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South African poverty lines: a review and two new money-metric thresholds

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Abstract

Unlike some other countries, there is no legislated poverty line for South Africa. Various absolute poverty lines exist, but there has been little analysis of the methodological decisions underpinning each line. There is no consensus as to which line is best. This paper critically reviews existing South African poverty lines and introduces two new money-metric thresholds. These poverty lines are created according to Ravallion's (1994) Cost of Basic Needs method and use a combination of household survey data, caloric information for various foods, and price data. Our methodology is described in depth, and the implications of unavoidable methodological decisions are discussed. The theoretical foundations of the method are also examined, and it is argued that the lower-bound poverty line is not conceptually coherent and is not appropriate for poverty measurement. The upper-bound and food poverty lines remain worthwhile, however. The implications of these lines for rudimentary estimates of poverty are then examined, using the 2010/2011 Income and Expenditure Survey.

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1. Introduction

Unlike many other countries, South Africa does not have one recognised, "official" poverty line. Instead, a number of different thresholds abound even when examination is limited to money-metric absolute lines. Poverty lines based on Ravallion's (1994) "Cost of Basic Needs" (CoBN) methodology are currently predominant, but different applications of this methodology have resulted in significantly different poverty thresholds. With no existing literature which discusses the methodological decisions which underpin and differentiate these poverty lines, researchers have little reason to prefer one over another. This paper reviews the current absolute poverty lines, and proposes a new set of lines. While remaining cognisant of the theoretical criticisms of these kinds of lines, the necessity of poverty lines for much empirical work is indisputable, and as Woolard and Leibbrandt (2006: 18) point out, "one frequently needs to draw the line *somewhere*". With this in mind, this paper should be seen as an attempt to create "the best poverty line we can", given prevailing methodologies and data. However the proposed lines are certainly not immune to criticism, and in an effort to stimulate fruitful discussion this paper will be as transparent as possible regarding the unavoidable methodological decisions which have to be made along the way. In 2011 Rands we propose R1042 per person per month and R327 per person per month as the poverty and extreme poverty thresholds respectively.

Section 1 of this paper constitutes this introduction, while Section 2 provides an historical overview of the absolute money-metric poverty lines developed for South Africa. Section 3 examines the theoretical underpinnings of absolute money-metric poverty lines and criticisms thereof, while introducing the Cost of Basic Needs methodology. It will motivate for the continued use of the Cost of Basic Needs approach for South African absolute lines, which is argued to be a useful complement of other kinds of poverty measures. The lower-bound poverty line, however, is argued not to be conceptually coherent or valuable. Section 4, which is the main part of this paper, outlines the contestable methodological decisions which must be made when applying Ravallion's (1994) methodology to South Africa. These decisions are identified as relating to the choice of dataset, construction of the consumption aggregate, the selection of a minimum daily caloric requirement, choosing which food expenditures to include as part of the food basket, the process of converting food expenditures into calories, using expenditure patterns of households or individuals, defining a reference group of the poor, identifying the correct non-food expenditures, and deciding whether the upper bound should be truncated due to data quality concerns.[1] In the case of each decision the methodologies currently in practice are examined, and the specific approach of this paper described in detail. Section 5 presents a preliminary analysis of South African poverty using our proposed set of lines as compared to the existing lines, while Section 6 concludes with a brief analysis of the substantive methodological decisions and discusses how this set of lines should be applied.

2. Historical overview

Edward Batson is usually credited with the development of South Africa's first poverty lines, in 1942 (Budlender, 1985). Covering six categories of expenditure (food, clothing, fuel and lighting, washing and cleaning, rent and transport), Batson's Poverty Datum Line constituted what were normatively considered to be the minimum essential items for "maintaining health and decency in the short run only" (Potgieter, 1974 cited in Budlender, 1985: 1). In the 1970s, versions of Batson's methodology were used by researchers at the University of South Africa (UNISA) and the University of Port Elizabeth (UPE) to create new poverty lines, which were called the Minimum Living Levels (MLL) and

[1] Unless the specific context makes it clear otherwise, "food" is assumed to include non-alcoholic and alcoholic beverages. These items are classified together because they form part of people's diets and contribute to calorie consumption.

Household Subsistence Levels (HSL) respectively. The researchers also published slightly higher versions of their original lines which either made provision for supposedly non-essential goods and services (UNISA's Supplemented Living Levels), or were increased by a fixed amount to account for more realistic prices and omitted but necessary expenditures (UPE's Household Effective Levels). Significantly, these lines were constructed with the specific aim of being used for wage-setting.[2] These normatively determined lines are now very rarely used by researchers, however.[3] Indeed, that they still made prescriptions which differed by racial group as late as 2004 perhaps reveals their inappropriateness.

Shortly after South Africa's transition from Apartheid, the World Bank in partnership with the Ministry in the Office of the President: Reconstruction and Development Programme published the *Key indicators of poverty in South Africa* report (Ministry in the Office of the President: Reconstruction and Development Programme, 1995). The indicators of poverty used in this report incorporated the MLL, SLL and HSL, but other thresholds were also included. Poverty lines based on the expenditure required for caloric intake of 2000 and 2500 kilocalories per day were developed, as were cut-off poverty lines set at the 40th and 20th percentile of households ranked by adult equivalent expenditure. When choosing which line should be used for their poverty analysis, the authors chose the line that defined the poorest 40% of households as poor, which resulted in 52.8% of individuals being classified as poor. To define the "ultra-poor" they chose the equivalent cut-off at the poorest 20% of households, leading to 28.8% of individuals being classified as "ultra-poor". This basket of poverty lines (see Table 1) was subsequently used by both researchers and the state (Magasela, 2006).

Table 1: Key indicators of poverty in South Africa (1993)

Types of poverty lines	Rands per month*	Headcount ratio (%)
Population cut-offs at the:		
40th percentile of households ranked by adult equivalence	301.0	52.8
20th percentile of households ranked by adult equivalence	177.6	28.8
Minimum per capita caloric intake (at 2 000 kcal per day)	143.2	39.3
Minimum per capita adult-equivalent caloric intake (2 500 kcal per day)	185.4	42.3
Minimum and supplemented living levels per capita**		
Supplemented living level (SLL)	220.1	56.7
Minimum living level (MLL)	164.2	44.7
Per adult equivalent Household Subsistence Level (HSL)**	251.1	36.2

Source: Ministry in the Office of the President: Reconstruction and Development Programme, 1995

* The poverty lines are in nominal 1993 Rands

** Based on values given for a family of five (average family size in South Africa at the time)

However by 2005 South Africa still did not have one widely accepted or official line. The National Treasury and national statistical office, Statistics South Africa (Stats SA), sought to address this, and in 2005 an initiative was launched by which an official poverty line would be developed (Studies in

[2] Until recently the SLL was still used by the University of Cape Town for this purpose.

[3] Budlender (1985) wrote a detailed critique of these thresholds showing that they are arbitrarily determined and often insufficient.

Poverty and Inequality Institute [SPII], 2007). This process, which included inputs from a wide range of experts, ultimately resulted in the production of two sets of poverty lines following Ravallion's (1994) Cost of Basic Needs methodology. First, in the course of their own analysis of poverty and inequality in South Africa, Hoogeveen and Özler (2006) developed a set of poverty lines following Ravallion's methodology.[4] These lines were published by Stats SA (2007) as part of a work-in-progress discussion note. They were then followed by a new set of Stats SA CoBN lines in 2008 (Statistics South Africa, 2008). The new Stats SA lines clearly drew on the Hoogeveen and Özler methodology to some extent, but included significant methodological changes which resulted in lines which were between 33% and 48% lower than their Hoogeveen and Özler equivalents. Both sets of lines were based on the 2000 Income and Expenditure Survey conducted by Stats SA. While the 2008 Stats SA lines were used by some government agencies, and most notably for the poverty reduction target of the National Development Plan (National Planning Commission, 2012), the Hoogeveen and Özler lines were much more widely used amongst academics. Indeed, it seems few researchers outside of government were aware of the 2008 Stats SA line until recently.

However this year's publication of Stats SA's rebasing (Statistics South Africa, 2015) of its 2008 lines, using the 2011 Income and Expenditure Survey, has brought into renewed focus the uncertainty regarding which poverty line should be used for analysis of absolute poverty. The 2015 Stats SA poverty lines are closer to the Hoogeveen and Özler estimates, and use much more recent data. There has however been some energetic criticism of the methodology of the 2015 Stats SA lines, even in the popular press (Forslund, 2015). While the 2008 Stats SA set of lines is no longer applicable, both the Hoogeveen and Özler and 2015 Stats SA lines are seen as plausible poverty thresholds, and researchers have insufficient evidence available to choose one over the other.[5] It is in this uncertain context that this paper finds itself.

It is worth mentioning that government has independently developed and continues to develop poverty thresholds for the purposes of means-tested social grants and the government package of Free Basic Services (Bhorat, Oosthuizen and Van der Westhuizen, 2011). However these lines have generally not been deemed suitable for poverty analysis purposes in South Africa, and are typically much lower than the poverty lines used by academics and policymakers. Sen (1983: 158), addressing the same issue but in general, argues persuasively against what he refers to as the "policy definition" of poverty, noting the use of these types of lines are likely to introduce distortions and perverse incentives.

[4] Note that while these poverty lines were first published in South Africa by Hoogeveen and Özler (2006) as an edited chapter in *Poverty and Policy in post-apartheid South Africa* (Bhorat and Kanbur, 2006), a substantially revised version of the paper was published by Özler (2007) in *Economic Development and Cultural Change.* The poverty lines are the same in both versions, and for the purposes of setting a poverty line the most widely cited version in South Africa is the book chapter. This paper follows this convention except when discussing the methodology of the Hoogeveen and Özler estimates, as this is discussed in much more detail in the journal article version.

[5] For example, at the June 2015 Academy of Science of South Africa *Workshop on Measuring Deprivation in order to promote Human Development*, researchers presenting work on absolute poverty fluctuated between using the 2015 Stats SA lines and inflation-adjusted versions of the Hoogeveen and Özler lines, highlighting current uncertainty on the issue

3. Theory of absolute money-metric poverty lines

3.1 What to measure[6]

3.1.1 Using a money-metric measure

Before poverty can be measured, it is necessary to have some way of measuring or identifying "well-being". This concept can be understood in a number of different ways. The most common proxies for well-being are generally income or consumption. These come out of the welfarist approach to conceptualising well-being, which has an established history in Economics. This approach takes as its starting point that a person's well-being is equivalent to her "utility". Every person assesses for themselves what they value and how much they value it (their preferences), and their overall well-being is a function of their attainment of the items they value. As Sen (1980) points out, in practice this ends up becoming a measure of a person's consumption of (or ability to consume) goods and services, which he argues is an unsatisfactory measure of wellbeing. Ravallion (1994) argues that this concept should more properly be called "economic welfare", though it is doubtful whether Sen would accept even this conceptualisation. In competition with the welfarist position, Sen proposes his influential "capabilities approach", where well-being is understood as being about a person's capability to function in society and live a life that is meaningful to them. This much broader definition necessitates a very different type of measurement. Welfare measures such as the Human Development Index (United Nations Development Programme, 1990) and the recent introduction of Multidimensional Poverty Indices (Alkire and Foster, 2011) represent attempts to more directly measure the other components of well-being which Sen identifies as important alongside income within his capabilities approach, such as health and education.

However while approaches which move beyond narrow analyses of income and consumption are appealing, economic welfare is certainly still a useful concept to measure, for both analytic and policymaking purposes. While economic welfare is not the only determinant of well-being, in a country such as South Africa it is not just a component but also an instrument by which other kinds of well-being can be improved. Being healthy, for example, is certainly a determinant of well-being, and rich people can be unhealthy while poor people are healthy. Economic welfare, however, gives richer people opportunities to address their ill-health in ways that are unavailable for poor people. The consequences of ill-health are often different for poor people and rich people, and this should probably be accounted for somewhere. Economic welfare, whether denoted by consumption or income, is not a comprehensive measure of well-being. But it is a fundamentally important determinant of the quality of people's lives, and measures of this kind are important complements to multidimensional or other types of analyses, which may incorporate a money-metric measure in any case.

3.1.2 Income or consumption data

Once the decision has been made to use money-metric welfare indicators, a decision must still be made as to what specific indicator should be chosen. This is usually a choice between using income or consumption data (Haughton and Khandker, 2009). In the developing country context, consumption data are normally preferred (Ravallion, 1994). It is generally argued that consumption

[6] There is much work which describes in depth the theory underpinning poverty lines and the conceptualisations of well-being associated with those theories. In order not to reproduce that work, and in the interests of succinctness, this section presents an overview of this theory. For a more detailed view, see Ravallion (1994; 2012). For more detailed discussion regarding the choice between using income or consumption data, see Deaton (1997). For this discussion applied to South Africa, Woolard and Leibbrandt (2006) and Yu (2013) are instructive. For discussion regarding equivalence scales in South Africa, see Woolard and Leibbrandt (2006) and Posel and Rogan (2014).

data, taken from an interview at a given point in time, are more likely to accurately represent a household's well-being than is the case with comparable income data. The theoretical argument for this assumption is related to the permanent income hypothesis. While incomes can fluctuate significantly over time, especially where they are derived from informal activities, agricultural production, or casual work, consumption will be smoothed as households save and borrow to buffer their standard of living (Haughton and Khandker, 2009). This suggests that consumption data, which are not as volatile as income data, are more likely to accurately represent standard of living.

