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Inflation and the Household: Towards a Measurement of the Welfare Costs of Inflation

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Inflation and the Household: Towards a Measurement of the Welfare Costs of Inflation

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Abstract

This paper considers household expenditure patterns through the estimation of parametric share estimates. The parameters from these expenditure share estimates are then used to simulate the underlying income transfer (compensating variation) that would be required to offset price increases for various goods. The simulations are considered across the expenditure distribution to provide a series of estimates of the welfare effects of inflation on both poor and non-poor households. Given data limitations, preventing the estimation of substitution effects, non-poor households generally bear the brunt of inflation, primarily due to their larger expenditures. The only exception to the aforementioned generalisation is the impact that food inflation has on low expenditure households relative to high expenditure households. The results in this paper are consistent with the expectation that food inflation has a larger welfare cost to poor households than it does for non-poor households, and we are able to present an estimate of those welfare cost differences.

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1 Introduction

The inflation tax is often referred to as the ‘cruellest tax of all’, possibly because it hurts the poor more than the rich, or possibly because the inflation tax is neither explicit nor part of the general legislative process. Given the implicit nature of the tax, the inflation tax may not be well understood by consumers and, therefore, could be seen as unfair.

Polling data and other macroeconomic research from around the world suggests that the inflation tax is more problematic for the poor. Easterly and Fischer (2001) find that the poor are more likely to mention inflation as a concern than the rich in 38 countries around the world, although their data do not include any African countries. Fischer and Huizinga (1982), in their study of data available in the United States (US) from 1939 to 1978, find that inflation was mentioned as a concern more often than unemployment, except during recessions. Shiller's (1996) survey of Americans, Germans and Brazilians noted that people perceived inflation as harming their standards of living and, therefore, people were averse to inflation.

In addition to polling data, macroeconomic research has also found strong correlations between inflation and other negative outcomes. For instance, Easterly and Fischer (2001) find reductions in the share of national income claimed by the poor, while the per cent decline in poverty and the per cent change in the minimum wage are also negatively correlated with inflation across a number of countries. Their research suggests that human capital is a hedge against inflation, rather than being an indicator of better knowledge regarding the adverse affects of inflation related to, e.g. difficulties in comparison shopping or the negative effects of holding cash. They find that older, poorer, less educated and less skilled individuals are more averse to inflation. However, they do not find that inflation is a big concern among those in countries that have experienced high levels of inflation, such as Russia, Brazil and the Ukraine, although there is a strong association between the perceived gap between the rich and the poor and the level of inflation experienced. Most of the results are as expected, confirming that “those who are more averse to inflation are relatively disadvantaged on several dimensions - the poor, the uneducated, and the unskilled (blue-collar) workers."

Although little evidence exists in Africa (at least up to 2001), evidence from the US, on the other hand, suggests that, although inflation hurts the poor, inflation does not have overly pernicious effects on the poor. Powers (1995), for example, finds that poverty rates increased from 1959-1992, as a result of inflation in the US, while Cutler and Katz (1991) find the opposite for the 1959-1989 period. Blank and Blinder (1986) find that, although poverty rates increase slightly, the share of income going to the bottom two quintiles had increased slightly, as well. In Latin America, Cardoso (1992) finds that higher inflation and lower real wages feature in seven Latin American countries. In Brazil, the Gini coefficient rose during high inflation periods in the 1980s, but fell as inflation stabilised in the mid-1990s (Rezende, 1998). In India, states with higher rates of inflation had higher rates of poverty (Datt and Ravallion, 1998). Romer and Romer (1998) also show that increased income for the poor is associated with lower inflation. In addition to Easterly and Fischer's (2001) survey analysis, they are able to combine survey responses with data on recent average inflation, economic growth and poverty rates. Using the merged data, they find that a "movement from zero inflation to hyperinflation would decrease the share of the bottom quintile by 1,7 per cent."[2] Considering that the average share is 6,2 per cent in their sample, a drastic change in inflation experience would be economically disastrous.[3]

As Easterly and Fischer (2001) point out, the poor may be more affected by inflation, because the rich are more likely to have better access to financial instruments, compared to the poor, whose portfolios are likely to be biased towards cash. Furthermore, the poor are more likely to receive government transfers that are not fully indexed to inflation, possibly due to the plutocratic nature of the Consumer Price

[2] Considering these results, Easterly and Fisher find it hard to believe that populist politicians would pursue anything other than an anti-inflationary stance. However, a political economy model would be needed to formalise any argument surrounding the behaviour of politicians. For example, the median voter may be more likely to benefit from inflation; in fact, maybe it is the actual politician who is more likely to benefit from higher inflation.

[3] Given the bivariate relationship considered in many of these final analyses, the results may not be robust.

Index (CPI). However, the rich may also suffer, as tax brackets also fail to adjust upward to account for inflation.

Although macroeconomic research looking into income shares and inflation suggests that inflation is bad for the poor, the microeconomic research is less robust. Recent research comparing demographic weighting to plutocratic weighting has shown that the price index does not represent the price experiences of the average consumer. The plutocratic weighting system is used for CPI calculations because, by definition, it closely mimics aggregate expenditure in the economy.[4] However, if households have different expenditure patterns than the pattern derived by the plutocratic system, or if households face differential prices, then it is clear that inflation for different types of households might not be reflective of the CPI calculation within the country. In Africa, at least two recent analyses have considered a democratic weighting system, where each household is treated equally rather than weighted according to their contribution to total expenditure in the economy.[5] In McKay and Sowa (2005), the difference between the actual CPI and a constructed democratic CPI is not robust, because expenditure patterns are quite aggregated, and, therefore, there are minimal differences between the actual CPI weights and the democratic weights. In Oosthuizen (2007), the weighting comparison is applied to South African data over an extensive period and although democratic weights suggest different CPI values, the differences are not extensive.

When considering both macroeconomic and microeconomic research, one notices that from a macroeconomic perspective, the evidence that inflation is bad for the poor seems pervasive. From the microeconomic perspective, however, the evidence is much less clear. Admittedly, such a difference between microeconomic and macroeconomic evidence is not uncommon, and is largely due to the fact that macroeconomic analysis is able to gloss over the heterogeneity that exists in large cross-sectional datasets by considering aggregates and averages, instead of individual effects. When more carefully considering the microeconomic approach, one is left to consider whether or not it is appropriate to ignore heterogeneity. Thus,

[4] Within the CPI, plutocratic expenditure weights are used; namely consumption basket weights are based on the shares of expenditures within a category and the shares are determined by total expenditure in the economy.

two main concerns must be noted. The first, which appears numerous times in Oosthuizen's paper, is substitution. Through simple aggregation and indexing, substitution is not allowed. Therefore, differential price effects are not included in the weights.[6] The second is household welfare; the focus on indexation does not provide a means for measuring the detrimental effect of inflation across households and/or the expenditure distribution. Instead, the detrimental effect is subsumed in the analysis, while the relative effects across the distribution cannot be considered.

Therefore, the research to be presented here will grapple with one of these remaining issues: measuring the welfare effects of inflation across the income/expenditure distribution. The measurement of the welfare effects will provide insight into the incidence of the inflation tax. In order to consider the incidence of the inflation tax, we undertook a series of micro-simulation exercises. Initially, household expenditure patterns were examined through the estimation of parametric demand share systems. The parameters from these expenditure share estimates were used to simulate the underlying income transfer (compensating variation) that would be required to offset price increases (inflation) for various goods. The simulations were considered across the expenditure distribution to provide a series of estimates of the welfare effects of inflation on both poor and non-poor households.

Given data limitations, which prevent the estimation of substitution effects, our results show that non-poor households generally bear the brunt of inflation, primarily due to their larger expenditures. However, there is an exception to this pattern. The exception to the aforementioned generalisation is the impact that food inflation has on low-expenditure households relative to high-expenditure households. Our results are consistent with the expectation that food inflation has a larger welfare cost to poor households than it does for non-poor households and we are able to present an estimate of those welfare cost differences.

The rest of the paper is presented as follows: section 2 discusses the wide range of microeconomic research that underlies our research programme. The data used in

[5] Many others could be considered. For example, a median household CPI might be insightful in much the same way as the median voter is considered insightful.
[6] Unfortunately, as we discuss below, our price data are nearly collinear and, therefore, we were also not able to capture the extent of substitution that we would have wanted to in our analysis.

the analysis is discussed in section 3. Section 4 outlines the methodology related to the estimation of demand systems, the simulation exercises and the nonparametric density estimates that describe the distributional impact of inflation. The results of the analysis are presented and discussed in section 5, while section 6 concludes and offers suggestions on a future research agenda that would shed additional light on this topic.

2 Background literature

In this section we consider research that has been undertaken in three broad areas, all of which are relevant to the research programme presented here. We begin by considering empirical approaches to the measurement of welfare. We continue by examining empirical results that are available, as well as simulation studies that have been conducted. This section concludes by examining the plutocratic gap, which is directly related to the impact of inflation on households.

2.1 Empirical approaches to the measurement of welfare

Initially, welfare was regarded as being synonymous with consumer surplus as a result of Harberger's (1971) call for its extensive application.[7] In keeping with Harberger's (1971) call, macroeconomists have generally considered either consumer surplus measures taken from estimates of the demand for money, as suggested by Bailey (1956) and Lucas (1981, 2000), or compensating variation, as developed by Lucas (1981, 2000), to determine the welfare costs of inflation. The estimated or calibrated welfare costs of inflation vary from 0,18 per cent to 0,9 per cent of GDP in the US.[8] Serletis and Yavari (2004) estimate the costs in Canada to range between 0,15 per cent and 0,35 per cent of GDP. In Europe estimates of 0,1 per cent of GDP in France to 0,45 per cent in Austria are found by Serletis and Yavari (2005, 2007).[9] In South Africa Gupta and Uwiligiye (2008, forthcoming) find

[7] Slesnick (1998) provides a very useful summary of many issues related to empirical welfare measurement. This section benefited greatly from his insights.
[8] See, for example, Fischer (1981), Lucas (1981, 2000), Serletis and Yavari (2004), and Ireland (2008).
[9] Other analysed countries include Germany (0,2 per cent), Belgium (0,3 per cent), the Netherlands, Ireland and Italy (0,4 per cent).

that the welfare costs in South Africa range from practically zero to 0,67 per cent of GDP.[10]

However, Chipman and Moore (1979, 1980) show that for consumer surplus to be a valid measure of welfare, a rather restrictive set of assumptions must be imposed. It is important to note that those restrictions are based on Uzawa's (1971) integrability conditions, namely that demands must be integrable and meet with standard utility maximisation conditions, such as Slutsky symmetry and semi-definiteness, as well as non-negativity and zero degree homogeneity in prices and income. Furthermore, the marginal utility of expenditure must be constant and, most problematic, only one price change can be considered. Therefore, attention has turned to other measures. For example, Hicksian surplus (Hicks, 1942), which makes use of compensated demand, is less restrictive and allows for multiple price changes. Hicksian surplus is equivalent to a generalised measure of compensating variation and allows for ordinal comparisons. Furthermore, it can be equated to compensating variation through evaluation at a slightly different base utility level. These benefits come at a high cost, since compensated demands are often unobservable.[11]

Given the failure of the most common surplus measures to identify welfare, other approaches have also received attention. For example, the indirect money metric utility function of McKenzie (1998) allows for an arbitrary demand system; requires only initial prices, final prices and expenditures, and can be approximated via Taylor expansion.[12] Practically, however, it is difficult to determine the number of terms to include in the Taylor expansion. Vartia (1983) suggested, instead, a numerical estimate of an underlying expenditure function, based on Roy's Identity. Given computing power, such an approach is more conceivable now than it was in 1983.

Although money metric functions can be estimated, demand functions are the most common applications in the literature. Given Roy's Identity, it might be possible to

[10] For a more detailed discussion of the aforementioned results, see Gupta and Uwilingiye (forthcoming).

[11] If only one price change is considered, Willig's (1976) analysis suggests that the Hicksian surplus can be reasonably well approximated, although later research has found examples where the approximation is less accurate (Hausman, 1981; Haveman, Gabay and Andreoni, 1987).

[12] McKenzie and Pearce (1976) showed that the money metric could be approximated via Taylor expansions about the initial equilibrium, since the higher-order derivatives of constant marginal utility of income were zero.

integrate up to the appropriate indirect utility or cost function. Muellbauer (1974) worked within the realm of the linear expenditure system (LES), which is based on Stone-Geary preferences (Stone, 1998) to take advantage of one integrable demand system.[13] From the LES, the parameter estimates can be used to determine utility, which allows for direct calculation of welfare effects. There are some problems with the LES, however, as it assumes that own-price elasticities are proportional to income elasticities (Deaton, 1974, 1975). Therefore, more flexible models have become more popular. Examples include Jorgenson, Lau and Stoker's (1982) model; Deaton and Muellbauer's (1980) Almost Ideal Demand System (AID system); and Banks, Blundell and Lewbel's (1997) Quadratic Almost Ideal Demand System. However, all of these require parametric specifications that may be incorrect.

Initially, linear models, such as those developed by Stone (1998) and validated by Hausman (1981), were the most common. More flexible forms, especially second-order approximations developed by Diewert (1971); Christensen, Jorgenson and Lau (1975); and Deaton and Muellbauer (1980) have also been developed. However, even these flexible forms are not all that flexible, especially since the constraints related to utility maximisation may reduce flexibility (Diewert and Wales, 1987). Since then, focus has switched to more careful consideration of full-rank systems. Gorman (1995) proposed a model that was linear in functions of total expenditure, showing that the greatest rank possible was three, although Lewbel (1989, 1990) has since extended the rank to four.[14] Importantly, rank three models have been shown to better approximate expenditure patterns in the US and the United Kingdom (UK) (Lewbel, 1991; Blundell, Pashardes and Weber, 1993; and Banks, Blundell and Lewbel, 1997).[15] Further flexibility can be added by considering Fourier transforms (Gallant, 1981; Elbadawi, Gallant and Souza, 1983; and Creel, 1987), as well as semi-parametric and nonparametric models (Bierens and Pott-Buter, 1990; Hausman and Newey, 1995; Banks, Blundell and Lewbel, 1997 – Blundell and Lewbel have

[13] Hausman (1981) showed that demand functions could be integrated up to the underlying cost function of the indirect utility function if the demand functions were linear or log-linear, as they are in many applied demand systems. However, it is rather more difficult with more complicated demand functions as well as multiple price or expenditure changes to complete the integration.

