Addendum to Engel's Law: the dispersion of household spending and the influence of relative income.

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Abstract

As households get rich they consume both a wider variety and higher quality of goods and services. We uncover new empirical facts about how this tradeoff between quality and variety itself responds to rising income by empirically studying the dispersion of household spending across expenditure categories. Examining UK household spending data (1970-2001), we find evidence that household spending dispersion does not always rise as household income grows, as many have claimed (Theil and Finke 1983). Rather the dispersion of household spending tends to saturate at an income level which broadly coincides with the point at which households begin to spend more on luxuries than on necessities. This saturation tendency is an important addendum to Engel's law and is consistent with evidence that rich households prefer high quality goods (Bils and Klenow 2001). Moreover, we find evidence that social comparisons affect patterns of spending diversity: households who are more wealthy than the average household in their region display a higher propensity to diversify their spending compared with households that possess the same level of (absolute) income but are less wealthy than the average household in their region.

Keywords: household diversification; Consumer specialization, Engel's Law

JELL Classification: D11, D13, O12, O40

1 Introduction

As households get rich they consume both a wider range and a higher quality of goods and services (Prais 1952, Jackson 1984, Bils and Klenow 2001). The precise manner in which household spending patterns evolve in response to rising income has vital implications for a range of economic issues, such as understanding how economic growth affects household standards (Romer 1990, Grossman and Helpman 1991) and how the industrial composition of economies may be shaped by the evolving structure of final demand (Pasinetti 1982, Foellmi and Zweimüller 2008). Among the most established empirical facts about this process, there exists a general consensus that spending patterns become more diversified as low income households concentrate their spending on food, while wealthier households typically consume a wider range of goods and services (Prais 1952, Jackson 1984). Moreover, most

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agree that wealthy households tend to consume higher quality goods and services which are relatively more expensive than their low quality alternatives (Bils and Klenow 2001).

These two facts alone suggest that households face a tradeoff between spending on a wider variety and spending on higher quality. Attaining more variety across different expenditure categories implies forsaking spending on higher quality goods within any one particular spending category. Therefore, if demand for high quality grows with income, then the dispersion of household spending across different categories can not continue to rise as household income grows, as many have argued (Theil 1967, Theil and Finke 1983, Falkinger and Zweimüller 1996, Clements et al 2003). Rather it is likely that the dispersion of household spending will begin to fall with rising income as affluent households begin to concentrate their spending into particular spending categories as they consume higher quality goods. Evidence for such a saturation level represents an important addendum to Engel's law that provides a new insight about how consumption patterns evolve as households become wealthy and the food budget share falls. Our model suggests that the income level at which saturation level takes place coincides with the point at which spending on luxuries begin to dominate spending on necessities in the consumption basket. If accurate, the location of such a threshold level and its sensitivity to changes in the household income distribution may have important implications for studying economic growth. Recent growth models suggest that innovative activity in an economy may be critically limited by the number of consumers who can afford to purchase high quality goods (e.g. Zweimüller 2000). In that regard, the greater the proportion of the population reach the turning point at which household spend more on luxuries than on necessities, the larger is the market for innovative products. Hence it is of particular interest to study a) whether the saturation level of diversity is robust to changes in the underlying income distribution and b) the percentage of the population that reach this level.

A second issue we examine is how social comparisons may affect the dispersion of household spending across spending categories. Precisely how consumption patterns are influenced by social comparisons has been the subject of intense debate (Frank 1985, Frank 2005, Arrow and Dasgupta 2008, Heffetz 2011). In the 1930s, John Maynard Keynes recognized there exists an important distinction between *absolute needs* and *social needs* that motivate consumption, where the satisfaction of the latter is influenced by social comparisons. Keynes (1935) argued that because spending related to absolute needs eventually becomes satiated, future households will substitute more consumption for more leisure time. In retrospect, scholars note that this prediction was incorrect because -among other things- Keynes underestimated the influence of relative needs on consumption which reflect how social environment may influence particular types of household spending such that these spending levels tend to keep up with average spending of peer consumers (Frank 2008, Becker and Rayo 2008). To examine precisely how much the overall composition of spending is affected by social comparisons, we study how the household's relative wealth (ratio of household income to regional average household income) influences spending dispersion. We investigate the hypothesis that a households with relatively incomes tend to adopt spending patterns of more affluent households.

To tackle these questions, we use data from the UK Family Expenditure Survey (1970-2001) to study how households diversify their spending across a different expenditure categories as their absolute and relative income rises. The novelty of this study is threefold: First, household level data is used to estimate the distribution of household spending that contains a wide range of spending categories and a large number of years. To date, studies of spending dispersion have used cross-country data to investigate relationship between variety demand and income (e.g. Falkinger and Zweimüller 1996; Clements et al 2006). Second, our results reveal that the dispersion of household spending tends to saturate at an income level below which 80 per cent of household fall. Using Theil's Luxury-Necessity Index (Theil 1967), we show that this point coincides with a structural break in the composition of the consumption bundle. Over time, we find that the saturation level does exhibit some drift as the average household income rises, although a growing proportion of households reach the saturation level of spending diversity. Third, in relation to social comparison effects, we find that households who are more wealthy than the average household in their region display a higher propensity to diversify their spending compared with households that possess the same level of (absolute) income but are less

wealthy than the average household in their region.

The paper is structured as follows. Section 2 discusses the background literature and presents a model of consumer behavior in which consumers initially diversify their spending across expenditure categories at low income levels, but switch to concentrating their spending into particular expenditure categories at high income levels. Section 3 reports the cross sectional Engel Curve for spending diversity. Section 5 considers how the saturation level of spending tends to change over time and co-moves with moments of the household income distribution. Section 5 uses regional differences in average household incomes to consider how the household's relative income affects their propensity to diversify their spending. Section 6 concludes.

2 Background and Model

The manner in which household consumption patterns evolve as household income rises has been subject of much research ever since Ernst Engel discovered his famous law in 1856. This interest reflects the fact that this subject has important implications for a number of subdisciplines in economics, such as growth theory (Kuznets 1973, Foellmi and Zweimüller 2008), trade theory (e.g. the Lindner hypothesis, see Hallak 2010), the measurement of inflation (Bils and Klenow 2001) and public policy (Banks et al. 1997). The main empirical method to investigating this important process has been via estimating Engel curves for individual expenditure categories and constructing demand systems in which expenditure on individual expenditure categories are modeled as function of price and income effects (e.g. Deaton and Muellbauer 1980A; Lewbel 2008). To date, there exist four empirical regularities about how the distribution of spending unfolds as household income grows that have become widely accepted and well established:

1. The consumption patterns of the poor is relatively concentrated on food. This represents about 50 to 70 per cent of their budget of the world's poorest (Banerjee and Duflo 2007).

2. Engel's Law: As household become more affluent, the share of household spending dedicated to food declines (Engel 1856, Houthakker 1957).

3. As households become more affluent, they consume a greater variety of other goods and services (Theil and Finke 1983, Jackson 1984).

4. High income households tend to consume relatively higher quality goods (as reflected in relatively higher prices) (e.g Bils and Klenow 2001, Moneta and Manig 2009).