However this theoretical argument is not necessary to justify the use of consumption data. Deaton (1997) argues that the methodological issues associated with data collection are indeed a more persuasive reason to prefer consumption data. In contexts where the meaning of income may be unclear, such as when engaged in self-employment, own-account agricultural production, and informal activities, consumption is more easily understood, recalled and measured than income (Yu, 2013). Consumption is also seen as less of a "sensitive" issue than income, and while households may hide expenditures on illicit or "sin" items such as drugs and alcohol (Haughton and Khandker, 2009), this is likely to be less of an issue than distortions created by high-income households under-reporting their income for fear of information being passed on to tax authorities, or low-income households over-reporting to avoid social stigma (Deaton, 1997). Income from illegal sources is also likely to be under-reported, if it is reported at all (Haughton and Khandker, 2009). Calculating income derived from assets requires knowledge of both assets and their returns, and questions about these topics are both sensitive and difficult. This frequently leads to under-reporting of income, whether deliberate or otherwise (Deaton, 1997).

While Deaton (1997) identifies a number of potential concerns, the main issue with consumption data is that their collection is expensive and laborious. Given that sufficient reliable surveys already exist in South Africa, this is not a problem for this paper. It may be an issue that these surveys tend to report expenditure rather than consumption directly, but it is unclear if this should be seen as significant generally.[7] There are other concerns though, such as how expenditures on durable household goods should be treated. At issue is the relatively infrequent purchase of these goods, which then remain in use (and therefore add to well-being) over a long period of time. Including purchases of these goods unadjusted can lead to very noisy expenditure data unless recall periods are extended very far back, but that would exacerbate various recall biases (Yu, 2013). This issue is considered in more depth in Section 4.5.3, which discusses our consumption aggregate. To conclude the above analysis it should be emphasised that despite these concerns, consumption measures are certainly still useful measures for the analysis of poverty. The Cost of Basic Needs methodology (Ravallion, 1994) used in this paper is by design a consumption- or expenditure-based technique in any case, and we therefore proceed with a consumption approach to measuring well-being.

3.1.3 Per capita measures and equivalence scales

Having decided on a money-metric consumption or expenditure measure for welfare, the last decision to be made is regarding the unit of analysis. While poverty measurement is generally required at the individual level, most surveys, including the 2010/2011 IES upon which this paper is based, report expenditures at the household level. It is exceedingly difficult to measure intra-household resource allocation, and this is simply an unavoidable limitation which needs to be dealt with as best as possible. The most straightforward option is to use per capita expenditure, where household expenditure is divided by the number of household members, and each household

[7] This issue is likely relevant when estimating the total expenditure of households which consume their own home-produced goods (Deaton, 1997), but this makes up a small part of national consumption. The Income and Expenditure Surveys used for CoBN estimates report households' expenditures. It requires that consumption of home-produced items be converted into money terms, implicitly by multiplying quantities by item prices. There is no guarantee that the prices which interviewees implicitly use for this process accurately represent prevailing prices.

member is assumed to consume an equal share of the household's resources (Woolard and Leibbrandt, 2006). This assumption is certainly not likely to reflect reality, but there are few other options. One approach, which has an established history, is the use of equivalence scales. Equivalence scales can adjust for households' economies of scale in consumption, and allow for the differing consumption needs of adults and children and sometimes of women and men. There is no strong underlying theory as to what parameters should be set when using these scales, however, and they may create more questions than they resolve(Deaton, 1997). Woolard and Leibbrandt (2006) showed in the mid-2000s that the use of equivalence scales makes little difference to South Africa's poverty profile, and since then the simplicity of per capita measures has generally been preferred in South African work. Posel and Rogan (2014) have recently drawn attention to distortions which are caused by the use of per capita measures, and the issue may need to be reopened. However until then this paper will proceed with the assumption that per capita measures are a necessary evil, with per capita expenditure being our preferred welfare measure.

3.2 Absolute, relative, or subjective poverty lines

3.2.1 Absolute and relative lines[8]

Absolute money-metric lines are developed by determining the level of consumption (assuming this is the welfare measure) required for a basket of goods and services which is seen as the minimum basket needed to be called "non-poor". This basket of goods is then kept constant, though its nominal cost will likely vary across time or space to keep its value fixed in real terms. A person is classified as poor if their consumption is below this line. The underlying conceptualisation of welfare is one where a person's well-being is related only to their own consumption or real income, and is not at all affected by their relative position in society or by society's changing standard of living. Relative poverty lines, in contrast, are in some way directly linked to a particular society's standard of living. This usually means the poverty line is some function of national mean or median income. The Organisation for Economic Co-operation and Development (OECD), for example, sets its poverty lines at 50% or 60% of median national income, meaning a person is categorised as poor if their income is below this line (OECD, 2014). The conceptualisation of poverty here is of a relative phenomenon, whereby being poor means being unacceptably poor in comparison to the standards of the rest of society (Townsend, 1979). As aggregate or typical living standards change, the amount of income or consumption required to be seen as non-poor also changes. Absolute poverty can be understood to be about physical survival and subsistence, and relative lines about social norms.

While absolute lines have tended to predominate in developing countries, developed countries tend to use relative lines (Ravallion, 2012). British policymakers, for example, have endorsed a relative conceptualisation of poverty despite the first absolute poverty lines being developed for that country (Magasela, 2006). Magasela (2006) attributes this shift to work by Abel-Smith and Townsend (1965, cited in Magasela, 2006) and Townsend (1979) in Britain, which showed that despite not being in absolute poverty, many people still faced significant hardship, deprivation and social exclusion. With absolute poverty less of a concern in richer countries, concern has shifted to relative deprivation. In South Africa, in contrast, there has been little serious use of relative lines except in the *Key indicators of poverty in South Africa* report (Ministry in the Office of the President: Reconstruction and Development Programme, 1995), which in any case suggested that those lines be used in an absolute sense.

[8] Discussion of whether poverty is better conceptualised as an absolute or relative phenomenon has dominated much of the debate on poverty measurement. This section, again, presents only a brief overview. For a fuller discussion of absolute and relative lines, see Deaton (1997) and Ravallion (2012).

There are good theoretical arguments for considering relative poverty. It makes little sense to define absolute poverty as the minimum needed to physically subsist when very many people do in fact live below whatever practical absolute line is used (Deaton, 1997). If ideas of what constitutes poverty are not purely survivalist, this lends support to the idea that they are socially determined. That this social determination should change as societies grow richer or poorer is intuitively appealing (Sen, 1983). There is a body of work (Atkinson and Bourguignon, 2001; Ravallion and Chen, 2011) which shows that across developing countries, national absolute poverty lines vary positively with national income, supporting the contention that ideas of poverty are somewhat context-dependent. Absolute poverty lines are nevertheless useful, but for specific purposes. A significant issue with most existing relative poverty lines is that distribution-neutral economic growth does not reduce poverty (Ravallion and Chen, 2011). This occurs when the elasticity of the national poverty line to national mean income is equal to 1, and is generally agreed to be undesirable at least in the developing country context (Deaton, 1997). There are interesting new relative poverty lines with less than unitary and changing elasticity (Ravallion and Chen, 2011), but the appropriateness of this literature to the South African context must still be ascertained.[9]

It may also be the case that policymakers or researchers are interested specifically in how people's material welfare has changed, which is certainly a valid question and one which would necessitate absolute lines. There is then also the purely practical question of what kinds of poverty lines enjoy the most widespread use in South Africa. Absolute lines certainly predominate, and if absolute lines are going to be used it makes sense to have as accurate and internally consistent a measure as possible.

3.2.2 Subjective poverty lines

What absolute and relative poverty lines have in common is that both are set by "experts", who determine by themselves the consumption required to be non-poor. This approach has been criticised, especially in South Africa. Organisations such as the Studies in Poverty and Inequality Institute (SPII) argue against poverty line determinations which are "given the appearance of technical neutrality, [but] which mask the political and ideological assumptions which are made" (SPII, 2007: 7). They insist on the importance of widespread consultation and transparent discussion amongst the various stakeholders who would be affected by the line, which includes the poor. This is related to a larger theoretical position, often called the "subjective" approach, which argues that people best placed to evaluate what defines poverty are poorer people themselves. It argues against the supposed expertise of academic researchers, and often doubts their perceived objectivity. Even in the absence of these claims, though, measures which are based on lay-people's perceptions of poverty may be valuable. If poverty is indeed understood to be socially determined, it makes sense to try to get some idea of how regular people define poverty.

In South Africa, promising work has been done in this vein by the Centre for the Analysis of South African Social Policy (CASASP) at the University of Oxford. Applying methodology pioneered in Britain, they attempt to define "socially perceived necessities", by which it is meant those necessities which people consider to be essential for an acceptable standard of living (Wright, 2008). The methodology involves people in a number of focus groups identifying what possessions, services and activities they judge to be a necessity for socially acceptable living, the incorporation of these potential "necessities" into the 2005 South African Social Attitudes Survey (SASAS) for analysis of national representivity, and finally their use in the 2006 SASAS which also measures whether people lack the necessities (Wright, 2008). Importantly, CASASP found that identification of necessities was significantly consistent across different classes and racial groups, amongst other demographic characteristics. They then use this approach to calculate poverty, which is the lack of some combination of the socially perceived necessities.

[9] See Budlender, Leibbrandt and Woolard (Forthcoming).

This approach is certainly useful and interesting, and it is plausible that this is a better measure of who achieves a socially acceptable standard of living than the already-existing poverty lines in South Africa. The main disadvantages of this approach as it currently stands are the difficulties associated with deriving a money-metric measure from it, and interpreting it for policy purposes. SPII is currently working on quantifying in money terms the socially acceptable standard of living (Frye, 2014). However this is a more complex task than simply costing a basket of items, as some of the identified necessities are non-market activities (such as having someone to care for you when ill), or are public goods (such as street lighting) (Wright, 2008). These are both difficult to monetise on a per capita basis. Non-market activities, such as having someone to care for you, exacerbate the difficulties associated with using the measure for policy purposes, as government's capacity to provide or induce these activities is presumably limited. Again, while this measure is undoubtedly valuable, it does not entirely negate the usefulness of a money-metric absolute line. Rather, these types of measures complement each other.

The conclusion to draw from this sub-section is not that absolute poverty lines should be preferred to relative or subjective poverty lines, but rather that they are useful measures which should be used alongside others. Indeed, all poverty lines are somewhat problematic. The idea that someone can be in poverty while earning R999 a month, while not in poverty when earning R1000 a month, to use an example from Woolard and Leibbrandt (2006), is certainly disconcerting. It suggests a discontinuity in people's welfare functions of which no evidence has been found. Equivalent discontinuities are implied in the socially perceived necessities literature when calculating poverty rates (Wright, 2008).[10] This clearly does not mean that poverty measurement should be abandoned, but rather that results need to be interpreted carefully. Having multiple credible measures of the different components of deprivation is probably useful in this regard.

3.3 Ravallion's Cost of Basic Needs method

As mentioned earlier, the Cost of Basic Needs (CoBN) method has dominated recent attempts to calculate South African poverty lines (Hoogeveen and Özler, 2006; Oosthuizen, 2008; Statistics South Africa, 2008; 2015). This methodology was first suggested formally by Ravallion (1994). The key advantage of the CoBN is that it is non-normative (or semi-normative) in its prescription of the goods needed to be non-poor. This is appealing practice globally, but is particularly appealing in South Africa given the country's history of normative prescriptions (such as the MLL and HSL), which were explicitly racialised and often arbitrary (Budlender, 1985; Magasela, 2006). The only explicitly normative prescription inherent in the CoBN method is of a daily caloric requirement (Rio Group, 2006). While the scientific rigour of this prescription can be overstated, as Section 4.3 shows, the arbitrariness related to choosing a caloric benchmark is far less than that associated with other methods of setting absolute lines. It seems that some normative prescription is unavoidable when setting absolute poverty lines, and the CoBN at least limits this to one component.

The CoBN measure is made up of three poverty lines: the food poverty line, lower-bound poverty line, and upper-bound poverty line. The food poverty line is calculated by determining the daily cost of a basket of foods which would satisfy the minimum recommended caloric requirement. However there are many ways in which different foods could be combined to achieve a certain amount of

[10] There are methods of measuring subjective poverty which do not impose these discontinuities, as evident in Posel and Rogan (2014). However this requires surveys which ask interviewees directly about their perception of their poverty status. Posel and Rogan in any case also note that the consensus view is not that subjective measures should displace absolute or relative lines (or the other way round), but rather that these measures should be combined to "provide a more composite measure of poverty" (Posel and Roga, 2014: 3).

calories, and it is unclear on which basis a normative prescription should be made.[11] The CoBN methodology suggests that researchers make these normative prescriptions by seeking to construct a food-basket which is representative of the existing food consumption habits of the poor. This requires an *ex-ante* identification of the poor ("the reference group"), which is unfortunate but unavoidable.[12] In South Africa, for example, Stats SA has tended to use deciles 2-4 of the national expenditure distribution for this purpose (Statistics South Africa 2008; 2015).

Once the reference group has been chosen, the average caloric intake of the reference group is calculated. The reference group's food expenditure associated with the caloric intake is then linearly adjusted, maintaining food item-shares, until the caloric threshold is met (Özler, 2007). This adjusted basket is then costed, and constitutes the food poverty line. Alternatively, this process can be thought of as calculating the prevailing cost-per-calorie of the reference group, and then multiplying this by the caloric requirement (Rio Group, 2006). The food poverty line can be thought of as the threshold below which people cannot afford sufficient food, even if they spend all of their income on food.[13]

While there are a number of contestable methodological decisions that must be made in constructing the food poverty line, the theory is relatively uncontroversial. The same cannot be said for the non-food component of the poverty line, where there is nothing comparable to caloric needs which can be used for anchoring. Ravallion's (1994) suggestion is to use the food poverty line for this purpose. The lower bound is determined by calculating the non-food expenditure of households which have *total* expenditure similar to the food poverty line, and adding this to the food line. The upper bound is determined by calculating the non-food expenditure of households which have *food* expenditure similar to the food poverty line, and adding this to the food line. The upper and lower bounds are perhaps more clearly explained by means of an example. The 2008 Stats SA CoBN calculation found that the food poverty line in 2000 was R148 per person per month (Statistics South Africa, 2008). The upper bound was then calculated by determining the non-food expenditure of households whose food expenditures were similar to R148 per person per month.[14] This was found to be equal to R175. Adding these amounts, the upper bound was R323 per person per month. For the lower bound, the non-food expenditure was calculated for households whose total expenditure was similar to R148 per person per month. This non-food expenditure was equal to R71. Adding the food poverty line and this non-food expenditure, the lower-bound poverty line was R219 per person per month.

