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Inequality, Welfare, Household Composition and Prices
A Comparative Study on Australian and Canadian Data

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Submitted in the fulfilment of the requirements

for the degree of

Doctor of Philosophy

University of Tasmania

June 2002

Declaration

This thesis contains no material which has been accepted for the award of any other higher degree or graduate diploma in any university, and, to the best of my knowledge and belief, contains no material previously published or written by another person, except when due reference is made in the text of the thesis.

…..………………………

Paul Andrew Blacklow

June 2002

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The Australian price and 1998-99 Household Expenditure Survey data were made available through the agreement between the Australian Bureau of Statistics (ABS) and the Australian Vice-Chancellors' Committee (AVCC). All survey data used in this thesis was confidentialised by the appropriate statistical agency before being obtained.

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Paul Andrew Blacklow

June 2002

Abstract

This thesis examines and compares the nature, magnitude and movement in the inequality of income and expenditure of Australian households from 1975-76 to 1998-99 and Canadian households from 1978 to 1992. The inequality of welfare impacts on an individual's feelings of belonging and participation in society and the level of social division within it. It may have such tangible effects as political unrest and increased crime. This raises the issue of, what is happening to the inequality of welfare and how to measure household welfare and inequality?

The thesis considers the normative judgements made in measuring the inequality, desirable properties of inequality indices and the appropriate variable to represent household welfare. It finds in favour of expenditure as a more appropriate measure of a household's living standards than income and that equivalence scales and cost of living indices should be used to account for variation in household composition and prices.

The majority of past studies of Australian and Canadian inequality report an increase in income inequality throughout the latter half of the 20th century. However, the timing and size of increase is dependent upon the inequality indices, equivalence scales and sample selection used in each study. While many studies have focussed on the distribution of income, few have considered the inequality of expenditure or the explicit role of prices in inequality movements via a cost of living index. The thesis specifies a demographically extended complete demand system and uses household survey and price data to obtain estimates of its parameters to construct and compare alternate equivalence scales and demographically varying cost of living indices.

The independence of the equivalence scale to reference utility was found not to hold suggesting that welfare comparisons between households of varying demographic types will be dependent on the specification of the household cost function. While the estimated price elasticities vary significantly across households, prices of commodity groups have moved such that the change in the cost of living over time is relatively uniform across households.

The thesis finds that the real adult equivalent disposable income inequality of households has been rising in Australia consistently from 1975-76 to 1998-99, while real adult equivalent expenditure inequality recorded a fall over the period as a whole. In contrast, the inequality of Canadian household real adult equivalent disposable income and expenditure, have moved together, rising from 1978 to 1986 before falling in 1992. Australia has a higher magnitude of inequality in the distribution of household equivalent expenditure compared to Canada. The decline in the inequality of accommodation expenditure has been significant for Australia and Canada in offsetting the rise in inequality of expenditure on food and alcohol and tobacco. The rise in wage inequality and to a lesser extent investment income inequality, have largely accounted for the rise in gross income inequality in both countries.

The thesis finds that the movement in Australian inequality is not overly sensitive to equivalence scale specification, although Engel, OECD and per capita scaled welfare tend to exaggerate the movement when compared to demand system based scales. In Canada from 1982 to 1986 changes in household composition resulted in significant difference in the movement of inequality estimates for different equivalence scales. The Engel, OECD and per capita based estimates showed a fall in inequality in contrast to the demand system based scales. The magnitude and the movement in inequality for both countries are insensitive to the specification of price indices. Excluding observations from the original sample can have extreme consequences on the reported magnitude and trend in inequality.

By exploiting the additive decomposability property of inequality, the employment status and education level of the household head for Australia and Canada respectively, were found to have a large effect on the magnitude and movement in inequality. Age of the household head and the demographic type of the household were found to explain less than a sixth of the magnitude and trend in household inequality for both Australia and Canada.

To summarise, this thesis makes the following contributions:

Methodological

i) It considers the normative judgements made in measuring inequality, the desirable properties of inequality indices and the appropriate variable to use to represent household welfare.

ii) It accounts for differences amongst the demographic composition of households by using equivalence scales based upon an explicitly defined demographic extended demand system.

iii) It accounts for price movements by developing a cost of living index based upon an explicitly defined demographic household cost function and complete demand system.

Empirical

i) Real adult equivalent disposable income inequality of households has been rising in Australia consistently from 1975-76 to 1998-99, while real adult equivalent expenditure inequality recorded a fall over the period as a whole.

ii) In contrast Canadian household real adult equivalent disposable income and expenditure inequality have moved together, rising from 1978 to 1986 before falling in 1992.

iii) The movement in Australian and Canadian inequality is not overly sensitive to different demand system based scales but Engel, OECD and per capita scaled estimates tend to exaggerate the movement of Australian inequality and report movements in Canadian inequality from 1982-1986 reverse to the demand system based scales.

iv) The magnitude and the movement in inequality for both countries are not very sensitive to the specification of price indices. However there is evidence that regional price movements in Canada have helped to offset inequality, while allowing for differing price impacts across households using the CLI reduces this effect. For Australia price movements appear to have reduced the fall in expenditure inequality and increased the rise in income inequality slightly.

v) Excluding observations from the original sample can have extreme consequences on the reported magnitude and trend in inequality.

vi) Employment status and education level of the household head for Australia and Canada respectively, were found to have a large effect on the magnitude and movement in inequality. Greater than, what could be explained by decomposing by age of the household head or the demographic type of the household.

Acknowledgments

This thesis represents the culmination of a process originally began in 1995 in which I have learn a great deal about research projects and acquired important research skills. I would like to thank Prof. Ranjan Ray for his advice, guidance and eternal patience over the past 5 years. Particularly in reading the numerous drafts and suggesting improvements to the text, layout and style. I would also like to thank Dr. Nic Groenewold for his initial supervision of my earlier topic before moving from Tasmania to U.W.A as a result of the funding cuts to higher education in 1997. Throughout my candidature I have been assisted by Dr Hugh Sibly and Dr Bruce Felmingham as associate supervisors and also other academic staff, all to whom I am grateful. I wish to thank Geoff Lancaster for his experience and assistance in handling large data sets and SAS programming as well as his general encouragement, support and friendship. I would like to thank and acknowledge the support of Tracy Kostiuk and Sue Abel, simultaneously the office, secretarial and IT staff of the school, particularly to Tracy for helping me with the formatting and footnotes of the final document. The academic and social environment in School of Economics at the University of Tasmania was inspiring and supportive, a tribute to the collegiality of the school and the academic leadership of Prof Ranjan Ray and Dr Bruce Felmingham, the heads of school over my candidature, through somewhat troublesome times.

I wish to thank the Tasmanian University Union and the Tasmanian University Postgraduate Association for looking after my social and education needs while a post-graduate student. Thank you to the Faculty of Commerce for granting me a Tasmanian University scholarship for the first three and half years of my PhD candidature. Thank you to the School of Economics, particularly the heads of school for providing me with employment over the later half of candidature.

I wish to thank my parents for their emotional and financial support and my sister and brother for their encouragement and inspiration to complete a higher degree. I would also like to thank the encouragement and confidence from my friends, extended family members and particularly my grand parents who unfortunately did not live to see my PhD's completion. Similarly for my PhD Cat who survived six years of moving and share-house living before succumbing to the pressure of the PhD. Finally I wish to thank my wife, Annette for her patience, support and understanding.

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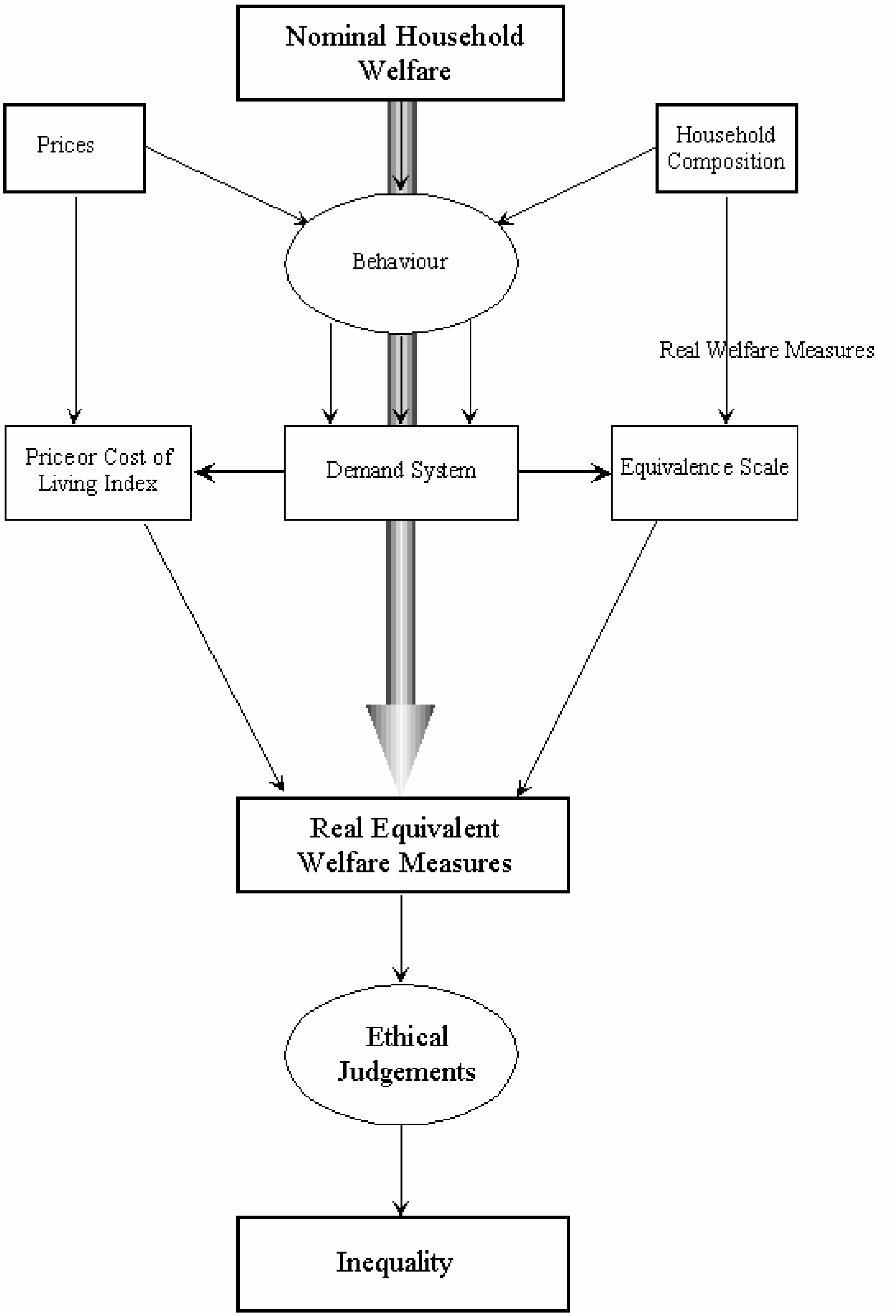
Chapter 1 Introduction

The inequality of welfare impacts on an individual's feelings of belonging and participation and the level of social division within a society. Significant increases in inequality may have such tangible effects as political unrest and increased crime. This raises the issue of, what is happening to the inequality of welfare and how to measure it? While it is common to use inequality indices or social welfare functions to characterise the dispersion of welfare, the explicit or implicit assumptions of their properties have significant effects upon the measurement of inequality. The choice of the variable to represent welfare also raises the question, what variable best measures welfare and what does the resulting index of inequality measure? Household level data is usually the only source of comprehensive data containing indicators of welfare for inequality studies, which raises the issue of how to use equivalence scales to facilitate welfare comparisons across households of different size and composition. Households also frequently face different prices and price movements due to geographical dispersion and may be affected differently by prices, depending upon their demographics and level of welfare. This raises the issue of how to measure the general level of prices through price and cost of living indices?

This thesis examines these issues mentioned above, in light of measuring the magnitude and trend in inequality for Australia from 1975-76 to 1998-99 and for Canada from 1978 to 1992. In order to make inferences about the distribution of welfare, one needs to ensure that the price index and equivalence scale used, adequately describes the effect of prices and household demographics on welfare. Figure 1.1 illustrates the link between the various concepts and information that allows the analysis of inequality based on explicit assumptions about household behaviour and judgments about inequality. Through assumptions about consumer behaviour, cost of living indices and equivalence scales can be recovered from demand analysis.

Figure 1.1 Flow Chart Of Concepts



These indices and scales can be used to deflate nominal household indicators of welfare (such as income) into real adult equivalent (or money metric) measures of welfare in a theoretical framework with explicit assumptions about behaviour. The inequality of real adult equivalent welfare can then be evaluated by considering the properties and ethical judgements made in choosing an index to quantify inequality. This thesis examines inequality, using indices with different sensitivities to inequality so as to examine the effects of ethical judgements on inequality measurement. An inequality index may be said to be more sensitive to inequality if it gives weight to welfare gains and losses at the lower end of welfare distribution than the upper end. It considers both disposable income and expenditure adjusted for variations in household size and prices with a range of equivalence scales and price indices, as measures of welfare. The study also analyses the nature of the movement in inequality over the two periods through the additively decomposable nature of the inequality indices employed.

1.1 Economics and Inequality

The analysis of the distribution of production and the issue of liberty versus equality was a central concern of the classical political economists. Ricardo (1817) believed that the study of the distribution of production was the principle problem in political economy. Coupled with the rise of Social Darwinism[1] and the establishment of General Equilibrium Theory[2], Adam Smith (1776) and David Ricardo established a tradition of liberal economic thought. Growing insecurity, inequality and falling production of the Great Depression, gave rise to Marx's (1867)

[1] Principally from Spencer (1897).
[2] From Walras (1874).

more radical views on problems of inequality within capitalism[3]. However, through the 1950s to the mid 1970s, the rise to prominence of the general equilibrium theory[4], solid economic growth and increases in education and social services, resulted in a relatively stable income distribution, in turn leading to a decline in the concern for inequality.

Since the 1970s economists have focussed more on the measurement of social welfare, inequality and its associated issues in a theoretically consistent model rather than the merits and costs of inequality. One of the earliest approaches to measurement of social welfare was the utilitarian approach pioneered by Bentham (1789). It proposed that the sum of individual utilities is an appropriate measure of social welfare. This measure was widely used in the late 19th and early 20th centuries to make social judgements and to judge alternative income distributions. Pigou (1912) assumed that interpersonal comparability was possible and argued that as long as one assumed that people have the same "equal capacity" for satisfaction, then the principle of diminishing marginal utility by itself might be enough to make pronouncements about the general desirability of equity. Robbins' (1938) and Hicks' (1939) critique of utilitarianism and cardinal utility led to a reliance on Pareto's (1906) Principle as the fundamental tool to judge alternative states of nature. Arrow's (1951) Impossibility Theorem, that interpersonal comparisons were impossible under a set of reasonable assumptions for ordinal utility, combined with the Pareto Principle halted theoretical and practical developments in the evaluation of inequality, until the pioneering work of Kolm (1969), Atkinson (1970) and Sen (1970).

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[3] Marx believed that under capitalism there was an inherent unequal distribution of land and capital ownership and exploitation of the working class and that this would lead to its downfall.

[4] Arrow and Debreu (1954) and Debreu (1959)'s work in extending the general equilibrium theory, established that perfect and complete competitive markets would achieve a Pareto–efficient allocation of resources given a certain initial endowment.

By taking a less nihilist view, Sen (1970) demonstrated that welfare comparisons and social welfare functions were possible and valid, by relaxing non-comparability and allowing the social analyst to weigh individuals' welfare gains and losses. Roberts (1980c) defined a number of other relaxations to the measurability and comparability assumptions, which allow the number of formulisations that can be established with non-dictatorial social welfare functions, to be expanded. Kolm (1969) and Atkinson (1970) considered the practical implications of the aggregation of individual welfare into social welfare functions and considered the link between such functions and their ethical bias.

In the Kolm-Atkinson framework, the social welfare function is defined on the distribution of 'income' rather than the distribution of individual utility or welfare. Muellbauer (1974) extends the approach to define the social welfare function on the distribution of money metric individual welfare such that the measure of welfare is adjusted with a price index and an equivalence scale based on demographics in a utility consistent measure. Muellbauer demonstrates that measures of social welfare based on 'income' coincide with measures based on individual welfare if and only if preferences are homothetic and identical for all consuming units. Roberts (1980a) extends the Muellbauer analysis to show that the restrictions on preferences under which measures of price independent welfare can be used to construct social welfare functions, are extremely restrictive.

Muellbauer's and Roberts' analyses suggest that prices and demographic factors that may alter preferences should be considered in constructing a money metric measure of welfare. While most inequality studies adopt the use of price indices and equivalence scales, income is still the most commonly used indicator of welfare. McGregor and Borooah (1992), Kakwani (1993), Slesnick (1994), Johnson and Shipp (1997), among others, argue that consumption expenditure is a more appropriate indicator of well being, since utility is derived from the consumption of goods and services. An argument often expressed in favour of use of expenditure in inequality comparisons is based on the fact that expenditure is less subject, than income, to short term fluctuations since households can smooth away the former by adjusting savings – see, for example, Blundell and Preston (1998). Moreover, given the reality of income concealment to escape taxation, income data is notoriously unreliable for use as a measure of welfare and welfare comparisons.

Until recently the Australian and Canadian literature on inequality has mostly been based on income rather than consumption expenditure. Most Australian studies have found that income inequality in Australia rose through the mid seventies to the early nineties – see, for example, Meagher and Dixon (1986), Saunders (1993), Borland and Wilkins (1996), and Harding (1997). Similarly for Canada, Buse (1982), Wolfson (1986), Phipps (1993), Blackburn and Bloom (1994) and Pendakur (1998) generally found that income inequality was rising from the 1960s through to the 1990s although with some evidence that it declined in the 1970s and late 1980s. The timing and severity of the inequality increases differed slightly according to the data, unit of analysis and the equivalence scale used to take note of differences in household size and composition. Relatively little attention has been paid to consumption inequality in Australia and Canada, or to comparisons between income and expenditure measures of inequality. For Australia, Barrett, Crossley and Worswick (1999) recently found that consumption inequality was rising but at a slower rate than income inequality from 1975-76 to 1993-94, while Blacklow and Ray (2000) found that expenditure inequality was falling over the period. For Canada, Pendakur (1998) found similar movements in expenditure and income inequality for Canada, rising in the early to mid 1980s, falling in the late 1980s before rising in 1992.

1.2 Motivation

This study seeks to answer the following three broad questions:

1.2.1 How should inequality and household welfare be measured? Specifically:

a. What are the assumptions required and the ethical judgements made in measuring inequality and household welfare in light of variations in household demographic compositions and prices?

b. Following from a., what is the preferred measure of household welfare?

c. How has inequality, equivalence scales and price indices been used in the past in measuring household welfare and inequality?

1.2.2 What has occurred to the inequality of welfare in Australia over 1975-76 to 1998-99 and Canada from 1978 to 1992? Specifically:

a. What is the difference in the magnitude and trend in income and expenditure inequality?

b. How do the estimates for Australia and Canada compare?

1.2.3 How does the measurement of welfare impact on the reported level and trend in the inequality of welfare for Australia and Canada? Specifically:

c. How do different equivalence scales impact upon the magnitude and trend in inequality?

d. How do price or cost of living indices impact upon the magnitude and trend in inequality?

e. How do different sample selections or units of analysis affect the magnitude and trend in income and expenditure inequality?

1.2.4 What economic or social changes can be identified as responsible for the magnitude and change in inequality in Australia and Canada?

The following section discusses the background to these questions and the methods used in achieving them.

1.2.1 Inequality

One would expect an unequal distribution of income to arise in a capitalist economy, where there is dispersion in the level of human capital and ownership of physical capital. However improving education standards and progressive taxation in many managed capitalist economies may curtail inequality and even allow the inequality of welfare to fall in such economies over time. One could argue that this indeed is an implicit or explicit goal of such societies. The analysis of the trend in inequality also serves to identify whether everybody shared equally in the long-term economic growth and apparent rise in standard of living.

One argument for equality is to view production as a social phenomenon and thus should be divided equally amongst society. This is similar to the view that equality is a public good that provides a happier, less envious and crime ridden society. The strongest moral argument for equality is the elimination of poverty. Increases in poverty are associated with increases in relationship breakdowns, drug abuse and crime. If individuals lack the necessities of life then they must endure suffering which may impose a negative externality upon those above the poverty line.

Stiglitz (1995) points out that there is no presumption that free markets and the distribution in accordance with them, will maximise national income or that increased rates of taxation on high incomes or estates would reduce innovation and production. Galor and Zeira (1993) show that increases in income inequality are likely to have negative impacts on aggregate economic activity in the short and long run. Chiu's (1998) theoretical model shows that given capital market imperfection and a variety of innate abilities, greater income inequality can imply lower human capital accumulation and deterioration in the distribution of the initial incomes for subsequent generations.

Australia and Canada have had similar histories, both were former British colonies that prospered due to their exports of agricultural and mineral produce. They are both managed capitalist economies with progressive income taxation and comprehensive government payment and education systems. While not necessarily true, both countries were traditionally regarded as egalitarian societies by their citizens. Indeed many members of the two countries express a concern for social justice and cohesion and distaste for inequality.

The expansion of global trade and shifts in tastes in the twentieth century has caused the prices for much of Australia's and Canada's traditional produce to fall. Consequently both countries have suffered high rates of unemployment in world recessions with many workers becoming unemployed for long periods due to the structural changes in their economies. Much of the workforce moved from the traditional agricultural and mining sectors to the service sector in both Australia and Canada. There has also been a strong decline in full-time work but a rise in part-time work. Saunders and Hobbes (1988) note that in both countries market incomes account for 90% and government benefits 9% of gross income similar to the U.S. but much different to Sweden.

Both countries have also experienced a number of similar social phenomena, such as a decline in fertility rates, resulting in an aging population, higher divorce rates with more single parent families, a greater number of women in the workforce and an urbanisation of the population. These economic and social factors over the last two to three decades are likely to impact upon the two countries' population's distribution of welfare in the two countries. This raises the question and principle motivation of this study, namely what has occurred to the inequality of welfare over this period in Australia and Canada?

1.2.2 Impact of the Measurement of Real Equivalent Welfare on Inequality

While the inequality in Australia and Canada has been examined before, many studies have not comprehensively considered the measurement of welfare, inequality and the role of household composition and prices. Previous studies have frequently differed in their conclusions on the magnitude and trend of inequality. This is primarily due to the variety of data sets, methods and variables used to measure welfare in each study. This provides the secondary motive for this study, to examine how choices made in the measurement of welfare impacts upon inequality. More specifically the study seeks to; a) compare and contrast the use of income and expenditure as measures of welfare in evaluating inequality; b) examine the effect of equivalence scales choice on inequality; c) study the sensitivity of inequality to the choice of price indices and d) to investigate the effect of sample selections on inequality. Moreover, the study presents the picture on inequality movements, disaggregated by household types, which may be quite different to aggregate figures. These four sub motives are elaborated on below.

a) Income and Expenditure as Measures of Welfare

Up until the late 1990s the majority of Australian and Canadian inequality studies have been based upon the distribution of income. In light of the arguments in Section 1.1, that consumption or expenditure may be a more appropriate indicator of welfare this thesis examines both the inequality of expenditure and income and compares them for Australia from 1975-76 to 1998-99 and Canada from 1978-1992.

b) Equivalence Scales

The majority of household or family inequality studies do not consider the interaction between household demographics and behaviour. Many use equivalence scales constructed from previous studies or are specified ad hoc. This thesis explicitly considers the implications of household size and composition on consumer behaviour by constructing equivalence scales from demand system estimation using the same data used to evaluate inequality. It also assesses the impact that different equivalence scales have upon the magnitude and trend in Australian and Canadian inequality.

c) Price or Cost of Living Indices

The Consumer Price Index (CPI) is used in almost all Australian and Canadian inequality studies to adjust for price movements over time. This study explicitly considers the impact of price movements on behaviour by constructing a cost of living index, from demand system estimation. The cost of living index considers different spending patterns of households and considers substitution effects unlike the CPI[5]. This thesis then considers the impact of different price and cost of living indices upon the magnitude and trend in Australian and Canadian inequality.

d) Sample selections and Units of Analysis

The data set available to researchers frequently guides the population of interest. To assess the level of inequality of the whole population, a comprehensive survey covering the whole population is required. This study uses full samples of household survey data that cover the entire population of Australian and Canadian households. This is in line with Kuznets' (1976) inclusion criterion, namely that if the welfare inequality of the whole population is of interest, the whole population should be considered. Excluding observations from the extremes of the distribution on statistical sample or narrowing the focus to sub groups of the population, is likely to cause misleading conclusions about the inequality within the population. Since many exclusions have been made from unit record data in past inequality studies, this

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[5] In this study goods are disaggregated into nine commodities, allowing substitution between broad commodity groups.

thesis, examines the effect of those choices upon the magnitude and trend in inequality.

1.2.3 Identification of Factors Responsible for Inequality

Concern has been mounting about the inequality within countries, caused by free trade and globalisation. This has resulted in large protests at many conventions representing or discussing such issues in the 21st century. What economic or social changes can be identified as responsible for the magnitude and change in inequality provides the third motive behind this study.

Australia and Canada have both experienced a number of similar social phenomena such as the trend for baby-boom children to establish their own houses, a decline in fertility rates and increased separation rates, which would tend to create smaller families and households, spreading the distribution of welfare out. This provides the motivation to adequately allow for changes in household composition over time with equivalence scales and to decompose the movement in inequality by household demographic structure. While the increase in female labour force participation experienced by most developed economies has allowed the incomes of some households to rise, the effect upon inequality depends upon where those households fall in the income distribution. Examining the movement in inequality with inequality indices of different sensitivities may shed some light on the net effect of such broad social phenomena.

The two countries chosen here have also faced a number of similar economic problems over the past 30 years. The decline in economic growth in the 1980s led the governments of Australia and Canada to adopt policies of deregulation in an attempt to regain the growth rates of the past, unleashing market forces upon industries previously protected. The liberation of international capital often encouraged production involving unskilled labour to shift to developing low cost countries. This resulted in a fall in the demand for unskilled labour in Australia and Canada, reducing the real earnings of unskilled workers and forcing many into unemployment. Deregulation also provided opportunities for skilled workers, to increase their wages, increasing inequality between skilled and unskilled workers. Increased international competition for traditionally safe markets resulted in major restructuring of the two countries, with increases in unemployment and part-time work at the expense of full-time jobs. Consequently the scope and level of government assistance to the unemployed and low income households has increased in both countries over the period. Meanwhile the rate of taxation on those on high incomes has generally been cut, with more avenues for tax minimisation and avoidance from the increased mobility of capital. This provides the motivation behind decomposing inequality by age for both countries and decomposing Australian inequality by employment status and Canadian inequality by education status of the household head.

1.3 Methods

This thesis uses the Household Expenditure Surveys (HES) 1975-76, 1984, 1998-89, 1993-94 and 1998-99 from the Australian Bureau of Statistics (ABS) and the Family Expenditure Survey (FES) 1978, 1982, 1986 and 1992 from Statistics Canada (SC) to examine the nature and movement in the inequality of welfare. These data sets contain information on household income, expenditure, demographic characteristics and other household information. Data of this nature can allow the estimation of equivalence scales and cost of living indices, so that real equivalent measures of expenditure and income can be used as measures of welfare.

While a range of equivalence scales and price indices are considered, the principal equivalence scale and cost of living index used as the basis for much of the analysis, is formed by applying Ray's (1983) price scaling technique for household demographics to the Quadratic Almost Ideal Demand System (QAIDS) of Banks, Blundell and Lewbel (1997). The "Generalised Entropy Family" (GE) of inequality indices proposed by Shorrocks (1980), is used to measure inequality since the GE indices possess a number of properties expressed as desirable in such indices. One of the properties the GE measures hold over many other indices, is that they are additively decomposable. This decomposability property allows the inequality within a population to be broken down into the inequality within population sub-groups and the inequality between such groups and can be used to identify sources of inequality. Additively decomposable measures can also be used to isolate the effects of movements in population shares of sub-groups over time from the rise in inequality within and between groups.

1.4 Structure of the Thesis

The theoretical background to the measurement of inequality and welfare is presented in Chapter 2. It begins in Section 2.1 by examining the degree of interpersonal comparability allowed and desirable properties in constructing a social welfare function. It demonstrates that social welfare functions can be defined directly over the distribution of a variable representing welfare to provide real number evaluation of welfare distributions for inequality. Desirable properties in the measurement of inequality are expressed in Section 2.2 before a selection of inequality indices are examined. Section 2.3 compares income and expenditure as measures of individual welfare. Section 2.4 demonstrates how information on prices, household composition and size can be incorporated in inequality indices with the use of money metric measures of welfare. Chapter 3 reviews the existing empirical literature on the Australia and Canadian inequality is reviewed. Section 3.1 reviews the Australian and Canadian income inequality in a recent international context.

Sections 3.2 and 3.3 contain the review of Canadian and Australian studies, respectively, primarily of income inequality but also the more recent expenditure inequality studies. Chapter 4 considers how to account for the variation in household composition and prices in measuring household welfare. Section 4.1 considers theoretical developments of equivalence scales and reviews their estimation for Australia and Canada from past studies. The construction of price indices and cost of living indices is examined in Section 4.2.

Chapter 5 discusses the Australian and Canadian data used in this study for the estimation of equivalence scales, price indices and the evaluation of inequality. In addition it examines basic statistics from the data. Chapter 6 specifies the demand system used in Section 6.1 and discusses the equivalence scales to be estimated in Section 6.2. Section 6.3 reports and compares the estimated equivalence scales for Australia and Canada. Section 6.4 specifies the cost of living index from the demographic demand system. The results of individual changes in prices and empirical price changes on the cost of living and real welfare are presented in Section 6.5 and 6.6, respectively.

In Chapter 7 the income and expenditure inequality estimates for Australia and Canada are presented, compared and discussed. In particular, Section 7.1 examines the movement in Australian and Canadian inequality, Section 7.2 and 7.3 report the sensitivity of inequality estimates to the equivalence scale and the price deflator, respectively, and Section 7.4 the sensitivity of inequality estimates to sample exclusion. Chapter 8 provides a decomposition analysis of Australia and Canadian inequality to provide insight into the factors responsible for the size and trend in inequality. Sections 8.1 and 8.2 decompose inequality for Australia and Canada by age of the household head and household demographic composition. Section 8.3 decomposes Australian inequality by the household head's employment status and Canadian inequality by the household head's education qualifications. Chapter 9 considers limitations of the analysis, suggests possible directions for future research and concludes the thesis.

Chapter 2 The Measurement of Inequality

Two approaches to the measurement of economic equality have been evident in economics literature. Inequality is sometimes objectively measured as the dispersion of individual welfare (or simply welfare). Alternatively inequality is measured through a normative concept of social welfare, such that inequality is measured by the loss it causes in social welfare, compared to social welfare of equality, for a given total of economic resources.[1] The objective approach has an advantage in that it directly identifies inequality, while the normative method allows inequality to be valued more or less in ethical terms in terms of the social welfare. However even if inequality is to be measured objectively it must relate to the normative concern for it. Normative judgment is required in the selection of objective inequality measurement, since each measure is likely to have different implicit assumptions about the 'value' of, or 'distaste' for inequality. Without knowledge of the normative assumptions involved in the measurement of inequality it is difficult to draw informed conclusions made about the size or trend of inequality.

Section 2.1 examines the normative judgements required about the degree of interpersonal comparability and the properties of the social welfare functional (SWFL) underlying the social welfare function (SWF) that can provide real number evaluation of individual welfare distributions for inequality. It demonstrates how the Inequality can be related to the SWF through the loss in SWF due to inequality. Section 2.2 examines the measurement of inequality directly over the distribution of a variable indicative of welfare. The properties commonly expressed as desirable of inequality indices are provided in 2.2.1. Alternative statistical, SWF and axiomatic measures of inequality are discussed in Sections 2.2.2, 2.2.3 and 2.2.4 respectively.

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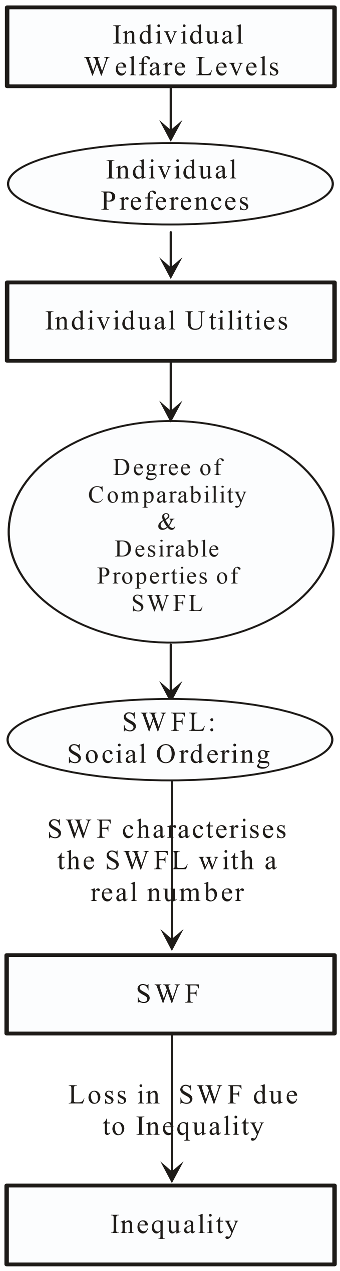
[1] See Section 2.1.9 and also, Atkinson (1970).

The measurement of inequality attempts to characterise the dispersion of a variable associated with welfare or well being, amongst the units of the population of interest. The variable used to measure a population unit's level of welfare that is typically chosen is some measure of current income. However the choice is contentious with arguments that other variables, such as current expenditure or lifetime income better represent the level of a population unit's welfare. The choice of the measure of welfare is discussed further in Section 2.3.

Section 2.4 considers the issues of prices and variations in household size and composition, in converting nominal measures of welfare into real adult equivalent or money metric measures of welfare for the use in SWF measurement. This leads to Chapter 4, which reviews the specification and empirical estimation of equivalence scales and price indices.

Figure 2.1 The Social Welfare approach to Measuring Inequality



2.1 Interpersonal Comparability and Social Welfare Functions

Regardless of whether inequality is examined objectively or normatively, the nature of the problem requires that distribution of welfare be considered. A comparison or assessment of the distribution of welfare requires interpersonal comparisons of welfare. The interpersonal comparability of welfare or well being, has fallen in and out of favour amongst economists and is still contentious today, however more attention is now focussed on how such comparisons can be made. Social welfare functions are used to judge alternate states of nature such as alternate distributions of income or expenditure. Appropriate assumptions based on normative judgements of inequality, allow the level of inequality within society to be judged or evaluated. Figure 2.1 demonstrates how assumptions about individuals' preferences effects the measurement of welfare, welfare comparisons and desirable SWF properties effect the measurement of inequality. The following sections contain the development of welfare comparisons, in order to facilitate social welfare functions that can be used to judge alternate welfare distributions with different levels of economic inequality.

2.1.1 Utilitarianism

Pioneered by Bentham (1789), the utilitarian approach assumes that the utilities of individuals are directly cardinally comparable and that the sum of their utilities is an appropriate measure of social welfare. This approach has been widely used, predominantly in the late 19th and early 20th century, to make both judgements about alternate social states and to judge alternative income distributions. It can be considered overly egalitarian if utility functions are identical and exhibit declining marginal utility in income as, ignoring prices and demographics, it implies the equalisation of incomes. Its consequences can be far from egalitarian if utility functions differ, especially if the poor or depressed have a lower capacity for utility[2]. The principal problem with the Utilitarian approach is that while it is concerned with the gains and losses in social welfare it is not concerned with who bears those gains and losses and thus does not consider distribution of utility within the sum. This renders it an ineffective social policy tool, especially when attempting to measure economic inequality.

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[2] Consider the situation where individual A generates twice as much utility as individual B, for example B may be suffering from depression, then the utilitarian approach would suggest that transfers should be made to person A who generates the most utility such that the marginal utility of income is equal. While utilitarianism is concerned with the gains and losses in social welfare it is not concerned with who bears those gains and losses.

2.1.2 The Rise of Ordinality

Such utilitarian ideas were sharply refuted by Robbins (1938) since utility only provides representations of each separate individual's underlying preferences for social states it can't be used to make any sort of welfare comparisons between individuals. For example if all individuals' preference over the social states were that they would prefer to have all the income and that everybody else receives nothing, it would be difficult to aggregate the utilities into a meaningful social welfare function.

Hicks (1939), Arrow (1951) and others demonstrated that since it was household's preference orderings that determine consumption choices, the utility function was merely a function used to represent such preferences. Thus any increasing monotonic transformation of utilities function would result in the same consumption choices and the same social ordering. Under ordinality the difference in utility has no meaning thus only rank comparisons of utility are possible making it difficult to measure the dispersion of welfare for inequality analysis. The acceptance of ordinality and non-comparability (ONC, see Appendix 2.3) early in the 20th century led to the use of concepts such as the Pareto Criterion and Pareto Optimality that were free of welfare comparisons.

2.1.3 Pareto Optimality and Ordinal Social Welfare Ordering

The Pareto Criterion was introduced by Pareto (1906) and allows comparisons of alternative social states without interpersonal comparisons of utility. Consider economic agents $h = 1,...,H$ with preferences over a set of states $\boldsymbol{s} = \{s_1, s_2,...\}$, where $\boldsymbol{s}$ may represent alternate distributions of utilities or income. Using $\succ_h$ as the strict preference of individual or household h and $\succeq_h$ for at least as good as, then state s_1 is Pareto preferred to state s_2 if $s_1 \succeq_h s_2$ for all $h = 1,...,H$ and

$s_1 \succ_h s_2$ for at least one *h*. State s_1 is Pareto Optimal if there exists no other state that is Pareto Preferred.

While the Pareto Criterion appears to be a sound principle for public policy without the requirement of interpersonal comparison of utility, there are major problems with its use. Consider the example of dividing a cake amongst two individuals who both prefer more cake to less. Any allocation to the two individuals will be Pareto improving since both will have more cake than they had before. Any further re-allocation will not be Pareto improving since cake must be taken away from one in order to give to another. Thus any allocation of the cake, no matter how unequal is Pareto Optimal and no redistribution of an existing cake can ever be Pareto Optimal.

Thus the Pareto Criterion breaks down as a social tool for choosing allocations, in that extreme allocations may be Pareto Optimal and that there may exist a multitude of Pareto Optimal allocations. The Pareto Criterion also suffers, as it is unable to rank two states when some economic agents gain and others lose, as is the case in many public policy decisions. This invalidates it as a rule to compare distributions of welfare and measure inequality.

2.1.4 The Bergsonian Social Welfare Function

The failings of the Pareto Criterion led to an exploration of alternate social policy tools for judging alternate social states. Bergson (1938) introduced the notion that a Social Welfare Function (SWF) could be used to assign real number to each state $\boldsymbol{s} = \{s_1, s_2, ...\}$ to represent the continuous social ordering of states $\succeq = \{s_1 \succeq s_2 \succeq \boldsymbol{...}\}$ over the entire **s**, such that if $SWF(s_1) > SWF(s_2)$ then $s_1 \succ s_2$, that is state 1 is socially preferred to state 2. The Bergsonian SWF plays a similar role to a utility function, except that instead of assigning a real number to characterise individual preferences over particular states, $u_h = u_h(s)$, the SWF characterises social preferences, $SWF = SWF(s)$ over the entire ***s***.

2.1.5 Social Welfare Functionals and Arrow's Impossibility Theorem

The reluctance by many economists to abandon the ordinality and non-comparability of wellbeing or utility, led to a focus on constructing a Social Welfare Functional (SWFL). A SWFL is a rule or mapping that provides a complete set of social orderings, $\succeq = \{s_1 \succeq s_2 \succeq \mathbf{...}\}$ over the entire ***s***, based on individual's preference orderings $\succeq_h = \{s_1 \succeq_h s_2 \succeq_h ...\}$ by all individuals $h = 1,2,...,H$ such that $SWFL : \succeq = F(\succeq_h)$. The SWFL provides rank comparisons of states or welfare distributions, where as the SWF provides a real number evaluation of the states. In addition to constructing the social ordering of states the function $F(\ )$ is normally restricted to satisfy some basic desirable properties. The appendix lists the five basic desirable properties of SWFL's, that they are transitive, complete and reflective, have Unrestricted Domain (*U*), are Independence of Irrelevant Alternatives (*I*), satisfy the Pareto Principle (*P*) and are Non-Dictatorial (*D*).

Arrow (1951) attempted to construct a SWFL that satisfied the five basic properties above. Arrow's (1951) impossibility theorem states that if *H* is infinite and ***s*** contains three or more states, there is no SWFL that satisfies the five basic properties of SWFL's. Thus a SWFL does not exist that can successfully aggregate individual preferences without violating one or more of the conditions, principally due to the lack of information contained individual preference orderings.

2.1.6 The Bergson-Samuelson Individualistic Social Welfare Function

An extension to the general form of the SWF proposed by Bergson (1938), Lange (1942) and Samuelson (1947), is to take an "individualistic" approach and attempt to obtain an "impersonal" SWF. The individualistic SWF reflects the SWFL over alternate income distributions from the utilities of individuals, representing their "personal preferences". The individualistic SWF assigns a real number to the alternative states of the income distribution, such that any state s is represented by $\boldsymbol{y} = \{y_1,...,y_H\}$ but it can easily be applied to the distribution of any other variable indicative of welfare, such that $s = \boldsymbol{w} = \{w_1,...w_h,...w_H\}$, where w_h is welfare of *h*. An impersonal SWF reflects personal preferences where each individual judges welfare distributions in terms of "what is in it for them", such that $\boldsymbol{w} \succeq_h \boldsymbol{w}'$ implies $w_h \geq w'_h$, where $\boldsymbol{w}' = \{w'_1,...w'_h,...w'_H\}$ is an alternate welfare distribution. When defined over utility, personal preferences exist if $\boldsymbol{w} \succeq_h \boldsymbol{w}'$ implies $u_h(w_h) \geq u_h(w'_h)$, which will occur when $u_h(\ )$ is increasing in w_h. Thus the Bergson-Samuelson Individualistic SWF may be written,

$$SWF = SWF(\boldsymbol{w}) = G(u_1(w_1),...u_h(w_h),...u_H(w_H)), \tag{2.1}$$

where $u_h(w_h)$ is the utility of individual or household *h*, for $h = 1,2,...,H$ and $G(\ )$ is increasing in its first argument, such that if $\boldsymbol{w} \succeq_h \boldsymbol{w}'$ for all *h*, then $SWF(\boldsymbol{w}) \geq SWF(\boldsymbol{w}')$. Such individualistic SWF typically assume that interpersonal comparisons of utility are possible and can be easily applied if utility is cardinal. However the function $G(\ )$ can incorporate various degrees of comparability through examining the set of transformations $\boldsymbol{\Phi} = \left\{\Phi^1, \Phi^2,...\Phi^H\right\}$ of the u_h, such that $\Phi^h\left(u^h\right)$ is an equally valid utility function for h, the degree of comparability can be expressed as restrictions on the set $\boldsymbol{\Phi}$ (see Appendix 2.3).

2.1.7 Possible Social Welfare Functions for Inequality

From Arrow's Impossibility Theorem it is obvious that to develop SWFL a greater degree of comparability must be allowed and/or some of previous basic desirable properties of *U*, *I*, *P* and *D*, need to be relaxed or additional restrictions applied[3]. The common additional requirements of the SWFL are Anonymity (*A*) and Separability (*SE*) and to relax *I* to the Partial Independence of Irrelevant Alternatives (*PI*). These properties are explained further in the Appendix 2.2. The various forms of comparability have been classified by Sen (1977) and Roberts (1980b,c) and are defined in Appendix 2.3, ranging from Ordinal Non Comparability (ONC), Cardinal Non Comparability (CNC), Ordinal Level Comparability (OLC), Cardinal Unit (difference) Comparability (CUC), Cardinal Full Comparability (CFC) and Cardinal Ratio Scale (CRS), a specialised form of CFC.

The additional properties in conjunction with a greater degree of comparability of households or individual utility, allow the construction of a SWFL and, as Roberts (1980c, p. 428) demonstrated, also the construction of a SWF that can be used to evaluate the alternate states or welfare distributions and so are useful in applied inequality studies. Roberts (1980c) conveniently cross classifies the real value SWF's possible as shown in Table 2.1, under various degrees of comparability and assumptions about the properties of the SWFL underlying the SWF.

While only ONC and CNC are formally justified via preference theorems we need to move further down the list in order to make welfare comparisons for the study of economic inequality. Adopting cardinal utilities and difference (unit) or full comparability (CUC or CFC) allows the construction of SWF that consider the whole of the welfare distribution and so provide SWF that can be used to measure the distribution of welfare and its inequality.

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[3] See Appendix 2.1 for a definition of the properties of Unrestricted Domain (U), Independence of Irrelevant Alternatives (I), the Pareto Principle (P) and Non-Dictatorship (D).

Table 2.1* SWF *allowed by Degree of Welfare Comparability by Desirable Properties of the SWF

	Informational basis	*U, I, P*	*U, I, P, A,* †-SE imposed	*U, PI, P, A,* $u_h(w_h) > u_h(\tilde{w})$, †-SE* imposed
ONC	Ordinality, no interpersonal comparability	$u_D(\boldsymbol{w})$ *D* Dictator	No possibilities	No possibilities
CNC	Cardinality, no interpersonal comparability	$u_D(\boldsymbol{w})$ *D* Dictator	No possibilities	$\prod_h^H [u_h(w_h) - u_h(\tilde{w})]$
OLC	Ordinal level comparability	$u_{D(\pi)}(\boldsymbol{w})$ *D(π)* Dictator where $\pi(u(\boldsymbol{w}))$ is a focusing function	† $\min_h u_h(w_h)$ $\max_h u_h(w_h)$	† $\min_h u_h(x_h); \max_h u_h(x_h)$ $\min_{h\in i} u_h(x_h); \max_{h\in i} u_h(x_h)$ $i = \{u_i(\tilde{w}) \le u_k(\tilde{w}) \forall k\}$ $\min_{h\in j} u_h(x_h); \max_{h\in j} u_h(x_h)$ $j = \{u_h(\tilde{w}) \ge u_k(\tilde{w}) \forall k\}$
CUC	Cardinal unit (difference) comparability	$\sum_h^H a_h u_h(w_h)$ $a_h > 0$	$\sum_h^H u_h(w_h)$	† $\sum_h^H \frac{(u_h(w_h) - u_h(\tilde{w}))^{1-\rho}}{1-\rho}$
CFC	Cardinal full (level and difference) comparability	$\bar{u} + g(\boldsymbol{u_h}(\boldsymbol{w_h}) - \bar{u})$ where $g(\ )$ is homogeneous of degree 1 and $\bar{u}$ is mean utility.	† $\sum_h^H u_h(w_h)$ $\min_h u_h(w_h)$ $\max_h u_h(w_h)$	† $\sum_h^H \frac{(u_h(w_h) - u_h(\tilde{w}))^{1-\rho}}{1-\rho}$ $\min_h [u_h(w_h) - s\, u_h(\tilde{w})]$ $\max_h [u_h(w_h) - s\, u_h(\tilde{w})]$
CRS	Cardinal ratio scale comparability	$G(\boldsymbol{u_h}(\boldsymbol{w_h}))$ $G(\ )$ is homothetic and increasing in all arguments	† $\sum_h^H \frac{(u_h(w_h))^{1-\rho}}{1-\rho}$	† $\sum_h^H g(u_h(w_h), u_h(\tilde{w}))$ where $g(\ )$ is homothetic

Source: Roberts (1980c), pp. 437.

Roberts (1980b) defines a focusing function $d(\pi)$ as giving the individual who is in lowest position and so dictatorial under rank invariant ordering of states by the $\pi = \pi(h)$ who is the individual in the h^{th} worse position for all *h*, $\bar{u} = \sum u_h(w_h)/H$ is mean welfare, $\tilde{w}$ is a reference level of welfare, income or expenditure.

See Appendix 2.1 for a definition of the properties of Unrestricted Domain (*U*), Independence of Irrelevant Alternatives (*I*), the Pareto Principle (*P*) and Non-Dictatorship (*D*).

Imposing A and SE on such an informational basis allows for utilitarianism while admitting CRS allows the construction of SWF based on utilities but with the functional form allowing the input of social planner. Relaxing I to PI and imposing SE^* allows comparisons to be in terms of some reference state or level of welfare, which is often desirable for SWF and implied inequality indices such that they are scale invariant.

2.1.8 Possible Non-Individualistic Social Welfare Functions for Inequality

The possible specifications for the SWF above are all *individualistic* in that they are based upon the individual utility functions and so require explicit specification of the household's or individual's utility functions. While utility is normally the economist's tool for evaluating welfare, it requires the specification of a utility function and full cardinal comparability of utility. *Non-individualistic* SWF are more suited to practical application since they are defined directly over the distribution of the economic state that is the chief determinant of utility, bypassing the need for information on individual utilities.

$$SWF(\boldsymbol{w}) = F(w_1,...w_h,...w_H) \tag{2.2}$$

In the *non-individualistic* SWF, F can be thought of a special case of the more general *individualistic* SWF, G in equation 2.1, where all individual utilities are the same and the utilities absorbed into the function F. The *non-individualistic* SWF can also be interpreted as SWF of a social planner or critic who may wish to bypass individual utilities in making social welfare judgments. This 'paternalistic' view may be appropriate when individuals are irrational or short sighted or for other similar reasons.

Since inequality indices are expressed directly over the welfare distribution $\boldsymbol{w} = \{w_1,...w_h,...w_H\}$, the function $F(\ )$ must capture all individual and social preferences over $\boldsymbol{w}$ and so is normally desired to possess as much flexibility as possible. To admit the more flexible SWF that are appropriate for inequality indices, we must adopt cardinal full comparability (CFC) with *U*, *PI*, *P*, *A* and *SE** being imposed as properties on the SWFL underlying the SWF. The majority of inequality indices that can be represented by a SWF implicitly or explicitly, accept a cardinal ratio scale (CRS) measure and impose *U*, *PI*, *P*, *A* and *SE**. Note that CUC and CFC under *U*, *PI*, *P*, *A* and *SE** allows the SWF to be of the widely accepted Atkinson-Kolm type that can be used to measure of inequality (see Section 2.2.3). Thus only cardinal difference and level comparability are required, without the assumption of CRS, to construct the Atkinson-Kolm SWF inequality measures.

2.1.9 The Relationship between *SWF* and Inequality

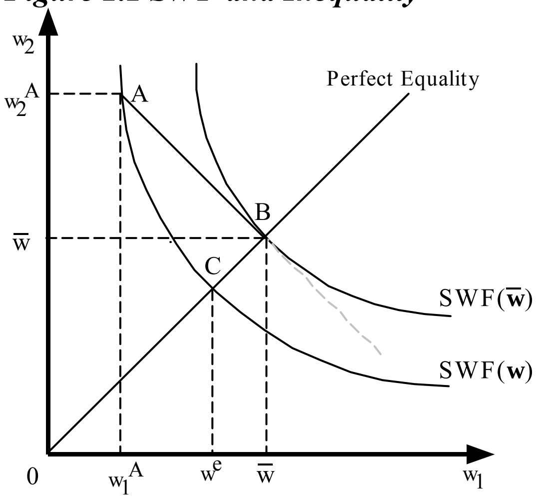
Principally the object of all the measures of inequality is to measure the distribution or dispersion of welfare, w_h over H individuals or households, $h = 1,...,H$, with a single index of inequality, $I(\boldsymbol{w})$ where $\boldsymbol{w} = \{w_1,...,w_H\}$ is the welfare distribution. Essentially many inequality measures used can be expressed as *non-individualistic* SWFs since they aim to evaluate the distribution of welfare, where SWF's evaluate the level and distribution of welfare. Where as SWF are normally concerned with both the level and distribution of welfare, inequality indices frequently wish to measure only the dispersion in welfare.

Figure 2.2 illustrates the relationship between SWF and inequality indices in a two person world, where w_1, w_2 and $\overline{w}$ are the welfare of person 1, 2 and the mean level welfare, respectively. Moving further from the origin increases social welfare thus $SWF(\overline{\boldsymbol{w}})$ is higher than $SWF(\boldsymbol{w})$ in Figure 2.2. Inequality can be measured by the difference between the SWF at *B* and *C* the amount lost due to the inequality of welfare, often expressed as a proportion of current SWF, *OC,* or some other measurement based upon the dimensions of *ABC*. This illustrates that inequality indices can be based upon the properties of the SWF and is suitably defined so long as $SWF(\ )$ is increasing and concave. Kolm (1969) and Atkinson (1970) considered the construction of inequality indices based on explicit assumptions about the SWF in this framework defined over money incomes. The measure of inequality defined over welfare is specified as,

$$I^{SWF} = 1 - \frac{SWF(\boldsymbol{w})}{SWF(\overline{\boldsymbol{w}})} \qquad (2.3)$$

Inequality can also be measured without the explicit specification of a SWF by defining inequality as the 'distance' from perfect equality. For example in Figure 2.2, the length of the ray *AB*.

Figure 2.2 SWF and Inequality



Notes: $\overline{w}$ is the mean level of welfare of person 1's welfare w_1^A and person 2's welfare w_2^A.
w^e is the equally distributed equivalent level of income that results in SWF(***w***).

Since the object of this thesis is to examine economic inequality, the remainder of the thesis will consider measures or indices of inequality $I(\boldsymbol{w})$ rather than the $SWF(\boldsymbol{w})$, although it will consider those based on SWF and those that are not. The exception to this is Section 2.4 where the role of prices and household size and composition in evaluating inequality is considered via measuring inequality as the loss in SWF from inequality.

2.2 Measuring Inequality

This section examines properties of inequality indices that are often expressed as desirable based on normative judgements in 2.2.1. Many observational or statistical measures of inequality are specified without explicit statement of their implied normative judgements. Section 2.2.2 describes a range of inequality measures that are often used in applied inequality evaluation and the properties they possess.

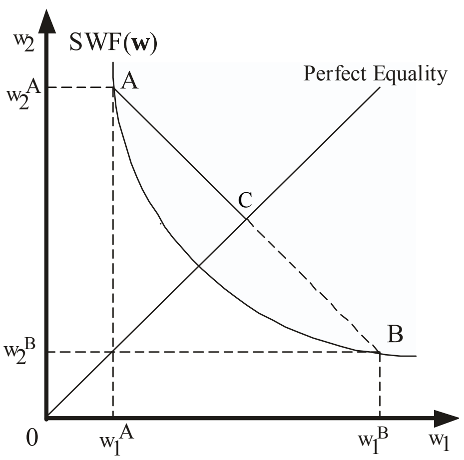
2.2.1 Desirable Properties of Measures of Inequality

The following section describes the desirable properties that may be used to construct appropriate measures of inequality or to evaluate the implicit assumptions of normative measures.

i) Symmetry (or Anonymity)

The property of *symmetry* or *anonymity* requires that the inequality measure not be affected by the order in which economic agents are labelled. This property may be represented in two-person space by the social welfare function being symmetric around the 45-degree line or line of perfect equality as illustrated in Figure 2.3.

Figure 2.3 Symmetric Measures of Inequality



Thus points *A* and *B,* which represent two symmetric welfare distributions that differ in only the order they are reported, record the same level of social welfare and so the same level of inequality. For an inequality index not based explicitly on social welfare but on the distance from equality, symmetry requires the rays *AC* and *CB* to be the same length.

More formally, if $I(\boldsymbol{w}) = I(\boldsymbol{Pw})$ for all permutation matrices ***P,*** then a measure of inequality is symmetrical or anonymous. A permutation matrix, ***P*** is a square matrix where each row and column contains a single digit, unity, and zeroes in all other entries.

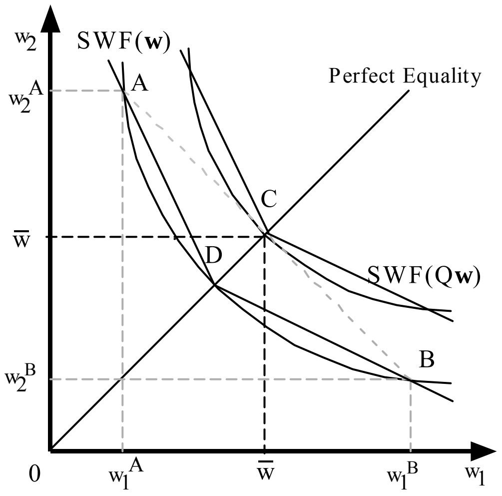
ii) Convex Measures of Inequality and Pigou-Dalton Principle of Transfers

An inequality measure is convex in welfare if $I(\boldsymbol{Qw}) \le I(\boldsymbol{w})$ for all bi-stochastic matrices ***Q***, that are not a permutation matrices. A bi-stochastic matrix is a square matrix whose columns and rows sum to one with its entries being non-negative and thus less than or equal to unity. Since ***Q*** can not be a permutation matrix no element of ***Q*** can be unity and so all elements must be positive but less then unity. For example a possible bi-stochastic matrix could be

$$\boldsymbol{Q} = \begin{bmatrix} 0.1 & 0.4 & 0.5 \\ 0.6 & 0.1 & 0.3 \\ 0.3 & 0.5 & 0.2 \end{bmatrix}.$$

Thus $\boldsymbol{Qw}$ can be considered a series of transfers from rich to poor that leaves the total welfare unchanged or ‘a mean preserving transfer’. Strict convexity exists if $I(\boldsymbol{Qw}) < I(\boldsymbol{w})$ and will occur if $\boldsymbol{I}''(\boldsymbol{w}) > \boldsymbol{0}$. Convex inequality measures imply that the underlying social welfare function is concave in welfare, $SWF(\boldsymbol{Qw}) \ge SWF(\boldsymbol{w})$ as illustrated for the two-person case in Figure 2.4. The dashed ray *AB* illustrates that all $\boldsymbol{Qw}$ transfers between the two symmetrical representations *A* and *B* of the welfare distribution.

Figure 2.4 Convex Measures of Inequality and Concave SWF



A move in the welfare distribution away from *A* (or *B*) to anywhere along *AB* will reduce inequality since the distribution is moving closer to perfect inequality and also reduce the loss in social welfare from inequality represented by *DC*. One such transfer where each person shares half the others welfare, such that they receive the mean of the two incomes is illustrated by point *C* in Figure 2.4 resulting in perfect equality.

A fundamental concept in inequality is the Pigou-Dalton principle of transfers, first developed by Pigou (1912) and Dalton (1920). The principle states that a mean and rank preserving transfer of Δw, from rich household *j* with measure of welfare, w_j, to poorer household *k* with welfare, w_k, should reduce the measure of inequality[4]:

$$I(w_1,\dots,w_k,\dots,w_j,\dots,w_H) > I(w_1,\dots,w_k+\Delta w,\dots,w_j-\Delta w,\dots,w_H) \qquad (2.4)$$

This property can also be expressed as

$$\left(\frac{\partial I}{\partial w_j}-\frac{\partial I}{\partial w_k}\right)(w_j-w_k)\leq 0 \qquad (2.4a)$$

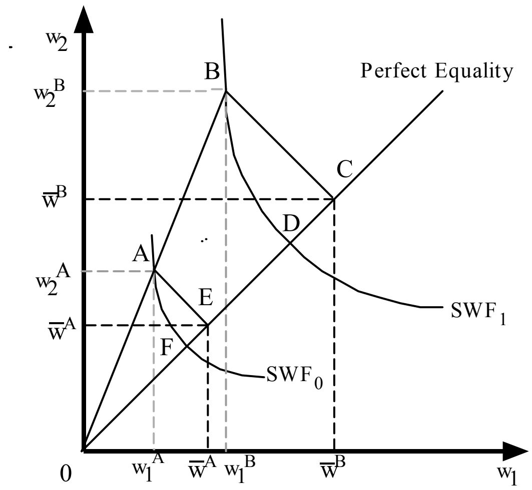
[4] Note that the welfare measures *w*'s, are arranged in ascending order.

and inequality functions with this property are termed Schur-convex. For two people this is represented in Figure 2.4 by any movement from point *A* towards *C* but not past it since this would alter their rank. While the Pigou-Dalton Principle of Transfers and the assumption of convex inequality indices (concave SWF) is egalitarian, it has little to say about the effect of transfers at different parts of the welfare distribution or the shape of curvature of the SWF.

iii) Mean or Scale Independence (Homotheticity or Relativity)

An inequality index is mean or scale independent if any constant scaling λ of the welfare vector $\lambda \boldsymbol{w} = \{\lambda w_1, ..., \lambda w_H\}$ will leave the measure of inequality unchanged $I(\lambda \boldsymbol{w}) = I(\boldsymbol{w})$, that is homogeneous of degree zero in $\boldsymbol{w}$. The majority of statistical measures of inequality are mean independent in that the inequality measure is invariant to changes in the mean level or total level of income of a constant population. This property ensures that the indices are relative, rather than absolute. Measures of inequality are unaffected by equal proportional increases in welfare, unlike SWF which measure both the level and dispersion of welfare. Mean independence is illustrated in Figure 2.5.

Figure 2.5 Mean Independent Measures of Welfare



A doubling of both person 1 and 2's welfare takes the welfare distribution from point *A* to *B*, while raising the social welfare curve from SWF_0 to SWF_1, but the measure of inequality must remain unchanged to be scale independent. Thus the inequality index must be measured relative to the mean, such that for distribution *B*, ray *BC* or *DC* must be measured relative to *0C* and for distribution *A* the ray *AE* or *FE* relative to *0E*, such that the measure of inequality is the same in both cases. A homothetic SWF implies that the distance between the SWF curves are the same proportion measured along any ray from the origin such that $\frac{AE}{0E}=\frac{BC}{0C}$ or $\frac{0F}{0E}=\frac{0D}{0C}$. This property is satisfied by expressing inequality indices as $I=I(\boldsymbol{w},\overline{w})$ with mean independence imposed as $\frac{\partial I}{\partial \overline{w}}=0$ such that $I=I(\boldsymbol{w},\overline{w})=\overline{w}\times I\left(\frac{\boldsymbol{w}}{\overline{w}}\right)$

iv) Population Invariance

Frequently comparisons of inequality or social welfare are required to be made across different time periods or countries where the population may vary. For this reason inequality measures are often required to be invariant to population size. Consider two countries with identical populations and income distributions. The same level of inequality should be the same if the two countries were considered as one than when considered individually. This can be extended to many countries or groups.

Consider an inequality index $I(\boldsymbol{w})=I^{H}(w_1,\ldots,w_H)$ over *H* individuals then to be invariant of population the index must be invariant to any scaling or replication *r* of the population *H,* such that $I^{Hr}(\boldsymbol{w}')=I^{H}(\boldsymbol{w})$, where $\boldsymbol{w}'$ is defined over *Hr* people such that $w_i'=w_{2i}'=\ldots=w_{ri}'=w_i$ for $1\le i\le H$ with any integer *r*. This is equivalent to the assumption that SWF of the *r* countries or groups of people with identical income and population distributions considered as a whole will be *r* times as great as the SWF of each group. Population invariance can also be specified as

$\frac{\partial I}{\partial H}=0$, where H is the number of individuals and thus is said to be homogeneous degree zero in population.

v) Transfer Sensitivity

Whilst every strictly concave inequality measure is sensitive to transfers at all earnings levels, the relative sensitivity of the indices differs substantially. The indices attach different levels of importance to inequality at various points of the distribution, or have different degrees of distaste for inequality. Atkinson (1970), Sen (1973), Kolm (1976) and Colwell (1977) amongst others, suggest that transfers at the lower end of the welfare distribution should affect social welfare more than a transfer at the upper end. Shorrocks and Foster (1987) formalise such a statement with the use of the notion of a *favourable composite transfer* which consists of a progressive transfer Δw at one stage in the distribution between economic agents *i* and *j* and a regressive transfer of the same size, higher up in the welfare distribution between *k* and *l*. An inequality index $I(\boldsymbol{w})=I(w_1,...,w_i,...,w_j,...,w_k,..,w_l,...,w_N)$ that is reduced by a *favourable composite transfer*, Δw, between a pair of individuals that are the same distance apart in welfare, such that $w_j-w_i=w_l-w_k>\Delta w$, is said to be *weakly sensitive to transfers* or *weakly transfer sensitive*, such that

$$I(\boldsymbol{w})>I'(w_1,...,w_i+\Delta w,..,w_j-\Delta w,...,,w_k-\Delta w,..,w_l+\Delta w,w_N). \quad (2.5)$$

Inequality indexes that are *weakly transfer sensitive* record a larger decrease in inequality from the progressive transfer among the poor than the regressive transfer amongst the rich and hence reduce overall inequality. This property was also termed the *Principle of Diminishing Transfers* by Kolm (1976). Shorrocks and Foster (1987) go on to show that if the inequality index is of the form,

$$I(\boldsymbol{w}) = F\left(\sum_{h}^{H} f(w_h), \overline{w}, H\right), \qquad (2.6)$$

where $F(\ )$ is strictly increasing in its first argument, then if $f''(w_i) > f''(w_k)$ whenever $w_k > w_i$, the index will be weakly transfer sensitive. Thus $f''(\ )$ must be strictly decreasing and therefore $I''(\boldsymbol{w})$ must be strictly decreasing. This renders the Atkinson measures and the General Entropy Indices for c<2, but not the Gini coefficient, *weakly transfer sensitive*. This demonstrates that inequality indices used introduce implicit value judgments to the measurement of inequality and may produce distinct results in the level and even the trend of inequality.

Shorrocks and Foster (1987, p. 488) also demonstrate that many inequality indices that are w*eakly transfer sensitive* are also *transfer sensitive.* If inequality is reduced by a favourable composite transfer, that need not be the same for the low and high pair of individuals so long as the variance of the welfare distribution remains unchanged, then the index is *transfer sensitive.*

2.2.2 Statistical Measures of Inequality

Statistical indicators of inequality were the most widely used measures in the Australian and Canadian empirical inequality literature before the 1980s. By attaching a single figure to inequality, statistical measures determine the "distance" of the actual distribution from complete equality. Statistical measures are a convenient way of summarising trends in the welfare distribution, and are of particular value when comparing distributions over time. Statistical measures have been traditionally defined over the distribution of income or wages but can also be applied to expenditure. For convenience the following statistical measures of inequality are defined over the distribution of $\boldsymbol{w} = \{w_1, ..., w_H\}$ a vector containing measures reflecting the welfare, w_h, of population unit *h,* which could be considered their income, y_h, expenditure, x_h, or some other measure. Common statistical indices used to measure inequality include the Relative Mean Deviation (*RMD*), Variance (*V*), Coefficient of Variation (*CV*), The Standard Deviation of Logarithms (SDL) and the Gini coefficient (G). Appendix 2.4 contains a brief description of the statistical measures mentioned above other than the Gini coefficient, which is discussed in the following section. The Gini coefficient is used in conjunction with other indices (see Section 2.2.3) in this study to allow the inequality results to be compared with other studies.

Gini Coefficient (G)

Of all the summary measures, the Gini coefficient developed by Gini (1912) is the most popular indicator in past empirical work. The Gini coefficient is implicitly based upon a welfare function that is essentially a rank-order-weighted sum of welfare shares .The Gini coefficient lies between 0 and 1, being equal to 0 when there is complete equality and equal to 1 when all welfare accrues to a single unit. Unlike other summary, axiomatic and welfare measures of inequality, the Gini coefficient has the appealing feature that it is able to incorporate negative income data into the calculation of inequality. The Gini coefficient can be expressed in a number of alternate ways. Consider a population of *H* units, individuals, households or equivalent persons, with welfare ***w***, and mean welfare $\overline{w}$. Then the corresponding definition expresses the Gini as a weighted sum of relative welfare levels and is given by:

$$G = 1 + \frac{1}{H} - \frac{2}{H^2\overline{w}}\,[w_1 + 2w_2 + \ldots + (H-1)\,w_{H-1} + H\,w_H] \qquad (2.7)$$

where the w_h's are arranged in descending order so that $w_1 \geq w_2 \geq \ldots \geq w_H$. When there is perfect equality, $w_h = \overline{w}$ for all *h* and $G = 0$. With complete inequality, $w_1 =$

$H\overline{w}$ and $G = 1 - \frac{1}{H} \approx 1$, if H is large. The Gini index considers all possible pairs of welfare and out of each one selects the minimum. Summing and normalising gives:

$$G = 1 + \frac{1}{H} - \frac{2}{\overline{w}H^2}\sum_{i=1}^{H}\sum_{j=1}^{H}\min(w_i, w_j) \tag{2.8}$$

It can be used to unambiguously rank welfare distributions considering the nature of the index. By considering a transfer from household i with w_i, to j with w_j, ($w_i > w_j$) of Δw, the change in the Gini is given by:

$$\Delta G = \frac{-2}{\overline{w}H^2}(j - i) < 0, \qquad \text{where } j > i \tag{2.9}$$

and thus satisfies the Pigou-Dalton Principles of Transfers. However the sensitivity of the Gini to transfers is dependent upon the number of population units between the units involved in the transfer and not the level of welfare. The Gini is most sensitive to transfers around the modal level of welfare and typically insensitive to transfers to low welfare households, thus violating *transfer sensitivity or Principle of Diminishing Transfers*.

The Gini coefficient can also be expressed as the ratio of; (i) the area between the Lorenz curve and the line of equality divided by (ii) the area below line of equality[5]. Since the height and the base of the line of equality for the Lorenz curve are both unity, the area (ii) is simply ½. Thus the Gini is simply twice the area enclosed by the Lorenz and equality line as illustrated in Figure 2.6.

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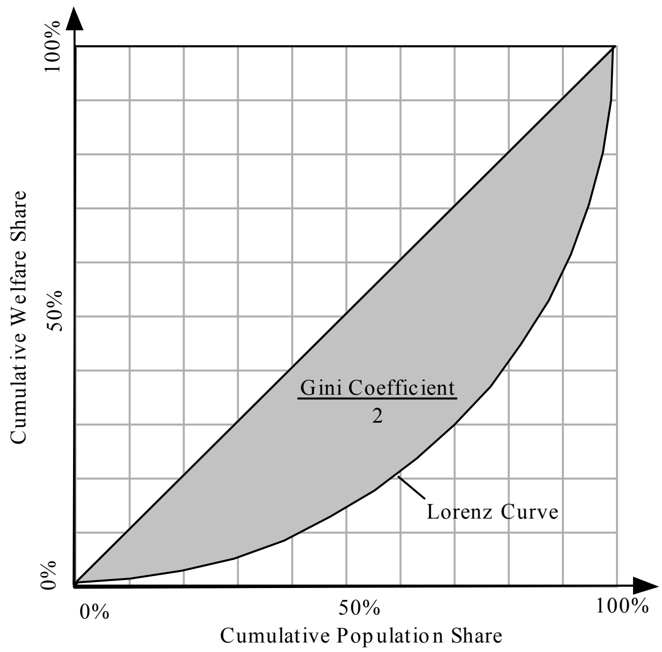
[5] See appendix 2.4 for an explanation of the Lorenz Curve

Figure 2.6 The Gini and Lorenz Curves



2.2.3 Social Welfare Function based Measures of Inequality

Welfare-based measures of inequality have the appealing feature that the value judgments they contain, whilst not universally agreed upon, are explicit. The Atkinson-Kolm family of inequality indices is the most well known group of welfare-based inequality measures. Such indices were first derived by Kolm (1969) and Atkinson (1970), who define a social welfare function (*SWF*) as the sum of each the population's units utility, generated by the function *f* over their level of income, ***y***, thus,

$$SWF = \sum_{h}^{H} f\left(y_h\right), \tag{2.10}$$

where $f\left(y\right)$ is increasing and strictly concave in income such that $f'\left(y\right) > 0$ and $f''\left(y\right) < 0$. Kolm (1969) and Atkinson (1970) define the level of the *equally distributed equivalent income* y_{EDE} as the level of income that would be enjoyed by all (perfect equality), that would result in the original level of social welfare, as the solution to:

$$\sum_{h}^{H} f(y_h) = H \times f(y_{EDE}) \quad (2.11)$$

This allows the specification of the Atkinson-Kolm inequality index as:

$$A = 1 - \frac{y_{EDE}}{\bar{y}} = \frac{\bar{y} - y_{EDE}}{\bar{y}}, \quad (2.12)$$

where $\bar{y} = \sum_{h=1}^{H} y_h \Big/ H$ is the mean level of income. Since $f(w)$ is concave it, ensures that $y_{EDE} < \bar{y}$ and thus the index is positive. It is also a relative index in that it is mean or scale independent. Equation (2.12) highlights an attractive empirical interpretation of the Atkinson indices. A value of say, $A = 0.2 = (1 - 0.8)$ indicates that if income's were equally distributed, then only 80% of current total income would be needed to achieve the original level of social welfare.

