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**EVALUATING THE DISTRIBUTIONAL IMPLICATIONS OF PRICE  
MOVEMENTS: METHODOLOGY, APPLICATION AND AUSTRALIAN  
EVIDENCE\***

Aaron Nicholas<sup>1</sup>, Ranjan Ray<sup>2</sup> and Ma. Rebecca Valenzuela<sup>3</sup>

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<sup>1</sup> Department of Economics, Monash University, Clayton Campus

<sup>2</sup> Department of Economics, Monash University, Clayton Campus Corresponding author. E-mail:  
[Ranjan.Ray@buseco.monash.edu.au](mailto:Ranjan.Ray@buseco.monash.edu.au)

<sup>3</sup> Department of Economics, Monash University, Caulfield campus

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## ABSTRACT

This paper investigates the distributional implication of inflation in Australia. It proposes and applies a method of evaluating the nature and size of the inequality bias of price movements. In the process, the study introduces a new demographic demand model that yields sensible and well determined estimates of the general equivalence scale and the size economies of scale. The study finds that inflation in Australia during the 1990s had an inequality increasing bias and that this bias increased in the late 1990s and the first part of the new millennium. The study also provides evidence on the decomposition of overall inequality between demographic groups and compares the decomposition between the nominal and real expenditure inequalities.

**Keywords:** Price scaling, demographic demand, real expenditure inequality, inequality aversion.

**JEL Classification:** C13, D12, D31, D63

## 1. INTRODUCTION

Inflation that is accompanied by a significant change in the relative prices of the principal items of consumption affects the various household groups differently due to differences in their expenditure patterns. For example, since by Engel's law the household's budget share of food declines with an increase in its aggregate expenditure, inflation that is accompanied by an increase in the relative price of food vis-a-vis non-food items will affect the poorer household groups more adversely than the affluent ones. Similarly, if the prices of items that are consumed primarily by children increase more than those consumed primarily by adults, then households with large numbers of children will be hit harder than, say, childless households. Again, if the price movement favours items that are bought in bulk and exhibit economies of scale (typically, consumer durables), then larger-sized households will benefit relative to smaller-sized households which are, typically, single adults and pensioners.

These remarks point to the need to distinguish between inequality movements in real and nominal terms. Relative price changes have an effect on expenditure inequality that cannot be captured by nominal expenditure inequality or by evaluating real expenditure inequality where the price deflator, used to convert nominal to real expenditure, is assumed to be invariant between households. In assessing temporal changes in inequality, it is necessary to incorporate the impact of relative price changes on expenditure patterns in the calculations of real expenditure inequality. This paper proposes a procedure to do so. The omission of relative prices changes can introduce a bias in the inequality calculations, whose magnitude and sign will depend on the nature of the price movements<sup>1</sup>. Over a long time period which has seen a significant adjustment of relative prices, the differences between the nominal and real expenditure inequalities can be considerable, with the sign of the difference indicating whether inflation has been inequality increasing or otherwise. While the inequality literature recognises the distinction between consumption inequality and income inequality<sup>2</sup> and generally favours the former [see, for example, Blundell and Preston (1998)], the evidence on the impact of relative price changes on inequality is quite limited<sup>3</sup>. One of the principal

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<sup>1</sup> For example, Muellbauer (1974) shows that "relative consumer price changes in the U.K. since 1964 have had an inequality increasing bias".

<sup>2</sup> See Barrett, Crossley and Worswick (2000), Blacklow and Ray (2000) for Australian evidence on the distinction between consumption and income inequality. Neither of these studies incorporates the impact of relative price changes in the inequality calculations.

<sup>3</sup> Besides Muellbauer (1974), this limited literature includes Pendakur (2002), who, using a different argument based on the price sensitivity of the equivalence scales, provides Canadian evidence that suggests that we should take "prices seriously in the measurement of inequality".

motivations of this study is to address this limitation and provide Australian evidence on the issue.

This paper proposes a methodology for assessing whether inflation has been inequality increasing or decreasing, and applies it to provide Australian evidence over a 15 year period (1988-2004). The proposed methodology combines the procedures in Muellbauer (1974) and Ray (1985) to allow for a flexible demand response to changes in prices and aggregate household expenditures. This is achieved through the use of a price-dependent equivalence scale specification within the framework of a rank 3 demand model<sup>4</sup>. Following Banks, Blundell and Lewbel (1997), but using a different demographic procedure that is based on the price scaling (PS) technique proposed in Ray (1983), this paper proposes a demographically extended rank 3 demand model, namely, the PS-QUAIDS model, that allows the equivalence scale to vary with relative prices in a transparent manner<sup>5</sup>. The price coefficients of the price-scaled equivalence scale specifications are readily interpreted as the elasticity of the equivalence scale with respect to relative prices.

This study has several other features that are of policy interest. We decompose the inequality estimates between the various household types, and compare the decomposition of the real and nominal expenditure inequalities. This study also provides evidence on the sensitivity of the inequality estimates to the commodity aggregation and to the price sensitivity of the equivalence scale. In each case, the study examines robustness of the evidence between the Gini and Atkinson measures of inequality.

The rest of this paper is organised as follows. Section 2 introduces the price dependent equivalence scale specification and the corresponding demographically-extended quadratic ‘almost ideal’ demand model (PS-QUAIDS). Section 3 derives the expression for real expenditure that is used to calculate real expenditure inequality. Section 4 describes, briefly, the data set and presents the demographic demand parameter estimates while the inequality results are presented and analysed in Section 5. Section 6 concludes.

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<sup>4</sup> A rank 3 demand model not only allows for non-monotonic relationships between budget share and aggregate household expenditure (unlike conventional demand models) but imposes no restriction between the coefficient of the linear and higher order terms in the real household expenditure.

<sup>5</sup> While Pendakur (2002) provides Canadian evidence that confirms the importance of allowing price sensitivity of the equivalence scale, Pashardes (1995) provides U.K. evidence that points to the empirical superiority of rank 3 demand models and the need to estimate equivalence scales within the framework of such general demand models.

## 2. EQUIVALENCE SCALE SPECIFICATION AND THE DEMOGRAPHIC DEMAND SYSTEM

The PS demographic technique, introduced in Ray (1983), stems from the definition of the general equivalence scale,  $m_{oh}$ , as the ratio of costs of obtaining a reference utility level,  $u$ , at a given vector of prices,  $p$ , of a household  $h$  with  $z$  children and a reference household,  $R$ .

$$c_h(u, p, z) = m_{oh}(z, p, u)c_R(u, p) \quad (1)$$

If one specifies a suitable functional form for the cost function of the reference household,  $c_R(u, p)$ , which satisfies the usual economic theoretic conditions of linear homogeneity in prices, symmetry and concavity, then the choice of a suitable functional form for  $m_{oh}(z, p, u)$ <sup>6</sup> gives us the corresponding form for the cost function of household  $h$ . The latter yields, on application of Shephard's Lemma, the price scaled demographic demand equations.

Pollak and Wales (1979) were the first to point out that utility independent equivalence scales cannot be estimated from demand data. Blackorby and Donaldson (1993) have however shown that the assumption of the utility independence – allows the scale to be identified from budget data that are pooled across different time periods containing price variation<sup>7</sup>.

We choose the following functional forms for the utility invariant general equivalence scale,  $m_{oh}(z, p)$ , and for the cost function of the reference household,  $c_h(u, p)$ ,

$$m_{oh}(z, p) = \prod_k p_k^{\delta_k z_h} (na_h + \sum_{g=1}^G \rho_g z_{gh})^\theta \quad (2)$$

where  $\sum_k \delta_k = 0$

$$\ln c_R(p, u) = \ln a(p) + \frac{ub(p)}{1 - uc(p)} \quad (3)$$

where  $na_h$  denotes the number of adults in household  $h$ ,  $z_{gh}$  denotes the corresponding number of children in age group  $g$ ,  $z_h (= \sum_{g=1}^G z_{gh})$  is the total number of children,  $\rho_g$  is

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<sup>6</sup>  $m_{oh}(z, p, u)$  must be homogenous of degree 0 in prices for  $c_h(u, p, z)$  to be homogenous of degree 1 in prices.