In relation to 3) a longstanding conjecture is that the demand for variety is positively correlated with income – the wealthier households are, the more they demand a greater variety of goods. This hypothesis is most explicitly stated in the empirical literature studying how the overall distribution of spending across expenditure categories evolves in response to rising household income (see Section 2.1 below for a formal definition). The dependent variable in these studies, it should be emphasized, are expenditures (money amounts) rather than quantities bought, expressed as a share of the total household spending. Here Theil and Finke (1983) stated that because food declines as incomes rises and other goods play a more prominent role in the consumers budget, " we should expect an increasing diversity of spending as income increases" (Theil and Finke1983). More recently, Clements et al. state that "A very poor consumer will devote much of the budget to necessities and little to luxuries. But as income increases, the budget shares of necessities fall while those of luxuries rise, so that there is more diversity, or less specialization, in the consumption basket" (Clements et al. 2006:8). Hence a link is made that the growing demand for consuming a variety of good and services leads to a growing dispersion of spending across different expenditure categories. This hypothesis of a positive relationship between variety demand and income echoes Prais' earlier conjecture that the Engel Curve

for food features a saturation level as more goods enter the consumption basket at high income levels (1953) and Senior's law of variety (see Jackson 1984). [1]

Elsewhere in economics, there exists several different accounts of why the variety of goods consumed by households may increase as the household budget constraint is relaxed. However, none of these predict the existence of a slowdown in the rate at which this phenomenon occurs. The literature on imperfect competition models increases in spending variety to be the consequence of firm behavior (Dixit and Stiglitz 1977, Salop 1977). It assumes the existence of individuals possess a taste for variety that is independent of their income. Hence the demand for variety is essentially constant as income increases, but the supply of variety may change. Household production theory conjectures that the growth of variety in demand is related to the relative prices of the underlying consumption activities that are associated with the purchase of good and services (Becker 1965, Gronau and Hamermesh 2008). The willingness for consumers to undertake certain activities depends on their shadow prices, expressed in terms of time and the goods and services they require. Here variety of goods and services purchased is related to the variety of consumption activities undertaken by households. It suggests that income affects variety demand since it increases the opportunity cost of different activities in an asymmetric fashion: activities which are less time intensive but require relatively more goods will increase in demand as household income rises. In such a way, the income of households indirectly affects the variety demand of households by changing the relative shadow price of different consumption activities. This enables theorists to preserve the assumption that preferences are homothetic.

Evidence for a positive correlation between household income and the dispersion of household spending has been found in a number of studies of cross-country demand analysis (Theil and Finke1983; Falkinger and Zweimüller 1996, Clements et al. 2006). For example, in a study featuring 91 consumption items across 57 countries, Falkinger and Zweimüller (1996) found a strong positive relationship between a country's per capita income and the number of items that it consumes. The poorest country in the sample (Tanzania) consumed 19 out of a possible 91 items, which is much lower than the 90 products consumed by the richest country in the sample (United States). In regard to the saturation hypothesis, it is interesting to note that while they do not identify a saturation level of spending diversity, the authors do in fact observe that marginal increase in diversity that takes place as income increases tends to diminish as per capita income increases. However, it should be noted that these studies suffer from a major drawback in that they use country level data in which inferences about the relationship between income and expenditure diversification have been drawn from comparing the spending patterns of a rich country to those of a poor country.

Yet there is good reason to question the notion that the diversity of household spending will always rise as household income increases. We propose that that there exists a saturation level of spending diversity beyond which the dispersion of household spending ceases to rise further as households income rises. When we consider the above facts (1-4) in their entirety, these suggest the existence of such a saturation level of spending diversity. At any income level, there exists a tradeoff between households diversifying their spending across expenditure categories (as per 3) and household obtaining higher quality goods in any one particular category (as per 4). Elsewhere, such a tradeoff has been discussed among scholars who consider the differences between 'horizontal' and 'vertical' types of quality (Abbott 1953, Duesenberry 1949, Sutton 1986, Cremer and Thisse 1991). Assuming that quality demand is heterogeneous across different categories, such a tendency suggests that household spending will become concentrated into particular spending categories as income grows. Therefore this tradeoff between quality and variety will itself vary with income if the demand for higher quality goods dominates the household demand for variety at high income levels. Hence there may exist a saturation level of spending diversity such that the observed dispersion of household spending initially increases up to

[1] Elsewhere discussion of how the overall distribution of spending changes with rising income has also been risen in discussions of the Adding up restriction and rank of demand systems. The adding up restriction requires at least one Engel Curve within the set of good must possess a non-saturating Engel Curve at the highest observed level of total expenditure. It is linked to the assumption that households face a budget constraint in which the sum of all particular expenditures must equal the household's total budget.

some point (as per 3), but then no longer rises beyond a particular level and may even fall as spending begins to be concentrated into particular expenditure categories. A model for this is developed in the next section in subsequent sections.

2.1 A measure of spending diversity

We define $S_i = (s_{i1}, s_{i2}, s_{i3}...s_{ik})$ as the vector of budget shares for household$i$. There are $j = 1...k$ categories of expenditure items and thus s_{ij} is the share of household i on expenditure category j. Therefore$s_{ij} \geq 0$ for all i, j and $\sum_{j=1}^{k} s_{ij} = 1$. When no ambiguity arises we will refer to a generic budget share s_j rather than the household specific share. To measure diversity in household expenditure we calculate the entropy of the household budget shares, an approach employed by Theil (1967) among others. This involves specifying the information content h of an 'event' occurring with probability s_j. Axioms of information theory require that $h(s_j)$ is non-negative and decreasing in $s_j$and that information is additive in the case of independent events. This imposes that the information associated with $h(s_j) = -\ln(s_j)$ and the total information content is the probability weighted sum of the individual contents:

$$E = -\sum_{j=1}^{k} s_j \times \ln(s_j) \tag{1}$$

The entropy of the stochastic consumption vector will be equal to zero in the limiting case where all expenditure is on a single category, and takes on a maximal value of $\ln(k)$ when $s_j = 1/k$ for $j = 1...k$. Hence it provides a useful measure of the equality in spending across the categories, where high values indicate greater dispersion of spending. Low values indicate that spending is more concentrated (low spending dispersion). A difficulty with this approach is that typical consumption data regularly contains zeros and in these situations the entropy is undefined. When this occurs we replace the probability weighted information function with its limiting case. That is we redefine the information as $s_j \times h(s_j) = -s_j \times \ln(s_j)$ for $s_j > 0$ and $s_j = 0$ as $\lim_{s_j \to 0} -s_j \times \ln(s_j) = 0$.

2.2 The Model

The model below highlights how a saturation level of spending diversity can be a straightforward outcome of recognizing that household demand is indeed non-homothetic. The claim of non-homothetic preferences enjoys a substantial amount of empirical evidence on Engel Curves which suggests that significant and robust differences exist in the value of income elasticities across different expenditure categories (Deaton and Muellbauer 1980B). This suggests that goods and services enter the utility function in asymmetric way, which has led to the development of lexicographic demand systems (Lancaster 1971, Ironmonger 1972, Jackson 1984, Drakopolous 1994). A large number of lexicographic models exist that differ in their complexity and assumptions. Many of them consider how the income elasticity of goods is determined by a hierarchy of needs that consumer possess. In the following, we develop a simplified two-goods version in which the income elasticity of the good is given (one luxury good, one normal good). Given that spending is concentrated at low income levels (as per 1 above) the saturation level of spending diversity takes place when spending on these goods are of exactly equal proportions. Once spending on luxuries dominates spending on the necessity, spending dispersion declines. We show that through the differences in these income elasticities, one can predict how the dispersion of consumption expenditure responds to rising income as households switch from normal goods to luxuries.