Atkinson (1970) proved that for the SWF to be symmetric and homothetic then the functional form for $f(y)$ must be

$$f(y) = \frac{a + by^{1-\varepsilon}}{1-\varepsilon} \qquad \varepsilon \neq 1, \varepsilon \geq 0, \quad (2.13)$$

$$f(y) = \ln(y) \qquad \varepsilon = 1, \quad (2.14)$$

where ε is the 'degree of inequality' aversion, (explained in more detail below). The SWF is concave if $0 \leq \varepsilon < 1$. If the SWF is considered utilitarian then the function $f(y)$ is essentially the identical utility for function for all individuals with constant relative risk aversion equal to ε. Substituting (2.13) or (2.14) into (2.11) implies:

$$y_{EDE} = \left[\left(\frac{1}{H} \right) \sum_{h=1}^{H} y_h^{1-\varepsilon} \right]^{\frac{1}{1-\varepsilon}} \quad (2.15)$$

Substituting (2.15) into (2.12) gives the Atkinson family of inequality indices:

$$A_{\varepsilon} = 1 - \left[\left(\frac{1}{H} \right) \sum_{h=1}^{H} \left(\frac{y_h}{\overline{y}} \right)^{1-\varepsilon} \right]^{\frac{1}{1-\varepsilon}} \qquad \varepsilon \neq 1, \varepsilon \geq 0 \qquad (2.16)$$

$$A_{\varepsilon} = 1 - exp \left[\left(\frac{1}{H} \right) \sum_{h=1}^{H} \ln \left(\frac{y_h}{\overline{y}} \right) \right] \qquad \varepsilon = 1 \qquad (2.17)$$

where ε = the "inequality aversion" parameter with larger values of ε corresponding to a greater aversion to low welfare. The minimum value for the Atkinson indices is 0, representing complete equality. Unlike the statistical measures, these measures are not upper-bounded at 1. The maximum of the Atkinson indices depends on the population size and the inequality aversion parameter.

The Atkinson inequality measures are consistent with a variety of views on distributive justice. The parameter ε measures the degree of (constant) risk aversion for an individual that has an equal chance of enjoying any level of income in ***y***. The sensitivity of the index to various parts of the income distribution depends upon the specification of the social welfare function, or alternatively the value of ε, the inequality aversion parameter used. For example, as $\varepsilon \to \infty$ the social welfare function approaches Rawls' (1971) *Maximum Criterion* where society is concerned only about the welfare of the lowest income earners. While $\varepsilon = 0$, corresponds to a utilitarian social welfare function where the population's utility is summed.

While originally defined upon income the Atkinson-Kolm SWF and inequality indices can just as easily be applied to any other measure of welfare, ***w***, such as food consumption or adult equivalent expenditure. In this thesis the Atkinson-Kolm inequality indices are extended to be defined over any welfare measure, ***w***, such that,

$$A_{\varepsilon} = 1 - \left[\left(\frac{1}{H} \right) \sum_{h=1}^{H} \left(\frac{w_h}{\overline{w}} \right)^{1-\varepsilon} \right]^{\frac{1}{1-\varepsilon}} \qquad \varepsilon \neq 1, \varepsilon \geq 0 \qquad (2.18)$$

$$A_{\varepsilon} = 1 - exp\left[\left(\frac{1}{H}\right)\sum_{h=1}^{H}\ln\left(\frac{w_h}{\overline{w}}\right)\right] \qquad \varepsilon = 1 \tag{2.19}$$

where $\overline{w} = \sum_{h=1}^{H} w_h \Big/ H$ is the mean level of the measure of welfare and

$w_{EDE} = \left[\left(\frac{1}{H}\right)\sum_{h=1}^{H} w_h^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}}$ is the *equally distributed equivalent level of welfare.*

2.2.4 Axiomatic Measures of Inequality

Axiomatic measures of inequality are derived from criteria, which it is believed an acceptable inequality measures should possess. The set of measures derived from the chosen axioms constitutes all indices with the desired properties. As the number of axioms increase, the set of indices that satisfy them will generally decrease. This is advantageous in focusing attention on a small number of alternate indices with clearly defined properties.

Whilst not classified as welfare measures, axiomatic measures of inequality are founded on notions of social welfare. The indices are derived from axioms which are value judgments concerning the type of properties desirable in an index. The relative importance to be attached to transfers at different parts of the distribution is often a major consideration in determining “appropriate” axioms. As such, many axioms do not meet with unequivocal approval either because they are considered unnecessary or because there are alternative, equally justifiable axioms available. The most commonly imposed axioms are a combination of those desirable properties mentioned in 2.2.1. Another attractive property imposed axiomatically is that of additive decomposition and is the motivation behind using axiomatic measures to evaluate inequality in this study.

Additive Decomposition

An additively decomposable inequality measure can be expressed as a weighted sum of the inequality values calculated for population subgroups ('within-group' inequality) and the contribution arising from inequality between the subgroup means ('between-group' inequality). Additive decomposable indices are particularly useful where there are distinct groups within the population whose levels of welfare may be difficult to compare, such as households with different demographic, geographic or labour characteristics. An inequality measure $I(\boldsymbol{w})$ must satisfy the following four assumptions in order to be additively decomposable:

(i) $I(\boldsymbol{w})$ must be continuous and symmetric.

(ii) $I(\boldsymbol{w}) \geq 0$. Perfect equality ($I(\boldsymbol{w}) = 0$) holds only when all individuals receive the same welfare.

(iii) $I(\boldsymbol{w})$ has continuous first-order partial derivatives.

(iv) Given a population ($H > 2$) there exists a set of coefficients such that $I(\boldsymbol{w})$ can be partitioned into two non-empty subgroups - the 'within' and 'between' inequality groups. An additive decomposition inequality index can be decomposed into the components of the two welfare distributions $\boldsymbol{w}_1, \boldsymbol{w}_2$ of the population subgroups, such that inequality index satisfies $I(\boldsymbol{w}_1, \boldsymbol{w}_2) = A(I(\boldsymbol{w}_1), \overline{w}_1, H_1, I(\boldsymbol{w}_2), \overline{w}_2, H_2)$ where $A(\ )$ is a continuous and strictly increasing function in $I(\boldsymbol{w}_1)$ and $I(\boldsymbol{w}_2)$.

In satisfying the assumptions (i)-(iv), additively decomposable inequality measures also fulfil, the Pigou-Dalton Principle of Transfers, Mean Independence, Population Invariance and Transfer Sensitivity.

Decomposable Generalised Entropy Family

Shorrocks (1980) proved that only members of the "Generalised Entropy Family" (GE) of inequality measures satisfy all four assumptions. The axiomatic Generalised Entropy measures developed by Shorrocks', I_c, principally I_0, I_1, and I_2 are given by:

$$\mathrm{I_c} = \frac{1}{H} \frac{1}{c(c-1)} \sum_h \left[\left(\frac{w_h}{\overline{w}} \right)^c - 1 \right], \ \mathrm{c} \neq 0{,}1 \qquad (2.20)$$

$$I_0 = \frac{1}{H}\sum_h log\left(\frac{\overline{w}}{w_h}\right) \tag{2.21}$$

$$I_1 = \frac{1}{H}\sum_h \frac{w_h}{\overline{w}} log\left(\frac{w_h}{\overline{w}}\right) \tag{2.22}$$

The parameter c reflects different perceptions of inequality. As c decreases, the GE index becomes more sensitive to transfers lower down the distribution. The GE class of inequality measures includes the mean logarithmic deviation (I_0), the Theil Index (I_1), and half the square of the coefficient of variation (I_2). I_0, I_1 and I_2 are particularly sensitive to changes in the bottom, middle and top, respectively, of the welfare distribution. Note that the GE family are related to the Atkinson Index of inequality via

$$A_\varepsilon = 1 - \left[\varepsilon(\varepsilon-1)I_{1-\varepsilon} + 1\right]^{1/1-\varepsilon} \qquad \varepsilon \neq 1, \varepsilon \geq 0 \tag{2.23}$$

$$A_1 = 1 - exp\left[-I_0\right] \qquad \varepsilon = 1 \tag{2.24}$$

Mookherjee and Shorrocks (1982) show that if the population is broken into k groups or classes of n_k people, with mean welfare of $\overline{w}_k$, then these measures can be decomposed into within group and between group inequalities.

$$I_c = \sum_k v_k(\lambda_k)^c I_c^k + \frac{1}{c(c-1)}\sum_k v_k\left[(\lambda_k)^c - 1\right] \quad c \neq 0{,}1 \tag{2.25}$$

$$I_0 = \sum_k v_k I_0^k + \sum_k v_k\, log(1/\lambda_k) \tag{2.26}$$

$$I_1 = \sum_k v_k \lambda_k I_1^k + \sum_k v_k \lambda_k\, log\,\lambda_k \tag{2.27}$$

where $v_k = H_k/H$ is the proportion of the population in group k,

I_c^k is the inequality in group k's distribution of nominal welfare as defined in equation 2.20.

$\lambda_k = \overline{w}_k/\overline{w}$ is the group k's mean welfare relative to that of the whole population.

The first term in these equations reflects within group inequality and is simply a weighted sum of the sub group inequality values. The second term represents the between group inequality which is the amount of inequality that would remain if all welfare levels were equal to their sub-group means and so measures the dispersion of sub-group mean welfare levels.

Mookherjee and Shorrocks (1982) demonstrate that the trend in inequality can also be decomposed, by applying the difference operator to the decomposed general entropy measures of welfare inequality.

$$\begin{aligned}\Delta \mathrm{I}_0 &= \mathrm{I}_0(t+1) - \mathrm{I}_0(t) \\ &= \Delta\left(\sum_k v_k I_0^k\right) - \Delta\left(\sum_k v_k \log \lambda_k\right) \\ &= \sum_k v_k(t)\Delta \mathrm{I}_0^k + \sum_k I_0^k(t+1)\Delta v_k - \sum_k \log \lambda_k(t+1)\Delta v_k - \sum_k v_k(t)\Delta \log \lambda_k\end{aligned} \tag{2.28}$$

This equation decomposes the change in inequality into four terms that can be interpreted respectively as the impact of intertemporal changes on within group inequality, the effects of changes in population shares of the groups on the 'within' group and 'between' group and the influence of changes in the relative welfare's of the groups. The aggregation weights in the above equation are base period values for v_k and final period values for I_0^k and λ_k. We could switch these base and final values or perhaps more appropriately use an average of the base and final period values.

$$\Delta \mathrm{I}_0 = \sum_k \bar{v}_k \Delta \mathrm{I}_0^k + \sum_k \bar{\mathrm{I}}_0^k \Delta v_k - \sum_k \overline{\log \lambda_k}\Delta v_k - \sum_k \bar{v}_k \Delta \log \lambda_k \tag{2.29}$$

The "barred" variables are simple averages of the base and final values for the specified variables. Note that the last term reflects changes in relative mean welfare's $\lambda_k = \overline{w}_k / \overline{w}$, which in turn depend on both the group means $\overline{w}_k$ and population shares v_k since $\overline{w} = \sum_k v_k \overline{w}_k$. Thus changes in population shares not only enter via the second and third terms but the fourth. The effects of changes in the population share can be separated by rewriting the fourth term as:

$$
\begin{aligned}
-\sum_k \bar{v}_k \Delta \log \lambda_k &= -\sum_k \bar{v}_k \Delta \log\left(\sum_l v_l \bar{w}_l / \bar{w}_k \right) \\
&= -\log\left[1 - \sum_k \lambda_k (t+1) \Delta v_k \right] + \log\left[1 + \sum_k \theta_k (t) \bar{w}_l / \bar{w}_k (t) \right] - \sum_k \bar{v}_k \Delta \log \bar{w}_k \\
&\cong \sum_k \bar{\lambda} \Delta v_k + \sum_k \left(\bar{\theta}_k - \bar{v}_k \right) \Delta \log \bar{w}_k \qquad (2.30)
\end{aligned}
$$

where $\theta_k = v_k \lambda_k$, is the welfare share of group k and the "barred" variables are again simple averages of the base and final values for the variable specified. This result can be used to decompose the change in I_0 into the following parts:

$$
\Delta \mathrm{I}_0 = \underset{\text{(i)}}{\sum_k \bar{v}_k \Delta \mathrm{I}_0^k} + \underset{\text{(ii)}}{\sum_k \mathrm{I}_0^k \Delta v_k} + \underset{\text{(iii)}}{\sum_k \left(\bar{\lambda}_k - log\, \lambda_k \right) \Delta v_k} + \underset{\text{(iv)}}{\sum_k \left(\bar{\theta}_k - \bar{v}_k \right) \Delta\, log\, \bar{w}_k}\,, \qquad (2.31)
$$

representing (i) the impact of changes on within group inequality, (ii) the effect of changes in population shares on the within group and (iii) between group components and (iv) the contribution due to relative changes in the group mean level of welfare.

2.3 Measures of Individual Welfare

Section 2.2 chiefly examined measures of inequality defined over a distribution of welfare $\boldsymbol{w} = \{w_1, ..., w_h, ..., w_H\}$ where w_h is the proxy for wellbeing or utility of household h in the population of H units. Traditionally, the distribution used to represent the welfare distribution $\boldsymbol{w}$, in inequality indices is the income distribution $\boldsymbol{y} = \{y_1, ... y_h, ... y_H\}$, since it is the most obvious policy tool for altering economic inequality. For many years it was also the most readily available source of data indicative of the welfare distribution and thus has been the basis of many applied studies of inequality. However the increasing availability of comprehensive cross sectional data on expenditure $\boldsymbol{x} = \{x_1,....x_h,....x_H\}$ has allowed the examination of the inequality of expenditure. The close traditional link of expenditure to utility and it's apparent greater stability and reliability from cross-sectional data has led to the use of expenditure or consumption as a measure of welfare in inequality studies in the past decade. McGregor and Borooah (1992), distinguish between consumption as the standard of living a household enjoys as the outcome of its economic activities, and income as the level of resources or ability entitlement it has to participate in such activities. Other studies have assessed the distribution of some other welfare variable representing lifetime wellbeing. Ignoring the effect of prices and household size and composition for the moment (these shall be examined in Section 2.4), this section discusses the nature and merits of alternative measures of welfare, principally current income and expenditure as used in this study.

2.3.1 Current Income as a Measure of Welfare

Current income data has traditionally been used in inequality studies as a measure of welfare due to its availability and the fact that many consider it a proxy for welfare. It is also the variable most easily changed through government transfer payments or direct taxation without interfering in a household's consumption choices. The period that *current income* is earned is typically determined by the length of the survey period of the available data. For most cross-sectional surveys this is 2 or 4 weeks.

Various measures of current income have been used to measure income inequality, such as:

Gross Income:	All sources of income including direct government benefits
Disposable Income:	Gross Income less direct taxes
Final Income:	Disposable Income less indirect taxes plus indirect benefits
Wages:	Wage and salary income in the study of wage inequality.

The simultaneous analysis of the first three variables enables the examination of the re-distributive effects of direct and indirect government taxes and benefits upon economic inequality.

While current income is not normally considered to generate utility, it can be regarded as a proxy for welfare since it represents an individual's ability to purchase goods and services for consumption. Current income can be a useful measure of welfare, when considered as the level of consumption that a household can enjoy, while leaving their accumulated stock of income, that is their wealth, unchanged. However this is restrictive since it assumes that no borrowing or saving is possible, as wealth can not change. Using income as a measure of welfare also suffers when using survey data, in that many respondents either misrepresent or under represent their income for fear of retribution by tax authorities.

Blundell and Preston (1998), amongst others, point out that current income may not reflect true level of resources available to the population unit since it may draw upon its wealth. Income is likely to exhibit temporary fluctuations, and if individuals or households are able to smooth out their expenditure by borrowing and lending, then income is likely to be more variable than expenditure. Since cross sectional data is normally a snapshot of the population at a given time, inequality measures based on income from such data, exaggerate the inequality of welfare. For example, a household whose only income earner is temporarily unemployed, will record a very low level of current income even though, they may have earned good wages for most of the year. Their current expenditure is not likely to be reduced as savagely as income, as an individual may borrow or spend wealth to compensate for temporarily low income.

Slesnick (1994) notes that studies of income inequality are more reflective of features of the labour market rather than informative studies about the distribution of well being. Paglin (1975) noted that comparisons of income across households with different ages are not appropriate due to differences in their level of human capital. He argued that in analysing income inequality the component that results from income differing across age groups should be removed or else income inequality would be overstated and subject to variation to changes in the age structure.

Creedy (1990) argues that the problem of temporary fluctuations recorded in cross-sectional data on household incomes can be overcome if the period of analysis is extended. Poterba (1989) demonstrates that income measured over a long horizon is less variable than income from year to year. However without such data, short period measures of income inequality are "…of very little value, if any, and that quite spurious comparisons can be made…" of household welfare. Thus it is argued that expenditure, being less effected in fluctuations in income may a better measure of welfare for inequality studies, especially when panel data is unavailable.

2.3.2 Consumption and Expenditure as a Measure of Welfare

More recently data on consumption and expenditure has been used as measures of welfare in inequality studies. McGregor and Borooah (1992), Cutler and Katz (1992), Johnson and Shipp (1997) and Slesnick (1994,1998), amongst others, argue that consumption or expenditure is a more appropriate indicator of well being than income, since utility is derived from the consumption of goods and services. Expenditure also forms the basis of money metric measures of welfare (see Section 2.4.5), which incorporate variations in prices and demographics based on consumer theory. Consumption as distinct from expenditure is typically defined as non-durable consumption plus the estimated service flow from non-durable goods. Estimating such a flow is difficult since a household does not record its flow of these services. Instead comparisons must be made with other households who choose to purchase or hire those service flows. Such comparisons are difficult given the heterogeneity of circumstances between such households.

Deaton and Paxson (1994) examine the link between intertemporal behaviour and inequality, through the rational expectations version of the permanent income hypothesis (PIH). They use Hall's (1978) result that if interest rates are equal to the rate of time preference, utility is quadratic in consumption and individuals face an uncertain income stream, then consumption follows a martingale, such that for individual (or household) *h* in period *t*

$$c_{h\,t} = c_{h\,t-1} + u_{ht} \tag{2.32}$$

where $c_{h\,t}$ is consumption of household *h* in period *t*, and $u_{h\,t}$ a disturbance term with zero mean and variance σ_t^2, which captures the revisions to planned consumption from new information. If the cross-sectional covariance is zero, such that $\operatorname{cov}(c_{h\,t-1}, u_{ht}) = 0$ then the variance of consumption over any fixed set of individuals *H* that exist both in period *t-1* and *t* will be

$$\operatorname{var}_t(\boldsymbol{c}_{\boldsymbol{t}}) = \operatorname{var}_{t-1}(\boldsymbol{c}_{\boldsymbol{t}-1}) + \sigma_t^2 \tag{2.33}$$

where $\boldsymbol{c_t} = \{c_{1\,t},..,c_{h\,t},...,c_{H\,t}\}$. Equation (2.33) indicates that under these assumptions, the variance of consumption will increase over time when σ_t^2 is constant or rising over time. This implies that consumption inequality within a particular cohort should rise over age, due to the effects of accumulated uncertainty. In addition they state that if the population membership is fixed, such that families live forever through eternal dynasties then (2.33) implies that consumption inequality should be rising over time. They also demonstrate that the PIH implies that dispersion of income rises with age (up to retirement) and that the rate depends upon the stochastic process for earnings. The implications of this for an aging society are that the rise in the relative number of aged compared to young persons, ceteris paribus, will result in a rise in consumption and income inequality.

This suggests that there may be problems when attempting to compare consumption expenditure of individuals at different stages of their life. Blundell and Preston (1988) examine the conditions, presented below, under which comparisons of current consumption suffice for comparisons of welfare in an intertemporal framework. Suppose that an individual that reaches adulthood at l_h has lifetime income Y_h and faces real interest rate r_s in period s. Individuals aim to maximise an increasing and quasi-concave lifetime utility function $U_h = U_h(\boldsymbol{c}_h)$ over their lifetime profile of consumption, $\boldsymbol{c}_h = \{c_{h0}, c_{h1}, ..., c_{hT}\}$. c_{it} is consumption at age t and can be given by Hicksian demands $c_{ht} = c_t(U_h, \boldsymbol{p}_h)$, where $\boldsymbol{p}_h = \{p_{i0}, p_{i1}, ..., p_{iT}\}$ and $p_{ht} = \prod_{s=0}^{t}\left(1 + r_{s+l_h}\right)^{-1}$ such that the rate of inflation is equal to the interest rate.

Comparisons within cohorts of the same age: $c_{it} \geq c_{jt}$ implies $U(\boldsymbol{c}_i) \geq U(\boldsymbol{c}_j)$ when individuals i and j that have the same birth year if and only consumption in all periods is a normal good.

Comparisons across cohorts of the same age: $c_{it} \geq c_{jt}$ implies $U(\boldsymbol{c}_i) \geq U(\boldsymbol{c}_j)$ for individuals i and j, of any birth year if and only if $c_t(U_h, \boldsymbol{p}) = f_t(U_h)$ where $f_t(.)$ is an increasing function for all t. This is only so when $U(\boldsymbol{c}_t) = \min_t u_t(c_{it})$ where $u_t(.)$ is an increasing function for all t.

Comparisons across ages: $c_{it} \geq c_{js}$ implies $U(\boldsymbol{c}_i) \geq U(\boldsymbol{c}_j)$ for all s and t whether individuals i and j have the same birth year or not, if and only if $c_t(U_h, \boldsymbol{p}) = f(U_h)$ where $f(.)$ is an increasing function. This is only so when $U(\boldsymbol{c}_t) = \min_t u(c_{it})$ where $u(.)$ is an increasing function.

While the assumptions for welfare comparisons within cohorts of the same age are agreeable, we must accept that individuals choose to equalise utilities across all periods of their life in order to make cross cohort or cross age comparisons. A more attractive and popular form for lifetime utility is to assume it is additive separability of within period utility, such that $U_t = \sum u_t(c_{it})$. The first order optimisation condition from this function implies that agents aim to equate their marginal utility of within period expenditure with the marginal utility of discounted lifetime income $u_0'(c_{i0}) = u_t'(c_{it})/p_{it}$. If utility is additive across periods, Blackorby, Donaldson and Moloney (1984) and Keen (1990) have demonstrated that the intertemporal substitution invalidates the use of sum of compensating variations as a measure of lifetime compensating variation. However it is still interesting to note the situations under which consumption can be used as a measure of lifetime welfare.

If within period utility u_t varies considerably over the life cycle then cross age welfare comparisons are problematic. If subjective discounting dominates, consumption will be pushed to earlier years, making the young appear better off. If real interest rates are high consumption will be pushed later in life making the old appear relatively better off. Cross cohort comparisons are also problematic since different cohorts are likely to have distinct rates of intertemporal substitution since they differ by age, their life cycle flow of resources and preferences. Thus comparisons of consumption across households or individuals that vary in their age may not be an appropriate welfare comparison. Furthermore the change in the distribution of consumption over time within the whole population will be influenced by changes in the age structure.

Blundell and Preston (1988) also argue that risk averse households with more uncertain incomes should be considered worse off. If the household undertakes precautionary saving then using consumption as a measure of welfare will capture this. However if the level of uncertainty differs amongst population then in order for consumption to be used for welfare comparisons, utility must exhibit constant absolute risk aversion.

Consumption may also better reflect lifetime resources. Creedy (1990) and Pendakur (1998) amongst others have argued that lifetime wealth is the appropriate measure of welfare. Lifetime wealth represents the lifetime budget constraint or opportunity set of lifetime consumption available to individuals or households. Thus Pendakur (1998) argues that lifetime wealth should be the real object of interest when concerned with the distribution of economic opportunity. Lifetime wealth LW_h , for individual *h,* is the discounted lifetime value of income y_{ht}, plus initial assets a_{h0}, and is equivalent to total discounted lifetime value of consumption c_{ht}, including bequests b_{hT}.

$$LW_h = a_{h0} + \sum_{t=1}^{T} \frac{y_{ht}}{(1+r)^t} = \sum_{t=1}^{T} \frac{c_{ht}}{(1+r)^t} + \frac{b_{hT}}{(1+r)^T} \tag{2.34}$$

If panel data on lifetime income or consumption were available then lifetime wealth could be estimated. However consistent panel data over a lifetime is rare, and when available can only provide accurate information on the current elderly.

Cross-sectional data on consumption can provide an alternate to measuring lifetime wealth, since it is can be considered proportionally related to lifetime wealth. If utility is additively separable across time, concave and only depends upon consumption in each period and bequests, $U(\boldsymbol{c}_h, b_h) = \sum_{1}^{T} \delta^t u(c_{ht}) + z(b_{hT})$ then lifetime wealth will be an indicator of an agents well being. If the rate of time preference balances with the real interest rate, $\delta = 1/(1+r)$, then consumers will want a constant marginal utility of consumption and thus a constant level of consumption. In addition if there is no utility from bequests then consumption is directly related to lifetime wealth, $c_h = c_{ht} = LW_h \Big/ \sum_1^T \delta^t$ and thus lifetime wealth maybe estimated by $LW_h = \sum_1^T \delta^t c_h$. This allows consumers of any age to be compared.

If $\delta < 1/(1+r)$ then the marginal utility of consumption will grow with age, and consumption fall with age and vice versa. In this case lifetime wealth can not be estimated without specifying the functional form of the utility function. This limits ordinal comparison between consumers of the same age. If the within period utility function $u(\ )$ exhibits constant relative risk aversion and consumers do not obtain utility from bequests then increases in consumption are proportional to increases in lifetime wealth. Baring in mind the above conditions, using a scale independent inequality index over the consumption distribution will provide an accurate measure of lifetime wealth inequality. Even without such restrictions, consumption expenditure is likely to be a better indicator of lifetime wealth than income.

2.4 Inequality, SWF, Price and Household Composition

The previous sections focussed on issues in the measurement of inequality over the distribution of a welfare variable, which ignored the role of prices and household size composition in nominal welfare and so in the inequality of its distribution. Inequality based on a SWF in the Kolm-Atkinson framework, was originally defined on the distribution of 'income' rather than the distribution of individual utility or some proxy welfare variable. Muellbauer (1974) extends the approach to define the SWF on the distribution of money metric individual welfare, such that the measure of welfare is adjusted with a price index and an equivalence scale, based on the representation of prices and demographics in a utility. This section based mainly on the analysis of Muellbauer (1974) and Roberts (1980a), considers the role of prices, household size and composition in the measurement of inequality through Bergson-Samuelson type SWF. It suggests that an equivalence scale and cost of living index should be used to deflate nominal household measures of welfare. This will provide real equivalent or money metric measures of welfare to provide an accurate picture of inequality in light of the variation in household size and composition and prices.

While Kolm, Atkinson and Muellbauer used nominal income as the indicator of nominal household welfare, $\boldsymbol{w} = \boldsymbol{y} = \{y_1,...,y_H\}$, in constructing inequality indices, their analysis could just as easily be applied to the expenditure distribution $\boldsymbol{w} = \boldsymbol{x} = \{x_1,...,x_H\}$ which maybe more appropriately given it's traditional links to utility. Since income or expenditure can be used as an indicator of welfare the sections below consider the distribution of nominal household welfare variable $\boldsymbol{w}$ that could be an income, expenditure or other variable.

Recall that in Section 2.23, the functional form required of $F(\ )$ in a non-individualistic SWF, $SWF(\mathbf{y}) = F(y_1,...y_h,...y_H)$, in order for it to be symmetric, homothetic, concave and additive were presented in equations (2.13) and (2.14) from Atkinson (1970). Also recall that in Section 2.1.9 a SWF can be used to evaluate inequality as the relative loss in social welfare due to inequality as $I^{SWF} = 1 - \dfrac{SWF(\boldsymbol{w})}{SWF(\overline{\boldsymbol{w}})}$. Muellbauer extends this framework by considering the restrictions required on a SWF defined over utilities, which are presented in Section 2.4.1. Sections 2.4.2 introduces prices and considers their implication when using a nominal measure of welfare. Section 2.4.3 examines the use of real measures of welfare in SWF. Section 2.4.4 considers prices and household composition based on consumer theory and introduces the notion of "money metric welfare".

2.4.1 Inequality Defined over Utilities on Nominal Welfare

Consider an individualistic $SWF(\boldsymbol{u}(\boldsymbol{w})) = G(u_1(w_1),...u_h(w_h),...u_H(w_H))$ where $G(\ )$ is increasing and concave and symmetric in utility functions $u_h(w_h)$, which are specified to be concave and increasing in w_h. Muellbauer(1974, p496) outlines the difficulty in expressing an inequality index of the form $I^{SWF} = 1 - \frac{SWF(\boldsymbol{u}(\boldsymbol{w}))}{SWF(\boldsymbol{u}(\overline{\boldsymbol{w}}))}$ due to the non-symmetrical relationship between total nominal welfare and the SWF through the utility functions. The problem can be resolved without the loss of symmetry by basing the SWF on distribution of utilities. Thus the inequality index measures the loss in the SWF relative to SWF of perfect equality in utilities, $SWF(\overline{\boldsymbol{u}})$ over the H households, not the perfect equality of nominal welfare measures as in 2.19, such that

$$I^{SWF} = 1 - \frac{SWF(\boldsymbol{u})}{SWF(\overline{\boldsymbol{u}})} \tag{2.35}$$

If $G(\ )$ is symmetric, homothetic and of the additive form such that $SWF(\boldsymbol{u}) = \sum_h^H g_h(u_h(w_h))$, then Muellbauer demonstrates that the SWF must take the form of

$$SWF(\boldsymbol{u}) = \sum_h \frac{a + b(u_h(w_h))^{1-\varepsilon}}{1-\varepsilon}, \qquad \varepsilon \neq 1 \text{ and } ,\varepsilon \geq 0 \tag{2.36}$$

$$SWF(\boldsymbol{u}) = \sum_h \ln(u_h(w_h)) \qquad \varepsilon = 1 \tag{2.37}$$

This allows the specification of the Atkinson-Kolm type Index as:

$$I^{AK} = 1 - \frac{u_{EDE}}{\overline{u}}, \tag{2.38}$$

where $\overline{u} = \sum_h^H u_h(w_h)$ and u_{EDE} is the *equally distributed equivalent* level of utility. u_{EDE} is equivalent to w_{EDE} but in utility space rather than welfare space and gives the level of utility that would be enjoyed by all if the current sum of utilities was divided equally. It is the solution to,

$$u_h(w_h) \sum_h^H g_h(u_h(w_h)) = H \times g_h(u_{EDE}(\ )). \tag{2.39}$$

Also Muellbauer notes that if $u_h(w_h) = u(w_h) = \alpha\, w_h^{\beta}$ then an inequality index defined over nominal welfare as in the previous section exits in this framework. Note that if utility is concave in nominal welfare, $\beta < 1$, a reasonably attractive assumption, then inequality defined over nominal welfare, will have more "inequality aversion" built into it and produce higher estimates than for inequality defined over utility, ceteris paribus.

2.4.2 Prices Independent Inequality Defined over Utilities on Nominal Welfare

Muellbauer (1974), Blackorby and Donaldson (1978) and Roberts (1980a) examine the conditions on preferences that inequality indices and SWF that are independent of price changes. Consider $SWF(\ ) = G(u_1(\ ),...u_h(\ ),...u_H(\ ))$ where $G(\ )$ is increasing and concave and symmetric in utility functions $u_h(\ )$ and which are defined as the indirect utility function $u_h(\ ) = v_h(w_h, \boldsymbol{p})$, where $\boldsymbol{p} = \{p_1,.., p_g,..p_G\}$ is the price vector over the G goods and w_h would normally represents nominal expenditure or consumption. Which allows the SWF to be defined over indirect utilities $\boldsymbol{v}$ as

$$SWF(\boldsymbol{v}) = G(\boldsymbol{v}(\boldsymbol{w}, \boldsymbol{p})) = V(\boldsymbol{w}, \boldsymbol{p}) \tag{2.40}$$

where $\boldsymbol{v}(\boldsymbol{x}, \boldsymbol{p}) = \{v_1(w_1, \boldsymbol{p}),...v_h(w_h, \boldsymbol{p}),..., v_H(w_H, \boldsymbol{p})\}$ and $v_h(w_h, \boldsymbol{p})$ is continuous, homogenous of degree zero, non-decreasing in w_h and $V(\boldsymbol{w}, \boldsymbol{p})$ can be considered a continuous non-decreasing indirect social welfare function. Inequality can be obtained by $I^{SWF} = 1 - \frac{SWF(\boldsymbol{v})}{SWF(\bar{\boldsymbol{v}})}$. Roberts proves that without restrictions on individuals' preferences in the form of $v_h(w_h, \boldsymbol{p})$ in the SWF, it must be dictatorial, violating D an unattractive property.

Roberts (1980a) examined the conditions under which price independent welfare prescriptions (PWIP) could be made such that when comparing the distributions of $\boldsymbol{w}$ and some alternative $\boldsymbol{w}'$, $V(\boldsymbol{w}, \boldsymbol{p}) > V(\boldsymbol{w}', \boldsymbol{p})$, for all $\boldsymbol{w}$, $\boldsymbol{w}'$, $\boldsymbol{p}$, $\boldsymbol{p}'$. PWIP can only be made if,

$$V(\boldsymbol{w}, \boldsymbol{p}) > V(\boldsymbol{w}', \boldsymbol{p}) \equiv V(\boldsymbol{w}, \boldsymbol{p}') > V(\boldsymbol{w}', \boldsymbol{p}') \tag{2.41}$$

which Roberts proves is only possible if the welfare distribution $\boldsymbol{w}$ can be separated from prices, $\boldsymbol{p}$, in the SWF such that

$$V(\boldsymbol{w}, \boldsymbol{p}) = G(H(\boldsymbol{w}), \boldsymbol{p}) \tag{2.42}$$

for some function $G(\;)$ and $H(\;)$ $H(\boldsymbol{w})$ can be considered the equally distributed equivalent level of welfare w_{EDE} of Atkinson (1970) except that it must be independent of prices in order to make the distribution of welfare separable from prices. $G(\;)$ must be homothetic since $v_h(w_h, \boldsymbol{p})$ are homogenous of degree zero. Roberts goes on to show that PWIP can only be made, if all individuals have identical tastes preferences and homothetic preferences (i.e. unitary income elasticities). Which implies identical budget shares for all households such that the indirect utility functions must be $v_h = v_h(w_h, \boldsymbol{p}) = \bar{v}_h(w_h \times f(\boldsymbol{p}))$. This was also termed as "income separability" by Slivinski (1983) who extends the case to where households face different prices, requiring that the social welfare aggregator have the Cobb-Douglas form. The above analysis expresses the extreme restrictions on consumer behaviour under which inequality indices (based on SWF) can be made independent of prices, which led Muellbauer to examine the incorporation of prices into the measure of individual welfare.

2.4.3 Inequality Defined over Utilities on Real Welfare

Muellbauer (1974) suggests that an appropriate measure of welfare that incorporates prices can be expressed using the individual's expenditure or cost function, $c(u, \boldsymbol{p})$. It defines the amount of expenditure required to reach utility *u*, with price vector $\boldsymbol{p}$. If we use base period prices to compare the current welfare distribution with the base period distribution then $c(u_h^1, \boldsymbol{p^0})$ would be an appropriate measure of real income, since it is the nominal measure of expenditure deflated by the appropriately based cost of living index (CLI), given below.

$$\frac{x_h^1}{CLI} = \frac{c(u_h^1, \boldsymbol{p}^1)}{CLI} = c(u_h^1, \boldsymbol{p}^1) \times \frac{c(u_h^1, \boldsymbol{p}^0)}{c(u_h^1, \boldsymbol{p}^1)} = c_h(u_h^1, \boldsymbol{p}^0) \tag{2.43}$$

Thus using this real CLI adjusted measure of welfare $w_h = c(u_h^1, \boldsymbol{p^0})$ where $u_h^1 = v\left(\frac{w_h^1}{\boldsymbol{p^1}}\right)$ allows the specification of the inequality index as based upon the $SWF(\boldsymbol{w}) = F(w_1, \ldots w_h, \ldots w_H)$ where $F(\ )$ is strictly concave of the form $I^{SWF} = 1 - \frac{SWF(\boldsymbol{w})}{SWF(\overline{\boldsymbol{w}})}$ or if $F(\ )$ is additive $I = 1 - \frac{w_{EDE}}{\overline{w}}$ where w_{EDE} is defined in Section 2.2.3 but defined over $\boldsymbol{w} = \{c(u_1^1, \boldsymbol{p^0}), \ldots, c(u_h^1, \boldsymbol{p^0}), \ldots c(u_H^1, \boldsymbol{p^0})\}$ where $u_h^1 = v\left(\frac{w_h^1}{\boldsymbol{p^1}}\right)$ for h = 1 to H.

2.4.4 Inequality Defined over Utility on Money Metric Welfare

Following the approach of Section 2.2.3 the measure of welfare can be defined as the $w_h^1 = c(u_h^1, \boldsymbol{p^0}, \boldsymbol{z_R})$ which is the amount of expenditure required to attain current utility u_h^1 where $u_h^1 = v\left(\frac{w_h^1}{\boldsymbol{p^1} m(z_h)}\right)$, at the reference prices, $\boldsymbol{p^0}$ and reference household composition and size, $\boldsymbol{z_R}$, where $m(z_h)$ is an equivalence scale used to adjust for variations in household demographics and is discussed further in Chapter 4. $c\left(u_h^1, \boldsymbol{p^0}, \boldsymbol{z_R}\right)$ can be considered the nominal measure of welfare divided by an appropriately based cost of living index (*CLI)* and an equivalence scale, $m\left(\boldsymbol{z}^h\right)$ since

$$\frac{x_h^1}{CLI\ m(z_h)} = \frac{c\left(u_h^1, \boldsymbol{p^1}, \boldsymbol{z_h}\right)}{CLI\ m(z_h)} = c\left(u_h^1, \boldsymbol{p^1}, \boldsymbol{z_h}\right) \times \frac{c\left(u_h^1, \boldsymbol{p^0}, \boldsymbol{z_R}\right)}{c\left(u_h^1, \boldsymbol{p^1}, \boldsymbol{z_R}\right)} \times \frac{c\left(u_h^1, \boldsymbol{p^1}, \boldsymbol{z_R}\right)}{c\left(u_h^1, \boldsymbol{p^1}, \boldsymbol{z_h}\right)} = c_h\left(u_h^1, \boldsymbol{p^0}, \boldsymbol{z_R}\right) \tag{2.44}$$

Observed spending patterns can be estimated against the demand system from an appropriately specified functional form of utility, in order to recover the cost function, $c\left(u_h, \boldsymbol{p}, \boldsymbol{z}_h\right)$, such that an equivalence scale $m(z_h) = \dfrac{c\left(u_h^1, \boldsymbol{p^1}, \boldsymbol{z_h}\right)}{c\left(u_h^1, \boldsymbol{p^1}, \boldsymbol{z_R}\right)}$, and cost of living index $CLI = \dfrac{c\left(u_h^1, \boldsymbol{p^1}, \boldsymbol{z_R}\right)}{c\left(u_h^1, \boldsymbol{p^0}, \boldsymbol{z_R}\right)}$ can be recovered. Blackorby and Donaldson (1988) note that money metric welfare utility must be concave in incomes, or else the Pigou-Dalton Principle of Transfers will be violated. Donaldson (1990) also points out that any conclusions about the distribution of money metric utility will depend upon the reference price vector and reference household used as the basis for comparison and the only case this is not true is where PIWP can be made. A review of the literature on the specification of equivalence scales and cost of living indices and their estimation for Australia and Canada is conducted in Chapter 4. The specification and estimation of equivalence scales and CLI used in this study are presented in Chapter 6.

2.5 Summary of Key Points

The following provides a convenient summary of the key points discovered in this chapter on the measurement of inequality. It briefly summarises the assumptions required for interpersonal welfare comparisons, measures of welfare and inequality and the measurement of inequality and how household composition and prices effect the measurement of inequality. Chapter 3 reviews the past literature on the magnitude, movement and nature of inequality for Australia and Canada, before Chapter 4 further examines the household composition and prices.

Interpersonal Comparisons, SWFL and SWF

- In order to construct SWF from a SWFL, suitable for the study of inequality, cardinal full comparability (CFC) across individuals must be allowed.

- The desirable properties of U, I and D, are allowed with the relaxation of P to PI and the additional requirements of Anonymity (A) and Separability (SE) in order to construct useful SWF under CFC.

- Inequality can be directly measured from SWF, by measuring the proportional loss in social welfare due to inequality

Measuring Inequality

- Inequality measures are frequently desired to be symmetric, mean independent, invariant to population and satisfy the Pigou-Dalton Principle of Transfers and Transfer Sensitivity.

- A wide range of indices has been used to measure inequality but only those based on explicit SWF or clear axioms consider the normative judgements they are making about inequality.

Measures of Individual Welfare

- Income has traditionally been the most popular measure of individual welfare, due to its availability. However it suffers as an indicator of well being, due to the temporary fluctuations in household income recorded in cross sectional data and that it only measures some of the resources available to households, ignoring saving and borrowing.

- The recent availability of data on household expenditure has allowed the use of consumption expenditure as a measure of welfare. It has much closer links to well being through utility and is more stable in cross sectional data. It is also considered a closer indicator of lifetime wealth or utility.

Inequality, SWF, Price and Household Composition

- In order for Inequality indices (and SWFs) to be independent of prices all individuals' preferences must be identical and homothetic, which is extremely restrictive.

- An alternative is to use a money metric measure of welfare, where nominal household welfare is divided by a *CLI* and an equivalence scale, based on the specification of the households cost function. Inequalities can be defined over such money metric welfare measures and allow for variations in prices and household size and demographics to provide a more accurate picture of the inequality of well being.

Chapter 3 A Review of Australian and Canadian Inequality

This chapter reviews the literature on studies of Australian and Canadian inequality. It begins with a brief review of international studies in Section 3.1, based on the Luxembourg Income Study (LIS) database. This identifies Australian and Canadian income inequality as similar and higher than the OCED average and close to estimates for the United States. Sections 3.2 and 3.3 review the literature on studies of Canadian and Australian inequality, respectively. They briefly examine inequality in the mid 1900s but concentrate on studies based on comprehensive nation wide surveys of the Canadian and Australian populations available since the 1970s.

3.1 Trends in International Inequality

Most of the developed world experienced strong economic growth in the years following the end of World War II. The subsequent fall in unemployment reduced the high level of inequality that had resulted from the Great Depression in the 1930s[1]. While economic growth declined from an average of 4 percent in the 1950s, to 3 per cent in the 1960s and 2 percent in the 1970s, income inequality remained relatively stable, rising only slightly from the 1960s to the mid 1970s[2].

During the late 1970s and 1980s politics in the western world shifted to the right, and many governments adopted policies of deregulation, unleashing market forces upon the western world. Restrictions were lifted on the movement of international capital, resulting in many localised boom and bust cycles. Production involving unskilled labour was often shifted to developing low cost countries and traditional markets were eroded as trade restrictions were lifted. The demand for

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[1] See Kaebel and Thomas (1991).
[2] See Gottschalk, Gustafsson and Palmer (1997).

unskilled labour fell, reducing the real earnings of unskilled workers and forcing many into unemployment. In contrast, deregulation provided opportunities for skilled workers, increasing their wages. The rise in unemployment and increase in earnings dispersions in many countries through the 1970s and 1980s subsequently increased income inequality[3].

The reaction of governments varied, some countries with centralised labour markets managed to limit the increase in earnings dispersion, while others increased transfer payments and altered their taxation system lowering family income inequality. However policies generally moved against the welfare state, with many developed countries decentralising their labour markets and making regressive tax reforms, such as the introduction of consumption taxes, the increase in flat rate contributions for social security and decreasing top marginal income tax rates. A counteracting influence on the growth in inequality came from high inflation from the oil shocks and the economic boom of the 1980s. These effects pushed many tax payers into higher tax brackets, helping to reduce or stabilise the growth in the dispersion in earnings.

Saunders, Stott and Hobbes (1991) extend the analysis of the Luxembourg Income Study (LIS) database by O'Higgins, Schmaus and Stephenson (1989), to include comparable Australian and New Zealand results. Table 3.1 contains the quintile shares and Gini coefficients of selected countries from the LIS. Australia records a Gini coefficient for gross family income inequality of 0.40, just below the U.S., while slightly higher than Canada and the U.K and considerably higher than Sweden. Removing income tax and adjusting for family size using an equivalence scale where a value of 0.5 is assigned for the first member and 0.25 for each

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[3] Ibid.

additional member, provides the net equivalent income estimates of Saunders, Stott and Hobbes, presented in the lower half of Table 3.1. The use of net equivalent income reduces inequality across all the countries listed. However the size of the effect varies due to differing degrees of income taxation and different joint distributions of family size and net income, across the countries studied. Adjusting for family size and income taxation, results in very similar quintile shares and Gini coefficients for Australia and Canada, suggesting they have a similar shaped distribution for real net equivalent income. In fact, as Saunders (1994, p. 209) notes, "In terms of other countries studied, both the Australian and New Zealand distributions are closer to that of Canada than of any other country".

Table 3.1 Distribution of Family Income from Six Countries

	Australia	**Canada**	**New Zealand**	**Sweden**	**United Kingdom**	**United States**
	Gross family income share among quintiles of families					
Lowest quintile	4.6	4.7	5.7	6.7	4.9	4.0
Second quintile	9.8	11.1	11.4	12.3	10.9	10.1
Third quintile	16.6	17.8	17.6	17.2	18.2	16.7
Fourth quintile	24.8	25.3	24.7	25.0	25.2	25.1
Highest quintile	44.1	41.2	40.5	28.9	40.8	44.2
Gini coefficient	0.40	0.37	0.35	0.33	0.36	0.41
	Net equivalent family income share among quintiles of individuals					
Lowest quintile	7.7	7.6	8.2	10.9	9.0	6.4
Second quintile	13.0	13.3	3.5	16.0	13.5	12.8
Third quintile	17.5	17.9	17.6	19.0	18.0	18.0
Fourth quintile	23.6	23.7	23.7	23.0	23.4	24.2
Highest quintile	38.2	37.4	37.0	31.1	36.1	38.6
Gini coefficient	0.31	0.30	0.29	0.20	0.27	0.32
Reduction in Gini (from removing tax and scaling for family size)	22.5%	18.9%	17.1%	39.4%	25.0%	22.0%

Source: Saunders, Stott and Hobbes (1991), Table 1.
Note: These results were derived from the January 1990 LIS database.

Atkinson, Rainwater and Smeeding (1995) provide a comprehensive study of OECD countries using the Luxembourg Income Study (LIS) database. The LIS database contains a collection of datasets from the mid 1980s that allow, to some extent, comparisons of inequality to be made across countries. Table 3.2 provides a ranking in descending order, of income inequality by Gini coefficients from the Atkinson, Rainwater and Smeeding (1995) study. The United Sates has the highest income inequality, with the continental European countries (excluding Italy and France) experiencing lower inequality and the Scandinavian countries enjoying the lowest levels of inequality in the OECD. Australia's income inequality along with that in Canada and France's is slightly above the OECD average.

Atkinson, Rainwater and Smeeding (1995) also examine the annual change in inequality for selected OECD countries over varying time frames. Basically their study covers the early 1980s to the early 1990s and a summary of the results are presented in the top portion of Table 3.3. The European countries exhibited a substantial decline in gross income inequality compared to the rise in inequality in non-European countries.

Table 3.2 OECD countries ranked in descending order by income inequality in the mid 1980s

Rank	**Country**	**Date**	**Gini (x 100)**	**Atkinson Index ε= 0.5**	**% Growth in Real GDP**
1	United States	1986	34.1	9.9	2.9
2	Ireland	1987	33.0	9.3	4.7
3	Switzerland	1982	32.3	9.9	-0.9
4	Italy	1986	31.0	8.0	2.9
5	United Kingdom	1986	30.4	8.2	4.3
6	France	1984	29.6	7.7	1.3
7	Australia	1985	29.5	7.5	4.5
8	Canada	1987	28.9	7.0	4.3
9	Netherlands	1987	26.8	n.a.	3.3
10	Germany	1984	25.0	5.2	3.3
11	Luxembourg	1985	23.8	4.6	6.2
12	Belgium	1988	23.5	4.9	4.9
13	Norway	1986	23.4	4.6	4.2
14	Sweden	1987	22.0	4.6	2.8
15	Finland	1987	20.7	3.6	4.1

Source: Atkinson, Rainwater and Smeeding (1995).
Notes: See Section 2.2.2 and 2.2.3 respectively for an explanation of the Gini and Atkinson (ε = 0.5) indices of inequality.
n.a. not available.

Of the countries selected, their study shows that Australia and New Zealand experienced the highest rate of growth in gross income inequality over the 1980s. The bottom half of Table 3.3 includes Pendakur (1998)'s Gini inequality estimates for Canada over a similar period and demonstrates that income inequality measured by the Gini coefficient has risen for both Australia and Canada to a similar degree.

Table 3.3 Changes in Gini Coefficients of Gross Income

	Date	**Coefficient**	**Annual % change**
United States	1967 1991	0.399 0.428	+ 0.29
United Kingdom	1968/69 1984-85	0.330 0.360	+ 0.37
Finland	1966 1985	0.318 0.2	-2.47
Germany	1950 1985	0.396 0.352	-0.43
Netherlands	1981 1989	0.283 0.296	- 1.50
New Zealand	1987-88 1993-94	0.290 0.340	+ 1.00
Australia	1981-82 1989-90	0.270 0.290	+ 0.90
Canada	1982 1992	0.289 0.316	+ 0.90

Source: United States, United Kingdom, Australia, New Zealand, Netherlands, Germany and Finland: Atkinson, Rainwater and Smeeding (1995), p. 40.
Canada: Pendakur (1998), Table 5, p. 276.

3.2 Canadian Inequality

Canada, like most of the developed world has been the subject of significant structural change in the 20th century. Increases in unemployment, part-time work and female labour participation and the decline of male labour participation have had significant economic and social effects upon Canadians. Yet it was generally considered until the mid 1980s that the distribution of income in Canada had not changed significantly since World War II. Goldberg and Podoluk (1957), McWaters and Beach (1990), Blackburn and Bloom (1994) found little change in the Gini coefficients and quintile income shares throughout the 1980s. Buse (1982) and Osberg, Erksoy and Phipps (1997), who examined the effect of unemployment on income inequality, also came to this conclusion.

The inequality measures from the above studies may have been insensitive to the change in the income distribution or the socio-economic changes, which may have had offsetting effect on the movement of income inequality. Wolfson (1979, 1986, 1994, 1997) has more closely examined these issues, while Barrett and Pendakur (1995) and Pendakur (1998) have turned their attention to the distribution of expenditure inequality, reporting no change and a slight increase, respectively for 1978 to 1992. This thesis provides an additional investigation into the factors contributing to inequality changes in Canada through additive decomposition analysis and provides additional evidence on Canadian expenditure inequality.

3.2.1 Long Term Trends in Canadian Inequality and Income Shares

Goldberg and Podoluk (1957) examined the distribution of earnings from paid employment of wage and salary earners between 1930-31 and 1951 for individuals and families. Adjustments had to be made to the 1930-31 census data and 1951 survey of incomes to allow for under reporting in the census data. The two periods for comparison are also fundamentally different in that 1930-31 was a depression year and 1951 a boom year. Goldberg and Podoluk discovered that income inequality had considerably declined with the bottom four income quintiles each increasing their share of income by approximately 2% while the top quintiles income share fell from 48.5% to 39.9%. Using the personal expenditure deflator from the National Accounts, the 1930-31 incomes were converted to real 1951 income. Real incomes were shown to rise over the period studied and fall in real income inequality was less pronounced than in the nominal results.

Table 3.4 Long-Term Trends in The Income Distribution of Canada

	1951	1961	1971	1981	1986	1991
Family[a] income quintile						
Per cent share of						
Poorest 20 per cent 1	4.4	4.2	3.6	4.6	4.7	4.7
2	11.2	11.9	10.6	10.9	10.4	10.3
3	18.3	18.3	17.6	17.6	17	16.6
4	23.3	24.5	24.9	25.2	24.9	24.7
Richest 20 percent 5	42.8	41.1	43.3	41.7	43.0	43.8
Mean family [a] income	$21,483	$28,531	$41,659	$52,518	$52,815	$53,940

Notes: All monetary figures are in 1992 Canadian Dollars
(a) Refers to economic families.
Source: Osberg and Phipps (1992), from Statistics Canada, Income Distributions by Size, 1990. Cat. No. 13-207, various issues and Census of Canada, 1951, 1961, 1971, 1981, 1986, 1991.

Table 3.4 contains a collection of family income quintiles form Osberg and Phipps' (1992) study based on census data at ten year intervals from 1951 to 1991. The middle quintile share of income has decreased substantially from 18.3% in 1961 through to 16.6% in 1991. The income share of the second poorest quintile has been declining over 1951 to 1991 from 11.2% to 10.3%.

Table 3.5 Quintile shares of total income in Canada

Year	1st Quintile	2nd Quintile	3rd Quintile	4th Quintile	5th Quintile
1980	4.2	10.7	17.8	25.2	42.1
1981	4.6	10.9	17.6	25.2	41.7
1982	4.6	10.8	17.4	24.9	42.4
1983	4.3	10.3	17.1	25.0	43.2
1984	4.5	10.4	17.2	25.0	43.0
1985	4.6	10.4	17.0	24.9	43.0
1986	4.7	10.4	17.0	24.9	43.0
1987	4.7	10.4	16.9	24.8	43.2
1988	4.6	10.4	16.9	24.9	43.2
1989	4.8	10.5	16.9	24.6	43.2
1990	4.7	10.4	16.9	24.8	43.3
1991	4.7	10.3	16.6	24.7	43.8
1992	4.6	10.3	16.7	24.8	43.6

Source: Osberg, Erksoy and Phipps (1997) Table 5.2, p. 87, from Statistics Canada, Income Distributions by Size, 1990, Cat. No. 13-207.
Note: Measured among all families and unattached individuals.

Table 3.5 above taken from Osberg, Erksoy and Phipps (1997), further illustrates the decline of the share of income going to the middle quintile, from 17.8% in 1980 to 16.7% in 1992. The shares of income to the 2nd and 4th quintiles, either side of the middle, also declined but less dramatically. While there has been a small increase in income going to the bottom quintile, the share going to the richest quintile has increased by 1.5 percentage points of total income.

McWaters and Beach (1990), who examined Statistics Canada's grouped income data, found that the ratio of top to bottom income quintile shares of family income rose over 1980-84 and decreased over 1984-87. Blackburn and Bloom (1994) analysed micro data from the Surveys of Consumer Finance and found that total family income inequality was about the same in 1987 as it was in 1979. Much of the research also found that net family income changed very little over the 1980s and was in general lower than U.S. inequality.

3.2.2 Unemployment and Canadian Income Inequality

While many OECD countries endured substantial labour market reforms in the 1980s and 1990s, Canada had been undergoing structural change since the Great Depression. However in the mid 1970s the strength in the labour market declined, with real wage growth halted from the high rates of approximately 35% of the 1950s and 1960s. The low rate of unemployment of the early post-war decades rose substantially in the late 1970s to 7.5%. The recessions of the early 1980s saw unemployment rise as high as 12.9% in December 1982 and fluctuate between 8 and 12% through out the 1980s and 1990s, averaging 9.5%[4]. This has lead to a focus in the Canadian inequality literature on the impacts of unemployment and cyclical variations in the economy on inequality.

Buse (1982) used the reportable taxable income of taxpayers from 1947 to 1978 in order to regress the rate of employment and inflation upon the Gini and the incomes of the top and bottom deciles over time. He found that apart from some

[4] CAN SIM, SC, Unemployment Rate (seasonally adjusted).

weak evidence that the bottom decile loses, the distribution of taxable income seemed unaffected by inflation. The effect of rising unemployment had only a small effect, increasing the level of overall income inequality, with the lowest decile suffering the most. In fact the largest effect found was the systematic reduction in inequality from the fall in the aggregate participation rate. Buse (1982, p.203) does not attempt to explain the 'detailed micro process' by which this takes place.

Erskoy (1994) used a dynamic micro-simulation to model the period from 1981 to 1987 and found that cyclical fluctuations in unemployment resulted in higher inequality than if unemployment had stayed constant. Johnson (1995) reaches the same result from a macroeconomic perspective using an income share model from 1981 to 1992 on data from the Survey of Consumer Finances.

In response to rising unemployment, Canada increased the coverage of unemployment insurance up to 90% of labour force in the 1980s. The re-distributional impact of unemployment insurance has been studied by Kapsalis (1979), Cloutier and Smith (1980) and Countryman (1999). By examining the net unemployment insurance receipts as a proportion of original income they revealed that the higher income quintiles received a greater proportion of the benefits.

Osberg, Erksoy and Phipps (1997) point out that these studies have problems in using discrete annual intervals since the timing of unemployment and payments will affect the annual amount received. They also note that this bias varies in response to fluctuations in unemployment and the prevailing macroeconomic conditions. Thus, the authors suggest that the business cycle is a more appropriate reference period and also stress the need to address the effect of unemployment benefits on behaviour.

Building on the previous work of Erksoy (1994), Osberg, Erksoy and Phipps perform a behavioural micro simulation that incorporates time varying macroeconomic variables based on the Labour Market Activity Survey 1986-87 and the Assets and Debts Survey of 1983. Their simulation found the Gini (CV) for annual earnings including unemployment insurance of 0.398 (0.757) in 1981 to 0.410 (0.774) in 1989. In the absence of unemployment insurance the CV would have been 0.437 (0.823) in 1989 and real income would have fallen further. This suggests that the unemployment insurance system and the automatic targeting to those affected by unemployment has been an important source of stability in the income distribution.

3.2.3 Canadian Wage Inequality

Wage inequality is not the focus of this thesis as it only measures the inequality of economic resources available to workers. Beach and Slotsve (1994), Morissette, Myles and Picot (1993), more recently found, using the Survey of Consumer Finances (SCF), that the inequality of the distribution of annual earnings in Canada has risen through the 1980s.

Doiron and Barrett (1996) and Morissette, Myles and Picot (1993) find that the increase in inequality can be entirely explained by the increase in hours worked per year and found no change in hourly wage inequality over the 1980s. Richardson (1997) found the distribution of weekly wages showed an increase in dispersion over 1981, 1982, and 1984 to 1992 using the SCF. He also found that inequality in the wage distribution is significantly positively related to the unemployment rate and that the state of the macro-economy must be considered when interpreting inequality estimates.

3.2.4 Canadian Income Inequality in More Detail

Wolfson (1979) examined the inequality of various income measures across age using data for 1969-70 from the Survey of Consumer Finances using an equivalence scale based upon Statistics Canada's 1969, "Low Income Cut-Offs" for various family sizes. Using the Gini coefficient, Coefficient of Variation, top 5% and bottom 20% shares, Wolfson examines the effect of including imputed rent and equivalent annuity from household financial wealth. He reported that the inclusion of imputed rent tends to reduce the overall income inequality by increasing it in young households with heads aged 25 to 44, and reducing it in all other households. Wolfson found that the use of an equivalence scale had the same result as including imputed rent, while including annuity wealth tended to increase inequality across all age groups.

Wolfson (1986) analysed family market income, total money income and disposable income data from the Survey of Consumer Finance from 1965 to1983. He found that after tax annual income inequality increased over the 1960s, decreased through the 1970s, before rising again in the 1980s. He also preformed a shift share analysis on the effect on inequality due to changes in the relative size in population subgroups such as family type and effective labour force participation. The rise of single parent families, double income couples, lower fertility rates, increased female labour participation, increased divorce and separation rates, and more baby boom children living away from their parents are likely to have increased income inequality. Contrary to popular belief, Wolfson's shift-share analysis by income composition showed that the decline in employment income and the rise in investment and government transfer income equalised the income distribution.

More recently, Wolfson (1994,1997) has turned his attention to measuring the polarisation of the Canadian labour income distribution. Wolfson argues that polarisation is different to the concept of inequality and that changes in the former will not necessarily be reflected in the latter. He proposes a convenient measure of polarisation that is related to the Gini coefficient and the area below the Lorenz curve and the tangent to the Gini at the median level of income. Using SCF for 1967, 1973, 1981, 1986, 1988, 1990 and 1994, Wolfson (1997) demonstrates that, in general, conventional measures of income inequality have moved in line with the scalar polarisation index with the exception from 1973 to 1981 when inequality significantly declined yet polarisation rose, illustrating his argument mentioned above. His 1997 study also provides additional evidence on the trend of Canadian income inequality in the early 1990s, indicating there was a significant fall in income inequality from 1993 to 1994 to levels more similar to 1990 or 1991.

Phipps (1993), using the 1986 Family Expenditure Survey (FES) from Statistic Canada examined the effect of equivalence scales on poverty estimates. In particular, Phipps found that scales with larger economies of scale increase the relative poverty of single parents. Macphail (2000) argues that the arbitrary exclusion of outliers can result in biases in inequality estimates. Using the SCF from 1981 and 1989, the 1981 Survey of Work History and the 1989 Labour Market Activity Survey, she estimated Gini, Atkinson and Theil indices and the CV and found a rise in inequality over the period. Exclusion of outliers at the bottom and/or the top of the income distribution reduced both the inequality levels and growth over the sample period. Minor variations in the choice of measurement of income (hourly, weekly and annual earnings, in/exclusion of self employed income) and sample selection were shown to change the level and the size of the increase in income equality.

3.2.5 Canadian Expenditure Inequality

Barrett and Pendakur (1995) were the first to favour the use of expenditure (real equivalent non-durable) over income in Canadian empirical studies of inequality. They estimated the Gini, S-Gini and E-Gini from the 1978, 1984 and 1990 FES, with varying degrees of inequality aversion using urban households adjusted by Statistics Canada's Low Income Cut Offs[5] for 1986. In general they found that non-durable expenditure inequality declined from 1978 to 1990, although rose from 1978 to 1984. They also note that mean non-durable expenditure declined by 10% from 1978 to 1984 and had not recovered by 1990. For the inequality averse S-Gini with s = 3.50 there was an significant increase in inequality from 1978 to 1990, while for lower values and the E-Gini's there was a mild increase. This indicates that the most severe divergence in expenditures from the mean, occurred at the extremes of the expenditure distribution, rather than from movements in the middle. The Absolute S-Gini's and E-Gini's, measures that were based upon real level of expenditure as opposed to expenditure relative to the mean, however exhibited a significant decline.

Using the FES (Family Expenditure Survey) datasets from 1978 to 1992, Pendakur (1998) was the first to simultaneously examine both income and consumption inequality for Canada. Using the Gini coefficient with an equivalence scale equal to the square root of the number of family members, Pendakur found that both gross and net equivalent family income inequality rose through the early to mid 1980s, falling somewhat between 1986 and 1990 and then rose again in the 1992 recession. Both non-durable and imputed consumption inequality rose over the sample period, except for a small improvement in 1990. Pendakur notes that income

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[5] See Section 4.1.3.2 in Chapter 4 for more details.

inequality, using the Gini coefficient, grew by 3% from 1978-1992, while consumption inequality rose only by 1%, which he suggests is a sign of the widening in the distribution of lifetime wealth. He also notes that consumption and income inequality move counter cyclically being lowest in times of strong growth.

3.3 Australian Inequality

In the years following Australia's federation in 1901, much of the concern over the distribution of income, not surprisingly, was directed at the distribution of taxation burden and revenue for each of the states. From the 1950s to the mid 1980s, Australian literature on distribution of income was mostly focussed upon full-time adult male earnings.

3.3.1 Australian Wage Inequality

The only Australian records available for wages in the early 20th century were award rates of pay. Richardson (1979) explains that from 1914 to 1920 there was a reduction in the dispersion of award wages, which stabilised through the 1920s, rising dramatically in 1931 gradually declining through to 1948-49 and then compressing sharply to 1952. From the 1950s the dispersion in individual wage earnings fell, [see Lydall (1968) and Hancock and Moore (1974)], before rising sharply in 1975, [see Norris (1977)]. The overall wage inequality in Australia rose throughout the 1970s and 1980s as demonstrated by King, Rimmer and Rimmer (1992), Gregory (1993), Borland and Wilkins (1996). Walker (1999) confirmed that this trend has continued through to 1995 from 1982, despite a reduction in real weekly wage dispersion in 1990.

3.3.2 The 20th Century: Long Run Changes in Inequality

Although the distribution of male earnings is likely to shed some light on the distribution of household welfare, it fails to account for labour force participation, female earnings, non-labour income and household composition. The impact of these factors, which have changed significantly for Australia, can only be examined through measures of household or family welfare. Before the Survey of Consumer Expenditures and Finances (SCEF) conducted by Macquarie and Queensland Universities in 1966 and the ABS's Income Distribution Surveys (IDS) first conducted in 1968, grouped Census data and income tax statistics, when available, were virtually the only alternative to wage records. While income tax statistics provide full income details for all taxpayers they ignore non-taxpayers and do not allow the examination of the household or family unit.

Brown's (1957) early work examined the distribution of income between 1938-39 and 1942-43. By linking the income tax statistics with grouped data from the partial census of June 1943, Brown was able to conduct a detailed breakdown of income by state, gender and occupation. While adjustments were made for the tax statistics that excluded gross annual incomes below £104, the partial census excluded rentiers, which proved difficult to exclude from the income tax data. The major shortcoming was that 1942-43 was at the height of World War II, when many women replaced men in the workforce. They were often paid less than the men increasing the number of low paid workers and increasing the dispersion of incomes.

Jones (1975) combined the 1915 war census with the 1968-69 Income Distribution Survey (IDS) to examine the male income distribution coefficient based on groupings of individuals with non-negative income, for the two survey periods.[6] He estimated the income of 15-17 year old males by their participation rate and also included pensioners to bring the war census data in line with the IDS. Doing this provides a Gini coefficient for the net income of males of 0.420 (compared to 0.409 before pensioner adjustment) in 1915. Reducing the IDS data to eleven income categories as in the war census, condenses the Gini to 0.338 (from 0.354) in 1968-69 for male gross income. The decline in inequality was most evident through the decline of the top 1% of male income earners' share of income. In 1915 they collected 14.6% of net income, while in 1968-69 they collected only 7.6% of gross income.

McLean and Richardson (1986) examined the income inequality using grouped data from the 1915 and 1933 census and the 1981 IDS. In 1933 depressed labour market conditions greatly increased income inequality for males, however allowing for this still gave higher earnings dispersion in 1933 compared to 1915 and 1981. They found that there had been a significant decline in male income inequality from 1915 to 1981 and that it was of a similar magnitude to that found by Jones from 1915 to 1968-69. Implying that the male income inequality rose from the beginning of World War I to the Great Depression in 1933 and then experienced a fall through to the late 1960s. They also found that the fall in inequality was consistent across all family types.

[6] In 1915 the Australian government organised a War Census to identify manpower and resources for the war effort. It was the first census of income and wealth of any country and provided the first comprehensive data on income and wealth. The census was hampered by federal proposals for the first income tax. Despite newspaper articles advising citizens of their obligations, many feared that the census would be used to calculate taxability. It also excluded government social benefits, thus ignoring persons whose sole source of income was invalid and old age pensions. Nor was any account made for 20,000 men serving in Egypt.

Saunders (1993) gives a good review of the longer run changes in the distribution of income by extending Brown's (1957) analysis from 1942-43 through to 1980s using samples from the 1981-82, 1985-86 and 1989-90 Survey of Income and Housing Costs and Amenities (SIHCA) comparable to Brown's data set.

Table 3.6 provides Saunders' decile shares and Gini coefficients for individuals above an annual income cut off (£50 for 1942-43 and $3437 in 1989-90).

Saunders concluded that there was little difference in the income distribution for individuals of 1942-43 compared to 1989-90 based on the examination of the decile shares. The Gini coefficient while falling from 1942-43 to 1981-82 rose to just below the 1942-43 level in 1989-90. This suggests that much of the decline in income inequality in the years of economic growth after World War II, was undone by the 1983 recession.

Table 3.6 Estimates of the Distribution of Individual Gross Incomes (decile shares)

Decile share of income	1942-43	1981-82	1985-86	1989-90
Lowest	2.3	2.4	2.5	2.4
Second	2.7	3.2	3.2	3.2
Third	4.3	4.1	3.8	4
Fourth	5.7	5.6	5.3	5.4
Fifth	7.6	7.6	7.4	7.3
Sixth	8.6	9.7	9.4	9.2
Seventh	11.1	11.5	11.4	11
Eighth	12.2	13.6	13.5	13.2
Ninth	14.3	16.5	16.5	16.3
Highest	31.2	25.7	27.1	28.1
Gini coefficient	0.409	0.377	0.392	0.396

Source: Saunders (1993), Tables 2, p. 359 and Table 4, p. 362.

3.3.3 The Modern Era: The Availability of Household and Family Data

Podder (1972) was the first to make use of the modern survey data sets, examining Australian inequality using the 1966-68 Australian Survey of Consumer Expenditures and Finances (SCEF). The SCEF was a joint project conducted by the Macquarie and Queensland Universities and sampled 5,500 households Australia wide. Until the release of the ABS's survey data in 1973 it was the only source of cross sectional household data. Podder's comprehensive study, examined the inequality of expenditure as well as pre and post tax income through decile analysis and measurement of the coefficient of variation, standard deviation of logarithms, Gini coefficient, Lorenz curve and others[7]. He also inspected the income inequality of various household sizes, occupational groups, education levels, ages and made international comparisons of Australia's inequality.

Podder (1972, p. 185) noted that the distribution of household income was less equitably distributed than household expenditure, which exhibited a sharper peak and greater positive skewness. The impact of income taxation did little to alter the decile shares of income and lowered the income inequality only marginally to a level still well above the recorded expenditure inequality. Adjusting income by Podder's (1971) estimated equivalence scale resulted in the Gini coefficient reducing from 0.332 to 0.305 and the coefficient of variation falling from 0.778 to 0.635[8]. Podder estimated that income inequality was highest amongst single person households, but lower for each household size than the overall level. The income inequality was found to be highest within households whose head was not in the labour force and for professionals. Households headed by a member with a low level of education and those with tertiary qualifications recorded the highest within group inequality while those with technical trade or craft education had the lowest. The inequality for each age group was lower than the aggregate measure, falling for households whose head were aged under 34 years before rising significantly to a level for times higher than households whose heads were over 69 years. By constructing an average of the Gini's for each demographic group weighted by their population shares, Podder

[7] See Appendix 2.4 for a description of the coefficient of variation, the standard deviation of logarithms and the Lorenz curve.