<sup>7</sup> See also Pendakur (2002).

the age-specific equivalence scale,  $\delta_k$  measures the price sensitivity of the equivalence scale and  $\theta$  denotes the household size economies of scale.

The expenditure function (3) of the reference household,  $R$ , which was introduced by Banks, Blundell and Lewbel (1997), generalises the PIGLOG cost function by allowing  $c(p)$  to vary with prices. The choice of the following functional forms for  $a(p)$ ,  $b(p)$ ,  $c(p)$ <sup>8</sup> yields the Quadratic Almost Ideal Demand System (QUAIDS) which is a rank 3 generalisation of the ‘almost ideal’ demand model.

$$\ln a(p) = \alpha_0 + \sum_k \alpha_k \ln p_k + \frac{1}{2} \sum_i \sum_j \gamma_{ij} \ln p_i \ln p_j \quad (4a)$$

$$b(p) = \prod_k p_k^{\beta_k} \quad (4b)$$

$$c(p) = \prod_k p_k^{\lambda_k} \quad (4c)$$

$$\sum_k \alpha_k = 1, \quad \sum_k \beta_k = \sum_i \gamma_{ij} = \sum_k \lambda_k = \sum_k \delta_k = 0, \quad \gamma_{ij} = \gamma_{ji}$$

Equations (1)-(3) yield, on application of Shephard’s Lemma, the following demographic demand system, PS-QUAIDS, in budget share terms,  $w_i$ .

$$\begin{aligned} w_{ih} &= \alpha_i + \delta_i z_h + \sum_j \gamma_{ij} \ln p_j \\ &+ \beta_i [\ln x_h - \alpha_0 - \sum_k \alpha_k \ln p_k - \frac{1}{2} \sum_i \sum_j \gamma_{ij} \ln p_i \ln p_j - \theta \ln (na_h + \sum_{g=1}^G \rho_g z_{gh}) - \sum_k \delta_k z_h \ln p_k] \\ &+ \lambda_i \prod_k p_k^{\lambda_k - \beta_k} [\ln x_h - \alpha_0 - \sum_k \alpha_k \ln p_k - \frac{1}{2} \sum_i \sum_j \gamma_{ij} \ln p_i \ln p_j - \theta \ln (na_h + \sum_{g=1}^G \rho_g z_{gh}) - \\ &\sum_k \delta_k z_h \ln p_k]^2 \end{aligned} \quad (5)$$

where  $x_h$  denotes the nominal expenditure of household  $h$ . In the estimations that are reported below, we set  $\alpha_0$  a priori at zero.

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<sup>8</sup> While  $a(p)$  is homogenous of degree 1 in prices,  $b(p)$  and  $c(p)$  are homogenous of degree 0 in  $p$ .

To check on the robustness of the inequality results, we also estimate a variant of (4c) with  $c(p)$  given as follows:

$$c(p) = \sum_k \lambda_k \ln p_k \tag{6}$$

This alternative framework ignored child age effects (i.e.  $\rho_g = \rho$  for all  $g$ ) and assumed the absence of consumption economies of scale ( $\theta = 1$ ). The reference household was taken to be a childless adult couple, and the estimation was performed only on 2-adult households. The PS-QAIDS demand functional form, in this alternative framework, is given as follows:

$$\begin{aligned} w_{ih} &= \alpha_i + \delta_i z_h + \sum_j \gamma_{ij} \ln p_j \\ &+ \beta_i [\ln x_h - \alpha_o - \sum_k \alpha_k \ln p_k - \frac{1}{2} \sum_i \sum_j \gamma_{ij} \ln p_i \ln p_j - \ln(1 + \rho z_h) - \sum_k \delta_k z_h \ln p_k] \\ &+ \lambda_i \prod_k p_k^{-\beta_k} [\ln x_h - \alpha_o - \sum_k \alpha_k \ln p_k - \frac{1}{2} \sum_i \sum_j \gamma_{ij} \ln p_i \ln p_j - \ln(1 + \rho z_h) - \sum_k \delta_k z_h \ln p_k]^2 \end{aligned} \tag{7}$$

Note that the adult-child relativity parameter,  $\rho$ , of equation (7) is not directly comparable with the child age-specific relativity parameter  $\rho_g$  ( $g = 1, \dots, G$ ) of equation (5). This is due to the fact that, besides the presence/absence of economies of scale, the two specifications differ with respect to the reference household. The reference household is a single adult in the case of (5) and a childless couple in the case of (7).

### 3. NOMINAL AND REAL EXPENDITURE INEQUALITIES

A comparison of the nominal and real expenditure inequalities will throw light on the inequality implications of price movements. Let us recall the cost or expenditure function of household  $h$  in period  $t$ .

$$\ln c_{ht}(u, p, z) \equiv \ln x_{ht} = \ln m_{0h}(z_h, p_t) + \ln a(p_t) + \frac{u_t b(p_t)}{1 - u_t c(p_t)} \quad (8)$$

where  $x_{ht}$  is the nominal expenditure of the household and  $u_t$  is the utility measure in year  $t$ . Following Muellbauer (1974, pg 42), we define real expenditure of household  $h$  in year  $t$ , namely,  $\tilde{x}_{ht}$ , is the minimum expenditure needed to obtain current year utility,  $u_t$  at base year price,  $p_0$ . In other words:

$$\tilde{x}_{ht} = c(p_0, u_t, z_h) \quad (9)$$

The application of (9) in (8) yields, after some rearrangement, the following expression for real expenditure:

$$\tilde{x}_{ht} = \bar{m}_{0h}(z_1, \dots, z_G) \prod_k p_{kt}^{\delta_k z_h} a_0 \exp \left[ \frac{b_0}{\left( c_t + \frac{b_t}{\ln x_t - \ln a_t - \ln \bar{m}_0 - \sum_k \delta_k z_h \ln p_{kt}} - c_0 \right)} \right] \quad (10)$$

where  $\bar{m}_{0h} = (na_h + \sum_{g=1}^G \rho_g z_{gh})^\theta$  is the equivalence scale, and  $a_t, b_t, c_t$  are given in (4a)-(4c) above. It is readily verified from (10) that in the base year the real and nominal expenditures are equal (i.e.  $\tilde{x}_{h0} = x_{h0}$ ) and consequently, the nominal and real expenditure inequalities will coincide. The magnitude and sign of the difference between the inequalities in real and nominal expenditures per adult equivalent, i.e. between the inequalities in  $\tilde{y}_{ht} (= \tilde{x}_{ht}/\bar{m}_{0h})$  and  $y_{ht} (= x_{ht}/\bar{m}_{0h})$  will, therefore, depend not only on the price vector in the given year but also on the estimated demand parameters that will determine the  $a_t, b_t$  and  $c_t$  values.

Note also, that the sign and magnitude of the difference between the real and nominal expenditure inequalities will depend, quite crucially, on the movement in relative prices. In the case of no change in relative prices between current year  $t$  and base year, 0, the two inequalities will coincide. To see this, suppose all prices increase by the same proportion, i.e.,  $p_t = kp_0$ .