3.3.1 Theorising the upper bound

The upper-bound method is intuitively appealing. However, it is not particularly well theorised. Ravallion (1998) justifies the upper bound by theorising that people have "survival food needs", without which they will die, and then "basic non-food needs" and "basic food needs" which are

[11] An existing approach is to cost the basket by determining the cheapest combination of foods which will allow for achievement of the nutritional requirement, but this approach has fallen out of favour. At issue is that this kind of prescription is almost certainly unrealistic, and in that case the cost of the basket of foods would not represent the typical cost associated with attainment of sufficient calories. It is doubtful whether poor consumers have sufficient information to construct the cheapest possible basket, and people have preferences other than calorie consumption which will affect their choices.

[12] Ravallion calls this choice a "first guess" at the region in which the poverty line will be found (1994). There are ways to mitigate the arbitrariness inherent in this selection, which are discussed in Section 4.7

[13] A caveat that must be made when asserting that the line represents "sufficient" food is that only caloric intake is used to determine this. Concerns raised about other nutritional requirements are valid. However if the food basket is constructed to contain all of these components of nutrition, it would likely lose its representivity of the food habits of the poor and become overly prescriptive, confounding its greatest strength. It seems that simplifying to one indicator is a necessary evil in this case.

[14] Section 4.8 will discuss what constitutes "similar" to the food poverty line.

needed to function effectively in society. As income increases, a person will firstly satisfy her survival food needs, then her basic non-food needs, and finally her basic food needs. This is based on the observation that poor people seem to substitute food consumption for essential non-food consumption even when below the minimum caloric threshold. Ravallion argues that some non-food needs, such as clothing and housing, will "take precedence over even quite basic food requirements beyond survival needs" (Ravallion, 1998: 18). From this, Ravallion argues that we know a person will have satisfied all of the basic needs outlined above when her food expenditure is equal to the food poverty line, this last bit of food expenditure being a poor person's last priority. This theory of needs'-fulfilment is certainly contestable, but the idea that a person who consumes sufficient food probably consumes sufficient non-food items is intuitively acceptable to many people. It may also be acceptable to justify the upper-bound line as simply being the level where people tend to have enough money to satisfy their caloric requirements, without making a comment on the sufficiency of their non-food expenditure. The same cannot be said for the intuitive appeal of the lower bound, however.

3.3.2 Theorising the lower bound

To justify the lower-bound method, Ravallion argues:

> At total expenditure below the food poverty line, one can assume that neither basic food nor basic non-food needs will be met. Consider a person for whom total expenditure is just enough to reach the food poverty line… Anything that this person spends on non-food goods can be considered a minimum allowance for 'basic non-food needs', since the person gave up the basic food needs. (Ravallion, 1998: 18)

This is an argument for calculating these non-food goods, calling them a "minimum allowance" of necessary non-food expenditure, and then adding them to the food poverty line to create a lower bound for poverty. However this argument is not persuasive. There is little reason to view this non-food expenditure (of households whose total expenditure is at the food line) as a minimum allowance. People with total expenditure below the food-line also spend some amount on non-food consumption, which tends to decrease as their incomes decrease. This belies Ravallion's assertion that we can calculate some lower bound which incorporates only the essential non-foods by his approach. This objection is partially addressed in Ravallion (1994), where he writes:

> There will undoubtedly be some displacement of basic food spending over a wide range of consumption levels. Even those households whose total consumption expenditure is below that required to meet their nutritional requirements with the traditional diet will almost certainly spend something on non-food goods. The better measure of basic non-food spending is to look at how much is spent on non-food goods by households who are *capable* [original emphasis] of reaching their nutritional requirements, but choose not to do so. (Ravallion, 1994: 120)

However it is not at all clear why we should care about the non-food spending of the rather arbitrary group of households whose total expenditure happens to equal the food poverty line. Just because these households could, in the abstract, have sufficient food if they spent nothing on non-food items, does not seem significant enough reason to call their non-food spending a plausible minimum, given that they face very similar circumstances to those whose total expenditure is somewhat below the food poverty line. It is not as if a household which has total expenditure at the food line makes substantially different decisions about the food and non-food trade off, compared to a similar but poorer household. Both households do not have money for sufficient food and non-food consumption, and must sacrifice some of their food for non-food. The same is true for a

household above the food poverty line but below the upper bound, as this household will also sacrifice some of its food expenditure for non-food goods (hence it being below the upper bound).

The lower bound is also not rescued by an appeal to intuition, as in light of the above it is unclear what exactly the threshold represents. Households with total expenditure below the lower bound do not have sufficient money to avoid sacrificing food, households with total expenditure on the lower bound do not have sufficient money to avoid sacrificing food, and households with total expenditure above the lower bound, but below the upper bound, do not have sufficient money to avoid sacrificing food. There is little reason to view the non-food expenditure associated with this line as somehow significant, as people will sacrifice their basic food for non-food continuously and to varying extents until the upper bound is reached and basic food expenditure tends to be realised.

This confusion has become evident in South African interpretations of this line. The lower bound has been described by Stats SA to policymakers as the point "below which one has to choose between food and important non-food items" (Statistics South Africa, 2014a). While this could be argued to be correct, depending on what is meant by "important non-food items", it likely misinterprets the meaning of the lower bound. Households both below and above the lower bound will sacrifice basic food for basic non-food items, so long as they are below the upper bound. It is only at the upper bound, where households' food expenditure is equivalent to the food line that households do not need to sacrifice basic food consumption for basic non-food consumption.[15] While this paper will calculate and report our lower-bound estimates for the sake of completeness, it does not seem like a coherent poverty line, and we argue that its future use should be limited if used at all. The implications of this are discussed further in Section 6, where we conclude.

3.3.3 Concluding on the Cost of Basic Needs measure

Despite the issues raised above, it seems that the Cost of Basic Needs method is the best absolute poverty line methodology available. A particular strength is that unlike other semi-normative calorie-based food lines, the CoBN method does not rely on calculating when people actually achieve the caloric requirement. Rather, the set of lines are based upon the cost at which people can afford the required calories, even though they may have to re-arrange their expenditures to achieve this practically (Ravallion, 1998). This avoids serious pitfalls associated with measures based on actual caloric achievement, such as the previously dominant Food-Energy Intake (FEI) method. Deaton (1997) and particularly Ravallion (1998) argue convincingly that the FEI method can lead to adverse results, as changing relative prices, tastes, and activity levels confound sensible poverty comparisons across regions.[16] There are few credible alternatives for an absolute, non-normative poverty line to the CoBN method. While it can be criticised, it seems to be the best method currently available, and we proceed with its use.

[15] It should be noted that Stats SA does not misinterpret the lower bound in either of their detailed reports on the Cost of Basic Needs line, and indeed describe it very carefully in other publications (Statistics South Africa, 2014b). It should perhaps be seen more as an issue of the lower bound's lack of intuitive meaning than being a fault on Stats SA's part that it is misinterpreted in efforts to explain the CoBN lines to policymakers.

[16] See Ravallion and Bidani (1994) for an empirical demonstration of these issues when measuring poverty in urban and rural Indonesia. As an interesting aside, it seems that this paper is the first instance where Ravallion develops a version of the Cost of Basic Needs poverty line, which he uses to show the inconsistencies of the FEI method.

4. Applying the CoBN method to South Africa

The application of the CoBN methodology to actually create poverty lines for South Africa is a somewhat protracted process. Throughout this process, potentially important methodological decisions must be made. While some decisions are straightforward, others are debatable. Without discussion of these methodological points, there is little reason to prefer one poverty line over another. The key decisions which must be made are discussed below, to facilitate understanding and critique. This is especially important because, as acknowledged earlier, the set of lines proposed here is by no means a perfect measure of absolute poverty, if that is even possible. Rather it is an attempt to create the best measure possible, given the constraints of existing data and methodology. In this context it is particularly important for users of the line to understand the methodological decisions and potential shortcomings inherent in the line.

4.1 Dataset

The dataset used for the construction of our set of lines is the 2010/2011 Income and Expenditure Survey (IES), conducted by Stats SA. The IES is one of the largest South African surveys, and is conducted approximately every 5 years. It contains detailed information on households' expenditures on individual items. The Stats SA 2015 rebasing (Statistics South Africa, 2015) also used this dataset, while the original Hoogeveen and Özler (2006) and Stats SA 2008 (Statistics South Africa, 2008) lines used the 2000 IES, also produced by Stats SA. The comparability of the different IES datasets has been questioned, and this should be taken into account when comparing Cost of Basic Needs estimates. For this paper our results are compared mostly to the Stats SA 2015 rebasing, given that we use the same data. A last point about the dataset used is that it is preferable to use the most recent data possible. As pointed out by Stats SA (2015), the applicability of Cost of Basic Needs estimates will likely decrease over time as expenditure habits and relative prices change, and in order to have a line which accurately represents people's expenditure decisions the line should be revised as new data emerge. Unless the context makes clear otherwise, monetary values are in March 2011 Rands, as per the 2010/2011 IES data. Appendix 1 details how these values should be updated over time.

4.2 Construction of the consumption aggregate

The building-block of any consumption-based measure is the consumption aggregate. This is the combination of goods and services which together constitute the overall consumption measure.[17] Choosing what should be included in the consumption aggregate is not a straightforward process, and decisions regarding specific items must sometimes be made on an unfortunately ad-hoc basis. Overall guiding principles help mitigate this arbitrariness. Deaton and Zaidi (2002) present a very helpful discussion of what kinds of items should be included or excluded from consumption aggregates, with reference to both theoretical and practical considerations. This paper was a useful guide for our purposes, with one caveat. While Deaton and Zaidi discuss the construction of a consumption aggregate for the purposes of welfare measurement, in determining an expenditure-based poverty line for South Africa our task is slightly different. We therefore depart from Deaton and Zaidi in a few circumstances.

A useful way of illustrating this point is with reference to the choices made in other estimates of the CoBN lines in South Africa, and in particular what they choose to exclude. It is standard to exclude

[17] In the case of the IES data, which record expenditures, this could perhaps more accurately be called an expenditure aggregate. However we persist with the generally accepted terminology of consumption aggregate.

so-called "lumpy" purchases from consumption aggregate, which are infrequent and expensive and whose inclusion would otherwise distort expenditure patterns (see Section 4.2.3). All of the existing reports exclude these items to some extent. Hoogeveen and Özler (2006) exclude the cost of purchased vehicles, household durables, audio-visual equipment, and religious or traditional ceremonies including funerals on this basis. They also exclude health costs on the grounds that they are "lumpy", though Özler (2007) notes that Deaton and Zaidi (2002) contemplate the exclusion of health expenditures on theoretical grounds in any case.[18] With respect to the exclusion of "lumpy" and health expenditures, the 2008 Stats SA report (Statistics South Africa, 2008) seems to directly follow Hoogeveen and Özler, with the exception that medical aid contributions are included. It is unclear whether the earlier reports do the same (they very well might), but it is notable that the 2015 Stats SA report (Statistics South Africa, 2015) excludes a significant number of recreational items, presumably on the basis that they are "lumpy". In definite contrast to the earlier reports, however, the 2015 report includes all health expenditures.

A potentially significant issue which is not much discussed in the earlier reports is the treatment of so-called "In-kind consumption". This can be broken down into two categories: consumption of home-produced goods, and consumption subsidised or provided for by the state. Hoogeveen and Özler (2006) exclude consumption of own-production of food, citing data unreliability, and this approach is followed in the 2008 and 2015 Stats SA reports (Statistics South Africa, 2008; 2015). The treatment of subsidised consumption is not as clear, however. The2015 Stats SA report excludes subsidised consumption, but there is no indication of the approach taken in this regard by Hoogeveen and Özler or in the 2008 Stats SA report.

Some miscellaneous items are also excluded from the various consumption aggregates. Hoogeveen and Özler (2006) exclude expenditures on water and some types of fuel, citing data unreliability in the 2000 IES (Özler, 2007), and also exclude gambling expenditure without explanation. The 2008 Stats SA report (Statistics South Africa, 2008) again follows much the same approach as Hoogeveen and Özler, except cigarettes and alcohol are excluded, and water and firewood expenses are added. The Stats SA 2015 rebasing (Statistics South Africa, 2015) follows similar lines to the 2008 Stats SA report with respect to these items, except that accommodation services are excluded as well as various fees and levies.

In light of the above, the potentially contentious decisions made in the construction of our consumption aggregate are to include health expenditures, other "regrettable necessities" such as licensing costs, accommodation services, cigarettes and alcohol, and consumption from own-production. Our debatable exclusions are of subsidised consumption. We exclude durable household goods and recreational items if they are excessively lumpy, but make these decisions on an item-by-item basis.