[8] Podder did not report the application of his equivalence scale to the expenditure distribution.

estimated that differences in education had the largest effect on inequality while age differences the smallest. Richardson (1979) and Murray (1981) expressed doubts over the validity of the SCEF sample selection and methodology. The proportion of household types in the SCEF does not match the 1968-69 IDS proportions from the ABS and the survey suffers from a high non-response rate[9].

Murray (1978) provides the first empirical implementation of income inequality decomposition analysis for Australia and one of the first in the world. Using the Gini coefficient and Theil's coefficient, which has the advantage of being additively decomposable[10]. Murray was also the first to examine the 1968-69, IDS income groups for Australian individuals. When decomposed by age, 90% of Theil coefficient of income inequality was due to variations of the inequality within age groups, while the remaining 10% was due to differences in the mean incomes of each age group. Differences in mean income by sex of the household head accounted for 29% of aggregate income inequality for all income earners, although it accounted for only 15% when full-time employees were considered. Decomposing by age and sex combined resulted in the differences in mean incomes of the age-sex groups contributing 40% towards the aggregate Theil's coefficient of income inequality. Decomposing full-time employee income inequality by sex and education illustrated that the differences in the mean incomes of those groups, that is, between group inequality, contributed 30% of the Theil coefficient, while inequality within the groups was 70%.

Murray (1979) extends his previous work by including 1973-74 IDS to examine the trend in income inequality using IDS income groups. For all income receivers the Gini coefficient exhibited a small decline from 1968-69 to 1973-74,

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[9] The non-response rate in the first round is not reported, but was almost 50% in the second round.

[10] See Section 2.2.3 for a discussion of the additively decomposable inequality indices.

while the Theil coefficient showed a more marked decline. Murray's decomposition suggests that decline is due to a narrowing of income differences between groups rather than narrowing of differences within groups.

Murray (1981) demonstrates that previously calculated inequality statistics may have understated the true degree of income inequality within Australia by as much as 15% since they ignored non-family individuals. Including such individuals included for the first time in the 1973-74 IDS resulted in the Gini coefficient rising from 0.320 to 0.376 and the coefficient of variation from 0.638 to 0.739. International comparisons of this measure result in Australia having a higher level of household inequality than the U.K. and similar to Ireland in contrast to Podder's (1972) international comparisons of family income inequality. Using Podder's (1971) estimated equivalence scale, Murray found only slight differences between family income and equivalent family income inequality and no change in the trend from 1968-69 to 1973-74. A decline in the inequality within households grouped by the number of earners is shown by Murray to have been partially offset by a rise in the dispersion of the mean incomes of such groups, but the overall decline was minimal.

Moore and Whiteford (1986) analysed the trends in disposable incomes of Australian families using taxation, social security and IDS data and found there was significant variation in the incomes amongst and between the groups studied. The real disposable incomes of families with children and pensioners fell up to 2.1% per year from 1976-77 to 1982-83, due to the decline in the real value of payments for children and pensioners, but those groups and other low income families' incomes rose by up to 3.3% a year from 1982-83 to 1985-86. While there had been an increase in payments for children, they had not been large enough to compensate for the earlier decline in disposable income.

Meagher and Dixon (1986) provide a progressive decomposition of the Australian inequality in gross incomes by population sun group from 1973-74 to 1981-82 using the Shorrocks I_0 index. They found that income inequality fell from 1973-74 to 1978-79 due to an increase in welfare payments, particularly to females, while there was little change from 1978-79 to 1981-82. Meagher and Dixon point out that their study is limited by the use of gross rather than disposable income. However their detailed multi level decomposition, while static, allowed a greater insight into the 'within' and 'between' inequality of particular population subgroups. Male and female income recipients were decomposed into sub-groups based on principal source of income, age, dependence upon social security and birthplace. 'Between' inequality, that is, the inequality caused by differences in the sub-group means, could account for about a third of male and female income inequality when decomposed by principal source of income or social security dependence. Decomposing by age, 'between' inequality could account for 20% of male income inequality but only 2.5% for female inequality. Meagher and Dixon also decompose male and female income earners by employment status, occupation and education with the corresponding measures of between group inequality explaining 15-30% of the total inequality.

Lombard (1991) provides evidence of Australian gross income distribution under the Hawke Labour Government from 1982-83 to 1988-89 using income tax statistics from the Australian Taxation Office (ATO). He found that that there had been an increase of over 20% in the Gini coefficient rising from 0.28 to 0.34 and proposed that the causes were; (a) the relative decline in the wage and salary share of national income, (b) the rise in the relative share of non wage and salary income, (c) the widening gap between award and non-award wages, and (d) high inflation and interest rates. Lombard also suggests that reduced progressivity of the personal income tax system and the lowering of the company tax rates have contributed to the widening of the disposable income distribution.

Saunders (1997) extends to 1989, the Luxembourg Income Study (LIS) based Australian work of Saunders, Stott and Hobbes (1991) on the distribution of gross income amongst income units and net equivalent income amongst individuals, to 1989-90[11]. Using the 1981-82 and 1989-90 Income and Housing surveys from the ABS, Saunders examined the gross and net income and net equivalent income distribution for individuals. Table 3.7 contains the decile shares, Gini coefficient and coefficient of variation from Saunders' work. The estimated Gini coefficient shows a rise through out the 1980s, with the top quintile's share of income rising while all other quintiles' shares fell. He suggests that changes in economic activity may explain long run movements in the income distribution.

Table 3.7 The Australian Distributions of Gross Income, Net Income and Equivalent Net Income for Individuals 1981-82 to 1989-90 of individuals

	Gross Income		**Net Income**		**Equivalent Net Income**	
Decile shares of income	**1981-82**	**1989-90**	**1981-82**	**1989-90**	**1981-82**	**1989-90**
Lowest	1.8	1.6	2.2	2.0	3.2	3
Second	2.9	2.8	3.6	3.4	5.5	5.3
Third	4.3	3.9	5.1	4.7	6.6	6.4
Fourth	5.7	5.2	6.4	6.1	7.6	7.3
Fifth	7.5	6.8	7.9	7.6	8.6	8.3
Sixth	9.2	8.7	9.6	9.1	9.6	9.4
Seventh	11.2	10.8	11.4	11	10.8	10.8
Eighth	13.6	13.5	13.6	13.5	12.5	12.5
Ninth	17.2	17.4	16.6	16.9	14.8	14.8
Highest	26.7	29.5	23.7	25.7	20.9	22.4
Gini coefficient	0.40	0.43	0.35	0.38	0.27	0.29
Coefficient of variation	0.78	0.92	0.65	0.75	0.52	0.61

Source: Saunders (1997) Table 4.2, pp68, from ABS, Income and Housing Survey 1981-2 and ABS Survey of Income and Housing Costs and Amenities 1990 unit record files.

[11] See Section 4.1.1 for a definition of an income unit.

Borland and Wilkins (1996) examine the distribution of average weekly earnings and the effects of changes in skill composition and returns to skills upon it, over 1975 to 1994 based on income groups. They found that earnings dispersion rose for both males and females over. A decrease in dispersion of male incomes in the bottom half of the distribution from 1975 to 1982 and an increase in dispersion in the top half from 1990 to 1994, were the chief changes responsible for the increase in male earnings inequality. A general increase in dispersion across the distribution from 1975 to 1982 was the major factor in increasing female income inequality while a decrease in dispersion from 1982 to 1994 in the lower half, reduced this effect. While there has been little change in the returns to skills, the change in skill composition have increased earnings dispersion with increases in the proportion of earners with degrees.

Harding's (1997) comprehensive study uses the 1982 Income Survey (IS) and the 1993-94 Household Expenditure Survey (HES) unit record files from the ABS to measure the income distribution amongst individuals. She concluded that earnings inequality increased over the period primarily due to rises in unemployment, part-time and casual work. However the rise in market income inequality was offset by changes in transfer payments, a more progressive income tax system and a decrease in the average household size and number of dependents, resulting in little change in equivalent income inequality. Increases in the equivalent income shares of the bottom and top 20% tales of the distribution, were balanced by the falls in the middle 50% of the distribution.

3.3.4 Australian Expenditure Inequality

The latest addition to the inequality literature in Australia is from Barrett, Crossley and Worswick (1999,2000) and Blacklow and Ray (2000) who examine the inequality of real, equivalent disposable income and expenditure (non-durables only for Barrett, Crossley and Worswick's study). Both studies are based upon data from four HES unit record files from 1975-76, 1984, 1988-89 to 1993-94. Barrett, Crossley and Worswick chose an equivalence scale, used the CPI to adjust for prices and excluded some of the survey data, where as Blacklow and Ray estimated an equivalence and cost of living index from demand system estimation and used the entire HES sample. Both studies concluded that real equivalent disposable income inequality rose over 1975-76 to 1993-94, however Barrett, Crossley and Worswick estimates suggested non-durable expenditure inequality rose at a slower rate than income while Blacklow and Ray's estimates suggested that it was falling.

3.4 Summary of Key Points

A summary of the chapter's conclusions on the magnitude and movement in Australian and Canadian inequality, taken from past empirical studies, is provided below. The variability of the inequality estimates from part studies to the specification of equivalence scales, demonstrated in this chapter, provides an incentive to examine past results and techniques in constructing equivalence scales and accounting for differences in household size and composition. This is carried out in Section 4.1 in Chapter 4.2, before the issue of how to account for prices and the difference between using cost of living indices (CLI) and the consumer price index (CPI) are examined.

Australian and Canadian Inequality in an International Context

- Compared with other OECD countries Australia and Canada have rather high level of income inequality, similar to the U.S., while considerably higher than Sweden.
- The Australian and Canadian disposable equivalent income distributions are more similar than any other OECD countries.

Canadian Inequality

- Buse (1982), Wolfson (1986), Phipps (1993), Blackburn and Bloom (1994) and Pendakur (1998) generally found that Canadian income inequality was rising from the 1960s through to the 1990s although with some evidence that it declined in the 1970s and late 1980s.

- The timing and severity of the inequality increases differed slightly according to the data, unit of analysis and the equivalence scale used to take note of differences in household size and composition.

- Pendakur and Barrett (1995) and Pendakur (1998) found similar movements in expenditure inequality and income inequality for Canada, rising in the early to mid 1980s, falling in the late 1980s before rising in 1992.

Australian Inequality

- Most Australian studies have found that income inequality in Australia rose through the mid seventies to the early nineties – see, for example, Meagher and Dixon (1986), Saunders (1993), Borland and Wilkins (1996), and Harding (1997).

- Barrett, Crossley and Worswick (1999,2000) found for Australia that consumption inequality was rising but at a slower rate than income inequality from 1975-76 to 1993-94, while Blacklow and Ray (2000) found that expenditure inequality was falling over the period.

Chapter 4 Household Composition and Prices

This chapter reviews the literature on equivalence scales in Section 4.1 and price indices in Section 4.2, to account for variations in household composition and prices across populations units when evaluating inequality. Section 4.1.1 discusses the choice of the population unit of analysis in the measurement of inequality. The development of equivalence scales in the literature is presented in Section 4.1.2. This segment demonstrates how equivalence scales can be estimated from the specification of a household utility or cost function through demand system estimation and discusses the problems and consequences of this approach. A review of estimated equivalence scales from Australian and Canadian studies is presented in Section 4.1.3.

Section 4.2 discusses price indices used to summarise a price regime, so that nominal measures of welfare can be converted to real measures comparable across different price regimes. The section begins with a look at basic fixed weight price indices in 4.2.1. A discussion of the nature and problems of consumer price indices in Section 4.2.2 follow this. Section 4.2.3 introduces cost of living indices based upon the cost to achieve a certain level of utility under different price regimes. The cost of living indices' dependence on base utility, their relationship with equivalence scales and their practical implementation is discussed in Sections 4.2.4, 4.2.5 and 4.2.6 respectively.

4.1 Household Composition

This section discusses the choice of the unit of analysis in 4.1.1, the development of equivalence scales in 4.1.2 and a review of estimated equivalence scales for Australia and Canada in Section 4.1.3.

4.1.1 Unit of Analysis

The *unit of analysis* is the unit of the population whose welfare distribution is of interest. For example, if female wage inequality was to be studied, the unit of analysis should be female wage earners. For a comprehensive study of a nation's inequality, the welfare of all the individuals from the population should be considered. This requires data on the consumption or resources available to each individual. In addition if the trend in inequality is to be studied, a series of such cross sectional data (or preferably panel data) is required. Unfortunately little data of this nature is available and such information is rarely comprehensive in its coverage of a nation's total population. The majority of nationwide surveys of income and expenditure, including those of Australia and Canada, are cross sectional and have used families or households as the unit of analysis. Thus the allocation of resources and consumption to individuals over time for the whole population cannot be directly examined for Australia and Canada due to limitations in available data. The recovery of individual members' level of consumption or resources from household data is only possible if one is willing to make assumptions about how the household level of consumption or resources is allocated amongst each of its members. This study is not prepared to make such assumptions and consequently restricts the unit of analysis to households[1].

Using the family or household as the unit of analysis may be more appropriate than the individual when members of a household gain an advantage by living with others in the form of lower housing costs, shared household facilities and resources. However, using the household as the unit requires a method to account for variations in the number and composition of members within each household. A

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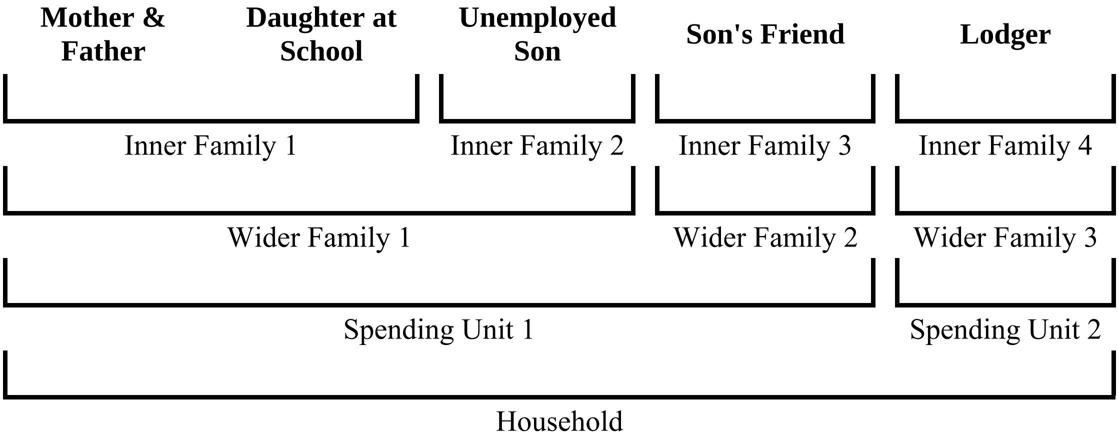
[1] The allocation of household resources amongst its members, has been examined by other studies such as Haddad and Kanbur (1990) and more recently for Australia and Canada, by Lancaster and Ray (2001) and Phipps and Burton (1998), respectively.

common method to account for variations in the size of households is to divide aggregate household expenditure by the number of household members, resulting in 'per capita' measures, which is equivalent to assuming that all members enjoy an equal share of household welfare. A more appropriate tool to allow for variations in household size and composition is to employ an equivalence scale. Equivalence scales can be used to account for differences in both the composition and size of households and to allow for the sharing of household public goods, through economies of scale in household size. Equivalence scales also allow for changes in family structure of households over time, evident in Australia and Canada in the past decades. These are discussed further in 4.1.2.

Sometimes the unit of analysis is restricted to units whose behaviour is similar, such as income earners or couples with children, but in doing so, only the welfare distribution of the population of such units can be examined. Before comprehensive nation based surveys were available, the unit of analysis was often restricted by the available data. For example wage data obviously ignores those that do not earn wages. If the welfare distribution of the total population is of interest, restricting the unit of analysis will give misleading results. This study, which is interested in the economic inequality of the total Australian and Canadian populations, uses the household as the unit of analysis and adjusts for households of different adults/child compositions by deflating with an equivalence scale.

Various definitions of households and families have been used as the unit of analysis in inequality studies. Atkinson (1998) conveniently classifies different types of units, see Figure 4.1, using the example of a hypothetical household containing a man and a woman, their school-going 13-year-old daughter, their unemployed 20-year-old son, their son's friend and a lodger. Using this example Atkinson illustrates the terms *inner family, wider family, spending unit* and *household*. 'Inner families' consist of household members who are dependent upon one another, such as husband and wife and parents and children. 'Wider families' are defined by those household members that are related by blood or marriage/defacto cohabitation. 'Spending units' are defined as those household members that make several joint spending decisions together even though they may be unrelated.

Figure 4.1 An Illustration of Different Units of Analysis



Source: Atkinson (1998), p35.

Redmond (1998) briefly examines the effect of varying the unit of analysis on the measurement of inequality. Table 4.1 shows the Gini coefficient Redmond calculates for inner families, wider families and households using the 1995-96 Survey of Incomes and Housing Costs. Redmond demonstrates that the Gini is smallest when the household is the unit of analysis and largest when inner families are considered. This is because many of the subsequent inner families have very low or zero incomes (ABS 1998, p127) and when considered as independent units appear as very low income units. There is likely to be less distortion in the Gini across different units of analysis when consumption is considered rather than income. Additional inner families within the household are likely to have consumption levels closer to the per person level of their associated inner family than income.

Table 4.1 Mean Incomes and Inequality Measures for Different Units of Analysis

% of people in units of analysis with…	Inner Families	Wider Families	Households
1 Inner family	100%	77%	71%
2+ Inner families		23%	29%
1 Wider family		100%	92%
2+ Wider families			8%
Mean Weekly Income	$297.10	$306.20	$309.80
Gini Coefficient	0.328	0.311	0.308

Source: Redmond (1998) Table 1, from the Census of Population and Housing: Selected Family and Labour Force Characteristic 1995-96, ABS 2017.0

4.1.2 Equivalence Scales

Equivalence scales are used to measure the size and composition of a household. They allow comparisons of households that vary in size and composition and/or other characteristics. Obviously a household earning $300 a week with one adult, is a lot better off than a household earning $400 a week with two adults and two children. By dividing a measure of household welfare, such as income or expenditure, by an equivalence scale, the resulting "equivalent" welfare of households can be compared.

The general problem in designing equivalence scales is to achieve an adjustment of household income or expenditure to take account of demographic differences. Scales can be; i) implied though an administrative process such as the taxation and social welfare system, ii) identified as a minimum level of needs or budget standards, often set on or above a level implied as poverty by either political lobbying, nutritional or physiological studies, or iii) estimated through empirical expenditure demand studies either based on minimum needs or minimum level of welfare in a theoretical framework.

Equivalence scales $m(\ )$, are normally specified such that if two households h and R, with vectors of household characteristics $\boldsymbol{z}_h$ and $\boldsymbol{z}_R$ are equally well off, in that they have the same level of welfare or utility,

$$u\left(\frac{\boldsymbol{x}_h}{m(\boldsymbol{z}_h)}\right) = \bar{u} = u\left(\frac{\boldsymbol{x}_R}{m(\boldsymbol{z}_R)}\right) \tag{4.1}$$

then they should have the same level of scaled or "equivalent" total expenditure, such that

$$\frac{x_h(\bar{u}, \boldsymbol{z}_h)}{m(\boldsymbol{z}_h)} = \frac{x_R(\bar{u}, \boldsymbol{z}_R)}{m(\boldsymbol{z}_R)} \tag{4.2}$$

where x_h is household h's total expenditure and x_R is reference household R's total expenditure, who have the same level of utility. The equivalence scale for the reference household is normally set to unity $m(\boldsymbol{z}_R) = 1$, thus rearranging equation 4.2 provides the equivalence scale $m(\boldsymbol{z}_h)$, for a household h as the ratio of total expenditure of the household h to the reference household R that have the same level of utility[2].

$$m(\boldsymbol{z}_h) = \frac{x_h(\bar{u}, \boldsymbol{z}_h)}{x_R(\bar{u}, \boldsymbol{z}_R)} \tag{4.3}$$

Typically the components of the $\boldsymbol{z}_h$ vector might be the number of children under five, number of school-aged children and number of adults and so on. It could simply be a count of the number of people in the household. This is inappropriate as it gives the same weight to children as to adults, implying that a household with one adult and three children, with four times as much expenditure as a single adult would be equally well off. Thus $m(\ )$ is normally expressed not as the number of people but as the number of equivalent adults, with children counting fractionally. There are also likely to be savings through the consumption of household public goods such as shelter, which can be incorporated as "household economies of scale" into the equivalence scale. The development of equivalence scales is discussed below.

4.1.2.1 Minimum Budgetary Standards

Rowntree (1901) identified food, rent and rates and household sundries as minimum needs for households that vary in size and composition. Such minimum need or budgetary scales, normally assign an index value of 100 or 1 for couples with no children and other compositions are set relative to this, based on the cost of the nominated bundle. Scales developed by this method do not take into account the household's optimisation decision and in focusing on a minimum or subsistence level of expenditure the scale can not be appropriately applied to households whose expenditure is above this level.

4.1.2.2 Engel

Engel (1895) observed that poor households spend a greater proportion of their income on food than richer households. He also noted that this was true for larger households over smaller households that have the same level of spending. Engel's Law states that the food share of expenditure falls as total expenditure rises. Consequently the household's budget share of food has been used as an indirect measure of welfare per member of the household. Thus two households that differ in household size but with the same food share s_f as depicted in *Figure 4.2* are assumed to have the same level of real welfare, irrespective of their money incomes, x_h and x_R. The ratio of the money incomes will provide an index of the cost of maintaining the larger household at the same level of utility relative to the smaller household, which is the Engel equivalence scale.

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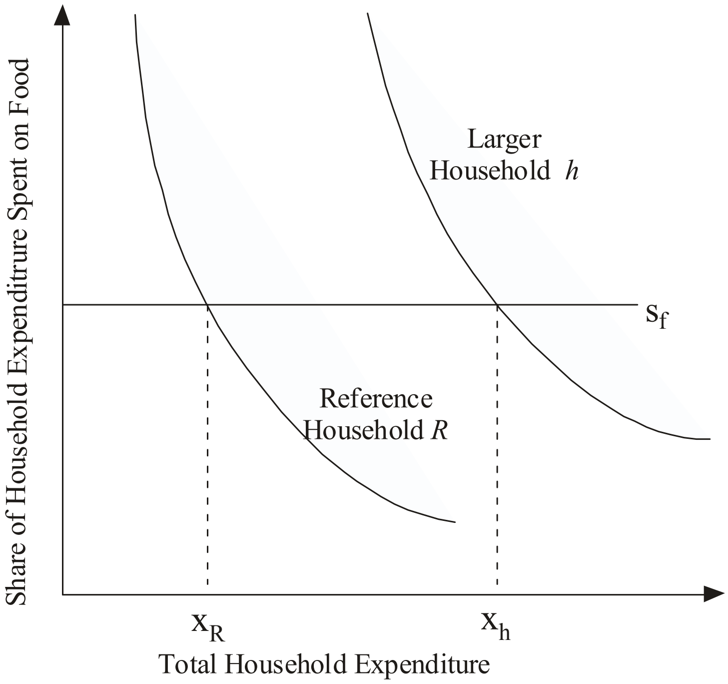
[2] Note that the equivalence scale may also depend upon the reference level of utility, which is discussed further in sections 4.1.2.9 to 4.1.2.11 in this chapter.

Figure 4.2 Engel's Model for Measuring Equivalence Scales



The Engel scale, $m_E(\ )$ is specified such that household *h*'s Engel equivalent expenditure $\frac{x_h}{m_E(z_h)}$ is the same as that of the reference household x_R, when household *h*'s budget share of food s_f^h, is the same as the reference household *R*, food budget share, s_f^R. In other words,

$$\begin{aligned} s_f^R &= s_f^h \\ \frac{p_f q_f^R}{x_R} &= \frac{p_f q_f^h}{x_h} \end{aligned} \tag{4.4}$$

where, p_f is the price of food,

q_f^h and q_f^h are household *h*'s and the reference household R's demand for food, respectively, and

x_h and x_R are household *h*'s and the reference household R's total expenditure.

Since $\dfrac{x_h}{m_E(\boldsymbol{z}_h)} = x_R$, rearranging equation 4.4 provides the Engel equivalence scale as the ratio of food demand of the household *h* and the reference household *R* as,

$$m_E(\boldsymbol{z}_h, \boldsymbol{p}) = q_f(x_h, \boldsymbol{z}_h, \boldsymbol{p}) \big/ q_f^R(x_R, \boldsymbol{p}) \tag{4.5}$$

It should be noted that Engel's traditional scale, $m_{E-T}(\boldsymbol{z}_h)$ did not depend on prices, with both households facing the same price of food.

$$m_{E-T}(\boldsymbol{z}_h) = q_f^h(x_h, \boldsymbol{z}_h) \big/ q_f^R(x_R) \tag{4.6}$$

While Engel's Law is empirically consistent for most households, it does not make it a basis for welfare comparisons. Sydenstricker and King (1921) pointed out that Engel's scale is restrictive in that it assumes the needs for children relative to adults and returns to scale of household size are the same for all goods. Households with children are likely to devote a larger share of their expenditure budget to food than when childless, even when receiving extra income so that they may maintain their standard of living, as argued by Nicholson (1976). The use of an Engel scale implies that a couple with a child has a lower standard of living and that a greater amount of expenditure is required in order to be equivalent to the childless state. Thus Engel scales are likely to exaggerate the cost of children and understate their welfare. While using a basket of goods appropriate for children can compensate for this, it still is unjustified theoretically. It also does not allow demographic change to affect a household's preferences between goods.

4.1.2.3 Rothbarth

Rothbarth (1943) selected a set of goods only consumed by adults, termed "adult goods", such that the expenditure upon them can be considered a measure of adult welfare. The presence of children is assumed to affect expenditure on adult goods through income-like effects, with the income required to maintain expenditure on adult goods, used to construct a Rothbarth equivalence scale. Adult goods are assumed to be unaffected by demographic changes and only affect expenditure through income effects. They are typically chosen to be tobacco, alcohol, adult clothing or food consumed outside the home. The use of alcohol or tobacco as adult goods however suffers empirically from measurement error in survey data. This will cause a bias in the equivalence scales if the under-reporting is not consistent across households of different demographic compositions. In addition the income inelastic nature of the goods can make it difficult to detect the income effect of children on these goods. Rothbarth scale can be specified in similar manner to the Engel scale but it is specified over adult goods rather than food,

$$m_{ROTH}(\boldsymbol{z}_h, \boldsymbol{p}) = q_a^h(x_h, \boldsymbol{z}_h, \boldsymbol{p}) / q_a^R(x_R, \boldsymbol{p}) \tag{4.7}$$

where, q_a^h and q_a^h are household h's and the reference household R's demand for adult goods, respectively.

If household h and the reference household R have spend the same proportion of their budget on adult goods then the Rothbarth scale is given by the ratio of household h's total expenditure to the reference households R,

$$m_{ROTH}(\boldsymbol{z}_h, \boldsymbol{p}) = x_h(\bar{u}) / x_R(\bar{u}) \tag{4.8}$$

where, x_h and x_R are household h's and the reference household R's total expenditure, when both households spend the same proportion of their total expenditure on adult goods, and so according to Rothbarth, the same level of welfare $\bar{u}$.

Whether adult expenditure is an adequate measure of a household's welfare is questionable. Nelson (1992) argues that the major limitation of the Rothbarth scale is that it ignores shared goods that are simultaneously consumed by all members of the household. The Rothbarth scale assumes that parents' preferences are separable between their expenditure and their children's. Deaton, Ruiz-Castillo and Thomas (1989) reject the separability of children preferences over several definitions of adult goods for Spanish 1981 survey. They admit however that there may be definitions of adult goods that are demographically separable from child preferences that could be used to construct a valid equivalence scale.

If parents' preferences are separable between their expenditure and their children's, then the demand for adult goods may still be dependent on children, if they alter the household's relative prices. When adults consume some shared goods, which children also consume, then relative prices of those shared goods may alter in the presence of children and affect the demand for adult goods. If shared goods become more expensive with children then, it is likely to lead to a substitution bias towards adult goods in the presence of children, underestimating the cost of children in the Rothbarth scale. Deaton and Muellbauer (1986) illustrate that in the presence of these effects, the Rothbarth scale will always be lower than Engel scale or any other equivalence scale based upon the expenditure of a shared good. They demonstrate that this is the case for Indonesian 1978 and Sri Lankan 1969-70 data. In the study the authors estimate that the cost of an additional child is approximately four times greater for the Engel scale compared to the Rothbarth scale.

If parents derive utility from their children's consumption, their marginal propensities to spend purely on adults goods is likely to be reduced in the presence of children, beyond the income effects. If this is the case and the phenomenon is ignored then the Rothbarth scale is likely to overstate the cost of children. The essential problem is the same for that of Engel scales, in that no allowance is made for the impact of demographic change on the adults' preferences between goods.

4.1.2.4 Prais and Houthakker

Rather than basing equivalence scales on a specific good or bundle of goods, Prais and Houthakker (1955) specify m_{PH} as a general equivalence scale that is an expenditure weighted average of the commodity specific equivalence scales m_{PH-i}, where

$$q_i^{h*} = \frac{q_i^h}{m_{PH-i}} = g_i\left(\frac{x_h}{m_{PH}}\right) \text{ and } m_{PH}^h = \frac{\sum m_{PH-i} p_i q_i^h}{\sum p_i q_i^h}, \qquad (4.9)$$

for the reference household, R, with all the m_{PH-i} and m_{PH} set to unity.

Note that q_i^{h*} is only a function of the equivalence scale adjusted expenditure and not individual prices. Hence, in the Prais and Houthakker model, the relative price effects of the different commodity equivalence scales are absent. This means that there is no substitution effect between goods from changes in family composition, only income effects as with the Engel and Rothbarth scales.

Muellbauer (1980) examines the consequences of the Prais-Houthakker equivalence scale on preferences in terms of restrictions on the utility and cost functions. The Prais-Houthakker cost function is given by,

$$x_h \equiv c(u,\boldsymbol{p},\boldsymbol{z}_h) \equiv \sum_i m_{PH-i}\ \beta_i(u,\boldsymbol{p}) \qquad (4.10),$$

where $\beta_i(u,\boldsymbol{p})$ is the non-demographic cost function for each good *i*. In order to satisfy (4.8) and (4.9) Muellbauer demonstrates, that either the $m_{PH-i}(\ )$ must be identical across commodities, or $\beta_i(\ )$, the reference household's cost function, must be independent of prices such that there is no substitution between goods. This second case results in non-homothetic Leontief utility function:

$$u_h = min_i\left\{q_i^{h*}/\alpha_i(u_h)\right\} \qquad (4.11)$$

where $\alpha_i(\ )$ is an increasing function of utility u_h such that $q_i^{h*} = u_h\alpha_i(u_h) = \beta_i(u_h) = g_i\left(\frac{x_h}{m_{PH}}\right)$. This restricts all goods to be non-inferior.

Empirically, there is a problem in estimating the n equivalence scales, since the demand aggregation restrictions allows only $n-1$ independent demand equations leaving us one short in estimating n scale parameters, m_{PH-i}, see Muellbauer (1975,

p. 808). Thus a restriction must be imposed in order to identify the m_i, such as children do not drink or smoke, essentially setting m_{PH-i}=1 for adult goods or by using nutritional requirements information. Abandoning the commodity specific scales in favour of a general scale eases the estimation troubles with the Prais-Houthakker model and removes the requirement of a non-homothetic Leontief utility function.

4.1.2.5 Barten's Model of Normalised Prices

While the previous equivalence scale methods implied certain restrictions on consumer preferences, none till Barten (1964) were explicitly based on utility directly. Barten proposed that the direct utility function of the households is defined as a function of the quantities of goods per adult equivalent. It is thus given by

$$u_h = v\left(\frac{q_1^h}{m_1^h}, \frac{q_2^h}{m_2^h}, ..., \frac{q_n^h}{m_n^h}\right). \tag{4.12}$$

If $q_i^{h*} = q_i^h / m_i^h$ and prices may be written as $p_i^{h*} = p_i m_i^h$, then the budget constraint, $\sum p_i^h q_i^h$ =x_h, may be written as $\sum p_i^{h*} q_i^{h*} = x_h$. Thus the Barten problem reduces to maximising utility, $u^h\left(q_1^{h*}, q_2^{h*}, ..., q_G^{h*}\right)$ subject to the budget constraint $\sum p_i^{h*} q_i^{h*} = x_h$ or alternatively to minimising the cost function $c^h\left(u_h, p^{h*}\right) = \sum p_i^{h*} q_i^{h*}$ subject to $u_h\left(q_1^{h*}, q_2^{h*}, ..., q_G^{h*}\right) \geq u_h$. For a given level of welfare $\bar{u}$ the equivalence scale is given by:

$$m_{BAR}\left(\bar{u}, \boldsymbol{p}, \boldsymbol{z}_h\right) = \frac{c_h\left(\bar{u}, \boldsymbol{p}^{h*}\right)}{c_R\left(\bar{u}, \boldsymbol{p}\right)} \tag{4.13}$$

With a single cross section Barten's model faces the same empirical identification problems as the Prais-Houthakker model, but pooled cross sectional data will allow some variation in relative prices and thus the identification of the equivalence scales. Note that while prices can identify the scales in the Barten model, they do not in the Prais-Houthakker model since, as previously discussed, prices play no role in the latter. Changes in family composition alter spending in the Barten model by modifying prices, not only absolutely as in the Engel model but also relatively. Thus the Barten model allows substitution between goods as the relative prices of goods change due to changes in family composition. This last feature constitutes an important distinction between the Barten and Prais-Houthakker models.

However, the interaction between prices and household composition in the Barten model, modelled by "quasi price" effects, place restrictions on consumer preferences. Muellbauer (1974b) solves the Barten utility function, equation (4.12) in terms of income (or more appropriately considered as expenditure) and prices to provide the indirect utility function,

$$u = v\left(\frac{y}{p_1 m_1}, \frac{y}{p_2 m_2}, \ldots, \frac{y}{p_n m_n}\right) \tag{4.14}$$

where $m_i = m_i(\boldsymbol{z_h})$ is an equivalence scale defined as a function of household demographics. Using Roy's identity the Marshallian demands for the Barten model may be given by

$$q_i = m_i d_i\left(\frac{y}{p_1 m_1}, \frac{y}{p_2 m_2}, \ldots, \frac{y}{p_n m_n}\right) \tag{4.15}$$

Differentiating with respect to $\boldsymbol{z}$ the vector of household demographics, Muellbauer demonstrates that changes in household demographics in the Barten model can be thought to have two additive effects on the demand for good *i*. A direct effect, through variation in $m_i(\boldsymbol{z})$ and an indirect effect through the other terms $\frac{y}{p_1 m_1}, \frac{y}{p_2 m_2}, \ldots, \frac{y}{p_n m_n}$. This indirect effect is like a substitution effect in that demographic changes work through the m_j via prices and so depend on cross elasticities between good *i,* and other goods *j*. For goods with high price elasticities this effect is likely to negate the quasi-price substitution in response to demographic changes and so biases equivalence scale estimates downwards. Muellbauer (1977, p. 481) demonstrates this by considering a change in demographics that only causes m_i to change then $\frac{\partial \ln q_i}{\partial \ln m_i} = 1 + \frac{\partial \ln q_i}{\partial \ln p_i}$ and similarly for Hicksian demands. These problems of “quasi price” or indirect price of the Barten model have often been termed “excessive substitution effects”.

Muellbauer (1977) estimated a Barten scale using a PIGLOG demand system for the U.K. from pooled 1968 to 1973 Family Expenditure Survey data. He found that the goods with high (negative) own price elasticities had implausibly low or negative scales, especially private transport services, and to a lesser extent durables. These goods tended to have higher income elasticities and so formed a larger share of the equivalence scale for high income (or total expenditure) households, exaggerating their equivalent welfare measures.

4.1.2.6 Gorman’s Fixed Costs of Children

Nelson (1993) points out that the designation of the reference household is of critical importance. Specifying a childless couple as the reference household means that the utility function, which defines all substitution between goods, is that of adults and their consumption. Thus normalising $m_i = 1$ for the single adults or adult couples in the Barten framework means that goods that are only purchased by households with children, for example nappies, can not be included in the equivalence scale. Gorman (1976) added some fixed costs that vary with household composition of demographics to the Barten cost function, to take account of purchases that are not part of childless couples utility function.

$$c(u,\boldsymbol{p},\boldsymbol{z}) = \sum_i p_i \alpha_i(\boldsymbol{z}_h) + c_R(u, p_1 m_1, p_2 m_2, ..., p_n m_n) \qquad (4.16),$$

where $\alpha_i(\boldsymbol{z}_h)$ is the fixed cost effect of demographic profile $\boldsymbol{z}_h$. This addition also reduces the excessive substitution effect of the Barten model.

4.1.2.7 Muellbauer's Demographically Generalised PIGL and PIGLOG Model

Muellbauer (1974,1975) developed the Price Independent Generalised Linear (PIGL) and Price Independent Generalised Logarithmic PIGLOG demand models. He specified a demographically generalised PIGL and PIGLOG model that nests the Barten model and so allows tests of its validity, see Muellbauer (1976). He specified non-demographic PIGL cost function as,

$$c(u,\boldsymbol{p}) = \left[\alpha(\boldsymbol{p})^{\gamma} + u\left(\beta(\boldsymbol{p})^{\gamma} - \alpha(\boldsymbol{p})^{\gamma}\right)\right]^{1/\gamma} \text{ for } \gamma \neq 0 \qquad (4.17)$$

where $\alpha(\boldsymbol{p}) = \sum_i \alpha_i p_i$ and $\beta(\boldsymbol{p}) = e^{\beta_0} \prod_i p_i^{\beta_i}$ are linear homogeneous concave functions of prices and $\beta(\boldsymbol{p}) > \alpha(\boldsymbol{p}) > 0$ and as $\gamma \to 0$ the PIGL model approaches the PIGLOG model with cost function

$$c(u,\boldsymbol{p}) = \alpha(\boldsymbol{p})[\beta(\boldsymbol{p})/\alpha(\boldsymbol{p})]^{u} \qquad (4.18)$$

. The PIGL and PIGLOG budget shares are,

$$s_i = \left(\frac{\alpha(\boldsymbol{p})\beta(\boldsymbol{p})}{x}\right)^{\gamma}\left[\frac{\beta_i - \alpha_i\beta_i/\alpha(\boldsymbol{p})}{\alpha(\boldsymbol{p})^{\gamma} - \beta(\boldsymbol{p})^{\gamma}}\right] + \frac{\beta_i\beta(\boldsymbol{p})^{\gamma} - \alpha(\boldsymbol{p})^{\gamma}\,\alpha_i\beta_i/\alpha(\boldsymbol{p})}{\beta(\boldsymbol{p})^{\gamma} - \alpha(\boldsymbol{p})^{\gamma}} \qquad (4.19)$$

$$s_i = \left(\frac{\ln x - \ln\alpha(\boldsymbol{p})}{\ln\beta(\boldsymbol{p}) - \ln\alpha(\boldsymbol{p})}\right)[\beta_i - \alpha_i\beta_i/\alpha(\boldsymbol{p})] + \frac{\alpha_i\beta_i}{\alpha(\boldsymbol{p})} \qquad (4.20)$$

The model allows for the substitution between goods to vary as expenditure moves away from α_i for each good i increasing or decreasing depending on β_i. The parameter β_i can be thought of the budget share of the rich and $\alpha_i/\alpha(\boldsymbol{p})$ the budget share for the poor.

Concentrating on the PIGLOG model, Muellbauer (1976) allows the parameters of the price functions, α_i, β_i and β_0 to vary demographically across households, thus α_{hi}, β_{hi} and β_{h0}. The Barten model implies that $\alpha_{hi} = \alpha_i m_{hi}(z)$, that $\beta_{hi} = \beta_i$ and $\beta_{h0} = \beta_0 + \sum_i \beta_i \ln m_{hi}$. Muellbauer (1977) tests the Barten restrictions in a pooled regression across UK FES households 1968-73 against separate regressions for each household type. By comparing values of the log likelihood functions of the Barten-restricted and unrestricted PIGLOG model, Muellbauer found evidence against the Barten model.

4.1.2.8 A Summary of Early Equivalence Scales

Muellbauer (1977) provides a useful table of the implied or specified demand, cost and utility functions of these early equivalence scale models.

4.1.2.9 Conditional vs. Unconditional Scales

The preceding scales implicitly assumed that demographic variables were beyond control of households and treated as exogenous, and thus were referred to as *conditional* scales by Pollak and Wales (1979). Conditional scales are suitable for demand analysis, since households treat their demographic profile as given in their allocation of household expenditure to goods and services. However in welfare and inequality analysis, the welfare of households with different demographic compositions has to be considered. If a household's demographic composition is also an object of choice, as well as affecting utility indirectly via scaling expenditure, then an *unconditional* ordering of preferences over both expenditure and demographics is required so that *unconditional* utility is given by

$$u_{UC} = f\left(u(\boldsymbol{q}, \boldsymbol{z}_h), \boldsymbol{z}_h \right). \tag{4.21}$$

Table 4.2 Summary of Early Equivalence Scale Models

Demand Relations	Utility and Cost Functions
Engel (1895)	
$\frac{p_i q_i}{m_0} = g_i\left(\frac{x}{m_0}\right)$ at constant prices	$u = u\left(\frac{q_1}{m_o(u)}, \frac{q_2}{m_o(u)}, ..., \frac{q_n}{m_o(u)}\right)$ $x = m_o(u)c^R(u, \boldsymbol{p})$
Prais-Houthakker (1955)	
$\frac{p_i q_i}{m_i} = g_i\left(\frac{x}{m_0}\right)$ $m_0 = m_0(m_1, m_2, ..., m_n, x)$ at constant prices	$u = Min\left(\frac{q_i}{m_i \alpha_i(u)}\right)$ $x = \sum_i p_i m_i(u)\beta_i(u)$ where $\beta_i(u) = g_i\left(\frac{x}{m_0}\right)$
Barten (1964)	
$\frac{q_i}{m_i} = d_i\left(\frac{p_1 m_1}{x}, \frac{p_2 m_2}{x}, ..., \frac{p_n m_n}{x}\right)$	$u = u\left(\frac{q_1}{m_1}, \frac{q_2}{m_2}, ..., \frac{q_n}{m_n}\right)$ $x = c(u, p_1 m_1, p_2 m_2, ..., p_n m_n)$
Gorman (1975)	
$\frac{\hat{q}_i}{m_0} = d_i\left(\frac{p_1 m_1}{\hat{x}}, \frac{p_2 m_2}{\hat{x}}, ..., \frac{p_n m_n}{\hat{x}}\right)$ where $\hat{q}_i = q_i - \alpha_i(\boldsymbol{z})$ and $\hat{x} = x - \sum_i p_i \alpha_i(\boldsymbol{z})$	$u = u\left(\frac{\hat{q}_1}{m_1}, \frac{\hat{q}_2}{m_2}, ..., \frac{\hat{q}_n}{m_n}\right)$ $x = \sum_i p_i \alpha_i(\boldsymbol{z}) + c^R(u, p_1 m_1, p_2 m_2, ..., p_n m_n)$
Muellbauer (1976)	
PIGLOG Model	
$s_i = \left(\frac{\ln x - \ln \alpha(\boldsymbol{p})}{\ln \beta(\boldsymbol{p}) - \ln \alpha(\boldsymbol{p})}\right)\left(\beta_i - \frac{\alpha_i \beta_i}{\alpha(\boldsymbol{p})}\right) + \frac{\alpha_i \beta_i}{\alpha(\boldsymbol{p})}$	$x = c(u, \boldsymbol{p}) = \alpha(\boldsymbol{p})[\beta(\boldsymbol{p}) / \alpha(\boldsymbol{p})]^u$
PIGL Model	
$s_i = \left(\frac{\alpha(\boldsymbol{p})\beta(\boldsymbol{p})}{x}\right)^\gamma \left[\frac{\beta_i - \alpha_i \beta_i / \alpha(\boldsymbol{p})}{\alpha(\boldsymbol{p})^\gamma - \beta(\boldsymbol{p})^\gamma}\right] + \frac{\beta_i \beta(\boldsymbol{p})^\gamma - \alpha(\boldsymbol{p})^\gamma \alpha_i \beta_i / \alpha(\boldsymbol{p})}{\beta(\boldsymbol{p})^\gamma - \alpha(\boldsymbol{p})^\gamma}$	$x = c(u, \boldsymbol{p}) = \left[\alpha(\boldsymbol{p})^\gamma + u\left(\beta(\boldsymbol{p})^\gamma - \alpha(\boldsymbol{p})^\gamma\right)\right]^{1/\gamma}$ for $\gamma \neq 0$

where

$\alpha(\boldsymbol{p}) = \sum_i \alpha_i p_i$ and $\beta(\boldsymbol{p}) = e^{\beta_0} \prod_i p_i^{\beta_i}$ are linear homogeneous concave functions of prices and $\beta(\boldsymbol{p}) > \alpha(\boldsymbol{p}) > 0$ with $\alpha_{hi} = \alpha_{i0} + \alpha_i(\boldsymbol{z})$ and $\beta_{hi} = \beta_{i0} + \beta_i(\boldsymbol{z})$

Source: Muellbauer (1977), p463.

Unconditional scales could only be recovered from households' unconditional choices, such as simultaneous choice of family size and expenditure vector. Pollak and Wales were the first to highlight that constructing scales from demand data alone will only convey information about $u(\boldsymbol{q}, \boldsymbol{z_h})$ not $f(\ )$ which is required for welfare comparisons and the construction of unconditional scales. For example, examining the spending behaviour of a couple with one child and a couple with two children does not reveal whether the 2nd child adds or detracts from the couples' welfare. Recovering unconditional scales, would require data not only household demographics and expenditure, but also information on the household's decision to have children or marry. Unfortunately little data of this nature is available or easily comparable across households.

Consider that households gain utility from having children, which one could assume they do if they have children by choice. If they were compensated for the cost of the child using a conditional scale this would overcompensate them for the constant utility, unconditional cost of the child. Unconditional utility would rise from the addition of the child, and in order to keep utility constant the cost function must fall further, than for the conditional case. Thus if households do have control over demographic variables *conditional* scales allow for excessive compensation, biasing the estimation of equivalence scales upwards compared to unconditional equivalence scales. Deaton and Muellbauer (1986) and Fisher (1987) also identified this problem.

If demographic and other characteristic variables do enter the utility function directly then the corresponding unconditional cost function should also contain demographic and characteristic variables. Let the unconditional cost function be:

$$x_h = f^{-1}\left[c(u, \boldsymbol{p}, \boldsymbol{z_h}), \boldsymbol{z_h}\right] \qquad (4.22)$$

where x_h is the expenditure of household *h*,

$\boldsymbol{p}$ is the vector of prices facing households,

$\boldsymbol{z_h}$ is the vector of characteristics or demographics for household h,

u is the level of utility to be attained and

$f^{-1}[\ ]$ is the inverse of unconditional utility function of equation 4.2.1.

To determine an unconditional equivalence scale that represents the true cost of demographics in terms of attaining the same level of utility, it must be the ratio:

$$m_{UC} = \frac{f^{-1}(c(\bar{u}, \boldsymbol{p}, \boldsymbol{z_h}), \boldsymbol{z_h})}{f^{-1}(c(\bar{u}, \boldsymbol{p}, \boldsymbol{z}_R), \boldsymbol{z}_R)} \tag{4.23}$$

where $\boldsymbol{z}_R$ is the vector of demographics for the reference household R. It is evident from equation 4.23, that the unconditional scale will depend on the base level of utility $\bar{u}$ at which the comparison is to be made and its interaction with household demographics.

4.1.2.10 Equivalence scales in Demand Systems

The previous sections have shown how equivalence scales have generally been specified as the ratio of expenditures of a particular household h to the reference household R, to achieve the same level of utility. In the spirit of Barten framework, this method can be expressed formally in a demographic utility maximising model,

$$u = \max_{q}\{ u(\boldsymbol{q}, \boldsymbol{z_h}) \text{subject to } x = \boldsymbol{p'q}\} \tag{4.24}$$

with an indirect utility function,

$$u = v(x, \boldsymbol{p}, \boldsymbol{z_h}) \tag{4.25}$$

which may be inverted to find the cost or expenditure function,

$$x = c(u_h, \boldsymbol{p}, \boldsymbol{z_h}) \tag{4.26}$$

which is the dual problem to utility maximisation,

$$x_h = c(u_h, \boldsymbol{p}, \boldsymbol{z_h}) \qquad = \min_q \{\boldsymbol{p'q} \text{ subject to } u(\boldsymbol{q}, \boldsymbol{z_h}) = u_h\} \tag{4.27}$$

$$\text{or} \qquad = \min_x \{\boldsymbol{p'q} \text{ subject to } v(x_h, \boldsymbol{p}, \boldsymbol{z_h}) = u_h\} \tag{4.28}$$

The specification of the cost function allows the application of Shephard's Lemma to provide Hicksian demands

$$\boldsymbol{q}_H(u_h, \boldsymbol{p}, \boldsymbol{z_h}) = \frac{\partial c(u_h, \boldsymbol{p}, \boldsymbol{z_h})}{\partial \boldsymbol{p}} \tag{4.29}$$

Substituting in the indirect utility function provides Marshallian demand functions: that incorporate demographic variables,

$$\boldsymbol{q}_M(x_h, \boldsymbol{p}, \boldsymbol{z_h}) = \frac{\partial c(\, v(x_h, \boldsymbol{p}, \boldsymbol{z_h}), \boldsymbol{p}, \boldsymbol{z_h})}{\partial \boldsymbol{p}} \tag{4.30}$$

or in budget shares, also termed Engel curves,

$$\begin{aligned} s_M(x_h, \boldsymbol{p}, \boldsymbol{z_h}) &= \frac{\partial c(v(x_h, \boldsymbol{p}, \boldsymbol{z_h}), \boldsymbol{p}, \boldsymbol{z_h})}{\partial \boldsymbol{p}} \frac{\boldsymbol{p}}{c(v(x_h, \boldsymbol{p}, \boldsymbol{z_h}), \boldsymbol{p}, \boldsymbol{z_h})} \\ &= \frac{\partial \ln c(\, v(x_h, \boldsymbol{p}, \boldsymbol{z_h}), \boldsymbol{p}, \boldsymbol{z_h})}{\partial \ln \boldsymbol{p}} \end{aligned} \tag{4.31}$$

Thus, if the cost function is appropriately specified, it would appear econometric techniques can be used to recover the estimates of the cost function' s parameters. Which in turn could be used to construct an estimate of an equivalence scale

$$\hat{m}_h = \frac{\hat{c}(\bar{u}, \boldsymbol{p}, \boldsymbol{z}_h)}{\hat{c}(\bar{u}, \boldsymbol{p}, \boldsymbol{z}_R)} \tag{4.32}$$

Ray's (1983) Price Scaling (PS) technique, conveniently allows the recovery of any equivalence scale $m(\boldsymbol{p}, \boldsymbol{z_h})$ that is homogenous of degree zero in prices, from any demand system based upon a valid cost function $c(u,\boldsymbol{p})$. By scaling the cost or expenditure function from utility theory with an equivalence scale dependent upon prices in addition to demographics, the expenditure function for household *h* is given by,

$$x_h \equiv c(u,\boldsymbol{p},\boldsymbol{z_h}) \equiv m_{PS}(\boldsymbol{p},\boldsymbol{z_h})\, c_R(u,\boldsymbol{p}) \tag{4.33}$$

Application of Shephard's lemma gives Hicksian demands in terms of the reference budget share and an additional term reflecting the effect of demographics.

$$\begin{aligned} s_H(x_h,\boldsymbol{p},\boldsymbol{z_h}) &= \frac{\partial \ln c_R(u_h,\boldsymbol{p})}{\partial \ln \boldsymbol{p}} + \frac{\partial \ln m_{PS}(\boldsymbol{p},\boldsymbol{z_h})}{\partial \ln \boldsymbol{p}} \\ &= s_R(x_h,\boldsymbol{p}) + \frac{\partial \ln m_{PS}(\boldsymbol{p},\boldsymbol{z_h})}{\partial \ln \boldsymbol{p}} \end{aligned} \tag{4.34}$$

This allows the parameters of an appropriately specified equivalence scale to be recovered through price variation via $\dfrac{\partial \ln m_{PS}(\boldsymbol{p},\boldsymbol{z_h})}{\partial \ln \boldsymbol{p}}$. Thus any appropriate specification of an equivalence scale can be applied to any cost function of any utility based demand model and recovered through observed budget shares and information on their response to price movements.

4.1.2.11 The Identification Problem and IB Equivalence Scales

Pollak and Wales (1979) in noting the dependence of unconditional equivalence scales on utility had essentially pointed out the *identification problem* formulated by Blundell and Lewbel (1991). Any utility function $f(u(\boldsymbol{q},\boldsymbol{z_h}),\boldsymbol{z_h})$ that is increasing and monotonic in $u(\boldsymbol{q},\boldsymbol{z_h})$ will yield the same demands $q(\boldsymbol{p},\boldsymbol{x},\boldsymbol{z_h})$, as the utility function $u(\boldsymbol{q},\boldsymbol{z_h})$. Blundell and Lewbel explain that demands $q(\ )$ only represent preferences in $\boldsymbol{q}$ space conditional on $\boldsymbol{z}$, while unconditional equivalence scales, $m_{UC}^h = \dfrac{f^{-1}(c(\bar{u},\boldsymbol{p},\boldsymbol{z_h}),\boldsymbol{z_h})}{f^{-1}(c(\bar{u},\boldsymbol{p},\boldsymbol{z}_R),\boldsymbol{z}_R)}$, depend on indifference curves being defined in ***q-z*** space jointly since in minimising the unconditional cost function, $f^{-1}(c(u_h,\boldsymbol{p},\boldsymbol{z}_h)) = \min\limits_{q_h}\{\boldsymbol{p'}\boldsymbol{q}_h$ subject to $f(u(\boldsymbol{q},\boldsymbol{z}_h),\boldsymbol{z}_h) > u_h\}$ the consumption and demographic decisions of the household effect one another.

Pollak and Wales contend that the identification problem renders unconditional equivalence scales drawn from demand data useless for welfare comparisons. Blundell and Lewbel argue that this is overly negative as such scales do provide information on attaining a level of utility in $\boldsymbol{q}$ space conditional on $\boldsymbol{z}$. They add that this is irrespective of whether $\boldsymbol{z}$ is jointly determined with $\boldsymbol{q}$ or whether $\boldsymbol{z}$ is exogenous to the demand system. They prove, that while demand data provides no information about equivalence scales in a single price regime, if the true scales were known in one period, demands can be used recover the true equivalence scales in all other price regimes. It follows that if unconditional equivalence scales are required, then using an equivalence scale recovered from demand estimates with no price interaction, such as the traditional Engel scale, can not be given a valid welfare interpretation of the cost of children.

Blundell and Lewbel demonstrate that an equivalence scale in price regime $\boldsymbol{p}$ may be expressed as the product of the ratio of the household specific cost of living indexes $CLI(\;)$ and the equivalence scale in the base price regime $\boldsymbol{p}_0$ dependent on the base level of utility, $\bar{u}$.

$$\begin{aligned}\frac{c(\bar{u},\boldsymbol{p},\boldsymbol{z})}{c(\bar{u},\boldsymbol{p},\boldsymbol{z}_0)} &= \frac{c(\bar{u},\boldsymbol{p},\boldsymbol{z})/c(\bar{u},\boldsymbol{p}_0,\boldsymbol{z})}{c(\bar{u},\boldsymbol{p},\boldsymbol{z}_0)/c(\bar{u},\boldsymbol{p}_0,\boldsymbol{z}_0)}\frac{c(\bar{u},\boldsymbol{p}_0,\boldsymbol{z})}{c(\bar{u},\boldsymbol{p}_0,\boldsymbol{z}_0)} \\ &= \frac{CLI(\boldsymbol{p},\boldsymbol{p}_0,\boldsymbol{z})}{CLI(\boldsymbol{p},\boldsymbol{p}_0,\boldsymbol{z}_0)}\frac{c(\bar{u},\boldsymbol{p}_0,\boldsymbol{z})}{c(\bar{u},\boldsymbol{p}_0,\boldsymbol{z}_0)}\end{aligned} \tag{4.35}$$

This shows that an equivalence scale estimated from demand data is the product of the ratio of the CLI's multiplied by an arbitrary constant determined by implicit assumption of the functional form $f(u(\boldsymbol{q},\boldsymbol{z_h}),\boldsymbol{z_h})$.

While utility functions of the form $u(\boldsymbol{q},z_h)$ and $f(u(\boldsymbol{q},\boldsymbol{z_h}),\boldsymbol{z_h})$ exhibit the same demands, choices of $f(u(\boldsymbol{q},\boldsymbol{z_h}),\boldsymbol{z_h})$ can be made and equivalence scales estimated based on the explicit assumption. The choice of $f(\;)$ may be suggested in light of the demand equations used. An approach first suggested by Gorman (1976) and later generalised by Lewbel (1985) is to specify demands as

$$\boldsymbol{q} = r(\boldsymbol{z})q\left(r(\boldsymbol{z})^{-1}\boldsymbol{p}, x\right) \tag{4.36}$$

where $r(\boldsymbol{z})$ is a non-singular matrix function of $\boldsymbol{z}$. The class of utility and cost functions that yield demands of these forms are respectively,

$$u(\boldsymbol{q}, \boldsymbol{z}) = g\left(\, h[r(\boldsymbol{z})\boldsymbol{q}], \boldsymbol{z}\right) \tag{4.37}$$

and $$x = c(u, \boldsymbol{p}, \boldsymbol{z}) = c\left(r(\boldsymbol{z})^{-1}\boldsymbol{p}, u\right). \tag{4.38}$$

Independence of Base (IB) Property

Another popular specification of the utility function $f(\ )$ is based upon the equivalence scale being independent of the level of base utility. In other words, the scale depends only on prices and demographics such that

$$m_{IB} = m_{IB}(\, \boldsymbol{p}, \boldsymbol{z_h}\,) \tag{4.39}$$

Equivalence scales of this nature, exhibit the *independent of the base* level of utility (IB) property identified by Lewbel (1989a) or Blackorby and Donaldson's (1988) *Equivalence Scale Exactness* (ESE) property. If equivalence scale is also invariant to prices then the equivalence scale maintains Blackorby and Donaldson's *Engel Exactness* (EE). Many empirical studies have implicitly made the IB assumption as in the case for Engel scales and homothetic demands or more explicitly in the case of Jorgenson and Slesnick (1984) and Ray (1983). While homothetic preferences are a sufficient condition for IB they are not a necessary condition, which is useful since homothetic preferences have been empirically rejected.

Lewbel (1989a) and Blackorby and Donaldson (1988) prove that an equivalence scale is IB (or ESE) if and only if the cost function can be specified as:

$$x_h \equiv c\left(u_h, \boldsymbol{p}, \boldsymbol{z}_h\right) \equiv m_{IB}\left(\boldsymbol{p}, \boldsymbol{z}_h\right) c_R\left(u_h, \boldsymbol{p}\right) \tag{4.40}$$

where $m_{IB}(\boldsymbol{p}, z_h)$, the IB equivalence scale, is homogeneous of degree zero in prices and the $c_R(u,\boldsymbol{p})$ reference cost function homogeneous of degree one in prices.

Thus the IB equivalence scale is given by

$$m_{IB}^{h}(\boldsymbol{p}, z_h) = \frac{c(\bar{u}, \boldsymbol{p}, z_h)}{c(\bar{u}, \boldsymbol{p}, z^R)} = \frac{m_{IB}(\boldsymbol{p}, z_h) c_R(\bar{u},\boldsymbol{p})}{m_{IB}(\boldsymbol{p},\boldsymbol{1}) c_R(\bar{u},\boldsymbol{p})} = \frac{m_{IB}(\boldsymbol{p}, z_h)}{m_{IB}(\boldsymbol{p},\boldsymbol{1})}. \quad (4.41)$$

By specifying $m_{IB}(\boldsymbol{1},\boldsymbol{1}) = 1$ for base level prices, $m_{IB}(\boldsymbol{p}, \boldsymbol{z_h})$ is identifiable from demand analysis. Such a scale is a money metric index for interpersonal welfare comparisons.

Two special cases of the IB cost function may occur. If $c_R(\ )$ is independent of $\boldsymbol{p}$, the cost function represents homothetic preferences. If $m_{IB}(\ )$ is independent of prices then the underlying utility function is of the form $u_h = u(x_h / m(\boldsymbol{z}_h))$, essentially a Barten scaled utility function. Lewbel states that since the $c_R(\ )$ and $m_{IB}(\ )$ can both depend on prices, IB consistent cost functions allow for much more general specification than Barten scales or homothetic demands.

Testing for IB

If we relax *IB* to allow the equivalence scale to depend on utility, $m_h(u_h, \boldsymbol{p}, \boldsymbol{z_h})$ and split the scale into two multiplicative factors $\alpha(\boldsymbol{p}, \boldsymbol{z_h})$ and $\beta(\boldsymbol{z_h}, u_h)$ then we obtain Ray's (1986) Generalised Cost Scaling (CGS) technique demographic demand model, with cost function.

$$x_h \equiv c(u_h, \boldsymbol{p}, \boldsymbol{z_h}) \equiv m_{CGS}(u, \boldsymbol{p}, \boldsymbol{z_h}) c_R(u, \boldsymbol{p}) \quad (4.42)$$

where $m_{CGS}(u_h, \boldsymbol{p}, \boldsymbol{z_h}) = \alpha(\boldsymbol{p}, \boldsymbol{z_h})\beta(\boldsymbol{z_h}, u_h)$. The price dependent term of the GCS scale, $\alpha(\boldsymbol{p}, \boldsymbol{z_h})$ measures the cost of household demographics to relative price changes overtime while holding utility constant. The utility dependent term,

$\beta(\boldsymbol{z_h}, u_h)$ measures the cost of household demographics to changes in the reference level of utility while holding prices constant. If $\beta(\boldsymbol{z_h}, u_h)$ is independent of demographics, $\beta(\boldsymbol{z_h}, u_h) = \beta(u_h)$ then the estimated equivalence is independent of base utility.

The GCS technique allows the validity of IB property to be tested by testing the demographic independence of $\beta(\boldsymbol{z_h}, u_h)$. Specifying $\beta(z_h, u_h) = e^{\nu_0 z_h u_h}$, Ray (1986) found that when $\boldsymbol{z_h}$ was specified as the number of children, ν_0 was significant under the Almost Ideal Demand System (AIDS[3]) using U.K. FES data from 1968-1979. Note that if the estimate of ν_0 is significant it implies via the demographic dependence of $\beta(\boldsymbol{z_h}, u_h)$, the rejection of the *IB* restriction on equivalence scales. To date the CGS technique has not been applied to rank-3 demand systems, since it often proves difficult to solve for the demand equations.

An alternative approach to test for *IB* is to allow the parameters of the utility and price function interaction terms to vary with demographics. Blundell and Lewbel (1991) propose an alternate test of *IB* by specifying the cost function

$$x \equiv c(u, \boldsymbol{p}, \boldsymbol{z}) \equiv m_{UC}(\boldsymbol{p}, \boldsymbol{z})\, g(\boldsymbol{p}, h(u, \boldsymbol{z})) \tag{4.43}$$

and testing whether the function $h(u, \boldsymbol{z})$ is independent of demographics. The function $h(u, \boldsymbol{z})$ allows demographics to affect the parameters in the budget share equations from the cost function (4.41). This allows the constant and slope of the Engel curves to depend on demographics. The authors demonstrate that the equivalence scales in this model are given by,

$$m_{Non-IB} = \frac{c(\bar{u}, \boldsymbol{p}, \boldsymbol{z}_h)}{c(\bar{u}, \boldsymbol{p}, \boldsymbol{z}_R)} = ln\, a(\boldsymbol{p}, \boldsymbol{z}_h) - ln\, a(\boldsymbol{p}, \boldsymbol{z}_R) + (b(\boldsymbol{p}, \boldsymbol{z}_h) - b(\boldsymbol{p}, \boldsymbol{z}_R))\bar{u} \tag{4.44}$$

[3] The Almost Ideal Demand System (AIDS) was developed by Deaton and Muellbauer (1980).

and are independent of reference or base utility when the price derivatives of $b(\boldsymbol{p}, \boldsymbol{z})$, β_i, are independent of demographics $\boldsymbol{z}$.

Dickens, Fry and Pashardes (1993) explain that tests for *IB* are likely to be misleading if a non-linear model is mis-specified as a linear model. The only exception is when the cost function is demographically homothetic[4]. Thus the demographic separability assumptions often assumed for the identification of *IB* or scales in linear models are made redundant in non-linear models. Using a demographic generalisation of a non-linear Extended Almost Ideal (EAI) they specify the cost function as,

$$c(u, \boldsymbol{p}, \boldsymbol{z}) = \ln a(\boldsymbol{p}, \boldsymbol{z}) + \frac{b(\boldsymbol{p}, \boldsymbol{z})}{[v_h(u_h)]^{-1} - g(\boldsymbol{p}, \boldsymbol{z})} \tag{4.45}$$

where $b(\boldsymbol{p}, \boldsymbol{z})$ and $\ln a(\boldsymbol{p}, \boldsymbol{z})$ are the price indices for the demographic generalised AIDS of Blundell and Lewbel (1991), with $g(\boldsymbol{p}, \boldsymbol{z}) = \lambda(z) b(\boldsymbol{p}, \boldsymbol{z})$ and $v_h(u_h) = \beta_{0h} u_h$. The authors empirically reject the linear model in favour of a non-linear model and reject the assumption of a demographically homothetic cost function, for employed working households with at least two adults from the U.K. Family Expenditure Surveys (FES) 1970-86. They found the presence of children had significant effects on the slope β_i and curvature $\lambda\beta_i$ of the Engel curves for each commodity *i* and hence found evidence against the IB property for the UK.

While the EAI model allows valid tests in a non-linear model it does not in a rank-3 model[5]. In the cost function the term $g(\boldsymbol{p}, \boldsymbol{z}) = \lambda(z) b(\boldsymbol{p}, \boldsymbol{z})$ is not a third independent price index but rather a scaled function of the second $b(\boldsymbol{p}, \boldsymbol{z})$. This

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[4] A cost function is demographically homothetic if $c^h(u, \boldsymbol{p}, \theta \times \boldsymbol{z}) \equiv c^h(u, \boldsymbol{p}, \boldsymbol{z})$.

[5] The 'rank' of demand system is measured by the number of unique price indices in the cost function. For a more explanation see Lewbel (1989b).

means that the curvature of the budget shares in $\ln(x - a(\boldsymbol{p}))$ is only allowed as a general scaling of the slope $\lambda_i = \lambda\beta_i$.

Blundell, Pashardes and Weber (1993) allow for demographic variation in a rank-3 framework by allowing the parameters of the price functions in a rank-3 cost function to vary with demographics. This enables the constant and slope of $\ln(x - a(\boldsymbol{p}))$ and quadratic curve of $\ln(x - a(\boldsymbol{p}))^2$ in the budget share demands curves to vary demographically. While Blundell, Pashardes and Weber (1993) do not explicitly test for *IB,* they find evidence against IB in the form of demographic and seasonal variation in the budget share slope and curve coefficients for the UK FES 1970-84. Pashardes (1995) explicitly tests for *IB* in a rank-3 demographically generalised QAIDS that allows for the intercept, slope and quadratic curvature for each Engel curve to vary demographically. Using the 1984 U.K. FES, Pashardes found significant demographic effects and hence interpret the result as evidence against the IB property.

4.1.3 Australian and Canadian Equivalence Scales

It is widely believed that the cost of children relative to adults and the economies of scale enjoyed by households are likely to differ across regions and countries. Saunders, Stott and Hobbs (1991) compare the use of the standard LIS equivalence scales with Henderson Poverty Scale[6] for Australia and the Department of Social Welfare (1988) scale for New Zealand. The New Zealand scale is lower than the standard LIS scale and the Australian scale even more so for larger families. Allowing for different demographic effects with country specific scales for Australia and New Zealand resulted in higher income inequality in international terms than previous studies using the LIS scale. Phipps and Garner (1994) estimated Engel scales for food, shelter and clothing and a third group which included health care for the FES from Statistics Canada and the Consumer Expenditure Survey Interview (CEX) from the U.S. Bureau of Labour Statistics. They found that the scales were not that different for smaller households and found no effect on measures of poverty when either scale was used for both countries. They did find however that U.S. households enjoyed considerably larger economies of scale for larger households compared to Canadian households.

The above suggests that if household behaviour or demographic composition is different between two countries, using a uniform scale across countries is likely to lead to uninformative and possibly biased results. However different countries frequently use different methods to construct their standard scales. Saunders, Stott and Hobbs (1991) suggest that using a uniform specification and estimation method from survey data collected and defined identically would greatly assist in cross country inequality comparisons. Lancaster, Ray and Valenzuela (1999) provide such a study estimating equivalence scales for a selection of 8 countries from different regions of the world including Australia using similar unit records from surveys containing household expenditure. They find significant variation in equivalence scales across countries, providing confirmation that using a single or inappropriate scale for all countries is likely to lead to significant bias in studies of inequality and poverty. While the Canadian FES and Australian HES survey methodologies are not perfectly aligned, they are common in that their nature, objectives and methodology are, on the whole, quite similar. This study uses the same utility-demand theory and equivalence scale specification in order to make the comparisons of inequality as accurate as possible. A review of Australian and Canadian equivalence scales, commonly used and estimated, follows in Sections 4.1.3.1 and 4.1.3.2.

[6] See Section 4.1.3.1 below for more explanation of the Henderson Poverty Scale.

4.1.3.1 A Review of Australian Equivalence Scales

Many of Australian inequality studies have used Income Distribution Surveys (IDS) and Census data from the ABS or Australian Taxation Office (ATO) records. Thus, they were concerned with individuals, earners or taxpayers and an equivalence scale was not required. However there have also been several Australian studies at a household level, requiring the use of an equivalence scale to make cross household welfare comparisons.

Australian Budgetary Scales

For many years the equivalence scale, commonly known as the Henderson Poverty Scale, was the main scale used in Australia. This scale was developed by Henderson, Harcourt and Harper (1970) for the 1966 Melbourne poverty survey and later used in the National Poverty Inquiry in 1973 and was essentially a Rothbarth equivalence scale. The scale was estimated based on budget standards by the Budget Standard Service of New York (1954) for New Yorkers. The reason for this, according to Henderson *et al,* was simply that there was no other appropriate data or source, despite the Consumer Finances and Expenditure Survey (CFES) being conducted jointly by Macquarie and Queensland Universities for 1966-68. Basing the scale on New York data has been widely criticised since the expenditure behaviour, demographics and prices facing New Yorkers and thus their minimum needs, are likely to differ from Australians.

Lovering (1984) developed a more recent budgetary scale in response to the Family Law Council request for an updated scale in order to determine child maintenance payments. While a major improvement on the Henderson scale, some of the minimum need estimates were based upon a very small non-random sample of family budgets. Such scales can be argued to be arbitrary, subject to bias and have fallen out of favour with many economists since they are not ground in utility theory.

Yet the scales are entrenched in the Australian social welfare system and other bureaucracies, in determining the cost of children and transfer payments.