From (10),

$$\ln \tilde{x}_{ht} = \ln \bar{m}_{0h} + \sum_k \delta_k z_h \ln p_{kt} + \ln a_0 + \left[ \frac{b_0}{\left( c_t + \frac{b_t}{\ln x_t - \ln a_t - \ln \bar{m}_0 - \sum_k \delta_k z_h \ln p_{kt}} - c_0 \right)} \right] \quad (11)$$

By linear homogeneity in prices,  $p$ , of  $a_t$  and zero degree homogeneity in  $p$  of  $b_t, c_t$  and  $\sum_k \delta_k z_h \ln p_{kt}$ , it follows:

$$\begin{aligned} \ln \tilde{x}_{ht} &= \ln \bar{m}_{0h} + \sum_k \delta_k z_h \ln p_{kt} + \ln a_0 + \left[ \frac{b_0}{\left( \frac{b_0}{\ln x_{th} - \ln a_0 - \ln \bar{m}_{0h} - \sum_k \delta_k z_h \ln p_{0t} - \ln k} \right)} \right] \\ &= \ln \left( \frac{x_{ht}}{k} \right) \end{aligned} \quad (12)$$

Since  $k$  is not indexed on  $h$ , it follows from the requirement that an expenditure inequality index must be homogenous of degree zero in expenditure that the real and nominal expenditure inequalities will coincide in the base year.

Besides the Gini inequality index, we have used the Atkinson inequality index (Atkinson, 1970). The expressions for the Atkinson index of real and nominal expenditure inequalities are given, respectively, as follows:

$$I_t^R = 1 - \left[ \frac{1}{H} \sum_{h=1}^H \left( \frac{\tilde{y}_{ht}}{\bar{\tilde{y}}_t} \right)^{1-\epsilon} \right]^{1/(1-\epsilon)} \quad (13)$$

$$I_t^N = 1 - \left[ \frac{1}{H} \sum_{h=1}^H \left( \frac{y_{ht}}{\bar{y}_t} \right)^{1-\epsilon} \right]^{1/(1-\epsilon)} \quad (14)$$

where  $\tilde{y}_{ht}$ ,  $y_{ht}$  are the real and nominal expenditures per adult equivalent, and  $\bar{\tilde{y}}_t$ ,  $\bar{y}_t$  are the corresponding means.  $\epsilon \geq 0$  is the inequality aversion parameter.  $(I_t^R - I_t^N) > 0$  implies that the relative price movement has been inegalitarian or inequality increasing, while the reverse is indicated if  $(I_t^R - I_t^N) < 0$ .

## 4. DATA SETS AND DEMOGRAPHIC DEMAND ESTIMATES

### 4.1. DATA SETS

The estimation and analysis are based on a pooled cross-section of the unit record files from the Household Expenditure Survey (HES) conducted by the ABS for the years 1988/9, 1993/4, 1998/9 and 2003/4. The household is chosen as the unit of analysis. The bulk of the estimation and analysis was based on the full sample of 29463 observations over the 4 HES data sets (7225 households in 1988, 8389 in 1993, 6892 in 1998 and 6957 in 2003). The following 9 item breakdown of household expenditure was used<sup>9</sup>: Housing ( $i=1$ ); Electricity and Household Fuel ( $i=2$ ); Food and Non-Alcoholic Beverages ( $i=3$ ); Alcohol and Tobacco ( $i=4$ ); Clothing and Footwear ( $i=5$ ); Health and Personal Care ( $i=6$ ); Transport ( $i=7$ ); Recreation ( $i=8$ ); and Miscellaneous items including Credit Charges and Education ( $i=9$ ). The price series used are based on the ABS (2003) Consumer Price Index quarterly series but reweighted to match the HES Commodity List<sup>10</sup>. The prices were reweighted, where necessary, by the mean budget shares for each period in order to obtain price indices for the above-mentioned nine commodity grouping. Since prices were merged by quarter, the prices for Sep 1988 and Dec 1988 are a little under unity, and the prices for March 1989 and June 1989 are a little over unity. Children were split into the following three age groups: children under 5 years of age ( $z_1$ ), those aged between 5 and 14 years ( $z_2$ ) and the number of dependent students aged 15 to 23 years ( $z_3$ ). To check on the robustness of the principal qualitative conclusions, we re-estimated the demographic demand systems on 3, 5 and 7 item groupings on a subsample<sup>11</sup> of the pooled HES data sets consisting solely of adult couple households but with varying numbers of children (including childless households). Note that, while in the case of the 9-item aggregation and the full sample, the inequality calculations were based on the demographic specification (eqn 5) that allowed child age effects and economies of scale, the inequality calculations for the 3, 5, and 7 item aggregation on adult couples were based on the restricted demand specification that assumed away these effects.

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<sup>9</sup> This is identical to the commodity aggregation considered in Blacklow and Ray (2000).

<sup>10</sup> We are grateful to Dr. Paul Blacklow of the University of Tasmania for allowing us to use the price series that he constructed from the ABS consumer price index.

<sup>11</sup> See Appendix for these commodity groupings and for details on sample size.

The demand estimation employed the non-linear Full Information Maximum Likelihood procedure and used the SAS and STATA<sup>12</sup> packages.

#### 4.2. DEMOGRAPHIC DEMAND ESTIMATES

Table 1 presents the parameter estimates of equation (5) based on the full sample. The estimates are generally well-determined with most of them registering strong statistical significance. All the  $\lambda$  estimates are highly significant, providing strong support for the QUAIDS generalisation over the nested AIDS model. The price scaling parameter estimates ( $\delta_i$ 's) are also highly significant, thus, confirming that the equivalence scales do vary with changes in relative prices. The equivalence scale and economies of scale parameter estimates ( $\rho_g, \theta$ ) are highly significant and so are the child-age effects with the difference in child-age effects being larger between the first 2 age groups than between the older children. The economies of scale,  $\theta$ , lies midway between 0 and 1, rejecting both extremes. The data, thus, rejects the use of both the non-deflated household expenditure ( $\theta = 0$ ) and the simple equivalence scale specification ( $\theta = 1$ ) that allows adult-child relativities but ignores economies of scale. It is important to distinguish between the two: while the adult-child relativities incorporate different needs between adults and children, scale economies occur due to the bulkiness of some items that favour the larger sized households over smaller sized ones. As Buhmann, et al (1988), Coulter, Cowell and Jenkins (1992), Banks and Johnson (1994) show, the inequality estimates are sensitive to the size of the economies parameter,  $\theta$ <sup>13</sup>. The present evidence suggests that it is necessary to incorporate both adult child relativities and economies of household size. Notwithstanding the large number of price coefficients in the 9 goods model, several of the  $\gamma_{ij}$  coefficients are highly significant.

Table 2 presents the estimates of the price scaling parameters ( $\delta_i$ ), the basic equivalence scale ( $\rho$ ) and the quadratic coefficients ( $\lambda_i$ )<sup>14</sup> of the demographically restricted demand specification (eqn. 7) for the 3, 5 and 7 goods commodity aggregations. Once again, the data provides evidence in favour of price dependence of the equivalence scale, and supports the generalisation of QUAIDS over the nested AIDS specification. The estimate of  $\rho$  suggests

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<sup>12</sup> We are grateful to Dr. Katy Cornwell of Monash University for help with the modification of Stata's QUAIDS program written by Brian Poi.

<sup>13</sup> The latter 2 studies disagree, however, on the nature of the relationship between inequality and size economies.

<sup>14</sup> The full set of parameter estimates are available on request.

that, in the base year when prices are normalised to unity, a child costs 21.1% of an adult couple if one considers only basic items such as Electricity and Fuel, Food and Non Alcoholic Beverages, Clothing and Footwear. The estimate declines sharply to lie between 9.4% and 11.3%<sup>15</sup> if one expands the consumption basket to include items such as Alcohol and Tobacco, Transport, Health and Personal Care, and Recreation.

## 5. THE INEQUALITY ESTIMATES

Table 3 presents the nominal and real expenditure shares of each of 5 quintile groups, arranged in an ascending order by the corresponding per adult equivalent expenditure distribution. The shares are calculated from the nominal and real expenditures for each household in the sample of 20463 households over the 4 HES data sets. The expenditure deflator, which is a function of the household size, the age distribution of children and the real expenditures, are based on the 9 item PS-QAIDS parameter estimates presented in Table 1. The following features emerge from Table 3:

(a) The bottom 20 percent of households have expenditure shares of less than 10 %, while the top 20 percent of households have expenditure shares of at least 38 %. Between 1988 and 2003 ( 15 year period), there was an overall decline in the expenditure shares of the bottom two quintiles and an increase in the corresponding share of the top quintile. The trend for the lowest quintile appears to be an inverted U, as their shares first increased before declining towards the end of the study period.