4.2.1 Health, cigarettes and alcohol, accommodation services, and own-production

Health and other "regrettable necessities" were included, after considering the Deaton and Zaidi (2002) discussion on the topic. Whether they add to welfare or not, these are expenditures that people must make to function in our society. While there may be an argument to exclude these items when trying to measure welfare, if the aim is to determine the minimum non-food expenditure at which people satisfy their food needs, then these kinds of necessary costs, which will induce sacrifice of food expenditure, must be included. Cigarettes and alcohol and accommodation services were included because there seems to be little if any reason for them to be excluded – they are part of normal expenditure. The expenditure value of home-production is included, despite concerns around its measurement, as whether people use monetary resources or productive resources to facilitate consumption, the trade-off between food and non-food goods is still pertinent

[18] Deaton and Zaidi (2002: 32) argue that many health expenditures do not add to welfare as they are "regrettable necessities", which if possible should be excluded.

to the question of the value of non-food expenditure when food expenditure equals the food poverty line.[19]

4.2.2 Subsidised consumption

Subsidised and free consumption is excluded for two reasons. Firstly, there are serious questions regarding the accuracy of the expenditure values, given the significant and well-documented difficulties associated with valuing state-supplied and public goods (Ravallion, 1994). In light of this, the conventional approach has been to ignore these goods (Woolard and Leibbrandt, 2006). The theoretical case for inclusion or exclusion is more complicated. That these goods are provided for free can motivate an argument for their exclusion.[20] Ravallion's underlying logic of the upper-bound poverty line is that people will first satisfy their "survival" food needs, then their "basic" non-food needs, and then their "basic" food needs. However with the non-food goods under consideration being provided for free (or at artificially low prices), some people will already be consuming them even if they do not achieve or only just achieve their "survival" food needs. The presence of free non-food expenditures may inflate the non-food component of the upper bound, and will likely be especially problematic for the lower bound in this regard. An argument can also be made for their inclusion, however. If the upper bound is primarily about determining the level of total expenditure at which people spend sufficiently on food, then free goods should be taken into account. If excluded, the provision of free goods will serve to artificially lower the non-food component of the upper bound, as people buy fewer non-food goods not because they are not needed, but because they are being accounted for somewhere outside the calculation (free services).

In light of the measurement difficulties and theoretical ambiguity, subsidised and free consumption is excluded. Its exclusion makes little difference to our poverty line estimates, however, as Table A2 in Appendix 2 shows.

4.2.3 "Lumpy" items: durable household and recreational goods

Recreational items were excluded if judged to be durable and excessively "lumpy", as were most household durable goods for the same reason. It is well established in the literature that durable goods which are bought infrequently pose a problem when constructing consumption aggregates (Haughton and Khandker, 2009). It is a basic assumption that the welfare associated with goods does not come from their purchase, but with their use (Deaton and Zaidi, 2002). This is not a problem for non-durable goods, as they are generally consumed shortly after their purchase. But people keep durables goods for a long time, and their use, and therefore their contribution to well-being, is spread over this long period. Surveys which ask people to record their expenditures of the last month, or even year, tend not to result in useful measures of the well-being associated with durable goods.[21] If durable goods purchases are included as reported in the survey data, a household which happened to buy durable goods during the recall period has artificially high consumption, while a household which bought these goods before the recall period has artificially low consumption. This is despite the two households potentially using the same items, though the second household's items may be a bit older. Though unfortunate, it is accepted practice in South Africa, and in other cases where there are no viable alternatives, for durable goods to be excluded

[19] It must be noted that the measurement error in home production may be significant, as interviewees are asked to report the monetary value of what the household consumes, rather than the quantity. Pricing home production is difficult even for economists with access to detailed price data (Deaton, 1997), and there will likely be high variance here. Nonetheless, as shown in Table A2 in Appendix 2, the inclusion or exclusion of home production items makes little difference to the resultant measure.

[20] We use the more extreme example of free rather than partly subsidised goods for the purposes of example, though the points made still apply in the case of partly subsidised expenditures.

[21] The IES 2011 recall periods range from 2 weeks to 1 year, depending on the item (Statistics South Africa, 2012a)

from the consumption aggregate in order to resolve this issue (Woolard and Leibbrandt, 2006).[22] The exception to this rule is owner-occupied housing, where invariably some effort is made to ascertain the welfare associated with housing. This is usually done by including an imputed rent item in the consumption aggregate. All of the previous incarnations of the CoBN in South Africa include an imputed housing variable but exclude other lumpy durable goods, and we follow this precedent.

The approach used by the 2015 Stats SA rebasing (Statistics South Africa, 2015), and likely the other CoBN estimates, is to exclude durable items by expenditure category.[23] While this allows for easy determination of inclusion and exclusion rules, it creates some issues. For example, while items such as lounge furniture are correctly excluded, items such as light bulbs and dry cells are (probably incorrectly) also excluded. Our preference is to go item-by-item when determining exclusion of durable goods. Our item-by-item exclusion decisions were based firstly on the infrequency of an item's purchase, and secondly on its cost. An expensive item which is bought very infrequently is the most problematic, while inexpensive items bought more frequently cause few distortions. There is clearly scope for contestation on the decisions made for some items, and as such our full consumption aggregate is available.[24]

4.3 Selection of a minimum daily caloric requirement

One of the most vociferously debated issues of the 2015 Stats SA rebasing (Statistics South Africa, 2015) was the caloric requirement used to determine the food poverty line (Forslund, 2015). While the 2015 Stats SA report set the caloric benchmark at 2100 kilocalories (kcal) per person per day, the previous Hoogeveen and Özler paper and 2008 Stats SA report set it at 2261 kcal per day (Özler, 2007; Statistics South Africa, 2008). As Deaton (1997) notes, caloric requirements tend not to be as scientific as they appear when it comes to their application for poverty lines. This is certainly true here, as there are few reasons to prefer one caloric allowance over another.

The 2261 kcal benchmark used by Hoogeveen and Özler and the 2008 Stats SA report comes from the 1989 *Recommended Dietary Allowances* published by the United States Food and Nutrition Board (1989). This publication sets out recommended energy intake in kilocalories differentiated by age and sex. The caloric recommendations are reproduced in Table 2. For adults, the values in Table 2 are appropriate for people engaged in "light to moderate activity" (Food and Nutrition Board [FNB], 1989: 33). For children, the caloric recommendation is based upon the requirements needed for normal growth. In all cases, the height and weight assumptions, which affect caloric requirements, are based on the median heights and weights of the US population prior to 1989. Hoogeveen and Özler (2006) applied the recommendations in Table 2 to the South African demographic profile as per the 2000 IES, and calculated a total national caloric requirement per day (Özler, 2007). Dividing by the population, they calculated their aggregate figure of 2261 kcal per

[22] The best way to resolve this issue is to rather record the depreciation in value of a household's durable goods over the survey period, as this is a reasonable measure of its use (Deaton and Zaidi, 2002). Though most surveys (including the IES) do not record this directly, it can be calculated with the requisite information. Unfortunately, this is not possible with the South African data.

[23] The 2011 IES expenditures are organised by the Classification of Individual Consumption by Purpose (COICOP) reference classification, published by the United Nations Statistics Division (2000). Each item is assigned an 8 digit code, which can be broken down into at least 3 categories. As an example, Paraffin has the code 04531101. It can be broken down into its main category of "Housing; water; electricity; gas and other fuels", which has code 04. The secondary category is "Electricity; gas and other fuels", which has code 045. The third category is "Liquid fuels", which has code 0453. The remaining 4 digits represent increasing specificity.

[24] The consumption aggregate is not reproduced here due its size. However it is available from the authors upon request.

person per day. The 2008 Stats SA report uses the same figure (Statistics South Africa, 2008). Performing the same process, but applying the demographic profile as per the 2011 IES, we calculate a per capita per day requirement of 2257 kcal per day, which is similar to the estimate based on 2000 data.

Table 2: Food and Nutrition Board caloric prescriptions

Age	Average energy allowance (kcal)	
	Male	Female
0.0-0.5	650	650
0.5-1.0	850	850
1-3	1300	1300
4-6	1800	1800
7-10	2000	2000
11-14	2500	2200
15-18	3000	2200
19-24	2900	2200
25-50	2900	2200
51+	2300	1900

Source: Food and Nutrition Board (1989: 33). Caloric allowance are in kilocalories and are daily.

The 2100 kcal benchmark used in the 2015 Stats SA rebasing originates in a 2000 document titled *Management of Nutrition in Major Emergencies*, published by the World Health Organisation (World Health Organisation [WHO], 2000). Similarly to the Food and Nutrition Board (FNB) report, energy requirements are set out differentiated by age and sex. Unlike the US report, the World Health Organisation (WHO) then applies these recommendations to the demographic and anthropometric profile of the "typical developing country" (WHO, 2000: 142). This results in a daily caloric requirement of 2080 kcal per person per day, which is rounded up to the familiar 2100 kcal per person per day. The values presented in Table 3 are based on people engaged in "light activity", and assume an adult male weight of 60 kg and adult female weight of 52 kg.[25] If we use the age- and gender-specific recommendations of Table 3 and apply them to South Africa (rather than the "typical developing country"), the caloric recommendation is 2078 kcal per person per day. This is remarkably similar to the WHO figure of 2080 kcal.[26]

[25] Note that these are apparently determined according to the anthropometric profile of the typical developing country. The WHO report (2000) also publishes a table for "industrialised" countries. It is still based on "light activity" levels, but adult male weight is set at 67 kg and adult female at 55kg. The industrialised country table results in an average caloric requirement of 2180 kcal per person per day. This is closer to the FNB estimate, which is unsurprising given that the United States of America is an industrialised country, and it forms the basis of the FNB estimates.

[26] The FNB (1989) and WHO (2000) prescriptions make additional caloric allowances for pregnant and lactating women. While the IES data cannot be used to determine the proportion of South African women who are pregnant or lactating, if we assume a similar proportion as the WHO for a "typical developing country" (which seems to match South Africa quite well), we would allocate an additional 19.84 kcal per capita. This would

Table 3: World Health Organisation caloric prescriptions

Age	Energy requirements (kcal)	
	Male	Female
0	850	780
1	1250	1190
2	1430	1330
3	1560	1440
4	1690	1540
5-9	1980	1730
10-14	2370	2040
15-19	2700	2120
20-59	2460	1990
60+	2010	1780

Source: World Health Organisation (2000: 142). Caloric allowance are in kilocalories and are daily.

In choosing which of these figures to use, it is important firstly to recognise that neither of the measures is formulated to be used as a *minimum* caloric allowance. The FNB (1989) estimates are for "Recommended Energy Intake" while the WHO (2000) figures are for "Energy requirements", but there is not a clear difference in their methodology which would explain these different descriptions. It seems there is some uncertainty as to how a true measure of minimum required energy would be calculated in any case (Allen, 2013), and we have no choice but to continue with these measures. Secondly, and probably more importantly, we see little reason to prefer one measure over the other for our purposes. The WHO figure is based on developing country anthropometrics, which are probably more appropriate for South Africa than the FNB assumptions of pre-1989 United States population characteristics. Contrastingly, the assumption of "light activity" by the WHO is likely more inappropriate for South Africa than the "light to moderate" activity assumed in the FNB report. Nonetheless, a decision must be made when applying the Cost of Basic Needs method, and we choose to use the 2100 kcal prescription. The main reasons for this choice are that the 2100 kcal allowance is already well-established in international literature on the topic (Ravallion and Bidani, 1994; Haughton and Khandker, 2009; Allen, 2013), allowing some cross-country comparison, and also because it is derived from a more recent report. The effect of this decision is shown in Table A2 in Appendix 2.

4.4 Constructing a food basket

Once the caloric allowance has been determined, the next step is to determine the cost of these calories. As already explained, the CoBN approach is to determine how much 2100 kilocalories would cost while respecting poor people's food expenditure habits. A natural question then, is how poor people's expenditure patterns are measured. At its most basic, this is about using survey data to find the proportion of poor people's food expenditure spent on each food. Leaving the definition

bring our estimate using the WHO technique very close to 2100 kcal per person per day. It would likely affect our FNB estimates similarly, increasing that allowance by about 20 kcal per capita, but we do not adjust our FNB estimate for this. The FNB allowance apportions calories per trimester, which we cannot estimate.

of “poor people” to Section 4.7, the first question is what foods will be examined and used to construct a basket of foods supplying 2100 kilocalories. The original Hoogeveen and Özler (2006) approach seems to have been to include all foods included in the 2000 IES, and then follow the procedure outlined in Section 3.3 (Özler, 2007). However the Stats SA approach has been to create what they call the “reference food basket”, which only includes foods with some minimum level of representivity amongst national and poor households (Statistics South Africa, 2008; 2015).[27] When calculating the caloric intake of the poor, only calories consumed from the food basket items are considered. This is then scaled up to give the cost of 2100 kcal of basket foods as per Section 3.3.

The Stats SA approach of determining a food basket rather than using all food expenditures is justified on two grounds. Firstly, quoting the Rio Group *Compendium of best practices in poverty measurement*, it is argued that including all food items “would result in an enormous variance in the basket structure” (Statistics South Africa, 2008: 18; Rio Group, 2006: 56). Secondly, they find that no household reported consumption of all the IES food items, and therefore selection of a basket which is “common to all households” was deemed a better indicator of “typical consumption patterns” (Statistics South Africa, 2008: 18). We did not consider these arguments to be persuasive enough to justify the basket approach. With respect to the first argument, it is not at all clear why variance in the basket structure is a significant issue, especially when the alternative approach is to omit expenditure from the calculation. The Rio Group (2006) quotation which is cited above is not about variance due to using all food expenditures recorded in the survey, but is about determining food expenditure patterns from the entire income distribution rather than a “reference group” of poor households. With respect to the second argument, even when using the reference food basket it is not the case that the basket items are common to all households. The requirement for item inclusion was that at least 10% of households nationally buy each item, in addition to certain food item-share requirements.[28] Again, it is unclear why this kind of representivity would be important in any case. As Stats SA points out, the purpose of the food basket is not for it to be used as some kind of dietary guide (Statistics South Africa, 2008). Rather, the main aim of this part of the CoBN process is to accurately determine the prevailing cost-per-calorie of the poor, whilst respecting their consumption habits. Excluding some parts of the poor’s expenditure is surely counter-productive in this regard.