Internationally Specified Scales

Often equivalence scales are specified in a crude manner, so as to be uniformly applied to a number of countries in international comparisons of inequality. While it is preferable to apply a consistent equivalence scale estimation procedure for each country, it is not always possible. Two commonly used internationally specified scales are the scale used in Luxembourg Income Studies (LIS) studies, termed the LIS equivalence scale and the OECD scale. The LIS scale uses a value of 0.5 for the first member in each income unit and 0.25 for subsequent members, with a maximum value of 3.0 for families with 10 or more persons. The OECD scale uses a value of 1 for the first member of the household, with each additional adult counting as 0.75 and children as 0.5.

Table 4.3 Administrative, Budgetary and International Scales for Australia

Method		**Adults, Children**							
		1,0	**1,1**	**1,2**	**1,3**	**2,0**	**2,1**	**2,2**	**2,3**
Administrative									
Based upon rates of pensions, benefits and family allowance prior to 1987		0.60	0.78	0.91	1.05	1.00	1.12	1.25	1.39
After the introduction of the Family Allowance Supplement in 1987	- all children aged under 13	0.60	0.80	0.96	1.12	1.00	1.14	1.29	1.45
	- all children	0.60	0.83	1.02	1.21	1.00	1.17	1.36	1.55
Budgetary									
Henderson et. al. (1970)	- head working	0.76	0.91	1.14	1.44	1.00	1.15	1.37	1.68
	- head not working	0.68	0.86	1.11	1.45	1.00	1.17	1.42	1.76
Lovering (1984)		0.60	0.78	0.93	1.12	1.00	1.12	1.28	1.47
Internationally Specified									
LIS Studies Scale		0.33	0.50	0.67	0.83	1.00	1.17	1.33	1.50
OECD Scale		0.59	0.88	1.18	1.47	1.00	1.29	1.59	1.88

Note: The scale for a childless couple is normalised at unity

Table 4.3 above provides a selection of administrative, budgetary and internationally specified equivalence scales used in Australia.

Estimated Australian Scales

Podder (1971) was the first to estimate an equivalence scale for Australia using the 1966-68 CFES. He used the Prais-Houthakker method, but used only food in the estimation procedure and thus essentially estimated an Engel scale. A similar method was used on the 1975-76 HES, by the Social Welfare Policy Secretariat (1981), where the basket of necessities of food, clothing, housing and fuel was used instead of food. Kakwani (1977) uses an approximation for permanent income in a modified form of the ELES on the 1966-68 CFES data to construct scales that are dependent upon the choice of reference level expenditure. Tran (1986) used a duality approach based upon the generalised Engel's law to estimate general scales as a weighted function of commodity specific scales for Australia. The additional cost of a child for all family types was estimated using grouped data from the HES 1975-76 and for low, medium and high expenditure families

Binh and Whiteford (1990) review a range of Australian equivalence scales, correct calculation errors in Podder's estimated scales and estimate a variety of Engel like scales and an ELES scale using the 1984 HES. The Engel scales were estimated using households of related persons, approximately 96% of the 1984 HES sample, on home food consumption (*F1*), total food consumption (*F2*) and two baskets of goods, *F1* and *F2* plus clothing, housing and fuel, (*B1* and *B2*, respectively). The ELES scale was estimated using households containing related persons of whom only one or two were adults and at most three children. Binh and Whiteford found, that there was considerable variation in the Engel type scales depending upon the basket of goods chosen. The *F1* scale gives the lowest value for single adult and the highest child costs since there is little scope for economies of scale (Binh and Whiteford (1990), p. 229). For single children households it was found that there was significant variation in the relative cost of children of different ages, for the Engel scale using the *F1* basket, see Table 4.4.

Table 4.4 Binh and Whiteford's Detailed[a] Engel Equivalence Scales [b]

	No Child	Child aged less then 5 years	Child aged 5 to under 15 years	Child aged 15 to 17 years
One Adult household	1.00	1.28 (0.08)	1.40 (0.05)	1.79 (0.13)
Two Adult household	1.00	1.10 (0.02)	1.21 (0.01)	1.34 (0.03)

Notes: **a** Detailed Scales allow for the cost of children to vary with their age.
b Standard errors are in parentheses.
Source: Binh and Whiteford (1990), Table 3.2

The Binh and Whiteford's ELES estimates from the 1984 HES, were very similar to Podder's estimates from the 1966-68 CFES, despite 20 years time difference, and thus the associated equivalence scales were also similar. While dependent upon the reference households' level of welfare, the ELES scales showed little variation when the reference level was varied. There was evidence that there were significant economies of scale when a second child was in the household but that this reversed with a third. The authors note that this may be due to the higher cost of older children, not included in their ELES model, that often exist in three child households. The ELES estimated equivalence scales were at the other extreme to the *F1* Engel scale with the highest value for single adult and the lowest child costs since the ELES estimates using total expenditure allow for greater for economies of scale in that they include expenditure on household public goods.

Lancaster and Ray (1998) use the 1984 and 1988-89 HES to compare alternative equivalence scales for Australia. They find that the linear Rothbarth scales generally exceed the Engel scale but that they are sensitive to the choice of the adult good. Including quadratic expenditure terms improved the estimation process and provides information on how the scales vary with the expenditure level of the household. Engel scales for Australia increased with reference expenditure while the Rothbarth scales declined. Using the PS-QAIDS, Lancaster and Ray find that utility consistent scales fall between the Engel and Rothbarth scales. They reject the hypothesis that equivalence scales are independent of the age of children for Australia. Lancaster and Ray (1998)'s estimates of the relative child costs dependent on age, provided in Table 4.5, demonstrate that their estimates are significantly lower, especially for older children, than Binh and Whiteford's. Lancaster and Ray could not decisively reject IB or ESE in Australia, as was found for Sri-Lanka by Deaton and Muellbauer (1986) but in contrast to its rejection for UK data by Blundell and Lewbel (1991).

Table 4.5 Lancaster and Ray's Detailed PS-QAIDS and PS-LES Equivalence Scales

	No Child	Child aged less then 5 years	Child aged 5 to u15 years	Child aged 15 to 17 years
Two Adult Household PS-LES	1.00	1.079 (0.028)	1.167 (0.028)	1.098 (0.041)
Two Adult Household PS-QAIDS	1.00	1.072 (0.040)	1.145 (0.044)	1.107 (0.042)

Notes: Standard errors are in parentheses,
Source: Lancaster and Ray (1998), from Table 6, p11.

Lancaster, Ray and Valenzuela (1999) find in their international study of equivalence scales and expenditure inequality that Engel scales for Australia were similar to Italy and the Philippines but higher than Peru, Tanzania and South Africa and lower than Thailand and India's. Most of the utility based rank 2 and 3 scales were significantly different to the Engel scales for each country. Australia's rank 3 scale was a little higher than Italy's, but lower than the Philippines and Peru.

Harding (1997) favours the Henderson equivalence scales which have been criticised since they are based on the relative expenditures of New York nuclear families in 1954, see Mitchell and Harding (1993). They do however allow for the additional costs faced by those who work and thus remove the bias during rapid labour market change. Barrett, Crossley and Worswick (1999,2000) use the square root of the number of family members as the equivalent scale in their study of income and consumption inequality. Blacklow and Ray (2000) estimate Engel and Price Scaled equivalence scales in the AIDS and QAIDS for a pooled cross section of 1975-76, 1984, 1989-90, 1993-94 HES using the national CPI series for price indices. The estimated equivalence scales exhibited significant differences in the relative cost of children of different ages and significant economies of scale.

Table 4.6 provides a comparison on various Australian equivalence scales that have been estimated.

Table 4.6 A Comparison of Estimated Australian Equivalence Scales

Method		**Adults, Children**							
		1,0	**1,1**	**1,2**	**1,3**	**2,0**	**2,1**	**2,2**	**2,3**
Podder (1971)									
- Engel (original)		0.49				1.00	1.25	1.48	1.68
- Engel (corrected by Binh & Whiteford))		0.73				1.00	1.10	1.19	1.24
Kakwani (1977)									
- ELES low income		0.60				1.00	1.21	1.38	1.48
- ELES high income		0.61				1.00	1.20	1.37	1.46
SWPS (1981)									
- overall basic		0.59	1.00	1.18	1.35	1.00	1.18	1.35	1.53
- overall detailed		0.58	1.05	1.14	1.30	1.00	1.15	1.28	1.51
- head working		0.69	1.10	1.22	1.40	1.00	1.14	1.33	1.67
Tran (1986)									
(1975-76 $A)	Low $0-100/week					1.00	1.41		
	Medium $100-$220/week					1.00	1.14		
	High $220+/week					1.00	1.21		
	Total								
Binh & Whiteford (1984)									
- Engel *F2* (Total Food expenditure)		0.59	0.73	0.90	1.11	1.00	1.23	1.52	1.88
- Engel *B2* (Food, Clothing, Housing and Fuel)		0.70	0.88	1.11	1.39	1.00	1.25	1.57	1.97
- ELES (1984 $A)	Low $325/week	0.53	0.80	0.95	1.27	1.00	1.20	1.28	1.44
	Medium $450/week	0.52	0.81	0.94	1.28	1.00	1.20	1.27	1.44
	High $700/week	0.52	0.81	0.94	1.29	1.00	1.19	1.26	1.45

Table 4.6 (continued)

Method		**Adults, Children** 1,0	1,1	1,2	1,3	2,0	2,1	2,2	2,3
Lancaster and Ray (1998)									
- Engel (*F2*) Linear		0.63	0.76	0.92	1.10	1.00	1.21	1.45	1.75
- Engel (*F2*) Quadratic		0.64	0.77	0.92	1.12	1.00	1.21	1.48	1.81
- Rothbarth Linear	Food Consumed Out of Home					1.00	1.06	1.11	1.18
	Alcohol Consumed Out of Home					1.00	1.26	1.59	2.01
	Adult Clothing					1.00	1.15	1.32	1.52
	Tobacco					1.00	0.88	0.78	0.69
- Rank-2 Models	Barten AIDS					1.00	1.08	1.16	1.24
	PS-AIDS					1.00	1.21	1.42	1.63
	PS-LES					1.00	1.12	1.24	1.36
- Rank-3 Models	PS-QAIDS					1.00	1.12	1.23	1.35

4.1.3.2 Canadian Equivalence Scales

The literature on the estimation and comparison of Canadian equivalence scales is relatively scarce compared to Australia. Many past Canadian inequality studies have used datasets with the individual taxpayers or wage earners as unit of analysis removing the need for equivalence scales. This explains the why little attention has been made to the estimation of equivalence scales and its implications until the 1990s, when household studies of Canadian inequality and poverty have emerged.

Phipps (1993) compared the equivalence scales implied by Statistics Canada's Low Income Cut Offs (LICO's), those implied by poverty levels from the Canadian Council of Social Development (CCSD) and the OECD equivalence scale. Table 4.7 contains the above scales taken from Phipps' study. The LICO equivalence scale exhibited significantly more economies of scale than the CCSD scale and also the OECD scale, which reported the largest scale for large households. Using 1986 FES data Phipps found that Poverty measures for Canada were extremely sensitive to the choice between equivalence scales. Choosing small household economies of scale as in the CCSD scale, results in much larger estimates of poverty, when compared to the LICO scale.

Table 4.7 A Comparison of Canadian Equivalence Scales

Size of Household		SC LICO equivalence scale	CCSD equivalence scale	OECD equivalence scale
1	1 adult	1.00	1.00	1.00
2	2 adults	1.36	1.66	1.70
3	2 adults and 1 child	1.72	2.00	2.20
4	2 adults and 2 children	1.98	2.33	2.70
5	2 adults and 3 children	2.17	2.67	3.20
6	2 adults and 4 children	2.35	3.00	3.70
7+	2 adults and 5 children +	2.53	3.33	4.20

Notes: All scales presented are scaled to unity for an adult living alone.
The OECD scale gives a weight of 0.7 to an extra adult and 0.5 for an extra child.
SC LICO is Statistics Canada's Low Income Cut Offs
CCSD Canadian Council of Social Development poverty levels.
Source: Phipps (1993, p. 165)

Pendakur and Barrett's (1995) study of Canadian expenditure inequality from 1978 to 1982, used household expenditure and household expenditure scaled by the SC LICO equivalence scale. They found, using the S-Gini and E-Gini, little difference in the magnitude or trend in expenditure inequality of household expenditure or scaled expenditure. Pendakur (1998) uses the square root of the number of economic family members as his equivalence scale in his study of Canadian inequality using the FES. In line with the LICO scale he imposes significant economies of scale but does not adjust for the costs of children.

Nicol (1994) estimates equivalence scales for Canada using a range of dummy variables for household size, age of head of household and region using a two adult, two children with head aged between 35-44 residing in an urban area in

Ontario as the reference household. The equivalence scales varied significantly across region, implying urban families in British Columbia require approximately 1.8 more income than those urban families in the Quebec, but less drastically in rural families. The equivalence scales were increasing with family size in favour of household economies of scale. The effects of the age of the household head on the equivalence scale increased considerably with age, but were not well determined with large standard errors.

Phipps (1998) estimates an equivalence scales for two parent families in a utility consistent framework for Canada using a collection of FES. Using a non-homothetic trans-log utility function, the following Cobb-Douglas style equivalence scale was estimated:

$$m_{PHIPPS} = (1 + 0.5\, n_k)^{S_0}\ exp\left(\sum_k S_k A_k\right) \sum_i p_i^{\gamma_i n_k} \tag{4.46}$$

Where n_k is the number of children,

A_k are dummy variables for region, labour force participation, teenagers,

p_i is the price of good *i* and

γ_i, S_0 and S_k are estimated.

While concentrating on the economies of scales of extra children, namely S_0, and the interaction of prices with the number of children γ_i, Phipps' scale also estimates the effect of region of residence, labour force participation, age of the household head (difference to spouse) and the presence of a teenager, through the S_k parameters. The equivalence scale was well determined with all the variables being statistically significant at 5% or less level of significance other than the interaction with the number of children and the transport price. Her estimates are presented in Table 4.8 on the following page.

Table 4.8 Price Sensitive Equivalence Scales, Evaluated at mean prices

Number of Children	**Equivalence Scale** (Childless Couple=1.000)	**Cost of extra an child as a proportion of a single adult**
0	1.000	
1	1.155	0.0775
2	1.279	0.062
3	1.383	0.052
4	1.475	0.046
5	1.557	0.041

Source: Phipps (1998), Table 6, p. 161.

4.2 Prices

Nominal variables need to be divided by a price index to allow real welfare comparisons under different price regimes. Price indices attempt to summarise the level and distribution of prices that different households or individuals face, into a single scalar. Spatial price indices measure the difference in prices between localities at a given point in time, while temporal price indices measure differences in prices over time in a particular locality. Differences in expenditure patterns and the nature of goods across localities result in theoretical and practical problems in constructing spatial price indices. The majority of price indices constructed are temporal indices, used to construct measures of price inflation. Typically, they compare the vector of prices in the current or comparison period of N_g goods or services, $\boldsymbol{p^1} = \{p_1^1,..., p_g^1,...p_{N_g}^1\}$, where p_g^1 is the price of good g in period 1, with prices in the reference period $\boldsymbol{p^0} = \{p_1^0,..., p_g^0,...p_{N_g}^0\}$, where p_g^0 is the price of good g in period 0, to construct a scalar price index $P_h(\boldsymbol{p^0},\boldsymbol{p^1},...)$ for household h. They are normally specified such that if the prices are identical then $P_h(\boldsymbol{p^0},\boldsymbol{p^0},...) = 1$.

If price changes are assumed to affect all households in the same way, then a single price index for all households adequately summarises the price regime.

Deflating nominal welfare variables by such a price index will not impact upon within period measures of real inequality if they are scale invariant. However if price changes or the impact of price changes vary across households, then choice of the price index is likely to have a significant impact on the measurement of real inequality. Differences in household size and composition, as well as varying expenditure budgets, are likely to result in the impact of prices varying across households and households in different geographic locations are likely to face different prices.

This chapter discusses fixed bundle price indices in Section 4.2.1. Section 4.2.2 discusses the most commonly available price index, namely, the consumer price index and the problems in its use. In Section 4.2.3 the cost of living index (CLI) in a utility theoretic framework is introduced and its properties discussed. Section 4.2.4 discusses the dependence of the CLI to base or reference level utility. Section 4.2.5 discusses how demographics can be incorporated into the CLI and the CLI's relationship to equivalence scales. Finally, issues in practically estimating the CLI are examined in Section 4.2.6.

4.2.1 Fixed Bundle Price Indices

The most common price indices are based upon a fixed reference bundle of N_g commodity demands, $\boldsymbol{q^R} = \{q_1,...,q_g,...q_{N_g}\}$, where q_g is the quantity demand for commodity g. They are specified as the relative cost of buying the N_g commodities at current prices $\boldsymbol{p^1}$ compared to reference period prices $\boldsymbol{p^0}$ regimes such that

$$P\left(\boldsymbol{p^0}, \boldsymbol{p^1}, \boldsymbol{q^R}\right) = \frac{\sum_g p_g^1 q_g^R}{\sum_g p_g^0 q_g^R} \tag{4.47}$$

The two most common specification of the reference bundle of commodity demands, are the demands of the reference population in the current period $\boldsymbol{q^R} = \boldsymbol{q}^1$ or the reference period $\boldsymbol{q^R} = \boldsymbol{q^0}$. These two specifications result in the Paasche (or current quantity) fixed bundle price index,

$$P\left(\boldsymbol{p^0}, \boldsymbol{p^1}, \boldsymbol{q}^1\right) = \frac{\sum_g p_g^1 q_g^1}{\sum_g p_g^0 q_g^1} \tag{4.48}$$

and the Laspeyres (or reference quantity) fixed bundle price index

$$P\left(\boldsymbol{p^0}, \boldsymbol{p^1}, \boldsymbol{q^0}\right) = \frac{\sum_g p_g^1 q_g^0}{\sum_g p_g^0 q_g^0}. \tag{4.49}$$

The fixed bundle price index is often expressed in terms of relative prices and budget shares,

$$\begin{aligned} P\left(\boldsymbol{p^0}, \boldsymbol{p^1}; \boldsymbol{q^R}\right) &= \frac{\sum_g \left(\dfrac{p_g^1}{p_g^0} \times p_g^0 q_g^R \right)}{\sum_g p_g^0 q_g^R} \\ &= \sum_g \left(\frac{p_g^1}{p_g^0} \times \frac{p_g^0 q_g^R}{\sum_g p_g^0 q_g^R} \right) \\ &= \sum_g \left(\frac{p_g^1}{p_g^0} \times s_g^{0R} \right) \end{aligned} \tag{4.50}$$

where $p_g^1 \big/ p_g^0$ is the relative price of good g and s_g^{0R} is the budget share, or expenditure weight of good g of the reference commodity demands at reference period prices. The specification above allows a price index to be considered as a weighted average of relative prices, where the weights are the budget shares of the reference household. While such fixed bundle or fixed weight price indices can provide an indication of pure price movements, they do not explicitly consider consumer preferences and the substitution effects of price changes.

4.2.2 Consumer Price Indices

Many statistical agencies publish consumer price indices (CPI's), which are normally fixed bundle temporal Laspeyres type price indices of retail prices for private households. The CPI's published by the Australian Bureau of Statistics (ABS) and Statistics Canada (SC) are such indices where the bundle is updated periodically to represent changes in consumption patterns over time.

The ABS collects prices from the capital cities of the six states and two territories and constructs the CPI using expenditure weights based upon the average spending behaviour of metropolitan households. Prior to the 13^{th} Review of the CPI in September 1998 the expenditure weights were based upon the spending behaviour of employee households in metropolitan areas, which included just over half of the population of the capital cities, ABS (1998). Employee households were defined as those, which obtain at least three quarters of their income from wages and salaries, but exclude the top ten percent (in terms of income) of such households. To ensure the CPI accurately reflects current spending, it is reviewed every four to five years and updated with expenditure weights from the Household Expenditure Surveys (HES) where possible. The new weights are introduced from the review period onwards by chain linking the old series with the new, such that there is no change in the index in the linking period[7].

SC collects prices from the ten provinces and the cities of Whitehorse and Yellowknife from the Yukon and Northwest Territories respectively, in the construction of its CPI. Up until 1995, the expenditure weights used to calculate the CPI were based upon the spending behaviour of those in urban centres of greater than 30,000 people, representing about 75% of total spending. These weights have

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[7] See ABS (1987, pp. 89-90)

been updated every four years, using data from the Family Expenditure Surveys (FES) conducted by SC. In January 1995, expenditure weights from the 1992 FES were introduced and since then the CPI has been based on the average spending of nearly all rural and urban private households.

Following the Boskin Report [Boskin et. al. (1996)], which reported a 1.1 percentage points bias in U.S. CPI inflation, the debate over possible measurement errors in CPI's has re-ignited. The principle source of measurement errors has been identified as; the improper or late treatment of new items, inadequate treatment of quality changes and the failure to fully capture outlet and product substitution. The last of these problems mentioned above stems from the use of fixed weights at various levels of aggregation and arithmetic means of price relatives at the micro level. SC, the ABS and other statistical agencies have generally defended their handling of new goods and quality changes, in the light of any practical alternatives, but have acknowledged and acted in some cases, on the issue of substitution bias.

If consumers substitute away from items that experience relatively large price rises and towards goods with smaller rises, then a fixed-weight index such as a CPI is likely to overstate the effect of price changes when compared to the reference period. However if the product substitution bias has been constant across time then the associated measures of inflation from a fixed weight index will not be biased. If the product substitution bias is not constant, then measures of welfare will be biased upward in the periods when the substitution bias is largest. However this substitution bias will only affect inequality if it is non-uniform across households within time or if the measure of inequality is not scale independent[8].

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[8] Also known as mean independent, see Section 2.2.1 ii) for details.

Since the expenditure weights used in most CPI are periodically updated, the product substitution bias from the use of fixed weights will depend upon the frequency and timing of the updates. The Australian and Canadian CPI has been updated more frequently than US CPI and so one would expect *ceteris paribus* for the CPI's in those countries to contain less substitution bias than for the U.S.. However, Crawford (1993) reports a similar level of product and outlet substitution bias in the Canadian CPI of 0.5% points to that found for the U.S. by the Boskin Report. More recently White (2000), found significant outlet substitution bias in the Canadian CPI due to under sampling from discount and warehouse stores and the lower price rises of goods at these stores.

Schultz (1987), Moulten (1993), Abraham et. al. (1998) and Boskin et al. (1996), amongst others, have highlighted that in using arithmetic means of price relatives in constructing the sub price indexes of the CPI, one implicitly assumes no substitution between goods. A basic alternative to weighted arithmetic means is a budget share weighted geometric mean of prices, which allows for unit elastic substitution so that budget shares remain constant when prices change. Upon the recommendation of Schultz, from 1978 SC has removed much of this problem, through using ratios of arithmetic mean prices from matched samples of outlets and products[9]. From the ABS's 14th Review of the Australian CPI in September 2000, ABS (2000), it has adopted geometric means in the construction of elementary price indices.

Calls have also been made for the CPI to improve the measurement of changes in the cost of living for different population groups. Both the ABS and SC indicate that their CPI's are not constructed as a true cost of living index, ABS (1988,

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[9] Schultz's (1994) empirical study showed that there was no large difference between index numbers obtained using ratios of geometric mean prices and those from arithmetic mean prices.

p6) and SC (1996, p3). Recently both agencies have begun publishing price indices for population groups such as households whose principal source of income is government benefits or pensions in addition to their CPI series.

4.2.3 Cost of Living Indices

The fixed bundle is a narrow view of what is a constant standard of living, in that it does not explicitly consider consumer preferences and the substitution effects of price changes. The theory of cost of living indices (CLI's) began in the 1920s with Konus (1939), who demonstrated that Laspeyres price indices would overstate price increases since it ignores substitution effects. A good coverage of CLI's is given by Pollak (1989). The cost of living index (CLI) overcomes this, by measuring the ratio of the cost in terms of expenditure $c(\ )$ of obtaining $\bar{u}^B$ the reference or base level of utility in two different price regimes, a comparison price vector $\boldsymbol{p}^1$ and a reference price vector $\boldsymbol{p}^0$:

$$CLI(\boldsymbol{p}^0, \boldsymbol{p}^1, \bar{u}^B) = \frac{c\left(\bar{u}^B, \boldsymbol{p}^1\right)}{c\left(\bar{u}^B, \boldsymbol{p}^0\right)} \tag{4.51}$$

Such a definition assumes that consumer tastes imbedded in the cost function are constant across time[10]. The CLI has a number of noteworthy properties that follow from the above definition.

i) $CLI(\boldsymbol{p}, \boldsymbol{p}, \bar{u}^B) = 1$

If the two price regimes are identical then the CLI is equal to one.

ii) $CLI(\boldsymbol{p}, \lambda\boldsymbol{p}, \bar{u}^B) = \lambda$

If the comparison prices are proportional to the reference prices then the CLI is equal to that proportion.

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[10] See Fisher and Shell (1972) for a CLI where preferences change over time.

iii) $CLI(\lambda \boldsymbol{p}, \boldsymbol{p}, \overline{u}^B) = \dfrac{1}{\lambda}$

If the reference prices are proportional to the comparison prices then the CLI is equal to the inverse of that proportion.

iv) $CLI(\lambda \boldsymbol{p}^0, \lambda \boldsymbol{p}^1, \overline{u}^B) = CLI\left(\boldsymbol{p}^0, \boldsymbol{p}^1, \overline{u}^B\right)$

If the price regimes are multiplied by a common factor the CLI is unchanged.

v) $CLI(\boldsymbol{p}^0, \boldsymbol{p}^1, \overline{u}^B) = \dfrac{1}{CLI\left(\boldsymbol{p}^0, \boldsymbol{p}^1, \overline{u}^B\right)}$

If the comparison and reference price regimes are interchanged then the resulting CLI is the reciprocal of the original CLI.

vi) If $\boldsymbol{p}^{1'} \geq \boldsymbol{p}^1$ then $CLI\left(\boldsymbol{p}^0, \boldsymbol{p}^{1'}, \overline{u}^B\right) \geq CLI\left(\boldsymbol{p}^0, \boldsymbol{p}^1, \overline{u}^B\right)$

That is if one set of comparison prices is higher than another then the CLI will be higher for that regime. If the CLI is differentiable, it can be expressed as

$$\frac{\partial CLI(\boldsymbol{p}^0, \boldsymbol{p}^1, \overline{u}^B)}{\partial p_g^0} \geq 0$$

This property holds so long as all goods are consumed in the initial price period and base utility and follows that any ceteris paribus price increase can not decrease the cost of attaining a particular level of utility.

vii) $Min\left\{\dfrac{p_g^1}{p_g^0}\right\} \leq CLI\left(\boldsymbol{p}^0, \boldsymbol{p}^1, \overline{u}^B\right) \leq Max\left\{\dfrac{p_g^1}{p_g^0}\right\}$

The CLI is bounded by the smallest and largest price relative p_g^1 / p_g^0 for any good, g. This follows because regardless of the collection of goods purchased, an individual compensated by $\text{Max}\left\{p_g^1 / p_g^0\right\}$ must be better off, even if only the good purchased was that which experienced the largest price rise. Similarly, if compensated less than $\text{Min}\left\{p_g^1 / p_g^0\right\}$ the individual would be worse off.

Note that in practice a reference period must be chosen and thus price indexes may be represented in either Laspeyres form: $CLI(\boldsymbol{p}^1, \boldsymbol{p}^0, \bar{u}^1) = \dfrac{c\left(\bar{u}^1, \boldsymbol{p}^1\right)}{c\left(\bar{u}^1, \boldsymbol{p}^0\right)}$ or Paasche form: $CLI(\boldsymbol{p}^1, \boldsymbol{p}^0, \bar{u}^0) = \dfrac{c\left(\bar{u}^0, \boldsymbol{p}^1\right)}{c\left(\bar{u}^0, \boldsymbol{p}^0\right)}$. The base utility of the CLI is normally specified in terms of a corresponding base expenditure.

4.2.4 Dependence of the CLI on Base Utility

The CLI will only be independent of base utility if

$$CLI\left(\boldsymbol{p}^1, \boldsymbol{p}^0\right) = \frac{\alpha\left(\boldsymbol{p}^1\right)\beta(\bar{u})}{\alpha\left(\boldsymbol{p}^0\right)\beta(\bar{u})} = \frac{\alpha\left(\boldsymbol{p}^1\right)}{\alpha\left(\boldsymbol{p}^0\right)} \tag{4.52}$$

in which case preferences must be homothetic to the origin and the implied demand functions are proportional in expenditure, see Pollak (1989). The dependence of the CLI on the base level utility results in unique CLI for a specified standard of living. Thus price changes will affect the CLI differently for different households even if they have identical preferences, if their levels of expenditure differ. Richer households are likely to spend a greater proportion of their expenditure on luxuries and less on necessities than poorer households. 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 be allowed to vary across households, through the use of demographic-price effects in equivalence scales.

4.2.5 Demographics, Equivalence Scales and the CLI

The CLI can vary across demographic groups within the population, when preferences vary according to a household's demographics. Differences in preferences are captured as variations in the cost functions and expressed as differences in the budget shares across demographic groups. Price scaling the non-demographic or base cost function with a price dependent equivalence scales $m(\boldsymbol{p}, z)$, allows the demographic CLI to be written as the product of the non-demographic CLI and the ratio of the equivalence scale in the two price regimes.

$$\begin{aligned} CLI(\boldsymbol{p}^1, \boldsymbol{p}^0, z, \bar{u}^B) &= \frac{c\left(\bar{u}^B, \boldsymbol{p}^1, z\right)}{c\left(\bar{u}^B, \boldsymbol{p}^0, z\right)} \\ &= \frac{m\left(\boldsymbol{p}^1, z\right)}{m\left(\boldsymbol{p}^0, z\right)} \frac{c\left(\bar{u}^B, \boldsymbol{p}^1\right)}{c\left(\bar{u}^B, \boldsymbol{p}^0\right)} \\ &= \frac{m\left(\boldsymbol{p}^1, z\right)}{m\left(\boldsymbol{p}^0, z\right)} CLI(\boldsymbol{p}^1, \boldsymbol{p}^0, \bar{u}^B) \end{aligned} \tag{4.53}$$

4.2.6 Practical Implementation of a CLI

There are a number of problems in practically estimating a CLI from demand system estimation. Firstly it is difficult to include the consumption of non-market goods, such as government provided services, in the utility function, since such data is often not available. Thus the CLI estimated must be considered a sub index of the true CLI that ignores substitution between market and non-market goods. Secondly, the commodity groups used in the demand system estimation limit the degree of substitution that a CLI can record. Since the number of parameters to estimate in a full demand system rises with the square of the number of commodity groups less one, it is difficult to allow for any detailed disaggregation. 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. Finer level substitution between goods within broad commodity groups has not been totally ignored, since the ABS and SC attempt to account for it in their price indices of broad commodities. Thirdly, demographic effects on the CLI are also limited by what can be successfully recovered through demand system estimation. Finally, in practice the construction of a CLI is based upon the prices (or price indices) available from statistical agencies in producing their CPI and thus may be prone to lower level substitution bias contained within these price indices.

In this study a PS-QAIDS is estimated for Australian and Canadian households with nine broad expenditure commodities of food, accommodation, household power, clothing and footwear, transport, health, recreation, alcohol and tobacco and miscellaneous, using regional price indices. The model allows for differing price effects on households that vary with respect to their adult equivalent expenditure and household demographics. 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. More details on the specification of the demand system and cost of living index are contained in Chapter 6 after a discussion of the data used in the study in Chapter 5.

4.3 Summary of Key Points

The following 'dot points' summarise the issues discovered in this chapter in accounting for variations in household size and composition and prices across households. This and the previous chapter conclude the review of past theoretical and empirical approaches to measuring inequality and accounting for differences in household size and composition and prices. Chapter 5, which follows, presents a discussion of the datasets used in this study, their problems and their basic statistics and a brief discussion on the demand system estimation.

Unit of Analysis

- Comprehensive surveys of nations are normally available at a household level

- If all units of the population are considered then the household as the unit of analysis generally results in lower inequality than if smaller family units are considered.

Equivalence Scales

- Equivalence scales are used to deflate household expenditure, for variations in household size and composition to facilitate welfare comparison across different households.

- They are normally defined as the ratio of total expenditure of a household to the reference household when the two households have the same standard of living or utility.

- If household size and composition are the object of control of households then unconditional equivalence scales provide a framework for justifiable welfare comparisons.

- However such unconditional scales require that they be independent of base (IB) utility.

Australian and Canadian Equivalence Scales

- Past evidence suggests that the cost of different demographic structures in different across countries and should be constructed independently.

- Past Australian equivalence scales are reasonably constant across past studies for the same model. However the estimates vary across the different techniques and models.

- Past studies suggest that there are significant differences in the cost of children of different ages.

- Past Canadian evidence suggests that there are economies of scale in caring for children.

Fixed Bundle Price Indices

- Fixed bundle price indices do not consider consumer preferences or substitution between goods.

Consumer Price Indices (CPI)

- CPI are effectively floating bundle price indices in that the weights used to construct the price indices are updated periodically to reflect changes in the average household spending behaviour.

- Criticism has been mounted at the CPI in the ignoring substitution effects and other measurement errors it overstates inflation. Efforts have been made to some of these issues by the relevant statistical authorities.

Cost of Living Indices

- Cost of living indices are specified as the ratio of the households cost functions in two price regimes and provide a theoretical and practical framework for considering substitution, demographic and utility effects of price changes.

Dependence of the CLI on Base Utility

- CLI depend on the base utility level at which the household cost function is evaluated.

- In order to be independent of the base level of utility preferences must be homothetic to the origin and the implied demand functions are proportional in expenditure.

- Thus CLI should be specified separately for groups with different preferences

Demographics, Equivalence Scales and the CLI

- The demographic CLI is the product of the non-demographic CLI and the ratio of the equivalence scale in the two price regimes.

Practical Implementation of a CLI

- The amount of substitution between goods that can be captured in a CLI is limited by the growth in the parameters required to estimate at a demand system at a detailed commodity level.

Chapter 5 Data and Estimation

This chapter describes the data used for the construction of equivalence scales and price indices and the examination of inequality trends and their decomposition. To study the level and trend of inequality a series of cross-sectional or panel data on individuals, families or households is required. The lack of available panel data has led to a time series of cross-sectional survey data on household income, expenditure and household characteristics, being used in this study. In addition to cross-sectional data, price data is required in order to take into account the variation of prices over the data sets. The variation in prices allows the estimation of equivalence scales (see Section 4.2). It also allows for cross price elasticity effects and price-demographic interaction effects to be modelled. This allows for substitution between goods by households and for the effect of prices to differ across households with different demographic structures. Sections 5.1 and 5.2 describe the Australian and Canadian data, respectively and the adjustments that need to be made to these datasets for the purpose of this study. Section 5.3 discusses the measurement errors frequently encountered with cross sectional data and the merits of sample selection procedures used to counter such data problems. Section 5.4 states the techniques used in constructing the estimates used in the study. Section 5.5 provides some basic statistics of the Canadian and Australian data sets used in this study and other variables that describe the survey periods of the data.

5.1 Australian Data

The principal Australian cross sectional data sets available for the study of inequality are the Australian Taxation Office records (when available) and the Australian Bureau of Statistics (ABS), Census, Income Distribution Surveys (IDS) and the Household Expenditure Surveys (HES). A pooled cross-section of HES data is chosen in this study since it provides information on both expenditure and income and is discussed further in Section 5.1.1. Section 5.1.2 discusses problems and adjustments made in pooling the HES data sets. The price data used from ABS is discussed in Section 5.1.3

5.1.1 Household Expenditure Survey (HES)

The confidentialised unit record files (CURF's) were obtained from the ABS for the 1975-76, 1984, 1988-89, 1993-94 and 1998-99 HES[1]. These were combined to provide a pooled cross section of household income, expenditure and demographic data containing 32,541 observations. The HES is a comprehensive and detailed survey of household demographic characteristics, income and, especially expenditure, for which there are over 400 expenditure classifications. Demographic information, income and infrequent expenditure were recorded by personal interview while the remaining expenditure items for all household members aged over 15, were recorded in personal diaries. The diaries covered a four-week period for the 1975-76 and 1984 surveys and two weeks for the others. All expenditure items were apportioned to represent average weekly expenditure by the ABS. Income was recorded as per pay period and apportioned to represent average weekly income by the ABS.

Table 5.1 HES Sample Size and Population

	1975-76	1984	1988-89	1993-94	1998-99
Number of Sampled Households	5,543	4,492	7,225	8,389	6,892
Population of Households	4,145,782	5,010,235	5,420,416	6,616,820	7,121,815
Population of Individuals in Households	12,791,565	14,202,812	14,986,471	17,394,261	18,516,004

Source: ABS HES Confidentialised Unit Record Files 1975-76, 1984, 1988-89, 1993-94 and 1998-99.

[1] The 1974-75 HES covered only households residing in capital cities.

The household is chosen as the unit of analysis and all estimation and analysis is weighted by the HES survey weights since the population of interest is all Australian households[2]. Table 5.1 above, shows the sample size of the HES for each survey and the population of households and individuals it represents.

Table 5.2 Expenditure Category Specification in terms of the HES and CPI groups

Broad Expenditure Goods	g	HES (ABS) expenditure categories	CPI (ABS) expenditure categories
Food and Non Alcoholic Beverages (FOOD)	1	Food and Non Alcoholic Beverages	Food
Accommodation (ACCOM)	2	Current Housing Costs, Household Furnishings and Household Services & Operation	Housing (less Electricity & Fuel), Household Furnishings, Supplies and Services,
Electricity and Household Fuel (POWER)	3	Domestic Fuel and Power	Electricity & Fuel (Sub-Group)
Clothing and Footwear (CLOTH)	4	Clothing & Footwear	Clothing and Footwear
Transport (TRANS)	5	Transport	Transportation
Health and Personal Care (HEALTH)	6	Medical Care & Health Expenses and Personal Care	Health
Alcohol and Tobacco (ALCT)	7	Alcoholic Beverages and Tobacco Products	Alcohol; Tobacco
Recreation (REC)	8	Recreation	Recreation
Miscellaneous and Education (MISC)	9	Miscellaneous Goods & Services	Education and Miscellaneous

Notes: HES: Household Expenditure Survey, CPI: Consumer Price Index, ABS: Australian Bureau of Statistics

To practically estimate demand systems, goods need to be aggregated into broad expenditure categories. Expenditure has been divided amongst $n_g = 9$ categories in this study, specified in the first column of Table 5.2. The third

[2] Note that in household based studies the survey weights are not multiplied by the number of persons in the household, as is the case when persons are the unit of analysis.

column specifies the CPI broad expenditure groups used to construct the prices of the $g = 1$ to n_g expenditure groups, which are discussed further in 5.1.2. The second column of Table 5.2 contains the HES broad expenditure groups, which form the expenditure groups used in this study. The HES commodity "Current Housing Costs" primarily consists of the interest component of mortgage repayments and rent payments, as well as rates, house and contents insurance and repairs[3]. Note that the Miscellaneous and Education (MISC) category includes Education that is contained in the HES as Miscellaneous Goods & Services. Education is responsible for approximately 30% of the MISC across the surveys while Consumer Credit charges are the other major component at approximately 15%.

5.1.2 Problems and Adjustments made to HES Data

While the 1988-89, 1993-94 and 1998-99 HES are quite similar in their definition and methodology there are differences with the earlier surveys. The income and expenditure records from the 1975-76 and 1984 HES were collected over a two-week period rather than four-weeks. Section 2.3.1 explained that surveys drawn over shorter periods are likely to report greater variation in income and to a lesser extent expenditure since they will capture more temporary fluctuations in the household's situation. No simple adjustment can be made for this thus the inequality estimates for 1975-76 and 1984 are likely to be biased upwards. This is likely to under report the trend in inequality from 1984 to 1988-89.

In addition, for the 1975-76 HES, the ABS used a different approach to constructing the data and different HES Commodity Code List (HESCCL) than the

[3] It does not include principal repayments of a housing loan or house purchases. Due to the limited information about house characteristics and values in the HES, estimates of consumption flows enjoyed by household members from partially and fully owned houses, were found to be too unreliable, with very high standard errors.

later HES[4]. Without exact knowledge of the ABS's approach to data construction, no allowance for this discrepancy is possible. The difference in the HES Commodity Code List for 1975-76 is no problem at the broad expenditure level. Although the 1975-76 HES has 11 broad expenditure categories, as opposed to 13 in the later surveys, the categories fit perfectly into the 9 broad expenditure categories used in this study, see Table 5.1.

Besides the difference in reporting period the 1984 HES differed from the other HES used in this study in that it converted negative income reported from business or rental property losses as zero and did not impute income tax paid for the survey period[5]. Ideally, the negative income values for business and rental property from the 1984 survey are required, but unfortunately this is not possible. An alternative is to change any negative income for business and rental property from the other surveys to zero and recalculate disposable income. This approach was used in order to maintain continuity between the surveys.

The data on net direct tax from the 1984 HES, is reported by respondents as the tax paid in previous years. The other HES imputed the direct tax paid in the survey year, based upon the household's regular gross income and its' characteristics. The net direct taxation for the 1984 sample was estimated based on the personal income tax system in 1984 and the household members' gross incomes and other household information. The values imputed are, on average, slightly higher than those reported by the 1984 HES for 1983. This is to be expected since aggregate household income was lower in 1983 from the depression the Australian economy was experiencing. Ideally a measure of the direct tax paid by households in

[4] This was the HESCCL used for the previous 1974-75 HES not survey not used in this study.

[5] In other HES negative income values reduced aggregate household income and the weekly income tax was imputed by the ABS.

the survey period would come from the tax office or respondents. The alternative is to either use gross income or to use the imputed disposable income figures. The latter is chosen in this study as it better reflects the resources a household has available for consumption.

In the entire HES, negative expenditure is possible when refunds, trade-ins, or sales are greater than the costs of acquisitions. This often results in low or negative consumption. The absolute value of any negative values found in the broad expenditure categories, were added to household expenditure category in order to remove the negative amount. The amount was also added to household income since negative expenditure is a form of income. A few households reported negative values of disposable income or expenditure. In order to include these households in the analysis negative values were converted to \$0.10.

To ensure that the number of persons aged 15 and over, was not affected by the various maximums used in the HES (normally 7+ and 10+), the household data was updated with the HES person records. To remove the bias introduced by upper limit existing on the age categories of children, a series of comparisons were made with other demographic variables contained in the HES to ensure that the true number of dependents in each age category was recorded. See Table 5.5 for details on the age categories used in the demand system estimation for Australia and also Canada.

5.1.3 Australian Price Data

In addition to data on household demographics and spending behaviour from the HES, price data is required in order to take account of the variation of prices over the data sets. The variation in prices allows the cross price elasticity effects to be estimated and the demographic-price interaction effects to be examined. The price data used is from Consumer Price Index CPI quarterly series for each state and territory's capital city based on its broad level expenditure groups with additional sub-group data for power and fuel. The HES records the state of residence but it does not record the capital city with the exception of the 1988-89 HES for which the reverse is true. There are also no true state based Australian price data that covers the whole of each state, and so this study uses the capital city prices but shall be referred to "state" prices for convenience.

The prices of the nine expenditure goods used in this study were constructed according to the third column of Table 5.2. Prices for some goods were removed and aggregated using state by year expenditure weights from the HES data sets and the ABS's 14th CPI Review weights. The HES are generally conducted over four quarters with approximately one quarter of the sample being surveyed in each quarter. For the 1975-76, 1984 and 1988-89 HES the prices used were the average of the prices over the four quarters of the survey period since the quarter of enumeration was not recorded for these surveys. Quarterly prices were used for the 1993-94 and 1998-99 since the HES from those years recorded the quarter each household was surveyed. When state/territory level price indices were unavailable for some goods in 1975-76 and 1984 the national price was used. Prices indices were re-based from 1989-90 back one year to 1988-89 since the 1988-89 HES CURF did not contain data on state/territory of residence. Thus all the broad commodity price indices are specified as unity, for all goods, in all states, in 1988-89[6]. Consequently all real expenditure or quantities are expressed in terms of what can be purchased for a dollar in the household's state/territory capital city, with the prices of 1988-89.

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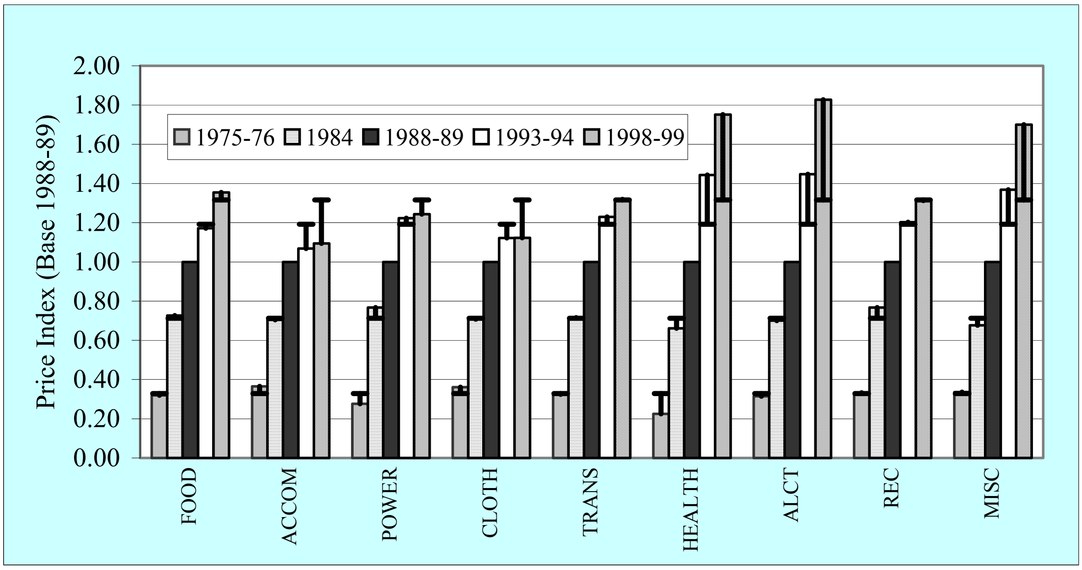
[6] Recall that the CPI price series are temporal rather than spatial price indices and do not measure differences in price levels across regions, merely price movements within regions.

Figure 5.1 below, contains the national price indices (the weighted average of the 8, state and territory capitals) of the nine expenditure groups used for the five HES survey periods. The CPI for each survey period is illustrated as t-bar against each price index. The figure illustrates the large rise in the price of health, alcohol and tobacco and miscellaneous goods and services from 1975-76 to 1998-99. It also illustrates the more recent decline in the relative price of accommodation, power and clothing from 1988-89 to 1998-99.

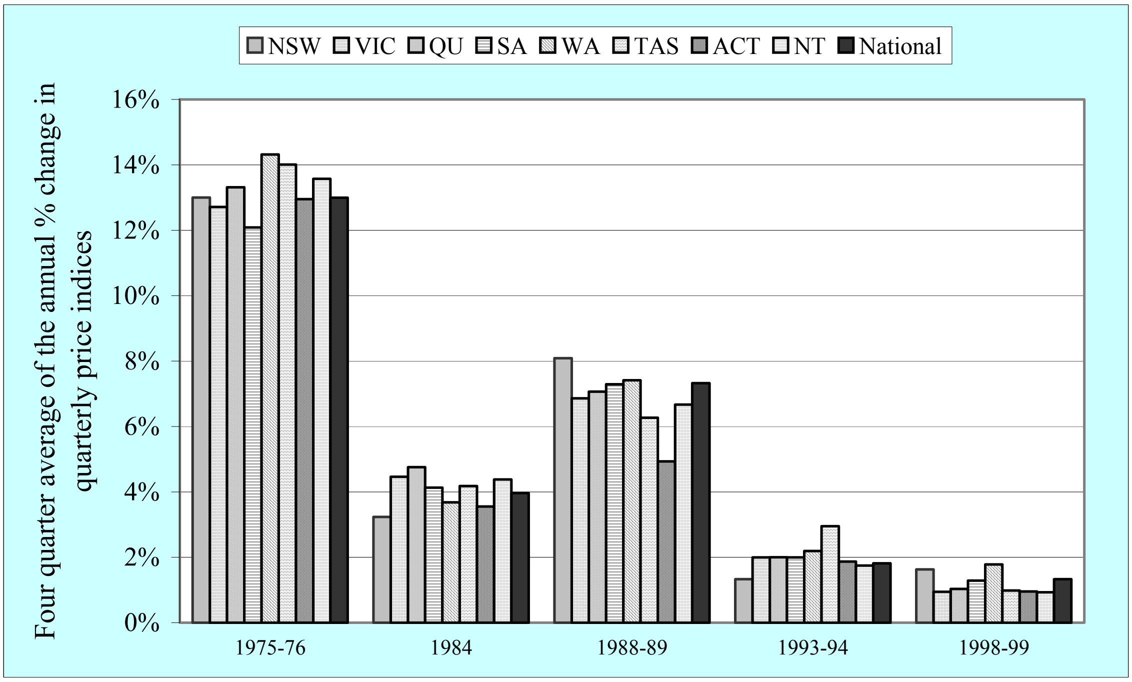
Figure 5.1 Australian Price Indices by Expenditure Group



Source: Transformed and re-based ABS CPI Quarterly Series: weighted average of capital cities.

Figure 5.2 below, shows the four-quarter average of the annual percentage change in the quarterly price index for each Australian state/territory capital city over the survey period. The same inflation rate is calculated for the annual CPI and illustrated with last black bar. While the inflation rates varied in 1975-76 between states the relative differences were small compared to the differences experienced in the late 1980s and 90s. Tasmania, the ACT and the NT experienced relatively smaller price rises in 1988-89, and to some extent Victoria and Queensland, than the national average. While in 1993-94, Tasmania experienced significantly higher inflation than the other states especially when compared to NSW. In 1998-99 the rates of inflation were lowest amongst the eastern states and the NT with the exception of NSW.

Figure 5.2 Australian Annual Inflation Rates by State



Source: Transformed and re-based ABS CPI Quarterly Series: capital cities.

The prices indices for each expenditure category by state and territory capital were constructed as a series from the mid-seventies through to the year 2000 and the prices corresponding to the HES surveys 1975-76, 1984, 1988-89, 1993-94 and 1998-99 are contained in Appendix Table 5.1.

5.2 Canadian Data

5.2.1 Family Expenditure Survey (FES)

The inequality estimates for Canada are based on a pooled cross section of the Family Expenditure Surveys (FES) confidentialised unit record files (CURF's) from Statistics Canada, for 1978, 1982, 1986 and 1992. The 1984 and 1990 FES were excluded since they only surveyed urban households unlike the other surveys whose population was urban and rural households from the 10 provinces.

The FES is similar in nature to the Australian HES, but there are important differences to be considered in their impact in level comparisons of Australian and Canadian Inequality. The FES is generally conducted in the three months following the calendar year to which the survey refers. It collects annual data on households and thus it's income, expenditure and demographic variables refer to the calendar year. The FES annual data, when compared to data collected fortnightly, will exhibit lower fluctuations in the previously mentioned variables, with the fortnightly fluctuations smoothed out over the year. Thus annual data will express lower inequality than a survey that differs in only that it has a shorter survey period. The FES data was converted to weekly data by dividing by 52 to provide a consistent methodology and aid in comparisons of the mean of household variables, not withstanding the numerous adjustments and value judgements required for true intra-country comparisons. Hence this study focuses on the trend comparison of inequality for Australia and Canada.

Like the HES, from 1990 the FES has used the household as the unit of analysis. Unfortunately the early FES, namely the 1978, 1982 and 1986 FES, used in this study treated the spending unit as the unit of analysis. A spending unit is defined as those household members that make spending decisions together and so may include friends of the family or multiple families but excludes lodgers, see Section 4.1 for more details. The effect of this upon inequality will depend upon the amount of income or expenditure lodgers bring into the household and whether it is typical for poor or rich families to have tenants in their house. A brief examination of the 1992 FES shows that there is little difference in the mean and variance of per capita income or expenditure of households with and without tenants. No allowance is made for the differing unit of analysis of the 1978, 1982, 1986 FES, since it is difficult to do so without altering the inherent distribution contained in the data.

Table 5.3 FES Sample Size and Population

	1978	1982	1986	1992
Number of Sampled Households	9,356	10,938	10,356	9,492
Population of Households	7,556,789	8,411,148	8,857,180	9,748,470
Population of Individuals in Households	22,625,688	23,508,146	24,524,790	25,942,022

Source: SC FES Confidentialised Unit Record Files 1978, 1982, 1986 and 1992

Table 5.3 above, contains the sample size for the four FES used in this study and the population of spending units/households and individuals the sample represents. All household based estimation and analysis of the FES data is weighted by the FES survey weights, so that the estimates represent the population of Canadian households.

Table 5.4 Expenditure Category Specification in terms of the FES and CPI groups

Broad Expenditure Goods	*g*	FES (SC) expenditure categories	CPI (SC) expenditure categories
Food and Non Alcoholic Beverages (FOOD)	1	Food	Food
Accommodation (ACCOM)	2	Shelter; less Electricity and Fuel; Household Operation; Household Furnishings and Equipment	Owned Accommodation; Rented Accommodation; less Water, Fuel and Electricity; Household Operations and Furnishings
Electricity and Household Fuel (POWER)	3	Electricity and Fuel	Water, Fuel and Electricity
Clothing and Footwear (CLOTH)	4	Clothing	Clothing and Footwear
Transport (TRANS)	5	Transportation	Transportation
Health and Personal Care (HEALTH)	6	Health Care and Personal Care	Health Care and Personal Care
Alcohol and Tobacco (ALCT)	7	Tobacco Products & Alcoholic Beverages	Alcoholic Beverages and Tobacco Products
Recreation (REC)	8	Recreation	Recreation
Miscellaneous and Education (MISC)	9	Education; Reading Materials and other Printed Matter; Miscellaneous;	Education and Reading; All-Items

Notes: FES: Family Expenditure Survey, CPI: Consumer Price Index, SC: Statistics Canada

For the estimation of the Canadian demand system, the same $n_g = 9$ broad categories are used as for the Australian data and are given in column one of Table 5.4 above. The second column of Table 5.4 contains the FES broad expenditure groups, which form the expenditure groups used in this study. The third column specifies Statistic Canada's CPI broad expenditure groups used to construct the prices p_g of the $g = 1$ to n_g expenditure groups, which are discussed further in section 5.2.3.

5.2.2 Problems and Adjustments made to FES Data

In general, the four FES CURF's that are used, compare much better with one another than the Australian HES. As with the HES data negative expenditure in transportation and recreation was removed and added as income for convenience, although it is probably better represented by rapidly depleting the household's stock of transport and recreation durables. The expenditure and income variables were converted from annual to weekly expenditure in line with the HES dollar weekly data.

Table 5.5 provides the child age categories used in the study for the demographically scaled demand system for the Australia and Canada. The age categories used for the HES and FES for children and dependents do not match, making the equivalence scale estimates for the two countries not directly comparable. The principal aim of this study is to compare the level and trend of the inequality of household welfare, while allowing for variations in household composition rather than produce comparable equivalence scales. For a few households that reported no adults aged 18 or above present in the FES, a person was removed from the 16 to 17 years category and added as an adult, to allow consistent estimation across all the survey units.

Table 5.5 A Comparison of the Definitions Between Australian and Canadian Child/Dependent Categories

Child/Dependent Categories			
		Australian HES	**Canadian FES (1982, 1986,1992)**
Young Children	n_{k1}	children under 5 years [1]	children under 4 years
Children	n_{k2}	children 5 to 14 years [1]	children 4 to 15 years
Dependents (Students)	n_{k3}	dependents 15 to 24 years	persons 16 to 17 years

Notes: 1. Used by the 1978 FES

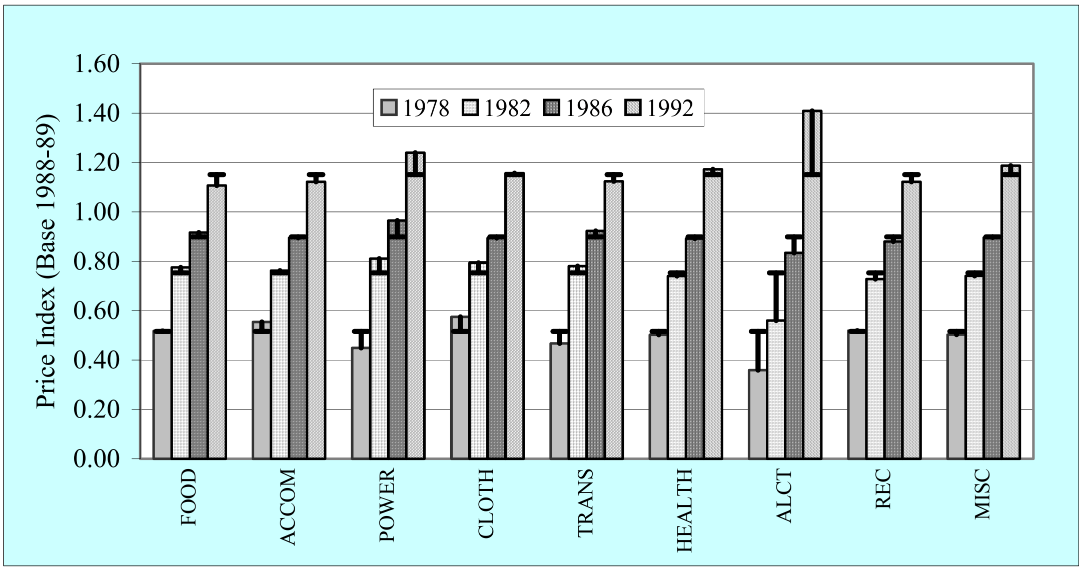
5.2.3 Canadian Price Data

Annual Canadian price indices data from 1978 to 2000 was obtained from Statistics Canada (SC) for the nation, Quebec, Ontario and British Columbia for each of the nine expenditure groups for 1978, 1982, 1986 and 1992. The CPI from 1978 to 2000 for the provinces that make up the Prairie Provinces: Newfoundland, Nova Scotia and New Brunswick; and the Atlantic Provinces: Manitoba, Saskatchewan and Alberta; were weighted by their expenditure weights obtained from the 1992 FES to construct a CPI for the Prairie and Atlantic provinces. The constructed Prairie and Atlantic CPI, were used in conjunction with the price indices for the nine goods for Quebec, Ontario, British Columbia and the nation, to approximately decompose the remaining nine price indices for the Atlantic and Prairie provinces, combined.

To aid in comparisons between Australia and Canada, the price indices for Canada are scaled to be unity in 1988-89 for each province’s expenditure categories. The 1988-89 prices were obtained as a simple average of the annual 1988 and 1989 price indices. Thus all real expenditures or quantities refer to the amount obtained for a dollar of expenditure in 1988-89 for a household in their province (category) price regime. The SC’s CPI broad expenditure groups match quite closely to the FES broad expenditure categories as shown in Table 5.4, with the price index of the sub-group for household electricity and fuel also being obtained to construct the price of household power expenditure. Some of the price indices were required to be aggregated from the SC's price indices, by weighting their price indices by the mean budget shares of the nine expenditure groups, by province, by survey year, obtained from the FES. The constructed prices for the 1978, 1982, 1986 and 1992 FES expenditure groups by province are contained in Appendix Table 5.2.

Figure 5.3 below provides the national Canadian prices for the FES expenditure groups which is the population weighted average of the provincial prices. As for Australia, Figure 5.3 illustrates the large rise in the price of alcohol and tobacco products in Canada from 1978 to 1992 from the increasing rates of taxation on those goods. In contrast to Australia which also experienced relative prices increases in health and personal care and miscellaneous and education commodities over 1975-75 to 1993-94 (and to 1998-99), the prices of those goods in Canada has risen in line with the CPI. Also in contrast to Australia, the relative price of household fuel and electricity has risen over 1978 to 1992, particularly from 1978 to 1982.

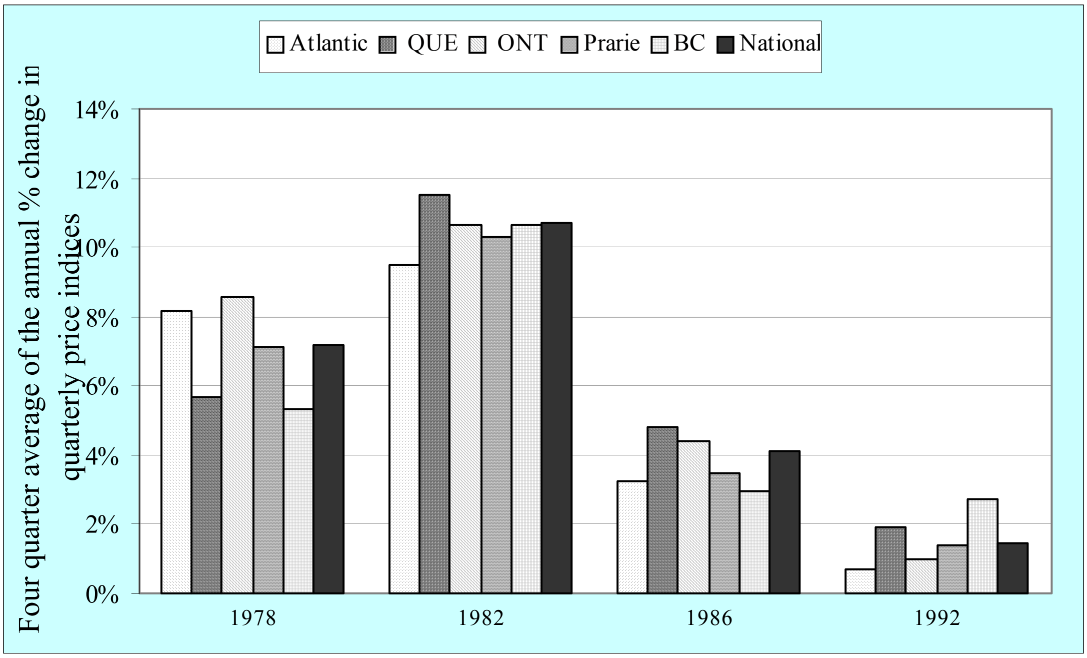
Figure 5.3 Canadian Price Indices by Expenditure Group



Source: Transformed and re-based SC CPI Annual Series: Canada.

Figure 5.4 shows the four-quarter average of the annual percentage change in the quarterly price index for each province/region of Canada and the national CPI over the survey periods covered. The provincial quarterly price series begins in the September quarter of 1978 and so the 1978 reported is the annual equivalent of the September to December 1978 inflation. While using the December quarter figure in this way may exaggerate the estimate of inflation for the provinces, the figures are in line with the national inflation in 1978. Inflation rates across the regions have not differed substantially in survey periods. However, British Columbia and Quebec experienced significantly lower inflation in 1978 but significantly higher in price increases in 1992. Prices in the Atlantic provinces have experienced the smallest increases in prices in the survey periods from 1982.

Figure 5.4 Canadian Annual Inflation Rates by Region



Source: Transformed and re-based SC CPI Annual Series: provinces.

5.3 Measurement Error and Sample Selection

The major problem of surveys of this nature is that income and even expenditure are often under reported. This is a difficult problem to avoid. It could be argued that those with higher incomes have a greater incentive to under report their income, since they may have the most to lose from any others knowledge of their income[7]. If this is the case then the reported inequality indices will be biased downwards since the true extent of high incomes is hidden. If this aggregate effect from the rich under-reporting their income upon the distribution of income is constant across time then the trend in income inequality will not be affected. There may also be a case that low income households may not want others to know the extent of their poverty and may inflate their income or expenditure, causing inequality estimates to be biased upwards since the true extent of low income levels is hidden. Again this will not affect the reported movement of income inequality if the aggregate effect of over reporting on the distribution of income, is constant over time. The same arguments could be applied to the under or over reporting of expenditure.

If all households under report their true income by the same proportion then their reported income is just a scaled value of their true income and scale independent inequality measures (see Section 2.2.3) will not be affected. This is not a totally unreasonable assumption to make combined with the use of scale independent inequality indices in this thesis, allows the level of inequality to be examined. While the less restrictive assumption that any under or over reporting, leaves the shape of the welfare distribution unchanged over time, allows the trend in inequality to be safely examined.

Many studies of inequality often over enthusiastically remove observations from the sample data obtained from the relevant statistical agencies in an attempt to minimise measurement error and outliers. Most statistical agencies take action to minimise measurement error and there is no reason to suspect that altering the

[7] For example the respondent with high income may fear retribution from the taxation authorities,

sample, by simply removing observations will provide any better estimate of inequality, especially when a measure for the country is desired. Samples are normally taken to represent the population and upon application of the sampling weights can be used to give a picture of the distribution of income and expenditure for whole of the population. A common practice is to remove a certain proportion of the lowest and highest reported income but there is no reason to suspect that those households who have reported an extremely low or high level of income or expenditure are those households that have mis-reported their financial position. To minimise the "effect" of changes in employment situations often households headed by the young and the aged are removed. However this has the effect of eliminating some of the poorest households of unemployed youth, students, pensioners and other potential welfare recipients. These two common practices are both likely to introduce a downward bias in the reporting of inequality.

Thus reducing an appropriately drawn sample is likely to lead to an unnecessary bias in the true level of inequality if the whole nation is the subject of interest. Since that is the aim in this study the full samples used were from the HES for Australia and the FES for Canada. Note that both surveys are likely to miss the homeless since their collection process is household based. The household sample weights for the HES and FES that are provided in the CURFs, are unique to each household and survey period. They are developed so that the projected number of household types in the population based upon census data, are reflected by the sample weights. The sample weights for the HES and FES can easily be used to provide valid weighted statistical estimates for the population of households. Their use in regression is more complex, see DuMouchel and Duncan (1983), but is incorporated into many econometric packages.

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business rivals, charities or beggars.

5.4 Estimation

The parameters of the equivalence scales and cost of living index used in the study is recovered from estimating a demographically varying demand system (see Chapter 6 for more details). The demand system consists of n_g -1 budget share equations, where n_g is the number of goods in the demand system, since the aggregation conditions allow the parameters of the one of the equation to be completely identified by the other equations' parameters. Systems of budget shares are frequently estimated as a system of seemingly unrelated regressions (SUR) for each household. SUR allows the regression errors to be correlated across equations (but not within) and uses the information through Generalised Least Squares (GLS) in the estimation of the parameters. The functional form of the demographically varying demand system specified in Chapter 6 is non-linear and requires the use of non-linear iterative seemingly unrelated regression (NL-IT-SUR), where the parameters are estimated iteratively until the likelihood function converges to maximisation.

Full Informational Likelihood (FIML) estimation allows for across and within equation relations and for covariance between the error terms and uses this information in the iterative procedure used to maximise the likelihood function. This is based on the assumption that the residuals are normally distributed. Appropriate specification of the demand system should result in this and provide superior estimates to SUR and NL-IT-SUR. The system of equations is estimated by Full Information Maximum Likelihood (FIML) estimation using the SAS 6.12 system for windows. No observations were removed and each household was weighted by its survey weight in the FIML estimation.

All reported statistics and inequality estimates are based on the full samples and have also been weighted by the household survey sample weights of the HES and FES so that they adequately reflect the population of Australian and Canadian households from which they are drawn.

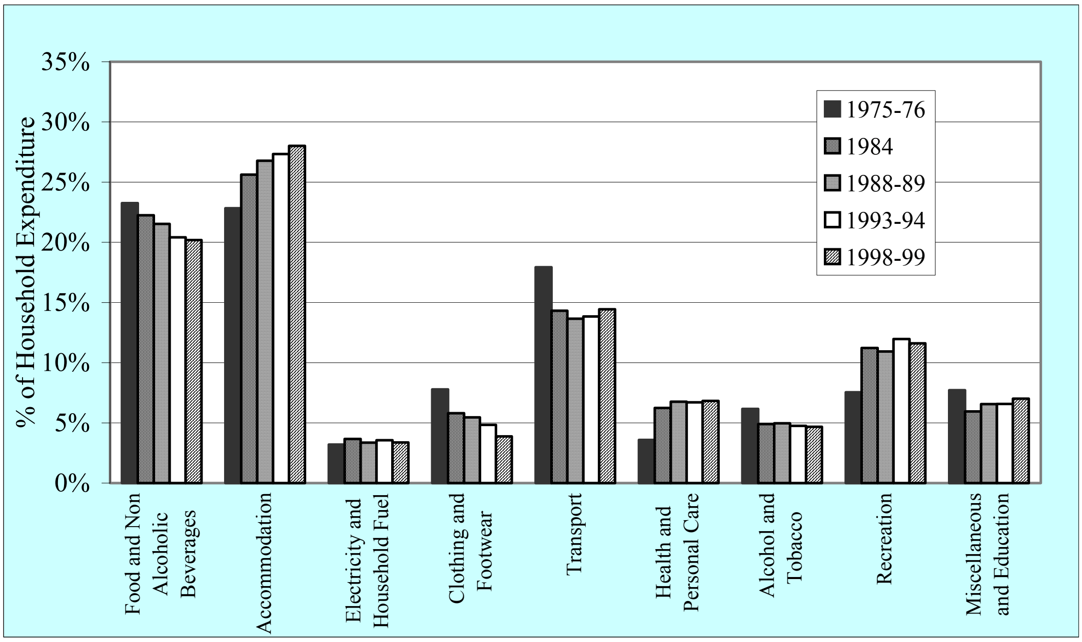
5.5 Basic Statistics from the HES and FES

This section provides some basic statistics of households from the HES and FES datasets combined in conjunction with the appended price data. More detailed discussion of the movements in the household characteristics is contained in Chapter 8 where their impact upon inequality is examined.

5.5.1 Budget Shares

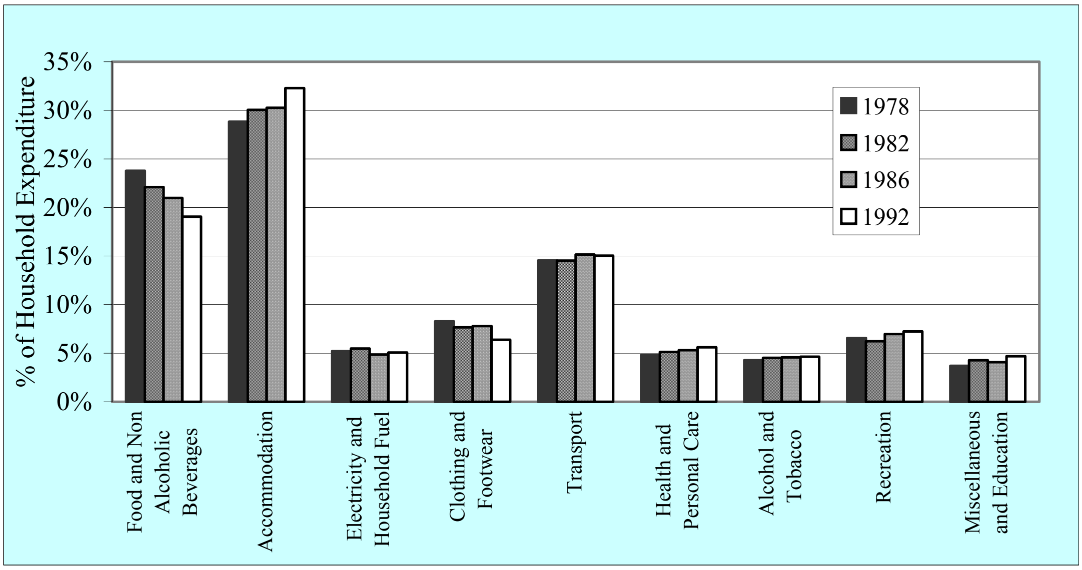
Figures 5.5 and 5.6 show the mean household budget shares from the Australian HES and Canadian FES respectively for the survey periods.

