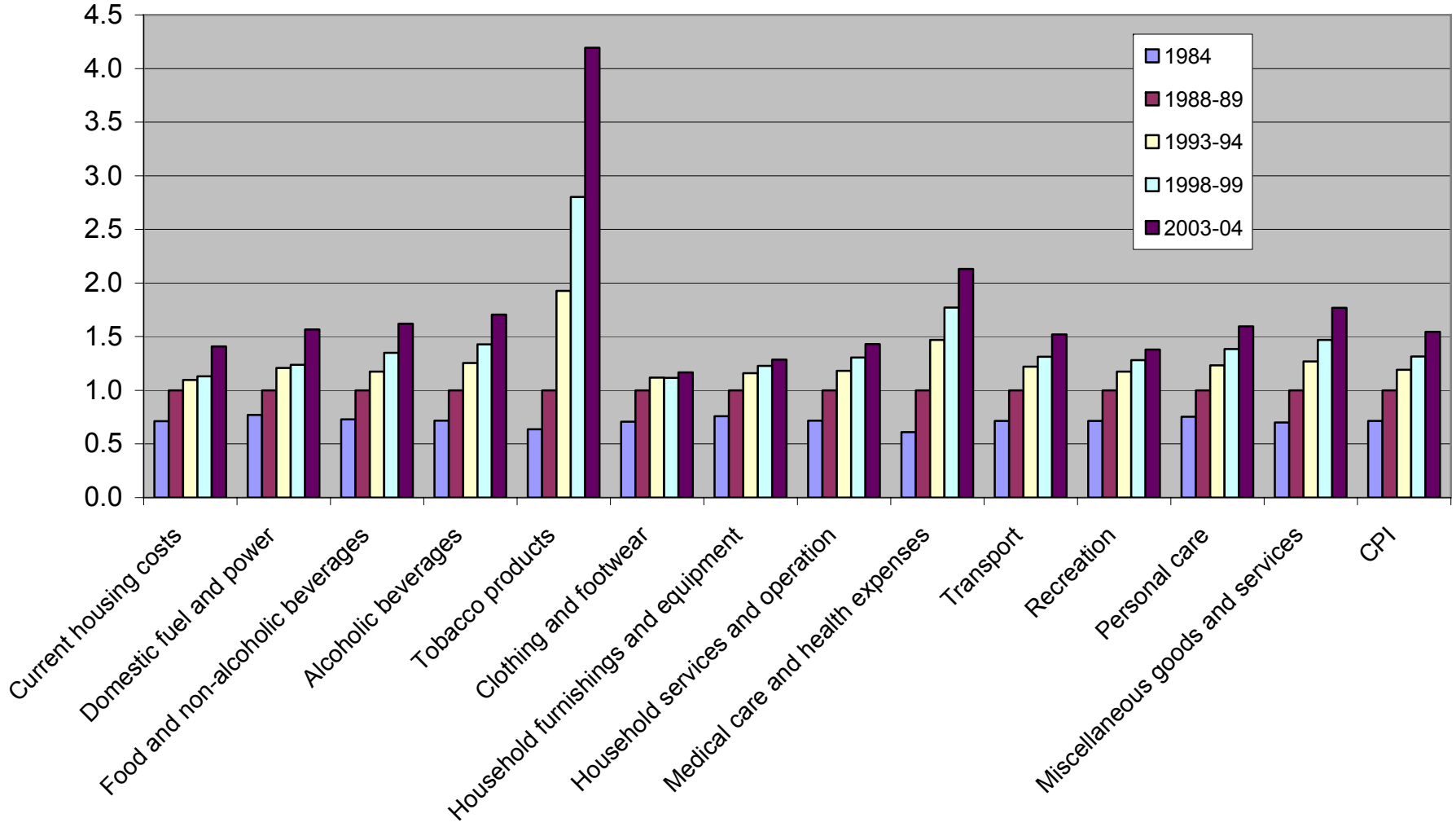


Table 3-2 Demographic Classes

Adults	Children aged 5-14 years	PS-QAIDS Equivalence Scale (1989-99)	PS-QAIDS Equivalence Scale (2003-04)	Real (1989-99) Weekly Expenditure	Nominal Weekly Expenditure 2003-04
1	0	1.000	1.000	$320.30	$478.69
1	1	1.352	1.350	$433.16	$646.01
1	2	1.63	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

Source: 2003-04 HES
Note: The equivalence scales and expenditure levels 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.