[14] The AID system applied in this paper is a rank two system.

[15] White (1980a, 1980b) suggests that even these flexible form models are likely to be biased, since the point of approximation is unknown and, thus, not much can be inferred from the estimates at other points. Byron and Bera (1983a, 1983b), however, show that second-order approximations do much better than White's first-order approximations.

numerous additional considerations of this). Specifically, Hausman and Newey (1995) consider Vartia's (1983) numeric approximation to analyse the effect of gasoline taxes on welfare. However, this is only for one good.[16] Difficulties related to the incorporation of nonparametrics within a demand system have yet to be resolved.

Empirically, since welfare is tied to utility, a model of utility could be more fruitful. However, as previously noted, that requires the careful consideration of demand system functional forms, especially given the nature of the expenditure data that are widely available. Unfortunately, the correct functional form is not known and, given the extensive array of products that are purchased by consumers (in households), goods must either be aggregated or considered within a subset of similar goods, which requires additional separability assumptions on the utility function. Finally, if it is individual welfare that interests the analyst, the household must be treated as a single unit, since most data are available only at the household level, using models proposed by either Samuelson (2001) or Becker (1981).[17]

2.2 Some empirical and simulation studies

The preceding discussion suggests that welfare analysis is best conducted within a demand system and that flexible demand systems are likely to be more appropriate than inflexible systems. Despite those suggestions, a lack of data has led researchers to work around those constraints. For example, Creedy and van de Ven (1997) make use of the LES to consider the effect of inflation on welfare in Australia, using data from a number of Australian Household Expenditure Surveys (1980−1995). Their analysis considered all households, as well as married households with and without dependants. Furthermore, all analysis was undertaken separately for each expenditure decile. The authors' welfare analysis revolves around the calculation of compensating variation, as summarised in Creedy (2000), and equivalent income, as described by King (1983). Creedy and van de Ven also kept the data as disaggregated as possible, but in some cases there were not

[16] Deaton (1989) summarises a number of additional examples of nonparametrically estimated welfare effects for single goods affected by price changes.
[17] Although models of this sort are often applied in the literature and in analysis, a large body of research suggests that these unitary models are not appropriate. See, for example, Manser and

enough observations to obtain estimates for a specific group, since some groups were too small: for example, they could not specifically consider pensioners, although we are able to include them in our analysis. Creedy and van de Ven's analysis consisted of both Atkinson (1970) and extended Gini measures of inequality (Yitzhaki, 1983). Creedy and van de Ven found that in periods of high inflation, inequality was generally higher. However, changes in inequality were small: "the highest increase in inequality over the *base* value as a result of differential price changes is less than one per cent" (p. 133).[18]

Newbery (1995) considers the distributional impact of price changes in both Hungary and the UK, making use of Feldstein's (1972) theory of marginal tax reform, which is discussed further by Newbery and Stern (1987). Newbery (1995), using the iso-elastic utility function, calculates social welfare weights, where utility is measured by real consumption per adult equivalent. These weights feed into a distributional characteristic that measures the concentration of consumption for that good among those with high social marginal values of consumption. The analysis of Hungary suggests little differentiation across most commodities relative to the UK, which is consistent with the fact that overall expenditure is more unequally distributed in the UK than in Hungary. The comparison is then extended through the consideration of other inequality measures, such as the Atkinson (1970) measure and the Gini coefficient. Finally, Newbery (1995) analyses the effect of changes in prices, primarily in Hungary, which switched economic systems during the epoch of analysis. The analysis finds that Hungary was generally less unequal than the UK, but that the switch from the command and control system to a more market-oriented system did not have much effect.[19]

Similar to Newbery (1995), Kaplanoglou and Newbery (2004) consider the distributional impact of indirect taxes and the changes in relative prices resulting from the change in indirect taxes in Greece. The analysis is predicated on the 1988 and

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Brown (1980), McElroy and Horney (1981), Lundberg (1988), Thomas (1989), Chiappori (1988, 1992), and Browning and Chiappori (1994).

[18] We did model the LES in an earlier analysis, since it only relies on own-price effects and our price data were collinear. However, in that analysis we found that the LES was a poor representation of the data and, therefore, it was not reasonable to use the LES. Further information is available from the authors.

[19] Future work will make use of these models, primarily for purposes of comparison.

1999 Greek Household Expenditure Surveys, although the analysis is for 1988 and 2002. They assume unitary own-price elasticities and zero cross-price elasticities, and consider the Gini, the Atkinson measures, and the Theil *T* and *N* indices (Theil, 1967). They find that the change in indirect taxes has had a negative distributional effect, although it is small. About half of the change in inequality across the decade appears to be due to changes in the indirect tax system. Estimates of the effects of changes in relative prices, due to changes in indirect taxes, suggest small, but negative, welfare effects, although the size of those effects rises with the aversion to inequality parameter, as expected.

The preceding research by Feldstein (1972); Newbery and Stern (1987); Newbery (1995); Mayshar and Yitzhaki (1995); and Kaplanoglou and Newbery (2004) is based on first-order approximations. Banks, Blundell and Lewbel (1996) analyse the extent to which simple approximations, such as first-order approximations, can be used to evaluate the welfare effects of price and tax reforms. They show that first-order approximations rarely work well, while second-order approximations work better. Importantly, they prove that welfare weights are not generally independent of prices, although they are if preferences are homothetic. Given that welfare weights are not independent of prices and that our price data are collinear, our analysis is forced to assume homothetic preferences; technically, we presume that preferences are independent of prices.

The study most closely related to ours was that conducted by Krishnakumar, Flores and Basu (2004). They estimate the LES, AID System and Quadratic AID System.[20] They also include demographic effects and make use of wave 55 of the Indian National Sample Survey. Their system estimates are further used to predict indirect utilities, cost functions and per capita equivalent expenditure, including cost of living indices. Their welfare analysis consists of the cost of living, the Foster, Greer and Thorbecke (1984) measure; the Watts (1968) measure; and the Clark, Hemming and Ulph (1981) measure. In addition, they also consider the Gini, the Atkinson (1970) index and Thiel's (1967) entropy measure of inequality. The main concern in their analysis is the potential bias arising from the different assumptions associated with

[20] They use the Banks, Blundell and Lewbel (1997) model, as well as the Ravallion and Subramanian (1996) model (unpublished).

the different demand systems. Essentially, they compare estimated expenditure from their systems with actual deflated expenditure. In some cases the bias is positive and in others it is negative. They also note that ignoring substitution effects understates poverty measures. In terms of their conclusions, they suggest that the rank three Quadratic AID model's quadratic terms are quite small; such that the inclusion of the quadratic terms does not seem to change the calculated welfare measures to a great extent. Furthermore, the inclusion of substitution effects, which we cannot actually do, underestimates total consumption, and, therefore, their poverty measures are overestimated. We are not able to follow the approach in Krishnakumar, Flores and Basu (2004) due to the collinearity of our price data, which does not allow us to estimate the price parameters in the demand systems, although we are able to simulate own-price and cross-price effects to a reasonable degree.

2.3 The Plutocratic gap

Given the difficulty that we have with estimating the demand system, inclusive of price effects, our analysis is also closely related to indexing. Rather than trying to measure the welfare effects of price changes directly, it is also possible to consider whether or not cost of living indices or consumer price indices vary by household and across the expenditure distribution.[21] Consumer price indices are calculated plutocratically (Prais, 1958), since they are weighted by expenditure. That weighting is deemed to be disproportionate, which has led to the consideration of democratic weighting structures, in terms of which each household (or even each individual) is treated equally (Fry and Pashardes, 1985). Ley (2005) provides an excellent discussion of both the modelling issues related to the democratic and plutocratic comparisons, as well as summarising the results of a few studies, with particular emphasis on Spain. This literature finds that richer households are more likely to represent the *average* inherent in plutocratic weighting, which is not surprising, since richer households are more likely to contribute a larger proportion of overall expenditure in the economy. In the UK, Muellbauer (1974) equates the 71st expenditure percentile with the plutocratic average, Deaton (1998) shows it is the

[21] Diewert (1983) provides a detailed development of cost-of-living indices, while Pollak (1980, 1981) and Fisher (2002) examine aggregate indices with regard to welfare.

75th percentile in the US, and Izquierdo, Ley and Ruiz-Castillo (2003) find that it is the 61st percentile in Spain.

In South Africa the skewness is more pronounced. According to Oosthuizen (2007), South Africa's CPI weights most closely resemble the 95th expenditure percentile, while democratic weights more closely reflect the 46th percentile. Given the large discrepancy in percentiles, one would expect to see rather large differences between the actual CPI and the democratic CPI. Although differences exist, the differences presented by Oosthuizen (2007) are not large. However, breaking down those differences across deciles of the expenditure distribution does suggest more definitive differences, although statistical significance is not tested. His results suggest that inflation is generally more damped for the richer deciles and that although many items are important in explaining inflation across the deciles, decile-specific inflation is affected differently in different expenditure categories. One of the most important conclusions from his research, as it relates to our paper, is that the inflation pattern itself does not appear to be generally pro-poor or anti-poor, when considered in levels; in some instances lower deciles appear to face higher inflation than higher deciles and vice versa, that is, the pattern is not consistent in one direction.

In addition to the finding that plutocratic weights are skewed towards the upper end of the distribution, this literature also finds that the difference in inflation rates across household types does not exhibit a consistent pattern of overstatement or understatement. Garner, Johnson and Kokoski's (1996) analysis of poor and non-poor households in the US from 1984 to 1994 finds minimal differences in the price indices for these two groups. Taktek's (1998) analysis of low-income, senior citizen, and low-income senior citizen households finds differences that lie within two percentage points. Murphy and Garvey (2004), who consider Ireland between 1989 and 2001, and Michael (1979), who considers the US between 1967 and 1974, find similarly small differences across the income distribution.

CPI differences have also been analysed by household structure. Idson and Miller's (1999) analysis of child poverty trends between 1968 and 1987 suggests that although families with children experience slightly lower rates of inflation, child poverty estimates were not affected. Hobijn and Lagakos (2005), who look at the period from 1987 to 2001, extend Idson and Miller (1999) to show that elderly households faced higher rates of inflation, primarily due to the rapid increase in health care costs over the period. However, inflation experiences were not persistent, as higher rates in one year did not suggest higher rates in the following year. McGranahan and Paulson (2006) used the most diverse set of demographic groupings. They found little difference in CPIs across the groups, even though the most vulnerable groups faced more volatility in those CPIs, possibly explaining why these groups are, in fact, vulnerable. Lieu, Chang and Chang's (2004) analysis of data from Taiwan over the period 1991−1996 does, however, find evidence of persistence, especially for younger heads of households and urban households with children. In South Africa, although Kahn (1985) finds that inflation rates in South Africa differed across rich and poor households from 1975 to 1982, Oosthuizen (2007) finds that between 1998 and the end of 2006, although household inflation rates differed by expenditure decile, the overall pattern was not persistent.[22] McKay and Sowa's (2005) investigation of Ghana, the only other country in Africa to receive attention, shows even smaller differences than those found in South Africa, primarily due to small differences in the democratic and plutocratic weights at the level of aggregation employed in the Ghanaian study.

The microeconomic research discussed in this section has focused on the use of actual price data, but has not always included direct estimation of a demand system, nor has it generally considered the heterogeneity that is inherent in cross-sectional data. Given the fact that price data in many countries are quite uniform, that is, do not vary within the country – this is especially true of developing countries including South Africa, the focus of our research – direct use of plutocratic and democratic weighting systems cannot fully reflect the distributional impact of inflation on households. Therefore, we extend the aforementioned studies by (1) incorporating the plutocratic and democratic weighting structures within a demand system; (2) estimating the demand system, primarily incorporating heterogeneity; and (3) presenting a distributional analysis of the underlying results.

[22] From January to March 1998, April 1999 to February 2000, October 2000 to October 2001 and July 2003 to February 2006 higher expenditure households experienced higher rates of inflation because the price of items consumed disproportionately by the richer households increased relatively faster during those periods (Oosthuizen, 2007: 26).

3 Data

3.1 Analysis variables

The data are taken from the most recent South African Income and Expenditure Survey (IES) conducted by Statistics South Africa (Stats SA). The survey provides information on income, acquisition and expenditure patterns of a nationally representative sample of South African households. In this study household total expenditure per annum was originally divided into 36 commodities, which match the commodities for which CPI data are available. These 36 expenditure categories were subsequently aggregated into the 10 commodity expenditure groups, which we analyse. Commodity groups were further aggregated (from 36 to 10) for one primary reason: a large number of households did not purchase a large number of commodities,[23] and large proportions of zeroes can be problematic in empirical analysis.[24] In some instances we decided to ignore the commodity, rather than to aggregate it with another variable. Specifically, household total expenditure per annum was calculated to exclude expenditure on vehicles, furniture, appliances, household equipment and textiles, primarily because of their durable nature, while domestic services and other household services were also ignored, given recorded zeroes exceeding 90 per cent of the sample. A secondary reason for aggregation was due to the collinearity of the CPI data. However, aggregation does not eliminate collinearity. We discuss our price aggregation algorithms below.

From the commodity expenditures, and for estimation of the AID system, household expenditure shares were calculated (commodity expenditure divided by total expenditure). Of the ten shares in our analysis there are four food categories: (1)

[23] For example, 97,5 per cent of households in the sample do not purchase domestic services, while vehicle running costs are only paid by about 12 per cent of the sample.

grain products, (2) protein and dairy products (including meat fish, nuts and oils), (3) fruit and vegetables, and (4) other foods (including sugar products and candy, coffee and cool drinks). Our commodity shares also include (5) clothing and shoes, (6) housing (including imputed rent), (7) other housing-related consumption (e.g. as fuel, power and electricity, and other housing expenses), (8) communications and transport (including public and private transportation costs), (9) entertainment expenditures (including recreation, reading material, tobacco and alcohol) and, finally, (10) general expenditures and investments on individuals in the household (including health, personal care items, education and miscellaneous items).