We consider household utility of the Stone-Geary variety

$$U = \prod_{j=1}^{k} (q_j - \gamma_j)^{\beta_j} \tag{2}$$

where $\gamma_j > 0$ denotes the autonomous consumption of good j. β_j is a parameter that captures the marginal effect of total expenditure upon the consumption of good j and $q_j$is the quantity consumed. The household wants to maximize utility subject to $\sum_{j=1}^{k} q_j = x$ where $\sum_{j=1}^{k} \beta_j = 1$. Here x is the number of goods consumed (we ignore prices at the moment). Taking logarithms, the problem can be written as a Lagrangian optimization application.

$$L = \left[\sum_{j=1}^{k} \beta_j \ln(q_j - \gamma_j) \right] + \lambda(x - q_1 - q_2) \tag{3}$$

The $j + 1$ first order conditions for maximization are $\frac{\delta L}{\delta q_j} = \frac{\beta_1}{q_j - \gamma_j} = 0$ and $\frac{\delta L}{\delta \lambda} = x - q_1 - q_2 = 0$. Solving simultaneously gives the typical linear expenditure system, which can be written in terms of expenditure shares:

$$s_j = \frac{\gamma_j + \beta_j \left(x - (\sum \gamma_j)\right)}{x}$$

Substituting into the Theil's diversity measure, (1) above, gives

$$E = -\sum_{j=1}^{k} \frac{\gamma_j + \beta_j \left(x - (\sum \gamma_j)\right)}{x} \times \ln\left(\frac{\gamma_j + \beta_j \left(x - (\sum \gamma_j)\right)}{x}_j\right)$$

Deriving with respect to x gives

$$\frac{dE}{dx} = -\sum_{j=1}^{k} \frac{(\beta_j(x - \sum \gamma_j) + \gamma_j) \times \ln\left(\frac{\beta_j(x - \sum \gamma_j) + \gamma_j}{x}\right) + (\beta_j(x - \sum \gamma_j) + \gamma_j)}{x^2} - \frac{\beta_j \times \ln\left(\frac{\beta_j(x - \sum \gamma_j) + \gamma_j}{x}\right) - \beta_j}{x}$$

Taking the two-good case and setting $\frac{dE}{dx} = 0$ gives the saturation point for diversity

$$\arg\max E(x) = \frac{(\beta_2 - \beta_1)(\gamma_1 + \gamma_2) - \gamma_1 + \gamma_2}{\beta_2 - \beta_1} \qquad \beta_1 \neq \beta_2$$

which is categorized as a global maximum. Lower income households have positive marginal diversity with respect to expenditure and richer households have negative marginal diversities. Thus we see that an inverted "U" shape is predicted in diversity as a function of income in the two good economy. The saturation level of diversity (which we call x^*) occurs where the diversifying process associated with low incomes exactly balances with the concentrating process of high incomes. This turning point is significant as it marks the income level at which there is a shift in how the composition of spending patterns evolve in response to further rises in income. Before this point, income increases lead to household diversifying their spending more evenly across expenditure categories. Beyond this level, the exact opposite will occur: incremental increases lead to a decline in spending dispersion. Thus x^* indicates the income level at which luxuries begin to dominate necessities in the consumption basket.

If we accept the notion that income elasticities are mainly determine by quality demand (rather than quantity demand) at high income levels (discussed above) then x^* yields information about the income level at which there is general shift by household from demanding relatively more quantity demand to quality demand. This has important implications for understanding patterns of economic growth if it is true that entrepreneurial product innovations and R&D are a feature of industries associated with the production of luxury goods (Zweimüller 2000). The greater the proportion of the population reach x^*, the larger is the market for innovative products. Hence it is of particular interest to study whether the position of x^* is robust to changes in the underlying income distribution and the percentage of the population that reach this level. These questions will be pursued below.

3 The Engel Curve for Spending Diversity

3.1 The Data

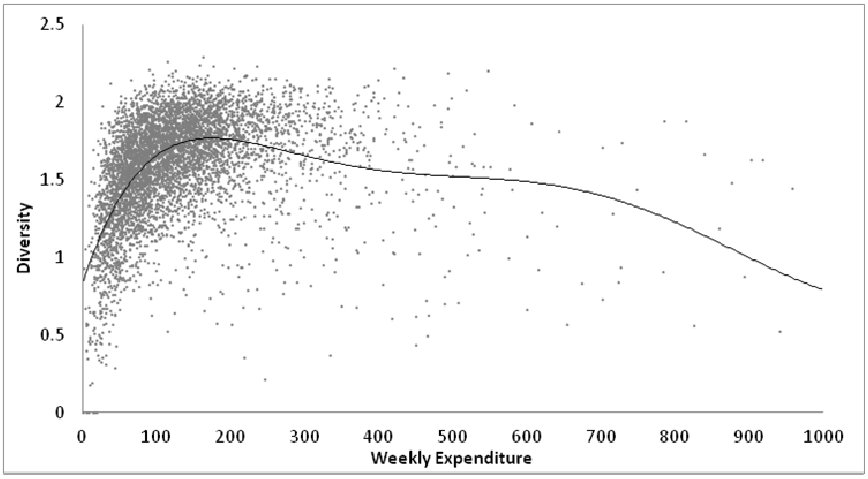
We use annual household data sourced from the UK Family Expenditure Survey from 1970 to 2001. Over this time period the classification method for expenditure categories has been subject to change. To ensure consistency across sample period, the classification method specified by the Office of National Statistics in 2001 featuring $k = 12$ categories (see table in Appendix A) was selected and retrospectively applied to the data 1970 and 2000. In this process, a small number of expenditure categories had to be dropped as there was insufficient information to properly allocate them to a 2001 expenditure category (e.g. The 1980 survey featured spending on 'other goods not elsewhere classified'). We exclude housing expenditure because of well-known problems with this data (Tanner, 1999; Blow et al. 2004). Savings was also excluded since earlier surveys did not adequately cover this category and it is questionable whether it should be considered as a type of spending. Moreover, we also had to exclude recall categories which were introduced in the mid 80s to cover annual items such as seasonal bus tickets, and other major spending items (e.g. automobile purchases). Following Blow et al. (2004), credit card spending post 1987 has been divided by two. We have also censored data by removing Northern Ireland and households with more than two adults (which affects mainly share houses). We do, however, keep all households with two adults and any number of children. The Figure 6 in Appendix A shows that the tends of total expenditure in our data set are broadly consistent with other data sets devised by Blow et al. (2004) and the UK National Accounts. Some differences are likely due to the fact that we have dropped household with more than two adults and exclusion of recall categories from 1986. Across the thirty year period, the average annual sample size is about 6000 observations but drops to 5000 between 1998 to 2000. Tests show that weak separability holds, which is consistent with a two stage budgeting process. Regarding equivalence scales, OECD equivalence scales were used to control for differences in household composition. For inflation, we have used the RPI Percentage change over 12 months - all items, excluding housing and mortgage payments (CDKG) produced by the UK Office of National statistics.