(b) The decline in the expenditure share of the bottom quintile group has been particularly sharp between 1998 and 2003. The beneficiary of this regressive transfer of spending has mainly been the top quintile group.

(c) The nominal expenditure shares generally exceed the corresponding real expenditure shares for the bottom two quintile groups, while the reverse is the case for the top quintile group. Moreover, the real expenditure shares appear to be more variable, over the 15 year period, than those in nominal terms. In particular, the expenditure shares dropped more sharply in real terms for the two lowest quintiles, particularly between 1998 and 2003; at the

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<sup>15</sup> These estimates are in line with U.K. evidence (7.8%) presented in Ray (1983, Table 3).

same time, real expenditure shares for the top quintile registered the larger increase compared to the nominal shares. These suggest that, especially in the late 1990s and early 2000s, the relative price changes have caused regressive transfers of real spending power from the poor to the rich households. This is seen more clearly from the inequality graphs presented later.

To check on the robustness of these findings to the choice of items included in consumption expenditure, Table 4 presents the corresponding expenditure shares for two adult households (with and without children) in the case of basic non-durable consumption items<sup>16</sup>, namely, fuel, food and clothing. The overall picture is robust between the two tables. While the sub period, 1993-98, stands out as a significant exception, there has been a redistribution of spending power, in both nominal and real terms, from the bottom to the top quintile group over the period 1988-2003 as a whole. Much of this regressive redistribution took place in the sub period 1998-2003 alone. Moreover, the large magnitude of the differences between the expenditure shares, in nominal and real terms, in 1998 and 2003, and the nature of the differences suggests that the price movements had a large inequality increasing bias in this latter period.

Table 5 presents the nominal and real expenditure inequalities in the full sample, based on the PS-QUAIDS parameter estimates of Table 1. The inequality estimates were calculated using the Gini and Atkinson inequality measures, with the latter evaluated at 2 levels of ‘inequality aversion’  $\epsilon$ . Table 5 confirms that, after an initial decline in the late 1980s, there has been an increase in expenditure inequality that accelerated sharply during the period 1998-2003. Note that, while the 1990s started out in recession, most of the years in this decade was characterised by relative growth and prosperity. This can in part explain the decline in nominal inequality during this period. However, the inequality measures based on real expenditures tell a different story - they indicate a gradual worsening of inequality during this period. Moreover, the larger magnitude of real expenditure inequality over nominal expenditure inequality is a direct confirmation of the inequality increasing nature of the price movement during the 1990s and beyond. These findings are robust to the choice of the measure used in the inequality calculations.

These features of Australian inflation during the 1990s and the early years of the new millennium are seen more clearly in Figures 1-3 which present the Lorenz curves of per

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<sup>16</sup> Barrett, Crossley and Worswick (2000) consider nondurable consumption items in their analysis of expenditure inequality on Australian data.

equivalent adult expenditures, in nominal and real terms, in the three years beyond the base year. The Lorenz curve of real expenditure lies outside that of nominal expenditure, and the gap between the two curves has been increasing over time. The inequality increasing bias of price inflation during 2003/4 is seen most clearly in Figure 3 where a wide gap opens up between the two non-intersecting Lorenz curves.

The inequality calculations were based on the PS-QUAIDS estimate of the economies of scale parameter,  $\theta$ , of 0.444 (see Table 1). The precise nature of the relationship between inequality and  $\theta$  has been a matter of some controversy [see Coulter et al (1992), Banks and Johnson (1994)]. Figure 4 provides Australian evidence on this issue by plotting the graphs of nominal and real expenditure inequalities against a range of  $\theta$  values varying from  $\theta = 0$  to  $\theta = 1.2$ <sup>17</sup>. Note that, unless substantial diseconomies of household size are assumed in consumption (i.e.  $\theta \simeq 1.2$ ), the real expenditure inequality exceeds nominal expenditure inequality. In other words, the inequality increasing nature of inflation during 2003/4 holds true for a wide range of  $\theta$  values. Both the inequality curves exhibit a mild U-shape. The gap between the two, which is an indicator of the inequality increasing bias of the price movement, initially increases but then decreases with an increase in the assumed value of consumption economies of scale. Theoretically, at least, there is a range of  $\theta$  values where the inflation can be inequality neutral or even inequality decreasing. However, the  $\hat{\theta}$  estimate of 0.444 in Table 1 suggests that the Australian economy is far from reaching that range.

Tables 6 and 7 present the decomposition of, respectively, the 2003/4 nominal and real expenditure inequalities between different demographic groups using the Atkinson inequality measure. The within-group inequality dominates the between-group inequality component in the case of both nominal and real expenditure. In nominal terms, within-group inequality accounts for 98 % of overall inequality; equivalent figure in real terms is 91 %. Generally, within-group inequality accounts for a significant proportion of inequality in a population, and this result is consistent with empirical regularity. More importantly, the results show that the dominance of the within-group inequality diminishes with an increase in the “inequality aversion”. In other words, the greater the weight that is given to poorer households, the smaller is that component of inequality that is due to the within-group differences. Note, also, from a comparison of Tables 6 and 7 that the divide between the nominal and real

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<sup>17</sup>  $\theta = 0$  implies that household expenditures are uncorrected for differences in household size and composition.  $0 < \theta < 1$  implies consumption economies of scale that favour larger sized households, while  $\theta > 1$  implies diseconomies that favour smaller sized households.

expenditure inequalities is much greater for the between-group component than the within-group component. This is possibly due to the much larger behavioural differences in expenditure patterns and their responses to price changes between households across different demographic groups rather than within the same group.

A significant feature of the present study is the price sensitivity of the equivalence scale that allows the scale to vary with relative prices and, consequently, across different time periods. This raises the question of sensitivity of the inequality calculations to the conventional assumption of price insensitivity of the equivalence scale. To provide evidence on this issue, we re-estimated the demand equation (7) with the restriction that the price scaling parameters,  $\delta_i$ 's, are all set to zero. Table 8 presents the parameter estimates of the unrestricted and restricted models in the case of the 5-item disaggregation of consumption expenditure (described above) which was estimated on the subset containing adult couple households (with and without children). The results show that while the imposition of the price invariance restrictions made no impact on the magnitude and strong statistical significance of the quadratic coefficients, the basic equivalence scale parameter,  $\rho$ , is quite sensitive to this restriction. However, Tables 9 and 10, which present the Gini and Atkinson coefficients of nominal and real expenditure inequalities implied by the restricted and unrestricted demand parameter estimates of Table 8, show that the imposition of the price invariance restriction on the equivalence scale has no impact on the inequality estimates.

## 6. CONCLUDING REMARKS

This paper investigates the distributional consequence of inflation in Australia due to a change in the structure of relative prices. The recent concern over high inflation in Australia, which is currently running outside the target range set by the Reserve Bank of Australia, stems from the fact that an increase in prices leads to a decline in the real income of all households. An added concern is due to the fact that the decline in real income or real expenditure will not be uniform across all households, depending on the nature of the price movements and the expenditure behavioural responses of the households. For example, poorer households with limited substitution possibilities will fare worse than the more affluent households in times of accelerating inflation. Alternatively, larger-sized households

will fare better if the price movements favour items which exhibit substantial economies of scale.