Figure 5.5 Australian Budget Shares



Source: ABS HES, Confidentialised Unit Record Files 1975-76, 1984, 1988-89, 1993-94 and 1998-99

Figure 5.6 Canadian Budget Shares



Source: SC FES Confidentialised Unit Record Files 1978, 1982, 1986 and 1992

In both Australia and Canada there has been a notable decline in the share of expenditure devoted to food and a rise in the budget share of accommodation from the late 1970s to the 1990s. The profile of budget shares for the two countries is quite similar. Australian households appear to spend more on recreation, health and personal care and education and miscellaneous goods. However the fortnightly survey period of the Australian HES may overstate the expenditure of such goods when compared to the annual survey period of the Canadian FES, since for some households they are likely to include large non–recurring expenditures. For example holidays, education fees and medical expenses.

5.5.2 Mean Household Size Demographics

Table 5.6 shows the mean number of persons, adults aged under 65 years, adults aged over 65 years and dependents per household for Australia and Canada across the survey periods. The level and trend in the means of the demographic variables is similar for both Australia and Canada. Both countries have experienced a decline in the average household size with both the mean number of adults under

65 and dependents falling, while the mean number of adults aged over 65 years per household has risen for both countries.

Table 5.6 Mean Household Size Demographics

Year	Persons	Adults under 65 Years	Adults over 65 years	Dependents
		Australia		
1975-76	3.09	1.80	0.25	1.04
1984	2.83	1.71	0.27	0.85
1988-89	2.76	1.69	0.27	0.80
1993-94	2.63	1.62	0.29	0.72
1998-99	2.60	1.61	0.30	0.69
		Canada		
1978	2.99	1.80	0.27	0.93
1982	2.74	1.71	0.26	0.77
1986	2.72	1.72	0.27	0.73
1992	2.61	1.65	0.29	0.67

Source: ABS HES, Confidentialised Unit Record Files
1975-76, 1984, 1988-89, 1993-94 and 1998-99.
SC FES, Confidentialised Unit Record Files 1978, 1982, 1986 and 1992

5.5.3 Mean Household Real Expenditure, Disposable and Gross Income

Table 5.7 provides the mean household expenditure, disposable and gross income deflated by the CPI of the state/province in which they reside. To relate the figures to the macroeconomic environment, statistics on such are provided in Table 5.8. Both Australia, from 1984 to 1993-94 and Canada, from 1986 to 1992 have experienced periods in which real mean disposable income fell. The double-digit levels of unemployment experienced in the early 1990s left many households without a wage earner, impacting heavily upon measures of household welfare. The effects of deep recessions can be seen on the mean levels of real expenditure for the two countries. Australian real spending per household fell from 1984 to 1988-89 as the recession of the early 1990s loomed and had only increased slightly in 1993-94 as the economy was recovering.

Table 5.7 Mean Real Household Expenditure, Disposable and Gross Income

Year	CPI	Real Household Expenditure	Real Household Disposable Income	Real Household Gross Income
Australia				
1975-76	0.372	$463	$509	$604
1984	0.705	$517	$525	$645
1988-89	1.000	$506	$511	$635
1993-94	1.191	$510	$505	$608
1998-99	1.317	$533	$547	$664
Canada				
1978	0.517	$542	$608	$727
1982	0.754	$514	$617	$737
1986	0.900	$557	$625	$764
1992	1.152	$540	$614	$769

Source: ABS HES, Confidentialised Unit Record Files
1975-76, 1984, 1988-89, 1993-94 and 1998-99
SC FES, Confidentialised Unit Record Files 1978, 1982, 1986 and 1992
ABS CPI Quarterly Series
SC CPI Annual Series

Table 5.8 Macroeconomic Statistics for Australia and Canada

Year	Unemployment Rate	Interest Rates	Annual GDP Growth		Annual Inflation	
	Current Period	Current Period	Current Period	Period to Period	Current Period	Period to Period
Australia						
1975-76	4.9%	n.a.	2.8%	-	12.9%	-
1984	9.0%	11.8%	6.7%	1.6%	3.9%	9.5%
1988-89	6.6%	15.0%	4.1%	2.6%	7.3%	7.8%
1993-94	10.6%	1.8%	4.1%	1.0%	1.8%	3.6%
1998-99	7.6%	4.9%	4.5%	3.2%	1.3%	2.0%
Canada						
1978	8.3%	n.a.	3.6%	-	9.0%	-
1982	11.0%	14.0%	-3.2%	0.3%	10.9%	9.2%
1986	9.5%	9.2%	3.2%	3.2%	4.1%	4.6%
1992	11.3%	6.8%	0.9%	0.5%	1.5%	4.2%

Source: Unemployment
Can: SC Year Book 1994, 1990 and 1980-81
Aus: ABS 6202.0 Labour Force, SC Labour Force
Interest Rates
Can: RBA Bulletin Overseas Official Interest Rates: 12 month average of target rate
Aus: RBA Bulletin Overseas Official Interest Rates: 12 month average of official cash rate
Inflation
Can: SC CANSIM M9957, % annual change in CPI (average of the 12 months)
Aus: ABS 6401.0 Table 3, % annual change in CPI (average of the 4 quarters)
Growth
Can: SC Year Book 1994, 1990 and 1980-81
Aus: ABS 5206.0 National Accounts.

Real mean expenditure per household fell between 1978 to 1982 and 1986 to 1992 for Canada, demonstrating the effect of the 1981-82 and 1990-92 recessions in Canada. Whether there has been an improvement in the welfare of households is difficult to determine without adjusting for changes in the various sizes and compositions of households. The use of the household equivalence scale specified in Chapter 6 will allow for greater inter-household comparability.

5.6 Summary of Key Points

The points below present a convenient summary of the nature and construction of the price data and pooled cross-sectional household level data sets for Australia and Canada. It also provides a summary of basic statistics from the household and price data. This data is used in to estimate the demand system, equivalence scales and cost of living indices that are specified and presented in Chapter 6.

Data Sets

- This thesis uses a pooled cross section of household surveys.
- The data sets used are the Household Expenditure Survey (HES) and the Family Expenditure (FES) Survey from the Australian Bureau of Statistics and Statistics Canada, respectively.
- For Australia the data set consists of the 1975-76, 1984, 1988-89, 1993-94 and 1998-99 HES confidentialised unit record files and for Canada the 1978, 1982, 1986 and 1992 FES.

Expenditure Groups

- Nine expenditure groups were formed for demand system estimation and construction of a cost of living index to match the HES, FES ABS CPI and SC CPI expenditure groups.

Adjustments and Comparability

- Numerous adjustments had to be made to the selected HES to ensure the consistency of the dataset, while relatively few had to be made for the FES.

- The HES and FES are not directly comparable, principally because the HES is a fortnightly survey where as the FES uses an annual reporting period.

Estimation

- Full Samples of HES and FES are used in this study.

- All estimation and statistics are weighted by the survey weights so that they represent the population.

- Demand system estimation is conducted using FIML

Price Data

- The largest relative increases over the sample period, has been in the price of alcohol and tobacco for both Australia and Canada.

- In contrast to Australia which also experienced relative prices increases in health and personal care and miscellaneous and education commodities the prices of those goods in Canada has risen in line with the CPI.

- While the annual inflation rates in Australia varied in 1975-76 between states the relative differences were small compared to the differences experienced in the late 1980s and 90s.

- Inflation rates across the Canadian regions have not differed substantially in survey periods. However, British Columbia and Quebec experienced significantly lower inflation in 1978 but significantly higher in 1992. Prices in the Atlantic provinces have experienced the smallest increases in prices in the survey periods from 1982.

Budget Shares

- In both Australia and Canada there has been a notable decline in the share of expenditure devoted to food and a rise in the budget share of accommodation from the late 1970s to the 1990s.

- The profile of budget shares for the two countries is quite similar. Australian households appear to spend more on recreation, health and personal care and education and miscellaneous goods. However the fortnightly survey period of the Australian HES may overstate the expenditure of such goods when compared to the annual survey period of the Canadian FES.

Household Size

- Both countries have experienced a decline in the average household size with both the mean number of adults under 65 and dependents falling, while the mean number of adults aged over 65 years per household has risen for both countries.

Mean Household Real Expenditure, Disposable and Gross Income

- Both Australia, from 1984 to 1993-94 and Canada, from 1986 to 1992 have experienced periods in which real mean disposable income fell from the world recession of the early 1990s.

- Australian real spending per household fell from 1984 to 1988-89 as the recession of the early 1990s loomed and had only increased slightly in 1993-94 as the economy was recovering. Real mean expenditure per household fell between 1978 to 1982 and 1986 to 1992 for Canada, demonstrating the effect of the 1981-82 and 1990-92 recessions in Canada.

- Comparisons of household income and expenditure do not account for differences in households' demographic structure. Chapter 6 contains the specification and estimated equivalence scales that help account for such differences.

- The CPI is not a cost of living index and may not adequately record the impact of prices on real welfare as described in Chapter 4. Chapter 6 contains the specification and estimated cost of living index to better account of the impact of prices on different households.

Chapter 6 Specification and Estimation of Equivalence Scales and Price Indices

This chapter contains the specification and estimates of the equivalence scales and a cost of living index used in this study of Australian and Canadian inequality. Much of the analysis in this study uses an equivalence scale and a cost of living index based on a complete demand system founded on the static utility maximising behaviour of households. In using a one period static model, one must assume that utility is separable over time, so that the maximisation of within period utility is consistent with maximisation of lifetime utility. Without panel data, tracking income and expenditure overtime, the analysis of lifetime utility maximising behaviour is difficult. It requires one to model the intertemporal behaviour of households and make many assumptions about price, income and family size expectations, as well as the functional form of lifetime utility and is left for future research.

Section 6.1 specifies the cost function and budget shares for the reference household from the Quadratic Almost Ideal Demand System (QAIDS) first introduced by Banks, Blundell and Lewbel (1992). The model is demographically extended in Section 6.2 by an application of Ray's (1983) Price Scaling (PS) technique to provide the PS-QAIDS model. A general functional form for the equivalence scales in terms of the number of equivalent single adults is specified in 6.2.1. By restricting the parameters of the general function and alternate estimation techniques, Section 6.2.2, presents the methods of constructing the ten equivalence scales used in this study. Section 6.2.3 contains the specification of the test that equivalence scales for Australia and Canada are independent of the base level of utility (IB). The IB assumption allows the recovery of equivalence scales consistent with utility theory, which allows welfare comparisons across households[1]. Section 6.3 reports and compares the equivalence scale parameters estimated for Australia and Canada based on household expenditure behaviour from the HES and FES data, respectively. It also compares the estimated scales with the four other specified scales and presents the tests of the IB assumption.

The implied cost of living index (CLI) for the PS-QAIDS from 6.1 and 6.2.1 is presented in 6.4. The PS-QAIDS CLI is used to examine the effect of a price rise in each of the nine broad commodities upon welfare in Section 6.5. The price elasticities for households with differing levels of equivalent expenditure and demographics are presented in this section and compared to those implied by the CPI from Australia and Canada. Section 6.6 examines the effect of price rises actually experienced by Australia and Canada over the sample periods. The PS-QAIDS CLI is used to construct the implied rates of inflation for households with differing levels of equivalent expenditure and demographics. Finally 6.7 summarises the key findings of the chapter.

6.1 Demand System Specification

The demand system specified in this study for the estimation of equivalence scales and cost of living indices is a static QAIDS, a non-linear rank-3 model[2]. QAIDS allows Engel curves that are quadratic in log of household expenditure and thus allows goods to change from necessities to luxuries across the expenditure distribution. The QAIDS cost function is given in non-demographic form

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[1] See Section 4.1.2.11 for a more detailed discussion of the independence of base utility assumption and its implications.

[2] The rank of a demand system is measured by the number of unique price dependent terms in the indirect utility function.

$$x_R = c_R(u, \boldsymbol{p}) = e^{\left[a(\boldsymbol{p}) + \frac{ub(\boldsymbol{p})}{1 - uc(\boldsymbol{p})}\right]} \tag{6.1}$$

where u is utility, $\boldsymbol{p}$ denotes the vector of prices p_i, and

$$a(\boldsymbol{p}) = \alpha_0 + \sum_i \alpha_i \log p_i + \tfrac{1}{2}\sum_i \sum_j \gamma_{ij} \log p_i \log p_j \tag{6.2}$$

$$b(\boldsymbol{p}) = \prod_i p_i^{\beta_i} \tag{6.3}$$

$$c(\boldsymbol{p}) = \prod_i p_i^{\lambda_i} \ , \tag{6.4}$$

with the adding up restrictions $\sum \alpha_i = 1$, $\sum \beta_i = \sum \delta_i = \sum \lambda_i = \sum_i \gamma_{ij} = 0$, the homogeneity restriction $\sum_j \gamma_{ij} = 0$, and the symmetry restriction $\gamma_{ij} = \gamma_{ji}$ for all i, j. α_0 is the level of expenditure required at base level prices (when $p_i = 1$ for all i) required for a set minimum level of welfare. In order to provide a positive real expenditure measure for all households α_0 is specified as $\alpha_0 = 0$[3].

In budget share terms s_i, QAIDS is given by

$$s_i = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i\left[\ln(x) - a(\boldsymbol{p})\right] + \lambda_i \prod_k p_k^{\lambda_k - \beta_k}\left[\ln(x) - a(\boldsymbol{p})\right]^2 \tag{6.5}$$

The rank-3 QAIDS nests rank-2 preferences in the form of the AIDS model, when all the λ_i equal zero and resulting in $c(\boldsymbol{p}) = 1$. This property can be used to test whether rank-3 is an improvement over a rank-2 specification.

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[3] In reference price regime $a(\boldsymbol{p}) = \alpha_0$ and if real expenditure is to be positive then $\alpha_0 < \ln(x_{MIN})$, where x_{MIN} is the lowest level of expenditure recorded by of households. 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, since they are to be included in the nationwide study of inequality. This imposes an lower bound of zero on α_0 but is specified as zero in line with previous studies, for example Lancaster and Ray (1996).

6.2 Equivalence Scale Specification

Price scaling (PS), a households cost function scaled with equivalence scale dependent on prices and household demographics, results in the PS cost or expenditure function, which is given by,

$$x_h = c_h(u_h, \boldsymbol{p}_h, \boldsymbol{z}_h) = c_R(u, \boldsymbol{p})\, m_{PS}(\boldsymbol{p}, \boldsymbol{z}) \qquad (6.6)$$

where x_h is the household expenditure, $c_h(u_h, \boldsymbol{p}_h, \boldsymbol{z}_h)$ the cost function for a particular household, $c_R(u, \boldsymbol{p})$ is the cost function of the reference household and $m_{PS}(\boldsymbol{p}, \boldsymbol{z})$ is the equivalence scale dependent on the vector of prices $\boldsymbol{p}$ and a vector of household characteristic variables, $\boldsymbol{z}$. If the reference households cost function is given by the QAIDS cost function equation 6.1, then equation 6.6 becomes the PS-QAIDS which is the principal model used for this thesis.

While equivalence scales are normally used to adjust for household size and composition they may also be used to adjust for other household characteristics that affect the cost of obtaining a certain level of utility. All Australian studies to date have concentrated on household size and composition based equivalence scales, but Phipps (1998) and Nichol (1999) examined the region, age and labour force status in their construction of equivalence scales for Canada. This thesis concentrates on household size and composition, thus a household equivalence scale, $m_{\mathrm{HH}}(\boldsymbol{p}, \boldsymbol{z}_{\boldsymbol{HH}})$ is used where $\boldsymbol{z}_{\boldsymbol{HH}}$ is a subset of demographic variables $\boldsymbol{z}_{\boldsymbol{h}}$, concerned with household size and composition effects in the measurement of inequality[4]. This results in the following demographic specification for the cost function

$$x_h = c_h(u, \boldsymbol{p}, \boldsymbol{z}) = c_R(u, \boldsymbol{p})\, m_{\mathrm{HH}}(\boldsymbol{p}, \boldsymbol{z}_{\boldsymbol{HH}}) \ . \qquad (6.7)$$

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[4] Preliminary investigation of a demographic QAIDS scaled by the state or province of residence encountered convergence problems in estimation.

The following Section 6.2.1 specifies the functional form of the equivalence scales for household size and composition $m_{\mathrm{HH}}(\boldsymbol{p}, \boldsymbol{z_{HH}})$.

The PS-QAIDS model neatly nests the PS-AIDS model just as the QAIDS nests AIDS. This provides a framework to examine how equivalence scales change when rank-3 preferences are considered over rank-2 and the strength of each model evaluated with a log likelihood ratio test. These results for Canada and Australia are presented in Section 6.3.1.

6.2.1 The Equivalence Scale: Functional Form

Household size and composition equivalence scales have attracted the most attention in empirical estimation of equivalence scales. The majority of scales have used either a childless single adult or a childless couple as the base and allowed for child costs proportionally. Some attention has been paid recently to the existence of returns to scale of household or family size by Jorgenson and Slesnick (1987) and Nelson (1988) who found significant household economies of scale for all goods for the U.S. using data from the Consumer Expenditure Survey. Clouter, Cowell and Jenkins (1992), Banks and Johnson (1994) and Jenkins and Cowell (1994) using UK data examined the sensitivity of inequality estimates to the specification of household economies of scale. They found economies of scale estimates of between 0.3 and 0.4 provided the lowest U.K inequality estimates, but also maximised the increase in U.K inequality from 1987 to 1988-89. Jenkins and Cowell (1994, p899) found that while this increase was consistent for a range of inequality indices the magnitude of the increase varied across index. Buhmann, Rainwater, Schmaus and Smeeding (1988) investigated the sensitivity of inequality of ten countries from the LIS database, including Australia and Canada, to the specification of household economies of scale. They found equivalence scale specification impacted on the magnitude of inequality estimates and therefore upon cross country comparisons of inequality.

The specification of the equivalence scale $m_{\mathrm{HH}}(\boldsymbol{p}, \boldsymbol{z_{HH}})$ chosen in this study is represented by the product of a two terms.

$$m_{\mathrm{HH}}(\boldsymbol{p}, \boldsymbol{z_{HH}}) = m_{GEN}(\boldsymbol{z_{HH}})\, m_{REL}(\boldsymbol{p}, \boldsymbol{z_{HH}}) \tag{6.8}$$

where $\boldsymbol{p} = \lfloor p_1 \ \ldots \ p_{n_g} \rfloor$ is price vector of the n_g goods, $\boldsymbol{z_{HH}} = [n_a \ n_{k1} \ n_{k2} \ n_{k3}]$ a demographic vector containing n_a, n_{k1}, n_{k2}, n_{k3} which denote, respectively, the number of adults, children under five years old, dependents aged between 5 and under 15 years old, and dependents aged between 15 and 25 years old, living in the household.

The first term $m_{GEN}(\boldsymbol{z_{HH}})$ captures the effect of household size and composition in scaling total or aggregate household expenditure or "general effect". It incorporates the costs of children of different ages and the economies of scale enjoyed by large households. 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, *EP*. It is defined as

$$m_{GEN} = EP = (n_a + \kappa_1 n_{k1} + \kappa_2 n_{k2} + \kappa_3 n_{k3})^{(1-\theta)} \tag{6.9}$$

where n_a, n_{k1}, n_{k2}, n_{k3} denote, respectively, the number of adults, children under five years old, dependents aged between 5 and under 15 years old, and dependents aged between 15 and 25 years old, living in the household. While the κ's represent their corresponding constant utility cost, 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 that can be simultaneously enjoyed by all household members, then $\theta = 1$ and the scale gives unscaled 'per household' measures of welfare. This is similar to Banks and Johnson's (1994) specification but where differing costs are allowed for different aged dependents and the θ is specified as one minus the elasticity of household expenditure with respect to an adult (or equivalent adult). The specification of the $m_{GEN}(\boldsymbol{z_{HH}})$, scales expenditure according to the size of the household measured by equivalent persons.

The second term $m_{REL}(\boldsymbol{p}, \boldsymbol{z_{HH}})$ captures the effect that household size and composition have in altering the relative demand for goods or "relative effect". It captures the effect of household composition price effects via the interaction with prices. Most of the composition effects of the relative cost of adults and different aged dependents has been captured in their size effects in $m_{GEN}(\boldsymbol{z_{HH}})$ in scaling household expenditure. Thus the remaining relative effect from the size of the household (including the relative cost of children) is small and can not be captured well by $m_{REL}(\boldsymbol{p}, \boldsymbol{z_{HH}})$. In light of this the relative effects are based purely upon the total number of dependents in the household to capture the effect that they have in shifting a household's budget shares for particular goods in addition to the effects they have of scaling/sharing total expenditure. Thus $m_{REL}(\boldsymbol{p}, \boldsymbol{z_{HH}})$ captures the relative effects of children and is specified as

$$m_{REL}(\boldsymbol{p}, \boldsymbol{z_{HH}}) = \left(\prod_{g=1}^{n_g} p_g^{\nu_g} \right)^{n_k} \qquad (6.10)$$

where p_g is the price of each good $g = 1$ to n_g,

n_g is the total number of goods in this study nine,

n_k is the total number of dependents, $n_k = n_{k1} + n_{k2} + n_{k3}$ and

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

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 $m_{REL}(\boldsymbol{p}, \boldsymbol{z_{HH}}) = 1$ and prices do not affect the household equivalence scale.

The product of the two equations (6.9) and (6.10) provides the household equivalence scale used in this study to take account of the number of adults and the number and age of dependents of the household, given by

$$m_{\mathrm{HH}}(\boldsymbol{p}, \boldsymbol{z_{HH}}) = (n_a + \kappa_1 n_{k1} + \kappa_2 n_{k2} + \kappa_3 n_{k3})^{(1-\theta)} \left(\prod_{g=1}^{n_g} p_g^{\nu_g} \right)^{n_k} .$$

(6.11)

The above specification in the reference period when all prices are unity, also neatly nests many other commonly used equivalence scales for household expenditure and income in studies of inequality.

6.2.2 The Equivalence Scale: Parameter Estimation and Specification

This study examines ten alternative scales, and the results presented later provide evidence on the sensitivity of the inequality magnitudes and trends to the scale employed. The alternative scales are as follows.

i) PS-QAIDS Estimated Scales

The $\kappa_1, \kappa_2, \kappa_3$ and θ and η_g (for all g = 1 to n_g.) may be estimated along with the standard QAIDS parameters within the budget shares of PS-QAIDS,

$$s_i = \nu_i n_k + \alpha_i + \sum_g \gamma_{ig} \, log \, p_g + \beta_i \, log(\tilde{x}) + \lambda_i \prod_g p_g^{\lambda_g - \beta_g} [log(\tilde{x})]^2$$

where, (6.12)

$$log \, \tilde{x} = log \, x - a(\boldsymbol{p}) - log \, m_{\mathrm{HH}}(\boldsymbol{p}, \boldsymbol{z_{HH}}) \quad (6.13a)$$

$$m_{\mathrm{HH}}(\boldsymbol{p}, \boldsymbol{z_{HH}}) = (n_a + \kappa_1 n_{k1} + \kappa_2 n_{k2} + \kappa_3 n_{k3})^{(1-\theta)} \left(\prod_{g=1}^{n_g} p_g^{\nu_g} \right)^{n_k} \quad (6.13b)$$

ii) PS-AIDS Estimated Scales

The $\kappa_1, \kappa_2, \kappa_3$ and θ and ν_g can be estimated from the budget shares resulting from the PS-AIDS cost function which are nested in the PS-QAIDS budget shares above when $\lambda_g = 0$ for all g = 1 to n_g. Testing whether PS-QAIDS is an improvement on PS-AIDS can be preformed by a log likelihood ratio test.

iii) Generalised Barten-QAIDS Estimated Scales

An alternate method of estimating the parameters of equivalence scales in demand systems is the Barten method, where the equivalence scale multiplies prices in a demand system $p_i^{h*} = p_i m_i^h$. This study estimates "generalised" Barten scales, where $m_i^h = m_{BAR}^h$ for all i = 1 to 9 broad expenditure groups, using the QAIDS demand system with budget shares

$$s_i = \alpha_i + \sum_j \gamma_{ij} \, log \, p_j^* + \beta_i \left[ln(x) - a\left(\boldsymbol{p}^*\right) \right] + \lambda_i \prod_k p_k^{*\lambda_k - \beta_k} \left[ln\left(x - a\left(\boldsymbol{p}^*\right) \right) \right]^2 \tag{6.14}$$

where $p_g^* = p_g \left(n_a + \kappa_1 n_{k1} + \kappa_2 n_{k2} + \kappa_3 n_{k3} \right)^{(1-\theta)}$ and the $\kappa_1, \kappa_2, \kappa_3$ and θ can be recovered in estimation of the budget shares.

iv) Generalised Barten-AIDS Estimated Scales

The Barten-AIDS equivalence scale is recovered from estimating AIDS budget shares upon Barten scaled prices, which are nested in the Barten-QAIDS budget shares (6.14) above when $\lambda_g = 0$ for all g = 1 to n_g.

v) Engel-Quadratic Estimated Scales

Engel scales are estimated such that two households with the same scaled equivalent expenditure have identical budget shares of food. The Engel model is not normally formally specified in utility framework, since the households cost function is only defined over food expenditure and does not easily allow the estimation of a full demand system. The following specification of a single budget share demand for food, as a quadratic function of real scaled total expenditure,

$$s_f = \nu_f n_k + \alpha_i + \sum_g \gamma_{fg}\, log(p_g) + \beta_f\, log(\tilde{x}^E) + \lambda_f \left[log(\tilde{x}^E)\right]^2 \qquad (6.15)$$

where,

$$log\,\tilde{x}_{ENG} = log\,x - log\,P_{Stone} - log(n_a + \kappa_1 n_{k1} + \kappa_2 n_{k2} + \kappa_3 n_{k3})^{(1-\theta)} - n_k \nu_f\, log(p_f) \qquad (6.16)$$

allows $\kappa_1, \kappa_2, \kappa_3$, θ, and ν_f to be estimated. Stone's price index for each household *h*, is given in logarithmic form by the $\log P_{Stone} = \sum_g s_g \log p_g$ where s_g are the budget shares observed for each household from the data. Solving $s_f^h = s_f^R$ for the equivalence scale gives the form of the quadratic Engel scale,

vi) Engel-Linear Estimated Scales

Engel Linear estimated scales are recovered in a similar way as the quadratic Engel scales by estimating the linear version of 6.15 and 6.16 by imposing $\lambda_g = 0$ for all g = 1 to n_g.

vii) "Common" Scale

Another form of the equivalence scale commonly imposed in inequality studies[5] has been to specify the scale as the square-root of the number of adults plus 0.5 for each child, thus $\kappa_1 = \kappa_2 = \kappa_3 = 0.5$ and $\theta = 0.5$.

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[5] For example Barrett Crosslet and Worswick (2000)

viii) OECD Scale

The OECD scale is used in many of the Luxembourg Income Studies (LIS) studies is specified as $\kappa_1 = \kappa_2 = \kappa_3 = 0.5$, with each additional adult counting as 0.7 of the first, thus θ, the measure of economies is not applicable for this scale.

ix) Per Capita

Specifying $\kappa_1 = \kappa_2 = \kappa_3 = 1,\;\; \theta = 0$ results in a scale where all individuals in the household have identical weighting and thus scaling the measure of household welfare by this scale results in a per capita measure per household.

x) Per Household (no equivalence scale)

If $\theta = 1$ then $m_{\mathrm{HH}}(1, z_{HH}) = 1$ scaling household income or expenditure by the scale results in household income or expenditure as the measure of welfare.

6.2.3 Generalised Cost Scaling Test of *IB*

The analysis of demand identifies preferences conditional on household demographics, while welfare comparisons between households depends on the joint preferences of goods and household demographics. If the equivalence scales are specified independent of the base utility level (*IB*) then equivalence scales can be completely recovered and used to make comparisons across households of different household size and composition. A violation of *IB* does not allow the recovery of equivalence scales across household types, since their estimation is based upon expenditure behaviour in light of prices but ignores the interaction of utility with demographics as first noted by Pollak and Wales (1979). It does however provide information about the movement of the scales over time due to changes in prices as demonstrated by Blundell and Lewbel (1991), see Section 4.1.2.1.

The price scaled equivalence scale used in the majority of the analysis in this study is specified as *IB* equivalence scale. However the thesis also examines the validity of the *IB* property with respect to dependents for Australia and Canada using the HES and FES respectively, over a long time frame with significant price variation. The Price scaling technique (PS) of Ray (1983) is actually a specific case of Ray's (1986) Generalised Cost Scaling (GCS) discussed in 4.1.2.11, which enforces the IB assumption. By applying GCS to the rank-2 demand system AIDS, giving GCS-AIDS, which nests PS-AIDS, a test of the *IB* property is obtained under rank-2 preferences by comparing the restricted and unrestricted version of the model.

The GCS equivalence scale is specified as

$$m_{CGS}(u,\boldsymbol{p}_h,\boldsymbol{z}_h) = m_{PS}(\boldsymbol{p},\boldsymbol{z})m_{UZ}(\boldsymbol{z},u), \tag{6.17}$$

where $m_{PS}(\boldsymbol{p},\boldsymbol{z})$ is specified as the price scaled household equivalence scale and $m_{UZ}(\boldsymbol{z},u)$ as $m_{UZ}(n_k,u) = e^{\nu_0 n_k u}$ to test the independence of the scale to reference utility with respect to number of dependents. This results in GCS-AIDS budget shares for the test:

$$s_i = \nu_i n_k + \alpha_i + \sum_g \gamma_{ig} \log p_g + \frac{\beta_i \prod p_g^{\beta_g}}{\nu_0 n_k + \prod p_g^{\beta_g}} \log \tilde{x} \tag{6.18}$$

The parameter ν_0 allows the scale to vary with reference utility by he number of dependents but violates *IB*. Thus testing whether ν_0 is equal to zero can be used to test for *IB*.

The GCS technique can also be applied to QAIDS cost function giving the GCS-QAIDS cost function,

$$x_R = c_R(u,\boldsymbol{p}) = e^{\left[a(p)+\frac{ub(p)}{1-uc(p)}\right]} \times m_{PS}(\boldsymbol{p},\boldsymbol{z}) \times m_{UZ}(\boldsymbol{z},u) \tag{6.19}$$

which nests PS-QAIDS when $m_{UZ}(\boldsymbol{z},u)=1$. Specifying $m_{UZ}(n_k,u)=e^{\nu_0 n_k u}$ allows the independence of the equivalence scale $m_{CGS}(u,\boldsymbol{p}_h,\boldsymbol{z}_h)$ to base utility (*IB*), to be examined by testing whether ν_0 is equal to zero. The GCS-QAIDS budget shares are given by the following non-linear equations,

$$s_i = \nu_i n_k + \alpha_i + \sum_g \gamma_{ig} \, log \, p_g$$
$$+ \frac{\left[-\nu_0 \, n_k - b(\boldsymbol{p}) + c(\boldsymbol{p}) log(\tilde{x})\right]\beta_i + \left[2\nu_0 \, n_k b(\boldsymbol{p}) + b(\boldsymbol{p})^2 + (\nu_0 \, n_k \text{ - } c(\boldsymbol{p}) log(\tilde{x}))^2\right]\lambda_i}{2\, b(\boldsymbol{p}) c(\boldsymbol{p})}$$
$$+ \frac{\sqrt{(\nu_0 \, n_k + b(\boldsymbol{p}) + c(\boldsymbol{p}) log(\tilde{x}))^2 - 4\nu_0 n_k c(\boldsymbol{p}) log(\tilde{x})}\left(\beta_i c(\boldsymbol{p}) - (\nu_0 \, n_k + b(\boldsymbol{p}) - c(\boldsymbol{p}) log(\tilde{x}))\lambda_i\right)}{2\, b(\boldsymbol{p}) c(\boldsymbol{p})^2} \quad (6.20)$$

which collapses to PS-QAIDS for $\nu_0 = 0$. Unfortunately estimation of the GCS-QAIDS would not converge under a range of estimation techniques and parameter starting values.

6.3 Estimated Equivalence Scales and IB Tests

6.3.1 Australian and Canadian Equivalence Scale Estimates

Table 6.1 provides the parameters of the six estimated Australian equivalence scales and their standard errors[6]. The lower half of the table provides the log likelihood value of the estimated models, and the χ^2 test of linear restrictions nested in the PS-QAIDS, (Generalised) Barten-QAIDS and Quadratic Engel models respectively. The models that are quadratic in log expenditure, as a whole preform better than their linear counterparts as evidenced by the rejection of the linear restrictions. The equivalence scale parameters however do not differ significantly between the quadratic and linear version of the PS, Barten and Engel scales, suggesting that although rejected by the data, the assumption of linearity does not

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[6] Appendix Tables 6.1 to 6.4 contain the full parameter estimates and standard errors of the PS-AIDS, GCS-AIDS and PS-QAIDS for Australia.

impact on equivalence scales for Australia. All parameter estimates are significant at the 5% level, except for the two Engel estimates for the adult equivalent cost of a child under five years. Thee Engel model yields very low estimates compared to Binh and Whiteford's (1990) and Lancaster and Ray's (1998) traditional Engel estimates for young children based upon the 1984 and 1988-89 HES. The relatively large budget share for takeaway and restaurant food in the later HES surveys included in this study has resulted in the increased food needs of young children being offset by the reduction in takeaway and restaurant food spending of parents. The Engel estimates for the adult equivalent cost of a child aged five to fifteen years of approximately 40% are in line with Binh and Whiteford (1990) and Lancaster and Ray (1998). This study's Engel estimate for the adult equivalent cost of older dependents is slightly lower than Whiteford (1990) and Lancaster and Ray (1998). However the estimates for dependents aged over 15 are not directly comparable to the previous Australian estimates for dependents aged 16 to 17 years.[7]

Table 6.1 Australian Estimated Equivalence Scale Parameters

Equivalence Scale Parameters	PS QAIDS	PS AIDS	Barten QAIDS	Barten AIDS	Engel Quadratic	Engel Linear
κ_1	0.294 (.033)	0.303 (.045)	0.383 (.024)	0.353 (.027)	0.040 (.029)	0.026 (.030)
κ_2	0.448 (.033)	0.488 (.049)	0.577 (.020)	0.556 (.022)	0.417 (.036)	0.406 (.040)
κ_3	0.607 (.047)	0.649 (.060)	0.756 (.042)	0.719 (.046)	0.668 (.051)	0.665 (.055)
θ	0.370 (.006)	0.367 (.008)	0.353 (.006)	0.360 (.007)	0.026 (.010)	0.040 (.011)
Log Likelihood	1,149,264	1,148,301	1,148,615	1,147,687	137,341	137,303
Chi Stat	1,927		1,857		76	
Chi Crit	15.51 {df=8, α=5%}		15.51 {df=8, α=5%}		3.84 {df=1, α=5%}	

Notes: Figures in ( ) denotes standard errors

[7] The inclusion of dependent students in this study is likely to explain the lower estimate as they may consume more food away from home that might not have been recorded in the HES.

The generalised Barten AIDS and QAIDS models used in this study that allow for economies of scale, preform reasonably well and provide similar estimates to their PS counter parts[8]. This is in contrast to the results of Muellbauer (1977) for the UK and Lancaster and Ray (1998) for Australia, who found implausibly low equivalence scale estimates for children using the Barten model. An attempt to estimate the Barten AIDS without economies of scale encountered severe convergence problems. This may suggest that without the inclusion of economies of scale, the Barten scale does not model the behaviour of the households in the HES and FES data very well. The inclusion of economies of scale in the Barten model allows for a smaller influence of children on the m_{BAR}, and may rectify its previous empirical failures[9]. The economies of scale estimate θ of approximately 0.36 is highly significant for the Barten and PS models implying that a three adult household in Australia requires twice as much expenditure as a single adult household to attain the same level of utility.

The implied equivalence scales for a selection of household types for the six estimated scales for Australia and the OECD and "Common" scale are provided in Table 6.2[10]. The Engel scales based on food expenditure estimate larger costs of children and little economies of scale in food consumption and thus exhibit larger scales than the Barten or PS scales especially for large households. The general Barten scales provide lower costs of children when the economies of scale is considered, than the food based Engel scales, as frequently reported in other studies, in line with Muellbauer (1977) and Lancaster and Ray (1998). However the Barten

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[8] Recall that the generalised Barten scale used in this thesis is specified as $m^h_{BAR} = m^h_i$ for all i=1 to n_g.

[9] The indirect or quasi-price effects of children on the m_{BAR} via scaling prices has resulted in low scales for goods which the price elasticities are low. The economies of scale parameter, allows the adult equivalent cost of a child to be estimated relative to an adult living alone. In light of the fact that the household does not have to bare the full burden of this cost as a whole due to economies of scale in household size, it reduces the indirect effect of children in the Barten scale.

scales in this study imply a slightly higher cost of children, relative to adults than the PS scales in contrast to Lancaster and Ray's (1998) results from an AIDS model that ignored cross price effects due to insufficient price variation. The PS QAIDS scales estimated here imply similar cost of children as a proportion of an adult couple of 14% for children aged five to fifteen than that estimated by Lancaster and Ray (1998) for a restricted QAIDS model for Australian of 14.5%.

Table 6.2 Australian Estimated Equivalence Scales [1]

Household Type [2]				PS QAIDS	PS AIDS	Barten QAIDS	Barten AIDS	Engel Quadratic	Engel Linear	OECD	Common
n_a	n_{k1}	n_{k2}	n_{k3}								
1	0	0	0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1	1	0	0	1.18	1.18	1.23	1.21	1.04	1.03	1.50	1.41
1	0	1	0	1.26	1.29	1.34	1.33	1.40	1.39	1.50	1.41
1	0	0	1	1.35	1.37	1.44	1.41	1.65	1.63	1.50	1.41
1	1	1	1	1.71	1.76	1.91	1.86	2.08	2.04	2.50	2.00
2	0	0	0	1.55	1.55	1.57	1.56	1.96	1.95	1.70	1.41
2	1	0	0	1.69	1.70	1.75	1.73	2.00	1.97	2.20	1.73
2	0	1	0	1.76	1.78	1.84	1.82	2.36	2.32	2.20	1.73
2	0	0	1	1.83	1.85	1.93	1.90	2.60	2.56	2.20	1.73
2	1	1	1	2.14	2.19	2.34	2.28	3.03	2.96	3.20	2.24
2	0	2	0	1.95	1.99	2.10	2.07	2.76	2.70	2.70	2.00
2	1	2	0	2.08	2.12	2.26	2.21	2.79	2.72	2.70	2.24
2	1	2	1	2.32	2.38	2.57	2.50	3.43	3.33	3.70	2.45
3	0	0	0	2.00	2.00	2.03	2.02	2.91	2.87	2.40	1.73
4	0	0	0	2.39	2.41	2.45	2.43	3.86	3.78	3.10	2.00

Notes: 1. Equivalence scale is given by $\left(n_a + \kappa_1 n_{k1} + \kappa_2 n_{k2} + \kappa_3 n_{k3}\right)^{(1-\theta)}$ and is normalized at unity for a single adult household.

2. n_a is the number of adults in the household.

n_{k1} is the number of children aged less than five years in the household.

n_{k2} is the number of children aged five and under fifteen years in the household.

n_{k3} is the number of dependents aged fifteen years and over in the household.

Table 6.3 provides the parameters of the six estimated Canadian equivalence scales and their standard errors[11]. The lower portion of Table 6.3 demonstrates that models that are quadratic in log expenditure, as a whole preform better than their linear counterparts as evidenced by the rejection of the linear restrictions by the log likelihood test and the higher standard errors of the linear equivalence scale

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[10] Recall that the Common Scale is specified as $\kappa_1 = \kappa_2 = \kappa_3 = 0.5$ and $\theta = 0.5$.

parameters. In contrast to the Australian results there is significant difference between the linear and quadratic models in their estimates for adult equivalent cost of a child, revising the cost downwards for the demand system estimates. The estimate of economies of scale for Canadian households is larger than the Australian estimate and approximately 0.5. This is in line with Barrett and Crossley and Worswick (1999) who impose such a level of economies of scale in their Australian inequality study, termed the "Common" scale in this study.

Table 6.3 Canadian Estimated Equivalence Scale Parameters

Equivalence Scale Parameters	PS QAIDS	PS AIDS	Barten QAIDS	Barten AIDS	Engel Quadratic	Engel Linear
κ_1	0.208 (.035)	0.441 (.051)	0.430 (.030)	0.525 (.036)	0.058 (.028)	-0.077 (.028)
κ_2	0.410 (.033)	0.631 (.052)	0.687 (.021)	0.725 (.025)	0.646 (.032)	0.450 (.036)
κ_3	0.507 (.054)	0.716 (.073)	0.783 (.049)	0.805 (.057)	0.994 (.050)	0.826 (.061)
θ	0.459 (.005)	0.474 (.006)	0.444 (.005)	0.471 (.006)	0.117 (.007)	0.164 (.008)
Log Likelihood	1,491,253	1,490,720	1,490,366	1,489,865	175,339	175,137
Chi Stat	1,066		1,002		404	
Chi Crit	15.51 {df=8, α=5%}		15.51 {df=8, α=5%}		3.84 {df=1, α=5%}	

Notes: Figures in ( ) denotes standard errors.

Table 6.4 illustrates the implied equivalence scales for a selection of household types for the six estimated scales for Canada and the OECD and "Common" scale. The OECD and Engel scale provide higher equivalence scales for children and large households due to their lower level of economies of scale, than the AIDS and QAIDS scales. The "Common" scale used by Pendakur (1998) in studying Canadian inequality correlates rather closely to the demand system estimated equivalence scales. The PS AIDS equivalence scales implies that the cost of a child aged 4 to under 16 years is 29% of lone adult for single parent families,

[11] Appendix Tables 6.5 to 6.8 contain the full parameter estimates and standard errors of the PS-AIDS, GCS-AIDS and PS-QAIDS for Canada.

while a child for an adult couple increases the scale by 16%, due to the economies of scale of household size. These results are similar to Nichol (1994) whose estimates imply that the cost of a child is 21% of an adult urban couple, with increasing cost for extra children, while Phipps (1998) estimate was 15.5%, with the cost declining with extra children. The PS QAIDS estimates are lower than the Rank-2 demand systems yielding an 11% increase in the equivalence scale for both single adult and two adult households with the addition of a child aged 4 to under 16 years.

Table 6.4 Canadian Estimated Implied Equivalence Scales [1]

Household Type [2]				PS QAIDS	PS AIDS	Barten QAIDS	Barten AIDS	Engel Quadratic	Engel Linear	OECD	Common
n_a	n_{k1}	n_{k2}	n_{k3}								
1	0	0	0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1	1	0	0	1.11	1.21	1.22	1.25	1.05	0.94	1.50	1.41
1	0	1	0	1.20	1.29	1.34	1.33	1.55	1.36	1.50	1.41
1	0	0	1	1.25	1.33	1.38	1.37	1.84	1.65	1.50	1.41
1	1	1	1	1.50	1.72	1.81	1.81	2.40	1.93	2.50	2.00
2	0	0	0	1.45	1.44	1.47	1.44	1.84	1.78	1.70	1.41
2	1	0	0	1.53	1.60	1.64	1.63	1.89	1.73	2.20	1.73
2	0	1	0	1.61	1.66	1.73	1.70	2.36	2.11	2.20	1.73
2	0	0	1	1.64	1.69	1.77	1.73	2.63	2.38	2.20	1.73
2	1	1	1	1.85	2.02	2.13	2.10	3.17	2.64	3.20	2.24
2	0	2	0	1.75	1.86	1.97	1.93	2.86	2.43	2.70	2.00
2	1	2	0	1.82	1.99	2.10	2.07	2.91	2.38	2.70	2.24
2	1	2	1	1.98	2.19	2.33	2.29	3.66	2.95	3.70	2.45
3	0	0	0	1.81	1.78	1.84	1.79	2.64	2.50	2.40	1.73
4	0	0	0	2.12	2.07	2.16	2.08	3.40	3.19	3.10	2.00

Notes: 1. Equivalence scale is given by $\left(n_a + \kappa_1 n_{k1} + \kappa_2 n_{k2} + \kappa_3 n_{k3}\right)^{(1-\theta)}$ and is normalized at unity for a single adult household.
2. n_a is the number of adults in the household.
n_{k1} is the number of children aged less than five years in the household.
n_{k2} is the number of children aged five and under fifteen years in the household.
n_{k3} is the number of dependents aged fifteen years and over in the household.

The relative cost of children seems higher for Australia than Canada. However care must be taken in such comparisons due to the different child categories used for each country. The second child category, n_{k2}, with parameter, κ_2 is roughly comparable between the countries, the category for Canada including 4 and 15-year old children in addition to the Australian category of children aged 5 to 14 years. Considering this we would expect, all else remaining the same, that estimates for κ_2

for Canada would be higher than for Australia, since the extra cost of the inclusion of 15-year olds, is likely to dominate the lower cost of 4-year olds. Since the opposite is true it does appear that relative to an adult, children ‘cost’ more in Australia. The estimated scales while quite similar for the two countries for small households with one adult, the scales for Australia are greater for larger households due to the smaller economies of scale estimate of approximately 0.36 compared to 0.46 for Canada. To some extent the lower equivalence scales estimates may be explained by the slightly larger household sizes and larger number of children recorded in the HES compared to the FES. For both Canada and Australia the Engel, and OECD scales are higher than the demand system based scales and are likely to reduce the equivalent measures of welfare for larger families by a greater degree than the demand system based estimates.

6.3.2 Tests of the IB (independent of base utility) Assumption

Table 6.5 gives the estimates of the parameters ν_0 in the GCS-AIDS framework that allows a test of the *IB* property in reference to whether the base utility is independent of the number of children. If the parameter is not equal to zero then the estimated equivalence scales will not be independent of base utility (*IB*).

Table 6.5 Tests of the IB parameter for Australia and Canada

	Australia	**Canada**
	ν_0	ν_0
Estimate	0.0246	0.0321
Std error	(.0050)	(.0043)
T-ratio	4.9263	7.4889
CGS-AIDS LLF	1,148,313	1,490,742
PS-AIDS LLF	1,148,301	1,490,720
Chi Stat	24.1	44.7
Chi Crit	3.84 {df=1, α=5%}	3.84 {df=1, α=5%}

For both Australia and Canada the estimate of the ν_0 parameter is significantly different from zero, suggesting that the equivalence scale is dependent of the base utility of the equivalence scale, when the rank-2 model of AIDS is considered. The log likelihood test of the IB restriction also confirms the result that the equivalence scale depends upon the reference level of utility in the CGS-AIDS model. This result is in line with the rejection of *IB* for UK data by Ray (1986) using CGS-AIDS. Efforts to estimate a GCS-QAIDS, as specified in equation 6.20, encountered convergence problems in estimation and so tests of IB in rank-3 framework were unobtainable.

If the *IB* assumption does not hold then demand system estimation across periods (with significant price variation) can only completely recover the movement in the equivalence scale overtime, not the difference in the scale across households of different demographics, see Section 4.1.2.11 and Blundell and Lewbel (1991). When IB does not hold, specifying a particular value for the equivalence scale for reference prices and reference demographics[12], the choice of functional form of the equivalence scale and cost function essentially determine the value equivalence scale for non-reference households. All welfare comparisons from the non-IB scale are made in terms of the reference household's preferences as the base utility is implicitly set at the reference household's. The QAIDS cost function and equivalence scale specified in this study allow a certain amount of flexibility in the estimation of equivalence scales. With the violation of *IB* reported in this section however, it must be acknowledged that the welfare comparisons across households preformed in the study of inequality in Chapters 7 and 8 are based upon the reference household's preferences and the specification of cost function and equivalence scale.

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[12] The reference household for this study is a single adult household, with an equivalence scale of unity and the functional form of the equivalence scale is given by equation (6.11).

6.4 The QAIDS Cost of Living Index

Little or no attention has been paid in Australia or Canada to developing or incorporating the cost of living indices (CLI) in measuring real welfare. Previous Australian or Canadian studies have used the national CPI from their respective statistical authorities[13]. This study derives the PS-QAIDS cost of living index (CLI) from the demographic price scaled QAIDS cost function specified in Section 6.2,

$$\begin{aligned} c_h(u,\boldsymbol{p},\boldsymbol{z}) &= c_R(u,\boldsymbol{p}) \times m_{PS}(\boldsymbol{p},\boldsymbol{z}) \\ &= exp\left[a(\boldsymbol{p}) + \frac{ub(\boldsymbol{p})}{1-uc(\boldsymbol{p})}\right] \times \left(n_a + \kappa_1 n_{k1} + \kappa_2 n_{k2} + \kappa_3 n_{k3}\right)^{(1-\theta)} \left(\prod_{g=1}^{n_g} p_g^{\nu_g}\right)^{n_k} . \end{aligned} \tag{6.21}$$

This yields the demographic-QAIDS CLI from applying the CLI definition in Section 4.2.1 and is as follows,

$$\begin{aligned} CLI &= \frac{exp\left[a(\boldsymbol{p_1}) + \frac{u_0 b(\boldsymbol{p_1})}{1-u_0 c(\boldsymbol{p_1})}\right] \times \left(n_a + \kappa_1 n_{k1} + \kappa_2 n_{k2} + \kappa_3 n_{k3}\right)^{(1-\theta)} \left(\prod_{g=1}^{n_g} p_g^{\nu_g}\right)^{n_k}}{exp\left[a(\boldsymbol{p_0}) + \frac{u_0 b(\boldsymbol{p_0})}{1-u_0 c(\boldsymbol{p_0})}\right] \times \left(n_a + \kappa_1 n_{k1} + \kappa_2 n_{k2} + \kappa_3 n_{k3}\right)^{(1-\theta)} \left(\prod_{g=1}^{n_g} p_g^{\nu_g}\right)^{n_k}} . \\ &= exp\left[a(\boldsymbol{p_1}) - a(\boldsymbol{p_0})\right] \times exp\left[\frac{u_0 b(\boldsymbol{p_1})}{1-u_0 c(\boldsymbol{p_1})} - \frac{u_0 b(\boldsymbol{p_0})}{1-u_0 c(\boldsymbol{p_0})}\right] \times \prod_g \left(\frac{p_1}{p_0}\right)_g^{\nu_g n_k} \end{aligned} \tag{6.22}$$

The base level of utility u_0 can be obtained as a function of prices, demographics and expenditure by using the PS-QAIDS indirect utility function. The base level of utility is given by

$$u_0 = \log\psi(x_0, \boldsymbol{p_0}) = \frac{\log \tilde{x}_0}{b(\boldsymbol{p_0}) + c(\boldsymbol{p_0}) \log \tilde{x}_0} \tag{6.23}$$

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[13] Crawford (1994) and Smolenksy et. al. (1987) developed CLI for the U.K and U.S respectively. Toh (1994) considered a CLI in the incidence of consumption taxes in Singapore.

where $\widetilde{x}_0$ is the real (deflated by the QAIDS price index $a(\boldsymbol{p_0})$), scaled (by the equivalence scale), such that the natural log of real scaled expenditure in the base period is given by, $log\,\widetilde{x}_0 = log\,x_0 - a(\boldsymbol{p}_0) - log\,m_{GEN}(z_{HH}, \boldsymbol{p}) - log\,m_{REL}(z_{HH}, \boldsymbol{p})$. Substituting in the level of base level of utility into the CLI function gives

$$CLI = exp\left[a(\boldsymbol{p_1}) - a(\boldsymbol{p_0}) + \frac{b(\boldsymbol{p_1})log\,\widetilde{x}_0}{b(\boldsymbol{p_0}) + (c(\boldsymbol{p_0}) - c(\boldsymbol{p_1}))log\,\widetilde{x}_0} - log\,\widetilde{x}_0\right] \times \prod_g \left(\frac{p_1}{p_0}\right)_g^{\nu_g\, n_k}$$

$$= exp\left[a(\boldsymbol{p_1}) - a(\boldsymbol{p_0}) + \frac{(b(\boldsymbol{p_1}) - b(\boldsymbol{p_0}))log\,\widetilde{x}_0 + (c(\boldsymbol{p_1}) - c(\boldsymbol{p_0}))(log\,\widetilde{x}_0)^2}{b(\boldsymbol{p_0}) - (c(\boldsymbol{p_1}) - c(\boldsymbol{p_0}))log\,\widetilde{x}_0}\right] \times \prod_g \left(\frac{p_{1g}}{p_{0g}}\right)^{\nu_g\, n_k} \tag{6.24}$$

If in the base period all prices are unity then

$a(\boldsymbol{p_0}) = \alpha_0$ which is specified as zero in this study[14]

$b(\boldsymbol{p_0}) = 1$

$c(\boldsymbol{p_0}) = 1$

and the CLI can be more easily written as

$$CLI = \underbrace{Exp[a(\boldsymbol{p_1})]}_{(I)} \times \underbrace{Exp\left[\frac{(b(\boldsymbol{p_1}) - 1)log\,\widetilde{x}_0 + (c(\boldsymbol{p_1}) - 1)(log\,\widetilde{x}_0)^2}{1 - (c(\boldsymbol{p_1}) - 1)log\,\widetilde{x}_0}\right]}_{(II)} \times \underbrace{\prod_g (p_{1g})^{\nu_g\, n_k}}_{(III)} . \tag{6.25}$$

The PS-QAIDS can be considered to have three multiplicative parts. The first component of the CLI (I) can be considered the standard income and substitution price effects that are invariant to demographics or household expenditure and shall be termed the 'fixed cost' component of the CLI. The second component (II) is the 'utility' effect of price movements that give the impact of prices of households of varying levels of base level expenditure. The third multiplicative factor (III) is the 'demographic' effect that prices have on households with children. Thus, using the

CLI is likely to be a better indicator of the impact prices on households since it allows for variations depending on a household's level of expenditure and demographics.

6.5 The Effect of Individual Price Changes Upon Measures of Real Welfare

Data on income and more recently expenditure is the most readily available source for an indicator of an individual's or household's level of welfare, w - see Section 2.1 for a discussion of alternate measures of welfare. To take account of price and demographic variation, the measure of welfare, w, is usually scaled by a price index P and equivalence scale m to provide a real equivalent measure $\tilde{w}$.

$$\tilde{w} = \frac{w}{P\,m} \tag{6.26}$$

The effect of price changes on real equivalent welfare can be analysed through price elasticity of welfare with respect to good i, given by

$$\begin{aligned} e_{p_i}^{\tilde{w}} &= \frac{\partial\,\tilde{w}/\tilde{w}}{\partial\,p_i/p_i} \\ &= \frac{\partial w/(P\,m)}{\partial p_i}\frac{p_i}{\tilde{w}} \\ &= -\left(\frac{\partial P}{\partial p_i}\frac{1}{P} + \frac{\partial m}{\partial p_i}\frac{1}{m}\right)\frac{\tilde{w}}{1}\frac{p_i}{\tilde{w}} \\ &= -\left(\frac{\partial P}{\partial p_i}\frac{p_i}{P} + \frac{\partial m}{\partial p_i}\frac{p_i}{m}\right) \end{aligned} \tag{6.27}$$

which is the negative of the sum of the price elasticity of the price index P and equivalence scale m. If the equivalence scale is independent of prices or interaction between prices and demographic is incorporated into the price index, then the elasticity may be written simply as the negative of price elasticity of the price index P.

[14] See footnote 2.

For a fixed weight price index, such as the CPI, the price elasticity of welfare with respect to good i is equal to the product of the weighting given to i, and the price of good i relative to the price index,

$$e_{p_i}^{\widetilde{w}} = weight_i \frac{p_i}{P} \tag{6.28}$$

With fixed price weights, the elasticity of welfare with respect to good g is constant across households and does not allow for income, substitution or demographic effects

Using the QAIDS CLI and incorporating the price-child effects of specified the equivalence scale allows the effect of price movements on households to vary across expenditure levels and the number of children. The construction of the price elasticity of the CLI,

$$e_{p_i}^{CLI} = \frac{\partial CLI/CLI}{\partial p_i / p_i} = \frac{\partial \log CLI}{\partial p_i} \frac{p_i}{1} \tag{6.29}$$

is aided by specifying the log of the CLI

$$log\, CLI = a(\boldsymbol{p_1}) + \frac{(b(\boldsymbol{p_1})-1)[log\,\widetilde{x}_0] + (c(\boldsymbol{p_1})-1)[log\,\widetilde{x}_0]^2}{1-(c(\boldsymbol{p_1})-1)[log\,\widetilde{x}_0]} + n_k \sum_g \nu_g \, log\, p_{1g} \tag{6.30}$$

Differentiating the above and multiplying through by p_i gives the elasticity of the CLI with the respect to the price of good i in three parts,

$$e_{p_i}^{CLI} = (I) + (II) + (III) \tag{6.31}$$

where $$(I) = \alpha_i + \sum \gamma_{ij} \log p_j \tag{6.31a}$$

$$(II) = \frac{\beta_i b(\boldsymbol{p_1}) \log \widetilde{x}_0}{1-(c(\boldsymbol{p_1})-1)\log \widetilde{x}_0} + \frac{\lambda_i c(\boldsymbol{p_1}) b(\boldsymbol{p_1}) (\log \widetilde{x}_0)^2}{[1-(c(\boldsymbol{p_1})-1)\log \widetilde{x}_0]^2} \tag{6.31b}$$

$$(III) = \nu_i n_k \tag{6.31c}$$

and $\log \widetilde{x}_0$, is the real equivalent expenditure in the base period.

The first component of the CLI elasticity (I) can be considered the standard income α_i and substitution $\sum \gamma_{ij} \log p_j$ price effects that are invariant to demographics or household expenditure and shall be termed the 'fixed cost' effect. The second effect (II) is the 'utility' effect of price movements that give the impact of prices of households of varying levels of base level expenditure. The third effect (III) is the 'demographic' effect that prices have on households with children, where n_k is the number of dependents and ν_i is the effect per child of a movement in the price of commodity *i*.

For infinitely small changes in prices in the base period when all prices are unity result in the price elasticity of the CLI simplifying to the budget shares for PS-QAIDS in the base period,

$$e_{p_i}^{CLI} = \alpha_i + \left(\beta_i \, log\, \widetilde{x}_0 + \lambda_i \, log\, \widetilde{x}_0{}^2\right) + \nu_i n_k \qquad (6.32)$$

Although this simplification ignores all substitution effects between commodities it allows the examination of a change in prices from the base period upon the CLI and thus measures of welfare. For households in the dataset, that exist outside the base period, an estimate of their real equivalent expenditure in the base period can be provided by

$$log\, \widetilde{x}_0 = log\, x - a(\boldsymbol{p}) - log\left(n_a + \kappa_1 n_{k1} + \kappa_2 n_{k2} + \kappa_3 n_{k3}\right)^{(1-\theta)} - n_k \sum \nu_g \, log\, p_g \qquad (6.33)$$

Tables 6.6 and 6.7 show the elasticity of the estimated CLI for Australia and Canada respectively, for five equivalent adult expenditure levels, see Appendix Table 6.9 for details on these levels. If measures of welfare are to be converted to real measures using the CLI, then the elasticities in Tables 6.6 and 6.7 give the negative of the elasticity of real welfare. For example the elasticity of food for an Australian Household with average real equivalent expenditure, is 0.19, implying that a 10% increase in the price of food will lead to a increase of the CLI by 1.9% and so reduce a real measures of welfare by 1.9%. Note that the base period elasticities or budget shares sum to unity for each household type

Table 6.6 Australian Price Elasticity of the CLI in the Base Period across Real Equivalent Expenditure

	Price Elasticity of the PS-QIADS CLI for:					Price Elasticity CPI[2]
	Very Low	Low	Average	High	Very High	
Broad Commodity Group	Levels of Real Equivalent Expenditure[1]					
Food and Non Alcoholic Beverages	0.30	0.24	0.19	0.14	0.09	0.18
Accommodation	0.27	0.26	0.26	0.26	0.28	0.29
Electricity and Household Fuel	0.06	0.04	0.02	0.02	0.01	0.02
Clothing and Footwear	0.04	0.05	0.06	0.07	0.07	0.05
Transport	0.09	0.13	0.16	0.19	0.21	0.15
Health and Personal Care	0.07	0.07	0.07	0.06	0.04	0.07
Recreation	0.07	0.10	0.12	0.14	0.16	0.12
Alcohol and Tobacco	0.05	0.06	0.06	0.05	0.03	0.07
Miscellaneous and Education	0.04	0.05	0.06	0.08	0.11	0.04

Notes: 1. Note that the very low, low, average, high and very high real equivalent expenditure in base period price, 1988-89 are based upon the distribution of log expenditures in the 1993-94 HES using the PS-QAIDS a(***p***) price term and equivalence scale.
Source: 2. ABS 6440.0, 2000, A Guide to the Consumer Price Index 14th Series

Table 6.7 Canadian Price Elasticity of the CLI in the Base Period across Real Equivalent Expenditure

	Price Elasticity of the PS-QIADS CLI for:					Price Elasticity CPI[2]
	Very Low	Low	Average	High	Very High	
Broad Commodity Group	Real Equivalent Expenditure[1]					
Food and Non Alcoholic Beverages	0.29	0.24	0.19	0.15	0.11	0.18
Accommodation	0.35	0.34	0.32	0.31	0.30	0.34
Electricity and Household Fuel	0.10	0.07	0.05	0.03	0.02	0.04
Clothing and Footwear	0.04	0.05	0.06	0.07	0.07	0.07
Transport	0.06	0.11	0.15	0.19	0.24	0.17
Health and Personal Care	0.06	0.06	0.06	0.05	0.05	0.04
Recreation	0.04	0.05	0.07	0.09	0.10	0.08
Alcohol and Tobacco	0.04	0.05	0.05	0.05	0.05	0.05
Miscellaneous and Education	0.02	0.03	0.04	0.05	0.06	0.02

Notes: 1. Note that the very low, low, average, high and very high real equivalent expenditure in base period price, 1988-89 are based upon the distribution of log expenditures in the 1992 FES using the PS-QAIDS a(***p***) price term and equivalence scale.
Source: 2. SC 62-557-XPB96001 Your Guide to the Consumer Price Index 62F0014MIB No. 13 Analytical Series Price Division: Comparative Study of Analytical Price indexes for Different Subgroups of Reference Population Tables 3 and C.

For both countries there is significant variation in the effect that changes in food prices have upon households across real equivalent expenditure. The impact upon households with very low levels of real equivalent expenditure is almost 3 times that for a household with very high level of real equivalent spending. Even more dramatic for both counties is the variation of the price elasticity for electricity and household fuel across households with different totals of real equivalent expenditure. Price movements in electricity and household fuel have about 5 to 6 times as much impact on households with a very low total expenditure compared to those with a very high total. The effect of rises in the prices of health and personal care products also rises with real expenditure for both countries, but to a much lesser degree than for food or electricity and household fuel.

The impact of price rises in accommodation has a large effect across households for all levels of real equivalent expenditure since accommodation consumes a large proportion of the household budget. The effect is greater in Canada since accommodation spending, as a proportion of total expenditure, is generally larger. Note that the rank-3 demand system allows for goods to change from necessities to luxuries and back again across levels as expenditure changes, as evident in Australia, where households with a very low or high level of real equivalent expenditure, spending a greater share of their budget on accommodation.

The impact of price movements in clothing and footwear, transport, recreation and miscellaneous and education upon the CLI, increases as real equivalent expenditure increases for both Australia and Canada, the opposite to food, electricity and personal care. The elasticities for transport and recreation vary considerably across spending levels, especially for Canada. The elasticity of the CLI with respect to alcohol and tobacco is relatively constant across real equivalent expenditure for Canada but for Australia, changes in the price of this group impact most heavily upon households with low and average real equivalent expenditure.

The price elasticities of the CPI's with their fixed weights do not vary across adult equivalent expenditure. The elasticities of the CPI's for Australia and Canada in general align with the CLI for households with average levels of household equivalent spending. Although compared to the CLI for an average spending household, it under reports the effect on real welfare of price movements in health and personal care items for Canada and price movements in miscellaneous and education spending for both countries.

Table 6.8 Demographic Variations in the Australian Price Elasticity of the CLI

	(I)+(II)	(III)	(I) +(II)+(III)	
Broad Commodity Group	**Non Demographic Effect for 'Average' Reference HH**	**Demographic Effect per child**	**Total Price Effect for 'Average' HH with 1 child**	**2 children**
Food and Non Alcoholic Beverages	0.19	0.009	0.20	0.21
Accommodation	0.26	-0.002	0.25	0.25
Electricity and Household Fuel	0.02	0.000	0.02	0.03
Clothing and Footwear	0.06	0.003	0.07	0.07
Transport	0.16	-0.002	0.15	0.15
Health and Personal Care	0.07	-0.004	0.06	0.06
Recreation	0.12	-0.004	0.12	0.11
Alcohol and Tobacco	0.06	-0.006	0.05	0.05
Miscellaneous and Education	0.06	0.005	0.07	0.07

Tables 6.8 and 6.9 show how price changes impact upon households of differing demographics in respect to the number of children for Australia and Canada respectively. The effect of price changes for households with children, on whole is not that much different to a household without children. This is probably due to the broad commodity grouping specified. Further disaggregation of the commodity groups may allow greater child-price effects to be identified in the demand system estimation. Not surprisingly the most significant impact of children is upon food expenditure in a household. The elasticity of the CLI with respect to food is approximately 0.01 higher per child for Australia and Canada. Also consistent for

both Australia and Canada is the decline in the impact of price rises in alcohol and tobacco for households with children relative to childless households.

Table 6.9 Demographic Variations in the Canadian Price Elasticity of the CLI

	(I)+(II)	(III)	(I) +(II)+(III)	
	Non Demographic Effect for 'Average' Reference HH	Demographic Effect per child	Total Price Effect for 'Average' HH with	
Broad Commodity Group			**1 child**	**2 children**
Food and Non Alcoholic Beverages	0.19	0.012	0.20	0.22
Accommodation	0.32	-0.004	0.32	0.31
Electricity and Household Fuel	0.05	0.001	0.05	0.05
Clothing and Footwear	0.06	0.004	0.06	0.07
Transport	0.15	-0.008	0.14	0.13
Health and Personal Care	0.06	0.000	0.06	0.06
Recreation	0.07	0.000	0.07	0.07
Alcohol and Tobacco	0.05	-0.004	0.05	0.04
Miscellaneous and Education	0.04	0.000	0.04	0.04

6.6 Empirical Price Effects upon the PS-QAIDS CLI

Analysing the change in a CLI allows the inflation in the cost of living for households to be examined. Since the PS-QAIDS CLI varies for expenditure levels and demographics, namely children in this study, movements in the CLI over time can be broken into the fixed cost effects, base utility effects and demographic effects. This section examines the movements in the CLI due to the changes in prices in Australia from 1975-76 to 1998-99 and Canada from 1978 to 1992.

Tables 6.10 and 6.11 show the PS-QAIDS cost of living and consumer price indices and annual inflation rates for the survey periods for Australia and Canada respectively. While there are important differences between the CLI's for the five levels of equivalent adult expenditure within the periods, the rate of inflation over the entire survey periods are only mildly higher for higher spending households.

In Australia from 1975-76 to 1984 price movements impacted more on households with lower levels of per equivalent adult expenditure, chiefly due to the large increase in the price of electricity and fuel over the period, despite it's relatively low budget share. From 1984 through to 1998-99 price movements have impacted more heavily on households with higher levels of per equivalent adult expenditure. Particularly from 1988-89 to 1993-94 the PS-QAIDS CLI reports an inflation rate of 4.8% for high spending households with weekly adult equivalent expenditure of $543 (1988-89 dollars) compared to 4.3% for very low spending household with $123 weekly adult equivalent expenditure. Large relative increases in the price of education and miscellaneous commodities from 1984 were chiefly responsible for the higher rate of inflation for high spending households.

In Canada price movements from 1978 to 1982 and 1986 to 1992 impacted most heavily upon households with higher levels of spending. A principal reason for this was the relatively large increase in the price of transport from 1978 to 1982 and recreation from 1986 to 1992 in Canada.

Table 6.10 Australian PS-QAIDS CLI and CPI

	CLI for Real Equivalent Expenditure					
	Very Low	**Low**	**Average**	**High**	**Very High**	**CPI**
1975-76	0.324	0.325	0.325	0.326	0.326	0.351
1984	0.723	0.721	0.719	0.716	0.714	0.704
1988-89	1.000	1.000	1.000	1.000	1.000	1.000
1993-94	1.231	1.243	1.253	1.262	1.269	1.192
1998-99	1.368	1.384	1.398	1.408	1.416	1.316
	Average Annualised Rate of Inflation					
1975-76 to 1984	9.9%	9.8%	9.8%	9.7%	9.7%	8.5%
1984 to 1988-89	7.5%	7.5%	7.6%	7.7%	7.8%	8.1%
1988-89 to 1993-94	4.3%	4.4%	4.6%	4.8%	4.9%	3.6%
1993-94 to 1998-99	2.1%	2.2%	2.2%	2.2%	2.2%	2.0%
1975-76 to 1998-99	6.5%	6.5%	6.5%	6.6%	6.6%	5.9%

Table 6.11 Canadian PS-QAIDS CLI and CPI

	CLI for Real Equivalent Expenditure					
	Very Low	**Low**	**Average**	**High**	**Very High**	**CPI**
1978	0.487	0.485	0.483	0.482	0.481	0.502
1982	0.771	0.769	0.768	0.767	0.767	0.751
1986	0.923	0.922	0.921	0.920	0.919	0.899
1992	1.176	1.178	1.179	1.178	1.177	1.151
	Average Annualised Rate of Inflation					
1978 to 1982	12.2%	12.2%	12.3%	12.3%	12.4%	10.6%
1982 to 1986	4.6%	4.6%	4.6%	4.6%	4.6%	4.6%
1986 to 1992	6.2%	6.3%	6.4%	6.4%	6.4%	6.4%
1978 to 1992	6.5%	6.5%	6.6%	6.6%	6.6%	6.1%

Compared to the PS-QAIDS CLI, the CPI seems to under predict the effect price increases have on households across the survey periods for Australia. This was due to the higher weight given to accommodation in the CPI than the CLI. The smaller relative price rises in accommodation across the survey periods from 1975-76 to 1984 and 1988-89 to 1998-98, resulting in the lower CPI inflation periods across these periods. The Canadian CPI also reports a lower rate of inflation than the PS-QAIDS CLI from 1978-1982, but reports similar inflation rates to the CLI of average households from 1982 to 1992. The difference from 1978 to 1982 between the two measures is chiefly the result of the lower weight given to transport by SC in their CPI compared to the CLI and the relative high price rises over that period.

Tables 6.12 and 6.13 show the multiplicative; substitution, income and demographic effects for households with average log equivalent spending, from the price rises experienced by Australia and Canada respectively. The lower half of each table provides the implied rate of inflation, of the average income effect (that is ignoring the substitution effect), the CLI for average households, the CLI for a household with two dependents and the CPI for reference.