A problem that must also be faced when working with any household expenditure data is sample bias. As most household expenditure surveys have less observations at high levels of household income. However, in the case of the UK Family Expenditure Survey, Tanner (1999) studied the reliability of FES expenditure data by comparing it to spending figures found in the UK National Accounts. She found that the ratio of non-housing total FES expenditure to non-housing total expenditure in the National Accounts was around 90 per cent between 1974 and 1992. This instils us with some confidence that the magnitude of the sampling bias is not too large given that FES expenditure match the National accounts relatively well. Moreover, this problem is also mitigated by the fact that our sample sizes are relatively large.

3.2 Results

This section conducts a cross sectional analysis of the spending dispersion as measured across each household according to Equation (1). We now examine the empirical relationship between spending dispersion and total household weekly expenditure. The latter is generally used as a proxy for household income. As such, the relationship between diversity can be understood as a type of Engel curve. A typical example of such a distribution (including the fitted regression line from Equation 7 below) is presented below for 2001 in Figure 1 (other years can be found in Appendix B).

Figure 1: Engel curve for Spending diversity, 2001



The horizontal axis shows weekly expenditure (in pounds) and the vertical axis shows the entropy measure of diversity. The regression line is a six order polynomial fitted using OLS.

The results show that at relatively low income levels, the extent to which household diversify their spending is positively correlated to the income level (as proxied by total weekly expenditure): low income households consistently possess relatively less diversified spending patterns in comparison to high income households. At low income levels, this figure shows that increases in income lead to household expenditure being distributed across these expenditure categories in an increasingly even fashion. This result is entirely consistent with previous studies of international consumption patterns (discussed above) and the notion that budget share of spending on food declines as income rises (Engel's law).

However, it should be noted that Engel's law is a necessary but not sufficient condition to observing an increase in the spending dispersion. An increase in spending dispersion implies not only a decline in the food budget share, but also that the household expenditure is distributed across consumption expenditure categories in a more even fashion. In other words, the budget share of the various expenditure categories tend to converge to a common level, as household income increases. This implies that households do not alter the composition of their spending in such a way that any one particular non-food expenditure category tends to dominate other non-food expenditure categories. Rather, it appears that spending diversification takes place in such a way that additional income is distributed in an increasingly equal proportions across non-food expenditure categories. While Engel's law does imply that the budget share of non-food expenditure will rise, it has no implications for how consumption expenditure will be distributed across these non-food categories. To attain an increasingly even

distribution across these expenditure categories, there must be an additional regularity at work that relates to how expenditure is distributed in increasingly equal proportions across different expenditure categories. More cross sectional Engel curves for spending dispersion from other years can be found in Appendix B.

3.3 Saturation of Spending Diversity and the Luxury/Necessity Index

A second important feature of Figure 1 is that the diversity of household spending across categories appears to reach a saturation level, after which it ceases to increase as household income increase, and may even perhaps be declining. The saturation level of diversity is shown to occur at an total expenditure level of around 170 pounds per week in 2001. Beyond this income level, the dispersion of spending does not rise further. Rather, it appears to follow a slow decline which suggests that spending tends to become increasingly concentrated at high income levels. We note that this estimate occurs well below the upper bound diversity level of $\ln(k) = 2.28$ imposed by the index, given there are $k = 12$ categories. Such a result is consistent with our model, which predicted that the point of maximal diversity occurs at structural break in how the composition of the basked responds to rising household income. To empirically confirm this hypothesis, we employ a variant of the Luxury/Necessity index from Theil (1967). This requires us to first estimate the relationship between the budget share dedicated to each spending category and household income. For 2001 data we estimate a simple linear expenditure system:

$$s_{ij} = \alpha_j + \beta_j x_{ij} + \varepsilon_{ij} \tag{4}$$

for categories $j = 1...k$. Further it is imposed that $\sum_{j=1}^{k} \alpha_j = 1$ and $\sum_{j=1}^{k} \beta_j = 0$ such that the signs and magnitudes of the marginal effects can be interpreted as relative indicators of the luxury or necessity status of each good.

A measure of the quality of the basket of goods of household i is then $\xi_i = \sum_{j=1}^{k} \beta_j x_{ij}$ (the Luxury/Necessity index) where negative values imply poorer quality baskets. If the maximal diversity point x^*corresponds with a definite shift towards luxuries and away from necessities we expect to see a structural break in favor of luxuries around this point. To check for a structural break around this point we estimate the relationship between the Luxury/Necessity index and household income as proxied by total weekly expenditure:

$$\xi_i = \kappa + \theta x_i + v_i \tag{5}$$

The Quandt-Andrews test for an unspecified break is applied to the equation in order to determine the existence, and subsequent location of a break. The testing methodology involves allowing the parameters of the test equation to vary either side of point $\widetilde{x}$ with the use of a binary variable. This is done for each i within a trimmed central range. We use a standard 15 per cent exclusion zone in both tails of the distribution. The point $\widetilde{x}$ that minimizes the sum of the squared residuals is the likeliest candidate for the location of the structural break and significance is tested for by examining the augmenting dummy variables. Performing the test places the break at a value $\widetilde{x} = 177.78$ with a p-value negligibly different from zero. For this reason we conclude that there does appear to be a change in luxury spending occurring at this point. This indicates that a break does exist, and we note that the estimated location lies within the interval estimate for x^* in 2001 (see Equation 8 below). Taking this structural break into account, we estimate the equation using least squares:

$$\xi_i = \kappa_0 + \delta_0 \times D + \theta x_i + (\delta_1 \times D) x_i + v_i \tag{6}$$

where $D = 1$ for $\widetilde{x} > 177.78$ and $D = 0$ for $\widetilde{x} < 177.78$. This yields the following parameter estimates

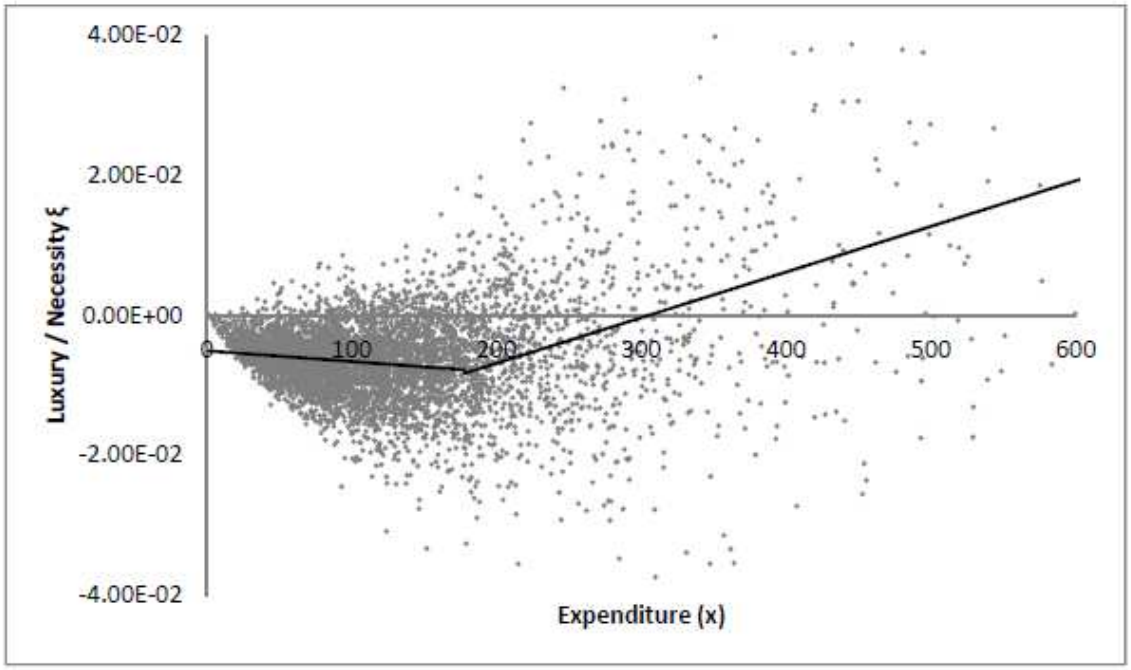
Table 1: Parameter Estimates Luxury /Necessity Index 2001