There are also more tangible problems associated with the food basket approach. According to this approach, food items must first satisfy criteria of national representivity before they can be examined for representivity amongst the reference group of the poor. This means that some items which are consumed significantly by the poor, such as samp, are not included in the reference basket because they do not have a large enough national consumption profile. This is a clear problem with the approach, as the consumption habits and cost-per-calorie faced by poor people are not accurately captured. Indeed it is unclear why criteria of national representivity are applied at all when trying to determine the consumption habits of the poor.

A second issue with the basket approach is that the requirements of food-item share and common consumption of goods by households makes the method overly sensitive to how food items are classified. For example, while eggs were all classified as one item in the 2000 IES, in the 2011 IES eggs were split up into medium eggs, large eggs, extra-large eggs and jumbo eggs. In the 2008

[27] The methodology of deriving the reference food basket was the same in 2008 as 2015, except for some changes in the percentage thresholds and the number of qualifying foods. The following is a description of the 2015 process. Inclusion in the food basket is determined in two stages. At the first stage, a food must make up at least 0.5% of total food expenditure and at least 10% of households must report expenditure on the food, nationally. At the second stage, item food-expenditure shares are calculated for the stage 1 foods and these foods are only kept if they make up at least 0.5% of total food expenditure by the “reference group” of poor households.

[28] See the preceding footnote.

basket, eggs were included as an expenditure item (Statistics South Africa, 2008). In the 2015 basket, only large eggs had sufficient expenditure share to be included, and therefore only consumption on these types of eggs is considered in the calculation of the poor's cost-per-calorie (Statistics South Africa, 2015). This is despite the fact that all of the differently sized eggs are fundamentally the same item. This causes the 2015 basket to underestimate the calories received by the poor from eggs, thus distorting their consumption habits. This will be true for a variety of items, such as tea. In the 2008 basket, "Ceylon tea" and "Rooibos and herbal teas" were included in the basket (Statistics South Africa, 2008). In the 2011 IES, expenditures on tea were further disaggregated by whether the tea was bought in the form of tea leaves, tagged teabags, or tag-less teabags.[29] Likely as a result of this, no category of tea had sufficient expenditure-share to be included in the 2015 basket (Statistics South Africa, 2015), thus distorting the prevailing cost-per-calorie.

This underlines a separate but more fundamental issue with the food basket approach. By excluding items on which the poor spend, but which do not qualify for the basket, the basket approach leads to a worse representation of the consumption habits of the poor than the alternative of using all foods. The Rio Group (2006) outlines one possible justification for the food basket approach, though the criticisms made here still apply. If there is a desire to cost the food poverty line such that it will accomplish nutrition beyond simply calories, a modified version of the basket approach can be used to ensure that the food basket contains foods from all of the important food groups. However this is not the approach taken by Stats SA, as they do not make any methodological decision which would necessitate the representation of different food groups. As it stands, the food basket does contain a diverse grouping of foods, but this is a characteristic of underlying consumption habits rather than methodology. As argued above, these underlying habits would be better captured by analysis which looked at all food expenditure. In any case, the food basket approach described by the Rio Group necessitates a trade-off between developing a threshold which accurately represents poor people's actual consumption, and one which represents the cost of a healthier, normatively determined bundle but which may be unrealistic. Given that the great strength of the Cost of Basic Needs approach is the minimal amount of normative prescription required, at this stage we prefer the approach of using all foods and do not explore the alternative Rio Group methodology.

The main issue associated with using all foods is that it requires much more work, and much more data, than the food basket approach. Converting the IES expenditures into calories requires price data and nutritional data for every food item. The process of calculation and imputation is described in Section 4.5 and Appendix 3, but it is sufficient to say here that the only issue we face regarding this is insufficient price data for some items. Of the 331 food items in the IES, we have sufficient price data for 226 items, and no price data for 105 items.

Fortunately, it is in the nature of our price data, which come from the Consumer Price Index determination (see Appendix 3), that we tend to have price information for the most widely-purchased items. Table 4 shows, by expenditure decile, the percentage of total food expenditure which is covered by foods we have data for. This is compared to the proportion of food expenditure covered by the 2015 Stats SA basket. The table shows that while the Stats SA basket does cover the large majority of food expenditures of the poor, our methodology covers almost all food expenditures of the poorer deciles. For this reason we argue that our methodology, of using all food items, is a better representation of the consumption habits of the poor. Interestingly, the cost-per-calorie and resultant food-line when using our "all-foods" approach is not substantially different to the Stats SA estimate. If the reference group of the poor is assumed to be expenditure deciles 2-4, as is the Stats SA specification, our cost-per-calorie is 0.4845 cents per kilocalorie, while the Stats SA

[29] Rooibos teabags were not differentiated by whether they were tagged or tag-less.

estimate is 0.5314 cents per kilocalorie.[30] Our resultant food poverty line is R310 per person per month, while the Stats SA line is R335 per person per month.[31] Ultimately it seems that this methodological change does not make a significant practical difference, which is a positive finding in terms of the robustness of the CoBN estimates. Nonetheless we argue that our methodology is more internally coherent than the basket approach, and should be used for future estimates.

Table 4: Share of food expenditure covered by different food basket techniques

Decile	Method	
	StatsSA	SALDRU
1	77%	96%
2	76%	96%
3	74%	96%
4	72%	96%
5	70%	95%
6	70%	95%
7	68%	95%
8	65%	95%
9	57%	93%
10	51%	90%

Source: own calculations using 2011 IES. The calculation above weights each household's expenditure shares equally.

4.5 Converting food expenditures into calories

The CoBN food poverty line is based on the cost of caloric attainment, while the Income and Expenditure Surveys record expenditures on food rather than quantities or calories consumed. This necessitates a conversion of expenditures into calories when trying to calculate the prevailing cost-per-calorie. None of the CoBN reports outline their methodologies in great detail, but the overall methodology is clear: use price information to convert expenditures into quantities, and then use nutritional information to convert quantities into calories. The first part of the process is to calculate an average cost in Rands per edible 100 grams of each food. The second part is to calculate the average kilocalories per edible 100 grams of each food. The final, simple part is to combine this

[30] It is not clear how much of even this small divergence is due to the basket method. A large part is likely due to differences in methodology when it comes to converting food expenditures into calories (explained in Appendix 3). Using our alternative conversion methodology, our comparable cost-per-calorie would be 0.5082 cents per kilocalorie, and the food poverty line would be R325 per person per month.

[31] Note that the R310 per person per month figure is not our proposed food poverty line. This estimate uses the same reference group (deciles 2-4) as the Stats SA line for the purposes of comparison. Our preferred specification uses a different reference group, as discussed in Section 4.7.

information to calculate a "kilocalories per Rand" for each item. This allows conversion of expenditures into calories.[32]

While this sounds straightforward, in practice it is an exceedingly messy process. It requires price data for the IES items, refuse-quantity ratios to correct food weights for their inedible components, data on food-specific volumes and weights to convert these items into a common unit of measurement (grams), and nutritional information to convert these grams into calories. Every step of this process involves procedures which have the potential to introduce inaccuracies, ranging from the necessity of sometimes matching IES foods to slightly different food-specific nutritional information, to the way in which various volume-specific prices are aggregated to create one price per IES food item.[33] These processes are outlined and discussed in detail in Appendix 3.

We ultimately calculate a "Kilocalories per Rand" coefficient for 226 of the 331 IES food items. 35 of the 226 items require imputed prices, which are discussed in Section A3.1 in Appendix 3. Of the 105 items for which we cannot calculate a "Kilocalories per Rand" coefficient, 33 are items which would always be excluded from our calculations due to their vagueness.[34] The other 72 items would have been included, but missing price data forces their exclusion.[35] Table A3.3 details which items are included or excluded, but as discussed in Section 4.4 above, we in any case have good coverage of the items which poor people consume.[36] Though the messiness of the process of converting expenditures into calories can hardly be overstated, this does not mean that the estimates derived from the process are not meaningful. Appendix 3 details what we argue is the best approach possible, given the data constraints. It should also be emphasised that inaccuracies in the "Kilocalories per Rand" coefficient for a few items are very unlikely to significantly affect the ultimate poverty lines. As Table A2 in Appendix 2 shows, the CoBN method is quite robust to reasonable methodological changes.

4.6 Using households or individuals as the unit of analysis

An important decision which seems not to have been discussed in the previous literature applying the CoBN method to South Africa is the correct unit of analysis for determining expenditure patterns. As already described, the cost-per-calorie implicit in the food poverty line is calculated by looking at the prevailing food habits of the poor. A question then arises as to whether these food habits should be determined by looking at the expenditure patterns of poor households or poor individuals. This issue is not well theorised, and arguments can be made for both options. We proceed by using the expenditure of poor households, on a per capita basis, which is the method used by Hoogeveen and Özler (Özler, 2007) and Stats SA (Statistics South Africa 2008; 2015). It is also the method suggested by the Rio Group (2006) in its international guidelines for setting Cost of Basic Needs lines. Apart from the local and international precedent, we choose this option because food expenditure decisions will likely be made at the household level, and it therefore seems most appropriate to weight each household's expenditure decisions equally. This does not negate the

[32] For example, R100 of rice is converted into 33 266 kcal.

[33] As explained in Appendix 3, the cost per 100g of a given food varies depending on the unit size. As is to be expected, larger volumes are typically associated with a lower cost per 100g. This creates difficulties when it comes to determining one price per 100g for each IES item, as prices are typically reported for a number of different volumes of each IES food.

[34] One cannot calculate the price or calories associated with "Unclassified expenditures on food" or "Other grains", for example. Exclusion of these items is unavoidable regardless of methodology, and therefore is not of significant concern.

[35] These are items such as "Garlic bread" and "Cottage cheese". Their exclusion is undesirable and potentially problematic.

[36] Table A3.3 is not reproduced here due to its size. However it is available from the authors upon request.

fact, however, that it is individuals and not households who actually consume goods, and household size therefore matters. This necessitates a subtle distinction. While we assume that expenditure decisions are made at the household level and we weight each household's expenditure habits equally, these expenditure patterns are reflected on a per capita basis, such that they represent actual calories consumed of each member of the household.

4.7 Choosing a reference group of the poor

Having determined that the food poverty line will be based on the expenditures of poor households, a decision must be made as to how these poor households will be chosen. This is the selection of the so-called "reference group" of the poor. The Rio Group suggests that the most appropriate method of setting the reference group is to choose the "group of households that satisfies, on average, the caloric requirements with the lowest income" (Rio Group, 2006: 56). This method is certainly appealing, but unfortunately is inappropriate for South Africa. As Oosthuizen (2008) confirms, it is only at relatively high income levels that South African households report food consumption sufficient to meet the caloric requirements, and the use of these households as the reference group would certainly not be representative of the poor.[37] In this context, the best alternative is to make what Ravallion (1994) calls a "first guess" at what group should represent the food consumption of the poor.

In South Africa this has been done by selecting deciles from the national expenditure distribution. Hoogeveen and Özler (2006) use quintile 3 (deciles 5 and 6), but without any explanation as to why they choose the middle of the expenditure distribution (Özler, 2007). Stats SA start by correctly noting that food expenditure habits vary significantly by total household expenditure (Statistics South Africa, 2008; 2015). The food budgets of poorer households tend to be dominated by "survivalist" foods which are cheap sources of calories, while richer households take other factors into consideration, such as taste and variety (Rose, Bourne and Bradshaw, 2002). In an effort to choose households which "reflect fairly typical, average consumption levels" (Statistics South Africa, 2008: 18), Stats SA choose their reference group so that it represents the "lower to middle distribution of consumption expenditures" (Statistics South Africa, 2015: 6). These are expenditure deciles 2-4. In their words, this "ensures that the cost of the reference food basket is not distorted by expenditure on expensive, luxury items or dominated by extreme consumption of 'survival-foods'" (Statistics South Africa, 2008: 18).

However it is not clear on what basis the "lower to middle distribution of consumption expenditures" is chosen as the relevant group of households. It could presumably be argued that the middle of the expenditure distribution, as per Hoogeveen and Özler (2006), would be a better reflection of typical consumption patterns. Counter to that, it could be argued that households in the middle of the expenditure distribution are too rich for their consumption habits to be useful in ascertaining the food habits of the poor. The primary aim of the reference group is to allow for identification of the food expenditure habits of the poor, so that 2100 kcal can be costed while

[37] This does not suggest that South Africa faces widespread malnutrition. Firstly there is a recognised issue of under-reporting in the IES, and secondly any method for converting IES expenditures into calories via prices will inevitably be approximate. Thirdly, the lack of price data on some IES items will skew total caloric intake estimates downwards, as calories from those items are not counted. While Table 4 shows that coverage is very good for poorer deciles, it gets progressively worse towards the top of the expenditure distribution. Lastly, Greer and Thorbecke (1986) explicitly note that being below a recommended dietary allowance does not imply malnutrition, as RDAs include a safety factor for those undergoing illness or injury. While the method developed in this paper may be the best option for calculating and inflating the caloric intake of the poor, it would need comparison against other evidence before being used to make conclusions about national nutrition.

respecting these food habits. The central issue is how to identify a group that is representative of the poor before the poverty line is calculated.

Ravallion (1998) suggests that an iterative method can be used to find a suitable reference group. Our method is ultimately somewhat iterative, though it would be wrong to over-emphasise its scientific rigour. We nonetheless see it is as the best basis on which to make this important methodological decision. We start by estimating food poverty lines from what can be considered reasonable reference group choices, and the corresponding upper-bound lines.[38] These are illustrated in Table 5. The proportion of households that are in poverty is then calculated for each upper bound, using per capita expenditure as the welfare measure. These are in effect modified headcount ratios, where the distribution of households is examined rather than that of individuals. As discussed in Section 4.6, the unit of analysis for determining food expenditure habits is the household, and thus the reference group must be composed of poor households rather than poor individuals. Table 5 therefore depicts the proportion of households identified as poor for each upper-bound poverty line.