These considerations point to the need to distinguish between expenditure inequalities in nominal and real terms with a view to examining the inequality bias of the price movements. This paper builds on the current literature in proposing a method of doing so, and applies it on time series of Australian Household Expenditure Surveys. This paper also uses the price scaling demographic technique proposed in Ray (1983) to derive a new demographic demand system, the PS-QUAIDS, that demographically extends the QUAIDS model. The application on Australian data shows that this demographic demand model yields sensible and well-determined estimates of the equivalence scales and size economies of scale which are parameters of considerable interest.

The period chosen for this study extends from the late 1980s to the early years of the new millennium. Besides covering a reasonably long time period to make this study worthwhile, this period also includes the early 1990s which saw recession in Australia and the late 1990s which witnessed low unemployment and considerable prosperity. The overall conclusion is that while the period 1988-2003 was marked by an increase in expenditure inequality, the nature of price inflation has had an inequality increasing bias that opened up a gap between the magnitudes of real and nominal expenditure inequalities. This is seen more clearly by the non-intersecting Lorenz curves of real and nominal expenditure distribution, with the former lying outside the latter throughout the period. The gap increases in the late 1990s and early 2000s clearly suggest that the impact of price increases during these years were not uniform across the various income groups in the population: poorer households were clearly more adversely affected and this has resulted in a worsening of the inequality levels during this time

While the motivation of the paper was primarily methodological in proposing a method of evaluating the nature and size of the inequality bias of changes in relative prices, the empirical results of this study have considerable policy significance. Much of the recent discussion on inflation in Australia and the concerns over the fact that the rate of price increase has been lying above the target range set by the RBA have revolved around an aggregate figure for price inflation. The results of this study, building on earlier results obtained for the UK, suggest that we need to move beyond the aggregated inflation figure for the whole economy and look at the inflation figures of the individual items and, more

crucially, at the movements in relative prices. As the present results suggest, two vastly different sets of relative price movements, but both consistent with the same aggregate picture on inflation as measured by the overall rate of inflation, may have quite different welfare connotations with quite different impacts on expenditure inequality. For example, it is significant that in the first half of the 1990s, inflation did not have a particularly adverse effect on real expenditure inequality, but it did in the period from late 1990s to the early part of the new millennium. This also points to the importance of collecting price data and publishing price indices by population subgroups and regions to a much greater extent than is done presently. The results of this study also suggest that the Australian Household Expenditure data sets are now available over a sufficiently long time period to allow meaningful and precise estimation of expenditure, price and demographic effects on household spending patterns within the framework of sophisticated demographic demand systems. Since these effects are needed in a variety of policy applications that involve welfare comparisons between households, the results of this study sound very positive for future investigations on HES data.

The concern of this study was on inequality rather than on poverty. However, the findings of this study have implications for poverty analysis as well. As the recent study on poverty in Australia shows [Saunders and Bradbury (2006)], poverty measurements in developed countries usually employ a relative poverty line, for example, half-median that is dependent on distributional movements. Consequently, a time series study of poverty requires temporal adjustment to the poverty line that will need to incorporate the movements of relative price similar to the exercise of this paper. A study that focuses on the methodology for re-evaluating the poverty line in light of price changes will be a logical and useful extension of this study.

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TABLE 1: PS-QUAIDS Parameter Estimates for 9 Goods\*

$\alpha_1$	0.993 (0.00)	$\beta_1$	-0.238 (0.00)	$\rho_1$	0.589 (0.00)	$\gamma_{27}$	-0.056 (0.00)	$\gamma_{57}$	0.014 (0.35)
$\alpha_2$	0.492 (0.00)	$\beta_2$	-0.141 (0.00)	$\rho_2$	0.650 (0.00)	$\gamma_{28}$	0.060 (0.00)	$\gamma_{58}$	0.022 (0.16)
$\alpha_3$	0.303 (0.00)	$\beta_3$	0.046 (0.00)	$\rho_3$	0.629 (0.00)	$\gamma_{29}$	-0.052 (0.00)	$\gamma_{59}$	-0.010 (0.46)
$\alpha_4$	-0.216 (0.00)	$\beta_4$	0.104 (0.00)	$\theta$	0.444 (0.00)	$\gamma_{33}$	0.069 (0.00)	$\gamma_{66}$	-0.052 (0.00)
$\alpha_5$	-0.194 (0.00)	$\beta_5$	0.075 (0.00)	$\gamma_{11}$	-0.007 (0.84)	$\gamma_{34}$	-0.045 (0.00)	$\gamma_{67}$	0.043 (0.00)
$\alpha_6$	-0.125 (0.00)	$\beta_6$	0.081 (0.00)	$\gamma_{12}$	-0.154 (0.00)	$\gamma_{35}$	-0.036 (0.00)	$\gamma_{68}$	-0.009 (0.28)
$\alpha_7$	0.063 (0.09)	$\beta_7$	-0.032 (0.02)	$\gamma_{13}$	-0.010 (0.61)	$\gamma_{36}$	-0.032 (0.00)	$\gamma_{69}$	0.013 (0.28)
$\alpha_8$	-0.323 (0.00)	$\beta_8$	0.119 (0.00)	$\gamma_{14}$	0.160 (0.00)	$\gamma_{37}$	0.007 (0.65)	$\gamma_{77}$	-0.063 (0.03)
$\alpha_9$	0.008 (0.72)	$\beta_9$	-0.014 (0.06)	$\gamma_{15}$	0.043 (0.01)	$\gamma_{38}$	0.047 (0.00)	$\gamma_{78}$	0.025 (0.20)
$\lambda_1$	0.019 (0.00)	$\delta_1$	-0.001 (0.11)	$\gamma_{16}$	0.012 (0.27)	$\gamma_{39}$	-0.034 (0.16)	$\gamma_{79}$	0.033 (0.27)
$\lambda_2$	0.010 (0.00)	$\delta_2$	0.000 (0.12)	$\gamma_{17}$	0.008 (0.73)	$\gamma_{44}$	-0.038 (0.00)	$\gamma_{88}$	-0.039 (0.11)
$\lambda_3$	-0.011 (0.00)	$\delta_3$	0.007 (0.00)	$\gamma_{18}$	-0.035 (0.11)	$\gamma_{45}$	-0.041 (0.00)	$\gamma_{89}$	-0.035 (0.15)
$\lambda_4$	-0.010 (0.00)	$\delta_4$	-0.007 (0.00)	$\gamma_{19}$	-0.017 (0.36)	$\gamma_{46}$	-0.010 (0.02)	$\gamma_{99}$	0.138 (0.00)
$\lambda_5$	-0.006 (0.00)	$\delta_5$	0.004 (0.00)	$\gamma_{22}$	-0.001 (0.68)	$\gamma_{47}$	-0.010 (0.33)		
$\lambda_6$	-0.008 (0.00)	$\delta_6$	-0.005 (0.00)	$\gamma_{23}$	0.033 (0.00)	$\gamma_{48}$	-0.035 (0.00)		
$\lambda_7$	0.008 (0.00)	$\delta_7$	-0.002 (0.00)	$\gamma_{24}$	0.054 (0.00)	$\gamma_{49}$	-0.035 (0.01)		
$\lambda_8$	-0.007 (0.00)	$\delta_8$	-0.004 (0.00)	$\gamma_{25}$	0.051 (0.00)	$\gamma_{55}$	-0.010 (0.53)		
$\lambda_9$	0.004 (0.00)	$\delta_9$	-0.222 0.000	$\gamma_{26}$	0.065 (0.00)	$\gamma_{56}$	-0.031 (0.00)		

Log-likelihood: 275998.9

Parameters estimated: 69

Observations: 29463

\*Figures in parenthesis denote p-values.