Parameter	Estimate	Standard Error	P value
κ_0	-0.00511	0.000145	0
δ_0	-0.01482	0.001738	0
θ	-1.52E-05	1.79E-06	0
δ_1	8.04E-05	7.05E-06	0

Estimates for 2001 involve 5456 observations and the model produces an R^2 of 27%. Standard errors are based upon the White covariance matrix. This is used as the the Breusch-Pagan residual equation $\hat{v}_i = \kappa_0 + \delta_0 \times D + \theta x_i + (\delta_1 \times D)x_i + v_i$produces significant regressors at all standard levels.

The estimated marginal effect of x on ξ is clearly greater passing the point $\widetilde{x}$ as the parameter estimate for $\delta_1$is positive and significant at all typical levels. Therefore we conclude that expenditure beyond this point consists of increased luxuries relative to necessities. A plot of ξ against x is given in Figure 2. Note that the structural break point appears to be close to the saturation level of diversity as shown in the Engel curve for diversity in Figure 1.

Figure 2: Luxury/Necessity Index against Expenditure 2001 (Breakpoint Shown)



Weekly expenditure is given on the horizontal axis and the estimated values $\xi_i = \sum_{j=1}^{k} \beta_j x_{ij}$ are on the vertical axis where greater values imply a greater luxury/necessity balance. The fitted regression line uses the parameter estimates in Table 1.

4 The saturation level of spending diversity over time and the distribution of income.

We now investigate how robust the saturation level of diversity is over time and the extent to which it it responds to changes in the income distribution of households that occur as the economy grows. Given that this point represents the income level at which households spend more on luxuries and higher quality goods, it is of particular interest to examine whether changes in the average household income affects affect the income level at it is located. In the literature, both the magnitude and manner in which household spending patterns are affected by the household's relative level of wealth is being intensely debated in the recent literature (Frank 1985, Frank 2005, Arrow and Dasgupta 2009). Recently Heffetz found considerable evidence for a strong positive correlation between the income elasticity of goods and the extent to which they are socially observable using US household expenditure data (Heffetz 2011). Other studies of spending patterns have revealed that spending on conspicuous, highly visible goods strongly depends on social group mean income (Charles et al. 2009, Kaus 2010). We investigate this link in two stages: this section will examine the relationship between the distribution of household income and $x*$ over time. The next section will examine how the individual household's relative income level influences the dispersion of spending across expenditure categories.

There are two possible ways in which the dispersion of household spending would be affected by changes in the income distribution given the existence of relative needs. On the one hand, if average housheols income grows then one may expect a greater percentage of the population of consumers to reach x^* if the income level at which x^* takes place is relatively robust to changes in the underlying distribution of household income (Hypothesis 1). On the other hand, it may also be the case that the level of spending dispersion at which saturation takes place tends to rise with increases in mean household income (Hypothesis 2). This latter hypothesis suggest that social comparisons may affect the point at which households begin to spend relatively more on luxuries. If households only begin to spend more on luxuries when they have reached a certain relative level of wealth, then we can the income level at which spending diversity saturates to move with average household income over time. To explore these hypotheses, we begin by studying the relationship between average household income and $x*$over time. The inverted-U shape and the existence of a saturation level of spending dispersion appears in a relatively consistent fashion over the observed years. To model the relationship formally, we estimate the polynomial equation:

$$E_i = \gamma_0 + \sum_{p=1}^{q} \gamma^p x_i + e_i \tag{7}$$

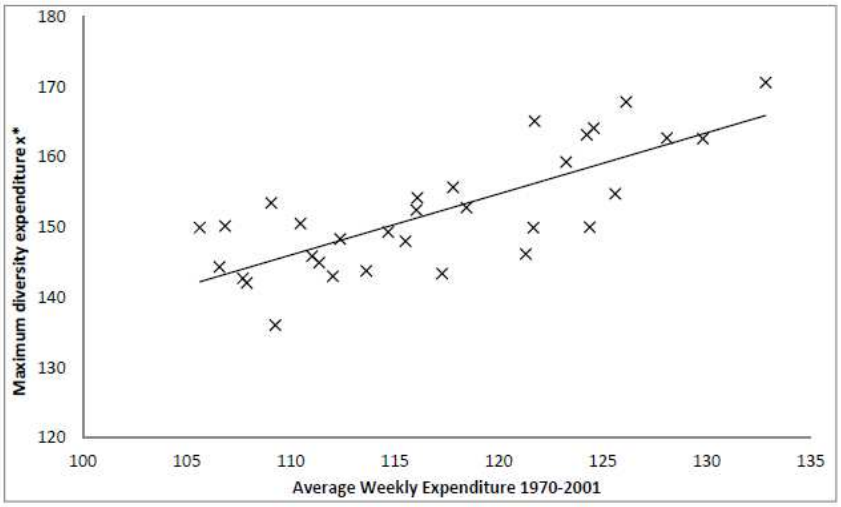
with an order $q = 6$. Although other parametric orders are possible, we find that this specification typically produces a good fit. This is estimated for the diversity of expenditure in each wave of the survey and the maximal point x_t* is determined numerically for years $t = 1...T$.[2]

Because many of the estimated curves are relatively flat around the estimated maximum, there is some uncertainty as to the precise location of the true point. Therefore x_t^* is accompanied with a bootstrapped standard error based on 1000 replications. The table in Appendix C reports x^*over time, along with the upper and lower bounds of the confidence intervals (UB and LB). It also reports the average expenditure ($\bar{x}$) and the median household expenditure ($\check{x}$). The table reveals x^*tends to drift upwards over time, which echoes previous findings by Chai and Moneta that there exists a relationship between the movement in the saturation point of Engel Curves for individual categories and changes in the income distribution (Chai and Moneta 2010). Given that average household income

[2] Analytical maximums are difficult to determine as they require the calculation of the roots of a fifth order polynomial. The role of relative prices changes over time have also been ignored at this preliminary stage of the investigation, although it should be noted that expenditure has been deflated to account for annual inflation.

has generally risen due to economic growth, this suggests that the x^*moves with changes in the income distribution. This is confirmed by the positive correlation between x_t^* and average weekly household expenditure (see Figure 3 below).