Table 5: Reasonable reference group choices and corresponding household poverty rates

	Reference group (expenditure deciles)				
	2,3,4	3,4,5	4,5	4,5,6	5,6
Food poverty line (Rands)	310	337	350	371	387
Upper-bound poverty line (Rands)	975	1042	1096	1183	1274
Households classified as poor, using the upper-bound	50.0%	50.1%	51.6%	54.2%	56.5%

Source: own calculations using 2011 IES. Poverty lines are monthly and per capita, in March 2011 Rands.

It is immediately clear from Table 5 that around 50% of households are classified as poor, regardless of what reference group is used. For this reason we argue that the reference group of the poor must include households in decile 5, the majority of which are unfailingly identified as poor. At the same time, the evidence weighs against including households in decile 6 in the reference group, as it is only in the most extreme specification that a majority of decile 6 households are counted as poor.[39] With decile 5 having been identified as the upper limit of the reference group, a more murky decision must be made as to how far down the expenditure distribution the reference group should extend.

It could be argued that the reference group should only include decile 5. An obvious objection is that this would hardly result in a reference group representative of the poor when only the richest of the poor households are included. Conversely it could be argued that the reference group should include all of those identified as poor, and thus be deciles 1-5. The response to this argument is that the reference group would then have an over-representation of survivalist foods, which the very poor are forced to spend on but would not choose when their food expenditure is close to the food poverty line. The fundamental tension is between a reference group which assumes the poor's food choices are entirely dependent on where they are in the expenditure distribution, in which case decile 5 alone would best represent food habits at the poverty line, or a reference group which

[38] Sections 4.8 and 4.9 explain the methodology used to construct upper bounds.
[39] And this is a very slim majority in any case.

assumes the poor's consumption habits are static and will not change as their total expenditure increases, which would justify a reference group of deciles 1-5. The truth is probably somewhere between these two extremes, with both pre-existing food expenditure habits and current expenditure level affecting current food expenditure habits. We therefore choose deciles 3-5 as the reference group. The choice of reference group can be an important one. For our calculations, the differences between what we consider to be plausible reference groups (from deciles 2-4 up to deciles 4-5) are minimal. But it is likely that the significant disparities between the Hoogeveen and Özler (2006) and 2008 Stats SA poverty line estimates (Statistics South Africa, 2008) are to a large extent due to their divergent reference group choices.

With the reference group chosen, it is a relatively simple process to derive the food poverty line. Firstly, household per capita caloric attainment of the reference group is calculated, by converting household per capita expenditures into calories as per the process outlined in Appendix 3.[40] For households in expenditure deciles 3-5, the average per capita caloric attainment is 1458 kcal per day. The cost of this caloric attainment is then calculated by summing the household per capita food expenditures which contribute to the caloric intake calculated above.[41] For the reference group of households, this is 770.1619 cents per capita per day. Dividing the cost by the calories gives a cost-per-calorie of 0.5282 cents per day. The per capita daily requirement of 2100 kcal translates into 63875 kcal per month. Multiplying the cost-per-calorie by this monthly requirement results in a food poverty line of R337 per person per month.[42]

4.8 Identifying the relevant group for non-food expenditure

The next step is to estimate the upper and lower bounds. As described in Section 3.3 , this involves calculating the non-food expenditure of households whose food expenditure is similar to the food poverty line (in the case of the upper bound), or whose total expenditure is similar to the food poverty line (in the case of the lower bound). To start this section will focus on the upper bound.

The first question which needs to be addressed is how to identify households which have food expenditure similar to the food poverty line. At issue is how to quantify "similar". If this is restricted to only households with food expenditure exactly on the food poverty line, the sample size will be too small. On the other hand, if the interpretation of "similar" is too expansive, the calculated non-food component will not reflect non-food expenditure related to the food poverty line. Ravallion (1998) suggests a non-parametric method whereby the mean non-food expenditure is calculated for households which are within a small interval of the poverty line, such as either 1% above or below. This is then repeated for 2%, 3%, 4% and so on, up until 10%. Ravallion (1998) would then take the average of all of these mean non-food expenditures, and thus calculate the non-food component of the upper bound. The appeal of this approach is its simplicity and non-parametric nature, and that it implicitly weights expenditures more heavily the closer is their food component to the food poverty line.

All of the prior work on developing CoBN lines for South Africa has used an adaptation of this approach. The Hoogeveen and Özler (2006) method is essentially the same, except that rather than stepping to 10% above or below the food poverty line, their broadest interval is 5% above or below (Özler, 2007). Stats SA (Statistics South Africa, 2008; 2015) apply the same method as Hoogeveen

[40] At this stage it should be noted that this will likely be an overestimate of actual calories consumed. While effort was made in Appendix 3 to only consider the calories per edible 100g, this does not consider excess wastage or the calories lost in cooking. Unfortunately there is no way to systematically estimate calorie loss by these processes, and the process outlined in Appendix 3 is the best option available.

[41] Note that this only includes the foods for which we have caloric information.

[42] Values are rounded off in this paragraph. For the actual calculation they are not.

and Özler, except they calculate the median non-food expenditure for each interval, rather than the mean. They then take the mean of their 5 medians to derive a single estimate of non-food expenditure. The non-food expenditure is added to the food poverty line, resulting in the upper-bound line. For our proposed poverty lines we adopt the South African practice of using 5% above or below the food poverty line as the largest interval, but incorporate significant changes as described below.[43]

When using the 2011 IES to calculate the upper bound according to these interval methods, it becomes immediately apparent that there are significant outliers in the distribution of non-food expenditures. Even when looking only at the sample of households whose food expenditure is within 1% of the food poverty line, two households report per capita non-food expenditure in the region of R11 000 per month. Indeed, when not using exclusion restrictions to try remove outliers, the 95th percentile of non-food expenditures of these households is R5310 per month.[44] Section 4.9 discusses more comprehensively the issue of outliers in the non-food distribution, but as illustrated by the 2015 Stats SA report, which also uses the 2011 IES, the difference between mean and median non-food expenditure is stark for every interval around their food poverty line (Statistics South Africa, 2015). In this context we agree with the 2015 Stats SA contention that the mean should not be used to calculate non-food components, and find it prudent to proceed with using median non-food expenditure, as per both Stats SA reports.

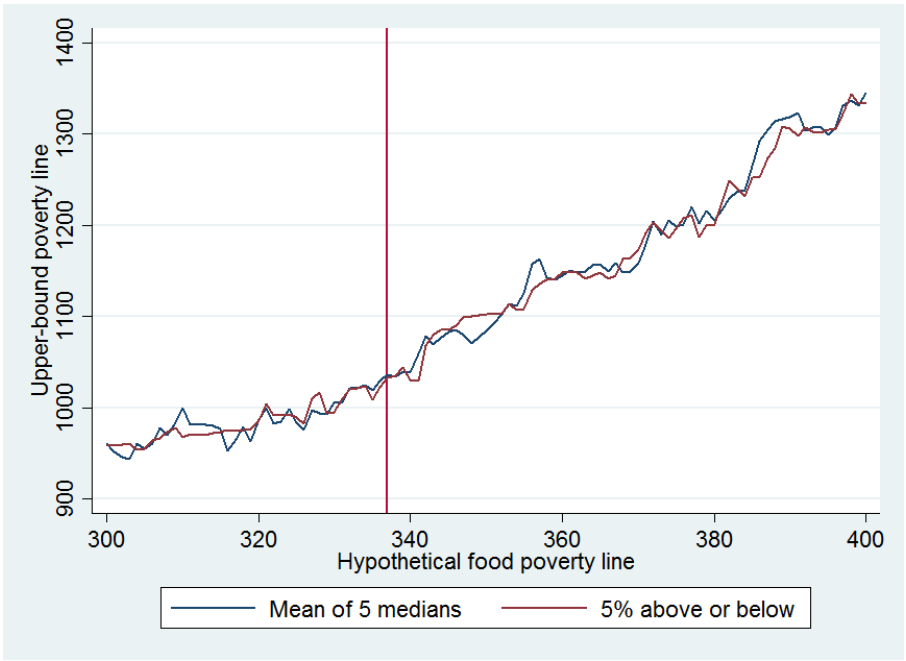
However we diverge significantly from the previous South African literature with regard to the interval approach. Rather than calculating medians in 5 intervals around the food poverty line, and taking the mean of these medians, we simply use the median non-food expenditure of households which have food expenditure in the interval 5% above or below the food poverty line. This is then added to the food line to formulate the upper bound. Figure 1, which relates upper-bound thresholds to hypothetical food poverty lines, illustrates the benefits of this method. While the "mean of 5 medians" approach is intuitively appealing, it results in upper-bound estimates which fluctuate significantly around the expected positive relationship with the food poverty line. The "5% above or below" approach is also somewhat noisy, but is more true to the expected trend than its alternative. With no good theoretical reason to view the spikes around the trend as anything other than measurement error, the "5% above or below" method is preferable.[45] Ultimately this decision does not make a significant difference to our eventual poverty line estimates, as Table A2 in Appendix 2 shows, though it has the capacity to do so.

[43] There is no reason to believe that Ravallion (1998) was particularly in favour of a 10% interval above or below the food line. His language suggests that 10% was merely used for the sake of example.

[44] Exclusion restrictions are discussed in Section 4.9.

[45] Figures A4.1 and A4.2 in Appendix 4 display Lowess-smoothed versions of the two different upper bounds, and support the use of the "5% above or below" method. Unfortunately, using Lowess smoothers on the underlying data is not appropriate, given the issue of outliers discussed above and in Section 3.9. Outlier-resistant smoothers do exist, but they require a battery of contentious methodological decisions which may introduce more uncertainty than they resolve in this context. A running-median, which is what we use here as the "5% above or below" method, is any case already an accepted outlier-resistant smoother.

Figure 1: Upper-bound poverty lines by two different methods



Source: own calculations using 2011 IES. Poverty lines are monthly and per capita, in March 2011 Rands. The reference line is set at the level of our food poverty line, R337 per person per month.

The lower bound is calculated in much the same way. The existing South African approach has been to calculate the mean of the 5 means (Özler, 2007), or the mean of the 5 medians (Statistics South Africa, 2008; 2015). Our approach, analogous to that used for the upper bound, is to calculate the median non-food expenditure of households whose total expenditure is within the interval of 5% above or below the food poverty line. This is then added to the food poverty line to calculate the lower bound.

4.9 Data quality issues and truncating the upper bound

As mentioned in the previous section, there is a serious issue of outliers in non-food expenditure in the 2011 IES. The most obvious cases are households which report food expenditure which is essentially at the food poverty line, and yet report implausibly high non-food expenditures. There are potentially two explanations, which could be operating simultaneously. It could be the case that non-food expenditures are overestimated, due perhaps to a household buying big lumpy non-food items which were not correctly removed from the consumption aggregate. Alternatively, it could be the case that some wealthy households have drastically under-reported their food consumption. There is little way to know, without going into a much more complicated analysis, whether the outlier households have overestimated or underestimated total expenditure.

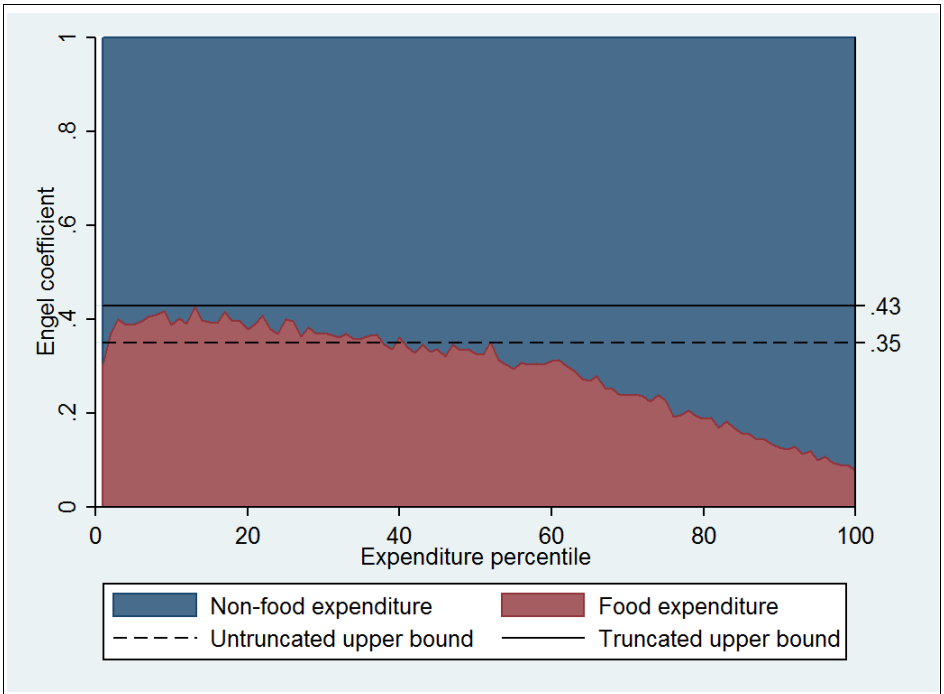
Stats SA (2015), recognising that there is some kind of data issue, decide to truncate the sample when determining the upper bound.[46] Arguing that their unadjusted upper-bound estimate is implausible, they restrict their upper-bound sample to households in expenditure deciles 2-7, rather than looking at the full distribution of households which have food expenditure similar to the food

[46] The issue is explained in the 2015 Stats SA report as likely being a consequence of South Africa's high levels of inequality. We think it is more likely a data quality issue as explained above.

poverty line. This reduces their upper-bound estimate significantly, but methodologically is a drastic action. At issue is that by cutting off the top 3 deciles, the implicit assumption is that the outlier households have overestimated total expenditure, and this corrects for that error. However as argued above, further evidence is required before the assumption of overestimation can be made.