The broad level substitution effect in Australia was quite large for 1975-76, raising the CLI by approximately 20% from the average income effect. Thus reducing the difference in prices in 1975-76 and the reference period that would have occurred had the substitution effect been ignored. The substitution effect was much smaller in 1984 and zero in the reference period when there is no substitution, since it is the yardstick to which substitution is measured. Ignoring the substitution effects on the PS-QAIDS CLI results in an overstated rate of inflation from 1975-76 to 1984, of 11.9% compared to 9.8%, and 8.1% compared to 7.6% from 1984 to 1988-89. The CPI from the ABS reports a much lower level of inflation from 1975-76 to 1984 of 8.5% and may have captured more substitution effects through the significant re-weighting and revision that occurred in the 9th review of the CPI in September 1976. From 1984 to 1988-89 the CPI appears to overstate the rate of inflation as suggested by the PS-QAIDS CLI in the absence of substitution effects. Interestingly from 1988-89 the CLI suggests that households have slightly substituted towards the broad expenditure commodities for which the price rises have been largest.

Table 6.12 Substitution, Income and Demographic Effects of Australian Price Movements 1975-76 to 1998-99

	Substitution Effect	x	Average Income Effect	=	CLI	Demographic Effect per Dependent	CLI with Two Dependents	CPI
1975-76	1.204		0.270		0.325	1.001	0.326	0.351
1984	1.022		0.703		0.719	1.000	0.718	0.704
1988-89	1.000		1.000		1.000	1.000	1.000	1.000
1993-94	1.007		1.244		1.253	0.999	1.249	1.192
1998-99	1.013		1.379		1.398	0.998	1.393	1.316
			Average Annualised Rate of Inflation					
1975-76 to 1984			11.9%		9.8%		9.7%	8.5%
1984 to 1988-89			8.1%		7.6%		7.6%	8.1%
1988-89 to 1993-94			4.5%		4.6%		4.6%	3.6%
1993-94 to 1998-99			2.1%		2.2%		2.2%	2.0%
1975-76 to 1998-99			7.3%		6.5%		6.5%	5.9%

Table 6.13 Substitution, Income and Demographic Effects of Canadian Price Movements 1978 to 1992

	Substitution Effect	x	Average Income Effect	=	CLI	Demographic Effect per Dependent	CLI with Two Dependents	CPI
1978	1.120		0.431		0.483	1.004	0.486	0.500
1982	1.021		0.752		0.768	1.001	0.770	0.750
1986	1.003		0.918		0.921	1.000	0.921	0.900
1992	1.004		1.173		1.179	0.999	1.175	1.150
			Average Annualised Rate of Inflation					
1978 to 1982			14.9%		12.3%		12.2%	10.7%
1982 to 1986			5.1%		4.6%		4.6%	4.7%
1986 to 1992			6.3%		6.4%		6.3%	6.3%
1978 to 1992			7.4%		6.6%		6.5%	6.1%

The size of substitution effects between broad expenditure commodities in Canada follows a similar pattern to Australia, being largest at about 12% in 1978, declining to 2% in 1982, 0.3% in 1986 and 0.4% in 1992. The effect of ignoring the substitution effects on the PS-QAIDS CLI for Canada, results in an exaggerated rate of inflation from 1978 to 1982 and 1982 to 1986. From 1986 to 1992 the size of substitution effect rose slightly resulting in a slightly higher rate of inflation in the CLI than when substitution effects are ignored.

The household composition effect of dependents upon the CLI (while maintaining the same equivalent expenditure) is small for both Australia and Canada. The presence of children, according to the PS-CLI results in a slightly lower rate of inflation rate in prices across the survey period for Canada but no notable result for Australia across the survey periods. For the late 1970s early 1980s households with children in both Australia and Canada tended to experience a lower rate of inflation, while through the mid 1980s households with children experienced a greater rate of inflation. It is difficult to disentangle the individual price movements that were responsible for the differing rates of inflation for households with children through the 1970s and 80s.

6.7 Summary of Key Findings

This section provides a convenient summary of the equivalence scale and price index estimates, used to account for household size and composition and price movements. These estimates are used in conjunction with the household level data sets described in Chapter 5 to construct ‘real’ ‘adult equivalent’ inequality estimates in Chapter 6. Particularly the range of equivalence scale and price indices estimated in this chapter, are used in Sections 7.2 and 7.3, respectively, to examine the sensitivity of Australian and Canadian inequality, to their specification.

Household Size and Composition

- The PS-QAIDS, Barten-QAIDS and quadratic-Engel models outperform the PS-AIDS Barten-AIDS and linear-Engel models for Australia and Canada.
- Although there is little difference in the equivalence scale parameters for the superior models for Australia there is considerable change in the Canadian scales.
- The estimated Engel scales were in line with previous studies
- The Barten scales were not found to be low as in other studies but close to the price scaled estimates, possibly due the inclusion of household economies of scale.
- Canadian households were found to exhibit a greater level of household economies of scale with an estimate of 0.46 compared to 0.36 for Australia
- The presence of children was found to render the *IB* assumption in a rank-2 framework invalid for both countries. Without the *IB* assumption, valid welfare comparisons across households with different numbers of children can not be made within time (only across time).
- Thus when using the IB enforced scales in cross household welfare comparisons of inequality, it must be recognised that the comparisons are made based upon an equivalence scale that is specified in terms of the reference household’s preferences and chiefly determined by the functional form of the cost function and equivalence scale. The nature of the equivalence scale and rank-3 framework used in this study is quite flexible to allow the best estimate of an equivalence scale in light of this.

Prices

- There is significant variation in the price elasticity of the CLI for most of the nine commodities across households of different levels of real equivalent spending for both Australia and Canada

- The price elasticity of the CLI and also real welfare, for food, electricity and household fuel fall considerably, as household real equivalent expenditure increases, while the elasticities of clothing and footwear, transport, recreation and miscellaneous and education rise.

- The actual level and movement in prices over the survey periods resulted in only mild differences in the CLI across households of different equivalent spending levels and in the presence of dependents and the implied rate of inflation.

- None the less, according to the PS-QAIDS CLI, price rises have impacted more heavily upon higher spending households in particular periods. Ignoring this effect using a single price index for all households will result in the real welfare of higher spending households being overstated and so exaggerate the level of inequality in these periods.

- While there appear significant substitution effects in late 1970s for both countries, their CPI's in this period do not seem to exaggerate inflation when compared to the CLI.

Chapter 7 Empirical Evidence on Income and Expenditure Inequality

This chapter presents inequality estimates for Australia from 1975-76, 1984, 1988-89, 1993-94, and 1998-99 and Canada from 1978, 1982, 1986, and 1992. This allows the trend of inequality to be compared between the two countries and extends the analysis of Australian inequality into the late 1990s. The distribution of real equivalent expenditure and income is examined initially using the PS-QAIDS CLI and equivalence scale to adjust for variations in prices and household composition, respectively. The sensitivity of the level and trend in inequality, to the choice of equivalence scale used, is examined in Section 7.2. This section also provides an insight into the effect of household size and composition on inequality by contrasting the non-scaled per household based measures of inequality with the inequality based on equivalence scaled measures of welfare. Section 7.3 examines the sensitivity of level and trend in equality, to the choice of price index or cost of living index. It also provides an insight into the effect of price movements on inequality, by contrasting the nominal household based measures of inequality with the inequality based on the real measures of welfare scaled by the CPI and also a CLI. By contrasting the nominal household based measures of inequality with the inequality based on the real measures of welfare scaled by the CPI (which varies across regions) and also a CLI (which varies across households), the impact of prices on household inequality can be examined. Section 7.4 examines the effect of the choice of unit of analysis and sample on the level and trend of inequality.

7.1 Movement in Australian and Canadian Inequality

7.1.1 Australian Inequality

Tables 7.1 and 7.2 present the means, and inequality measured by the I_0, I_1 and I_2, General Entropy (GE) indices and Gini coefficient for real equivalent expenditure and disposable income, respectively, for Australian households in 1975-76, 1984, 1988-89, 1993-94 and 1998-99[1].

Table 7.1 Australian Expenditure Inequality Estimates

	Inequality Magnitude				
	1975-76	**1984**	**1988-89**	**1993-94**	**1998-99**
Mean Expenditure	$261.32 (2.4095)	$301.48 (2.7226)	$298.86 (2.1582)	$307.55 (2.0275)	$324.69 (2.3770)
I_0	0.1760 (0.0080)	0.1574 (0.0085)	0.1622 (0.0068)	0.1515 (0.0060)	0.1586 (0.0068)
I_1	0.1798 (0.0151)	0.1550 (0.0130)	0.1594 (0.0103)	0.1518 (0.0095)	0.1570 (0.0103)
I_2	0.2356 (0.0241)	0.1832 (0.0185)	0.1884 (0.0141)	0.1823 (0.0132)	0.1847 (0.0141)
Gini	0.3179 (0.0031)	0.3047 (0.0033)	0.3083 (0.0026)	0.2996 (0.0025)	0.3071 (0.0027)
	Period to Period Percentage Change				
	1975-76 to 1984	**1984 to 88-89**	**1988-89 to 1993-94**	**1993-94 to 1998-99**	**1975-76 to 1998-99**
Mean Expenditure	15.4% [11.04]	-0.9% -[0.75]	2.9% [2.93]	5.6% [5.48]	24.2% [18.72]
I_0	-10.6% [-1.61]	3.1% [0.45]	-6.6% -[1.18]	4.7% [0.78]	-9.9% -[1.66]
I_1	-13.8% -[1.24]	2.8% [0.26]	-4.7% -[0.54]	3.4% [0.37]	-12.7% -[1.25]
I_2	-22.3% -[1.73]	2.8% [0.22]	-3.2% -[0.32]	1.3% [0.12]	-21.6% -[1.82]
Gini	-4.2% -[2.91]	1.2% [0.84]	-2.8% -[2.40]	2.5% [2.07]	-3.4% -[2.66]

Notes: Figures in ( ) denote standard errors of the estimates.
Figures in [ ] denote t-ratios of the absolute change in the estimates, for the periods stated.
All estimates are based on 'real', equivalent' measures of disposable income, using the PS-QAIDS CLI, and equivalence scale.

The most striking feature of the results is that, over the sample period as a whole (that is 1975-76 to 1998-99), while the estimates for disposable income inequality increased substantially, expenditure inequality fell. This is consistent with Blacklow and Ray (2000) who found a similar result from 1975-76 to 1993-94 using HES data. This study illustrates that despite the overall falling expenditure

[1] See Section 2.2.2 and 2.2.3 for a discussion of the Gini coefficient and Shorrocks' (1980) GE

inequality from 1975-76 to 1998-99, real equivalent expenditure inequality rose from 1993-94 to 1998-99. Meanwhile a significant rise in real equivalent income inequality from 1993-94 to 1998-99, (as shown by the Gini and I_0 in Table 7.2) indicates a continuation of the rapid growth in real income inequality recorded in earlier sub-periods.

Table 7.2 Australian Disposable Income Inequality Estimates

Inequality Magnitude					
	1975-76	**1984**	**1988-89**	**1993-94**	**1998-99**
Mean Disposable Income	\$286.05 (2.0029)	\$306.03 (2.4083)	\$300.91 (2.2869)	\$302.99 (2.0292)	\$331.80 (2.4367)
I_0	0.1438 (0.0081)	0.1556 (0.0094)	0.1780 (0.0081)	0.2005 (0.0086)	0.2357 (0.0106)
I_1	0.1246 (0.0092)	0.1333 (0.0093)	0.1595 (0.0133)	0.1611 (0.0099)	0.1738 (0.0095)
I_2	0.1359 (0.0126)	0.1391 (0.0105)	0.2087 (0.0261)	0.1881 (0.0158)	0.1858 (0.0118)
Gini	0.2729 (0.0034)	0.2874 (0.0035)	0.2998 (0.0028)	0.3067 (0.0025)	0.3217 (0.0028)
Period to Period Percentage Change					
	1975-76 to 1984	**1984 to 1988-89**	**1988-89 to 1993-94**	**1993-94 to 1998-99**	**1975-76 to 1998-99**
Mean Disposable Income	7.0% [6.38]	-1.7% -[1.54]	0.7% [0.68]	9.5% [9.08]	16.0% [14.51]
I_0	8.3% [0.95]	14.3% [1.80]	12.7% [1.90]	17.6% [2.57]	64.0% [6.87]
I_1	7.0% [0.67]	19.6% [1.62]	1.0% [0.09]	7.9% [0.93]	39.5% [3.73]
I_2	2.4% [0.20]	50.0% [2.47]	-9.8% -[0.67]	-1.2% -[0.12]	36.8% [2.89]
Gini	5.3% [2.95]	4.3% [2.77]	2.3% [1.83]	4.9% [3.93]	17.9% [10.93]

Notes: Figures in ( ) denote standard errors of the estimates.
Figures in [ ] denote t-ratios of the absolute change in the estimates, for the periods stated.
All estimates are based on ‘real’ ‘equivalent’ measures of disposable income, using the PS-QAIDS CLI and Equivalence scale.

Expenditure inequality fell considerably from 1975-76 to 1984, rising slightly through to 1988-89, before falling again in 1993-94 and rising once more in 1998-99. This result differs from Barrett, Crossley and Worswick (1999,2000) who report a

inequality indices, respectively.

small rise in non-durable consumption inequality throughout the sample periods from 1975-76 to 1993-94 and a significant rise in the Gini over the period. The difference in results is primarily due to the restricted sample of working aged population and removal of the top and bottom 3% of observations in the Barrett, Crossley and Worswick's study; see Blacklow and Ray (2000). Section 7.3.1 further examines the effect of sample restrictions on the Australian inequality estimates.

In contrast to expenditure, disposable income inequality has risen significantly over the 23-year period. Table 7.2 illustrates this with real equivalent disposable income inequality rising by almost 40% in the case of the I_1 index, with half this increase occurring from 1984 to 1988-89, during the speculative boom of the late 1980s. The reported rise in equivalent disposable income inequality through out the period is consistent with the findings of Saunders (1991), Lombard (1990) and Barrett, Crossley and Worswick (1999) amongst others. It is however in contrast to Harding (1997) who found little change in equivalent disposable income inequality from the 1982 IDS and the 1993-94 HES.

The estimates for 1975-76 in Tables 7.1 and 7.2, indicate that the level of equivalent expenditure inequality was considerably higher than that for disposable income. This is in contrast to an earlier result from Podder's (1972) analysis, based on the 1966-68 Survey of Consumer Expenditures and Finances (SCEF)[2]. However his finding was based on per household figures unadjusted by an equivalence scale. Later in Section 7.2.1 this study demonstrates that per household income inequality was higher than expenditure inequality in 1975-76 in line with Podder's result for 1966-68. Barrett, Crossley and Worswick (1999) report a higher gross income inequality than non-durable consumption inequality in 1975-76, with income inequality rising further above non-durable consumption inequality from 1975-76 to 1993-94. Tables 7.1 and 7.2 show income inequality had risen to become higher than expenditure inequality in 1993-94, which had been falling before that time. This may reflect the increasing availability of consumer credit to Australian households that from 1988-89 has allowed them to smooth out their expenditure. However to accurately check whether households smooth their consumption levels as their income fluctuates, would require panel data or an accurate intertemporal model for the households.

The I_0, I_1 and I_2, indices are particularly sensitive to changes in the bottom, middle and top of the welfare distribution, respectively, and allow greater insight into the movements in inequality caused by transfers to different parts of the welfare distribution. The real equivalent expenditure inequality measures presented in Table 7.1, all exhibit the same pattern of movement across the whole sample period, indicating that the movement in expenditure inequality has been consistent amongst the bottom, middle and top of the distribution.

From 1975-76 through to 1988-89, all three of the Shorrocks indices (I_0, I_1, I_2) reported a rise in disposable income inequality, with the I_2 measure reporting a 50% increase from 1984 to 1988-89. The movement in disposable income inequality differs across the distribution from 1988-89 to 1993-94. The I_0, which is sensitive to the lower end of the distribution, records a significant increase while the middle sensitive I_1 reports little change and the I_2 measure sensitive to the top of the distribution reports a sizeable fall. Both the bottom and middle sensitive I_0 and I_1 measures report a rise in income inequality from 1993-94 to 1998-99, but the trend in I_2 is again in the opposite direction, downwards. Recall that the I_2 measure is half

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[2] The SCEF was conducted by staff at the Macquarie and Queensland Universities which sampled 5,500 households, Australia wide. The sample selection and non-response rate of the SCEF has been questioned by Richardson (1979) and Murray (1981), see Section 3.3.3.

the square of the coefficient of variation and is not transfer sensitive, (see Section 2.2.1)[3].

Focussing on expenditure inequality in 1998-99, the I_0, I_1 and I_2 estimates show that disparities in equivalent spending of households in the upper tail of the distribution were larger than differences amongst the middle and bottom of the distribution. While for equivalent disposable income, the rise in inequality is higher amongst households in the upper and lower sections of the distribution. Appendix Tables 7.1 and 7.2 contain Atkinson inequality indices for Australian expenditure and disposable income distributions as well as the results presented in this section, for easy comparison.

Of special interest is the more recent movement in Australian household inequality, which can be examined due to the recent release of the 1998-99 HES. The strong economic growth from 1993-94 to 1998-99 resulted in a rise in both the mean household real equivalent measures of expenditure (24%) and disposable income (16%), whose growth had been relatively stagnant since 1984. These increases were not uniformly distributed with the I_0 estimate reporting an 18% rise in disposable income inequality and a 4.7% rise in expenditure inequality compared to the I_2 estimate, which reports a 1.3% rise and 1.2% fall respectively. Given that later in Section 8.3.1 employment status of the household head is shown to contribute 20% and 30% respectively of Australian real equivalent expenditure and disposable income inequality the impact of economic growth on inequality may be explained by its effect on employment and employment income. While the mean real equivalent measures of welfare grew by approximately 20%, unemployment fell by only 3%[4] and no or little fall in long term unemployment rates. Later in Tables 7.5 and 7.6 the

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[3] The I_2 measure is equally sensitive to transfers amongst any individuals.

[4] See Table 5.8 in Chapter 5.

inequality of expenditure by commodity and inequality of income by type or source are examined, to shed more light on reasons behind the movements in aggregate inequality. While the decomposition by household characteristics, performed in Chapter 8 may also help explain the movement in inequality.

7.1.2 Canadian Inequality

Tables 7.3 and 7.4 present the real equivalent expenditure and disposable income inequality estimates respectively for Canada and contain the I_0, I_1 and I_2, inequality indices, the Gini coefficient and means of the respective distributions. Across the sample period disposable income inequality and expenditure inequality have moved in a similar manner, both rising from 1978 through to 1986 before falling in 1992. The movements from 1978 to 1986 are consistent with Pendakur (1998) for families from the FES. From 1986 to 1990, Pendakur reports a fall and then a rise of larger magnitude from 1990 to 1992, increasing the Gini of rural family equivalent inequality for both imputed consumption and income in the recession of 1992. The results presented in Tables 7.3 and 7.4 show a small decline in the Gini for expenditure inequality, and no change in disposable income inequality, while the other estimates report larger falls over the period.

The general rise in expenditure inequality from 1978 through to 1986 is consistent across all inequality estimates. The I_2 estimate, illustrates that throughout this period the inequality recorded in the top of the expenditure distribution rose faster than the inequality recorded by the rest of the distribution and was higher than the I_0 and I_1 measures in 1986. The fall in expenditure inequality from 1986 to 1992 was more evident in the lower end of the distribution than for the middle or upper end. Income inequality was higher in 1978 than expenditure inequality, particularly so for the middle and bottom sensitive I_1 and I_0 estimates. Estimated income inequality rose at a faster rate and fell at a slower rate than expenditure inequality across the period, there by increasing the gap between expenditure and disposable income inequality.

Table 7.3 Canadian Expenditure Inequality Estimates

	Inequality Magnitude			
	1978	**1982**	**1986**	**1992**
Mean Expenditure	\$350.46 (1.6899)	\$339.68 (1.5833)	\$365.23 (1.8015)	\$364.24 (1.8589)
I_0	0.1104 (0.0050)	0.1136 (0.0047)	0.1178 (0.0048)	0.1134 (0.0049)
I_1	0.1034 (0.0057)	0.1091 (0.0059)	0.1145 (0.0063)	0.1115 (0.0065)
I_2	0.1088 (0.0066)	0.1188 (0.0073)	0.1260 (0.0076)	0.1236 (0.0079)
Gini	0.2515 (0.0028)	0.2577 (0.0025)	0.2645 (0.0025)	0.2613 (0.0026)
	Period to Period Percentage Change			
	1978 to 1982	**1982 to 1986**	**1986 to 1992**	**1978 to 1992**
Mean Expenditure	-3.1% -[4.65]	7.5% [10.65]	-0.3% -[0.38]	3.9% [5.48]
I_0	2.9% [0.47]	3.7% [0.62]	-3.7% -[0.63]	2.8% [0.44]
I_1	5.5% [0.69]	4.9% [0.63]	-2.5% -[0.32]	7.9% [0.94]
I_2	9.2% [1.03]	6.0% [0.68]	-1.9% -[0.22]	13.6% [1.45]
Gini	2.5% [1.67]	2.6% [1.92]	-1.2% -[0.87]	3.9% [2.60]

Notes: Figures in ( ) denote standard errors of the estimates.
Figures in [ ] denote t-ratios of the absolute change in the estimates, for the periods stated.
All estimates are based on 'real' 'equivalent' measures of disposable income, using the PS-QAIDS CLI and Equivalence scale.

Table 7.4 illustrates that like the expenditure distribution, disposable incomes diverged at the top, middle and bottom of the distribution from 1978 to 1986. Inequality increased at a greater rate at the top and middle of the income distribution with the I_2, measure rising significantly by 27.2% from 1982 to 1986. From 1986 to 1992, while the bottom sensitive I_0 reported a small increase in income inequality, the middle sensitive I_1 and top sensitive I_2 measures report a moderate falls of 4.1% and 14.4% respectively. Throughout the sample period the I_1 is lower than the other Shorrocks measures presented indicating that disposable income disparities amongst the poor and rich have dominated that of the middle class. Appendix Tables 7.3 and 7.4 contain Atkinson inequality indices for Canadian expenditure and disposable income distributions, as well as the results presented in this section for ease of comparison.

Table 7.4 Canadian Disposable Income Inequality Estimates

Inequality Magnitude				
	1978	**1982**	**1986**	**1992**
Mean Disposable Income	\$392.96 (2.0407)	\$406.81 (2.0526)	\$408.93 (2.3916)	\$412.67 (2.3324)
I_0	0.1295 (0.0056)	0.1382 (0.0053)	0.1464 (0.0056)	0.1485 (0.0062)
I_1	0.1187 (0.0063)	0.1287 (0.0063)	0.1414 (0.0097)	0.1357 (0.0074)
I_2	0.1262 (0.0074)	0.1392 (0.0076)	0.1771 (0.0195)	0.1516 (0.0093)
Gini	0.2685 (0.0027)	0.2801 (0.0024)	0.2865 (0.0024)	0.2864 (0.0025)
Period to Period Percentage Change				
	1978 to 1982	**1982 to 1986**	**1986 to 1992**	**1978 to 1992**
Mean Disposable Income	3.5% [4.78]	0.5% [0.67]	0.9% [1.12]	5.0% [6.36]
I_0	6.7% [1.13]	5.9% [1.07]	1.5% [0.26]	14.7% [2.28]
I_1	8.4% [1.12]	9.9% [1.10]	-4.1% -[0.47]	14.3% [1.74]
I_2	10.4% [1.23]	27.2% [1.81]	-14.4% -[1.18]	20.2% [2.14]
Gini	4.3% [3.25]	2.3% [1.92]	0.0% -[0.03]	6.7% [4.94]

Notes: Figures in ( ) denote standard errors of the estimates.
Figures in [ ] denote t-ratios of the absolute change in the estimates, for the periods stated.
All estimates are based on 'real' 'equivalent' measures of disposable income, using the PS-QAIDS CLI and Equivalence scale.

The reasons behind these movements are further examined in Chapter 8 where the magnitude and trend of inequality is decomposed by household characteristics. The following Section 7.1.3 compares the inequality movements between the two countries. Tables 7.5 and 7.6 report measures of the inequality of expenditure by commodity and income inequality by source. These provide more information on the rise in Canadian expenditure and income inequality from 1978 to 1986 and fall to 1992.

7.1.3 Australian v Canadian Inequality - A Comparison

Figure 7.1 displays the Australian and Canadian estimates of expenditure and disposable income inequality as measured by the I_0 index, which is most sensitive to transfers to the lower part of the welfare distribution. The estimates of inequality of the two countries are not directly comparable since the Canadian FES uses an annual recording period while the Australian HES uses a fortnightly recording period. Fortnightly disposable income is likely to exhibit more variation than an annual measure as is reflected in Figure 7.1 with income inequality in Australia being higher than that in Canada[5]. One would also expect the fortnightly expenditure to exhibit more variation than an annual measure, but to a lesser degree, due to the effect of consumption smoothing. Figure 7.1 indicates however that difference in estimate for expenditure inequality between Australia and Canada is larger than that for disposable income, suggesting that Australian expenditure inequality is higher than Canadian. The most striking feature of Figure 7.1 is the rapid rise in Australian disposable income inequality, when compared to Canada over the 1980s and 1990s.

Figure 7.2 provides the Australian and Canadian estimates of expenditure and disposable income inequality as measured by the I_1 index. This enables the examination of whether the conclusions based upon I_0 are valid for a more middle sensitive index. The I_1 estimates show that until the mid 1980s, Australian fortnightly disposable income inequality was very similar to Canadian annual disposable income. This suggests that when more weight is given to the middle of the distribution, disposable income inequality is higher in Canada than in Australia

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[5] See Section 2.3.1 of Chapter 3 and Section 5.3 in Chapter 5.

for identical recording periods. As with I_0, the I_1 estimates in Figure 7.2 indicate that the difference in expenditure inequality estimates between Australia and Canada is larger than that for disposable income, suggesting that expenditure inequality is higher in Australia than in Canada.

Figure 7.1 Australian versus Canadian I_0 Inequality

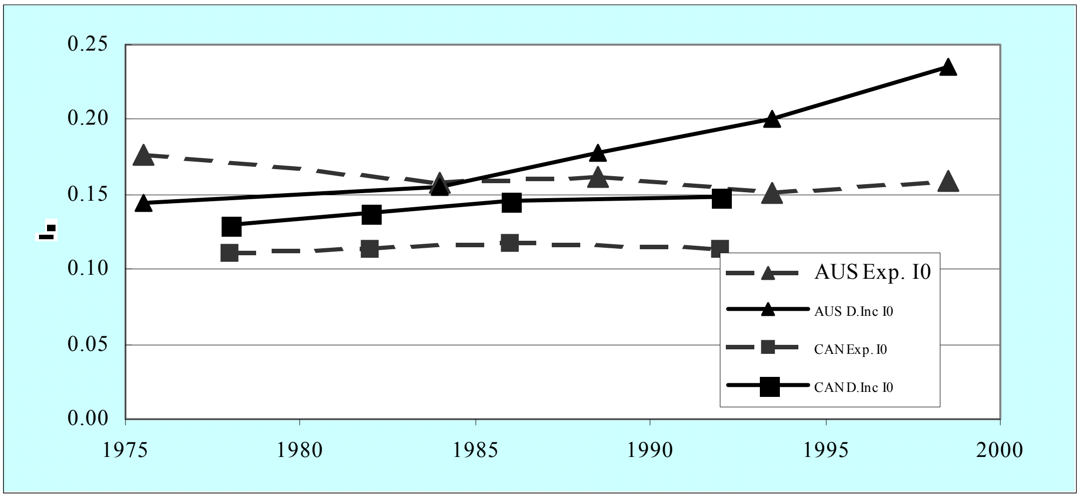

Figure 7.2 Australian versus Canadian I_1 Inequality

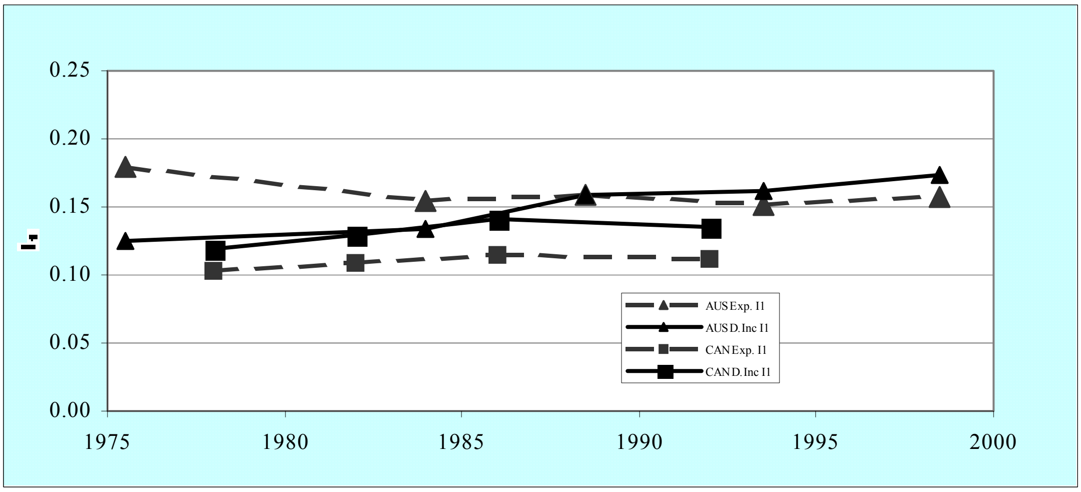

Table 7.5 provides the I_0 inequality index for Australia and Canada, by commodity group. This sheds light on which components of household spending are the most unequal and which are responsible for the higher expenditure inequality in Australia.

Table 7.5 Australian v Canadian I_0 Inequality of Expenditure by Commodity

I_0	Magnitude		Percentage Change		
Commodity	Australia 1993-94	Canada 1992	Australia 1975-76 to 1993-94	Canada 1982 to 1992	Australia 1993-94 to 1998-99
Food and Non Alcoholic Drinks	0.148	0.107	42.9% {2.0%}	16.0% {1.1%}	11% {2.2%}
Accommodation	0.297	0.178	-41.1% {-2.9%}	-12.6% {-1.0%}	-7% {-1.4%}
Electricity and Household Fuel	0.238	0.647	2.6% {0.1%}	6.9% {0.5%}	-25% {-5.7%}
Clothing and Footwear	1.732	0.442	31.7% {1.5%}	14.0% {0.9%}	4% {0.7%}
Transport	0.891	0.697	33.1% {1.6%}	-5.3% {-0.4%}	3% {0.7%}
Health and Personal Care	0.608	0.250	-6.6% {-0.4%}	-5.2% {-0.4%}	15% {2.8%}
Recreation	0.828	0.569	-12.1% {-0.7%}	-12.8% {-1.0%}	2% {0.5%}
Alcohol and Tobacco	1.518	1.173	25.1% {1.3%}	36.4% {2.2%}	6% {1.3%}
Miscellaneous and Education	1.009	0.934	6.7% {0.4%}	13.9% {0.9%}	3% {0.5%}

Notes: Figures in { } indicate annualised compound rates of percentage change in I_0.
All measures of income where scaled to be 'real', 'adult equivalent' by the PS-QAIDS CLI and equivalence scale.
The average budget shares for Australia in 1993-94 and Canada in 1992 are provided in Section 5.5.1 in Figures 5.5 and 5.6 respectively.

Comparing Australia in 1993-94 to Canada in 1992, demonstrates that inequality of spending in Australia is higher for all commodity groups, except for electricity and household fuel. The higher inequality of spending on electricity and household fuel for Canada can be explained by the dispersion in heating requirements across geographical regions. Spending on clothing and footwear is considerably more unequal in Australia, where the I_0 estimate is almost four times the Canadian estimate. This is possibly due to the greater spread in prices of clothing in Australia from expensive domestic and imported European clothing to cheaper imported Asian clothing, compared to Canada that has less cheap imported clothing available. Australia reports estimates of I_0 inequality almost twice as high as Canada for the largest items in the household budget of food, transport and particularly accommodation.

The inequality in Australian accommodation spending has fallen across the survey periods, despite a small rise in 1988-89 due to higher interest repayments on mortgages resulting from high interest rates. The inequality in Canadian accommodation equivalent spending as measured by the I_0 measure has declined by only about 1% a year, compared to 2.9% for Australia, from the late 1970s to the early 1990s. The fall in accommodation expenditure inequality has been a major factor behind the fall in real equivalent expenditure inequality from 1975-76 to 1993-94 in Australia and a strong influence in limiting the rise in Canadian expenditure inequality over 1978 to 1992[6]. In contrast the rise in the inequality of food spending in Australia has been rising at a faster rate of 2% a year compared to 1.1% for Canada[7]. Another distinction between the two countries is in the inequality of spending on transport. This is higher in Australia due to its geographically dispersed population, and has been rising by 1.6% a year from 1975-76 to 1993-94, but has been falling for Canada by 0.4% from 1978 to 1992[8]. In contrast the two countries have experienced similar large rises in the inequality of expenditure on clothing and footwear, and alcohol and tobacco and falls in the inequality of recreation expenditure.

While the overall rise in real equivalent expenditure inequality for Australia over 1993-94 to 1998-99 was small it contained large movements in the inequality of components of spending, as shown in columns 5 and 6 of Table 7.5. Food and non-alcoholic drinks, health and personal care and to a lesser degree, alcohol and tobacco, expenditure inequality rose while, the inequality in household expenditure on fuel and electricity fell. This is possibly reflective of the growth in diversity of tastes for

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[6] Recall that from Section 5.5.1 in Chapter 5, the average Australian and Canadian households spend approximately 30% of their household expenditure on accommodation.

[7] Recall, also from Section 5.5.1 in Chapter 5,that the average budget share for food of Australian and Canadian households was approximately 20%.

food, alcohol and tobacco and the increase in the proportion of retired households with diverse health expenditures.

The I_0 inequality estimates for Australia and Canada by source of income are given in Table 7.6. This provides greater insight into the basis of the higher magnitude and rise in disposable income inequality recorded for Australia than for Canada.

Table 7.6 Australian v Canadian I_0 Income Inequality by Source

I_0	Magnitude		Percentage Change		
Income Source	**Australia 1993-94**	**Canada 1992**	**Australia 1975-76 to 1993-94**	**Canada 1982 to 1992**	**Australia 1993-94 to 1998-99**
Disposable Income	0.200	0.148	39.5% {1.9%}	14.6% {1.0%}	18% {4.1%}
Gross Income	0.318	0.193	44.8% {2.1%}	18.4% {1.2%}	12% {2.9%}
Wages	2.779	1.622	38.1% {1.8%}	17.8% {1.6%}	1% {0.3%}
Government Benefits	2.546	1.095	-29.9% {-2.0%}	2.1% {0.2%}	3% {0.8%}
Self Employed Income	4.766	2.827	-1.2% {-0.1%}	-0.1% {-0.0%}	1% {0.2%}
Investment Income	3.827	2.054	17.3% {0.9%}	7.8% {0.8%}	8% {2.0%}
Other Income	2.814	2.373	-2.1% {-0.1%}	11.4% {1.1%}	29% {6.6%}

Notes: Figures in { } indicate annualised compound rates of percentage change in I_0.
All measures of income where scaled to be "real", "adult equivalent" by the PS-QAIDS CLI and equivalence scale.

All of the Australian estimates of real equivalent disposable income inequality are higher for Australia in 1993-94 than for Canada in 1992. This result is not surprising, since the Canadian FES records annual income while the Australian HES fortnightly income. Interestingly the Australian estimate of the magnitude of gross income inequality is 65% higher than the Canadian estimate, while the disposable income estimate is 35% higher. In addition to the larger rise in Australian gross income inequality reported in column 3 of Table 7.6, than the rise in disposable income inequality, while for Canada the reverse is true for 1982 to 1992. This

[8] Transport has the third largest budget share of approximately 15% for both countries, see Section 5.5.1 in Chapter 5.

suggests that the Australia taxation system has more effect in reducing inequality than the Canadian system. However the fortnightly survey period of the Australian HES is likely to record greater fluctuation in gross incomes and thus also greater fluctuations in fortnightly direct tax, than the annually drawn Canadian FES, there by exaggerating this effect.

The inequality of Australian wage incomes and self-employed incomes is approximately 70% higher than for Canada, a ratio similar to the gross income comparison. The inequality of investment and government benefit income is considerably larger in Australia at approximately 86% and 232% of the respective Canadian estimates. Turning to the growth in income inequality, for Australia from 1975-76 to 1993-94 and from 1978 to 1992 for Canada, it is evident that gross income inequality has been growing at a slightly higher rate than disposable income inequality for both countries.

From 1982 to 1992 the rise in Canadian wage inequality, as shown in column four of Table 7.6, was a major influence on the rise in income inequality over this period. Similarly the increase in wage inequality in Australia from 1975-76 to 1993-94 was the major influence on the rise of Australia income inequality over this similar period. Both countries have also experienced a rise in the inequality of real equivalent investment income over the two periods.

The final column of Table 7.6 provides the trend in income inequality by source for Australia from 1993-94 to 1998-99. This indicates a period of rapid growth in disposable income inequality of 4.1% per year. In contrast Australian gross income inequality rose by only 2.9% per year, indicating that the Australian taxation system has significantly contributed to the rise in disposable income inequality from 1993-94 to 1998-99. Over this period inequality of most of the income sources has risen by only a moderate amount, although there has been a considerable rise in investment income inequality. This may be due to the increased ownership of shares in Australia and also a large rise in the inequality of other income, chiefly consisting of child support and maintenance, and workers or accident compensation.

7.2 Sensitivity of Inequality Estimates to the Equivalence Scale

The results reported in Section 7.1 were based upon the use of the PS-QAIDS equivalence scale and cost of living index. This section examines whether the conclusions drawn about the movement and nature of inequality in Section 7.1 are sensitive to the choice of equivalence scale. To reduce the large number of possible results, the sensitivity of equivalence scales in this section focuses on the middle sensitive I_1 index. Of more interest than the magnitude of such estimates is the trend in inequality they imply. Sections 7.2.1 and 7.2.2 examine the sensitivity of the trend in Australian and Canadian inequality respectively, to the equivalence scale used. Sections 7.2.1 and 7.2.2 also provide an insight into the effect of household size and composition on inequality by contrasting the non-scaled per household based measures of inequality, with the inequality based on equivalence scaled measures of welfare.

The inequality of equivalent measures of welfare, are a product of the distribution of per household welfare, household size/composition and the correlation between the two. For example consider the standard deviation of the logarithm of scaled household welfares, $SD(Log(\tilde{\boldsymbol{w}}))$, from which the I_0 and I_1 inequality indices are based. If $\tilde{\boldsymbol{w}}$ the vector of scaled household welfare $\tilde{w}_h$ for h = 1 to H households is given by $\tilde{w}_h = w_h / S_h^{(1-\theta)}$,where S_h is the absolute size of the household and θ the economies of scale in household size, then

$$SD(Log(\tilde{\boldsymbol{w}})) = \sqrt{\begin{aligned}&SD(Log(\boldsymbol{w}))^2 + (1-\theta)^2 SD(Log(\boldsymbol{S}))^2 - \\ &2(1-\theta)Cor(\boldsymbol{w},\boldsymbol{S})SD(Log(\boldsymbol{w}))SD(Log(\boldsymbol{S}))\end{aligned}} \tag{7.1}$$

where $\boldsymbol{w}$ is the vector of (unscaled) household welfare w_h for all H

$\boldsymbol{S}$ is the vector of household size welfare S_h for all H and

$SD(Log(\boldsymbol{w}))$, $SD(Log(\boldsymbol{S}))$ their respective logarithmic standard deviations and $Cor(\boldsymbol{w},\boldsymbol{S})$ the correlation between them.

First, ignoring economies of scale, notice that the larger the variation in household size, as measured by $SD(Log(\boldsymbol{S}))$, the larger $SD(Log(\tilde{\boldsymbol{w}}))$ although this is offset by the $Cor(\boldsymbol{w},\boldsymbol{S})$ and the effect of household size could be negative if $1-\theta-Cor(\boldsymbol{w},\boldsymbol{S})<0$. Thus so long as $1-\theta-Cor(\boldsymbol{w},\boldsymbol{S})>0$ the greater the variation in household size the greater the measure of inequality based on the $SD(Log(\tilde{\boldsymbol{w}}))$, *ceteris paribus*. Secondly notice the smaller the economies of scale, the more the variation in household size $SD(Log(\boldsymbol{S}))$, impacts upon $SD(Log(\tilde{\boldsymbol{w}}))$. This is offset by smaller economies of scale increasing the impact of $Cor(\boldsymbol{w},\boldsymbol{S})$ in reducing $SD(Log(\tilde{\boldsymbol{w}}))$ so long as $Cor(\boldsymbol{w},\boldsymbol{S})-(1-\theta)SD(\boldsymbol{S})<0$. Thus the smaller the economies of scale, so long as $(1-\theta)SD(\boldsymbol{S})-Cor(\boldsymbol{w},\boldsymbol{S})>0$, the greater the measure of inequality based on the $SD(Log(\tilde{\boldsymbol{w}}))$, *ceteris paribus*.[9]

This provides the framework to examine the sensitivity of inequality to equivalence scale specification. Recall that Banks and Johnson (1994) and Jenkins and Cowell (1994) found economies of scale estimates of between 0.3 and 0.4 provided the lowest U.K inequality, while values of 0 and 1 provided the highest estimates. More insight into the impact of households' demographic types on inequality is examined in Section 8.2 of Chapter 8, where inequality is decomposed by household type.

7.2.1 Sensitivity of Australian Inequality to the Equivalence Scale

Tables 7.7 and 7.8 provide the period-to-period percentage change and the magnitude of I_1 inequality in 1998-99, for real expenditure and disposable income respectively for Australia. The movement in equivalent expenditure inequality reported in Section 7.1.1 from 1975-76 to 1998-99 is generally consistent for all the equivalence scales presented as found by Blacklow and Ray (2000) from 1975-76 to 1993-94. When no scale is used, giving per household expenditure inequality, the magnitude of inequality is higher than the other estimates. However only a small fall in inequality is reported across the whole sample, while the per capita estimate reports the largest increase in inequality. Barrett, Crossley and Worswick (1999) discovered a rise in the Gini for consumption inequality from a restricted HES sample from 1975-76 to 1993-94. They found considerable variation in the size of the trend across scaling methods, with the per household figure reporting the smallest rise and per capita the largest over this period.

The results in Tables 7.7 and 7.8 suggest that ignoring changes in household size by using per household estimates, severely under estimates the movements in expenditure inequality. While giving children the same weight as adults and ignoring economies of scale, as the per capita scale does, severely exaggerates the trend when compared to the other scales. It has consistently been found that the reported per capita magnitude of Australian expenditure inequality is higher than that when equivalence scales are used; see for example Blacklow and Ray (2000), Barrett, Crossley and Worswick (1999), Lancaster, Ray and Valenzuela (1999). The Engel scales also result in a higher reported level of inequality in 1998-99 and more exaggerated movements in expenditure inequality than the Barten and PS scales. The lack of any significant economies of scale in the Engel scales, results in a bigger

[9] Buhmann et. al. (1988, p124) also show that the lower $Cor(\boldsymbol{w},\boldsymbol{S})$ the higher correlation between any two welfare measures $Cor(\tilde{w}_1,\tilde{w}_2)$.

adjustment for larger households, diminishing their level of Engel scaled welfare. Such larger households seem to dominate in the lower end of the expenditure distribution, as the equivalent inequality for this estimate is larger than the scales that consider economies of scale in household expenditure.

Table 7.7 Australian I_1 Real Equivalent Expenditure Inequality Estimates

I_1	Magnitude	Percentage Change				
Equivalence Scale	**1998-99**	**1975-76 to 1984**	**1984 to 1988-89**	**1988-89 to 1993-94**	**1993-94 to 1998-99**	**1975-76 to 1998-99**
PS-QAIDS	0.1570 (0.0103)	-13.8%	2.8%	-4.7%	3.4%	-12.7% -[1.25]
PS-AIDS	0.1543 (0.0101)	-13.7%	2.7%	-5.7%	2.6%	-14.2% -[1.41]
BART-QAIDS	0.1577 (0.0105)	-13.8%	2.1%	-4.5%	3.2%	-13.3% -[1.29]
BART-AIDS	0.1576 (0.0104)	-13.8%	2.3%	-4.5%	3.3%	-13.1% -[1.28]
ENG-Quad	0.1608 (0.0115)	-17.6%	4.1%	-5.7%	4.5%	-15.4% -[1.41]
ENG-Lin	0.1602 (0.0114)	-17.5%	4.1%	-5.6%	4.4%	-15.4% -[1.40]
Common	0.1646 (0.0105)	-11.2%	0.3%	-3.9%	2.9%	-11.9% -[1.21]
OECD	0.1647 (0.0113)	-15.6%	0.8%	-4.7%	2.9%	-16.6% -[1.60]
Per Capita	0.1892 (0.0133)	-16.8%	-0.1%	-5.9%	3.4%	-19.2% -[1.84]
None	0.2058 (0.0112)	-4.3%	1.6%	-3.7%	5.5%	-1.3% -[0.14]

Notes: Figures in ( ) denote standard errors of the estimates.
Figures in [ ] denote t-ratios of the absolute change in the estimates, for the periods stated.
All estimates are based on 'real' measures of expenditure, using the PS-QAIDS CLI to allow for variations in prices.
The 'Common' scale is specified as $\sqrt{\textbf{Adults} + \tfrac{1}{2}\textbf{Children}}$, see Section 6.2.2.

Table 7.8 shows that all the estimates of disposable income inequality rose significantly from 1975-76 to 1998-99. However the size of the changes varied from 21.6% for the per capita scale, to approximately 30% for the OECD and Common scale and approximately 40% for the remaining estimated scales[10].

[10] The 'Common' scale is specified as $\sqrt{\textbf{Adults} + \tfrac{1}{2}\textbf{Children}}$, see Section 6.2.2.

Table 7.8 Australian I_1 Real Equivalent Disposable Income Inequality Estimates

I_1	Magnitude	Percentage Change				
Equivalence Scale	1998-99	1975-76 to 1984	1984 to 1988-89	1988-89 to 1993-94	1993-94 to 1998-99	1975-76 to 1998-99
PS-QAIDS	0.1738 (0.0095)	7.0%	19.6%	1.0%	7.9%	39.5% [3.73]
PS-AIDS	0.1729 (0.0094)	6.9%	19.4%	0.6%	7.6%	38.2% [3.63]
BART-QAIDS	0.1753 (0.0096)	6.5%	18.7%	1.1%	7.8%	37.8% [3.59]
BART-AIDS	0.1750 (0.0096)	6.7%	18.8%	1.2%	7.8%	38.3% [3.63]
ENG-Quad	0.1762 (0.0103)	7.1%	19.5%	0.6%	10.4%	42.0% [3.69]
ENG-Lin	0.1756 (0.0103)	7.1%	19.6%	0.6%	10.3%	42.2% [3.71]
Common	0.1839 (0.0098)	5.7%	16.3%	1.2%	6.7%	32.8% [3.29]
OECD	0.1835 (0.0103)	3.7%	16.1%	0.0%	8.2%	30.3% [2.93]
Per Capita	0.2093 (0.0120)	1.6%	11.6%	-1.8%	9.3%	21.6% [2.19]
Per Household	0.2232 (0.0108)	8.3%	14.5%	1.3%	6.9%	34.3% [3.80]

Notes: Figures in ( ) denote standard errors of the estimates.
Figures in [ ] denote t-ratios of the absolute change in the estimates, for the periods stated.
All estimates are based on 'real' measures of disposable income, using the PS-QAIDS CLI to allow for variations in prices.
The 'Common' scale is specified as $\sqrt{\textbf{Adults} + \textbf{½Children}}$, see Section 6.2.2.

The PS and Barten, AIDS and QAIDS estimated scales, result in similar estimates and trends for I_1 across all sample periods for Australia. In ascending order of magnitude, the Common, OECD, per capita and per household inequality estimates are higher than the estimated equivalence scale estimates in 1998-99. This is consistent with the Barrett, Crossley and Worswick (1999) findings for gross income on a restricted sample of HES for 1975-76, with the exception that their per household estimate of inequality was the lowest estimate of the four. It is also consistent with Banks and Johnson (1994) and Jenkins and Cowell (1994) for the U.K. The trend in the per capita estimate of inequality that gives a greater weight to children, reports a much smaller rise from 1975-76 to 1988-89 compared to the other scales and shows a fall from 1988-89 to 1993-94 unlike any of the other estimates.

7.2.2 Sensitivity of Canadian Inequality to the Equivalence Scale

Tables 7.9 and 7.10 provides the period to period percentage change and the magnitude of inequality in 1992 for Canada, by equivalences scale, for real expenditure and disposable income respectively.

Table 7.9 Canadian I_1 Real Equivalent Expenditure Inequality Estimates

I_1	Magnitude	Percentage Change			
Equivalence Scale	**1992**	**1978 to 1982**	**1982 to 1986**	**1986 to 1992**	**1978 to 1992**
PS-QAIDS	0.1115 (0.0065)	5.4%	4.9%	-2.6%	7.8% [0.93]
PS-AIDS	0.1114 (0.0065)	5.7%	5.0%	-2.9%	7.7% [0.92]
BART-QAIDS	0.1102 (0.0066)	5.8%	3.7%	-2.5%	6.9% [0.81]
BART-AIDS	0.1109 (0.0066)	5.9%	4.2%	-2.7%	7.3% [0.86]
ENG-Quad	0.1172 (0.0073)	5.5%	-4.4%	-1.1%	-0.3% -[0.03]
ENG-Lin	0.1168 (0.0072)	5.3%	-4.2%	-1.0%	-0.2% -[0.02]
Common	0.1130 (0.0067)	5.9%	4.4%	-3.0%	7.2% [0.85]
OECD	0.1149 (0.0071)	5.1%	-2.5%	-1.7%	0.8% [0.09]
Per Capita	0.1385 (0.0082)	3.7%	-6.3%	-2.3%	-5.0% -[0.61]
Per Household	0.1508 (0.0075)	5.2%	11.9%	-6.9%	9.5% [1.33]

Notes: Figures in ( ) denote standard errors of the estimates.
Figures in [ ] denote t-ratios of the absolute change in the estimates, for the periods stated.
All estimates are based on 'real' measures of disposable income, using the PS-QAIDS CLI to allow for variations in prices.
The 'Common' scale is specified as $\sqrt{\textbf{Adults} + \tfrac{1}{2}\textbf{Children}}$, see Section 6.2.2.

Note that the inequality estimates based on equivalence scales with very low household economies of scale as the Engel and per capita scale, report a higher magnitude of inequality compared to the estimated scales with moderate economies of scale. This is consistent with Banks and Johnson (1994) and Jenkins and Cowell (1994) U.K. results. This result implies that larger households have lower household welfare and that low economies of scale equivalence scales with high equivalent cost for children, overly reduce their welfare.

The largest magnitude of inequality reported in 1992 was from the per household estimate. This suggests that if all household spending was on household public goods and none on private household goods, then inequality would be larger. The estimated trend in Canadian expenditure inequality estimates appears to be more sensitive to the choice of equivalence scale than the Australian estimates. The OECD and restricted-Engel (see Section 6.2) scales report a fall from 1982 to 1986, resulting in little change in expenditure inequality across the sample period. The per capita scale reports smaller rises and larger falls than all estimates, and reports a 5% fall in expenditure inequality across the sample period. This result is a similar to Pendakur (1998) who reported the trend in per capita consumption inequality was virtually flat compared to the rise reported by the per household and a scaled estimates. The PS, Barten and Common scales report similar estimates and trends, with about a 7% rise in inequality over this period. The per capita and per household estimates, report higher expenditure inequality in 1992 than the other equivalence scale estimates, as Pendakur (1998) reported[11].

The trend in Canadian disposable income inequality, as shown in Table 7.10, is also very sensitive to the choice of equivalence scale. The trend in per capita estimate of income inequality from 1978 to 1992 reports a fall of 5%; while the Engel and OECD scaled estimates, report little change across the period. The Barten and Common scales reports a moderate increase of 7%, the PS scaled estimates report a 14% rise significant at the 10% level over 1978 to 1992.

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[11] Which is also in line with Banks and Johnson (1994) and Jenkins and Cowell (1994) for the U.K.

Table 7.10 Canadian I_1 Real Equivalent Disposable Income Inequality Estimates

I_1 Equivalence Scale	Magnitude 1992	Percentage Change 1978 to 1982	1982 to 1986	1986 to 1992	1978 to 1992
PS-QAIDS	0.1357 (0.0074)	8.4%	9.9%	-4.1%	14.3% [1.74]
PS-AIDS	0.1373 (0.0075)	8.2%	10.2%	-4.4%	14.0% [1.70]
BART-QAIDS	0.1102 (0.0066)	5.8%	3.7%	-2.5%	6.9% [0.81]
BART-AIDS	0.1109 (0.0066)	5.9%	4.2%	-2.7%	7.3% [0.86]
ENG-Quad	0.1172 (0.0073)	5.5%	-4.4%	-1.1%	-0.3% -[0.03]
ENG-Lin	0.1168 (0.0072)	5.3%	-4.2%	-1.0%	-0.2% -[0.02]
Common	0.1130 (0.0067)	5.9%	4.4%	-3.0%	7.2% [0.85]
OECD	0.1149 (0.0071)	5.1%	-2.5%	-1.7%	0.8% [0.09]
Per Capita	0.1385 (0.0082)	3.7%	-6.3%	-2.3%	-5.0% -[0.61]
Per Household	0.1508 (0.0075)	5.2%	11.9%	-6.9%	9.5% [1.33]

Notes: Figures in ( ) denote standard errors of the estimates.
Figures in [ ] denote t-ratios of the absolute change in the estimates, for the periods stated.
All estimates are based on 'real' measures of expenditure, using the PS-QAIDS CLI to allow for variations in prices.
The 'Common' scale is specified as $\sqrt{\textbf{Adults} + \tfrac{1}{2}\textbf{Children}}$, see Section 6.2.2.

The sensitivity of estimates to the choice of equivalence scale is most significant from 1982 to 1986 a period of solid economic growth[12]. Over this period per household income inequality rose by 12%, while the per capita figure reported a 6% fall. This indicates that the welfare of large households, to which the per capita scale gives more weight, converged towards the centre of the distribution.

[12] In which Annual GDP grew at an average of 3.2%, see Table 5.8 in Chapter 5

7.3 Sensitivity of Inequality Estimates to the Price Deflator

The results of Section 7.1 on the movement in aggregate inequality for Australia and Canada were based upon the use of the PS-QAIDS equivalence scale and cost of living index. This section examines whether the conclusions drawn about the movement and nature of inequality in Section 7.1 are sensitive to the choice of the price deflator. Sections 7.3.1 and 7.3.2 examine the sensitivity of inequality estimates to the price index for Australia and Canada respectively. To reduce the permutations of results, the sensitivity of inequality to the choice of price deflator in this section focuses on the middle sensitive I_1. Sections 7.3.1 and 7.3.2 also provide an insight into the effect of price movements on inequality by contrasting the inequality based on nominal measures of welfare with the inequality based on the CPI and CLI price deflated real measures.

7.3.1 Sensitivity of Australian Inequality to the Price Index

The magnitude and trend of Australian inequality estimates of equivalent expenditure and disposable income as presented in Tables 7.11 and 7.12, do not seem overly sensitive to the choice of price deflator. The apparent insensitivity of inequality to the price index is not surprising given that Table 6.10 (in Section 6.6) illustrated, that using the PS-QAIDS CLI resulted in similar rates of inflation for households characterised by different levels of total expenditure and different demographic structures than to the CPI inflation.

The PS-QAIDS and PS-AIDS CLI that allow for differing price effects for different levels of expenditure, report smaller falls in equivalent expenditure inequality from 1975-76 to 1984 and larger rise from 1993-94 to 1998-99 than the CPI based estimates. The variation in the CLI across households increased over those periods thus reducing the fall in inequality from 1975-76 to 1984 and increasing the rise from 1993-94.

Table 7.11 Australian I_1 Equivalent Expenditure Inequality Estimates by Price Index

I_1	Magnitude	Percentage Change				
Price Index	**1998-99**	**1975-76 to 1984**	**1984 to 1988-89**	**1988-89 to 1993-94**	**1993-94 to 1998-99**	**1975-76 to 1998-99**
PS-QAIDS	0.1570 (0.0103)	-13.8%	2.8%	-4.7%	3.4%	-12.7% -[1.25]
PS-AIDS	0.1542 (0.0100)	-13.7%	2.9%	-5.7%	2.7%	-14.1% -[1.40]
Stone	0.1535 (0.0100)	-12.7%	2.6%	-5.1%	1.4%	-13.8% -[1.35]
CPI	0.1547 (0.0100)	-15.1%	3.5%	-4.7%	1.9%	-14.7% -[1.46]
None (Nominal Figures)	0.1548 (0.0100)	-15.1%	3.7%	-4.8%	2.1%	-14.4% -[1.43]

Notes: Figures in ( ) denote standard errors of the estimates.
Figures in [ ] denote t-ratios of the absolute change in the estimates, for the periods stated.
All estimates are based on 'equivalent' measures of expenditure, using the PS-QAIDS equivalence scale to allow for variations in household size.
The Stone price index is a weighted average of prices where the weights are the actual budget shares of each household.

The use of nominal equivalent income and expenditure, yields inequality estimates that are very similar in magnitude and trend to the CPI based estimates. Since the I_1 is mean independent, the CPI only affects inequality through the regional differences in price experiences of the Australian capital cities.[13] The very minor difference between the magnitude and trend in inequality when deflating for prices using the state based CPI and the nominal estimates, indicates that regional price movements did little to alter the trend or magnitude in inequality. The QAIDS CLI, which allows for different price impacts across households, reports a smaller fall in expenditure inequality and a larger rise in disposable income inequality than the CPI over the whole sample period. This is particularly so from 1993-94 to 1998-99, when the price of health commodities rose by 20% and the price of food, which had been rising with the CPI, rose at 16% compared to the CPI, which rose by 11%. The Stone price index, in using households' actual budget shares to estimate a price index

[13] Using the national CPI figure, which does not differ across households, results in the same mean independent inequality as using nominal figures.

individual to each household, may best capture price effects for each household. Deflating nominal welfare measures using this price index, reports a smaller fall in expenditure inequality and a smaller rise in disposable income inequality, particularly from 1993-94 to 1998-99, suggesting that price movements have helped to reduce the inequality in Australia as proposed in Section 6.6.

Table 7.12 Australian I_1 Equivalent Disposable Income Inequality Estimates by Price Index

I_1	Magnitude	Percentage Change				
Price Index	**1998-99**	**1975-76 to 1984**	**1984 to 1988-89**	**1988-89 to 1993-94**	**1993-94 to 1998-99**	**1975-76 to 1998-99**
PS-QAIDS	0.1738 (0.0095)	7.0%	19.6%	1.0%	7.9%	39.5% [3.73]
PS-AIDS	0.1726 (0.0094)	7.0%	19.7%	0.6%	7.6%	38.6% [3.66]
Stone	0.1709 (0.0094)	6.7%	19.8%	0.9%	6.2%	36.9% [3.52]
CPI	0.1728 (0.0094)	6.0%	20.2%	1.3%	7.0%	38.0% [3.62]
None (Nominal Figures)	0.1728 (0.0094)	6.0%	20.4%	1.2%	7.1%	38.3% [3.63]

Notes: Figures in ( ) denote standard errors of the estimates.
Figures in [ ] denote t-ratios of the absolute change in the estimates, for the periods stated.
All estimates are based on 'equivalent' measures of disposable income, using the PS-QAIDS equivalence scale to allow for variations in household size.
The Stone price index is a weighted average of prices where the weights are the actual budget shares of each household.

7.3.2 Sensitivity of Canadian Inequality to the Price Index

Tables 7.13 and 7.14 provide the 1992 estimate and trend in I_1 Canadian real equivalent expenditure and disposable income, respectively, using different price indices. The magnitude and overall trend in inequality for both expenditure and disposable income in Canada are insensitive to the price index chosen, as are the Australian inequality estimates. Again this is not unexpected given that Table 6.11 in Section 6.6, demonstrates that the effective rates of inflation experienced through the PS-QAIDS CLI was neither different amongst different types of households or to that of the CPI. This result is consistent with Buse (1982), who found that the distribution of taxable income in Canada seemed unaffected by inflation from 1947 to 1978. The CLI from the PS-QAIDS and PS-AIDS reported a larger rise in both expenditure and income inequality from 1978 to 1982, than the CPI. This was due to the CLI for all households being lower than the CPI in 1978, resulting in higher measures of real (CLI adjusted) welfare and also lower inequality than the CPI measure. In 1982 the reverse was true, depressing real welfare and raising CLI inequality by more than the CPI measure.

Table 7.13 Canadian I1 Equivalent Expenditure Inequality Estimates by Price Index

I_1	Magnitude	Percentage Change			
Price Index	**1992**	**1978 to 1982**	**1982 to 1986**	**1986 to 1992**	**1978 to 1992**
PS-QAIDS	0.1115 (0.0065)	5.4%	4.9%	-2.6%	7.8% [0.93]
PS-AIDS	0.1115 (0.0065)	5.4%	5.0%	-2.6%	7.7% [0.93]
Stone	0.1120 (0.0065)	6.0%	4.3%	-1.8%	8.5% [1.01]
CPI	0.1114 (0.0065)	3.8%	5.6%	-2.3%	7.0% [0.85]
None (Nominal Figures)	0.1110 (0.0065)	4.8%	4.8%	-1.9%	7.7% [0.92]

Notes: Figures in ( ) denote standard errors of the estimates.
Figures in [ ] denote t-ratios of the absolute change in the estimates, for the periods stated.
All estimates are based on 'equivalent' measures of expenditure, using the PS-QAIDS equivalence scale to allow for variations in household size.
The Stone price index is a weighted average of prices where the weights are the actual budget shares of each household.

Note that the CPI used in this study varies across provinces and reports a smaller rise in expenditure and income inequality over 1978 to 1992 compared to nominal inequality. This suggests that regional price movements have helped to reduce the growth in inequality in Canada. The CLI deflated inequality estimates, which allow for the impact of price to vary across households, reports a larger rise in inequality over the sample period. The Stone price index, which may best capture the price effects on households, also reports a larger rise, suggesting that price movements in Canada have helped to increase the growth in inequality.

Table 7.14 Canadian I1 Equivalent Disposable Income Inequality Estimates by Price Index

I_1	Magnitude	Percentage Change			
Price Index	**1992**	**1978 to 1982**	**1982 to 1986**	**1986 to 1992**	**1978 to 1992**
PS-QAIDS	0.1357 (0.0074)	8.4%	9.9%	-4.1%	14.3% [1.74]
PS-AIDS	0.1357 (0.0074)	8.3%	10.0%	-4.1%	14.3% [1.74]
Stone	0.1360 (0.0075)	9.2%	9.9%	-3.6%	15.7% [1.90]
CPI	0.1356 (0.0074)	7.2%	10.5%	-3.9%	13.8% [1.69]
None (Nominal Figures)	0.1351 (0.0074)	7.9%	9.8%	-3.6%	14.3% [1.74]

Notes: Figures in ( ) denote standard errors of the estimates.
Figures in [ ] denote t-ratios of the absolute change in the estimates, for the periods stated.
All estimates are based on 'equivalent' measures of disposable income, using the PS-QAIDS equivalence scale to allow for variations in household size.
The Stone price index is a weighted average of prices where the weights are the actual budget shares of each household.

7.4 Sensitivity of Inequality Estimates to Sample Exclusion

Many studies of inequality frequently restrict the sample of survey data obtained from statistical agencies, by removing certain observations or focussing the study on a certain type of households. This restricts the inequality analysis to those observations or households selected and will bias the result if it is to be used as a national measure of inequality[14]. This study examines the sensitivity of the magnitude and trend in inequality to the exclusion of observations from the sample. In particular, removing: (i) multiple family households, (ii) non-working aged households[15], (iii) the top and bottom three percent and (iv) the top and bottom one percent, of observations from the distribution of the welfare variable in question from the sample. In addition to (i) to (iii) the top and bottom one percent of observations

[14] See Section 5.3 for a discussion of why restricting the sample is likely to lead to an unnecessary bias in inequality estimates.

[15] Working aged households are defined as those with a household head aged between 25 and 60 years.

from both the expenditure and income distributions are removed (iv) and (v) a combination of (i), (ii) and (v) are removed. The results for Australia and Canada are presented in Sections 7.4.1 and 7.4.2, respectively.

7.4.1 Sensitivity of Australian Inequality Estimates to Sample Exclusion

Tables 7.15 and 7.16 provide the Australian real equivalent expenditure and disposable income inequality, respectively, by various sample exclusions. The trend in expenditure inequality appears quite sensitive to the exclusion of observations from the sample. Not surprisingly, eliminating the extreme 1% and 3% of observations based on nominal welfare reduces the magnitude of inequality. However it also significantly reduces the fall in expenditure inequality in the full sample, resulting in a reported rise of 2.2% when exclusion (iii) is enforced. Restricting the sample to working aged household heads reduces the magnitude of inequality in 1998-99, but reports similar movements in inequality to the full sample from 1978 to 1992. The exception is from 1993-94 to 1998-99 when it only reports a small rise in inequality when ignoring the increase in the number of lower spending retired households. Restricting the sample to working aged, single family households and removing the extreme 1% of the expenditure and income distribution (i.e. exclusion (vi)), results in virtually no change in expenditure inequality over the sample period in contrast to the 12.7% fall reported in the full sample.

Table 7.15 Australian I_1 Real Equivalent Expenditure Inequality Estimates by Sample Exclusion

	Observations Excluded	Magnitude 1998-99	Percentage change 1975-76 to 1984	1984 to 88-89	1988-89 to 93-94	1993-94 to 98-99	1975-76 to 1998-99
	None	0.1570 (0.0103)	-13.8% -[1.24]	2.8% [0.26]	-4.7% -[0.54]	3.4% [0.37]	-12.7% -[1.25]
(i)	Number of Families in Household > 1	0.1593 (0.0106)	-15.8% -[1.44]	6.0% [0.55]	-3.4% -[0.38]	2.3% [0.24]	-11.8% -[1.15]
(ii)	Age of HH Head < 25 or Age of HH Head > 60	0.1321 (0.0088)	-14.2% -[1.16]	2.9% [0.25]	-1.8% -[0.18]	0.8% [0.08]	-12.6% -[1.15]
(iii)	Bottom and top 3% of household expenditure	0.1178 (0.0075)	-0.3% -[0.03]	2.1% [0.21]	-7.0% -[0.86]	7.9% [0.88]	2.2% [0.23]
(iv)	Bottom and top 1% of Household expenditure	0.1364 (0.0084)	-7.0% -[0.70]	1.6% [0.17]	-5.3% -[0.66]	6.4% [0.74]	-4.8% -[0.52]
(v)	Bottom and top 1% of household disposable expenditure and income	0.1346 (0.0083)	-7.2% -[0.71]	1.0% [0.10]	-5.4% -[0.68]	5.9% [0.68]	-6.1% -[0.66]
(vi)	Number of Families>1, Age of HH Head < 25 or Age of HH Head > 60, bottom and top 1% of household expenditure and disposable income	0.1163 (0.0076)	-6.4% -[0.57]	0.9% [0.09]	0.6% [0.07]	5.8% [0.63]	0.5% [0.05]

Notes: Figures in ( ) denote standard errors of the estimates.
Figures in [ ] denote t-ratios of the absolute change in the estimates, for the periods stated.
All estimates are based on 'real' 'equivalent' measures of disposable income, using the PS-QAIDS CLI and equivalence scale.

While Table 7.16 shows that the effect of sample restrictions is not so dramatic on disposable income inequality across the entire period of analysis, the combined exclusion results in considerable differences in the trend of inequality. The combined sample exclusion (vi), implied increases in disposable income inequality from 1975-76 to 1984 and 1988-89 to 1993-94 of approximately 20%, which are much higher than those reported by the full sample. It also reported a fall between 1984 and 1988-89 when compared to the full-sample trend that reported a 20% rise. The inequality of working households' reports a much smaller rise in income inequality than for the full sample, suggesting the distribution of labour income became less unequal relative to household income over the period. Restricting the analysis to single-family households does not seem to alter the magnitude or trend when compared to the full sample for both income and expenditure inequality. This suggests that proportion of households with multiple families is reasonably consistent across the welfare distribution.

Table 7.16 Australian I_1 Real Equivalent Disposable Income Inequality Estimates by Sample Exclusion

Observations Excluded		Magnitude	Percentage change				
		1998-99	**1975-76 to 1984**	**1984 to 88-89**	**1988-89 to 93-94**	**1993-94 to 98-99**	**1975-76 to 1998-99**
	None	0.1738 (0.0095)	7.0% [0.67]	19.6% [1.62]	1.0% [0.09]	7.9% [0.93]	39.5% [3.73]
(i)	Number of Families in Household > 1	0.1771 (0.0097)	7.2% [0.68]	22.6% [1.80]	1.6% [0.15]	6.8% [0.80]	42.5% [3.95]
(ii)	Age of HH Head < 25 or Age of HH Head > 60	0.1460 (0.0083)	13.4% [1.16]	19.1% [1.45]	5.1% [0.44]	0.2% [0.02]	42.2% [3.63]
(iii)	Bottom and top 3% of household expenditure	0.1623 (0.0088)	8.3% [0.76]	8.6% [0.85]	6.6% [0.73]	10.5% [1.26]	38.4% [3.58]
(iv)	Bottom and top 1% of Household expenditure	0.1690 (0.0091)	7.5% [0.71]	11.5% [1.06]	4.7% [0.50]	10.5% [1.26]	38.7% [3.66]
(v)	Bottom and top 1% of household disposable expenditure and income	0.1484 (0.0080)	10.9% [1.03]	1.1% [0.12]	11.0% [1.35]	14.1% [1.75]	42.1% [4.09]
(vi)	Number of Families>1, Age of HH Head < 25 or Age of HH Head > 60, bottom and top 1% of household expenditure and disposable income	0.1257 (0.0069)	19.4% [1.64]	-3.3% -[0.34]	21.7% [2.48]	7.6% [0.96]	51.3% [4.53]

Notes: Figures in ( ) denote standard errors of the estimates.
Figures in [ ] denote t-ratios of the absolute change in the estimates, for the periods stated.
All estimates are based on ‘real’ ‘equivalent’ measures of disposable income, using the PS-QAIDS CLI and equivalence scale.

7.4.2 Sensitivity of Canadian Inequality Estimates to Sample Exclusion

Table 7.17 provides estimates of Canadian expenditure inequality using I_1 for various sample exclusions.

Table 7.17 Canadian I_1 Real Equivalent Expenditure Inequality Estimates by Sample Exclusion

	Observations Excluded:	Magnitude	Percentage change			
		1992	**1978 to 1982**	**1982 to 1986**	**1986 to 1992**	**1978 to 1992**
	None	0.1115 (0.0065)	5.4% [0.69]	4.9% [0.63]	-2.6% -[0.33]	7.8% [0.93]
(i)	Number of Families in Household > 1	0.1122 (0.0065)	4.1% [0.52]	4.9% [0.63]	-2.0% -[0.26]	7.0% [0.84]
(ii)	Age of HH Head < 25 or Age of HH Head > 60	0.0947 (0.0060)	10.7% [1.15]	11.1% [1.23]	-1.7% -[0.20]	20.9% [2.10]
(iii)	Bottom and top 3% of household expenditure	0.0839 (0.0048)	2.6% [0.34]	1.8% [0.23]	-0.9% -[0.12]	3.5% [0.42]
(iv)	Bottom and top 1% of Household expenditure	0.0964 (0.0053)	2.8% [0.37]	2.8% [0.38]	-1.7% -[0.23]	3.8% [0.49]
(v)	Bottom and top 1% of household disposable expenditure and income	0.0946 (0.0052)	4.0% [0.53]	2.4% [0.33]	-1.9% -[0.25]	4.6% [0.58]
(vi)	Number of Families>1, Age of HH Head < 25 or Age of HH Head > 60, bottom and top 1% of household expenditure and disposable income	0.0783 (0.0046)	9.6% [1.08]	6.8% [0.83]	-1.6% -[0.20]	15.2% [1.64]

Notes: Figures in ( ) denote standard errors of the estimates.
Figures in [ ] denote t-ratios of the absolute change in the estimates, for the periods stated.
All estimates are based on 'real' 'equivalent' measures of disposable income, using the PS-QAIDS CLI and equivalence scale to allow for variations in prices and household size respectively.