Figure 3: Maximal Diversity vs Weekly Expenditure 1970 to 2001



Average weekly expenditure per year is given on the horizontal axis and the estimated values x^* are on the vertical axis. Note that income (and hence expenditure growth) implies that observations towards the right occur in later periods while observations from earlier periods are on the left.

We wish to model the time-series relationship between $x_t^*$and the average household income $\bar{x}_t$ formally. Initially we examine the univariate properties of each series by testing each for a unit root. The Augmented Dickey Fuller (ADF) test is used which has the following generic test equation

$$\Delta y_t = \alpha_0 + \lambda t + \rho y_{t-1} + \varepsilon_t$$

where y_t is the dependent variable and t is a time-trend. Stationarity requires that $\rho > 0$ and we report results for estimates in levels and differences in Table 2 below.

Table 2: Unit Root Tests x_t^* and $\bar{x}_t$

Variable	$\hat{\rho}$	τ	P-value
$\bar{x}_t$	-0.398	-2.517	0.318
$\Delta\bar{x}_t$	-0.868	-4.525	0.006
x_t^*	-0.415	-2.535	0.311
Δx_t^*	-1.156	-6.124	0.000

The results indicate that both variables are I(1) which introduces the prospect of cointegration. To test for this we estimate the test equation

$$x_t^* = \phi_0 + \phi_1 \bar{x}_t + e_t \tag{8}$$

and examine the residuals for stationarity. An Engle-Granger test on e_t rejects the null of a unit root with a p-value of 0.031. We therefore persist with the equation and use it to form some hypotheses about the change in expenditure with economic growth.

The null hypothesis is that the income distribution has no influence on x_t^*, in which case we would expect $\phi_1 = 0$. This implies that there exists no relationship between $x_t^*$and $\bar{x}_t$ such that x_t^*does not change as average household income rises or falls. If $\phi_1 = 1$, this suggests a translative relationship between $\bar{x}_t$ and x_t^*. In this instance if the economy grows by some fixed (additive) constant λ then x_t^*should grow by the same amount. In the most extreme case $\phi_0 = 0$ and $\phi_1 = 1$ in which case the relationship between $x_t^*$and $\bar{x}_t$ is purely proportional in that the diversification point would be completely determined by mean household income. An intermediate case would be a situation where $\phi_0 > 0$ and $0 < \phi_1 < 1$, which indicates that increases in our point of interest occurs with income growth, but at a slower rate.

Estimates of the parameters are presented in Table 3 below. The regression employs a single observation over each of the 32 waves. As there was evidence of autocorrelation, standard errors were determined using Newy-West HAC covariance.

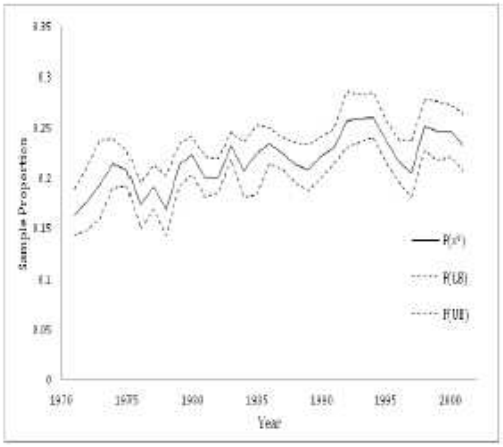
Table 3: Parameter Estimates Maximal Diversity vs Weekly Expenditure 1970-2001

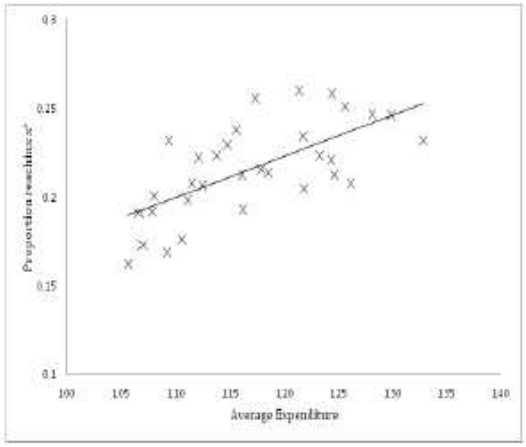
Parameter	ϕ_0	ϕ_1
Estimate	50.19564	0.871366
Standard Error	17.36664	0.147784
T statistics	2.890348	5.896228

The regression employs a single observation over each of the 32 waves. The R2 for the regression is 0.599.

These parameter estimates enable us to reject the null hypothesis $\phi_1 = 0$ as zero does not lie on the interval for$\hat{\phi}_1$. Similarly we reject the hypothesis for a proportional relationship based upon the interval for $\hat{\phi}_0$ where zero does not lie on the interval for $\hat{\phi}_0$. We can not reject the hypothesis of translative relationship as $\phi_1 = 1$ is plausible given our interval, although our point estimate of $\phi_1 = 0.871$ indicates that the true value is likely to be less than unity. These results suggest that the income level at which the household spending diversity saturation does in fact move with the average household income. It is consistent with the notion that social comparisons influence in determining the dispersion of household spending and that households only spend more on luxuries once they have reached a particular level of relative wealth. However, the rate at which x_t^* grows is less than the rate at which $\bar{x}_t$ increases. Hence, we expect a larger proportion of the total household sample should reach x_t^* over time, in spite of the fact that $\bar{x}_t$ increases. In that sense, the relative position in society at which household begin to spend more on luxuries seems to be decreasing as a greater proportion of households reach the income level at which spending diversity saturates. The increase in this percentage of the population over time is confirmed in the following figure that shows the share of consumers who have reached x_t^* over time (left hand side) and in relation to average household income (right hand side).

Figure 4: Proportion of consumers who have reached x_t^* over time and against $\bar{x}_t$.





5 Relative income and spending diversity

We turn to consider how relative income affects individual household diversification patterns using cross sectional data from 2001. Relative income is the ratio of individual income relative to the average household income found in the social environment. In the following, the social environment is taken as the geographic region in which the household is located. Using 2001 data, it is possible to calculate the average household income for the 11 different regional areas to obtain the regional average. Values greater than unity imply a greater than average regional income for the household, while values less than unity imply relatively low income for the household. As such, the relative income parameter will capture how spending diversity is affected by the extent to which the household income is above or below the average income found in their local region. By comparing this parameter with the effects of (absolute) household income, we can ascertain whether the relationship between affluence and spending diversification uncovered in the previous section is affected by social comparisons. Our previous results are inconclusive on this point. On the one hand, we found that the income level at which x_t^* is located tends to drift with average household income, which supports the idea that social comparisons do affect the dispersion of household spending across expenditure categories. On the other hand, we also found that a growing proportion of households reach x_t^* over time, this suggests that the dispersion of household spending is more reflective of individual behavior and not influenced by social comparisons.