IV. RESULTS

Table 4-1 CLI for Different Expenditure Groups

Income Class	Very Low	Low	Average	High	Very High	CPI
Nominal Equivalent (Single Adult) 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%**

IV. RESULTS

Table 4-2 CLI for Different Demographic Groups

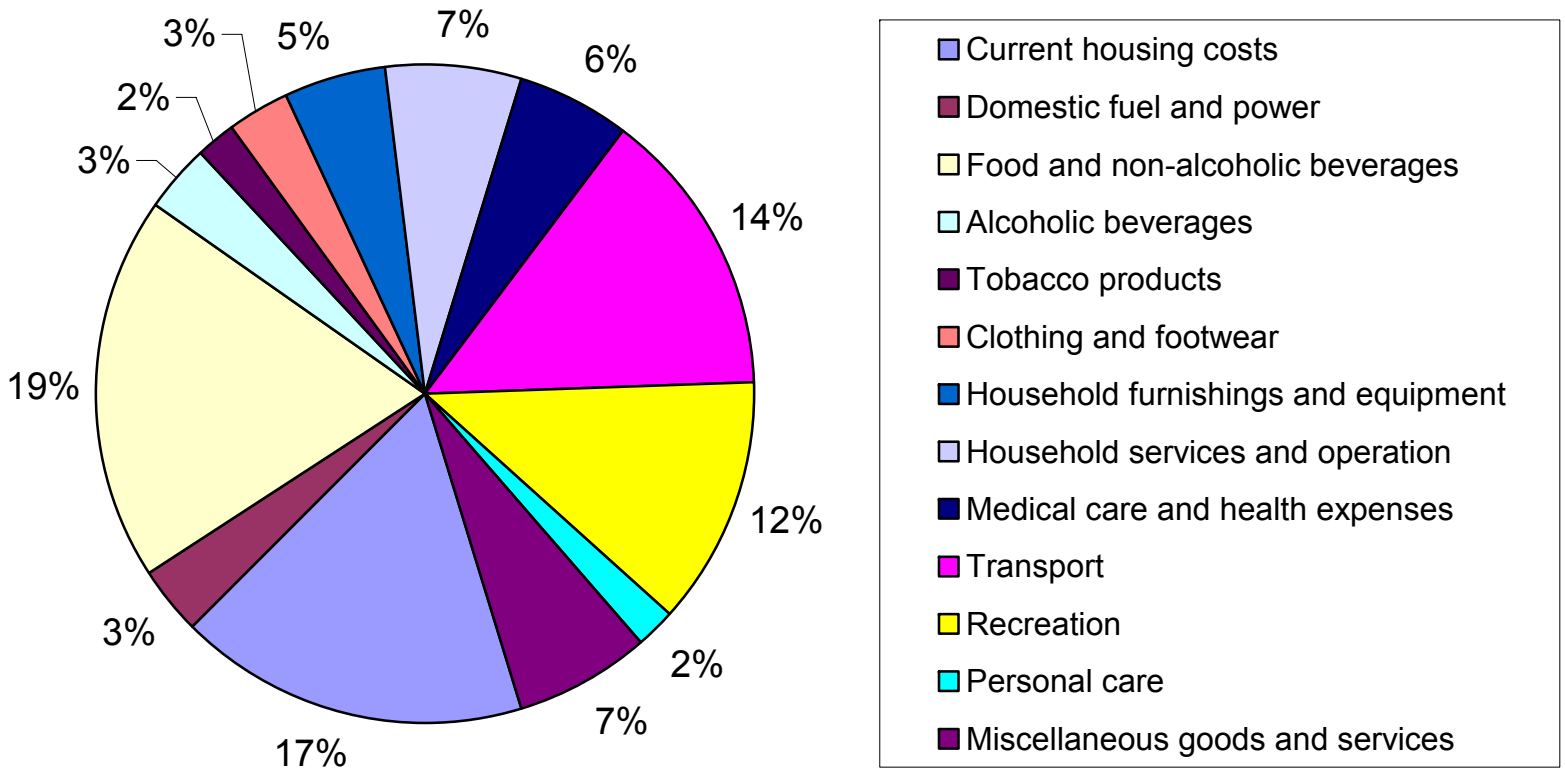
Adults:	**1**	**1**	**1**	**1**	**2**	**2**	**2**	**2**	**2**
Children:	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**4**
				CLI					
1984	0.715	0.715	0.716	0.716	0.715	0.715	0.716	0.716	0.716
1988-89	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1993-94	1.202	1.201	1.199	1.197	1.202	1.201	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%**