Although we are not directly able to use the prices in the AID system estimates due to their collinearity, we can exploit that collinearity and still make use of CPIs within the AID system.[25] In our analysis, CPI values are matched to the region in which the household resides based on three demographic areas: urban, rural and metropolitan.[26] The IES 2005/2006 data are inflated or deflated to March 2006 prices, since the survey was conducted across a number of months. Therefore, the price data were taken from Stats SA's CPI for March 2006. The price index and weight of

[24] It is possible to consider hurdle models, of which Tobit is an example, and other empirical models. We leave those considerations for further research.

[25] Although CPI values are relative prices through time, such that a time dimension in the analysis might shed some additional light, it is important to note that prices in the AID system are used to create price aggregations, that is, price indices. For example, $a(p)$ in the AID system makes expenditure 'real', much like a price index can be used to turn nominal values into real values. Similarly, since the parameters in $b(p)$ sum to zero, the units related to the price variables are not all that important. Furthermore, CPI values can be changed quite easily within the simulation exercise to mimic different levels of inflation. Finally, regional differences in CPI values can be treated as measures of relative prices within the country. Therefore, although actual prices are more intuitively appealing, they are not necessary in the analysis.

[26] Special thanks to Piet Alberts at Stats SA for helping us match the household region to the price regions. It should also be noted that the urban and metropolitan CPI values had to be reverse engineered, in the sense that Stats SA provides data by rural areas separately from urban and metropolitan areas, and that CPI data are also available by metropolitan areas. Therefore, secondary urban area CPI values were extrapolated from the combined urban and metropolitan data, after netting out the metropolitan CPI values. Further information is available from Stats SA, http://www.statssa.gov.za/Publications/P0100/P01002005.pdf.

each commodity were calculated for each of 30 regions;[27] thus, there are 30 prices and weights for each of the 36 commodity groups. However, these prices had to be aggregated further to match the 10 commodity groups used in the analysis. This aggregation was conducted using both plutocratic and democratic weights. For each commodity, the aggregated price is calculated as

$$p_{jr}^{\hbar} = \frac{\sum_{i=1}^{m} \omega_{ir}^{\hbar} p_{ir}}{\sum_{i=1}^{m} \omega_{ir}^{\hbar}}. \tag{3.1}$$

In the aggregation, $\hbar = \{p, d\}$ connotes either plutocratic or democratic weights, r denotes the region within which the aggregation is undertaken, while m denotes the number of products aggregated within any specific commodity group.[28] Finally, ω, which is discussed below, represents the weighting function applied in the analysis. As already noted, we employ both the plutocratic and democratic weighting functions.

3.2 Descriptive statistics

The data used in the analysis are summarised, via means and standard errors, which are presented in Table 1. The summary is split across the three groups considered, as well. Those three groups are: households in the lowest 40th percentile of total expenditures, households between the 40th and 70th percentile, and households above the 70th percentile. The descriptive statistics are separated into two separate categories: household characteristics and expenditure shares. Although statistical tests of the differences across all of the household characteristics and product shares are not presented, it is clear that households within the three expenditure groups differ rather significantly.[29]

[27] A complete list is available from the authors on request.
[28] For protein and dairy products, $m = 4$, representing the meat, fish, dairy and oils categories, which is just one subset of the main 36 commodities.
[29] Both means ($\overline{z}$) and standard errors are presented in the tables; from these standard errors (se), confidence intervals around the estimated means can be calculated as $\overline{z} \pm 2 \times (se)$. In nearly all cases the confidence intervals do not overlap.

The analysis data highlight many of the features of post-apartheid South Africa. Expenditure, a proxy for income, is not evenly distributed. Households in the bottom portion of the expenditure distribution are more likely to be Africans, more likely to live in rural areas and have a poorly educated household head. By contrast, the top portion of the expenditure distribution largely includes white households, living in urban and metropolitan areas. Furthermore, households at the top of the expenditure distribution are more likely to have a head of household who has at least matriculated from high school. Generally, these means are monotonic in expenditure, with the exceptions of household size and adult equivalence, each of which is highest in the middle of the expenditure distribution.

The expenditure share data, on being split by the household's location in the expenditure distribution, follow expected patterns. The proportion of the budget devoted to food products, clothing and footwear, and housing decreases as total expenditure increases. Basic necessities (i.e. food, clothing and shelter) represent approximately 57 per cent of household expenditures for the poorest 40 per cent, but only about 42 per cent for the richest 30 per cent of households. Health, education and miscellaneous expenditures represent approximately 23 per cent of the wealthiest households' budgets, but only 11 per cent for the poorest households. Entertainment expenditures (i.e. reading, recreation, tobacco and alcohol), by contrast, are the most evenly distributed, with the wealthiest households devoting nearly 9 per cent of their budgets to these expenditures, while the poorest households expend roughly 7,5 per cent of their budgets on these goods.

4 Methodology

We employ a two-stage analysis in this research. In the first stage our data are broken into more homogeneous subsets – we consider approximately 50. Within each subset, an Almost Ideal Demand System *sans* price effects is estimated for 10 different commodity groupings. Those estimates are then used to predict adult equivalent indirect utility and from this predicted indirect utility a number of simulations are modelled. In each simulation, the underlying compensating variation per adult equivalent is calculated and the resulting univariate density of the compensating variation per adult equivalent is estimated nonparametrically across the three previously described expenditure subsets in the population to illustrate the impact of inflation across the income distribution. Although the analysis could have been conducted for the entire distribution, the separation does provide additional insight that would not otherwise be available, if the distribution was treated unitarily.

4.1 The demand system

Demand systems have a long history in the economics literature and the AID system (Deaton and Muellbauer, 1980) has been part of that for nearly 30 years. The AID system has been applied to South African data in a number of instances (see, for example, Koch (2007), who makes use of cross-sectional data, and Dunne and Edkins (2008), who make use of national accounts data).[30] Our theoretical model is based on a variation of the AID system developed by Deaton and Muellbauer (1980). Within that variation, we assume that households are singleton decision units, but that households account for household size in a very particular fashion, that is, household utility is based on expenditures per adult equivalent. Formally,

$$V = \frac{\ln\left(\frac{x}{e}\right) - a(p)}{b(p)} \tag{4.1}$$

In the household's indirect utility function, V, x represents household expenditure, e represents adult equivalence in the household, based on the semi-parametric estimates in Yatchew, Sun and Deri (2003), while $a(p)$ and $b(p)$ are the price aggregator functions as defined by Deaton and Muellbauer (1980). Yatchew et al's estimates of adult equivalence are given by $e = \left(A + .74K\right)^{0.59}$, where A is the number of adults, aged 16 or older, and K is the number of children, aged less than 16, in the household. From Deaton and Muellbauer,

$$a(p) = \alpha_0 + \sum_{i=1}^{M} \alpha_i \ln p_i + \sum_{i=1}^{M} \sum_{j=1}^{M} \frac{\gamma_{ij}}{2} \ln p_i \ln p_j \tag{4.2}$$

and

$$b(p) = \prod_{i=1}^{M} p_i^{\beta_i} \tag{4.3}$$

Applying Roy's Identity to the definition of indirect utility, in log form, yields share equations, which are functions of household expenditure per adult equivalent and the prices in the economy.

[30] Bopabe and Myers (2007) consider a panel version of the Quadratic Ideal Demand System developed by Banks, Blundell and Lewbel (1997).

$$-\frac{\partial \ln V / \partial \ln p_k}{\partial \ln V / \partial \ln x} \equiv w_k = \alpha_k + \sum_{i=1}^{m} \gamma_{ik} \ln p_i + \beta_k \ln\left(\frac{x/e}{a(p)} \right) \tag{4.4}$$

The empirical results presented in this paper, however, are based on the additional assumption that $\gamma_{ik} = 0 \ \forall i \in \{1,2...,m\}$; the assumption results from collinearity between the prices in our data.[31] However, the underlying price aggregator *a(p)* was calculated based on different possible weights, $\alpha_k \ \forall k \in \{1,2,...,m\}$. Further elaboration on those weights is found below.

Given our preceding assumptions, the version of the AID system that we estimate is given in equation (4.5).

$$w_{k\ell} = \alpha_{k\ell} + \beta_{k\ell} \ln\left(\frac{x/e}{a_\ell(p)} \right) \tag{4.5}$$

In the preceding equation, x is total expenditure, e is adult equivalence, $a_\ell(p)$ is the subgroup price aggregator function and $k = \{1,2,...,m\}$ represents the commodity group, while $\ell = \{1,2,...,L\}$ denotes the subgroups over which the shares, *w*, are estimated. Nearly 50 subgroups are considered; the empirical results presented in Table 2 include only about 30 subgroups.[32] The estimated parameters $\widehat{\alpha_{k\ell}}$ and $\widehat{\beta_{k\ell}}$ are used to predict the adult equivalent indirect utility used in each simulation for the further estimation of the subsidies required to offset the simulated effects of inflation, although other assumptions are also considered; see below for further elaboration.

4.2 Simulation exercises and nonparametric density estimates

4.2.1 Compensating variation

As noted in, for example, Creedy (2000), compensating variation is implicitly determined by the indirect utility function.

[31] In results not presented in this paper, but available from the authors, there is near perfect collinearity between regional prices for any two products. A common problem with cross-sectional data is that price variation is not adequate for the identification of price effects. Although Stats SA prepares CPI figures for various urban and metropolitan areas in South Africa, suggesting that there are a large number of price points in the data, these CPI figures are intertwined by definition. In other words, the CPI values are not calculated from observed regional price variation; rather, they are calculated from regional expenditure weights, via the plutocratic weighting method.

[32] A number of subgroups are subsumed into larger groups for ease of presentation, although more detailed results are available from the authors. The additional groups are primarily based on urban, rural and metropolitan area delineations available in the data. For example, most of the African analysis is, in fact, undertaken separately for urban, rural and metropolitan households.

$$V(p',\ x+CV) \ = \ V(p,x) \tag{4.6}$$

Therefore, the compensating variation, or the subsidy required to offset the simulated effects of inflation can be calculated by noting first that:

$$\ln\left(\frac{x_{i\ell}^{h}}{e_{i\ell}}\right)=\frac{b_{\ell}^{h}(p^{\hbar})}{b_{\ell}^{h}(p^{\hbar})}\left[\ln\left(\frac{x_{i\ell}}{e_{i\ell}}\right)-a_{\ell}^{h}(p^{\hbar})\right]+a_{\ell}^{h}(p^{\hbar})\,. \tag{4.7}$$

In the preceding equation, $x_{i\ell}^{h}$ denotes the required total expenditure needed to solve the equation, inclusive of the compensating variation, where i represents the household in subgroup ℓ. The required total expenditure is determined by actual estimates of $a_{\ell}^{h}(p^{\hbar})$ and $b_{\ell}^{h}(p^{\hbar})$, as well as by the simulated inflation effects $a_{\ell}^{h}(p^{\hbar})$ and $b_{\ell}^{h}(p^{\hbar})$, where $h=\{p,pa,d,da\}$ represent the four simulation exercises, below, and $\hbar=\{p,d\}$ represents the aggregation applied to the price data. From the AID system,

$$\widehat{a_{\ell}^{h}(p)}=\widehat{\alpha_{0\ell}^{h}}+\sum_{k=1}^{M}\widehat{\alpha_{k\ell}^{h}}\ln p_{k\ell}^{\hbar}\,. \tag{4.8}$$

Note that $k=\{1,2,...,m=10\}$ represents the commodity groups. We further assume $\widehat{\alpha_{0\ell}^{h}}=0 \ \ \forall\ell$, since it cannot be identified empirically. The AID system also specifies:

$$\widehat{b_{k\ell}^{h}(p^{\hbar})}=\prod_{k=1}^{M}\left(p_{k\ell}^{\hbar}\right)^{\widehat{\beta_{k\ell}}}\,. \tag{4.9}$$

From the predicted values in equations (4.8) and (4.9), we can predict:

$$\widehat{\ln\left(\frac{x_{i\ell}^{h}}{e_{i\ell}}\right)}=\frac{\widehat{b_{\ell}^{h}(p^{\hbar})}}{\widehat{b_{\ell}(p^{\hbar})}}\left[\ln\left(\frac{x_{i\ell}}{e_{i\ell}}\right)-\widehat{a_{\ell}(p^{\hbar})}\right]+\widehat{a_{\ell}^{h}(p^{\hbar})}\,. \tag{4.10}$$

Note that $\widehat{b_{\ell}(p^{\hbar})}$ and $\widehat{a_{\ell}(p^{\hbar})}$ represent the base price aggregator functions before any simulations are performed. From equation (A.5), we can further predict the required subsidy:

$$CV_{i\ell}^{h}=\exp\left\{\widehat{\ln\left(\frac{x_{i\ell}^{h}}{e_{i\ell}}\right)}\right\}-\exp\left\{\ln\left(\frac{x_{i\ell}}{e_{i\ell}}\right)\right\}. \tag{4.11}$$

4.2.2 Simulation weighting functions

Four separate simulation exercises are considered in the analysis. The first uses only plutocratic weights. By definition, plutocratic weights sum to one and, therefore, plutocratic weights are consistent with the adding-up properties of the AID system, as described in Deaton and Muellbauer (1980). The second uses AID system parameter estimates and plutocratically weighted commodity price aggregates; see equation (3.1). The third and fourth simulations are based on democratic weights, rather than plutocratic weights. In the third, only democratic weights are used; again, AID system adding-up properties are satisfied since expenditure shares sum to one. The fourth simulation uses AID system parameter estimates and democratically weighted price aggregates within commodities, as described in equation (3.1).