TABLE 2: Selected Parameter Estimates\*

	<i>3 goods</i>	<i>5 goods</i>	<i>7 goods</i>		<i>3 goods</i>	<i>5 goods</i>	<i>7 goods</i>
$\alpha_1$	2.945 (0.00)	1.789 (0.00)	1.755 (0.00)	$\delta_1$	-0.006 (0.00)	0.001 (0.14)	0.000 (0.68)
$\alpha_2$	-3.560 (0.00)	0.092 (0.46)	0.025 (0.84)	$\delta_2$	-0.005 (0.00)	0.008 (0.00)	0.006 (0.00)
$\alpha_3$	1.614 (0.00)	-1.036 (0.00)	-0.698 (0.00)	$\delta_3$	0.011 (0.00)	-0.005 (0.00)	-0.005 (0.00)
$\alpha_4$	-	-0.615 (0.00)	-0.835 (0.00)	$\delta_4$	-	0.003 (0.00)	0.003 (0.00)
$\alpha_5$	-	0.770 (0.00)	0.967 (0.00)	$\delta_5$	-	-0.006 (0.00)	-0.001 (0.32)
$\alpha_6$	-	-	-0.581 (0.00)	$\delta_6$	-	-	0.001 (0.38)
$\alpha_7$	-	-	0.367 (0.04)	$\delta_7$	-	-	-0.004 (0.00)
$\beta_1$	-0.533 (0.00)	-0.304 (0.00)	-0.299 (0.00)	$\lambda_1$	0.025 (0.00)	0.013 (0.00)	0.013 (0.00)
$\beta_2$	1.023 (0.00)	0.137 (0.00)	0.151 (0.00)	$\lambda_2$	-0.060 (0.00)	-0.012 (0.00)	-0.012 (0.00)
$\beta_3$	-0.490 (0.00)	0.220 (0.00)	0.156 (0.00)	$\lambda_3$	0.036 (0.00)	-0.011 (0.00)	-0.008 (0.00)
$\beta_4$	-	0.113 (0.00)	0.156 (0.00)	$\lambda_4$	-	-0.005 (0.00)	-0.007 (0.00)
$\beta_5$	-	-0.166 (0.00)	-0.206 (0.00)	$\lambda_5$	-	0.014 (0.00)	0.012 (0.00)
$\beta_6$	-	-	0.136 (0.00)	$\lambda_6$	-	-	-0.004 (0.00)
$\beta_7$	-	-	-0.094 (0.01)	$\lambda_7$	-	-	0.006 (0.00)
LL	23016.19	72929.97	93456.59	$\rho$	0.211 (0.00)	0.094 (0.00)	0.113 (0.00)
Estimated Para.	12	27	46				

\*Figures in parenthesis denote p-values. See Appendix for description of these items.

Table 3: Quintile Shares of Total Expenditure in the 9-Item Case

Quintile	<i>Nominal Expenditure Share</i>				<i>Real Expenditure Share</i>			
	1988/9	1993/4	1998/9	2003/4	1988/9	1993/4	1998/9	2003/4
1	7.737	8.051	7.867	7.447	7.742	7.969	7.761	6.476
2	12.765	12.985	12.798	12.557	12.780	12.725	12.427	11.230
3	17.597	17.467	17.436	17.587	17.590	17.203	17.062	16.194
4	23.516	23.291	23.406	23.514	23.502	23.281	23.319	23.534
5	38.403	38.228	38.511	38.885	38.405	38.824	39.422	42.550

Table 4: Quintile Shares of Total Expenditure in the 3-Item Case

Quintile	<i>Nominal Expenditure Share</i>				<i>Real Expenditure Share</i>			
	1988/9	1993/4	1998/9	2003/4	1988/9	1993/4	1998/9	2003/4
1	9.722	9.308	9.505	9.095	9.722	9.216	9.291	8.668
2	14.353	14.157	14.379	14.121	14.353	14.088	14.182	13.737
3	18.066	17.756	18.160	17.812	18.066	17.716	18.026	17.604
4	22.686	22.238	22.881	22.816	22.686	22.241	22.869	22.854
5	35.173	36.542	35.075	36.156	35.173	36.738	35.633	37.137

Table 5: Nominal and Real Expenditure Inequalities

Year	NOMINAL			REAL		
	GINI	Atkinson $\epsilon=0.5$	$\epsilon=2$	GINI	Atkinson $\epsilon=0.5$	$\epsilon=2$
1988/9	0.308	0.076	0.287	0.308	0.076	0.286
1993/4	0.302	0.073	0.270	0.309	0.076	0.276
1998/9	0.306	0.075	0.278	0.317	0.080	0.287
2003/4	0.315	0.080	0.297	0.361	0.105	0.364

Table 6: Decomposition of Atkinson Inequality for Nominal Expenditure in 2003/4 by Family Type

<i>Nominal Expenditure Inequality</i>			
Family Type	$\epsilon=0.5$	$\epsilon=1$	$\epsilon=2$
2 Adults only	0.084	0.164	0.309
2 Adults and 1 child	0.057	0.113	0.224
2 Adults and 2 children	0.053	0.106	0.217
All others	0.084	0.162	0.304
<i>Inequality Decomposition</i>			
	$\epsilon=0.5$	$\epsilon=1$	$\epsilon=2$
Within-group Inequality	0.079	0.154	0.292
Between-group Inequality	0.001	0.002	0.006
Total Inequality	0.080	0.157	0.299

Table 7: Decomposition of Atkinson Inequality for Real Expenditure in 2003/4 by Family Type

<i>Real Expenditure Inequality</i>			
Family Type	$\epsilon=0.5$	$\epsilon=1$	$\epsilon=2$
2 Adults only	0.088	0.170	0.319
2 Adults and 1 child	0.059	0.116	0.230
2 Adults and 2 children	0.056	0.112	0.226
All others	0.113	0.214	0.382
<i>Inequality Decomposition</i>			
	$\epsilon=0.5$	$\epsilon=1$	$\epsilon=2$
Within-group Inequality	0.096	0.184	0.338
Between-group Inequality	0.009	0.019	0.040
Total Inequality	0.105	0.203	0.378

Table 8: Sensitivity of Demand Estimates to Equivalence Scale Specification\*

	$\delta_i=0$	$\delta_i \neq 0$		$\delta_i=0$	$\delta_i \neq 0$
Para.	Estimate <sup>a</sup>		Para.	Estimate <sup>a</sup>	
$\gamma_{11}$	-0.379 (0.00)	-0.505 (0.00)	$\beta_1$	-0.306 (0.00)	-0.304 (0.00)
$\gamma_{12}$	0.124 (0.01)	0.214 (0.00)	$\beta_2$	0.153 (0.00)	0.137 (0.00)
$\gamma_{13}$	-0.600 (0.16)	0.844 (0.00)	$\beta_3$	0.208 (0.00)	0.220 (0.00)
$\gamma_{14}$	-0.794 (0.07)	0.678 (0.02)	$\beta_4$	0.109 (0.00)	0.113 (0.00)
$\gamma_{15}$	1.650 (0.05)	-1.232 (0.03)	$\beta_5$	-0.165 (0.00)	-0.166 (0.00)
$\gamma_{22}$	0.003 (0.95)	-0.080 (0.09)	$\lambda_1$	0.013 (0.00)	0.013 (0.00)
$\gamma_{23}$	0.717 (0.06)	-0.573 (0.02)	$\lambda_2$	-0.012 (0.00)	-0.012 (0.00)
$\gamma_{24}$	0.816 (0.04)	-0.516 (0.04)	$\lambda_3$	-0.010 (0.00)	-0.011 (0.00)
$\gamma_{25}$	-1.660 (0.03)	0.955 (0.06)	$\lambda_4$	-0.004 (0.00)	-0.005 (0.00)
$\gamma_{33}$	10.481 (0.03)	-5.477 (0.07)	$\lambda_5$	0.014 (0.00)	0.014 (0.00)
$\gamma_{34}$	10.921 (0.03)	-5.486 (0.08)	$\delta_1$	-	0.001 (0.14)
$\gamma_{35}$	-21.520 (0.03)	10.691 (0.08)	$\delta_2$	-	0.008 (0.00)
$\gamma_{44}$	11.343 (0.02)	-5.540 (0.08)	$\delta_3$	-	-0.005 (0.00)
$\gamma_{45}$	-22.286 (0.02)	10.864 (0.08)	$\delta_4$	-	0.003 (0.00)
$\gamma_{55}$	43.816 (0.02)	-21.278 (0.09)	$\delta_5$	-	-0.006 (0.00)
$\alpha_1$	1.794 (0.00)	1.789 (0.00)	$\rho$	0.138 (0.00)	0.094 (0.00)
$\alpha_2$	0.015 (0.91)	0.092 (0.46)	LL	72832.03	72929.97
$\alpha_3$	-0.978 (0.00)	-1.036 (0.00)			
$\alpha_4$	-0.592 (0.00)	-0.615 (0.00)			
$\alpha_5$	0.762 (0.00)	0.770 (0.00)			

\*These correspond to the 5 item breakdown of household expenditure – see Appendix.

a: The figures in parenthesis denote p-values.