IV. RESULTS

Table 4-3 Contribution to the ∆CLI by each HES good for Log Average 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 compositions. The annualised rate of CLI inflation for single adult households was only 0.06% higher than two adult, four children households.

V. CONCLUSIONS

- 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.

REFERENCES

Australian Bureau of Statistics (1998), *A Guide to the Consumer Price Index: 13th Series*, ABS 6440.0, ABS, Canberra.

Australian Bureau of Statistics (2001), *A Guide to the Consumer Price Index: 14th Series*, ABS 6440.0, ABS, Canberra.

Australian Bureau of Statistics (2005), *A Guide to the Consumer Price Index: 15th Series*, ABS 6440.0, ABS, Canberra.

Banks, J., Blundell, R. and Lewbel, A. (1997), 'Quadratic Engel Curves and Consumer Demand', *Review of Economics and Statistics*, vol. 79, no. 4, pp. 527-539.

Blacklow, P. (2003), Inequality, Welfare, Household Composition and Prices: A Comparative Study on Australian and Canadian Data, PhD Thesis, University of Tasmania, Tasmania.

Boskin, M.J., E.R Dulberger and R.J. Gordon, Z. Griliches and D.W. Jorgenson (1996), "Towards a More Accurate Measure of the Cost of Living", Final Report to the Senate Finance Committee, reprinted in, *Journal of Economic Perspectives*, vol. 12, no. 1, pp. 3-26.

Jorgenson, D.W. and Slesnick, D.T. (1987), 'Aggregate Consumer Behaviour and Household Equivalence Scales', *Journal of Business and Economic Statistics*, vol. 5, no.2, pp. 219-232.

Konus, A. A. (1939), "The Problem of the True Index of the Cost of Living", *Econometrica,* vol. 7, no. 1, pp. 10-29.

REFERENCES

Lancaster, G. and Ray, R. (1998), 'Comparison of Alternative Methods of Estimating Household Equivalence Scales: The Australian Evidence on Pooled Time Series of Unit Record Data', *Economic Record*, vol. 74, no. 224, pp. 1-14.

Madden, K., (2002), 'Regional Incomes and the Cost of Living for Low Income Households: How Does Tasmania Compare?', Social Action and Research Centre, Anglicare Tasmania.

Nelson, J. (1988), 'Household Economies of Scale in Consumption: Theory and Evidence', *Econometrica*, vol. 56, no.6, pp. 1301-1314.

Pollak, R.A. (1989), *The Theory of the Cost of Living Index*, Oxford University Press, Oxford.

Ray, R. (1983), 'Measuring the costs of children: an alternative approach', *Journal of Public Economics*, vol. 22, no.1, pp. 89-102.

The Department of Treasury (1998a), *Tax Reform: Not a New Tax, A New Tax System*, August 1998.

The Department of Treasury (1998b), Submission To The Senate Select Committee On A New Tax System, December 1998.

APPENDIX

Table A1 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 $D_{ependants}$	$n_k = n_{k1} + n_{k2} + n_{k3}$	dependants aged under 25 years

APPENDIX

Table A2 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

APPENDIX

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

Trans-log Price Parameters													
γ_{ij}	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.