In any case, the method used by Stats SA to derive their upper bound, which is the mean of 5 medians, is very resistant to outliers already. Indeed it seems that their initial upper-bound estimate, before truncation, should not be seen as farfetched. The 2015 Stats SA food poverty line is R335 per person per month. The upper bound they calculate before truncation is R959 per person per month. After truncation it is R779. Based on the innocuous assumption that the food poverty line is not considered unbelievable, our preferred method for assessing the plausibility of the upper bounds is to examine the Engel coefficients they imply.[47] The untruncated upper bound implies an Engel coefficient of 0.35, while the truncated upper bound implies an Engel coefficient of 0.43. As shown in Figure 2, this provides strong evidence against the conclusion that the Stats SA upper bound needs to be truncated. There is no percentile of the expenditure distribution which has as high an Engel coefficient as implied by the truncated upper bound, while the untruncated upper bound implies an Engel coefficient quite similar to that of the poor deciles.[48]

Figure 2: Implied Engel coefficients, by expenditure percentile



Source: own calculations using 2011 IES.

[47] The Engel coefficient is the proportion of total expenditure spent on food. The concept has a long history in Economics, and indeed has been used as a basis on which to set poverty lines, or to examine the developmental status of different countries (Deaton, 1997).

[48] Some caveats must be considered when looking at Figure 2. Firstly, Figure 2 is calculated using our consumption aggregate, rather than the Stats SA one. If our consumption aggregate contains more non-food items than Stats SA, the point made in Figure 2 will be less stark when the Stats SA consumption aggregate is used. Secondly, it could be argued that the outlier issue also distorts the Engel coefficients calculated in Figure 2. This may be true to some extent, but the consistency of the percentile estimates suggests otherwise.

The issue of outliers is nonetheless a genuine one, which if possible should be addressed in some way. Based on the understanding that the outliers are most likely caused by data quality issues, we construct exclusion criteria aimed at addressing this. The exclusion criteria consist of two conditions, both of which must be met in order for a household to be excluded from the upper- and lower-bound calculations. Firstly, a household must report expenditure which is either more than 3 times smaller or 3 times greater than its reported income. Secondly, non-food expenditure must be more than 10 times greater than food expenditure. The first condition aims to identify households which have significantly overestimated or underestimated expenditure. The second aims to identify households which have disproportionately high non-food expenditure.[49] While neither of these conditions is independently sufficient to disqualify a household, collectively they suggest data quality problems sufficient for exclusion. With the food poverty line as calculated in Section 3.9, 1099 households in the IES sample have food expenditure which renders them relevant for the upper-bound calculation. With the exclusion restrictions applied, only 15 of these households are excluded from the upper-bound calculation. Unsurprisingly, the effect of applying the exclusion criteria is not hugely significant, as shown in Table A2 in Appendix 2. This underlines the fact that the median measure used for the upper and lower bounds is significantly resistant to outliers, and it is doubtful whether steps to identify and exclude outliers are necessary.

With the preferred specification explained in this and the previous section, the upper bound is calculated to be R1042 per person per month, while the lower bound is calculated to be R534 per person per month. The exclusion criteria are applied to the lower bound as they are for the upper.

5. Measuring poverty with the new lines

Of particular interest is how our poverty lines compare to the previous CoBN poverty lines estimated for South Africa. Stats SA's official method for updating CoBN estimates between rebasing is to inflate the food and non-food components of the lines separately, by total country inflation in food and non-food items respectively (Statistics South Africa, 2008).[50] This is an appealing process that preserves the underlying logic of the CoBN estimates, and we persist with this technique.[51] Using this inflation technique, the Hoogeveen and Özler, 2008 Stats SA and 2015 Stats SA estimates are presented alongside our new lines in Table 6. All lines are for per capita expenditure, presented in March 2011 Rands. As can be seen from the table, the 2008 Stats SA lines are substantially lower than any of the alternatives, while the Hoogeveen and Özler lines are much higher. Our lines are most similar to the 2015 Stats SA set of lines, except with regard to the upper bound, which is closer to the Hoogeveen and Özler estimate.

Table 6 also shows the poverty headcount ratios associated with each poverty line.[52] Our proposed lines differ from the other lines in a manner consistent with what would be expected. The headcount ratios are most similar to the 2015 Stats SA rebasing, except in relation to the upper-bound headcount ratio, which is closest to the Hoogeveen and Özler estimate. The difference

[49] The threshold of non-food expenditure being more than 10-times greater than food expenditure was chosen after examination of the percentile Engel coefficients, as per Figure 2.

[50] More specifically, this is inflation for "Food and non-alcoholic beverages (NAB)" and inflation "excluding food and NAB" (Statistics South Africa, 2011).

[51] Appendix 1 provides a more systematic discussion of how these lines should be adjusted over time. This appendix includes calculations of inflated values up until March 2015.

[52] There are recognised issues associated with using the headcount ratio to measure poverty (Deaton, 1997), but it is a useful measure for the purposes of comparing the different poverty lines. Analysis of poverty itself would incorporate more nuanced measures.

between the headcount ratio associated with our upper bound and that associated with the 2015 Stats SA upper bound is substantial.

Table 6: New SALDRU lines in comparison with existing CoBN lines

Poverty line		Hoogeveen and Ozler	Statistics SA 2008	Statistics SA 2015	SALDRU
Food	Rands	480	321	335	337
	Headcount	*34.54%*	*19.14%*	*20.76%*	*20.98%*
Lower bound	Rands	680	443	501	534
	Headcount	*48.12%*	*31.60%*	*36.15%*	*38.70%*
Upper bound	Rands	1164	620	779	1042
	Headcount	*65.96%*	*44.66%*	*53.19%*	*62.76%*

Sources: Hoogeveen and Ozler (2006), Statistics South Africa (2008; 2015) and own calculations using 2011 IES. This paper's poverty lines are indicated under "SALDRU". Poverty lines are monthly and per capita, in March 2011 Rands. All headcount ratios are calculated using our consumption aggregate, with the 2011 IES data.

6. Conclusion

With the above tables in mind, it is useful to reconsider what methodological decisions drive the substantial differences between our poverty lines and the 2015 Stats SA estimates, which also used the 2011 IES. The main difference between the lines is in the estimation of the upper bound. Here, two methodological differences play a substantial role. Firstly, our decision not to truncate the upper bound, but rather to identify and remove outliers directly, results in a substantially higher upper bound than Stats SA calculate. That the truncation decision is important can be seen from the 2015 Stats SA report itself, in which it is shown that without truncation they would estimate the upper bound to be R959 per person per month. This is substantially closer to our estimate than the final Stats SA estimate. The second important difference is in the selection of the "reference group" of the poor.[53] We argue and show that for plausible reference group choices the poverty thresholds do not change significantly. Yet, the differences between our final estimates and what we would calculate using Hoogeveen and Özler's middle quintile are substantial. In contrast, the differences created when choosing our reference group instead of the Stats SA reference group are not overly significant. These differences are shown in Table 5.

Our choices regarding the construction of our consumption aggregate, the use of "all foods" rather than a food basket, and the use of the "5% above and below" method do not seem to have a substantial effect on the poverty lines. Nonetheless, we motivate them carefully as being the best choices in our context and would recommend that these methodological decisions are sustained for

[53] From our work, it seems plausible to suspect that this was the main difference between the Hoogeveen and Özler (2006) and earlier Stats SA (Statistics South Africa, 2008) estimates, which both used the 2000 IES. Another important difference may have to do with how the upper bounds were calculated: Hoogeveen and Özler used mean non-food expenditures (Özler, 2007), while Stats SA used median non-food expenditures. However without information on the presence of outliers in the 2000 IES, this last point remains conjecture.

future CoBN estimates, as these choices may play a more important role as expenditure habits or data collection methodologies change. The same recommendation applies to our decisions which are ultimately more substantive, such as not truncating the upper bound and the choice of reference group. Both of these decisions are made on as scientifically-determined grounds as is possible under the circumstances.

A last methodological point to be made regards the remarkable consistency of the CoBN measure. The significant disparities between the Hoogeveen and Özler (2006), 2008 Stats SA (Statistics South Africa, 2008) and 2015 Stats SA (Statistics South Africa, 2015) estimates generated some concerns about the method's robustness. The above analysis has shown, however, that apart from one or two decisions which understandably have a significant impact on the eventual poverty lines, the measure is generally quite robust to reasonable changes in its specification.

Methodology having been determined, an important question concerns how these lines should be interpreted. We argued in Section 3.3.2 that there does not seem to be any intuitive meaning associated with the lower-bound poverty line, when it comes to representing some level of well-being. For this reason we do not recommend its use.[54] The upper-bound and food poverty lines, in contrast, have clear meanings which are useful for analysis of well-being. The upper bound can be interpreted in two ways. At its most conservative, it is the minimum level of total expenditure that a person requires such that their food expenditure will generally be sufficient in terms of calories. More generously, it is the level of total expenditure at which basic food and basic non-food needs are satisfied. The meaning of the food poverty line is however unambiguous: it is the level of total expenditure below which a person does not have sufficient money for food, even if all of their expenditure is on food. In using this line it should be emphasised that expenditure above the food poverty line does not mean a person has sufficient food expenditure. At any point below the upper bound, people have non-food needs which necessitate the sacrifice of basic food spending. But in understanding the cost of sufficient caloric consumption, the food poverty line is undoubtedly useful. In the interpretation of these lines in a more abridged form, Statistics South Africa (2008; 2014b; 2015) has defined expenditure below the upper-bound line as poverty, whereas expenditure below the food poverty line is extreme poverty. This seems to us to be a useful classification, with each poverty line representing a clearly understood level of well-being.

To conclude, we have used Ravallion's Cost of Basic Needs methodology to derive poverty lines for South Africa. While remaining cognisant of the limits of the methodology and data we use, this is an attempt to create the most methodologically sound set of poverty thresholds possible. The process of deriving the lines has been described in full. Our resultant poverty lines differ from previous estimates, and we argue that the lower-bound poverty line is not a useful measure of well-being. Ultimately we suggest that our upper-bound poverty line should be used for the purposes of measuring poverty, while the food poverty line is an appropriate threshold for extreme poverty.

[54] The only justification we can imagine for the use of the lower bound is that a researcher views the upper bound as too high and food poverty line too low for practical use. However this kind of ad-hoc decision, based on a purely subjective basis, is precisely what poverty line quantification with some theoretical basis seeks to avoid.

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Appendix 1: Updating the poverty line over time

As discussed in Section 3.2.1, absolute poverty lines should retain the same real value over time. This necessitates that the lines be adjusted for inflation. Section 5 mentions that the Statistics South Africa (2008) approach for updating these lines between rebasings is to inflate the food and non-food components separately, by total country inflation in food and non-food items respectively. This approach, which reflects the relevant price changes as accurately as possible, is also relatively straightforward to implement, and we adopt it below. Table A1 shows our poverty lines adjusted for inflation in this manner.

Table A1: SALDRU lines adjusted for inflation

Year	Month	Food	Lower bound	Upper bound
2000	Jan	148	258	542
2001	Jan	155	273	577
2002	Jan	174	295	613
2003	Jan	207	341	688
2004	Jan	209	343	690
2005	Jan	212	351	710
2006	Jan	219	363	736
2007	Jan	238	390	783
2008	Jan	272	435	857
2009	March	320	499	962
2010	March	322	511	999
2011	March	337	534	1042
2012	March	368	575	1111
2013	March	388	608	1176
2014	March	420	652	1252
2015	March	444	685	1307

Source: own calculations using 2011 IES data and inflation reports published by Statistics South Africa. Poverty lines are monthly and per capita, in Rands.

However if the purpose of the CoBN methodology is to develop a poverty line which reflects the minimum cost of basic food and non-food requirements, while remaining anchored to the actual consumption habits of the poor, inflation-adjusting can only serve as a short-term solution. Consumption habits and relative prices will change over time, thus removing the poverty lines from their foundations in existing expenditure patterns. Changes in relative prices can occur within foods and non-foods, for example if some food becomes relatively more expensive than another food, and this will affect what is consumed and the prevailing cost-per-calorie. Relative prices may also change between food and non-food items generally, affecting the proportion of non-food expenditure attached to the food poverty line level of food expenditure, and therefore the upper bound. These changes make CoBN estimates increasingly unrealistic as time goes on. As Statistics South Africa (2008) notes, these lines need to be recalculated periodically with new data.

The Cost of Basic Needs methodology is in this respect somewhat relativistic. As a society grows richer, and even poor people consume more expensive calories and non-food items, it is likely that the real value of the poverty lines will increase. The methodology does not lead to proper relative poverty lines, of course, as in their interpretation across time the real value of the lines is kept constant, with poverty line rebasings typically replacing prior lines and being deflated for poverty comparisons with the past (see Statistics South Africa, 2015). The somewhat relative nature of the CoBN lines is nevertheless interesting, and could perhaps be exploited in future research on relative poverty lines in South Africa.