From Ley (2005), plutocratic weights, which are normally applied in the standard calculation of consumer price indexes, are given by

$$\omega_k^p = \frac{\sum_{j=1}^{N} x_{kj}}{\sum_{k=1}^{m} \sum_{j=1}^{N} x_{kj}} \tag{4.12}$$

In other words, the weight placed on good *i* is determined by the total amount of expenditure on that good in the economy relative to total expenditure; x_{ij} is household *j*'s expenditure on good *i*. Democratic weights, also defined in, for example, Ley (2005) are given by:

$$\omega_k^d = \frac{x_{kj}}{\sum_{i=1}^{M} x_{kj}} \tag{4.13}$$

Again, the *k* subscript denotes the good under consideration, the *j* subscript denotes the household, while x_{kj} represents expenditure by household *j* on good *k*. Therefore, democratic weights use budget share data at the household level to determine the importance of the commodity within the representative household's budget.

Our analysis calculates $CV_{k\ell}^h$ for four separate scenarios; furthermore, the scenarios are presented across three different subsets of the expenditure distribution: those households below the 40th percentile, those households between the 40th and 70th percentiles and those households above the 70th percentile. In the first scenario, $CV_{k\ell}^p$, we set $\widehat{\alpha_{k\ell}^p} = \omega_{k\ell}^p$, while using $\widehat{b_{k\ell}^p}$. In the second scenario, $CV_{k\ell}^{pa}$, we make use of both $\widehat{\alpha_{k\ell}^{pa}}$ and $\widehat{b_{k\ell}^{p}}$; plutocratic weighted price aggregations are used for each of these two simulations. The third and fourth scenarios, however, are predicated on democratically weighted prices, rather than plutocratically weighted prices. In the third, $CV_{k\ell}^{d}$, we set $\widehat{\alpha_{k\ell}^{d}} = \omega_{k\ell}^{d}$. In the fourth, $CV_{k\ell}^{da}$, we make use of $\widehat{\alpha_{k\ell}^{d}}$. In both of the remaining scenarios, we continue to make use of $\widehat{b_{k\ell}^{d}}$, but it is calculated from democratically weighted prices.

4.2.3 Nonparametric density estimation

From all four simulations, it is possible to derive each household's per adult compensating variation, which we refer to as CV_i^h, where *i* represents the household and *h* represents the simulation being considered. These compensating variations are then separated by (approximate) household expenditure terciles. Actually, they are not terciles, although there are three groups: households below the 40th percentile, households between the 40th and 70th percentiles and households above the 70th percentile. The 40th percentile was chosen, as it has been used to demarcate poverty in South Africa (National Treasury, 2007). The remaining two distribution breaks, although *ad hoc*, were chosen to split the remaining distribution equally.

Within each of the three expenditure groups, $g = \{1,2,3\}$, nonparametric estimates of the unconditional univariate density of compensating variations are calculated. The nonparametric unconditional univariate density estimate is given by

$$\widehat{f_g\left(cv_g\right)} = \frac{1}{n_g h_g} \sum_{i=1}^{n_g} K\left(\frac{CV_{ig} - cv_g}{h_g}\right). \tag{4.14}$$

In equation (4.2), $\widehat{f_g\left(cv_g\right)}$ is the estimated univariate density, n_g is the number of observations in the group *g*, h_g is the ordinary least squares cross-validated bandwidth or estimation window,[33] CV_{ig} is an observed compensated variation for household *i* in group *g*, cv_g is a point within the window h_g and *K* is the

[33] Li and Racine (2007) provide a detailed discussion of both the univariate kernel density and the ordinary least squares cross-validation calculation.

Epanechnikov Kernel (Härdle, 1990). Results from these different density estimates are illustrated in Figures 1-4, and discussed below.

5 Results

In this section, we focus on the results of the analysis. We first consider the Aid system estimates, although not in complete detail. We continue by examining the simulation results.

5.1 AID system estimates

In order to undertake the micro-simulation exercise, the main focus of this research, demand system estimates were necessary and, due to the large degree of heterogeneity in the South African IES 2005/06, the demand system estimates were undertaken for reasonably homogeneous subsets of the population. As noted previously, the demand systems were estimated for more than 50 subsets of the data, although the results in Table 2 present only 30 subsets. The subsets were chosen by population group of the household head, as well as whether or not the head of the household was male/female, whether or not the household head was old enough to retire (pensioner/not), and the level of education of the household head.[34]

Each of the demand system estimates is presented in Table 2 across the household subgroups.[35] Although there are too many tables to discuss in great detail, there are some rather notable generalisations. The estimated coefficients on the natural log of household expenditure per adult equivalent (lnxae) for food products, as well as clothing and footwear are generally negative and statistically significant. These combined results suggest that food products, clothing and footwear are household necessities. Among population groups, the estimated coefficients on lnxae are generally more negative for African households, followed by coloured households, Asian households and white households, while increased education of the household head is associated with less negative coefficient estimates on the lnxae for grain

[34] Additional subsets include whether or not non-pensioner African-headed households were located in urban, rural or metropolitan areas, and whether or not coloured-headed households were located in either urban/metropolitan or rural areas. These separate results are available from the authors on request.

[35] Further subgroups are possible, such as provincial differences along with urban, rural and metropolitan classifications, as well as income stratifications. Additional research will consider whether those additional subgroups affect the analysis.

products. Furthermore, the estimated constants are positive for food products, as well as clothing and footwear. These positive constants imply that households will always spend some positive proportion of their budget on these goods.

The largest positive coefficient estimates for the lnxae is for health, education and miscellaneous goods; these estimates are generally positive and significant for all population subgroups, suggesting that health, education and miscellaneous goods are luxury items. The estimates on the lnxae for communication, transport and running costs, as well as entertainment expenditures (i.e. reading material, recreation, tobacco products and alcoholic beverages) are also positive, suggesting that these products are also luxury items for the household. Furthermore, as the education level of the household head increases, there is a general increase in the estimate on lnxae for health, education and miscellaneous goods, suggesting that either more educated household heads have preferred investing in their household's human capital or that higher education levels are associated with a greater share of expenditure towards miscellaneous goods; unfortunately, the analysis cannot separate the two. Furthermore, the estimated intercept for health, education and miscellaneous goods is generally negative, suggesting that households require a minimum level of expenditure outlay per adult equivalent before they will either invest in household human capital or purchase miscellaneous goods. Finally, estimates for housing and household goods are not either always positive or always negative and, therefore, cannot be generalised.[36]

5.2 Micro-simulation and kernel densities

The micro-simulations are summarised in four figures and one table; Table 3 presents the estimated mean inflation subsidy necessary for each of the simulations, as well as the proportional increase in lnxae required to offset the effects of simulated inflation. Figures 1–4, on the other hand, illustrate the estimated densities for the inflation subsidy (compensating variation). Figure 1 presents results of the simulation for an increase in all prices; Figure 2 illustrates the simulation results for an increase in food prices; Figure 3 shows results for increases in clothing and housing costs, while Figure 4 illustrates the results for increases in all other prices, that is, those prices not directly related to food, housing or clothing.

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[36] The reader is directed to Table 2 for a more careful examination of the parameter estimates and their significance across the subgroup specific demand system estimates.

The estimated means of the compensating variation calculated from the analysis (reported in the top panel of Table 3) summarise the effect of inflation on lnxae. Since inflation results in a decrease in purchasing power, inflation generally requires a positive compensating variation. There are some exceptions, though. When all prices increase by 10 per cent, as seen in the first three columns of the top panel of Table 3, the weighting structure does not matter much, which is to be expected given the AID system functional form.[37] In addition, as seen in this same set of columns, because richer households spend more, inflation reduces their purchasing power to a greater extent, requiring a larger compensating variation.

However, when inflation hits certain products differently from other products, as seen in the last nine columns of the top panel of Table 3, the compensating variations are rather different, although means from simulations *p* and *d* are similar to each other, as are results from simulations *pa* and *da*. There are also product categories for which inflation results in negative compensating variations. Although the negative compensating variation implies that these households would be willing to pay for inflation, we prefer to interpret these negative values in their relative sense, that is, if for certain households the compensating variation is positive, while for others it is negative, then inflation creates a greater relative difference in the impact of inflation on households.[38]

In the bottom panel of Table 3, the relative impact of inflation is more easily observed. In this table, the mean of one minus the ratio of the compensating variation to the lnxae is presented for each of the simulation exercises. As expected, in the first three columns of the bottom panel, we see that that a 10 per cent increase in all prices results in a 10 per cent increase in lnxae, that is, the compensating variation is 10 per cent of the original lnxae. Columns three through six of the bottom panel of Table 3 show the negative impact of food inflation more clearly. Food inflation

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[37] Importantly, *a(p)* is homogeneous of degree one, while *b(p)* is homogeneous of degree zero. Therefore a 10 per cent increase in prices does not affect *b(p)*, but increases *a(p)* by 10 per cent, resulting in a 10 per cent required increase in the natural log of per adult equivalent household expenditure.

[38] A number of additional analyses were conducted to ascertain the sensitivity of these negative estimates. For example, we removed the top and the bottom 5 per cent of that portion of the distribution. Little change was uncovered in these sensitivity analyses.

requires a greater compensating variation, as a proportion of initial outlay per adult equivalent, among poorer households than among wealthier households. Our results show that poorer households require an increase in lnxae of between 1,1 per cent and 3,7 per cent for every 10 per cent increase in food-related prices, while richer households are willing to pay between 2,3 per cent of original lnxae and require payment of up to 1,7 per cent of lnxae to offset any 10 per cent increase in food prices, depending on the simulation. By contrast, inflation for all other goods (not food, clothing or housing) more negatively affects wealthier households. Wealthier households require a compensating variation of between 4,5 per cent and 9,6 per cent of original lnxae, while poorer households require a compensating variation of between 2,9 per cent and 6,7 per cent of original lnxae to offset a 10 per cent increase in the prices of all other goods, depending on the simulation exercise.

Figures 1–4 present the density estimates of the compensating variations for each of the simulation experiments. There are four panels in each figure, representing each of the simulations. Figures 1a–1d show that a 10 per cent increase in all prices results in nearly the same distribution of compensating variations, as expected, given the function form of the AID system. Figures 4a–4d also show that a 10 per cent increase in all other prices results in nearly the distribution of compensating variations, regardless of the simulation exercise. The empirical similarity between Figures 1a–-1d and Figures 4a–4d is backed by the importance of all other prices in determining the ratio of the compensating variation to the natural log of per adult equivalent household expenditure. Given how large the values are in the last three columns of the bottom panel of Table 3, it is not surprising that Figures 4a–4d approximately replicate Figures 1a–1d.[39]

Figures 2 and 3, however, highlight the fact that the effect of inflation on households differs by both the type of product that is inflated and the weighting assumptions used in the simulation exercises. The difference is most notable in Figures 2a and 2c, as well as in Figures 3b and 3d. The estimated density for food inflation for simulation *p*, illustrated in Figure 2a is the least smooth of all the estimated densities, and is generally bimodal, related to the two separate impacts of food inflation within this

[39] As can be seen in both Figures 1a–1d and Figures 4a–4d, the compensating variations are approximately lognormal, although no formal test of functional form has been conducted.

simulation exercise. Given the functional form, we can be sure that food inflation increases *a(p)*. However, the coefficient estimates on lnxae for all of the food products in each of the subgroups is negative, resulting in a decrease in *b(p)*.[40] The estimated densities show that for certain households, the *a(p)* effect dominates the *b(p)* effect, while for other households, the opposite is true. In Figure 2c, however, the estimates are smoother, that is, there is no bimodality. Despite the unimodal density, it is still true that there are two opposing forces in the compensating variation calculation. Importantly, though, households are smoothly segregated, rather than abruptly segregated by which effect dominates. The smooth transition likely results from the fact that the densities in Figure 2c are based on democratic weighting, which makes use of actual household expenditure patterns, rather than plutocratic weighting, which makes use of a specific household's expenditure pattern to determine the weights.[41]

The estimated compensating variation densities for clothing and housing inflation illustrated in Figure 3, especially in Figures 3b and 3d, are also less smooth than most of the other estimated densities. There are also signs of bimodal responses in Figures 3b and 3d, similar to the bimodal response in Figure 2a, although the reason for bimodality is slightly different than those given previously. Although the estimated coefficients on lnxae for clothing are generally negative, the estimated coefficients on lnxae for both housing and household goods are both positive and negative. Therefore, there are two types of households, namely (1) those with generally positive housing and household goods coefficients and (2) those with generally negative housing and household goods coefficients. It is these differences in the sign of the estimated coefficients on lnxae that drive the bimodal responses in these estimates.

[40] In equation (4.3) *b(p)* is defined. Negative values of the coefficients imply negative exponents in the definition, such that an increase in food prices (raised to a negative power) is a reduction in *b(p)*.

[41] In Oosthuizen (2007) it is the household at the 95th percentile of the distribution that represents the plutocratic weighting structure. In other words, in the plutocratic weighting simulation, households are expected to act like the household in the 95th percentile. For poorer households that are similar to this reference household, we get one set of estimates, but for poorer households that are not similar to the reference household, we get a different set of estimates. These differences drive the bimodality in the estimated densities.

6 Concluding thoughts

The research presented in this paper describes the effect of inflation on various goods across the expenditure distribution based on both plutocratic and democratic weighting structures. The results are based on a two-stage analysis. In the first stage parametric share systems were estimated across a wide range of relatively less heterogeneous subsets of the data, compared to the entire data set. The parameter estimates from the parametric demand systems were used to calculate inflation offsets or the compensating variation required to keep a household equally happy following an episode of inflation. We considered the effect of general inflation, in which all prices increase; food price inflation; clothing and housing inflation; and inflation in all other goods. Furthermore the simulation results are presented across three different subsets of the population, where subsets were determined by percentiles of the expenditure distribution.