APPENDIX

Appendix A4

Taylor Series Expansion of the CLI

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

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

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

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

APPENDIX

Appendix A4

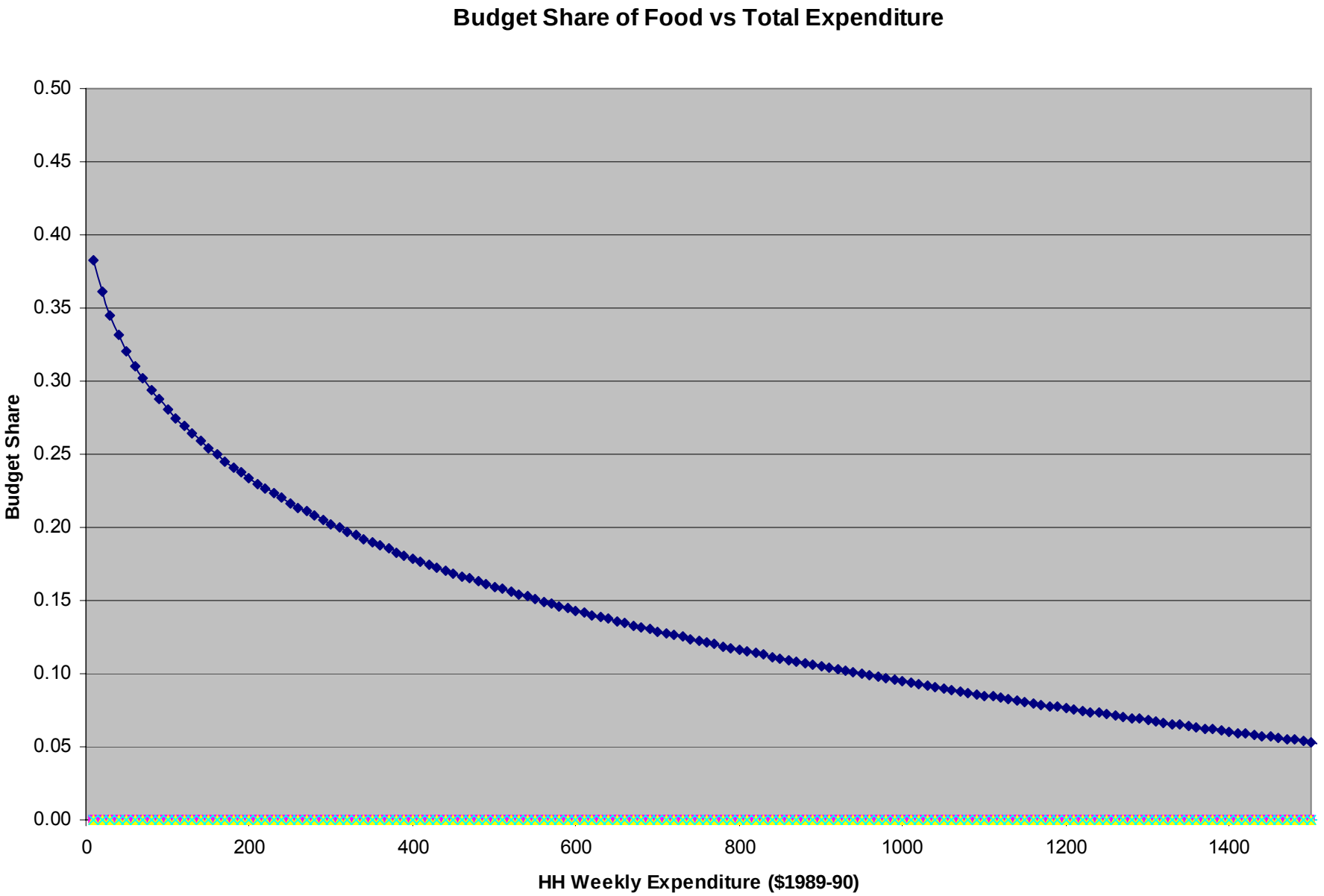
Taylor Series Expansion of the CLI

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

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

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

APPENDIX


Budget Share of Food vs Total Expenditure
Budget Share
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
200
400
600
800
1000
1200
1400
HH Weekly Expenditure ($1989-90)