In a nutshell, we argue that households which have a high relative income leads them to adopt the same diversification profile of more affluent households. This implies that increasing the relative income of households will have the same effect on spending diversity as increasing the real household income level by some amount. Reducing the average household income level in the local region will affect spending diversity as increasing the household's absolute income level. Given the inverted-U shape relationship between household income and spending diversity, this implies that the effect of relative income on spending diversity will be different for low income and high income households. Among those below (above) x^* a high level of relative income would lead to a greater (lower) dispersion of spending. To empirically examine the effect of relative incomes on diversity of expenditure we specify the equation:

$$E_i = \gamma_0 + \sum_{p=1}^{q} \gamma^p x_i + \sum_{u=1}^{q} \psi_u z_{ui} + \tau_1 r_i + \tau_2 r_i \times x_i + e_i \tag{9}$$

where there are a u demographic variables z for each household i. These are Age of household head (z_1) and number of children (z_2). The other demographic variable that was considered was number of years of education, although it was not used as this variable was strongly correlated to income. Variable r_i refers to the relative income of household i. Parameter τ_1 captures the marginal effect of relative income on E_i while τ_2 captures the interaction between relative income and the level of income. The equation is estimated using least squares and robust standard errors. The results are reported in Table 4.

Table 4: Parameter Estimates for Determinants of Household Spending Diversity

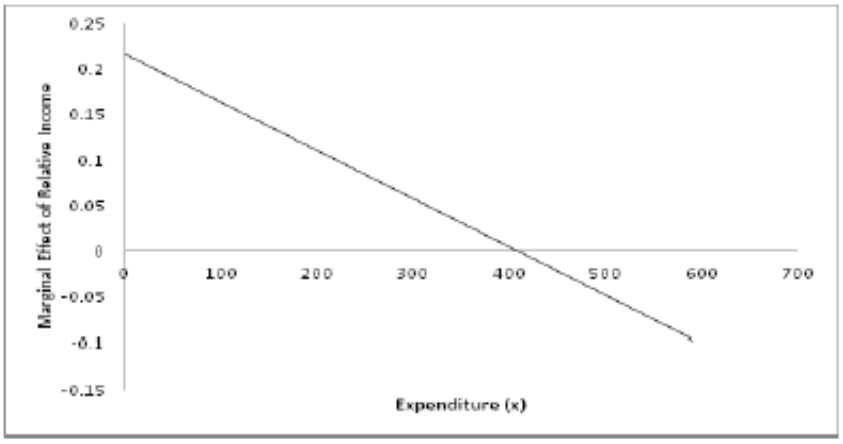
Parameter	Estimate	S.E.	P-value
γ_0	0.990738	0.030728	0
γ_1	0.011446	0.000803	0
γ_2	-6.76E-05	5.93E-06	0
γ_3	1.73E-07	2.10E-08	0
γ_4	-2.08E-10	3.40E-11	0
γ_5	1.18E-13	2.46E-14	0
γ_6	-2.48E-17	6.49E-18	0.0001
ψ_1	-0.00209	0.000238	0
ψ_2	0.035147	0.003639	0
τ_1	0.216713	0.052708	0
τ_2	-0.00053	0.000153	0.0005

Estimates for 2001 involve 5456 observations and the model produces an R^2 of 35%. Standard errors are based upon the White covariance matrix. This is used as the the Breusch-Pagan residual equation $e_i = \gamma_0 + \sum_{p=1}^{q} \gamma^p x_i + \sum_{u=1}^{q} \psi_u z_{ui} + \tau_1 r_i + \tau_2 r_i \times x_i + v_i$ produces significant regressors at all standard levels.

The estimated equation produces an R^2 of 0.3159 and is based upon 5456 observations. The results show that all parameter estimates are significant including the two coefficients of relative income. We find that that τ_1 is positive while τ_2 is small and negative. The change in the sign confirms our hypothesis that relative income has the same influence on spending diversity as absolute income: at low income levels, a higher relative income leads households to increase the dispersion of household spending, while at high income levels, it leads to a reduction in spending dispersion (hence the negative sign). However, given that most of our observations are located at low income levels, some question remains about the negative effect that relative income has on household spending dispersion at high income levels. A plot of the estimated marginal effect of relative income on diversity is given in Figure 5. It shows that the parameter value is positive at low levels of relative income, but falls steadily as average household income rises.

This is illustrated in Figure 5

Figure 5: Estimated Marginal Effect of Relative Income on Household Diversity



We also examine how relative income affected the Luxury Necessity Index, controlling for the same factors as were used in the above equation:

$$\xi_i = \gamma_0 + \sum_{p=1}^{q} \gamma^p x_i + \sum_{p=1}^{q} \psi_u z_{ui} + \tau_1 r_i + e_i \tag{10}$$

A similar result was found in that the τ parameter is again positive and significant, which suggests that relative income has a positive effect on the luxury/necessity index. Households that are richer than those in their region consume a more luxury-orientated basket of goods than those that are relatively poorer, controlling for absolute levels of income. The results suggests that if there was a reduction in the average household income in the region, but no change in the income of an individual household, then the resulting increase in their relative income level would increase the ratio of luxuries to necessities that the household consumes. In other words, simply by changing the household's relative wealth, household tend adopt a consumption profile that is consistent with more affluent households who consume a higher share of luxury goods.

Table 5: Parameter Estimates for Determinants of ξ_i

Parameter	Estimate	S.E.	P
γ_0	-0.00074	0.000868	0.3953
γ_1	-0.00013	2.82E-05	0
γ_2	3.22E-07	2.79E-07	0.2486
γ_3	2.34E-10	1.13E-09	0.8362
γ_4	-1.70E-12	2.01E-12	0.3982
γ_5	1.94E-15	1.57E-15	0.2176
γ_6	-6.59E-19	4.41E-19	0.1357
ψ_1	-2.78E-05	5.81E-06	0
ψ_2	-0.00034	0.000104	0.0012
τ_1	0.006388	0.001837	0.0005

Estimates for 2001 involve 5456 observations and the model produces an R^2 of 32%. Standard errors are based upon the White covariance matrix. This is used as the the Breusch-Pagan residual equation $e_i = \gamma_0 + \sum_{p=1}^{q} \gamma^p x_i + \sum_{p=1}^{q} \psi_u z_{ui} + \tau_1 r_i + v_i$produces significant regressors at all standard levels.

6 Conclusion

This paper has investigated the existence of a saturation level of household spending diversity, and the extent to which this level is affected by changes in the underlying household income distribution. In contrast to several studies, we find evidence that this saturation of spending diversity does indeed exist. We find that the income level at which saturation takes place does drift upwards with rises in average household income, although rate at which this drift takes place is less than the rate at which average household income rises. Therefore, a greater percentage of the household population tend to reach the income level at which the household spending dispersion saturates. When we study how relative income affects the household's tendency to diversify spending, we find more evidence that confirms the hypothesis that social comparisons affect the composition of household spending: households who are more wealthy than the average household in their region display a higher propensity to diversify their spending compared with households that possess the same level of (absolute) income but are less wealthy than the average household in their region.

Such evidence casts doubt on the notion that households always seek greater variety of goods and service across expenditure categories as their income increases. In fact, the negative correlation between between spending dispersion at household income found at high income levels suggests that the household's demand for certain high quality goods and services leads to a reduction in spending dispersion and the concentration of spending into particular expenditure categories. This implies that there is a limit the extent to which household diversify their spending as their income grows and the food expenditure share begins to fall - an important addendum to Engel's law. We also find that the saturation of diversity was to correspond with the income level at which luxuries begin to dominate necessities in the consumption basket.