Removing multiple families, restriction (i), from the sample does little to alter the magnitude or trend of inequality throughout the sample period. Restricting the sample to households with working aged heads (ii), reduces the magnitude of inequality but also indicates a much greater increase in expenditure inequality from 1978 to 1986. Removing the extreme 1% and 3% of households reduces the magnitude of inequality but also dampens the rise in inequality from 1978 to 1986 and the fall from 1986 to 1992. This confirms Macphail's (2000) conclusion for Canada[16].

[16] Macphail (2000) found that typical sample exclusion reduce the reported movement in inequality for Canada, over 1981 to 1989, using the Survey of Consumer Finance and other data

Restricting the sample to working aged, single family households and removing the extreme 1% of the expenditure and income distribution, exclusion (vi), results in an increase in expenditure inequality of 15.2% from 1978 to 1992, almost twice the rate reported by the full sample.

Table 7.18 Canadian I_1 Real Equivalent Disposable Income Inequality Estimates by Sample Exclusion

	Observations Excluded:	Magnitude	Percentage change			
		1992	**1978 to 1982**	**1982 to 1986**	**1986 to 1992**	**1978 to 1992**
	None	0.1357 (0.0074)	8.4% [1.12]	9.9% [1.11]	-4.1% -[0.47]	14.3% [1.74]
(i)	Number of Families in Household > 1	0.1370 (0.0075)	7.4% [0.99]	9.9% [1.11]	-3.1% -[0.36]	14.4% [1.75]
(ii)	Age of HH Head < 25 or Age of HH Head > 60	0.1196 (0.0067)	11.4% [1.35]	14.8% [1.59]	0.5% [0.05]	28.4% [3.04]
(iii)	Bottom and top 3% of household expenditure	0.0982 (0.0052)	6.8% [0.92]	-1.9% -[0.27]	3.4% [0.45]	8.3% [1.06]
(iv)	Bottom and top 1% of Household expenditure	0.1151 (0.0059)	7.4% [1.03]	0.1% [0.02]	3.4% [0.47]	11.2% [1.44]
(v)	Bottom and top 1% of household disposable expenditure and income	0.1127 (0.0059)	7.3% [1.00]	0.0% [0.00]	3.5% [0.48]	11.0% [1.41]
(vi)	Number of Families>1, Age of HH Head < 25 or Age of HH Head > 60, bottom and top 1% of household expenditure and disposable income	0.0991 (0.0052)	12.9% [1.59]	4.6% [0.63]	7.5% [0.99]	26.9% [3.05]

Notes: Figures in ( ) denote standard errors of the estimates.
Figures in [ ] denote t-ratios of the absolute change in the estimates, for the periods stated.
All estimates are based on ‘real’ ‘equivalent’ measures of disposable income, using the PS-QAIDS CLI and equivalence scale to allow for variations in prices and household size respectively.

Table 7.18 reports the Canadian disposable income inequality as measured by I_1 when various exclusions (i) to (vi) are imposed on the sample. Restricting the sample to households with working heads has a similar effect on the income distribution as for expenditure, increasing the upward trend from 1972 to 1986 and reducing the rise from 1986 to 1992. Removing extremes from the distribution, as in exclusions (iii) to (vi) of Table 7.18, does little to alter the trend from 1978 to 1982, but reduces the large rise in income inequality reported in the fall sample from 1982 to 1986, to virtually nothing. In addition, from 1986 to 1992 results from these restricted samples report a rise in inequality, in contrast to the fall recorded for the full sample over this same period. This indicates that the divergence in disposable incomes away from the centre of the distribution, of extremely income poor and rich families, from 1982 to 1986 and the convergence from 1986 to 1992, was chiefly responsible for the rise and fall in Canadian disposable inequality reported in the full sample.

7.5 Summary of Key Findings

The points below summarise the results of Chapter 7 about the nature, magnitude and trend in Australian and Canadian real adult equivalent expenditure and income inequality. In particular it also summarises the sensitivity of these results to equivalence scale, price index specification and sample exclusion. The final chapter of results, Chapter 8 decomposes the inequality reported in this by age of the household head, household type, and employment status and education level of the household head.

Australia

- Real equivalent disposable income inequality has been consistently rising throughout the period 1975-76 to 1998-99.
- Real equivalent expenditure inequality fell from 1975-76 to 1998-99, but rose in the two sub-periods 1984 to 1988-89 and 1993-94 to 1998-99.
- The inequality of disposable income was lower than that of expenditure at the beginning of the sample but rose to become higher than expenditure by 1993-94, in line with consumption smoothing theories in the absence of credit constraints.
- Disposable income inequality is higher in magnitude, for the I_0 measure, which is more sensitive to the lower part of the distribution than the I_1 or I_2 indices. The I_0 reports smaller falls and larger rises for expenditure and disposable income respectively, across the sample period, suggesting that

largest increase in equality has occurred in the lower section of the welfare distribution.

- These movements are broadly consistent for a range of equivalence scales, although the magnitude and the size of the movements vary between different scales. This is especially so for the per capita measures of welfare inequality and to a lesser extent the Engel and non-estimated scales, which inflate the magnitude of inequality and exaggerate the movement in inequality, while the per household estimates dampen movements.

- The PS-QAIDS CLI results in smaller rises and falls in expenditure and income inequality from 1975-76 to 1988-89 than the CPI, but larger rises in both from 1993-94 to 1998-99. This suggests that price movements in Australia from 1975-76 had generally helped to reduce inequality but from 1993-94 to 1998-99 they have contributed to inequality.

- The exclusion of certain observations from the sample has a significant effect in altering the magnitude and trend in expenditure inequality. For example removing the top and bottom 1% of the reported expenditure distribution, halves the reported rise from 1975-76 to 1984 and doubles the rise from 1993-94 to 1988-89 reported by the whole sample. Removing a large number of 'outlying' observations even results in no reported fall in expenditure inequality over the period 1975-76 to 1998-99. Sample exclusions also alter the size of the magnitude and trend in disposable income inequality within periods but still report a significant rise from 1975-76 to 1998-99.

- The rise in disposable income inequality was larger than rise in gross income inequality in Australia from 1993-94 to 1998-99, indicating that while the taxation system still reduced income inequality it was not so successful as it had been in the past.

Canada

- Real equivalent expenditure and disposable income inequality rose from 1978 to 1986 but fell from 1992.

- Disposable income inequality was higher than expenditure in 1978 and grew to be more so by 1992.

- Expenditure and disposable income inequality is reported as larger for the I_2 measure, which is more sensitive to the higher part of the welfare distribution than the I_0 or I_1 indices. The I_2 index also reports larger rises and smaller falls in both expenditure and disposable income respectively, across the sample period. This suggests that most of the changes in inequality in Canada have occurred from changes in the welfare levels of the better off households.

- From 1982 to 1986 changes in household composition resulted in significant difference in the inequality estimates for different equivalence scales, with the Engel, OECD and per capita predicting a fall in expenditure and income equality while the Barten and Price Scaled estimates predict a rise. From 1986 to 1992 while all equivalence scales predicted a small fall in inequality, the size varied, with the Engel scales reporting the smallest fall of 1% compared to the per household figure of a 7% fall.

- The PS-QAIDS CLI results in larger rises from 1978 to 1982 in inequality than the use of the provincial CPI, but marginally smaller rises from 1982 to 1986 and a larger fall from 1986 to 1992. From 1978 to 1992, the use of the provincial based CPI compared to no price index resulted in a lower trend in inequality, suggesting that regional price movements have helped reduce inequality. The use of the CLI increases the movement in inequality, back in line with the nominal welfare inequality, suggesting that differing price impact across households reduced the effect of any fall in inequality from regional price movements.

- Sample exclusions tend to reduce the magnitude of inequality and significantly affect the size of the increase in inequality from 1978 to 1986. Restricting the sample to household heads aged 25 to 60 years almost triples the rise in inequality reported in by the full sample. Removing a percentage of outlying observations from the raw expenditure and gross income distributions, halves the rise reported by the full sample.

Australia vs. Canada

- While the HES reports higher inequality in Australia than the FES does for Canada, it is difficult to compare the results due to the difference in recording periods of the two surveys

- Australian expenditure inequality is substantially higher than that for Canada, while the difference between disposable income inequalities is much smaller. Lending evidence to suggest that real equivalent expenditure inequality is higher in Australia than Canada.

- Australian expenditure inequality is higher for all nine of the commodities considered in the household budget except for household electricity and fuel, where expenditure inequality is higher in Canada.

- The fall in inequality expenditure of accommodation, being a large part of household budgets, has been a major source of the fall in Australian expenditure inequality from 1975-76 to 1993-94 and reduced the rise in Canadian expenditure inequality

- When using the bottom sensitive I_0 index Australian disposable income inequality has risen rapidly since the mid 1980s compared to Canada, which has only had slight rise in disposable income inequality through to 1992.

- When using the middle sensitive I_1 index, the rise in Australian disposable income inequality while still larger than rise for Canada is much smaller than the rise in the I_0 estimate of inequality.

- The rise in disposable income inequality in Australia compared to Canada has been more pronounced amongst the lower part of the welfare distribution.

- All sources of income exhibit more inequality in Australia than Canada, especially investment and government benefits income.

- The rise in wage income inequality for Australia from 1975-76 to 1993-94 and Canada from 1978 to 1992 was a major influence on the rise in disposable income inequality for the two countries over these periods.

- Regional price movements in Canada have helped to offset inequality, while in Australia they have done little to help reduce inequality. While allowing for differing impacts of price movements through the CLI, reduces this effect in Canada, in Australia it helped to reduce expenditure inequality from 1975-76 to 1993-94, but increased it from 1993-94 to 1998-99.

Chapter 8 Inequality Decomposition

This chapter exploits the additive decomposable property of the generalised entropy inequality indices, to examine some of the factors that have been responsible for changing inequality in Australia from 1975-76 to 1998-99 and Canada from 1978 to 1992. An additively decomposable inequality measure can be expressed as a weighted sum of the inequality values calculated for population groups ("within-group" inequality) and the contribution to the inequality of the population arising from inequality in the subgroup means ("between-group" inequality)[1]. The proportion that the between group inequality forms of total inequality can be used to measure the how much inequality can be explained by household characteristic used to group the households in the decomposition[2]. Decomposing inequality estimates over time provides an insight into whether the movements in inequality have been caused by changes in inequality within the sub-groups, changes in the sub-groups relative means or by movements in the population shares of the sub-groups.

This chapter decomposes Canadian and Australian household inequality by age of the household head (in Section 8.1) and demographic household type (in Section 8.2). The age of the household head can be assumed an indicator of the age of adult members of the house and is likely to affect household incomes through labour experience and education and expenditure due to lifecycle decisions. Differences between the real equivalent mean expenditures and disposable incomes of households grouped by age of the household head may be able to able to explain a sizeable portion of inequality for these reasons. A household's demographic type, defined by the number of working aged adults, non-working aged adults and children

[1] See Mookherjee and Shorrocks (1982)
[2] See Cowell and Jenkins (1995).

in the household, may also be able to account for some of the difference in household equivalent incomes. For example households with working age members with no children or retired members have the least time constraints on their available working time. Decomposition of inequality over time sheds light on whether the increase in income inequality for the two countries and movement in expenditure inequality is consistent between households of different demographic type and age.

Unfortunately other comparable decompositions between the two countries are not possible from the data used in this study. The employment status of the household head for the fortnight surveyed in the HES provides a useful insight into how employment status contributes to Australian inequality and is presented in Section 8.3.1. An interesting decomposition of inequality possible for the Canadian dataset is to group households by education status of the household head and is presented in Section 8.3.2. A household head's level and type of education is likely to effect the household's ability to earn income and its access to credit to smooth consumption.

The different reference periods of the Australian and Canadian household surveys, fortnightly and annually respectively make comparisons between the two countries at a point in time difficult especially when comparing income inequality as described in Section 5.2.1 and 7.1.3. The inequality within different groups of households will be particularly biased downwards in the fortnightly Australian estimates compared to the annual Canadian estimates. Examining the trend in inequality which is less effected by survey collection period particularly the between component of expenditure inequality provides some avenue for a useful comparison.

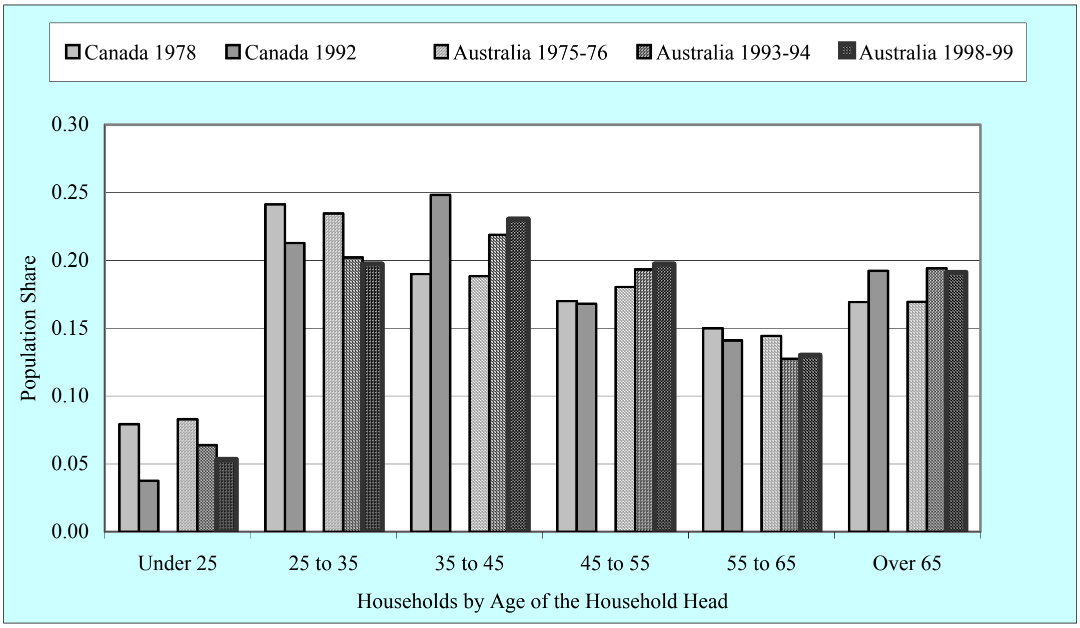
The mean logarithmic deviation of welfare, I_0, is chosen for the decomposition since it is more sensitive to the lower half of the welfare distribution, the poorest households than the other members of the Generalised Entropy Family of inequality measures, such as I_1 and I_2. The previous chapter in Section 7.2 illustrated that the trend in inequality is not sensitive between the estimated equivalence scales. It also demonstrated that the use of the PS-QAI CLI in measuring inequality did not substantially differ from that when using the state/provincial based CPI's. Thus for convenience and consistency all the decompositions and analysis following are based on the PS-QAIDS equivalence scale and cost of living index. Note that references to expenditure and income inequality denote real adult equivalent expenditure and disposable income inequality respectively.

8.1 Decomposition by Age of Household Head

The age of the household head is likely to reflect the life-cycle stage of a household and decomposing the households on this basis will allow the influence of life cycle variations in equivalent real expenditure on inequality to be examined. The household head's age is also likely to reflect experience in the labour market and influence household income. Paglin (1975) argued that when analysing income inequality the age component should be removed since it reflects that human capital is a function of age. His suggestion can easily be applied to the decomposition framework by ignoring the income inequality between groups of households of different ages and focusing on the inequality within each group.

Households were divided into six groups based on the age of the head beginning at less than 25 years and continuing with 10-year intervals to the final age group of over 65 years and for simplicity shall be referred to as "household age" or HDAGE. Figure 8.1 below provides the proportion of households that the six different age groups form of the total population of households, or "population share" for Australia in 1975-76, 1993-94 and 1998-99 and for Canada in 1978 and 1992. It illustrates that in the mid 1970s Australia and Canada had a very similar distribution of household age, with the highest proportion of households headed by persons aged 25 to under 35 years. Throughout the 1980s and early 1990s the Australian and Canadian household age distributions altered significantly. The slow down in the birth rate and the general aging of many western countries is evident for Australia and Canada in Figure 8.1. Both countries have experienced a decline in the proportion of households aged under 35 years and a increase in the proportion of households with heads aged 35 to 45 over 65 years.

Figure 8.1 Australian and Canadian Population Shares: by Age of Household Head (HDAGE)



8.1.1 Australian Decomposition by Age of Household Head

Table 8.1 contains the contribution of Australian inequality within and between households based on the age of the household head to total expenditure and disposable inequality for Australia. This table shows that the majority of disposable income and expenditure inequality is due to inequality within each age group rather than inequality between the different age groups who account for approximately 10% of the inequality across the sample period.

Table 8.2 breaks down the contribution to the movement in real equivalent expenditure and income inequality for each sub-period and the whole sample into

Table 8.1 Australian Within and Between Inequality by Age of Household Head (HDAGE)

Measure of Welfare	Composition of Inequality	1975-76	1984	1988-89	1993-94	1998-99
Expenditure Inequality I_0	Within HDAGE Inequality	88%	89%	87%	88%	90%
	Between HDAGE Inequality	12%	11%	13%	12%	10%
	Aggregate I_0	0.176	0.157	0.162	0.151	0.159
Disposable Income Inequality I_0	Within HDAGE Inequality	91%	90%	90%	89%	89%
	Between HDAGE Inequality	9%	10%	10%	11%	11%
	Aggregate I_0	0.144	0.156	0.178	0.200	0.236

Notes: All estimates are based on 'real' 'equivalent' measures of household welfare, using the PS-QAIDS CLI and equivalence scale to allow for variations in prices and household size.

changes from 'within' inequality, population shares (on 'within' and 'between' inequality) and 'between' inequality. Note that the percentage contribution may be over 100% when another component had an off setting effect to the change in aggregate inequality and is indicated by a negative percentage. Table 8.2 shows that from 1975-76 to 1998-99 most of the decrease in expenditure inequality and increase in income inequality has been due to decreases and increases, respectively of the inequality within age groups.

Movements in the population shares of the age groups increased expenditure inequality reducing the decline in expenditure inequality from 1975-76 to 1998-99, by almost 20%. This was chiefly due a rise in the number of households with heads over 65 from 1975-76 to 1984 with lower mean expenditure levels and higher inequality and a rise in the number of households with heads aged 45 to 55 from 1988-89 to 1993-94 with higher mean expenditure levels. The mean expenditure by age of household head has generally converged to one another over the period, with the exception from 1984 to 1988-89, contributing approximately 35% to the downward trend in expenditure inequality. The divergence in the mean equivalent disposable incomes of the age groups has contributed between 10% and 20% of the reported rise in income inequality, through out the sample periods. See Table 8.A1 and 8.A2 in the appendix for the movement in Australian mean real equivalent expenditure and disposable income (relative to the population mean), respectively.

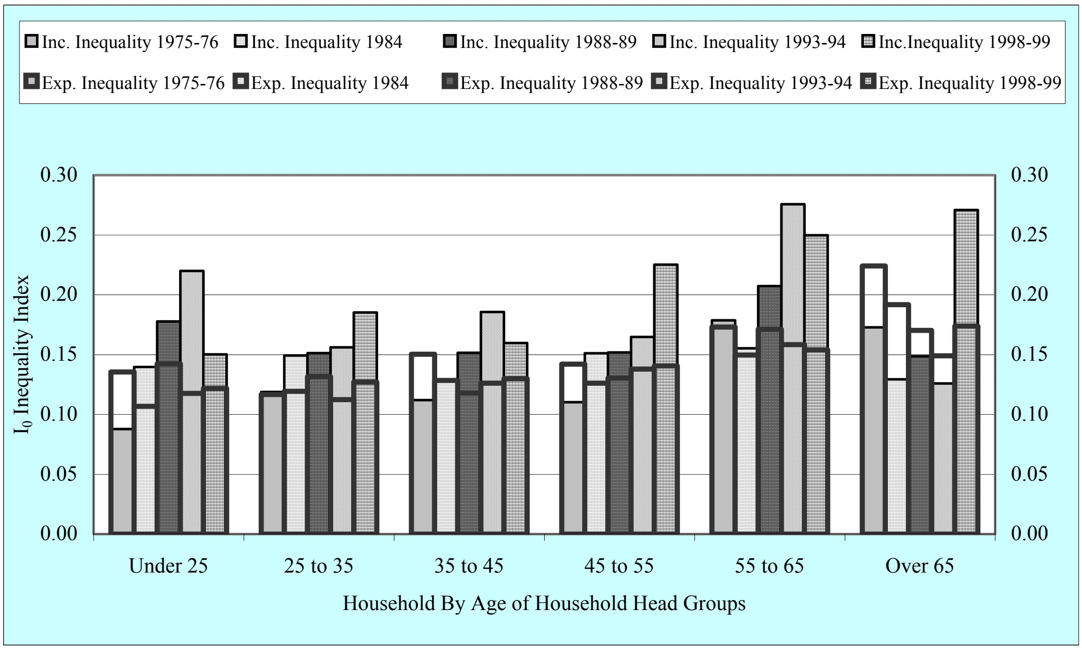
Table 8.2 Trend in Australian Inequality by Age of Household Head (HDAGE)

Composition of the movement in inequality I_0		**1975-76 to 1984**	**1984 to 1988-89**	**1988-89 to 1993-94**	**1993-94 to 1998-99**	**1975-76 to 1998-99**
Change in Expenditure Inequality		-1.87	0.48	-1.07	0.71	-1.74
	Within HDAGE Group Inequality	95%	50%	75%	122%	85%
Contribution due to changes in:	Population shares on within HDAGE group inequality	-12%	-13%	0%	2%	-10%
	Population shares on between HDAGE group inequality	-7%	-6%	-7%	-2%	-9%
	Mean HDAGE group expenditures	24%	70%	31%	-23%	35%
Change in Disposable Income Inequality		1.19	2.23	2.25	3.52	9.20
	Within HDAGE Group Inequality	68%	95%	82%	92%	87%
Contribution due to changes in:	Population shares on within HDAGE group inequality	8%	-3%	-7%	0%	-1%
	Population shares on between HDAGE group inequality	6%	0%	4%	0%	1%
	Mean HDAGE group disposable incomes	19%	9%	20%	8%	13%

Notes: All estimates are based on 'real' 'equivalent' measures of household welfare, using the PS-QAIDS CLI and equivalence scale to allow for variations in prices and household size.

In contrast to expenditure inequality, movements in population shares had little effect on the overall movement in income inequality across the sample period, with the exception of the first sub-period when movements in population shares where at their greatest. The increase in income inequality expected by the "aging of the population", that is, the increase in the proportion of the population with household head's aged 35 to 54 years with relatively high incomes and the increase in proportion of households with heads aged over 65 years with lowest mean income, has not eventuated. The large decline in the number of household with heads aged 25 to 35 years whose mean disposable income has risen over the sample period to become the 2nd largest of the groups in 1998-99 has offset much of the populations aging upon income inequality. The large decrease in the number of households with heads aged under 25 years, which in 1975-76 had the 2nd highest mean disposable income of the groups but in 1998-99 had a mean similar to that of the whole population has also offset the aging of the population.

Figure 8.2 Australian Real Equivalent Disposable Income and Expenditure Inequality: by Age of Household Head



Notes: Where expenditure inequality exceeds income inequality the bar is shown as blank.

Figure 8.2 provides the estimates for disposable income and expenditure inequality within each of the six households groups based on age of the household head. The solid bar, which is generally within the shaded bars, indicates the level of real equivalent expenditure inequality, where it exceeds the income inequality (the shaded bars) the area below the solid bar is blank. Notice that expenditure inequality increases with age from households whose head's are over 25 years as predicted by Deaton and Paxson (1994) model (see Section 2.3.2). In comparison disposable income inequality increases with age after 25 years, until retirement, with the exception of 1998-99 when income inequality has continued to rise for households whose head is aged over 65. Typically the loss of wage income and the addition of pensions and superannuation income are likely to result in lower income inequality for retired households compared to working aged households. The 1998-99 result may be explained by the diversity of investment in superannuation by such households. The higher income inequality in youngest aged households compared to those with heads aged 25 to 35 is higher, possibly due to the diversity of financial support and labour force decisions available for the youngest households. Since such households are likely to suffer liquidity constraints, they are also likely to exhibit higher expenditure inequality than households with head's aged 25 to 35

Income inequality for households with heads aged 55 years and under has been rising consistently from 1975-76 to 1993-94. This has also been true for households headed by a person aged 55 to under 65-years for this period, despite a decrease in income inequality in 1984. From 1993-94 to 1998-99 the trend in income inequality amongst the households by age of household head is mixed. The income inequality within household with heads aged less than 25 years has fallen substantially possibly due to the rise in unemployment and decreased participation in the labour market, reducing the high incomes of previously working young households. This is in contrast to the substantial rise in the inequality for households with heads aged over 65 years, as described in the previous paragraph. There are also moderate increases in income inequality for households with heads aged 25 to 35 and 45 to 55 years for the period 1993-94 to 1998-99 driving the rise income inequality.

The w-shaped downward sloping aggregate expenditure inequality is somewhat mirrored in the 'within' inequality measures for each household age category. The significant exception is the expenditure inequality for households with heads aged 65-years and over. It fell considerably from 1975-76 to 1993-94, before rising with the inequality of income from 1993-94 to 1998-99. The other notable exception to the general trend in the decline in expenditure inequality is for households with heads aged 25 to under 35-years the only age group to report a rise in expenditure inequality.

8.1.2 Canadian Decomposition by Age of Household Head

Table 8.3 presents the contribution of inequality within and between households based on the age of the household head, to total expenditure and disposable inequality for Canada. This table shows that as with Australia the majority of disposable income and expenditure inequality is due to inequality within each age group rather than inequality between the different age groups. Difference between mean levels of welfare between the six age groups explains slightly more of the variation in expenditures than incomes in Canada as for Australia. This suggests that life-cycle effects on household equivalent expenditure dominate age-experience effects on household equivalent income in their dispersion.

Table 8.3 Canadian Within and Between Inequality by Age of Household Head (HDAGE)

Measure of Welfare	Composition of Inequality	1978	1982	1986	1992
Expenditure Inequality I_0	Within HDAGE Inequality	79%	81%	86%	87%
	Between HDAGE Inequality	21%	19%	14%	13%
	Aggregate I_0	0.111	0.114	0.118	0.113
Disposable Income Inequality I_0	Within HDAGE Inequality	86%	89%	91%	91%
	Between HDAGE Inequality	14%	11%	9%	9%
	Aggregate I_0	0.130	0.138	0.146	0.148

Notes: All estimates are based on 'real' 'equivalent' measures of household welfare, using the PS-QAIDS CLI and equivalence scale to allow for variations in prices and household size.

Table 8.4 demonstrates that increases in the expenditure inequality within age groups had a large impact on increasing expenditure inequality, 358% the size of the small increase in Canadian equivalent expenditure from 1978 to 1992. However the convergence in the household age group's mean expenditure to the aggregate mean over time had a similar sized but opposite effect in cancelling out the rise in expenditure I_0 caused by rising within age group inequality. Also contributing to the small rise in expenditure inequality from 1978 to 1992 has the been the large rise (19% to 25%) in the proportion of households with heads aged 35 to 45 with higher mean equivalent expenditure and higher within expenditure inequality. To a lesser extent the rise in households with heads aged over 65 that have lower mean expenditure has also contributed to the rise in expenditure inequality.

The lower half of Table 8.4 shows that rises in the disposable income inequality within age groups accounted for 126% of the significant increase in aggregate disposable income inequality from 1978 to 1992. Note that the mean of real equivalent disposable income for each of the age groups has converged to the aggregate mean, reducing the increase in aggregate Canadian income inequality by 32%.

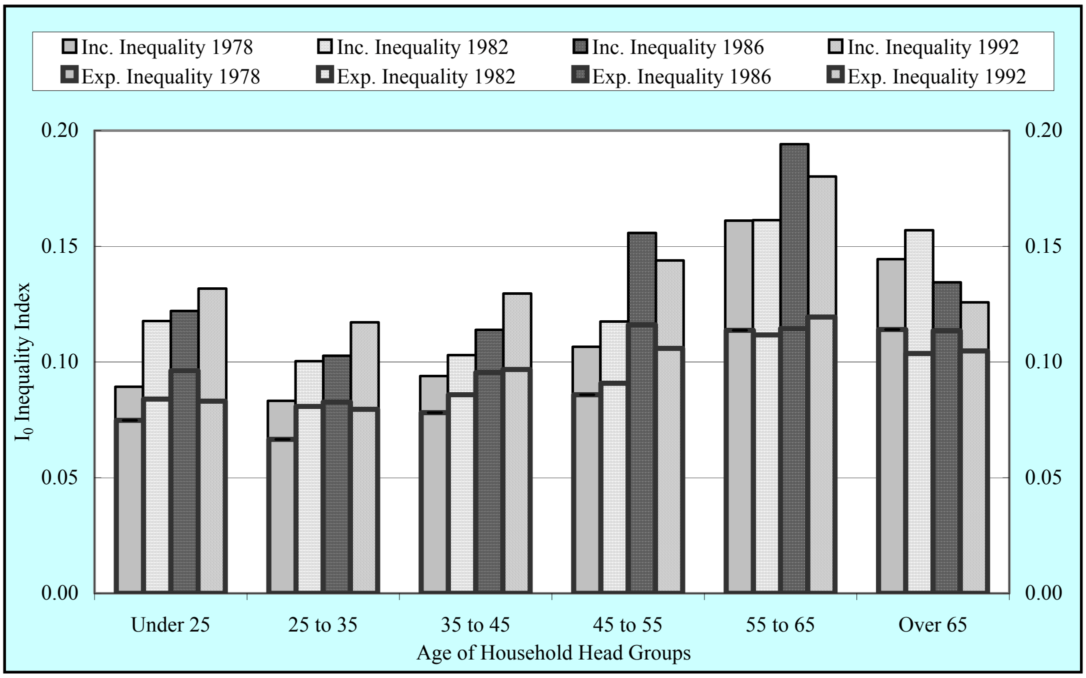
Table 8.4 Trend in Canadian Inequality by Age of Household Head (HDAGE)

Composition of the movement in inequality I_0		**1978 to 1982**	**1982 to 1986**	**1986 to 1992**	**1978 to 1992**
Change in Expenditure Inequality		0.32	0.41	-0.44	0.29
Contribution due to changes in:	Within HDAGE Group Inequality	143%	226%	82%	358%
	Population shares on within HDAGE group inequality	-7%	8%	-17%	29%
	Population shares on between HDAGE group inequality	21%	18%	-16%	75%
	Mean HDAGE group expenditures	-56%	-152%	51%	-362%
Change in Disposable Income Inequality		0.86	0.82	0.21	1.89
Contribution due to changes in:	Within HDAGE Group Inequality	140%	121%	87%	126%
	Population shares on within HDAGE group inequality	-6%	5%	17%	2%
	Population shares on between HDAGE group inequality	4%	6%	4%	5%
	Mean HDAGE group disposable incomes	-38%	-32%	-10%	-32%

Notes: All estimates are based on 'real' 'equivalent' measures of household welfare, using the PS-QAIDS CLI and equivalence scale to allow for variations in prices and household size.

Figure 8.3 provides the 'within' I_0 inequality index for real equivalent disposable income for Canada by groups of households based on the age of their heads. Notice again that expenditure inequality increases with age from households whose head's are over 25 years as for Australia and as suggested by Deaton and Paxson (1994), see Section 2.3.2. In comparison, disposable income inequality increases with age after 25 years, until retirement before falling, as the replacement of wage with pension and superannuation income reduces the income inequality. Figure 8.3 demonstrates that income inequality has been rising for all households with heads of working age (65 years or less) from 1978 to 1986 and for all households with heads under 45 years from 1986 to 1992. These "working aged" households are most exposed to uncertainty in the labour market compared to retired households.

Figure 8.3 Canadian Real Equivalent Disposable Income and Expenditure Inequality: by Age of Household Head



Notes: Where expenditure inequality exceeds income inequality the bar is shown as blank.

8.1.3 Australian and Canadian Decomposition by Age of Household Head

The convergence in both the mean expenditure and income of the Canadian household age groups to their respective aggregate means has had a significant effect in reducing the rise in Canadian inequality. Without this effect the rise in expenditure inequality would have been almost 3½ times as great, while the rise in income inequality would have been approximately 30% higher. While for Australia the mean income of the households grouped by age have diverged from the aggregate mean disposable income contributing 13% to the rise in income inequality. Yet the mean expenditures of such groups have converged contributing 35% to the fall in expenditure inequality.

Both countries have experienced a similar decrease in the proportion of households headed by an adult under 35 years and an increase in the proportion of households headed by an adult over 65 years. Movements in the population shares of households grouped by age have caused similar movements in the I_0 index of inequality for both countries, raising it by 0.33 (19% of the total fall) for Australia from 1975-76 to 1998-99 and by 0.29 for Canada from 1978 to 1992. The changing age distribution of household heads has little effect on either country's rise in income inequality over their respective sample periods.

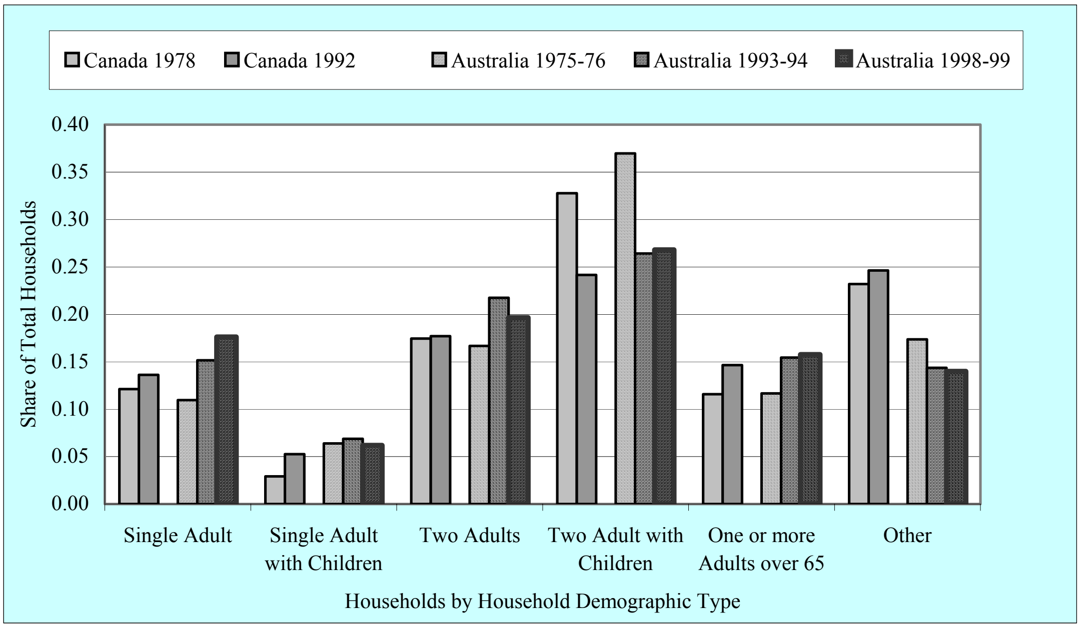
The majority of the movements in real equivalent expenditure and disposable inequality for the two countries have been due to increases in inequality within the households grouped by the age of the household head. That is the majority of the movements in real equivalent expenditure and disposable can not be explained by inequality between households grouped by the head's age or by movements in the population shares of such grouped households. See Section 7.1.3 for an explanation of the movements in inequality for the two countries, which is applicable for an explanation of the movements of inequality 'within' households grouped by the household head's age.

8.2 Decomposition by Household Type

The differences in household size and composition (or household type) are likely to affect households spending behaviour and their capacity to generate income. A decomposition of expenditure inequality by households', who only differ in their household demographic type and no other respect, when a perfect equivalence scale could be constructed, should in theory result in no 'between group' expenditure inequality. However if households of a particular size and composition have a higher mean level of spending for other reasons, such as their equivalent income, then differences in the mean equivalent level of expenditure will still exist. Households are divided into six groups, of single adults under 65 years, one adult under 65 years with children, two adults under 65 years, two adults under 65 years with children, adults over 65 years and other households not falling into the previous groups, chiefly consisting of multiple person households.

Figure 8.4 provides the population shares by the six demographic groups for Canada in 1978 and 1992 and Australia in 1975-76, 1993-94 and 1998-99. For a given period Australia and Canada have similar population proportions for the demographic groups. The exceptions are that Australia appears to have more single parent families than Canada, which has a higher proportion of other households, compared to Australia. From the mid 1970s to the early 1990s both Australia and Canada have experienced a dramatic decrease in two adult households with children, from a third to a quarter of the population. In contrast both have experienced an increase in the proportion of households with one or more adults over 65 years and single adult households over this period. The rise in single person households has been more dramatic in Australia and has continued into the late 1990s. Canada has experienced almost a doubling of the proportion of single parent households to 5%, while Australia's proportion has remained relatively constant at 6%. The proportion of two adult childless households has remained constant in Canada, however in Australia it increased from 1975-76 to 1993-94 before falling slightly in 1998-99.

Figure 8.4 Australian and Canadian Population Shares: by Household Demographic Type (HHT)



8.2.1 Australian Decomposition by Household Type

Table 8.5 illustrates that approximately 10% of the level of inequality in Australia can be explained by differences between mean levels of equivalent spending and income of households of different demographic types. This is a similar level explained by differences between mean levels of equivalent spending and income of households divided into groups based on the households heads age in 8.1.1. Thus while explaining a moderate proportion of expenditure inequality it suggests that there may be factors other than size and the presence of children captured in the equivalence scale, that are responsible for the inequality. Alternately the inequality may be caused by differences in unobserved characteristics and factors within groups of households.

The majority of the decrease in expenditure inequality is shown in Table 8.6, to be due to the decrease of equivalent expenditure inequality within household types

(127%), with the convergence in mean equivalent expenditure of the household types also contributing to the decline (49%).

Table 8.5 Australian Within and Between Inequality by Household Type (HHT)

Measure of Welfare	Composition of Inequality	1975-76	1984	1988-89	1993-94	1998-99
Expenditure Inequality I_0	Within HHT Inequality	89%	88%	88%	87%	90%
	Between HHT Inequality	11%	12%	12%	13%	10%
	Aggregate I_0	0.176	0.157	0.162	0.151	0.159
Disposable Income Inequality I_0	Within HHT Inequality	87%	86%	88%	88%	89%
	Between HHT Inequality	13%	14%	12%	12%	11%
	Aggregate I_0	0.144	0.156	0.178	0.200	0.236

Notes: All estimates are based on 'real' 'equivalent' measures of household welfare, using the PS-QAIDS CLI and equivalence scale to allow for variations in prices and household size.

Movements in the population towards more single adult and retired households with higher 'within' inequality and lower mean equivalent expenditure than the population average; have had a significant impact in raising expenditure inequality, offsetting the aggregate decrease by -76%.

Table 8.6 Trend in Australian Inequality by Household Type (HHT)

Composition of the movement in inequality I_0		1975-76 to 1984	1984 to 1988-89	1988-89 to 1993-94	1993-94 to 1998-99	1975-76 to 1998-99
Change in Expenditure Inequality		-1.87	0.48	-1.07	0.71	-1.74
	Within HHT Group Inequality	123%	71%	108%	128%	127%
Contribution due to changes in:	Population shares on within HHT group inequality	-26%	13%	-18%	12%	-47%
	Population shares on between HHT group inequality	-17%	-1%	-19%	0%	-29%
	Mean HHT group expenditures	18%	17%	29%	-39%	49%
Change in Disposable Income Inequality		1.19	2.23	2.25	3.52	9.20
	Within HHT Group Inequality	49%	100%	83%	86%	84%
Contribution due to changes in:	Population shares on within HHT group inequality	18%	6%	3%	6%	7%
	Population shares on between HHT group inequality	25%	-1%	11%	-1%	5%
	Mean HHT group disposable incomes	8%	-5%	3%	8%	4%

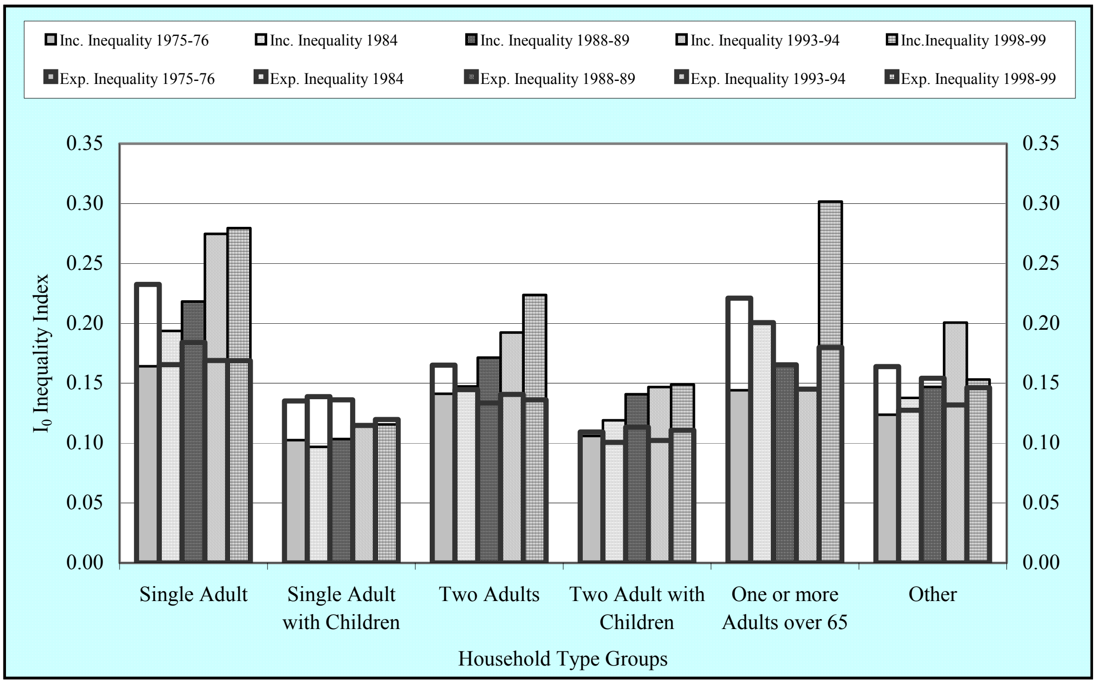
Notes: All estimates are based on 'real' 'equivalent' measures of household welfare, using the PS-QAIDS CLI and equivalence scale to allow for variations in prices and household size.

The lower half of Table 8.6 shows that approximately 85% in the rise of equivalent disposable income inequality can be attributed to increases in income inequality within households of different types. Movements in the population shares previously mentioned for expenditure inequality also contributed to the rise in income inequality (12%) as they did for expenditure inequality but to a much lesser degree. The divergence in the mean incomes of the household types away from one another contributed only 4% of the aggregate rise in income inequality for Australia from 1975-76 to 1998-99.

Figure 8.5 illustrates that in general across the sample period and in particular 1998-99, the income inequality of childless single and two adult households and those with one or more adults over 65 years exhibit the largest I_0 inequality index for the income and expenditure distributions. These households are likely to exhibit the highest inequality since they have the largest range of income earning possibilities compared to other households. Households with one or more adults over 65 years are likely to contain both single and two-adult retired households as well as households that contain workers. For example a retired adult's spouse may continue to work, or households with workers may be living with retired relatives. Childless households are more likely to earn income from self-employment and investment, which exhibit high income inequality compared to other income sources. Households without children also have the widest range employment opportunities, from not in the labour force to full-time work.

Childless households also display the largest increases in income inequality from 1975-76 to 1998-99, as the diversity of their income earning opportunities has grown. The trend in expenditure inequality for the six household types generally moves with the aggregate inequality, falling over the sample period 1975-76 to 1998-99, despite small increases from 1984 to 1988-89 and from 1993-94 to 1998-99. The exception to this is the expenditure inequality for two adult households with children, whose expenditure inequality was in 1998-99 much the same as it was in 1975-76.

Figure 8.5 Australian Real Equivalent Disposable Income and Expenditure Inequality: by Household Type



Notes: Where expenditure inequality exceeds income inequality the bar is shown as blank.

8.2.2 Canadian Decomposition by Household Type

Table 8.7 illustrates that there are significant differences in the mean levels of expenditure and income between household types contributing to inequality. The difference between household types mean expenditure and income levels in Canada, can account for slightly more expenditure inequality (approximately 15% across the sample) compared to approximately 10% for Australia.

Table 8.8 shows that increases in expenditure inequality within household types, particularly amongst two adult households with and without children has been the major source of the small rise in Canadian expenditure inequality. However the increase in the proportion of single adult, single adult with children and retired households with higher expenditure inequality and lower mean equivalent expenditure has also contributed to the rise in expenditure inequality.

Table 8.7 Canadian Within and Between Inequality by Household Type (HHT)

Measure of Welfare	Composition of Inequality	1978	1982	1986	1992
Expenditure Inequality I_0	Within HHT Inequality	81%	84%	86%	86%
	Between HHT Inequality	19%	16%	14%	14%
	Aggregate I_0	0.111	0.114	0.118	0.113
Disposable Income Inequality I_0	Within HHT Inequality	85%	89%	89%	89%
	Between HHT Inequality	15%	11%	11%	11%
	Aggregate I_0	0.130	0.138	0.146	0.148

Notes: All estimates are based on 'real' 'equivalent' measures of household welfare, using the PS-QAIDS CLI and equivalence scale to allow for variations in prices and household size.

Table 8.8 Trend Canadian in Inequality by Household Type (HHT)

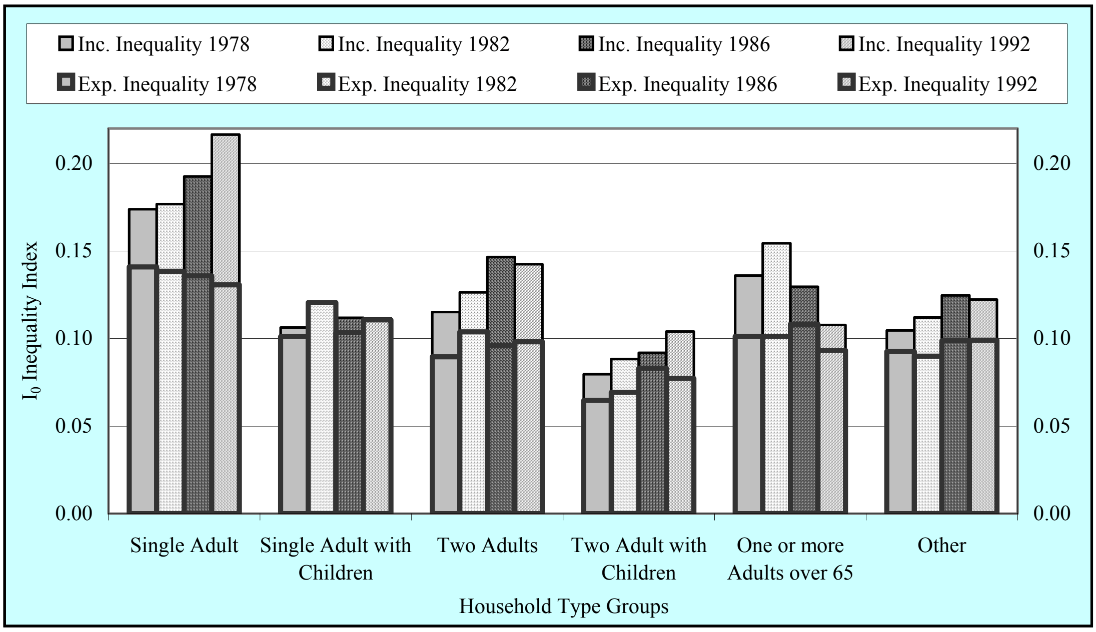
Composition of the movement in inequality I_0		1978 to 1982	1982 to 1986	1986 to 1992	1978 to 1992
Change in Expenditure Inequality		0.32	0.41	-0.44	0.29
Contribution due to changes in:	Within HHT Group Inequality	110%	112%	80%	160%
	Population shares on within HHT group inequality	79%	14%	-1%	109%
	Population shares on between HHT group inequality	50%	12%	-26%	113%
	Mean HHT group expenditures	-139%	-37%	46%	-278%
Change in Disposable Income Inequality		0.86	0.82	0.21	1.89
Contribution due to changes in:	Within HHT Group Inequality	108%	76%	98%	93%
	Population shares on within HHT group inequality	37%	10%	-17%	19%
	Population shares on between HHT group inequality	17%	6%	83%	19%
	Mean HHT group disposable incomes	-61%	8%	-62%	-31%

Notes: All estimates are based on 'real' 'equivalent' measures of household welfare, using the PS-QAIDS CLI and equivalence scale to allow for variations in prices and household size.

The convergence in mean levels of equivalent expenditure between household types has had a strong effect in lowering expenditure inequality, reducing much of the rise in Canadian expenditure from 1978 to 1992. The lower half of Table 8.8 demonstrates that an increase in disposable income inequality within household types has been the major contributor to the rise in total inequality. The population movements outlined above, also played a significant role in the rise of disposable income inequality. Convergence in the mean income levels of the household types from 1978 to 1982 and from 1986 to 1992 had a significant effect in reducing the rise in income inequality across the whole period.

The I_0 inequality index within each of the six household types is presented in Figure 8.6. Single adult households display the highest magnitude of disposable income and expenditure inequality, being almost twice as high as the inequality within other household types. To a lesser degree childless two adult households and households with one member aged over 65 years also present a higher level of income inequality. As mentioned previously for Australia these households are likely to have the widest range of income earning opportunities. In addition to this, single adult households over the period of a year have less capacity to reduce the variation in income unlike households with additional members. This explains to a large degree why annual income and expenditure inequality for single Canadian households is larger than other household types.

Figure 8.6 Canadian Real Equivalent Disposable Income and Expenditure Inequality: by Household Type



Notes: Where expenditure inequality exceeds income inequality the bar is shown as blank.

Single adult households also display the largest increases in income inequality from 1978 to 1992, as the diversity of their income earning opportunities has grown. Despite this their expenditure inequality is falling suggesting that higher income single person households are spending less while the income poor are spending more in 1998-99 than they were in 1975-76. This may be due to the increased availability and take-up of credit and increased consumerism amongst such households. In fact single person households and households with one more persons aged over 65 where the only household types to go against the aggregate trend of a mild growth in expenditure inequality over the period. Two adult households with and without children have also experienced a considerable rise in income inequality from 1978 to 1982 with moderate increases in expenditure inequality.

8.2.3 Australian and Canadian Decomposition by Household Type

Convergence in Australian expenditures of household grouped by demographic type contributed 49% of the decline in aggregate expenditure inequality from 1975-76 to 1998-99. While there was only a small effect, 4%, on the large rise in income inequality from divergence in the groups mean incomes. In contrast the mean incomes of Canadian households grouped by demographic type converged from 1978 to 1992 to the aggregate mean, reducing the rise in income inequality by 31%. The mean expenditures of the households grouped by household type also converged considerably, reducing the rise in expenditure inequality. Without this effect the rise in Canadian expenditure inequality from 1978 to 1992 would have almost been triple the reported rise of 0.29 in I_0.

Both Australia and Canada have recorded a similar large increase in the proportion of single person households and households with an adult over 65 years present and a decrease in childless two adult households. These population movements have raised inequality in the two countries over the respective sample periods. In Australia from 1975-76 to 1998-99, such population movements caused an increase in inequality, 76% the size or the reported decrease in aggregate expenditure inequality while contributing 12% to the large rise in income inequality. In Canada from 1978 to 1992 these population movements raised the I_0 index for expenditure inequality by 0.64 (over twice the size of the increase in aggregate expenditure inequality) and contributed 38% to the rise in disposable income inequality.

8.3 Other Decompositions

Unfortunately there are few other comparable decomposition that can be carried out both upon the Australian HES and Canadian FES data sets due to differences in variables contained in the surveys and also their definitions. Australian and Canadian inequality estimates were decomposed by state/ province but shed little light on the magnitude or trend in inequality for both countries. Two of the most interesting factors that may be affecting inequality are the changes in employment status of household heads and their level of education. Both are likely to significantly affect the income of a household and possibly their expenditure. Unfortunately employment status of the household head is not available from the FES and only the latest release of the HES has included education level of the household head. None the less, the decomposition by the household's head employment status for Australia and education status for Canada are preformed in Sections 8.3.1 and 8.3.2 respectively.

8.3.1 Australian Decomposition by Household Head's Employment Status

Households were divided into five groups depending on the employment status of the household's head; of full-time worker, part-time worker, self employed, unemployed and not in the labour force. The household head's employment status is likely to significantly affect household income and possibly expenditure recorded in a two-week period covered by the HES. Thus decomposing inequality by the head's employment status may be able to help explain inequality. Decomposing over time may shed light on the degree that the decline in full-time employment and rise in part-time employment and unemployment have affected Australian inequality over the sample period.

Figure 8.7 provides the Australian population shares of the five by the head employment status over the sample period. It demonstrates that the proportion of households headed by those in full-time work and self-employed has fallen, while the proportion of those not in the labour force or in part-time work has increased.

Figure 8.7 Australian Population Shares: by Employment of Household Head

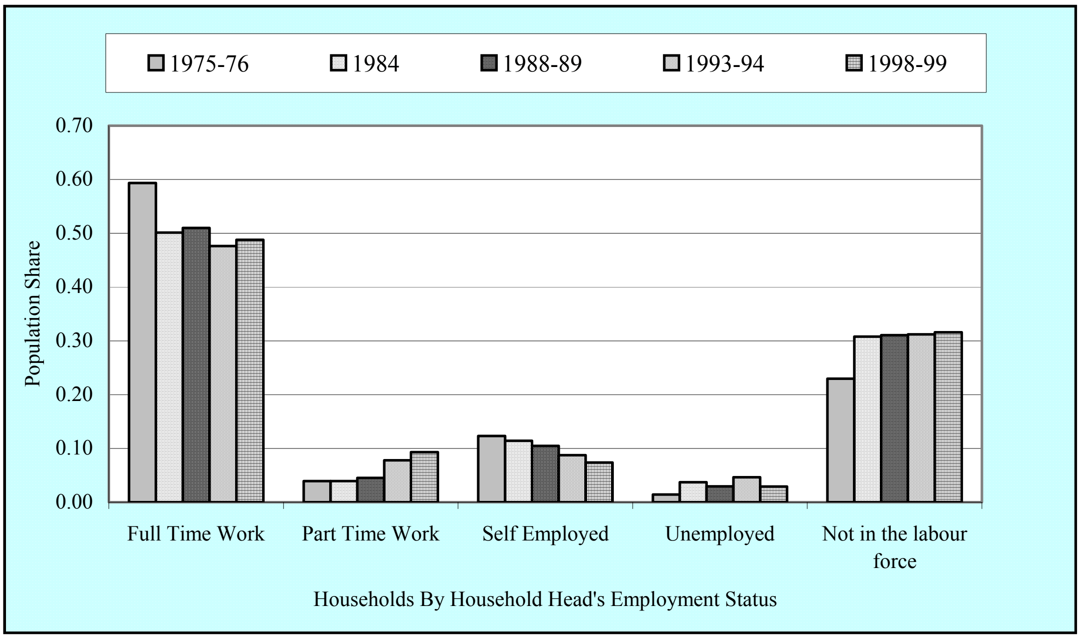


Table 8.9 illustrates that differences between the mean levels of expenditure and income of households with heads of different employment status, can account for approximately 20% of variation in equivalent spending and 30% of the differences in equivalent income. Thus employment status can be seen as one of the most significant contributors to the magnitude of inequality in Australia and its impact has been increasing from 1975-76 to 1998-99.

Table 8.9 Australian Within and Between Inequality by Household Head's Employment Status (HDEMP)

Measure of Welfare	Composition of Inequality	1975-76	1984	1988-89	1993-94	1998-99
Expenditure Inequality I_0	Within HDEMP Inequality	86%	84%	83%	82%	81%
	Between HDEMP Inequality	14%	16%	17%	18%	19%
	Aggregate I_0	0.176	0.157	0.162	0.151	0.159
Disposable Income Inequality I_0	Within HDEMP Inequality	80%	71%	73%	71%	69%
	Between HDEMP Inequality	20%	29%	27%	29%	31%
	Aggregate I_0	0.144	0.156	0.178	0.200	0.236

Notes: All estimates are based on 'real' 'equivalent' measures of household welfare, using the PS-QAIDS CLI and equivalence scale to allow for variations in prices and household size.

A decrease in the expenditure inequality within households with heads of different employment status is shown in Table 8.10 to be partly offset by population movements and divergence in expenditures. In particular an increase in the number of households with heads unemployed (with lower mean expenditures) and a rise in household heads part-time employed or not in the labour force (with higher 'within group' inequality), have been responsible for the reducing the decline in expenditure inequality. In addition the decline in spending by unemployed headed households and the increased spending of self-employed households also reduced the decline.

The lower half of Table 8.10 illustrates that only half of the growth in equivalent disposable income inequality can be explained by increases in inequality within groups of households based on their head's employment status. A divergence in the mean equivalent disposable income of households with heads in different employment situations has contributed 42% to the rise from 1975-76 to 1998-99. This has been the result of mean real equivalent income for households whose head is unemployed or not in the labour force remaining almost constant over the period while the incomes of other groups has increased, particularly full-time employed headed households. In addition increases in the proportion of households whose head was not in the labour force over the period has contributed about 8% of the rise.

Table 8.10 Trend in Australian Inequality by Household Head's Employment Status (HDEMP)

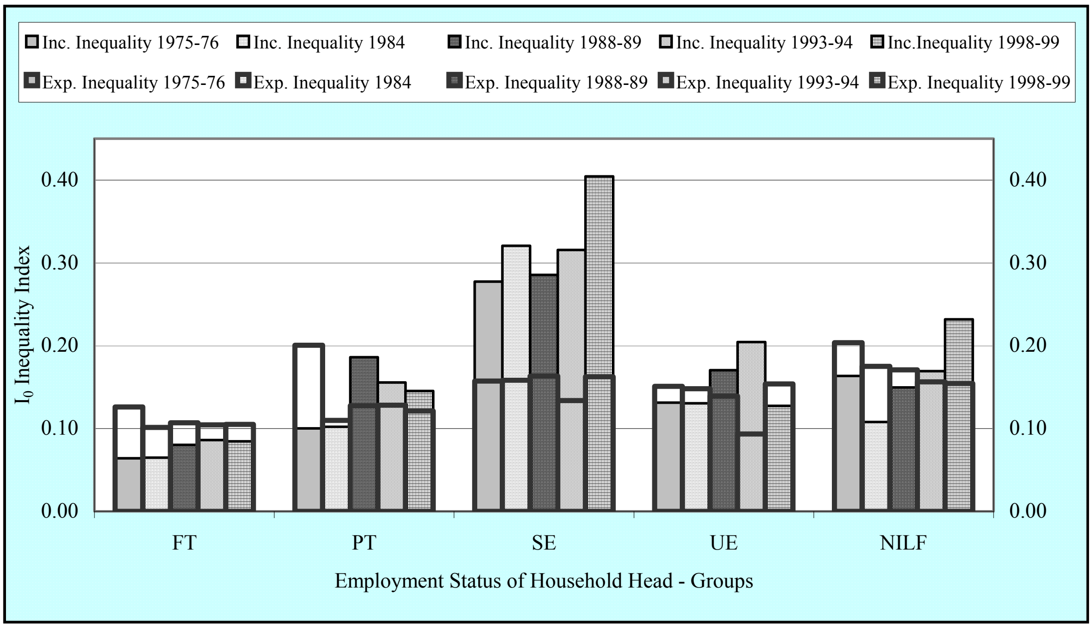
Composition of the movement in inequality I_0		1975-76 to 1984	1984 to 1988-89	1988-89 to 1993-94	1993-94 to 1998-99	1975-76 to 1998-99
Change in Expenditure Inequality		-1.87	0.48	-1.07	0.71	-1.74
Contribution due to changes in:	Within HDEMP Group Inequality	132%	52%	96%	51%	166%
	Population shares on within HDEMP group inequality	-34%	-12%	-2%	-6%	-32%
	Population shares on between HDEMP group inequality	-23%	-2%	-3%	-6%	-24%
	Mean HDEMP group expenditures	24%	62%	10%	60%	-10%
Change in Disposable Income Inequality		1.19	2.23	2.25	3.52	9.20
Contribution due to changes in:	Within HDEMP Group Inequality	-78%	97%	50%	63%	50%
	Population shares on within HDEMP group inequality	42%	-10%	4%	-10%	0%
	Population shares on between HDEMP group inequality	70%	-4%	8%	-6%	8%
	Mean HDEMP group disposable incomes	64%	17%	39%	53%	42%

Notes: All estimates are based on 'real' 'equivalent' measures of household welfare, using the PS-QAIDS CLI and equivalence scale to allow for variations in prices and household size.

Figure 8.8 shows that the inequality of real equivalent income for those households whose head is self-employed is highest compared to that of other households. This is explained by the diversity of business success vital to the income of self–employed households. Those households headed by full-time workers report the lowest income inequality compared to other households, since the diversity in the household incomes of full-time employed heads is much less than for employment situations.

Across the sample period 1975-76 to 1998-99 as a whole, within income inequality increased mildly for households whose head was in full-time, part-time, or self employment or not in the labour force, although movements in the sub-periods varied between the groups. In particular from 1993-94 to 1998-99 households whose heads were self-employed and those not in the labour force, experienced large increases in income inequality. Many of those households whose head is not in the labour force consist of retired households and other households with a high proportion of investment and other income, shown to be the most unequal source of income in Section 7.1.3.

Figure 8.8 Australian Real Equivalent Disposable Income and Expenditure Inequality: by Employment Status of Household Head.



Notes: Where expenditure inequality exceeds income inequality the bar is shown as blank.

The expenditure inequality between the groups is much less than that for income inequality. Indicating that despite the varying degrees of 'within' income inequality across the different household employment status groups, consumption smoothing provides a similar level of expenditure inequality between the groups. Note that the inequality of income for households with full-time working heads is greater than that for expenditure indicating that the diversity in consumption decisions outweighs the diversity of real equivalent income earning for these households in a fortnight.

8.3.2 Canadian Decomposition by Household Head's Education Status

Canadian households were divided into six groups depending on the education status of the household's head (HDED), of (i) less than 9 years of education, (ii) some or completed secondary education, (iii) some post-secondary education, (iv) post-secondary certificate or diploma and (v) university degree or higher. Figure 8.9 shows the population shares of households by education of the household head. It illustrates the proportion of households with heads with post-secondary certificate or diploma and above, increased from 1978 to 1992, while the proportion of households headed by adults with less than 9 years education has declined.

Figure 8.9 Canadian Population Shares: by Education of the Household Head (HDED)

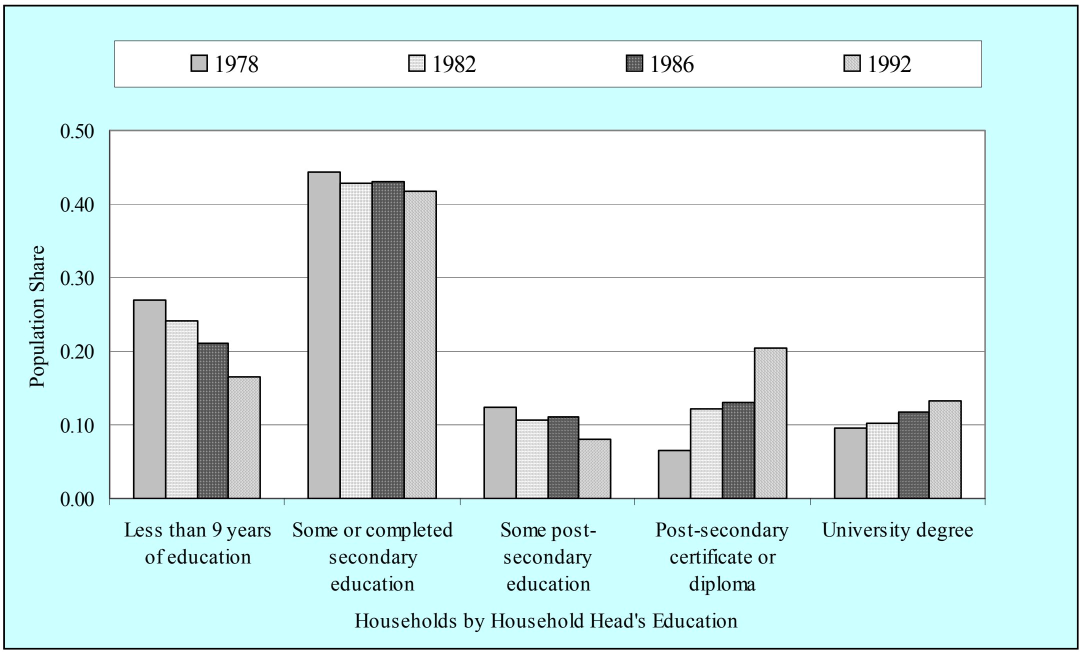


Table 8.11 on the following page, shows that differences between the mean levels of expenditure and income of households grouped by their head's education level, can account for approximately 17% of variation in equivalent spending and 19% of the differences in equivalent income. Thus the household head's employment status can explain a significant proportion of Canadian inequality, more than age or household demographic type.

Table 8.11 Canadian Within and Between Inequality by Household Head's Education Level (HDED)

Measure of Welfare	Composition of Inequality	1978	1982	1986	1992
Expenditure Inequality I_0	Within HDED Inequality	86%	82%	85%	83%
	Between HDED Inequality	14%	18%	15%	17%
	Aggregate I_0	0.111	0.114	0.118	0.113
Disposable Income Inequality I_0	Within HDED Inequality	83%	82%	83%	81%
	Between HDED Inequality	17%	18%	17%	19%
	Aggregate I_0	0.130	0.138	0.146	0.148

Notes: All estimates are based on 'real' 'equivalent' measures of household welfare, using the PS-QAIDS CLI and equivalence scale to allow for variations in prices and household size.

Table 8.12 decomposes the trend in household real equivalent expenditure and disposable income inequality over 1978 to 1992. Movements in the mean expenditures of the households grouped by education would have resulted in twice the reported rise in expenditure inequality if it had not been for movements in the population proportions of the households.

Table 8.12 Trend in Canadian Inequality by Household Head's Education Level (HDED)

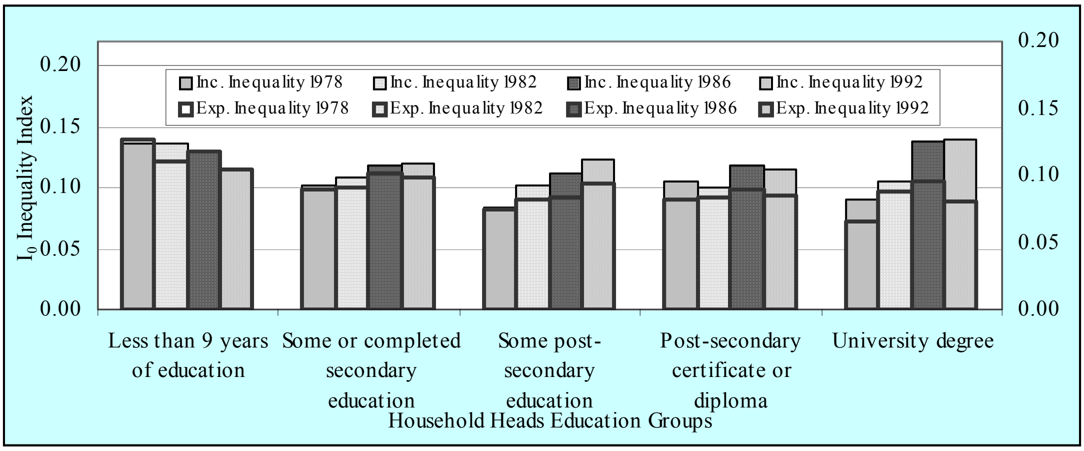
Composition of the movement in inequality I_0		1978 to 1982	1982 to 1986	1986 to 1992	1978 to 1992
Change in Expenditure Inequality		0.32	0.41	-0.44	0.29
Contribution due to changes in:	Within HDED Group Inequality	-10%	176%	108%	77%
	Population shares on within HDED group inequality	-37%	-17%	30%	-112%
	Population shares on between HDED group inequality	-7%	-8%	30%	-66%
	Mean HDED group expenditures	154%	-51%	-67%	200%
Change in Disposable Income Inequality		0.86	0.82	0.21	1.89
Contribution due to changes in:	Within HDED Group Inequality	66%	118%	-74%	73%
	Population shares on within HDED group inequality	-11%	-6%	6%	-7%
	Population shares on between HDED group inequality	-1%	2%	-46%	-5%
	Mean HDED group disposable incomes	46%	-14%	209%	38%

Notes: All estimates are based on 'real' 'equivalent' measures of household welfare, using the PS-QAIDS CLI and equivalence scale to allow for variations in prices and household size.

The increased proportion of more moderately educated households (with some post-secondary education) with higher expenditure and lower expenditure inequality at the expense of less educated households has helped to reduce expenditure inequality in Canada. Households with heads with some post-secondary education, tend to have lower income inequality since a higher proportion are full-time employed than households with less educated heads. Increases of 'within' education group income inequality could account inequality for 73% of the rise in I_0 income inequality from 1978 to 1992. Movements in the population shares had only a minor effect of, -12% in reducing the increase in Canadian disposable income inequality.

Figure 8.10 on the following page, demonstrates that in 1978 Canadian households headed by those with either very low or high levels of education had the highest magnitude of expenditure inequality (shown by the solid bars) compared to other more moderately educated households. Though by 1992 the reverse was true. The income inequality within each group rises as the household head's education level increases. Expenditure inequality tends to be highest amongst households whose head has had less than nine years of education and closely match income inequality. Such households are likely to face the tightest access to credit and a lower ability to smooth their consumption from fluctuations in income

Figure 8.10 Canadian Real Equivalent Disposable Income and Expenditure Inequality: by Education Status of Household Head



Notes: Where expenditure inequality exceeds income inequality the bar is shown as blank.

8.4 Summary of Key Results

The results of the decomposition analysis conducted on Australia from 1975-76 to 1998-99 and Canada from 1978 to 1992 are summarised below. The results are broken up into the decomposition by age of the household head, household demographic type and the other compositions preformed of employment status for Australia and education level for Canada. The final Chapter 9, summarises the thesis, discusses the limitations of the thesis and directions for future research, before concluding the thesis.

Decomposition by Age

- Differences between the mean expenditure and income of households with household heads of different age, accounts for approximately 10% of Australian inequality.
- Differences between mean expenditure of Canadian households with heads of different age accounts for slightly more than Australia, approximately 15% of total expenditure inequality.
- Approximately 85% of the decrease in expenditure inequality and the rise in income inequality in Australia can be explained by increases in inequality within age groups.
- The changing age distribution has had little to no effect on the decrease in expenditure inequality and the rise of income inequality in Australia.
- Large increases in inequality within age groups in Canada was partly offset by convergences in the mean levels of expenditure and disposable income of households with heads of different age.
- Population movements amongst the age groups in Canada had some effect in contributing to the small rise in expenditure inequality and moderate rise in disposable income inequality.