Generally, the results are consistent with theory: inflation lowers purchasing power and because wealthier households spend more, they require larger compensation to offset the impact of inflation. However, our results also show that food inflation affects poorer households more negatively than wealthier households, although the effects may not be as large as might have been expected, given the share of expenditure devoted to food related goods in poorer households. The empirical observation that food inflation does not greatly alter poor household welfare, while also improving welfare among the wealthier segments of the population is due to (1) the negative coefficient estimates on food products within the demand system for the natural log of per adult equivalent household expenditure and (2) the fact that we are not able to estimate substitution effects within our demand system, due to collinearity in our price data.

Although the results are reasonable, a number of issues remain to be resolved. Importantly, households are also likely to change their expenditure patterns when prices rise. Unfortunately, our analysis is not able to address substitution patterns, since useful price data are not available and until a wider range of price data are available, substitution patterns cannot be addressed. Although substitution patterns could not be estimated in our data, Stats SA segregates households into 30 separate price regions. Future research could make use of this segregation to proxy price differentiation and substitution patterns, although the analysis would likely have to be undertaken at a more aggregated level. It should also be noted that the empirical analysis was based on only one demand system, the Almost Ideal Demand System, which may not adequately reflect household expenditure responses within the demand system. Therefore, future research should also allow for further flexibility within the demand system to determine the robustness of our results to demand system specification.[42] In addition, although our analysis did control for some heterogeneity; there are likely to be additional sources of heterogeneity beyond those considered, and, therefore, future research should also examine the robustness of our results with respect to additional sources of heterogeneity. Finally, a number of researchers have examined the impact of inflation through the various poverty measures; future research could easily incorporate various poverty measures to determine if inflation affects poverty, generally, and inequality, specifically.

[42] Unfortunately, the lack of adequate price data means that rank-three demand systems are not properly specified, and, therefore, cannot be estimated (Banks, Blundell and Lewbel, 1997).

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Figure 1: The distribution of income subsidies to offset a 10 per cent increase in all prices

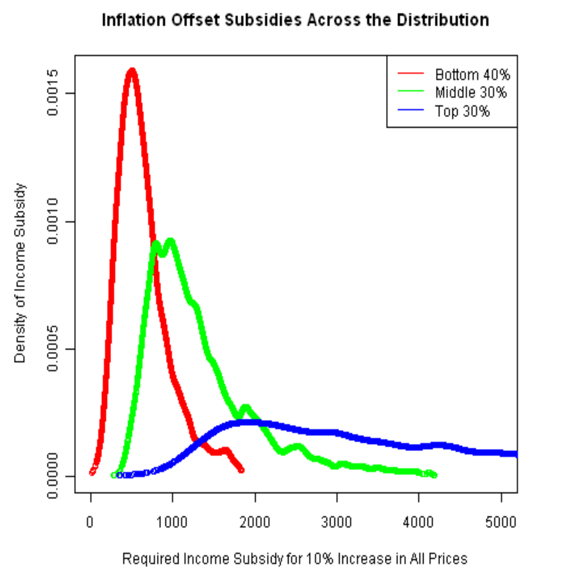


Figure 1a. Plutocratic weights – Fixed

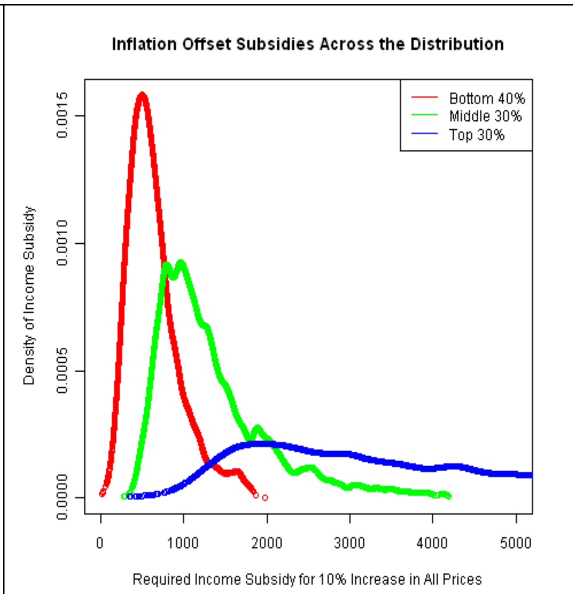


Figure 1b. Plutocratic weights – Estimated

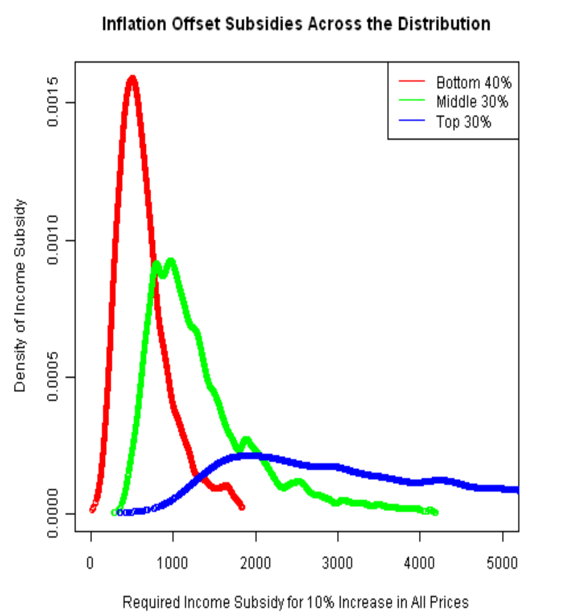


Figure 1c. Democratic weights – Fixed

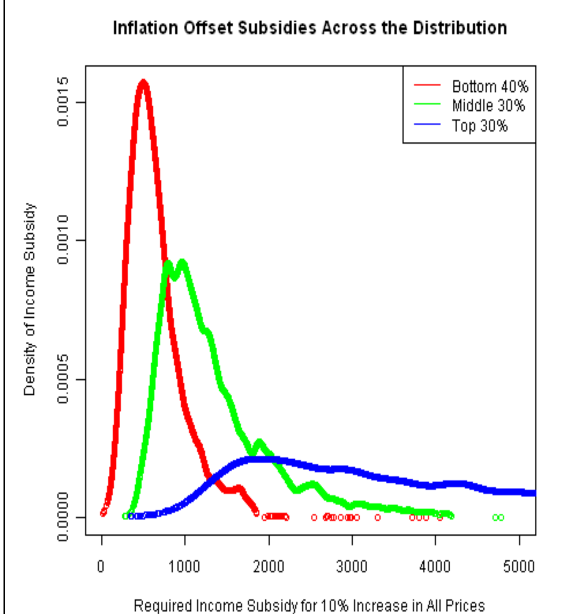


Figure 1d. Democratic weights – Estimated

Source: Data from South African IES 2005/06 following regression; densities calculated via np package 0.30-1 (Hayfield and Racine, 2008) from R (R Core Development Team, 2008).

Figure 2: The distribution of income subsidies to offset a 10 per cent increase in food prices

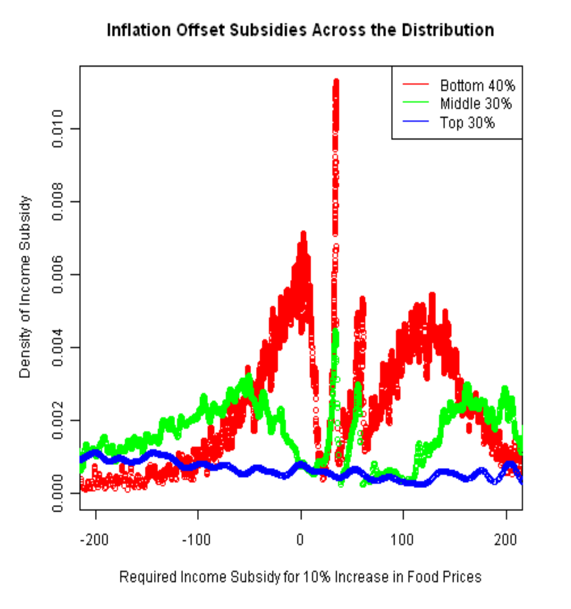


Figure 2a. Plutocratic weights – Fixed

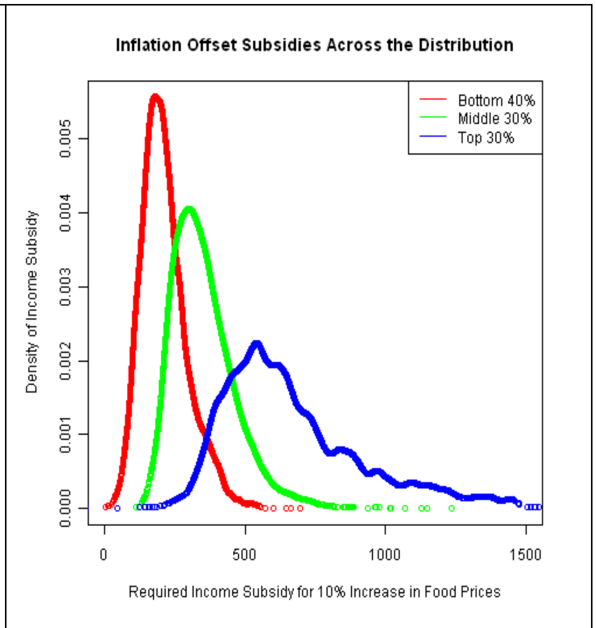


Figure 2b. Plutocratic weights – Estimated

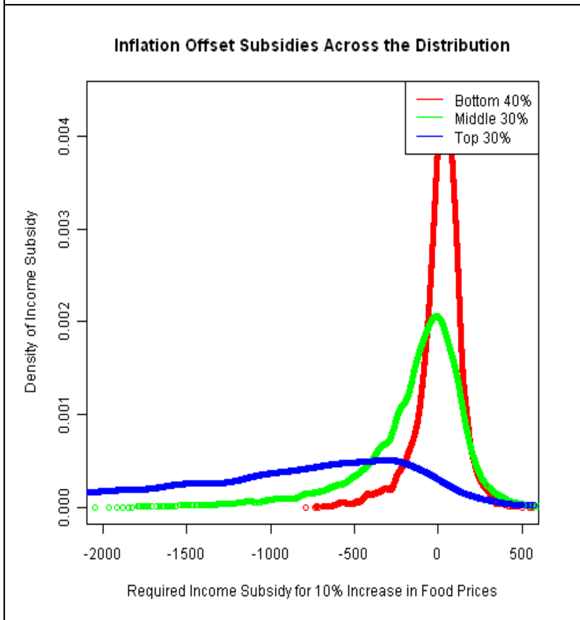


Figure 2c. Democratic weights – Fixed

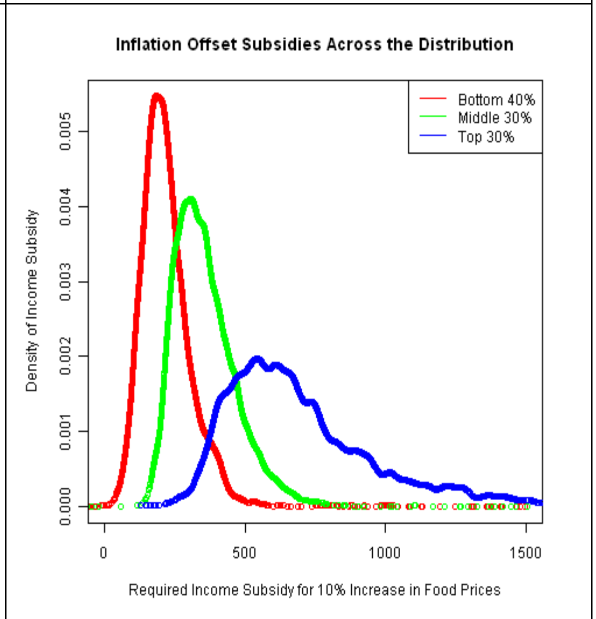


Figure 2d. Democratic weights – Estimated

Source: Data from South African IES 2005/06 following regression; densities calculated via np package 0.30-1 (Hayfield and Racine, 2008) from R (R Core Development Team, 2008).