Table 9: Sensitivity of Nominal Expenditure Inequality Estimates to Equivalence Scale Specification

year	$\delta_i=0$ Atkinson			$\delta_i \neq 0$ Atkinson		
	GINI	$\epsilon=0.5$	$\epsilon=2$	GINI	$\epsilon=0.5$	$\epsilon=2$
1988	0.301	0.074	0.257	0.300	0.073	0.259
1993	0.304	0.074	0.273	0.303	0.074	0.273
1998	0.305	0.075	0.280	0.304	0.074	0.281
2003	0.308	0.077	0.282	0.308	0.077	0.284

Table 10: Sensitivity of Real Expenditure Inequality Estimates to Equivalence Scale Specification

year	$\delta_i=0$ Atkinson			$\delta_i \neq 0$ Atkinson		
	GINI	$\epsilon=0.5$	$\epsilon=2$	GINI	$\epsilon=0.5$	$\epsilon=2$
1988	0.301	0.074	0.257	0.300	0.073	0.259
1993	0.302	0.073	0.270	0.300	0.073	0.270
1998	0.304	0.074	0.279	0.303	0.074	0.280
2003	0.309	0.077	0.284	0.309	0.077	0.287

Figure 1: Lorenz Curves of Nominal and Real Expenditures in 1993/4

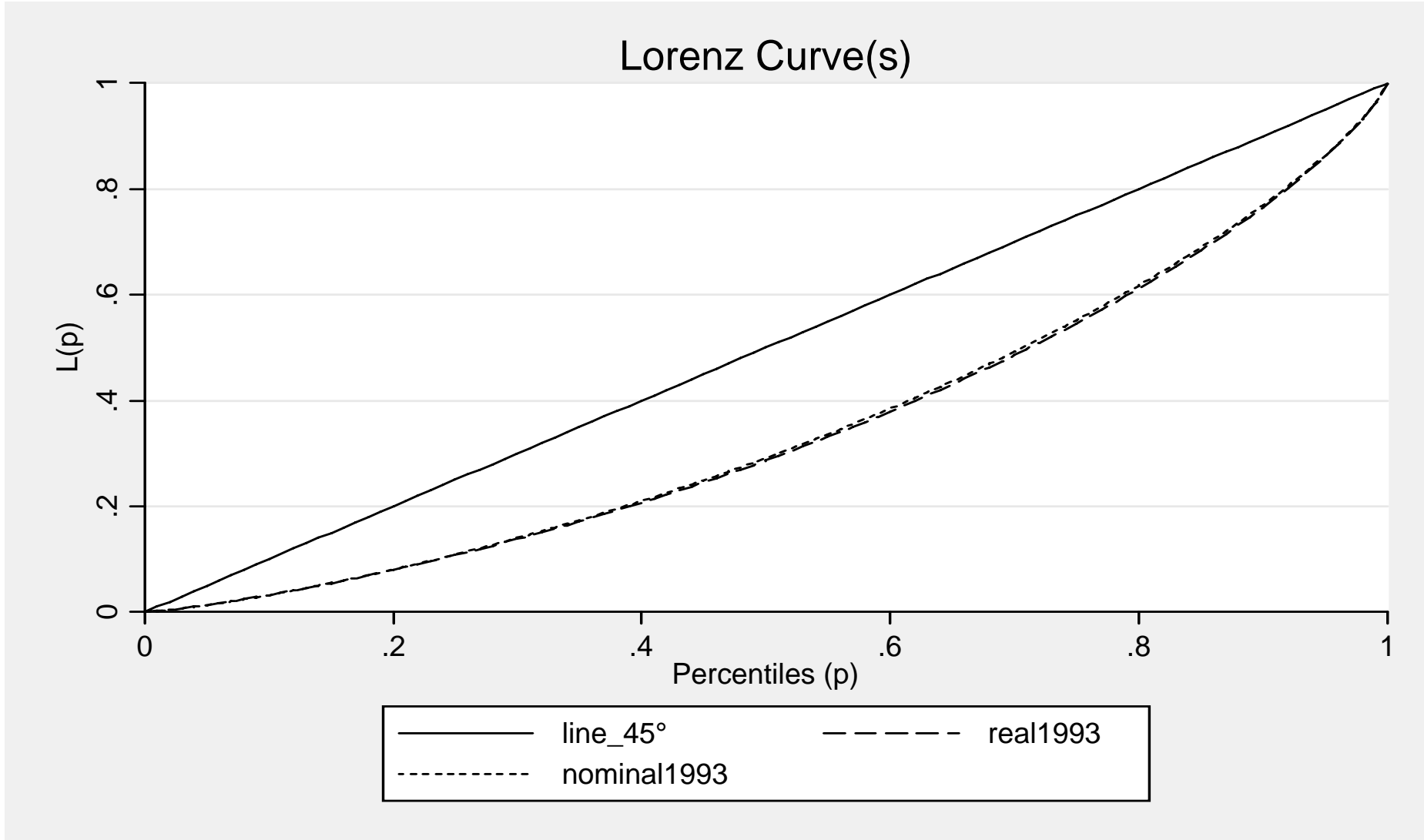


Figure 2: Lorenz Curves of Nominal and Real Expenditures in 1998/9



Figure 3: Lorenz Curves of Nominal and Real Expenditures in 2003/4

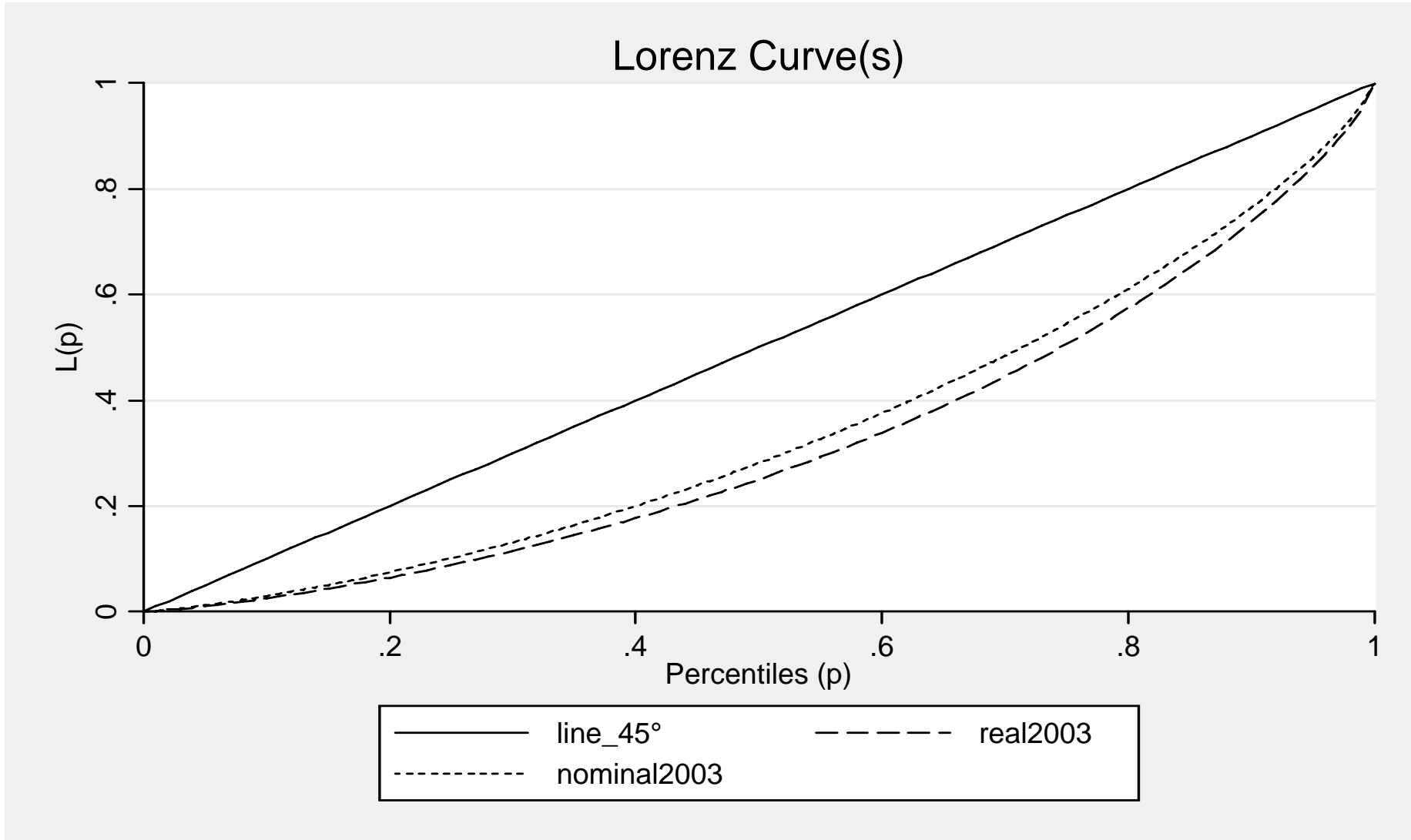
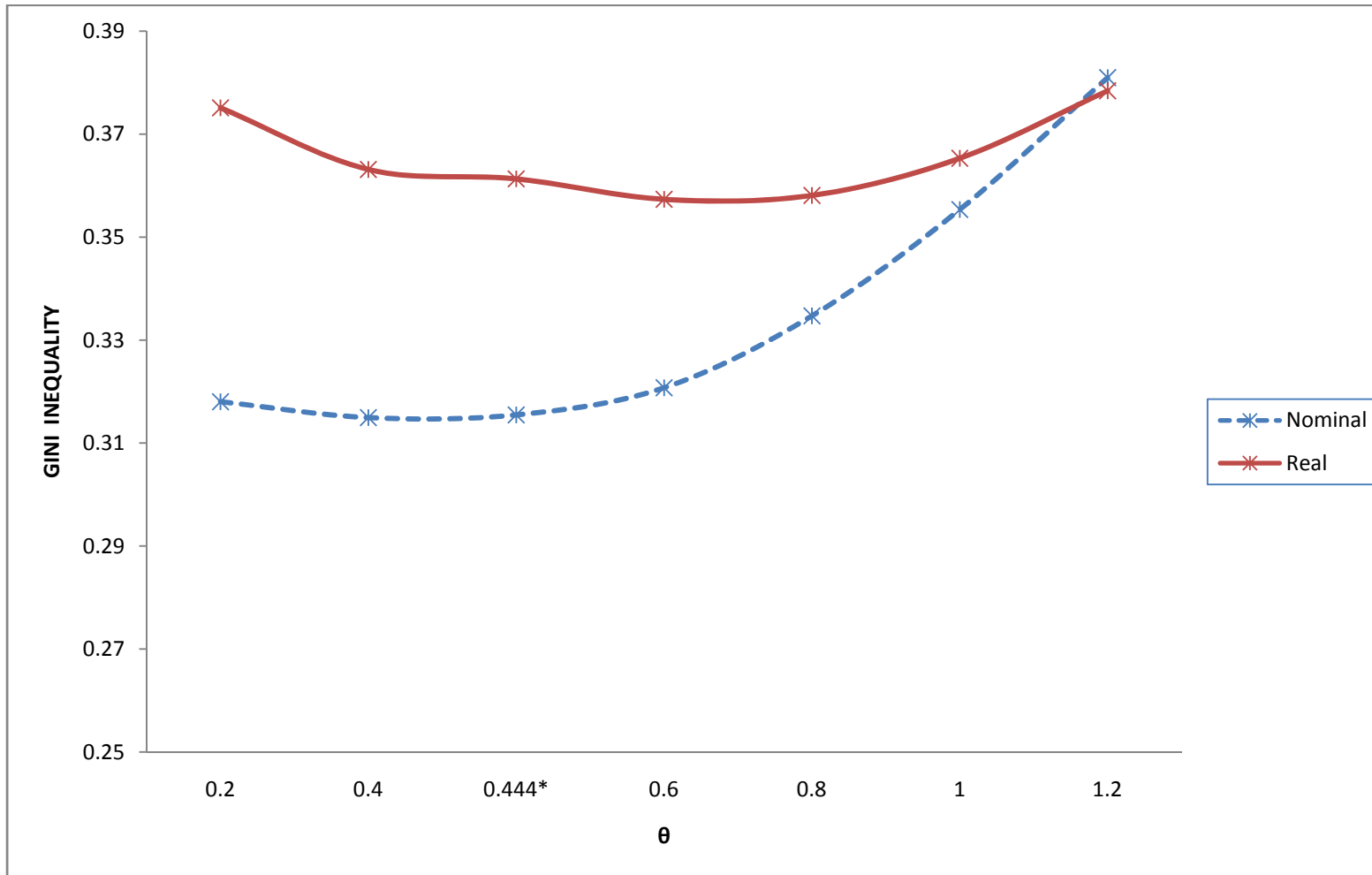


Figure 4: Relationship between Expenditure Inequality and Household Size Economies ( $\theta$ )



\*Original value of  $\theta$  estimated by the 9 goods PS-QUAIDS specification.

## APPENDIX: Data details

Commodity Groupings:

The 3, 5, 7 and 9 item groupings are as follows:

3-Item Group: Electricity and Household Fuel; Food and Non-Alcoholic Beverages; Clothing and Footwear