Decomposition by Household Type

- While the equivalence scale attempts to help explain variation in spending across households of different sizes and composition, substantial differences still exist in the mean level of spending and disposable income of households of different types.
- Differences between mean expenditure and incomes of households of different types can explain approximately 10% of the inequality in Australia across the sample period.

- This result is similar for Canada except that differences in the mean expenditure of households contributed approximately 15% of the expenditure inequality in Canada.

- The majority of the decrease in Australian expenditure inequality can be attributed to decreases in inequality within household types, with the convergence in mean equivalent expenditure of the household types also contributing to the decrease, while population movements in the proportion of household types offset some of the decrease.

- Population movements and divergence of the mean equivalent disposable income of household types could explain only a small proportion (15%) of the rise in Australian disposable income from 1975-76 to 1998-99.

- Increases in inequality within household demographic types and also increases in the proportion of single adult, single adult with children and retired households where partially offset by the convergence in the mean equivalent expenditure of household types, to result in a small increase in expenditure inequality for Australia.

- The population movements outlined in the previous point, had a more significant effect in explaining approximately 40% of the rise disposable income inequality in Canada. However this was offset by a convergence in the mean disposable income levels of household types, leaving almost 95% of the rise to be due to increases in income inequality within household types.

Other Decompositions

- Differences between mean expenditure and incomes between groups of households with different employment situations for their head, contributed 20% to expenditure and 30% to income inequality in Australia.

- Divergence in the mean disposable equivalent incomes of households with different employment status can explain just approximately 42% of the rise in income inequality in Australia across the sample period.

- Differences between mean expenditure and incomes between groups of households divided by the education status of the household head, contributed 19% to expenditure and 17% to income inequality in Canada. Thus education of the household head is able to explain more of the magnitude of Canadian inequality than age or household type.

- There has been a decrease in the income and expenditure of less educated households relative to more educated households contributing to the rise in inequality as well as a rise of inequality within most of the education groups.

- The improvement in the education of household heads has helped to offset the rise in expenditure inequality by pushing up the expenditure levels of the poor and moving them into higher education groups with relatively lower expenditure inequality.

Chapter 9 Summary and Conclusion

This thesis has examined the economic inequality of Australian and Canadian households in a framework based on utility maximising household behaviour theory. It has considered the implications for the measurement of inequality of different indicators of inequality, household welfare, equivalence scales, price indices and sample selection.

Australia and Canada have shared similar histories and experienced similar changes in economic and social trends in recent decades. Evidence on the inequality of income and expenditure provides an insight into the picture of the inequality of opportunity and living standards in the two countries. While economic growth generally delivers growth in average living standards, measures of inequality can indicate whether all households are enjoying the increase. The inequality of welfare impacts on the level of social cohesion or division within a nation. Increases in inequality may have such tangible effects as an increase in crime, political unrest and in extreme cases acts of rebellion or terrorism.

While the previous empirical literature on Australian and Canadian inequality is relatively extensive, few empirical studies have explicitly considered the assumptions and properties of the index or indicator used to measure inequality. Until recently, the empirical inequality literature had focussed on the inequality of income, where as this study also examines the inequality of expenditure. The specification of equivalence scales in studies of household inequality has frequently been of an ad hoc nature and there has been little to no use of cost of living indices. Many studies have focussed their attention on particular subsets of the population or excluded sample observations, making a consistent judgement on a nation's inequality difficult over time. This thesis also fills a void in providing a decomposition of magnitude and movement in the inequality of expenditure in addition to that of income, last preformed in the mid 1980s for Australia and Canada. With the addition of the recently available 1998-99 HES, this thesis also provides an insight into Australian inequality in through the late 1990s a period of solid economic growth.

To summarise, this thesis makes the following contributions:

Methodological

i) It considers the normative judgements made in measuring inequality, the desirable properties of inequality indices and the appropriate variable to use to represent household welfare.

ii) It accounts for differences amongst the demographic composition of households by using equivalence scales based upon an explicitly defined demographic extended demand system.

iii) It accounts for price movements, by developing a cost of living index based upon an explicitly defined demographic household cost function and complete demand system.

Empirical

iv) This thesis examines and compares the nature, magnitude and movement in the inequality of disposable income and expenditure of Australian households from 1975-76 to 1998-99 and Canadian households from 1978 to 1992.

v) It examines the sensitivity of the magnitude and movement in Australian and Canadian inequality to the choice of equivalence scale, price index and sample selection.

vi) It provides further insight into inequality in the two countries by decomposing the magnitude and trend in inequality by employment status and education level of the household head for Australia and Canada respectively and age of the household head and the demographic type of the household for both countries.

In Chapter 1 the following questions were raised:

1.2.1 How should inequality and household welfare be measured in light of variations in household demographic compositions and prices?

1.2.2 What has occurred to the inequality of welfare in Australia over 1975-76 to 1998-99 and Canada from 1978 to 1992?

1.2.3 How does the measurement of welfare impact on the reported level and trend in the inequality of welfare for Australia and Canada?

1.2.4 What economic or social changes can be identified as responsible for the magnitude and change in inequality in Australia and Canada?

The following Section 9.2 explains how this thesis answers these questions and provides a summary of the thesis major findings. Section 9.3 discusses the limitations and possible directions for future research in the area. Finally Section 9.4 concludes the thesis.

9.1 Summary of the Thesis

Chapter 1 introduced the thesis followed by Chapters 2 to 4, which addressed question 1.2.1. Chapters 5 to 6 were concerned with the methodology of the thesis and examined the data, equivalence scales and cost of living indices used in the inequality study. Questions 1.2.2 and 1.2.3 were dealt with in Chapter 7; the first empirical results chapter, before Chapter 8 addressed question 1.2.4 through decomposition of inequality.

In addressing question 1.2.1, how inequality should be measured, Chapter 2 considered the normative judgements required to make welfare comparisons and desirable properties of inequality indices. In light of this, it reviewed a range of inequality indices and selected the General Entropy class for much of the thesis' analysis due to its additive decomposability and other attractive properties.

Income as a measure of available resources has traditionally been the most popular measure of individual welfare, principally due to its availability. However cross sectional data on household income only provides a snapshot of current resources at a period of time and so captures temporary fluctuations in household income, exaggerating the inequality of household resources. Expenditure was argued in Chapter 2, to give a better indication of living standards since it indicates the level of household resources used, has a closer link to utility and forms the basis of money metric measure of welfare. Expenditure is also likely to be a more stable measure of well being if households smooth out the effect of income fluctuations on their spending and provides a better indicator of lifetime wealth than income. This provided the motivation for the dual investigation of income and expenditure inequality.

The chapter demonstrated that individuals' preferences must be identical and homothetic in order for inequality indices to be independent of prices and household demographic composition. A more attractive approach is to examine the distribution of money metric or real adult equivalent welfare by scaling the measure of nominal household welfare by a cost of living index and equivalence scale.

Chapter 3 reviewed the empirical literature on Australian and Canadian inequality throughout the latter half of the 20th century. Buse (1982), Wolfson (1987), Phipps (1993), Blackburn and Bloom (1994) and Pendakur (1998) generally found that Canadian income inequality was rising from the 1960s through to the 1990s although with some evidence that it declined in the 1970s and late 1980s. Most Australian studies have found that income inequality in Australia rose through the mid seventies to the early nineties, for example, Meagher and Dixon (1986), Saunders (1993), Borland and Wilkins (1996), and Harding (1997). The magnitude and timing and severity of the movements in income inequality differed slightly according to the data and/or sample selection, unit of analysis and the equivalence scale. Chapter 4 reviewed the theoretical and empirical literature on the estimation of equivalence scales, cost of living and price indices. It found that a wide range of equivalence scale estimates exist for Australia and Canada. It also explained the possible bias, particularly the substitution bias that may exist in the use of consumer price indices to account for prices in inequality studies.

The household survey and price data sets from the Australian Bureau of Statistics and Statistics Canada used in the study were discussed in Chapter 5. Problems in using the data to make inequality comparisons across years and between countries were examined and applicable remedies suggested. Chapter 5 discussed the joint issue of measurement error and sample selection and found in favour of using full samples from national survey data when performing inequality studies on countries. The budget shares from the data revealed that Australian and Canadian households have been increasing the proportion of expenditure spent on accommodation while decreasing the proportion on food. An analysis of the data revealed that the average size of Australian and Canadian households is similar, at approximately 2.6 persons in the early 1990s and declining at a similar rate. While the mean household disposable income and expenditure increased in Australia from 1975-76 to 1998-99 and in Canada from 1978 to 1992, they did not increase across all the sub-periods.

Chapter 6 presented the Price Scaled-Quadratic Almost Ideal Demand System (PS-QAIDS) model to provide a framework for the specification of the equivalence scales and cost of living index used in much of the study. The chapter also presented and compared a range of equivalence scale estimates. The equivalence scale estimated from QAIDS was quite similar to the AIDS based estimates for Australia, but the AIDS equivalence scales for Canada reported higher costs of children than the corresponding QAIDS estimates. The Barten equivalence scale estimates were found to be similar to the Price Scaled estimates, when allowance was made for household economies of scale. The Engel and OECD scales seem to overestimate the cost of children and large families, compared to the PS, Barten and Common scales. Thus the use of Engel or the OECD scale may bias the equivalent welfare of larger households, downwards. A test of the independence of the equivalence scale to reference utility in the AIDS model was rejected. This result disallows theoretically consistent welfare comparisons across households using such a scale, and only identifies equivalence scales across time. Cross household comparisons of welfare using a utility dependent scale are dependent upon the specification of the household's and reference household's cost function.

Chapter 6 also derived the cost of living index and implied price elasticities for Quadratic Almost Ideal Demand System (QAIDS) and for a demographically extended Price Scaled model, both of which appear to be missing in the literature. While the implied price elasticities from the cost of living index were found to vary significantly across Australian and Canadian households, prices of commodities have moved such that the change in the cost of living over time is relatively uniform across households.

In Chapter 7 the thesis found, in response to question 1.2.2, that real adult equivalent disposable income inequality of households has been rising in Australia consistently from 1975-76 to 1998-99, while real adult equivalent expenditure inequality recorded a fall over the period. In contrast the inequality of Canadian household real adult equivalent disposable income and expenditure have moved together, rising from 1978 to 1986 before falling in 1992. While the different survey periods make inequality comparisons over Australia and Canada difficult, Australia appears to have a higher magnitude of expenditure inequality compared to Canada. The decline in the inequality of accommodation expenditure has been significant for Australia and Canada in offsetting the rise in inequality of expenditure on food and alcohol and tobacco. The rises in wage inequality and to a lesser extent investment income inequality, were largely responsible for the rise in gross income inequality in both countries. The rapid rise in disposable income inequality reported in Australia from 1993-94 to 1998-99 is not reflected in the trend of gross income inequality. Which suggests that the direct taxation system of households significantly contributed to the rise in disposable income inequality over this later period, in contrast to 1975-76 to 1993-94.

In answer to 1.2.3 the thesis finds that the movement in Australian inequality is not overly sensitive to equivalence specification, although Engel and OECD scales tended to exaggerate the movement when compared to scales empirically estimated. The magnitude and the movement in inequality for both countries were found to be reasonably insensitive to the specification of price indices. Regional price movements in Canada have helped to reduce inequality, while in Australia they have done little to help reduce inequality. While allowing for differing impacts of price movements through the CLI, reduces this effect in Canada, in Australia it helped to reduce expenditure inequality from 1975-76 to 1993-94, although increased it form 1993-94 to 1998-99.

Excluding observations from the original sample was found to lower the recorded magnitude inequality and have extreme consequences on the trend in inequality. For example removing the top and bottom 1% of the reported Australian expenditure distribution, thirds the reported fall in expenditure inequality from 1975-76 to 1988-89 reported by the whole sample, while removing top and bottom 3% reports a rise in expenditure inequality. Removing households with heads who are not of working age from Canadian data, reports double the rise in expenditure and income inequality from 1978 to 1992, than when compared to the full sample.

To investigate some of the economic and social changes responsible for the magnitude and change in inequality in Australia and Canada over the sample period (question 1.2.4) the additive decomposability of the inequality index used was exploited. Chapter 8 decomposed the magnitude and trend in inequality by population groups based upon the household head's age and household demographic type for Australia and Canada. It also decomposed Australian inequality by employment status of the household head and Canadian inequality by education status of the household head. Employment status of the household head was found to explain approximately one third of the magnitude and rise in real equivalent disposable income inequality in Australia from 1975-76 to 1999-99. While for Canada the most significant contributor was the household heads education level, explaining one fifth of the magnitude of Canadian inequality from 1978 to 1992 and half the movement.

In contrast the age of the household head and the demographic type of the household could explain less than a sixth of the magnitude and trend in household inequality for both Australia and Canada. The aging of the populations was shown to have contributed to the small rise in expenditure inequality and moderate rise in disposable income inequality for Canada from 1978 to 1992, but had little effect upon Australian inequality from 1975-76 to 1998-99. The income inequality within groups of households based on the head's age has been rising for all groups in Australia over 1975-76 to 1998-99 and all pre-retirement aged households in Canada from 1978 to 1992.

Income inequality has been rising most significantly for childless one adult households and to a lesser extent two adult childless households in Australia and Canada. These households are likely exhibit the highest inequality since they have the largest range of income earning possibilities compared to other households and are more likely to earn income from self-employment and investment, which exhibit high income inequality compared to other income sources. Despite this the expenditure inequality of such childless households is falling suggesting that higher income childless working age households are spending less while the income poor are spending more. This may be due to the increased availability and take-up of credit and increased consumerism amongst such households.

9.2 Limitations and Directions for Future Research

For better comparisons across countries the survey data should ideally be drawn over identical periods, particularly for comparisons of income inequality. The fortnightly survey period of the Australia HES data and the annual survey period of the Canadian FES, make comparisons of inequality between the two countries problematic. The longer survey period of the FES provides a better indication of households' circumstances as it includes less temporary fluctuations in income and expenditure, then the fortnightly drawn HES. Ceteris paribus a survey of income (and to a lesser extent expenditure) drawn over a longer period will exhibit less inequality.

An interesting result revealed in this study for Australia is that while disposable fortnightly income inequality has increased significantly from 1975-76 to 1998-99, fortnightly expenditure inequality has fallen slightly. This may suggest that the income rich are earning more but spending less, while the income poor are earning less but spending more. This could have dire consequences for the poor if maintained over a longer period, eroding their wealth and sending them bankrupt. This begs the question of examining the trend and magnitude of the inequality of household wealth in Australia.

Unfortunately the cross sectional data used in this study for Australia only provides a fortnightly snapshot of households' savings behaviour and their investment income. Extrapolating this into wealth is problematic as the survey responses to income questions are often understated and is sensitive to the assumed rate of return on a household's investments. Thus to analyse the inequality of households lifetime welfare and/or wealth requires either, a panel data set tracking household income, expenditure and characteristics over time or a series of cross-sectional data on households that includes wealth is required.

Alternatively an accurate and well performing intertemporal model of household behaviour, incorporating expectations about, prices, income and family size may also allow estimates of households' lifetime welfare to be constructed. In addition the effects on that lifetime welfare of prices and family size and composition could be evaluated to give the lifetime cost of changes in prices or the presence of children.

A greater allowance could be made for the heterogeneity of household characteristics or situations that affect household behaviour, such as employment status, data allowing. This could provide more accurate equivalence scales and price indices, providing a more accurate picture of inequality. Greater disaggregation of commodities in the demand system analysis may result in a more useful cost of living index, capturing price movents in goods other than from the nine commodity groups used in this study. Developments in modelling the household demographic cost function, may allow the independence of base utility assumption to hold, theoretically justifying the use of equivalence scales to make welfare comparisons across households.

9.3 Conclusion

This thesis has examined the economic inequality of Australian and Canadian while explicitly considering the assumptions about household behaviour and the normative judgements about inequality being made in the process. It has found that while expenditure inequality has moved with income inequality in Canada, it has declined for Australia while income inequality continued to rise. The measurement of Australian and Canadian inequality is not overly sensitive to price index or equivalence scale used, but highly sensitive to the sub-sample used from survey data. The changing age and demographic structure of the Australian and Canadian populations have had little effect upon the movement in inequality, rather inequality movements within sub-groups have been responsible. The rise in part-time work and unemployment at the expense of full-time work can explain almost one third of the rise in income inequality in Australia, while improvements in education levels in Canada have helped to reduce the rise in inequality.

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Appendices

Appendix 2 for Ch 2 The Measurement of Inequality

Appendix 2.1 Basic Desirable Properties of the General SWF

The basic properties imposed the $f(\ )$ function of ordinal social welfare functions are listed below

$$SWF = f(\succeq_h) \text{ for all } h = 1,2,...,H \qquad (2.A1)$$

where the function $f(\ )$ gives the relationship between individual preference $\succeq_h$ orderings and the social orderings $\succeq$. In addition to constructing the social ordering of states the function $f(\ )$ is normally restricted to satisfy some basic desirable properties.

i) Transitive, Complete and Reflective

The SWF must result in social preference orderings $\succeq$ that are transitive, complete and reflective. This will in occur when the range of $f(\ )$ is restricted to individual preference orderings $\succeq_h$ that are transitive, complete and reflective. This property permits systematic social choice

ii) Unrestricted Domain (*U*)

If the function $f(\ )$ of the SWF, includes all possible combinations of *h* individual orderings $\succeq_h$ of the states ***s*** then it has an unrestricted domain. This allows individuals to have any preference ordering and for all orderings to be considered.

iii) Independence of Irrelevant Alternatives (*I*)

A SWF is independent of irrelevant alternatives if it's social ordering $\succeq$ of any pair states $\{s_1, s_2\}$ is only a function of the individuals preferences for those states $\succeq_h$. such that the $\succeq(s_1, s_2) = f(\succeq_h(s_1, s_2))$ for all $h = 1,2,...,H$ This allows pairs of states to be ranked without examining other states.

iv) Pareto Principle (*P*)

A SWF satisfies the weak Pareto principle if for any pair of states $\{s_1, s_2\}$ where all individuals prefer s_1 over s_2 or are indifferent, $s_1 \succ_h s_2$ for all *h* the function $f(\ )$ results in a social ordering that prefers to s_1 over s_2 or is indifferent such that, $s_1 \succ s_2$. $SWF = f(\succeq_h(s_1, s_2)) = s_1 \succ s_2$ if $s_1 \succ_h s_2$ for all $h = 1,2,...,H$

v) Non Dictatorship (D)

In order for the SWF to be non-dictatorial, there must be no individual d, which holds a dictatorial position. Thus no one person's preferences single-handedly determine the social ordering, such that $s_1 \succ_d s_2$ implies $s_1 \succ s_2$ for any ordered pair of states.

Appendix 2.2 Additional Properties to allow the construction of a SWFL

vi) Anonymity (A)

A SWF satisfies the property of anonymity if $SWF = f(\succeq_h) = f(\boldsymbol{P}\succeq_h)$ for all permutation matrices $\boldsymbol{P}$. A permutation matrix is a square bio-stochastic matrix, where each row and column randomly contains a single digit, unity, and zeroes in all other entries, for example $\boldsymbol{P} = \begin{bmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix}$. Therefore $\boldsymbol{P} \times \succeq_h$ is merely a re-arranging of the order that individual's preference relations $\succeq_h = \{s_1 \succeq_h s_2 \succeq_h ...\}$ in the function $f(\ )$ are considered. The property of *anonymity* requires that the inequality measure not be affected by the order in which economic agents are labelled and thus no special importance is given to who in particular hold which preference. This property is also termed *symmetry* and may be represented in two-person space by the social welfare function $I(\mathbf{w})$ being symmetric around the 45-degree line between the two people.

vii) Partial Independence of Irrelevant Alternatives (PI)

The Independence of Irrelevant Alternatives (I) is often relaxed since it does allow such ethical notions as horizontal equity where states that equalise welfare are preferred. If relaxed to Partial Independence of Irrelevant Alternatives (PI) the SWF is independent of all irrelevant alternatives other than the reference state $\widetilde{s}$, such that the social ordering $\succeq$ of any pair states $\{s_1, s_2\}$ is only a function of the individuals' preferences for those states $\succeq_h$. and the reference state $\widetilde{s}$ such that the $\succeq(s_1, s_2, \widetilde{s}) = f(\succeq_h(s_1, s_2), \widetilde{s})$ for all $h = 1, 2, ..., H$. This allows pairs of states to be ranked in terms of a reference state.

viii) Separability (*SE*)

Welfare functions are frequently specified as additively separable which allows a greater degree of permissible SWF. A SWF satisfies separability (*SE*) when it is independent of any individual *h,* who is indifferent to two alternate states s_1 and s_2 and thus has the same level of welfare in each state. Roberts (1980c) terms this as the elimination of the influence of indifferent individuals. An additional requirement of is required to allow greater choice of possible SWF is *SE** which is satisfied if, when an individual has the same level of welfare in all states excluding $\widetilde{s}$, then the social ordering over those states, $\widetilde{s}$, is independent of this level of welfare

Appendix 2.3 The Degree of Comparability and the *SWF*

Consider a utility function u^h that represents the preferences for each individual *h* and $\boldsymbol{\Phi}$ is a set of transformations $\boldsymbol{\Phi} = \{\Phi^1, \Phi^2, ...\Phi^H\}$ such that $\Phi^h(u^h)$ is an equally valid utility function for *h*. Any social ordering based on the u^h's, must be unaffected if each u^h is transformed by an arbitrary monotonic increasing transformation $\Phi^h(u^h)$ with the degree of comparability being examined as restrictions on the set of $\boldsymbol{\Phi}$ allowed. Sen (1977) and Roberts (1980c) classified the various forms of comparability as follows.

i) Ordinality and Non-Comparability (ONC)

$\boldsymbol{\Phi}$ is a set of independent strictly monotonically increasing transformations. This is the set of transformations when utility is viewed as only a representation or preferences in conditions of certainty and implies no comparisons can be made.

ii) ***Cardinality and Non-Comparability (CNC)***

$\boldsymbol{\Phi}$ is a set of independent strictly positive affine transformations:

$$\Phi^h\left(u^h\right) = a^h + b^h u^h \text{ , } b^h > 0$$

This is the set of transformations that allows expected Von Neumann-Morgenstern utility to be used to represent preferences when uncertainty is involved, without making any interpersonal comparisons possible.

iii) ***Ordinality and Level Comparability (OLC)***

$\boldsymbol{\Phi}$ is a set of identical strictly monotonically increasing transformations that are independent of *h*:

$$\Phi^h\left(u^h\right) = \Phi\left(u^h\right)$$

Under OLC it is possible to rank households in terms of their utility, but not differences in utility can not be compared.

iv) ***Cardinal Unit Comparability (CUC)***

$\boldsymbol{\Phi}$ is a set of identical strictly positive affine transformations that differ only in their constants:

$$\Phi^h\left(u^h\right) = a^h + bu^h \text{ , } b > 0$$

While CUC does not allow comparisons of the level of utility of households since the constants differ, it does allow examination of gains and losses.

v) ***Cardinal Full Comparability (CFC)***

$\boldsymbol{\Phi}$ is a set of identical strictly positive affine transformations:

$$\Phi^h\left(u^h\right) = a + bu^h \text{ , } b > 0$$

CFC is the maximum degree of comparability in that it allows for comparisons of levels and changes in utility without the introduction of a natural zero.

vi) ***Cardinal Ratio Comparability (CRC)***

$\boldsymbol{\Phi}$ is a set of identical strictly positive linear transformations:

$$\Phi^h\left(u^h\right) = bu^h \text{ , } b > 0$$

With the introduction of a natural zero, CRS allows ratio comparisons of utility, such household A is twice as well of as household B if it's utility level is twice as high.

Appendix 2.4 Statistical Measure of Inequality

Relative Mean Deviation (*RMD*)

One method of evaluating the distribution of welfare is by summing the absolute difference of each welfare level with the mean as a proportion of the total welfare. Namely the relative mean deviation:

$$RMD = \sum_{h=1}^{H} \frac{|w_h - \overline{w}|}{H\mu},$$

where $\overline{w} = \sum_{h=1}^{H} w_h \Big/ H$ is the mean level of welfare. Perfect equality is given by $RMD = 0$ and bounded above by $RMD = \frac{2(n-1)}{n}$. Unfortunately RMD is not at all sensitive to transfers from a richer to a poorer person if they both lie below or above the mean. Such a transferring of 1 unit of welfare would result in the $|w_i - \overline{w}|$ gap increasing by 1 for the poorer person and decreasing by 1 for the richer person.

Variance (*V*)

Rather than the absolute differences the variance uses the squared deviations, accentuating differences furthest from the mean.

$$V = \sum_{h=1}^{H} \frac{(w_h - \overline{w})^2}{H}$$

Any transfer from a richer to a poorer person, *ceteris paribus*, will result in a decrease in V, and thus satisfies the Pigou-Dalton Principle of Transfers. However, the size of the variance is dependent on the mean level of welfare $\overline{w}$.

Coefficient of Variation (*CV*)

The Coefficient of Variation (*CV*) overcomes the mean independence problem by square-rooting the variance (*V*) and expressing it as a proportion of mean welfare $\overline{w}$.

$$CV = \frac{\sqrt{V}}{\overline{w}}$$

The *CV* applies equal weight to transfers at different welfare levels, the impact of a transfer from a person with a measure of welfare of *w* to one with *w-a*, is the same regardless of the value of *w*. This property may not be considered desirable, although is useful for a point of reference.

The Standard Deviation of Logarithms (SDL)

A method to attach more weight to transfers to the lower end of the distribution is to transform the measure of welfare by taking its logarithm. It also has the advantage of mean independence in that scaling welfare will be an addition to welfare in logarithmic form and thus vanish when pair wise differences are being taken. The standard deviation of logarithms is thus commonly used as a measure of inequality.

$$SDL = \sqrt{\sum_{h=1}^{H} \frac{\left(\log \overline{w} - \log w_h\right)^2}{H}}$$

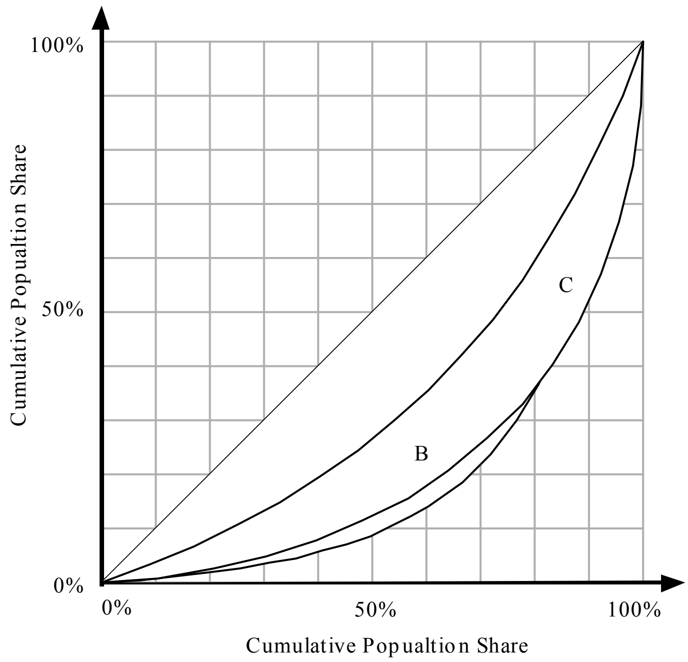
The logarithmic transformation reduces the overall deviation but highlights differences at the lower end of the distribution. However it is not strictly concave in welfare, with the logarithm compressing the level of welfare at higher levels and does not satisfy the principle of transfers at such higher levels.

The Lorenz Curve (L)

Lorenz's (1905) curve provides a useful graphical tool for representing a summary of a welfare distribution. The Lorenz curve is constructed by arranging the data in ascending welfare order, then graphing the cumulative share of welfare against the cumulative population share. If all units had identical welfare levels then the Lorenz curve would be a diagonal from (0%, 0%) to (100%, 100%). Thus the Lorenz curve shows diagrammatically, the relationship between the proportion of the population on the x-axis and the proportion of total resources they enjoy on the y-axis.

Although the Lorenz curve does not assign an index it can be used to unambiguously rank the inequality of welfare distributions when two distributions do not intersect. Figure 2.4 shows that distribution A is everywhere above distribution B and closer to the line of equality. A is unambiguously considered a more equal distribution of welfare than B, when the principle of transfers holds, as it is possible to move from A to B, by a series of transfers from rich to poor units. Similarly C is more unequal than A, but since B and C intersect more restrictive assumptions are required in order to rank the distributions. A decision must be made on the sensitivity of transfers beyond the principle of transfers, since distribution B has greater inequality at the upper tail, while C has more inequality in the bottom of the tail.

Appendix Figure 2.1 Intersecting and Non-Intersecting Lorenz Curves



Generalised Lorenz Curve (*GL*)

While Lorenz curve can be used to rank the equality of welfare distribution, when the means of the distribution differ it can not be used to rank the two distributions in terms of social welfare. For example a welfare distribution may be more unequal than another but if everyone in it receives more welfare than in the more equal distribution, it could hardly be considered worse.

Shorrocks (1983) and Kakwani (1984) developed the Generalised Lorenz (*GL*) curves, which allow comparisons of alternate distributions of welfare, where the mean differs. A Generalised Lorenz curve (*GL*) is the Lorenz Curve scaled by the mean, with each income share being multiplied by the mean. Thus it relates the cumulative amount of income rather than its proportion to the cumulative population share. Thus the Generalised Lorenz curve may be used to rank welfare distributions with differing means when the curves do not intersect. This makes it easier to compare welfare distributions across time.

Appendix 5 for Ch 5 Data and Methodology

Appendix Table 5.1 Australian Prices for HES Expenditure groups re-based to 1988-89 by State and Territory

	Year.Qtr	FOOD	ACCOM	POWER	CLOTH	TRANS	HEALTH	ALCT	REC	MISC	CPI
N.S.W	1975-76	0.33	0.35	0.30	0.37	0.33	0.23	0.31	0.33	0.34	0.33
	1984	0.73	0.68	0.73	0.72	0.71	0.66	0.70	0.77	0.68	0.71
	1988-89	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	1993.3	1.17	1.09	1.16	1.12	1.22	1.32	1.42	1.19	1.32	1.18
	1993.4	1.18	1.07	1.16	1.12	1.22	1.33	1.44	1.21	1.33	1.18
	1994.1	1.19	1.07	1.16	1.11	1.22	1.37	1.46	1.19	1.35	1.18
	1994.2	1.18	1.09	1.16	1.11	1.24	1.37	1.49	1.21	1.36	1.19
	1998.3	1.35	1.15	1.22	1.12	1.36	1.72	1.86	1.29	1.66	1.32
	1998.4	1.37	1.15	1.22	1.12	1.36	1.71	1.86	1.30	1.67	1.32
	1999.1	1.39	1.16	1.22	1.12	1.35	1.55	1.87	1.31	1.71	1.33
	1999.2	1.39	1.16	1.22	1.12	1.37	1.55	1.88	1.31	1.71	1.33
Victoria	1975-76	0.31	0.37	0.28	0.36	0.33	0.23	0.33	0.33	0.34	0.33
	1984	0.72	0.69	0.81	0.70	0.73	0.66	0.72	0.77	0.66	0.71
	1988-89	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	1993.3	1.16	1.03	1.35	1.14	1.23	1.47	1.41	1.22	1.34	1.20
	1993.4	1.16	1.02	1.36	1.14	1.24	1.48	1.43	1.23	1.34	1.20
	1994.1	1.16	1.02	1.36	1.13	1.23	1.54	1.44	1.23	1.38	1.20
	1994.2	1.16	1.02	1.36	1.13	1.26	1.56	1.45	1.23	1.38	1.21
	1998.3	1.33	1.00	1.26	1.15	1.30	1.94	1.79	1.34	1.63	1.30
	1998.4	1.34	1.00	1.30	1.14	1.29	1.92	1.80	1.34	1.63	1.31
	1999.1	1.35	1.00	1.30	1.14	1.28	1.74	1.82	1.36	1.68	1.31
	1999.2	1.36	1.01	1.27	1.14	1.30	1.75	1.83	1.34	1.68	1.32
Queensland	1975-76	0.32	0.38	0.29	0.37	0.32	0.23	0.32	0.33	0.34	0.33
	1984	0.74	0.76	0.79	0.72	0.72	0.66	0.68	0.77	0.70	0.73
	1988-89	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	1993.3	1.16	1.14	1.07	1.11	1.20	1.32	1.44	1.17	1.40	1.18
	1993.4	1.17	1.13	1.07	1.11	1.21	1.31	1.46	1.19	1.40	1.19
	1994.1	1.18	1.14	1.07	1.10	1.20	1.36	1.46	1.19	1.45	1.19
	1994.2	1.17	1.14	1.08	1.10	1.22	1.37	1.48	1.21	1.46	1.20
	1998.3	1.32	1.17	1.08	1.10	1.30	1.82	1.86	1.30	1.79	1.32
	1998.4	1.33	1.18	1.08	1.11	1.30	1.80	1.86	1.32	1.79	1.32
	1999.1	1.34	1.17	1.08	1.10	1.29	1.61	1.87	1.33	1.84	1.32
	1999.2	1.34	1.18	1.08	1.10	1.31	1.62	1.88	1.33	1.84	1.32
South Australia	1975-76	0.32	0.39	0.25	0.35	0.31	0.23	0.33	0.33	0.33	0.33
	1984	0.73	0.74	0.79	0.70	0.70	0.66	0.70	0.77	0.68	0.72
	1988-89	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	1993.3	1.16	1.07	1.17	1.13	1.25	1.63	1.50	1.20	1.40	1.21
	1993.4	1.17	1.06	1.17	1.12	1.25	1.62	1.51	1.20	1.41	1.21
	1994.1	1.18	1.05	1.17	1.11	1.25	1.73	1.54	1.20	1.46	1.22
	1994.2	1.19	1.06	1.17	1.11	1.26	1.77	1.56	1.21	1.47	1.23
	1998.3	1.32	1.03	1.29	1.11	1.29	2.08	1.85	1.28	1.82	1.32
	1998.4	1.35	1.04	1.30	1.11	1.29	2.07	1.85	1.28	1.83	1.32
	1999.1	1.34	1.03	1.30	1.09	1.28	1.82	1.86	1.30	1.89	1.32
	1999.2	1.35	1.04	1.30	1.11	1.30	1.82	1.88	1.30	1.89	1.32

Appendix Table 5.1 Australian Prices for HES Expenditure groups re-based to 1988-89 by State and Territory (continued)

	Year.Qtr	FOOD	ACCOM	POWER	CLOTH	TRANS	HEALTH	ALCT	REC	MISC	CPI
Western Australia	1975-76	0.31	0.39	0.28	0.36	0.31	0.23	0.31	0.33	0.33	0.33
	1984	0.73	0.68	0.80	0.70	0.72	0.66	0.69	0.77	0.68	0.71
	1988-89	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	1993.3	1.17	1.04	1.18	1.13	1.22	1.37	1.35	1.16	1.37	1.17
	1993.4	1.17	1.03	1.18	1.13	1.23	1.38	1.41	1.18	1.38	1.18
	1994.1	1.17	1.03	1.18	1.13	1.22	1.41	1.42	1.16	1.41	1.18
	1994.2	1.17	1.04	1.18	1.14	1.24	1.41	1.44	1.16	1.41	1.18
	1998.3	1.35	1.07	1.22	1.10	1.32	1.78	1.72	1.27	1.68	1.30
	1998.4	1.36	1.08	1.22	1.11	1.31	1.77	1.72	1.29	1.68	1.30
	1999.1	1.37	1.07	1.22	1.09	1.30	1.63	1.74	1.30	1.72	1.30
	1999.2	1.38	1.08	1.22	1.10	1.32	1.63	1.76	1.30	1.73	1.31
Tasmania	1975-76	0.31	0.43	0.24	0.36	0.31	0.23	0.29	0.33	0.34	0.33
	1984	0.73	0.75	0.74	0.71	0.70	0.66	0.64	0.77	0.70	0.71
	1988-89	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	1993.3	1.17	0.99	1.31	1.13	1.18	1.58	1.42	1.17	1.41	1.19
	1993.4	1.18	0.97	1.32	1.13	1.18	1.58	1.43	1.20	1.41	1.19
	1994.1	1.19	0.97	1.32	1.12	1.18	1.62	1.44	1.17	1.47	1.20
	1994.2	1.19	0.98	1.32	1.12	1.19	1.62	1.44	1.19	1.47	1.20
	1998.3	1.32	1.03	1.41	1.11	1.27	2.12	1.71	1.28	1.75	1.31
	1998.4	1.32	1.03	1.40	1.12	1.25	2.09	1.70	1.30	1.75	1.31
	1999.1	1.33	1.02	1.42	1.11	1.25	1.83	1.73	1.31	1.80	1.31
	1999.2	1.34	1.02	1.43	1.10	1.27	1.84	1.71	1.30	1.80	1.31
ACT	1975-76	0.31	0.35	0.29	0.35	0.31	0.23	0.31	0.33	0.33	0.32
	1984	0.76	0.80	0.68	0.80	0.69	0.66	0.69	0.77	0.68	0.74
	1988-89	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	1993.3	1.17	1.14	1.09	1.07	1.18	1.47	1.34	1.13	1.25	1.17
	1993.4	1.18	1.12	1.09	1.07	1.19	1.48	1.41	1.18	1.26	1.19
	1994.1	1.18	1.13	1.09	1.07	1.17	1.52	1.42	1.15	1.28	1.18
	1994.2	1.19	1.14	1.09	1.09	1.19	1.51	1.44	1.16	1.29	1.19
	1998.3	1.31	1.22	1.15	1.09	1.27	1.76	1.70	1.22	1.45	1.30
	1998.4	1.33	1.22	1.15	1.08	1.26	1.77	1.69	1.23	1.45	1.30
	1999.1	1.32	1.22	1.16	1.07	1.25	1.65	1.71	1.22	1.48	1.30
	1999.2	1.33	1.23	1.16	1.06	1.25	1.65	1.72	1.21	1.49	1.30
Northern Territory	1975-76	0.34	0.39	0.18	0.37	0.31	0.23	0.31	0.33	0.34	0.33
	1984	0.76	0.74	0.71	0.71	0.72	0.66	0.69	0.77	0.72	0.72
	1988-89	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	1993.3	1.18	1.13	1.20	1.14	1.24	1.38	1.37	1.19	1.33	1.19
	1993.4	1.19	1.12	1.20	1.13	1.25	1.38	1.39	1.19	1.33	1.20
	1994.1	1.20	1.12	1.20	1.13	1.23	1.41	1.40	1.19	1.37	1.20
	1994.2	1.19	1.13	1.19	1.13	1.25	1.42	1.42	1.20	1.38	1.20
	1998.3	1.37	1.07	1.34	1.14	1.36	1.78	1.74	1.27	1.70	1.30
	1998.4	1.38	1.07	1.33	1.14	1.35	1.76	1.73	1.28	1.71	1.31
	1999.1	1.38	1.07	1.33	1.13	1.34	1.59	1.76	1.29	1.75	1.30
	1999.2	1.38	1.07	1.34	1.13	1.36	1.59	1.75	1.27	1.75	1.31

Appendix Table 5.2 Canadian Prices for FES Expenditure groups re-based to 1988-89 by Province

	Year	FOOD	ACCOM	POWER	CLOTH	TRANS	HEALTH	ALCT	REC	MISC	CPI
Atlantic	1978	0.49	0.56	0.40	0.53	0.49	0.45	0.32	0.49	0.68	0.53
	1982	0.79	0.80	0.82	0.80	0.77	0.71	0.54	0.72	1.04	0.76
	1986	0.92	0.91	0.98	0.89	0.91	0.88	0.80	0.88	0.91	0.92
	1992	1.12	1.11	1.25	1.15	1.09	1.16	1.38	1.12	1.20	1.15
Quebec	1978	0.51	0.54	0.45	0.61	0.49	0.52	0.37	0.55	0.46	0.51
	1982	0.77	0.74	0.82	0.80	0.81	0.74	0.57	0.74	0.66	0.75
	1986	0.91	0.90	0.94	0.90	0.94	0.90	0.88	0.88	0.90	0.91
	1992	1.09	1.14	1.28	1.21	1.10	1.19	1.51	1.12	1.23	1.16
Ontario	1978	0.53	0.54	0.45	0.57	0.47	0.52	0.37	0.51	0.43	0.50
	1982	0.76	0.73	0.79	0.78	0.76	0.74	0.56	0.72	0.64	0.73
	1986	0.91	0.87	0.96	0.88	0.91	0.89	0.83	0.87	0.88	0.88
	1992	1.09	1.12	1.24	1.14	1.12	1.18	1.38	1.12	1.16	1.14
Prairie Provinces	1978	0.49	0.56	0.40	0.53	0.48	0.45	0.32	0.49	0.68	0.54
	1982	0.79	0.80	0.82	0.80	0.76	0.71	0.54	0.72	1.04	0.78
	1986	0.92	0.91	0.98	0.89	0.89	0.88	0.80	0.88	0.91	0.91
	1992	1.12	1.11	1.25	1.15	1.11	1.16	1.38	1.12	1.20	1.15
British Columbia	1978	0.56	0.62	0.54	0.60	0.47	0.54	0.39	0.54	0.46	0.54
	1982	0.80	0.85	0.85	0.83	0.77	0.80	0.59	0.72	0.67	0.79
	1986	0.93	0.93	1.00	0.92	0.91	0.92	0.83	0.90	0.91	0.92
	1992	1.17	1.13	1.15	1.14	1.17	1.15	1.37	1.13	1.18	1.17
National	1978	0.52	0.55	0.45	0.58	0.47	0.50	0.36	0.52	0.50	0.50
	1982	0.78	0.76	0.81	0.79	0.78	0.74	0.56	0.73	0.74	0.75
	1986	0.92	0.90	0.97	0.89	0.92	0.89	0.83	0.88	0.90	0.90
	1992	1.11	1.12	1.24	1.16	1.12	1.17	1.41	1.12	1.19	1.15

Appendix 6 for Ch 6 Household Composition and Prices

Appendix Table 6.1 Australian Demand System Estimates

Parameter	PS-AIDS	GCS-AIDS	PS-QAIDS
Log Likelihood	1,148,301	1,148,313	1,149,264
α_1	0.7228 (0.0033)	0.7294 (0.0035)	0.7505 (0.0168)
α_2	0.3120 (0.0065)	0.3117 (0.0066)	0.8456 (0.0310)
α_3	0.1867 (0.0009)	0.1889 (0.0009)	0.4766 (0.0040)
α_4	-0.0345 (0.0033)	-0.0351 (0.0033)	-0.2488 (0.0216)
α_5	-0.1769 (0.0064)	-0.1813 (0.0065)	-0.3158 (0.0369)
α_6	0.1254 (0.0025)	0.1266 (0.0025)	-0.0871 (0.0148)
α_7	-0.1129 (0.0047)	-0.1155 (0.0047)	-0.2254 (0.0280)
α_8	0.0668 (0.0030)	0.0663 (0.0030)	-0.2778 (0.0194)
α_9	-0.0894 (0.0033)	-0.0910 (0.0033)	0.0821 (0.0176)
β_1	-0.0923 (0.0006)	-0.0935 (0.0007)	-0.1026 (0.0066)
β_2	-0.0089 (0.0011)	-0.0089 (0.0012)	-0.2093 (0.0113)
β_3	-0.0277 (0.0002)	-0.0281 (0.0002)	-0.1364 (0.0017)
β_4	0.0166 (0.0006)	0.0167 (0.0006)	0.0969 (0.0079)
β_5	0.0579 (0.0011)	0.0587 (0.0011)	0.1101 (0.0132)
β_6	-0.0106 (0.0005)	-0.0108 (0.0005)	0.0691 (0.0056)
β_7	0.0402 (0.0008)	0.0407 (0.0008)	0.0825 (0.0099)
β_8	-0.0022 (0.0006)	-0.0021 (0.0006)	0.1271 (0.0074)
β_9	0.0270 (0.0006)	0.0273 (0.0006)	-0.0373 (0.0062)
θ	0.3670 (0.0078)	0.3684 (0.0077)	0.3700 (0.0063)
κ_1	0.3033 (0.0449)	0.2566 (0.0451)	0.2937 (0.0331)
κ_2	0.4881 (0.0488)	0.4424 (0.0490)	0.4481 (0.0332)
κ_3	0.6491 (0.0605)	0.5750 (0.0618)	0.6074 (0.0472)

Appendix Table 6.1 Australian Demand System Estimates (continued)

Parameter	PS-AIDS	GCS-AIDS	PS-QAIDS
υ_0		0.0246	
		(0.0050)	
υ_1	0.0082	-0.0027	0.0089
	(0.0009)	(0.0020)	(0.0006)
υ_2	-0.0027	-0.0037	-0.0015
	(0.0007)	(0.0007)	(0.0007)
υ_3	-0.0007	-0.0040	0.0001
	(0.0003)	(0.0006)	(0.0002)
υ_4	0.0033	0.0052	0.0027
	(0.0003)	(0.0005)	(0.0003)
υ_5	-0.0015	0.0054	-0.0021
	(0.0008)	(0.0015)	(0.0007)
υ_6	-0.0034	-0.0047	-0.0038
	(0.0003)	(0.0004)	(0.0003)
υ_7	-0.0034	0.0014	-0.0039
	(0.0006)	(0.0010)	(0.0005)
υ_8	-0.0052	-0.0054	-0.0059
	(0.0003)	(0.0003)	(0.0003)
υ_9	0.0053	0.0085	0.0055
	(0.0004)	(0.0007)	(0.0004)
λ_1			0.0010
			(0.0006)
λ_2			0.0185
			(0.0010)
λ_3			0.0101
			(0.0002)
λ_4			-0.0074
			(0.0007)
λ_5			-0.0048
			(0.0012)
λ_6			-0.0074
			(0.0005)
λ_7			-0.0039
			(0.0009)
λ_8			-0.0120
			(0.0007)
λ_9			0.0059
			(0.0006)

Notes: Figures in ( ) denote standard errors
Almost all parameters are significant at the 1% level of significance

Appendix Table 6.2 Australian Demand System: PS-AIDS Cross Price Term Estimates

γ_{ij}	1	2	3	4	5	6	7	8	9
1	0.1205	-0.0397	-0.0183	0.0410	-0.0540	-0.0153	-0.0020	0.0143	-0.0465
	(0.0181)	(0.0082)	(0.0049)	(0.0087)	(0.0156)	(0.0057)	(0.0131)	(0.0097)	(0.0000)
2		-0.0317	-0.0181	-0.0402	0.1459	-0.0438	-0.0354	0.0364	0.0266
		(0.0092)	(0.0036)	(0.0067)	(0.0115)	(0.0043)	(0.0077)	(0.0068)	(0.0000)
3			0.0334	-0.0097	0.0196	0.0349	-0.0104	-0.0051	-0.0263
			(0.0031)	(0.0032)	(0.0077)	(0.0021)	(0.0044)	(0.0047)	(0.0000)
4				0.1296	-0.0175	-0.0074	-0.0692	-0.0221	-0.0046
				(0.0082)	(0.0108)	(0.0048)	(0.0080)	(0.0070)	(0.0000)
5					-0.2464	0.0592	0.0714	-0.0020	0.0238
					(0.0282)	(0.0073)	(0.0145)	(0.0152)	(0.0000)
6						-0.0563	-0.0167	0.0314	0.0140
						(0.0041)	(0.0054)	(0.0042)	(0.0000)
7							0.0805	-0.0178	-0.0004
							(0.0141)	(0.0084)	(0.0000)
8								-0.0221	-0.0131
								(0.0113)	(0.0000)
9									0.0264
									(0.0111)

Notes: Figures in ( ) denote standard errors

Appendix Table 6.3 Australian Demand System: GCS-AIDS Cross Price Term Estimates

γ_{ij}	1	2	3	4	5	6	7	8	9
1	0.1187	-0.0399	-0.0188	0.0414	-0.0530	-0.0155	-0.0010	0.0142	-0.0459
	(0.0182)	(0.0083)	(0.0049)	(0.0087)	(0.0156)	(0.0057)	(0.0131)	(0.0097)	(0.0000)
2		-0.0316	-0.0182	-0.0402	0.1459	-0.0439	-0.0353	0.0365	0.0266
		(0.0092)	(0.0036)	(0.0067)	(0.0115)	(0.0043)	(0.0077)	(0.0068)	(0.0000)
3			0.0333	-0.0096	0.0198	0.0348	-0.0102	-0.0050	-0.0261
			(0.0031)	(0.0032)	(0.0077)	(0.0021)	(0.0044)	(0.0047)	(0.0000)
4				0.1296	-0.0176	-0.0074	-0.0694	-0.0220	-0.0047
				(0.0082)	(0.0108)	(0.0048)	(0.0080)	(0.0070)	(0.0000)
5					-0.2468	0.0593	0.0710	-0.0021	0.0236
					(0.0282)	(0.0073)	(0.0145)	(0.0152)	(0.0000)
6						-0.0563	-0.0165	0.0314	0.0141
						(0.0041)	(0.0054)	(0.0042)	(0.0000)
7							0.0800	-0.0177	-0.0007
							(0.0141)	(0.0084)	(0.0000)
8								-0.0221	-0.0130
								(0.0113)	(0.0000)
9									0.0262
									(0.0111)

Notes: Figures in ( ) denote standard errors

Appendix Table 6.4 Australian Demand System: PS-QAIDS Cross Price Term Estimates

γ_{ij}	1	2	3	4	5	6	7	8	9
1	0.1166 (0.0186)	-0.1001 (0.0093)	-0.0535 (0.0055)	0.0654 (0.0092)	-0.0359 (0.0163)	0.0081 (0.0061)	0.0144 (0.0136)	0.0528 (0.0105)	-0.0676 (0.0000)
2		-0.1688 (0.0177)	-0.1049 (0.0059)	0.0210 (0.0095)	0.2118 (0.0155)	0.0022 (0.0064)	0.0178 (0.0112)	0.1192 (0.0094)	0.0018 (0.0000)
3			-0.0198 (0.0034)	0.0275 (0.0044)	0.0576 (0.0092)	0.0641 (0.0030)	0.0236 (0.0060)	0.0465 (0.0056)	-0.0411 (0.0000)
4				0.1037 (0.0093)	-0.0440 (0.0115)	-0.0282 (0.0054)	-0.0923 (0.0086)	-0.0587 (0.0079)	0.0056 (0.0000)
5					-0.2697 (0.0291)	0.0352 (0.0079)	0.0497 (0.0150)	-0.0414 (0.0161)	0.0368 (0.0000)
6						-0.0711 (0.0046)	-0.0351 (0.0059)	0.0039 (0.0048)	0.0208 (0.0000)
7							0.0581 (0.0151)	-0.0502 (0.0095)	0.0141 (0.0000)
8								-0.0717 (0.0127)	-0.0004 (0.0000)
9									0.0301 (0.0111)

Notes: Figures in ( ) denote standard errors

Appendix Table 6.5 Canadian Demand System Estimates

Parameter	PS-AIDS	GCS-AIDS	PS-QAIDS
Log Likelihood	1,490,720	1,490,742	1,491,253
α_1	0.7181 (0.0033)	0.7250 (0.0034)	1.1105 (0.0242)
α_2	0.4859 (0.0058)	0.4923 (0.0059)	0.4641 (0.0434)
α_3	0.2646 (0.0019)	0.2692 (0.0019)	0.7306 (0.0138)
α_4	-0.0400 (0.0022)	-0.0422 (0.0022)	-0.1964 (0.0125)
α_5	-0.3725 (0.0062)	-0.3825 (0.0063)	-0.4045 (0.0447)
α_6	0.0982 (0.0015)	0.0990 (0.0015)	-0.1346 (0.0105)
α_7	-0.1241 (0.0030)	-0.1276 (0.0031)	-0.1355 (0.0191)
α_8	0.0479 (0.0025)	0.0470 (0.0025)	-0.1148 (0.0179)
α_9	-0.0781 (0.0000)	-0.0802 (0.0000)	-0.3193 (0.0006)
β_1	-0.0897 (0.0006)	-0.0909 (0.0006)	-0.2272 (0.0087)
β_2	-0.0298 (0.0010)	-0.0309 (0.0010)	-0.0243 (0.0153)
β_3	-0.0373 (0.0004)	-0.0381 (0.0004)	-0.2012 (0.0051)
β_4	0.0188 (0.0004)	0.0192 (0.0004)	0.0741 (0.0043)
β_5	0.0917 (0.0010)	0.0934 (0.0011)	0.1036 (0.0152)
β_6	-0.0080 (0.0003)	-0.0081 (0.0003)	0.0741 (0.0038)
β_7	0.0331 (0.0005)	0.0337 (0.0005)	0.0371 (0.0064)
β_8	0.0005 (0.0004)	0.0007 (0.0004)	0.0578 (0.0064)
β_9	0.0208 (0.0000)	0.0212 (0.0000)	0.1059 (0.0001)
θ	0.4735 (0.0061)	0.4793 (0.0061)	0.4591 (0.0054)
κ_1	0.4413 (0.0512)	0.3465 (0.0540)	0.2084 (0.0349)
κ_2	0.6311 (0.0520)	0.5262 (0.0544)	0.4103 (0.0333)
κ_3	0.7163 (0.0725)	0.5850 (0.0741)	0.5074 (0.0537)

Appendix Table 6.5 Canadian Demand System Estimates (continued)

Parameter	PS-AIDS	GCS-AIDS	PS-QAIDS
υ_0		0.0321 (0.0043)	
υ_1	0.0084 (0.0007)	-0.0053 (0.0016)	0.0117 (0.0006)
υ_2	-0.0056 (0.0006)	-0.0102 (0.0009)	-0.0048 (0.0005)
υ_3	-0.0008 (0.0004)	-0.0065 (0.0007)	0.0009 (0.0003)
υ_4	0.0057 (0.0002)	0.0086 (0.0004)	0.0049 (0.0002)
υ_5	-0.0050 (0.0008)	0.0091 (0.0018)	-0.0078 (0.0007)
υ_6	-0.0001 (0.0002)	-0.0013 (0.0002)	-0.0001 (0.0001)
υ_7	0.0012 (0.0003)	0.0063 (0.0007)	0.0002 (0.0003)
υ_8	-0.0044 (0.0002)	-0.0043 (0.0003)	-0.0046 (0.0002)
υ_9	0.0006 (0.0000)	0.0038 (0.0000)	-0.0003 (0.0000)
λ_1			0.0119 (0.0008)
λ_2			-0.0003 (0.0013)
λ_3			0.0143 (0.0005)
λ_4			-0.0049 (0.0004)
λ_5			-0.0011 (0.0013)
λ_6			-0.0072 (0.0003)
λ_7			-0.0003 (0.0005)
λ_8			-0.0050 (0.0006)
λ_9			-0.0074 (0.0000)

Notes: Figures in ( ) denote standard errors
Almost all parameters are significant at the 1% level of significance

Appendix Table 6.6 Canadian Demand System: PS-AIDS Cross Price Term Estimates

γ_{ij}	1	2	3	4	5	6	7	8	9
1	-0.3031	0.0432	-0.0487	-0.0381	0.1258	0.1462	0.1567	-0.0825	0.0005
	(0.0002)	(0.0001)	(0.0000)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0000)	(0.0000)
2		0.0532	0.0181	-0.0942	0.0112	-0.0543	0.0234	0.0433	-0.0441
		(0.0003)	(0.0000)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0000)	(0.0000)
3			0.0173	-0.0079	-0.0003	-0.0249	0.0329	-0.0066	0.0200
			(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
4				0.0436	0.0254	0.0505	0.0415	-0.0411	0.0202
				(0.0001)	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)
5					-0.0636	-0.0158	-0.1108	0.0220	0.0060
					(0.0001)	(0.0000)	(0.0001)	(0.0000)	(0.0000)
6						-0.0186	-0.1132	0.0332	-0.0031
						(0.0002)	(0.0001)	(0.0000)	(0.0000)
7							-0.0598	0.0374	-0.0081
							(0.0002)	(0.0000)	(0.0000)
8								-0.0042	-0.0016
								(0.0000)	(0.0000)
9									0.0102
									(0.0000)

Notes: Figures in ( ) denote standard errors

Appendix Table 6.7 Canadian Demand System: GCS-AIDS Cross Price Term Estimates

γ_{ij}	1	2	3	4	5	6	7	8	9
1	-0.3043	0.0427	-0.0486	-0.0378	0.1265	0.1460	0.1572	-0.0825	0.0009
	(0.0002)	(0.0001)	(0.0000)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0000)	(0.0000)
2		0.0526	0.0176	-0.0939	0.0121	-0.0543	0.0237	0.0435	-0.0439
		(0.0003)	(0.0000)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0000)	(0.0000)
3			0.0171	-0.0078	-0.0001	-0.0249	0.0329	-0.0065	0.0201
			(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
4				0.0435	0.0252	0.0505	0.0414	-0.0411	0.0201
				(0.0001)	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)
5					-0.0644	-0.0158	-0.1111	0.0219	0.0056
					(0.0001)	(0.0000)	(0.0001)	(0.0000)	(0.0000)
6						-0.0186	-0.1131	0.0332	-0.0030
						(0.0002)	(0.0001)	(0.0000)	(0.0000)
7							-0.0600	0.0374	-0.0082
							(0.0002)	(0.0000)	(0.0000)
8								-0.0042	-0.0016
								(0.0000)	(0.0000)
9									0.0101
									(0.0000)

Notes: Figures in ( ) denote standard errors

Appendix Table 6.8 Canadian Demand System: PS-QAIDS Cross Price Term Estimates

γ_{ij}	1	2	3	4	5	6	7	8	9
1	-0.4360 (0.0004)	0.0352 (0.0002)	-0.1766 (0.0001)	0.0086 (0.0001)	0.1738 (0.0002)	0.2022 (0.0001)	0.1700 (0.0001)	-0.0431 (0.0000)	0.0658 (0.0000)
2		0.0564 (0.0003)	0.0087 (0.0001)	-0.0909 (0.0001)	0.0092 (0.0001)	-0.0503 (0.0001)	0.0235 (0.0001)	0.0472 (0.0000)	-0.0390 (0.0000)
3			-0.1005 (0.0000)	0.0355 (0.0000)	0.0507 (0.0001)	0.0213 (0.0000)	0.0510 (0.0000)	0.0293 (0.0000)	0.0807 (0.0000)
4				0.0278 (0.0001)	0.0073 (0.0000)	0.0315 (0.0000)	0.0363 (0.0001)	-0.0540 (0.0000)	-0.0021 (0.0000)
5					-0.0731 (0.0002)	-0.0415 (0.0000)	-0.1120 (0.0001)	0.0049 (0.0000)	-0.0193 (0.0000)
6						-0.0334 (0.0002)	-0.1225 (0.0001)	0.0193 (0.0000)	-0.0266 (0.0000)
7							-0.0600 (0.0002)	0.0312 (0.0000)	-0.0176 (0.0000)
8								-0.0147 (0.0000)	-0.0202 (0.0000)
9									-0.0216 (0.0000)

Notes: Figures in ( ) denote standard errors

Appendix Table 6.9 Expenditure Classes

Expenditure Class	**Definition**	**Percentile if** $\log\tilde{x} \sim N$	**Australian Real Equivalent Weekly Expenditure 1993-94**	**Canadian Real Equivalent Weekly Expenditure 1992**
Very Low	$mean(\log\tilde{x}) - 2std.dev(\log\tilde{x})$	2.5%	\$103.07	\$125.88
Low	$mean(\log\tilde{x}) - 1std.dev(\log\tilde{x})$	16%	\$179.15	\$203.44
Average	$mean(\log\tilde{x})$	50%	\$311.38	\$328.81
High	$mean(\log\tilde{x}) + 1std.dev(\log\tilde{x})$	84%	\$541.23	\$531.43
Very High	$mean(\log\tilde{x}) + 2std.dev(\log\tilde{x})$	97.5%	\$940.74	\$858.92

Source: Australia: 1993-94 HES, Canada: 1992 FES

Note: Prices have risen by approximately 20% for Australia from 1993-94 to 2001, and 15% for Canada from 1992 to 2001.
Thus the mean of log Australian equivalent expenditure in 1993-4 in nominal 2001 Australian dollars is approximately 374 $AUS per week and the mean of log Canadian equivalent expenditure in 1992 in nominal 2001Canadian dollars is approximately 377 $CAN per week.

Appendix 7 for Ch 7 Empirical Evidence on Income and Expenditure Inequality

Appendix Table 7.1 Australian Real Equivalent Expenditure using PS-QAIDS Equivalence Scale and CLI

	Magnitude					Percentage change				
	1975-76	**1984**	**1988-89**	**1993-94**	**1998-99**	**1975-76 to 1984**	**1984 to 88-89**	**1988-89 to 93-94**	**1993-94 to 98-99**	**1975-76 to 1998-99**
Mean	261.32	301.48	298.86	307.55	324.69	15.4%	-0.9%	2.9%	5.6%	24.2%
	(2.4095)	(2.7226)	(2.1582)	(2.0275)	(2.3770)	[11.04]	-[0.75]	[2.93]	[5.48]	[18.72]
I_0	0.1760	0.1574	0.1622	0.1515	0.1586	-10.6%	3.1%	-6.6%	4.7%	-9.9%
	(0.0080)	(0.0085)	(0.0068)	(0.0060)	(0.0068)	-[1.61]	[0.45]	-[1.18]	[0.78]	-[1.66]
I_1	0.1798	0.1550	0.1594	0.1518	0.1570	-13.8%	2.8%	-4.7%	3.4%	-12.7%
	(0.0151)	(0.0130)	(0.0103)	(0.0095)	(0.0103)	-[1.24]	[0.26]	-[0.54]	[0.37]	-[1.25]
I_2	0.2356	0.1832	0.1884	0.1823	0.1847	-22.3%	2.8%	-3.2%	1.3%	-21.6%
	(0.0241)	(0.0185)	(0.0141)	(0.0132)	(0.0141)	-[1.73]	[0.22]	-[0.32]	[0.12]	-[1.82]
Gini	0.3179	0.3047	0.3083	0.2996	0.3071	-4.2%	1.2%	-2.8%	2.5%	-3.4%
	(0.0031)	(0.0033)	(0.0026)	(0.0025)	(0.0027)	-[2.91]	[0.84]	-[2.40]	[2.07]	-[2.66]
$A_{0.5}$	0.0846	0.0750	0.0771	0.0729	0.0758	-11.3%	2.8%	-5.5%	4.0%	-10.4%
	(0.0107)	(0.0107)	(0.0085)	(0.0078)	(0.0086)	-[0.63]	[0.15]	-[0.37]	[0.25]	-[0.64]
A_1	0.1614	0.1456	0.1497	0.1405	0.1467	-9.8%	2.8%	-6.1%	4.4%	-9.1%
	(0.0080)	(0.0085)	(0.0068)	(0.0060)	(0.0068)	-[1.36]	[0.38]	-[1.01]	[0.67]	-[1.40]
A_2	0.3040	0.2758	0.2855	0.2647	0.2761	-9.3%	3.5%	-7.3%	4.3%	-9.2%
	(0.0133)	(0.0137)	(0.0109)	(0.0099)	(0.0111)	-[1.47]	[0.55]	-[1.40]	[0.77]	-[1.60]

Notes: Figures in ( ) denote standard errors of the estimates.
Figures in [ ] denote t-ratios of the absolute change in the estimates, for the periods stated.
All estimates are based on ‘real’ ‘equivalent’ measures of expenditure, using the PS-QAIDS CLI and equivalence scale.

Appendix Table 7.2 Australian Real Equivalent Disposable Income using PS-QAIDS Equivalence Scale and CLI

	Magnitude					**Percentage change**				
	1975-76	**1984**	**1988-89**	**1993-94**	**1998-99**	**1975-76 to 1984**	**1984 to 88-89**	**1988-89 to 93-94**	**1993-94 to 98-99**	**1975-76 to 1998-99**
Mean	286.05	306.03	300.91	302.99	331.80	7.0%	-1.7%	0.7%	9.5%	16.0%
	(2.0029)	(2.4083)	(2.2869)	(2.0292)	(2.4367)	[6.38]	-[1.54]	[0.68]	[9.08]	[14.51]
I_0	0.1438	0.1556	0.1780	0.2005	0.2357	8.3%	14.3%	12.7%	17.6%	64.0%
	(0.0081)	(0.0094)	(0.0081)	(0.0086)	(0.0106)	[0.95]	[1.80]	[1.90]	[2.57]	[6.87]
I_1	0.1246	0.1333	0.1595	0.1611	0.1738	7.0%	19.6%	1.0%	7.9%	39.5%
	(0.0092)	(0.0093)	(0.0133)	(0.0099)	(0.0095)	[0.67]	[1.62]	[0.09]	[0.93]	[3.73]
I_2	0.1359	0.1391	0.2087	0.1881	0.1858	2.4%	50.0%	-9.8%	-1.2%	36.8%
	(0.0126)	(0.0105)	(0.0261)	(0.0158)	(0.0118)	[0.20]	[2.47]	-[0.67]	-[0.12]	[2.89]
Gini	0.2729	0.2874	0.2998	0.3067	0.3217	5.3%	4.3%	2.3%	4.9%	17.9%
	(0.0034)	(0.0035)	(0.0028)	(0.0025)	(0.0028)	[2.95]	[2.77]	[1.83]	[3.93]	[10.93]
$A_{0.5}$	0.0632	0.0681	0.0779	0.0815	0.0912	7.7%	14.3%	4.7%	11.8%	44.2%
	(0.0084)	(0.0096)	(0.0089)	(0.0080)	(0.0089)	[0.38]	[0.75]	[0.31]	[0.81]	[2.28]
A_1	0.1339	0.1441	0.1630	0.1817	0.2100	7.6%	13.1%	11.4%	15.6%	56.8%
	(0.0081)	(0.0094)	(0.0081)	(0.0086)	(0.0106)	[0.82]	[1.52]	[1.58]	[2.07]	[5.69]
A_2	0.4471	0.5151	0.6422	0.7831	0.8172	15.2%	24.7%	22.0%	4.3%	82.8%
	(0.0132)	(0.0152)	(0.0134)	(0.0126)	(0.0139)	[3.37]	[6.27]	[7.68]	[1.81]	[19.28]

Notes: Figures in ( ) denote standard errors of the estimates.
Figures in [ ] denote t-ratios of the absolute change in the estimates, for the periods stated.
All estimates are based on 'real' 'equivalent' measures of expenditure, using the PS-QAIDS CLI and equivalence scale.

Appendix Table 7.3 Canadian Real Equivalent Expenditure using PS-QAIDS Equivalence Scale and CLI

	Magnitude				Percentage change			
	1978	**1982**	**1986**	**1992**	**1978 to 1982**	**1982 to 1986**	**1986 to 1992**	**1978 to 1992**
Mean	350.46	339.68	365.23	364.24	-3.1%	7.5%	-0.3%	3.9%
	(1.6899)	(1.5833)	(1.8015)	(1.8589)	-[4.65]	[10.65]	-[0.38]	[5.48]
I_0	0.1104	0.1136	0.1178	0.1134	2.9%	3.7%	-3.7%	2.8%
	(0.0050)	(0.0047)	(0.0048)	(0.0049)	[0.47]	[0.62]	-[0.63]	[0.44]
I_1	0.1034	0.1091	0.1145	0.1115	5.5%	4.9%	-2.5%	7.9%
	(0.0057)	(0.0059)	(0.0063)	(0.0065)	[0.69]	[0.63]	-[0.32]	[0.94]
I_2	0.1088	0.1188	0.1260	0.1236	9.2%	6.0%	-1.9%	13.6%
	(0.0066)	(0.0073)	(0.0076)	(0.0079)	[1.03]	[0.68]	-[0.22]	[1.45]
Gini	0.2515	0.2577	0.2645	0.2613	2.5%	2.6%	-1.2%	3.9%
	(0.0028)	(0.0025)	(0.0025)	(0.0026)	[1.67]	[1.92]	-[0.87]	[2.60]
$A_{0.5}$	0.0519	0.0541	0.0564	0.0547	4.1%	4.3%	-3.0%	5.3%
	(0.0058)	(0.0056)	(0.0059)	(0.0061)	[0.26]	[0.28]	-[0.20]	[0.32]
A_1	0.1045	0.1074	0.1111	0.1072	2.8%	3.5%	-3.5%	2.6%
	(0.0050)	(0.0047)	(0.0048)	(0.0049)	[0.42]	[0.56]	-[0.56]	[0.39]
A_2	0.2115	0.2118	0.2151	0.2057	0.2%	1.5%	-4.3%	-2.7%
	(0.0080)	(0.0075)	(0.0078)	(0.0081)	[0.03]	[0.30]	-[0.83]	-[0.51]

Notes: Figures in ( ) denote standard errors of the estimates.
Figures in [ ] denote t-ratios of the absolute change in the estimates, for the periods stated.
All estimates are based on 'real' 'equivalent' measures of expenditure, using the PS-QAIDS CLI and equivalence scale.

Appendix Table 7.4 Canadian Real Equivalent Disposable Income using PS-QAIDS Equivalence Scale and CLI

	Magnitude				Percentage change			
	1978	**1982**	**1986**	**1992**	**1978 - 1982**	**1982 -1986**	**1986 -1992**	**1978 -1992**
Mean	392.96 (2.0407)	406.81 (2.0526)	408.93 (2.3916)	412.67 (2.3324)	3.5% [4.78]	0.5% [0.67]	0.9% [1.12]	5.0% [6.36]
I_0	0.1295 (0.0056)	0.1382 (0.0053)	0.1464 (0.0056)	0.1485 (0.0062)	6.7% [1.13]	5.9% [1.07]	1.5% [0.26]	14.7% [2.28]
I_1	0.1187 (0.0063)	0.1287 (0.0063)	0.1414 (0.0097)	0.1357 (0.0074)	8.4% [1.12]	9.9% [1.10]	-4.1% -[0.47]	14.3% [1.74]
I_2	0.1262 (0.0074)	0.1392 (0.0076)	0.1771 (0.0195)	0.1516 (0.0093)	10.4% [1.23]	27.2% [1.81]	-14.4% -[1.18]	20.2% [2.14]
Gini	0.2685 (0.0027)	0.2801 (0.0024)	0.2865 (0.0024)	0.2864 (0.0025)	4.3% [3.25]	2.3% [1.92]	0.0% -[0.03]	6.7% [4.94]
$A_{0.5}$	0.0597 (0.0063)	0.0642 (0.0061)	0.0685 (0.0069)	0.0673 (0.0068)	7.6% [0.52]	6.7% [0.47]	-1.8% -[0.13]	12.7% [0.82]
A_1	0.1215 (0.0056)	0.1290 (0.0053)	0.1361 (0.0056)	0.1380 (0.0062)	6.2% [0.99]	5.5% [0.92]	1.4% [0.22]	13.6% [1.98]
A_2	0.3269 (0.0092)	0.3132 (0.0086)	0.3924 (0.0098)	0.5875 (0.0109)	-4.2% -[1.08]	25.3% [6.10]	49.7% [13.32]	79.7% [18.21]

Notes: Figures in ( ) denote standard errors of the estimates.
Figures in [ ] denote t-ratios of the absolute change in the estimates, for the periods stated.
All estimates are based on 'real' 'equivalent' measures of expenditure, using the PS-QAIDS CLI and equivalence scale.