Figure 3: The distribution of income subsidies to offset a 10per cent increase in clothing and housing prices

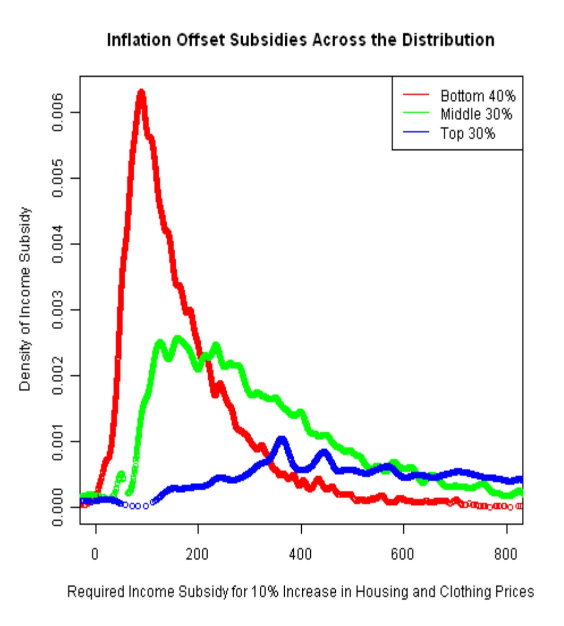
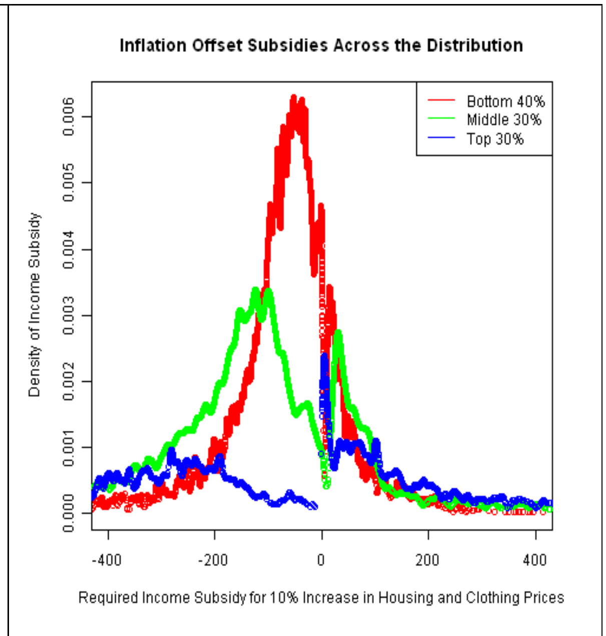


Figure 3a. Plutocratic weights – Fixed



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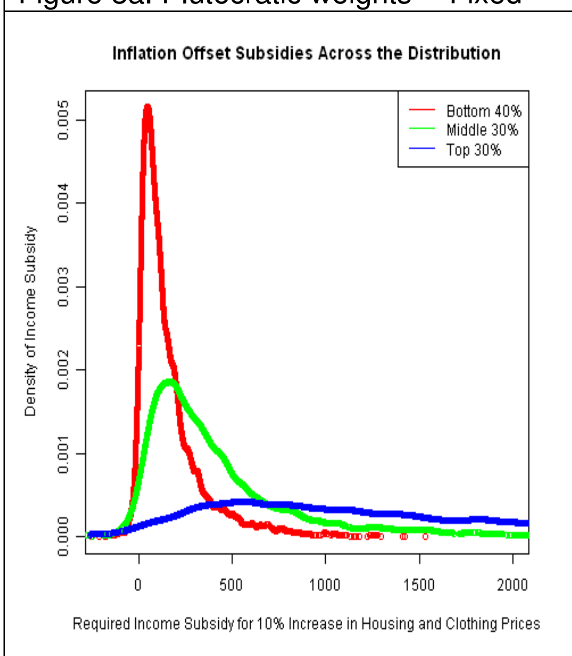

Figure 3c. Democratic weights – Fixed

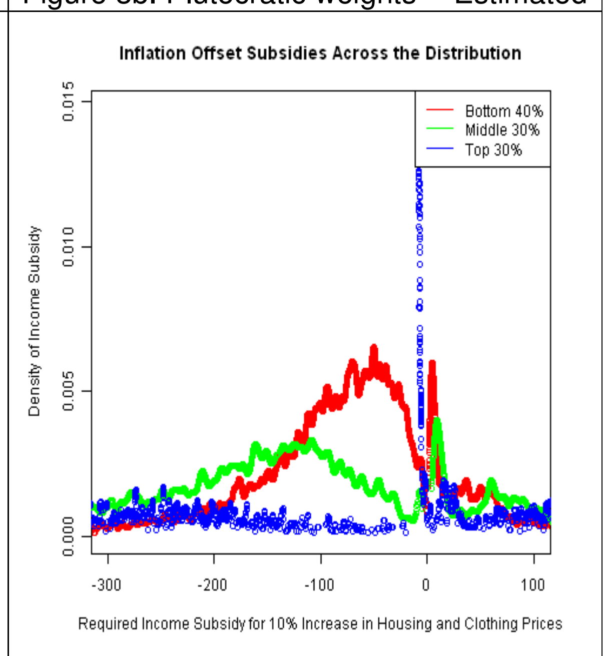

Figure 3d. Democratic weights – Estimated

Source: Data from South African IES 2005/06 following regression; densities calculated via np package 0.30-1 (Hayfield and Racine, 2008) from R (R Core Development Team, 2008).

Figure 4: The distribution of income subsidies to offset a 10 per cent increase in all other prices in the economy

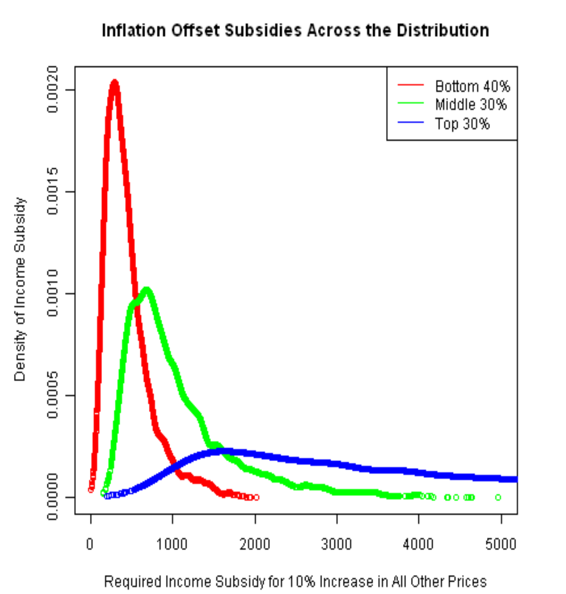

Figure 4a. Plutocratic weights – Fixed

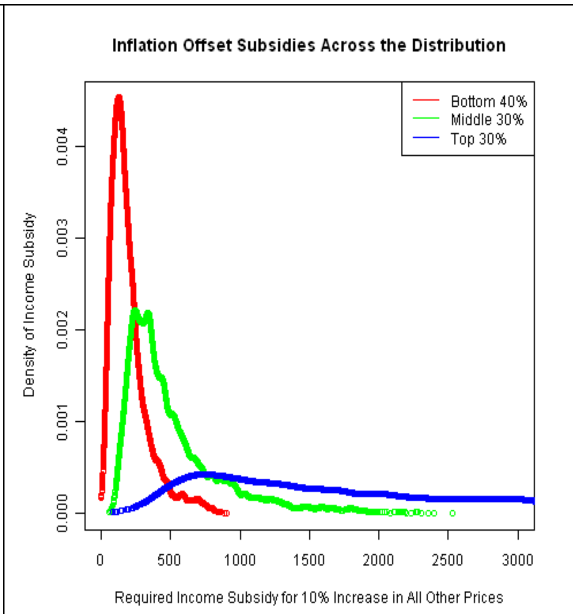

Figure 4b. Plutocratic weights – Estimated

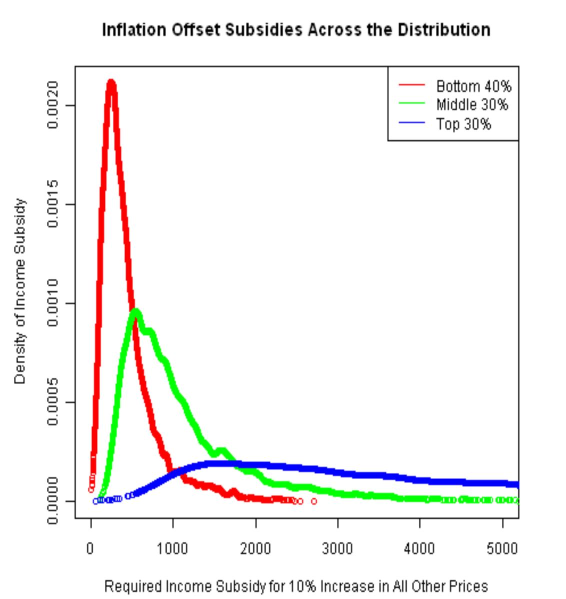

Figure 4c. Democratic weights – Fixed

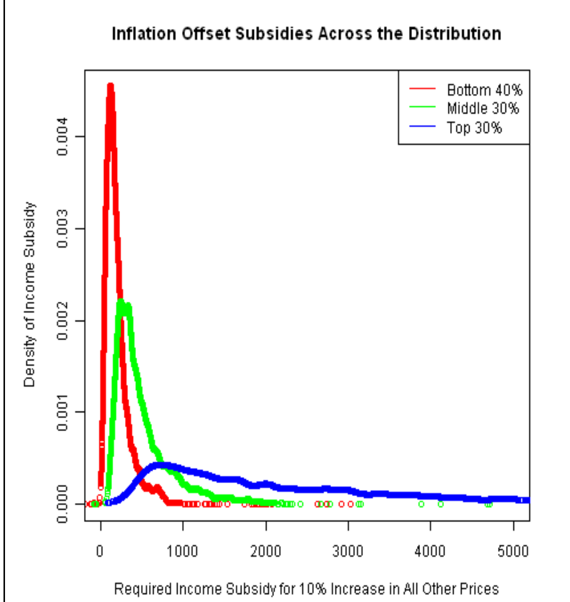

Figure 4d. Democratic weights – Estimated

Source: Data from South African IES 2005/06 following regression; densities calculated via np package 0.30-1 (Hayfield and Racine, 2008) from R (R Core Development Team, 2008).

Table 1: Descriptive statistics of the data

Household characteristics

	Bottom 40 per cent	Middle 30 per cent	Top 30 per cent
Total household expenditure	10,896** (41.3)	25,921** (79.1)	102,496** (1,334.7)
Log of real expenditure per adult equivalent	8.645** (0.005)	9.389** (0.006)	10.638** (0.010)
Adult equivalence	1.892** (0.008)	2.254** (0.010)	2.090** (0.010)
Male household head	0.506** (0.005)	0.531** (0.006)	0.693** (0.006)
African household head	0.887** (0.003)	0.827** (0.005)	0.472** (0.007)
Asian household head	0.001** (0.000)	0.008** (0.001)	0.043** (0.003)
Coloured household head	0.108** (0.003)	0.140** (0.004)	0.148** (0.005)
White household head	0.003** (0.001)	0.025** (0.002)	0.337** (0.006)
Rural location	0.487** (0.005)	0.340** (0.006)	0.157** (0.005)
Urban location	0.284** (0.005)	0.369** (0.006)	0.467** (0.007)
Metropolitan location	0.228** (0.004)	0.291** (0.006)	0.375** (0.007)
No education (household head)	0.259** (0.005)	0.188** (0.005)	0.047** (0.003)
Some education (household head)	0.394** (0.005)	0.341** (0.006)	0.122** (0.005)
Primary education (household head)	0.270** (0.005)	0.306** (0.005)	0.244** (0.006)
Matriculant (household head)	0.076** (0.003)	0.161** (0.005)	0.562** (0.006)
Household size	3.513** (0.026)	4.690** (0.037)	4.023** (0.035)
Observations	9324	6372	5176

Expenditure shares

	Bottom 40 per cent	Middle 30 per cent	Top 30 per cent
Grain	0.114** (0.001)	0.079** (0.001)	0.029** (0.000)
Protein	0.128** (0.001)	0.122** (0.001)	0.076** (0.001)
Fruit and vegetables	0.051** (0.000)	0.036** (0.000)	0.018** (0.000)
Other food and beverages	0.070** (0.001)	0.064** (0.001)	0.045** (0.001)
Clothing and footwear	0.090** (0.001)	0.090** (0.001)	0.065** (0.001)
Housing cost	0.118** (0.001)	0.116** (0.001)	0.190** (0.002)
Household goods cost	0.140** (0.001)	0.133** (0.001)	0.106** (0.001)
Health, education and miscellaneous	0.108** (0.001)	0.152** (0.001)	0.231** (0.002)
Communication, transport and running cost	0.106** (0.001)	0.130** (0.001)	0.153** (0.001)

Household characteristics

	Bottom 40 per cent	Middle 30 per cent	Top 30 per cent
Reading, recreation, tobacco and alcohol	0.075** (0.001)	0.078** (0.001)	0.087** (0.001)

Bootstrapped (500 replications) standard errors in parentheses
** $p < 0.01$, * $p < 0.05$
Source: Author's own calculations, data from South Africa IES 2005/06.

Table 2: Almost Ideal Demand System Estimates

African male pensioners

Coefficients	Grain	Protein	Fruit and vegetables	Other food and beverages	Clothing and footwear	Housing cost	Household cost	Health, education and miscellaneous	Communication, transport and running cost	Reading, recreation, tobacco and alcohol
Log of real expenditure per adult equivalent	-0.0357**	-0.0145	-0.0144**	-0.0039	-0.0043	0.0171	0.0029	0.0436**	0.0166*	-0.0074
	(0.0078)	(0.0110)	(0.0050)	(0.0050)	(0.0052)	(0.0132)	(0.0104)	(0.0111)	(0.0083)	(0.0271)
Constant	0.2553**	0.2059**	0.1054**	0.0835**	0.0718**	0.0693	0.1299**	-0.0441	0.0208	0.1022
	(0.0325)	(0.0459)	(0.0209)	(0.0207)	(0.0217)	(0.0550)	(0.0433)	(0.0464)	(0.0346)	(0.1129)
Observations = 219										

African female pensioners

Coefficients	Grain	Protein	Fruit and vegetables	Other food and beverages	Clothing and footwear	Housing cost	Household cost	Health, education and miscellaneous	Communication, transport and running cost	Reading, recreation, tobacco and alcohol
Log of real expenditure per adult equivalent	-0.0333**	-0.0008	-0.0239**	-0.0071	-0.0170**	0.0487**	-0.0115	0.0352**	0.0026	0.0071
	(0.0062)	(0.0065)	(0.0035)	(0.0047)	(0.0041)	(0.0092)	(0.0085)	(0.0089)	(0.0065)	(0.0203)
Constant	0.2491**	0.1335**	0.1549**	0.1020**	0.1274**	-0.0703	0.2225**	-0.0091	0.0752**	0.0148
	(0.0261)	(0.0274)	(0.0148)	(0.0200)	(0.0171)	(0.0387)	(0.0361)	(0.0375)	(0.0274)	(0.0854)
Observations = 423										

African male non-pensioner, no education

Coefficients	Grain	Protein	Fruit and vegetables	Other food and beverages	Clothing and footwear	Housing cost	Household cost	Health, education and miscellaneous	Communication, transport and running cost	Reading, recreation, tobacco and alcohol
Log of real expenditure per adult equivalent	-0.0411**	0.0080*	-0.0165**	-0.0102**	-0.0121**	0.0029	-0.0107**	0.0413**	0.0305**	0.0079
	(0.0032)	(0.0036)	(0.0017)	(0.0024)	(0.0028)	(0.0043)	(0.0039)	(0.0044)	(0.0039)	(0.0104)
Constant	0.2786**	0.0984**	0.1119**	0.1105**	0.1320**	0.0956**	0.1734**	-0.0349*	-0.0098	0.0443
	(0.0126)	(0.0141)	(0.0067)	(0.0094)	(0.0109)	(0.0169)	(0.0152)	(0.0173)	(0.0155)	(0.0408)
Observations = 1 379										