5-Item Group: Electricity and Household Fuel; Food and Non-Alcoholic Beverages; Alcohol and Tobacco; Clothing and Footwear; Transport, Health and Personal Care, Recreation, Furniture, Miscellaneous.

7-Item Group: Electricity and Household Fuel; Food and Non-Alcoholic Beverages; Alcohol and Tobacco; Clothing and Footwear; Transport; Health and Personal Care, Recreation, Miscellaneous; Furniture.

9-Item Group: Housing; Electricity and Household Fuel; Food and Non-Alcoholic Beverages; Alcohol and Tobacco; Clothing and Footwear; Health and Personal Care; Transport; Recreation; Miscellaneous

For the first three commodity aggregations, the exercise was conducted on couples with no children and with children below 15 years of age. The sample sizes for each year are as follows: [3124 in 1988/9, 3614 in 1993/4, 2959 in 1998/9 and 2667 in 2003/4]. This gave a total of 12364 households.

The exercise in the case of the 9 item aggregation was performed on all the observations in the pooled data sets (29463 in total) consisting of 7225 in 1988/9, 8389 in 1993/4, 6892 in 1998/9 and 6957 in 2003/4.

The price series for the first 3 item groupings was calculated as a weighted average of the CPI (published by the ABS) in the 8 capital cities, with a base of 1.0 for 1988/9. In the case of the 9-item grouping, the CPI series was matched with each quarter and state that the HES was carried out in, and similarly based in the first quarter in 1988.