There are several shortcoming to this preliminary study. Time series analysis ignores change in relative price and changes in the quality of goods over time, both of can have important effects (Bils and Klenow 2001). Most importantly, it does not fully exploit the dataset to examine how household spending diversity is affected by relative income. We look to fix this in future versions of the paper. Also, the UK data does not have any independent information of the prices that household's paid for their goods. A similar study using US data should be considered in this regard, as it would be possible to decompose changes in spending dispersion into price effects and quantity effects.

Appendix A

Table 6: Categories of the UK Family Expenditure Survey,2001

Category	Examples of spending
Food	Milk, Eggs, vegetables, meats, sweets, non-alcoholic beverages. Take away meals, food bought and consumed at work and school.
Fuel Light and Power	Gas, Electricity, Coal, bottled gas, paraffin, wood, Electricity slot meters.
Alcoholic Drinks	Beer, Lager, Cider, Spirits Liqueurs.
Tobacco	Cigarettes, Pipe tobacco, cigars
Clothing and Footwear	Outerwear, Underwear, Clothing accessories, Footwear, Haberdashery and clothing materials
Household goods	Furniture and Furnishings, Electrical and gas appliances. Hardware, decorative goods. Toilet paper, Pet and garden expenditure.
Domestic and Paid services	Childcare, domestic help, laundry, postage and telephones, subscriptions and stamp duty.
Personal Goods and Services	Hairdressing, cosmetic requisites. Baby goods, medicines and medical goods. Personal effects and travel goods.
Motoring Expenditure	Accessories, parts, repairs and servicing of motor vehicles. Petrol and oil. Insurance, driving lessons and other payment.
Travel	Fares, other transport costs, Purchase and maintenance of non-motor vehicles.
Leisure Goods	TV, video and Audio equipment. Sports, camping and outdoor good and equipment. Newspapers, magazines, books and stationary. Toy, hobbies and photography.
Entertainment and Education Services	Cinema, spectator sports, TV rental and subscription, hotels and holiday expenses, betting stakes, educational fees and maintenance, Ad hoc school expenditure, betting stakes.

Figure 6: Annual: Percentage Growth of Total Weekly Household Expenditure

Appendix B

Figure 7: The Engel Curve for Spending Diversity in 1971, 1981 and 1991.

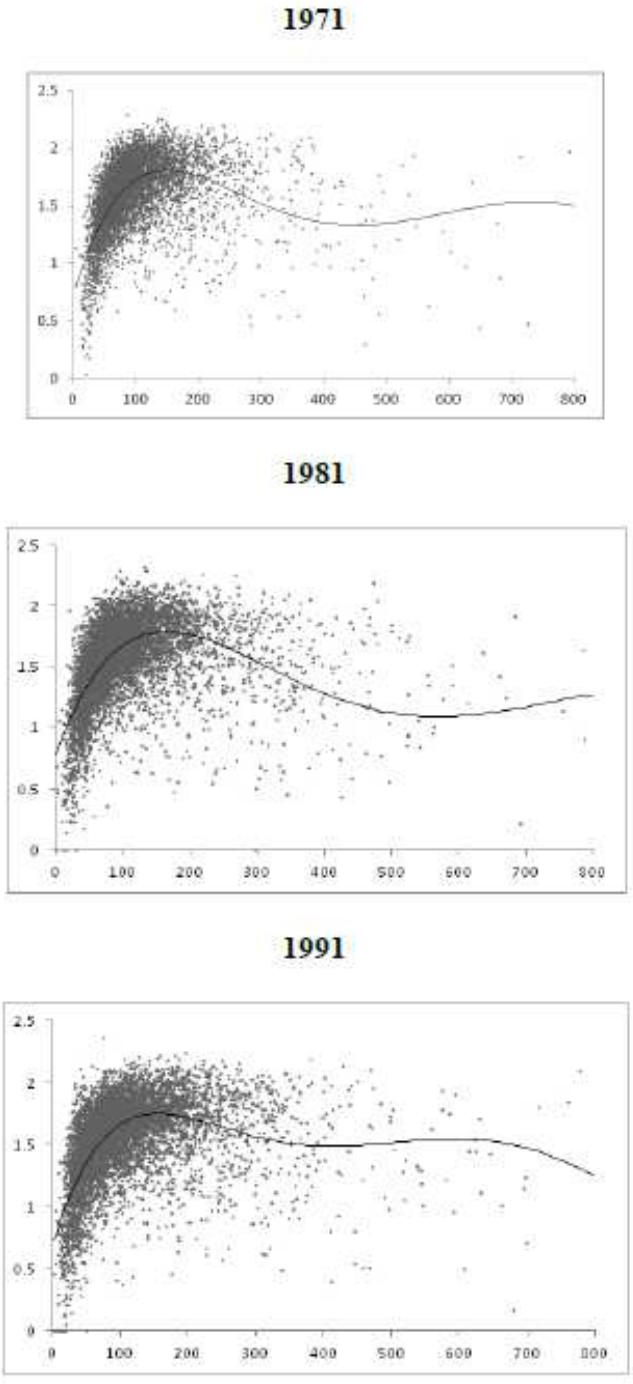


Table 7: Estimated Values of the turning point, average expenditure and median expenditure, 1970-2001

Year	$x*$	SE	LB	UB	$\bar{x}$	x_M
1970	142.73	3.58	135.58	149.88	107.69	89.97
1971	149.96	3.87	142.22	157.71	105.62	88.26
1972	150.54	5.38	139.79	161.29	110.46	90.64
1973	154.22	5.95	142.32	166.11	116.08	97.49
1974	152.81	3.89	145.02	160.59	118.44	97.79
1975	144.97	2.45	140.07	149.88	111.37	92.31
1976	150.19	3.81	142.56	157.81	106.84	89.22
1977	144.36	3.21	137.93	150.79	106.57	88.64
1978	153.48	4.74	144.00	162.96	109.06	91.67
1979	152.48	3.13	146.21	158.75	116.04	94.46
1980	143.02	2.52	137.97	148.07	112.02	92.98
1981	145.88	3.19	139.50	152.26	111.02	89.57
1982	142.08	3.15	135.77	148.38	107.88	85.87
1983	136.07	2.12	131.83	140.31	109.25	87.29
1984	148.34	4.35	139.63	157.04	112.37	90.76
1985	143.79	4.01	135.76	151.82	113.63	90.49
1986	149.95	3.02	143.92	155.99	121.66	93.48
1987	159.31	3.23	152.84	165.77	123.23	92.25
1988	164.13	3.81	156.51	171.76	124.57	96.10
1989	167.87	4.14	159.59	176.14	126.12	97.70
1990	163.18	3.81	155.55	170.81	124.23	95.77
1991	149.33	2.74	143.84	154.81	114.68	92.53
1992	143.41	3.55	136.30	150.51	117.27	96.37
1993	150.03	3.74	142.55	157.50	124.37	99.27
1994	146.20	3.43	139.34	153.05	121.30	96.49
1995	148.01	3.01	141.99	154.02	115.51	94.53
1996	155.69	3.24	149.22	162.17	117.80	97.84
1997	165.14	5.25	154.65	175.63	121.72	99.44
1998	154.78	3.64	147.49	162.07	125.60	102.46
1999	162.64	4.34	153.96	171.33	129.81	105.30
2000	162.72	4.04	154.64	170.81	128.09	105.94
2001	170.62	4.64	161.35	179.90	132.83	109.93

The upper and lower bounds of the confidence intervals are reported as UB and LB.

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