African male non-pensioner, some education

Coefficients	Grain	Protein	Fruit and vegetables	Other food and beverages	Clothing and footwear	Housing cost	Household cost	Health, education and miscellaneous	Communication, transport and running cost	Reading, recreation, tobacco and alcohol
Log of real expenditure per adult equivalent	-0.0447**	-0.0064**	-0.0169**	-0.0110**	-0.0115**	-0.0046	-0.0171**	0.0549**	0.0452**	0.0121*
	(0.0019)	(0.0024)	(0.0010)	(0.0016)	(0.0019)	(0.0031)	(0.0026)	(0.0033)	(0.0031)	(0.0073)
Constant	0.2816**	0.1474**	0.1095**	0.1090**	0.1319**	0.1296**	0.1967**	-0.0952**	-0.0545**	0.0440
	(0.0079)	(0.0100)	(0.0042)	(0.0067)	(0.0080)	(0.0129)	(0.0108)	(0.0137)	(0.0130)	(0.0305)
Observations = 2 755										

African male non-pensioner, primary education

Coefficients	Grain	Protein	Fruit and vegetables	Other food and beverages	Clothing and footwear	Housing cost	Household cost	Health, education and miscellaneous	Communication, transport and running cost	Reading, recreation, tobacco and alcohol
Log of real expenditure per adult equivalent	-0.0412**	-0.0188**	-0.0161**	-0.0078**	-0.0140**	0.0058	-0.0179**	0.0500**	0.0398**	0.0202**
	(0.0015)	(0.0022)	(0.0008)	(0.0015)	(0.0020)	(0.0032)	(0.0025)	(0.0031)	(0.0031)	(0.0070)
Constant	0.2581**	0.2023**	0.1045**	0.0914**	0.1581**	0.0873**	0.1977**	-0.0913**	-0.0255	0.0174
	(0.0069)	(0.0097)	(0.0037)	(0.0066)	(0.0090)	(0.0142)	(0.0112)	(0.0136)	(0.0139)	(0.0314)
Observations = 2 457										

Source: Authors' own calculations following regression analysis and simulation using data from South Africa IES 2005/06

African male non-pensioner, matric or more education

Coefficients	Grain	Protein	Fruit and vegetables	Other food and beverages	Clothing and footwear	Housing cost	Household cost	Health, education and miscellaneous	Communication, transport and running cost	Reading, recreation, tobacco and alcohol
Log of real expenditure per adult equivalent	-0.0325**	-0.0281**	-0.0130**	-0.0112**	-0.0141**	0.0151**	-0.0160**	0.0782**	0.0142**	0.0074
	(0.0011)	(0.0021)	(0.0007)	(0.0014)	(0.0021)	(0.0037)	(0.0024)	(0.0042)	(0.0036)	(0.0079)
Constant	0.2109**	0.2343**	0.0895**	0.1023**	0.1632**	0.0516**	0.1803**	-0.1982**	0.1035**	0.0626
	(0.0056)	(0.0108)	(0.0034)	(0.0074)	(0.0106)	(0.0191)	(0.0122)	(0.0218)	(0.0186)	(0.0408)
Observations = 1 552										

African female non-pensioner, no education

Coefficients	Grain	Protein	Fruit and vegetables	Other food and beverages	Clothing and footwear	Housing cost	Household cost	Health, education and miscellaneous	Communication, transport and running cost	Reading, recreation, tobacco and alcohol
Log of real expenditure per adult equivalent	-0.0484**	0.0073*	-0.0218**	-0.0072**	-0.0100**	0.0020	-0.0021	0.0418**	0.0199**	0.0185*
	(0.0033)	(0.0031)	(0.0017)	(0.0022)	(0.0027)	(0.0042)	(0.0038)	(0.0045)	(0.0033)	(0.0099)
Constant	0.3249**	0.0950**	0.1399**	0.0992**	0.1285**	0.0988**	0.1501**	-0.0277	0.0185	-0.0272
	(0.0130)	(0.0121)	(0.0065)	(0.0084)	(0.0105)	(0.0164)	(0.0146)	(0.0174)	(0.0127)	(0.0385)
Observations = 1 812										

African female non-pensioner, some education

Coefficients	Grain	Protein	Fruit and vegetables	Other food and beverages	Clothing and footwear	Housing cost	Household cost	Health, education and miscellaneous	Communication, transport and running cost	Reading, recreation, tobacco and alcohol
Log of real expenditure per adult equivalent	-0.0451**	0.0028	-0.0196**	-0.0063**	-0.0090**	-0.0021	-0.0088**	0.0494**	0.0209**	0.0178*
	(0.0023)	(0.0025)	(0.0012)	(0.0018)	(0.0022)	(0.0035)	(0.0030)	(0.0035)	(0.0028)	(0.0079)
Constant	0.2913**	0.1086**	0.1285**	0.0926**	0.1301**	0.1218**	0.1798**	-0.0559**	0.0253*	-0.0221
	(0.0092)	(0.0099)	(0.0048)	(0.0074)	(0.0089)	(0.0140)	(0.0122)	(0.0139)	(0.0112)	(0.0317)
Observations = 2 500										

African female non-pensioner, primary education

Coefficients	Grain	Protein	Fruit and vegetables	Other food and beverages	Clothing and footwear	Housing cost	Household cost	Health, education and miscellaneous	Communication, transport and running cost	Reading, recreation, tobacco and alcohol
Log of real expenditure per adult equivalent	-0.0437**	-0.0094**	-0.0177**	-0.0056**	-0.0136**	0.0004	-0.0033	0.0527**	0.0196**	0.0206**
	(0.0023)	(0.0027)	(0.0012)	(0.0020)	(0.0025)	(0.0040)	(0.0035)	(0.0041)	(0.0033)	(0.0090)
Constant	0.2773**	0.1567**	0.1179**	0.0866**	0.1598**	0.1169**	0.1530**	-0.0808**	0.0447**	-0.0321
	(0.0097)	(0.0117)	(0.0053)	(0.0084)	(0.0109)	(0.0170)	(0.0149)	(0.0177)	(0.0139)	(0.0383)
Observations = 1 767										

African female non-pensioner, matric or more education

Coefficients	Grain	Protein	Fruit and vegetables	Other food and beverages	Clothing and footwear	Housing cost	Household cost	Health, education and miscellaneous	Communication, transport and running cost	Reading, recreation, tobacco and alcohol
Log of real expenditure per adult equivalent	-0.0385**	-0.0307**	-0.0163**	-0.0139**	-0.0185**	0.0182**	-0.0067*	0.0911**	0.0032	0.0121
	(0.0016)	(0.0022)	(0.0009)	(0.0020)	(0.0026)	(0.0043)	(0.0032)	(0.0053)	(0.0035)	(0.0094)
Constant	0.2441**	0.2374**	0.1097**	0.1193**	0.1892**	0.0407	0.1490**	-0.2281**	0.1313**	0.0074
	(0.0080)	(0.0108)	(0.0045)	(0.0101)	(0.0129)	(0.0217)	(0.0160)	(0.0265)	(0.0176)	(0.0470)
Observations = 1 029										

Source: Authors' own calculations following regression analysis and simulation using data from South Africa IES 2005/06

Coloured pensioner

Coefficients	Grain	Protein	Fruit and vegetables	Other food and beverages	Clothing and footwear	Housing cost	Household cost	Health, education and miscellaneous	Communication, transport and running cost	Reading, recreation, tobacco and alcohol
Log of real expenditure per adult equivalent	-0.0260**	-0.0577**	-0.0148**	-0.0209*	-0.0046	0.0863**	-0.0228	0.0372**	0.0309**	-0.0076
	(0.0046)	(0.0153)	(0.0037)	(0.0094)	(0.0062)	(0.0198)	(0.0184)	(0.0122)	(0.0088)	(0.0368)
Constant	0.1794**	0.4396**	0.1080**	0.1738**	0.0595*	-0.2135*	0.2936**	-0.0614	-0.0769	0.0979
	(0.0214)	(0.0714)	(0.0171)	(0.0436)	(0.0288)	(0.0920)	(0.0858)	(0.0568)	(0.0411)	(0.1712)
Observations = 94										
Coloured male non-pensioner, no education										
Log of real expenditure per adult equivalent	-0.0261**	-0.0068	-0.0043	-0.0058	-0.0039	0.0085	-0.0093	0.0209*	0.0432**	-0.0164
	(0.0051)	(0.0114)	(0.0030)	(0.0076)	(0.0069)	(0.0101)	(0.0111)	(0.0092)	(0.0088)	(0.0256)
Constant	0.1817**	0.1964**	0.0582**	0.1208**	0.0890**	0.0759	0.1884**	0.0244	-0.1066**	0.1718*
	(0.0206)	(0.0459)	(0.0122)	(0.0307)	(0.0279)	(0.0409)	(0.0448)	(0.0370)	(0.0354)	(0.1035)
Observations = 197										
Coloured male non-pensioner, some education										
Log of real expenditure per adult equivalent	-0.0402**	-0.0329**	-0.0153**	-0.0080	-0.0015	0.0347**	-0.0060	0.0276**	0.0415**	0.0001
	(0.0028)	(0.0058)	(0.0018)	(0.0043)	(0.0038)	(0.0066)	(0.0063)	(0.0057)	(0.0053)	(0.0149)
Constant	0.2438**	0.3011**	0.1036**	0.1254**	0.0792**	-0.0283	0.1695**	-0.0073	-0.0912**	0.1042
	(0.0120)	(0.0249)	(0.0079)	(0.0184)	(0.0165)	(0.0285)	(0.0272)	(0.0247)	(0.0229)	(0.0642)
Observations = 529										
Coloured male non-pensioner, primary education										
Log of real expenditure per adult equivalent	-0.0285**	-0.0293**	-0.0112**	-0.0137**	-0.0082*	0.0363**	-0.0316**	0.0383**	0.0452**	0.0027
	(0.0019)	(0.0045)	(0.0013)	(0.0039)	(0.0036)	(0.0062)	(0.0051)	(0.0055)	(0.0051)	(0.0132)
Constant	0.1849**	0.2741**	0.0837**	0.1398**	0.1155**	-0.0371	0.2831**	-0.0452	-0.0954**	0.0966
	(0.0090)	(0.0215)	(0.0061)	(0.0184)	(0.0172)	(0.0294)	(0.0242)	(0.0263)	(0.0244)	(0.0629)
Observations = 527										
Coloured male non-pensioner, matric or more education										
Log of real expenditure per adult equivalent	-0.0201**	-0.0449**	-0.0088**	-0.0118**	-0.0155**	0.0490**	-0.0319**	0.0469**	0.0279**	0.0092
	(0.0015)	(0.0046)	(0.0012)	(0.0040)	(0.0045)	(0.0096)	(0.0048)	(0.0088)	(0.0070)	(0.0174)
Constant	0.1379**	0.3361**	0.0670**	0.1164**	0.1637**	-0.0990	0.2854**	-0.0577	-0.0086	0.0588
	(0.0081)	(0.0256)	(0.0065)	(0.0223)	(0.0253)	(0.0537)	(0.0266)	(0.0494)	(0.0394)	(0.0974)
Observations = 288										
Coloured female non-pensioner, no education										
Log of real expenditure per adult equivalent	-0.0339**	0.0070	-0.0006	-0.0138	0.0008	0.0045	-0.0181	0.0196	0.0411**	-0.0066
	(0.0086)	(0.0142)	(0.0044)	(0.0147)	(0.0093)	(0.0157)	(0.0175)	(0.0118)	(0.0095)	(0.0371)
Constant	0.2121**	0.1171*	0.0394*	0.1607**	0.0770*	0.0942	0.2539**	0.0358	-0.1026**	0.1124
	(0.0347)	(0.0573)	(0.0178)	(0.0591)	(0.0375)	(0.0630)	(0.0703)	(0.0476)	(0.0384)	(0.1495)
Observations 138										

Source: Authors' own calculations following regression analysis and simulation using data from South Africa IES 2005/06

Coloured female non-pensioner, some education

Coefficients	Grain	Protein	Fruit and vegetables	Other food and beverages	Clothing and footwear	Housing cost	Household cost	Health, education and miscellaneous	Communication, transport and running cost	Reading, recreation, tobacco and alcohol
Log of real expenditure per adult equivalent	-0.0301**	0.0010	-0.0107**	0.0113	0.0079	-0.0118	-0.0054	0.0210**	0.0325**	-0.0157
	(0.0036)	(0.0065)	(0.0024)	(0.0059)	(0.0049)	(0.0084)	(0.0076)	(0.0066)	(0.0061)	(0.0181)
Constant	0.1974**	0.1513**	0.0871**	0.0489*	0.0431*	0.1705**	0.1840**	0.0251	-0.0554*	0.1480*
	(0.0149)	(0.0270)	(0.0098)	(0.0244)	(0.0205)	(0.0348)	(0.0315)	(0.0274)	(0.0254)	(0.0752)
Observations = 405										

Coloured female non-pensioner, primary education

Log of real expenditure per adult equivalent	-0.0245**	-0.0187**	-0.0134**	-0.0109*	-0.0160**	0.0262**	-0.0213*	0.0320**	0.0327**	0.0139
	(0.0029)	(0.0062)	(0.0019)	(0.0045)	(0.0052)	(0.0080)	(0.0084)	(0.0068)	(0.0068)	(0.0180)
Constant	0.1664**	0.2242**	0.0941**	0.1213**	0.1675**	0.0106	0.2634**	-0.0159	-0.0517	0.0201
	(0.0130)	(0.0280)	(0.0088)	(0.0205)	(0.0233)	(0.0361)	(0.0381)	(0.0308)	(0.0309)	(0.0816)
Observations = 352										

Coloured female non-pensioner, matric or more education

Log of real expenditure per adult equivalent	-0.0263**	-0.0391**	-0.0104**	-0.0128	-0.0092	0.0384**	-0.0293**	0.0481**	0.0198*	0.0208
	(0.0026)	(0.0068)	(0.0020)	(0.0070)	(0.0080)	(0.0123)	(0.0099)	(0.0117)	(0.0081)	(0.0249)
Constant	0.1747**	0.3145**	0.0796**	0.1312**	0.1476**	-0.0406	0.2858**	-0.0658	0.0051	-0.0321
	(0.0138)	(0.0359)	(0.0106)	(0.0370)	(0.0426)	(0.0656)	(0.0526)	(0.0619)	(0.0429)	(0.1324)
Observations = 133										

Asian male with primary education

Log of real expenditure per adult equivalent	-0.0273**	-0.0287**	-0.0098**	-0.0148**	-0.0023	0.0957**	-0.0510**	0.0308	0.0175	-0.0101
	(0.0040)	(0.0083)	(0.0034)	(0.0055)	(0.0085)	(0.0255)	(0.0174)	(0.0159)	(0.0196)	(0.0423)
Constant	0.1849**	0.2220**	0.0755**	0.1136**	0.0655	-0.2728*	0.4428**	-0.0216	0.0692	0.1209
	(0.0210)	(0.0441)	(0.0181)	(0.0293)	(0.0451)	(0.1353)	(0.0923)	(0.0844)	(0.1040)	(0.2244)
Observations = 84										

Asian male with matric or more education

Log of real expenditure per adult equivalent	-0.0135**	-0.0297**	-0.0083**	-0.0086	-0.0069	-0.0030	-0.0243*	0.1002**	-0.0060	0.0001
	(0.0017)	(0.0050)	(0.0015)	(0.0047)	(0.0050)	(0.0173)	(0.0096)	(0.0141)	(0.0106)	(0.0279)
Constant	0.0997**	0.2322**	0.0639**	0.0830**	0.1009**	0.2402*	0.2719**	-0.3822**	0.2008**	0.0896
	(0.0102)	(0.0295)	(0.0087)	(0.0280)	(0.0297)	(0.1026)	(0.0572)	(0.0839)	(0.0632)	(0.1660)
Observations =147										

Asian female

Log of real expenditure per adult equivalent	-0.0221**	-0.0229*	-0.0119**	0.0162	-0.0343*	0.0611*	-0.0413**	0.0413	-0.0066	0.0205
	(0.0037)	(0.0104)	(0.0040)	(0.0122)	(0.0152)	(0.0296)	(0.0152)	(0.0223)	(0.0153)	(0.0485)
Constant	0.1522**	0.2032**	0.0883**	-0.0306	0.2504**	-0.1217	0.3679**	-0.0392	0.1687*	-0.0392
	(0.0199)	(0.0551)	(0.0215)	(0.0650)	(0.0807)	(0.1572)	(0.0807)	(0.1187)	(0.0815)	(0.2580)
Observations = 46										

Source: Authors' own calculations following regression analysis and simulation using data from South Africa IES 2005/06

White male pensioner, primary education

Coefficients	Grain	Protein	Fruit and vegetables	Other food and beverages	Clothing and footwear	Housing cost	Household cost	Health, education and miscellaneous	Communication, transport and running cost	Reading, recreation, tobacco and alcohol
Log of real expenditure per adult equivalent	-0.0106** (0.0025)	-0.0356** (0.0121)	-0.0030 (0.0045)	-0.0103 (0.0071)	-0.0051 (0.0045)	-0.0299 (0.0398)	-0.0462** (0.0135)	0.1359** (0.0332)	0.0104 (0.0239)	-0.0056 (0.0607)
Constant	0.0826** (0.0147)	0.2820** (0.0712)	0.0402 (0.0264)	0.0966* (0.0421)	0.0491 (0.0267)	0.4521 (0.2350)	0.3799** (0.0799)	-0.5331** (0.1959)	0.0676 (0.1413)	0.083 (0.3584)
Observations = 55										

White male pensioner, matric or more education

Log of real expenditure per adult equivalent	-0.0100** (0.0022)	-0.0208** (0.0056)	-0.0025 (0.0026)	-0.0071 (0.0060)	0.0026 (0.0024)	0.0286 (0.0237)	-0.0336** (0.0084)	0.1101** (0.0208)	-0.0541** (0.0110)	-0.0132 (0.0356)
Constant	0.0782** (0.0134)	0.1791** (0.0346)	0.0346* (0.0160)	0.0804* (0.0372)	-0.0011 (0.0148)	0.1469 (0.1459)	0.3037** (0.0516)	-0.4282** (0.1283)	0.4586** (0.0678)	0.1478 (0.2196)
Observations = 122										

White female pensioner, primary education

Log of real expenditure per adult equivalent	-0.0168** (0.0054)	-0.0327** (0.0077)	-0.0078 (0.0047)	-0.0126 (0.0080)	-0.0029 (0.0056)	0.0728* (0.0339)	-0.0311 (0.0173)	0.0416* (0.0206)	-0.0060 (0.0136)	-0.0045 (0.0476)
Constant	0.1183** (0.0309)	0.2420** (0.0444)	0.0697** (0.0267)	0.1056* (0.0458)	0.0361 (0.0321)	0.0004 (0.1946)	0.3010** (0.0991)	-0.0879 (0.1180)	0.1388 (0.0782)	0.076 (0.2729)
Observations = 56										

White female pensioner, matric or more education

Log of real expenditure per adult equivalent	-0.0090** (0.0017)	-0.0195** (0.0054)	-0.0007 (0.0031)	-0.0117** (0.0037)	0.0061** (0.0022)	0.0712** (0.0234)	-0.0286** (0.0108)	0.0163 (0.0160)	-0.0289 (0.0156)	0.0048 (0.0350)
Constant	0.0716** (0.0105)	0.1663** (0.0330)	0.0241 (0.0189)	0.0958** (0.0223)	-0.0204 (0.0135)	-0.0681 (0.1433)	0.2879** (0.0661)	0.0954 (0.0979)	0.3163** (0.0954)	0.0311 (0.2141)
Observations = 80										

White male non-pensioner, primary education

Log of real expenditure per adult equivalent	-0.0165** (0.0016)	-0.0240** (0.0049)	-0.0046** (0.0017)	-0.0047 (0.0040)	-0.0117** (0.0039)	0.0141 (0.0145)	-0.0349** (0.0066)	0.0700** (0.0109)	0.0110 (0.0083)	0.0013 (0.0224)
Constant	0.1169** (0.0093)	0.2161** (0.0281)	0.0448** (0.0097)	0.0650** (0.0227)	0.1060** (0.0222)	0.1968* (0.0832)	0.3209** (0.0381)	-0.2123** (0.0624)	0.0676 (0.0480)	0.0782 (0.1286)
Observations = 234										

White male non-pensioner, matric or more education

Log of real expenditure per adult equivalent	-0.0093** (0.0005)	-0.0292** (0.0019)	-0.0056** (0.0006)	-0.0023 (0.0024)	-0.0041** (0.0015)	0.0200** (0.0069)	-0.0199** (0.0030)	0.0483** (0.0061)	-0.0077 (0.0041)	0.0098 (0.0111)
Constant	0.0730** (0.0034)	0.2361** (0.0120)	0.0495** (0.0035)	0.0500** (0.0157)	0.0619** (0.0096)	0.1349** (0.0446)	0.2180** (0.0196)	-0.0681 (0.0391)	0.1974** (0.0262)	0.0473 (0.0714)
Observations = 987 Source: Author's own calculations following regression analysis and simulation using data from South Africa IES 2005/06										

Coefficients	Grain	Protein	Fruit and vegetables	Other food and beverages	Clothing and footwear	Housing cost	Household cost	Health, education and miscellaneous	Communication, transport and running cost	Reading, recreation, tobacco and alcohol
White female non-pensioner, primary education										
Log of real expenditure per adult equivalent	-0.0094**	-0.0193*	-0.0032	-0.0082	-0.0022	0.0287	-0.0384**	0.0637**	-0.0023	-0.0094
	(0.0025)	(0.0093)	(0.0037)	(0.0108)	(0.0054)	(0.0299)	(0.0118)	(0.0198)	(0.0157)	(0.0439)
Constant	0.0718**	0.1805**	0.0370	0.0904	0.0427	0.1647	0.3223**	-0.1860	0.1403	0.1363
	(0.0142)	(0.0523)	(0.0206)	(0.0604)	(0.0302)	(0.1680)	(0.0664)	(0.1111)	(0.0878)	(0.2462)
Observations = 63										
White female non-pensioner, matric or more education										
Log of real expenditure per adult equivalent	-0.0075**	-0.0232**	-0.0043**	0.0021	-0.0051	-0.0333*	-0.0153*	0.0767**	-0.0047	0.0146
	(0.0009)	(0.0037)	(0.0011)	(0.0051)	(0.0039)	(0.0147)	(0.0067)	(0.0122)	(0.0066)	(0.0226)
Constant	0.0610**	0.1938**	0.0427**	0.0260	0.0745**	0.5006**	0.1876**	-0.2674**	0.1680**	0.0132
	(0.0055)	(0.0234)	(0.0072)	(0.0325)	(0.0249)	(0.0928)	(0.0422)	(0.0775)	(0.0417)	(0.1430)
Observations = 273										

Source: Authors' own calculations following regression analysis and simulation using data from South Africa IES 2005/06

Table 3: Equivalent variations

Estimated means of inflation offset simulations

	10 per cent increase in all prices			10 per cent increase in food prices			10 per cent increase in H and C prices			10 per cent increase in other prices		
Applied weighting	**Bottom 40 per cent**	**Middle 30 per cent**	**Top 30 per cent**	**Bottom 40 per cent**	**Middle 30 per cent**	**Top 30 per cent**	**Bottom 40 per cent**	**Middle 30 per cent**	**Top 30 per cent**	**Bottom 40 per cent**	**Middle 30 per cent**	**Top 30 per cent**
Plutocratic weighting	641.4** (3.4)	1,331.0** (8.4)	5,556.1** (79.6)	47.0** (1.1)	-28.9** (3.1)	-457.4** (15.9)	170.5** (1.3)	371.0** (3.7)	1,631.2** (28.6)	449.0** (3.0)	1,049.0** (8.3)	4,654.5** (70.4)
Estimated plutocratic weighting	642.0** (3.4)	1,331.4** (8.4)	5,556.4** (79.6)	212.6** (0.8)	353.0** (1.4)	670.1** (3.9)	-71.4** (1.4)	-149.0** (4.1)	-178.3** (30.3)	198.9** (1.4)	506.7** (4.4)	2,749.8** (47.1)
Democratic weighting	641.4** (3.4)	1,331.0** (8.4)	5,556.1** (79.6)	9.6** (1.3)	-149.1** (4.0)	-1,443.5** (31.0)	157.7** (1.8)	423.6** (5.3)	2,355.1** (52.0)	448.1** (3.6)	1,124.4** (10.9)	5,446.8** (97.3)
Estimated democratic weighting	651.2** (3.6)	1,339.2** (8.8)	5,562.8** (79.9)	226.7** (1.4)	365.6** (2.3)	698.8** (5.3)	-73.5** (1.8)	-152.4** (4.6)	-170.7** (30.0)	201.7** (1.8)	505.1** (4.7)	2,713.1** (46.8)
Observations	9 309	6 339	5 045	9 309	6 339	5 045	9 309	6 339	5 045	9 309	6 339	5 045

Bootstrapped (500 repetitions) standard errors in parentheses

** p < 0.01, * p < 0.05

Source: Author's own calculations following regression analysis and simulation using data from South Africa IES 2005/06

Estimated means of simulation ratio distributions

	10 per cent Increase in all prices			10 per cent Increase in food prices			10 per cent increase in H and C prices			10 per cent increase in other prices		
Applied weighting	**Bottom 40 per cent**	**Middle 30 per cent**	**Top 30 per cent**	**Bottom 40 per cent**	**Middle 30 per cent**	**Top 30 per cent**	**Bottom 40 per cent**	**Middle 30 per cent**	**Top 30 per cent**	**Bottom 40 per cent**	**Middle 30 per cent**	**Top 30 per cent**
Plutocratic weighting	0.1000** (0.0000)	0.1000** (0.0000)	0.1000** (0.0000)	0.0107** (0.0002)	0.0015** (0.0002)	-0.0080** (0.0002)	0.0262** (0.0001)	0.0269** (0.0001)	0.0290** (0.0002)	0.0668** (0.0001)	0.0758** (0.0002)	0.0839** (0.0002)
Estimated plutocratic weighting	0.1001** (0.0000)	0.1000** (0.0000)	0.1000** (0.0000)	0.0351** (0.0001)	0.0288** (0.0001)	0.0167** (0.0001)	-0.0109** (0.0001)	-0.0117** (0.0002)	-0.0071** (0.0003)	0.0287** (0.0001)	0.0357** (0.0001)	0.0459** (0.0001)
Democratic weighting	0.1000** (0.0000)	0.1000** (0.0000)	0.1000** (0.0000)	0.0057** (0.0002)	-0.0063** (0.0002)	-0.0228** (0.0002)	0.0223** (0.0002)	0.0287** (0.0002)	0.0395** (0.0003)	0.0647** (0.0002)	0.0794** (0.0003)	0.0955** (0.0004)
Estimated democratic weighting	0.1013** (0.0001)	0.1005** (0.0001)	0.1002** (0.0001)	0.0373** (0.0001)	0.0298** (0.0001)	0.0173** (0.0001)	-0.0116** (0.0002)	-0.0122** (0.0002)	-0.0070** (0.0003)	0.0288** (0.0001)	0.0355** (0.0001)	0.0453** (0.0001)
Observations	9 309	6 339	5 045	9 309	6 339	5 045	9 309	6 339	5 045	9 309	6 339	5 045

Bootstrapped (500 repetitions) standard errors in parentheses

** p < 0.01, * p < 0.05

Source: Authors' own calculations following regression analysis and simulation using data from South Africa IES 2005/06