Appendix 2: Sensitivity Analysis

Table A2: SALDRU lines with various specifications

SALDRU estimate	Spec. 1	Spec. 2	Spec. 3	Spec. 4	Spec. 5	Spec. 6	Spec. 7	Spec. 8
Food poverty line (Rands)	337	338	338	363	337	337	354	339
Lower-bound poverty lines (Rands)	534	539	539	582	536	537	566	535
Upper-bound poverty lines (Rands)	1042	1058	1058	1144	1040	1064	1107	1044

Source: own calculations using 2011 IES. Poverty lines are per monthly and per capita, in March 2011 Rands.
Specification 1 is our preferred specification as outlined in the paper.
Specification 2 excludes home production from the consumption aggregate.
Specification 3 includes state-subsidised and free consumption in the consumption aggregate.
Specification 4 uses a caloric benchmark of 2261kcal per person per day.
Specification 5 uses the Stats SA "mean of 5 medians" approach to calculate the upper and lower bounds.
Specification 6 does not use the exclusion criteria to exclude outliers in non-food consumption.
Specification 7 uses the "unweighted" method of assigning kilocalories per Rand.
Specification 8 sets the cost-per-calorie of the IES "Burger" item at 4x the average cost-per-calorie of other items.

Appendix 3: Converting IES expenditure data into calories

As alluded to in Section 4.5, the necessary conversion of IES expenditure data into calories requires price and caloric information. This is used to develop a "Kilocalories per Rand" coefficient for food items with sufficient data. The process is outlined below.

A3.1 Matching price data and expenditures

There is no publicly available in-depth dataset of prices in South Africa. However Stats SA regularly carries out extensive price surveys, for the purposes of producing their Consumer Price Index (CPI) updates. As we found throughout our experience in writing this report, Stats SA were very willing to advise us and send through data, and we received two detailed datasets. Understandably, Stats SA only collects prices on items included in their various CPI calculations. The CPI is periodically updated though, and the weights and basket of goods and services included in the CPI are revised (Statistics South Africa, 2012b). The two datasets we received reflect this updating process. The first dataset contains 405 food prices for the period January 2008 to December 2012. The second dataset is distinct from the first in that it includes prices (of 492 items) from January 2013 up to February 2015, when we requested the dataset. There is significant overlap of items which are included in both the first and second dataset. However there are some differences, as Stats SA revised the CPI basket and weights in November 2012 (Statistics South Africa, 2012), and this necessitated the exclusion of some previously-surveyed items, and the inclusion of some new items.[55] Table A3.1 presents an example of these data. Separate prices are reported for the different volumes of goods, per month.

Once these data have been received, the next step is to match it to the expenditures reported in the 2011 IES. March 2011 prices are used, as IES expenditures are all inflated or deflated to this point. In some cases matching is a relatively simple process. An example from Table A3.1 would be "Full cream milk - fresh", which clearly matches with the 2011 IES item "Fresh full cream milk". Similarly, "Tuna - tinned", matches very well with the IES item "Canned tuna". However in some cases the price information does not match perfectly with the IES categories. For example, there is no direct price for the IES item "Canned pilchards". Instead, this item is matched with the price data for "Fish (excluding tuna) tinned", shown in Table A3.1. The IES item "Other canned fish" is similarly matched with these price data. It should be emphasised that the matching process is very messy. Attempts were made to be as rigorous as possible, but there are no firm rules which can be used to decide when an item is similar enough to be matched with specific price data. Table A3.3 indicates whether IES items are matched directly or to a similar item, and if to a similar item the full name of that item is given.[56] Debatable decisions in the case of a few items would make no appreciable difference to our poverty line estimates, which is comforting, but the rigour of this process should not be over-emphasised. Rather, our practice here is the best we can do given the data constraints.

A further issue is that there are some IES items which were included in Stats SA's CPI calculations only after their November 2012 CPI revision. In the case of these items, there are no price data for March 2011, which is the time period required. For these items, we impute March 2011 prices by deflating from the reported March 2013 prices. This, again, is a process which will cause loss of precision but is unavoidable. The most important methodological decision for this process is the choice of deflator. As part of their monthly CPI updates, Stats SA publishes inflation statistics for

[55] Statistics South Africa (2012b) outlines this process in detail, and lists the changes to the basket post-2012.
[56] As mentioned in Section 4.5, Table A3.3 is not reproduced here due to its size. It is available from the authors upon request.

specific food groups.[57] Using the November 2012 CPI revision report (Statistics South Africa, 2012), it is straightforward to match the new (post-2012) CPI items to their food groups, and we therefore deflate these items to March 2011 by their food group deflator. The choice of deflating from March 2013 (as opposed to January 2013) is to limit any price variation due to seasonal availability of items. In very few cases, it was necessary to deflate from January 2013 or inflate from April 2008 due to missing price data. Table A3.3 details which items were imputed, their food group deflator, and the period they were deflated or inflated from.

[57] These food groups are: Bread and cereals; Meat; Fish; Milk, eggs and cheese; Oils and fats; Fruit; Vegetables; Sugar, sweets and desserts; Other food; Hot beverages (non-alcoholic); Cold beverages (non-alcoholic); Spirits; Wine; Beer (Statistics South Africa, 2011).

Table A3.1: Example of raw price data

prod4Desc	prodDesc	unitCode	unitDesc	Dec2010	Jan2011	Feb2011	Mar2011	Apr2011	May2011
FISH	TUNA - TINNED	4731	170 Gram	10.14	10.10	9.90	9.75	9.52	9.73
FISH	FISH (EXCL TUNA) - TINNED	4801	215 Gram	8.26	8.30	8.20	8.11	8.13	8.13
FISH	FISH (EXCL TUNA) - TINNED	4991	400 Gram	13.04	13.29	13.31	13.14	13.06	13.01
FISH	FISH (EXCL TUNA) - TINNED	5031	425 Gram	11.66	11.44	11.48	11.38	11.18	11.23
FISH	FISH PASTE	4531	85 Gram	8.30	8.39	8.43	8.67	8.94	9.10
FISH	FISH PASTE	4651	125 Gram	10.72	10.69	10.81	11.18	11.66	11.82
FISH	FISH PASTE	4821	225 Gram	15.96	15.86	15.97	16.82	16.73	17.17
MILK	FULL CREAM MILK - FRESH	5811	1 Litre	8.27	8.27	8.28	8.39	8.47	8.56
MILK	FULL CREAM MILK - FRESH	5841	2 Litre	15.75	15.68	15.82	15.95	16.08	16.54
MILK	FULL CREAM MILK - FRESH	5866	3 Litre	24.80	23.46	23.31	23.68	22.48	24.54
MILK	FULL CREAM MILK - FRESH	6541	250 Millilitre	3.74	3.89	4.03	4.18	3.80	4.22
MILK	FULL CREAM MILK - FRESH	6721	500 Millilitre	5.79	6.12	6.17	6.20	6.27	6.22

Source: Statistics South Africa (from correspondence)

A3.2 Calculating a cost per edible 100 grams

As the example in Table A3.1 shows, the price information is disaggregated by item volume. In order to develop a price which can be used to convert IES reported expenditure on an item into quantities or calories, a single price needs to be calculated from these different volume-specific prices. At this juncture it makes sense to calculate an aggregate cost per edible 100 grams of each food (using all of the volume-specific prices), as the nutritional data used for this process are expressed in these terms. This means excluding inedible components such as banana skins or chicken bones from those items' masses. Broadly speaking, the process at this stage is to convert all of the volumes into grams, subtract the inedible components of each food, and then aggregate the volume-specific prices in some way which leads to a single price per IES item.

Converting the various volumes indicated in the price data into grams was done using the South African Medical Research Council's *Food Quantities Manual, 2nd edition* (Langenhoven et al., 1991). This provides a standard approach for converting volumes into grams. This can be done either for standard volume measures, such as a litre of milk, or for irregular volumes, such as a dozen eggs. Similarly to Section A3.1, there is again an issue of matching, as sometimes there is no direct match between IES foods and the foods included in the report. This is uncommon though, and likely not as potentially significant an issue as it is in Section A3.1.

Having converted the volume-specific prices into prices per some amount of grams, it is then necessary to make adjustments for inedible components in those foods. This requires information on the "Refuse quantity" of each food, which is a percentage of the food that cannot be consumed. Upon recommendation from the South African Medical Research Council, the report we use to obtain refuse quantities is *Food Yields: summarized by different stages of preparation*, produced by the United States Department of Agriculture (USDA) Agricultural Research Service (USDA Agricultural Research Service, 1975). In the very few cases where this handbook does not have the refuse quantity of a required item, it is supplemented by data from the USDA National Nutrient Database for Standard Reference, Release 27 (USDA Agricultural Research Service, 2014). The matching issue is potentially problematic once again, as the USDA information (from both publications) is sometimes slightly different to the price categories. In this case though it is a minority of items which require data regarding refuse percentage, and with the exception of a few complicated matches (such as various cuts of beef), the matching was mostly straightforward. The matching process here is unlikely to cause any appreciable distortion.

With a measure of the edible grams per volume-specific price, it is straightforward to calculate "Rands per edible 100 grams" for each volume-specific price. These then need to be aggregated into one price which can be used for each IES item. Volume-specific prices are generally not all the same for a particular item. It is generally the case that larger volumes are associated with a lower cost per edible 100 grams, as would be expected, but this is not always the case. Table A3.2 presents an example of 4 IES items which have multiple volume-specific prices. The ideal approach for creating one price would be to use existing data on food-expenditure patterns to determine the frequency with which people buy each volume, and use this to create an expenditure-weighted average price. Unfortunately, expenditure data at this level do not exist for South Africa.

One approach is to take a simple average of the various "Rands per edible 100 grams", and use this as the item price. This is shown in the table as "Unweighted mean". However the assumption in this case is that each volume-specific price should be weighted equally when determining an item price, even though some of the prices represent much larger volumes. This is a debatable assumption.[58]

[58] The issue is best illustrated by means of an example. The example of "Frozen peas" from TableA3.2 is instructive. For peas bought in 250g packets the cost per edible 100 grams is R2.68. For peas bought in 1kg packets the equivalent cost is R2.49. If a household has bought 10kg of frozen peas, the "Unweighted mean" approach assumes that this person bought twenty 250g packets of peas, and five 1kg packets. The assumption

An alternative approach is to weight the volume-specific prices by the volumes they represent, and then take the mean. This is shown as the "Weighted mean" in Table A3.2. The assumption in this case is that each volume of a particular item is bought at the same rate.[59] Both assumptions can be contested, but a decision between these two methods is unavoidable. We prefer to use the "Weighted mean", as it seems likely to be less of a deviation from what we would expect in reality. We therefore calculate the cost per edible 100 grams of each item to be as listed under "Weighted mean" in Table A3.3. In the case of individual items, the choice between weighted or unweighted often makes little practical difference. However in aggregate the choice does affect our results quite significantly, as shown in Appendix 2.

requires that each volume-specific price be equally represented when it comes to the total volume of peas bought, requiring that small-volume items be bought at a very high frequency.

[59] With regard to the example in footnote immediately preceding, the "Weighted mean" approach would assume that out of 10 kilograms of peas, a household bought eight 250g packets of peas and eight 1kg packets of peas.

Table A3.2: Aggregating volume-specific process

IES item	Price item	Volume	Price	Edible grams	Volume-specific Rands per edible 100 grams	Mean price per 100 edible grams	
						Weighted	Unweighted
Brown bread	LOAF OF BROWN BREAD	600 Gram	4.94	600	0.8233	1.0038	0.9904
	LOAF OF BROWN BREAD	700 Gram	7.30	700	1.0429		
	LOAF OF BROWN BREAD	800 Gram	8.84	800	1.1050		
Cake flour	CAKE FLOUR	1 Kilogram	9.29	1000	0.9290	0.7415	0.7768
	CAKE FLOUR	2.5 Kilogram	17.94	2500	0.7176		
	CAKE FLOUR	5 Kilogram	36.12	5000	0.7224		
	CAKE FLOUR	10 Kilogram	73.82	10000	0.7382		
Beef and veal	BEEF RUMP STEAK -FRESH	Per Kilogram	86.26	875	9.8583	6.9760	7.0167
	BEEF BRISKET - FRESH	Per Kilogram	51.27	860	5.9616		
	BEEF CHUCK - FRESH	Per Kilogram	52.71	850	6.2012		
	BEEF T-BONE - FRESH	Per Kilogram	68.80	880	7.8182		
	BEEF MINCE - FRESH	Per Kilogram	52.44	1000	5.2440		
Peas frozen	PEAS - FROZEN	250 Gram	6.64	247.5	2.6828	2.5309	2.5879
	PEAS - FROZEN	1 Kilogram	24.68	990	2.4929		

Source: own calculations and Statistics South Africa data. Prices are in March 2011 Rands.

A3.3 Calculating calories per edible 100 grams

Having calculated the cost in Rands per edible 100 grams of each item, it is necessary to determine the calories per edible 100 grams. Our primary source of caloric information is the South African Medical Research Council's *Condensed Food Composition Tables for South Africa* (Wolmarans et al., 2014). If we cannot adequately match an IES item to these data, we use the USDA National Nutrient Database for Standard Reference, Release 27 (USDA Agricultural Research Service, 2014). In the case of the few IES items which could not be matched to either of these datasets, we use the table of caloric values reproduced in Rose, Bourne and Bradshaw (2002). All of the IES food items for which we have price data are covered by at least one of these sources. Matching is once again an issue, as the caloric information tends to be described on a more disaggregated basis than each IES item. This necessitates that averages sometimes be created for the purpose of assigning a caloric value to each IES item. Table A3.3 describes the source of caloric information for each IES item, and a code indicating the item (or items) it is matched to in that source. The caloric information in these sources is always indicated per edible 100 grams, which is what necessitates calculation of the Rand cost in these terms. Wolmarans et al. (2014) indicate energy in kilojoules rather than kilocalories, but this is easily converted.

A3.4 Kilocalories per Rand

The last step of this process is the relatively simple procedure of combining the information calculated in Sections A3.2 and A3.3 above to determine the Kilocalories per Rand for each IES item. This is then used to convert the expenditure reported in the IES into kilocalories. Kilocalories per Rand for each item are shown in Table A3.3, using both the unweighted and weighted methods of determining prices. As indicated in Section A3.2, our preferred specification uses the weighted prices.

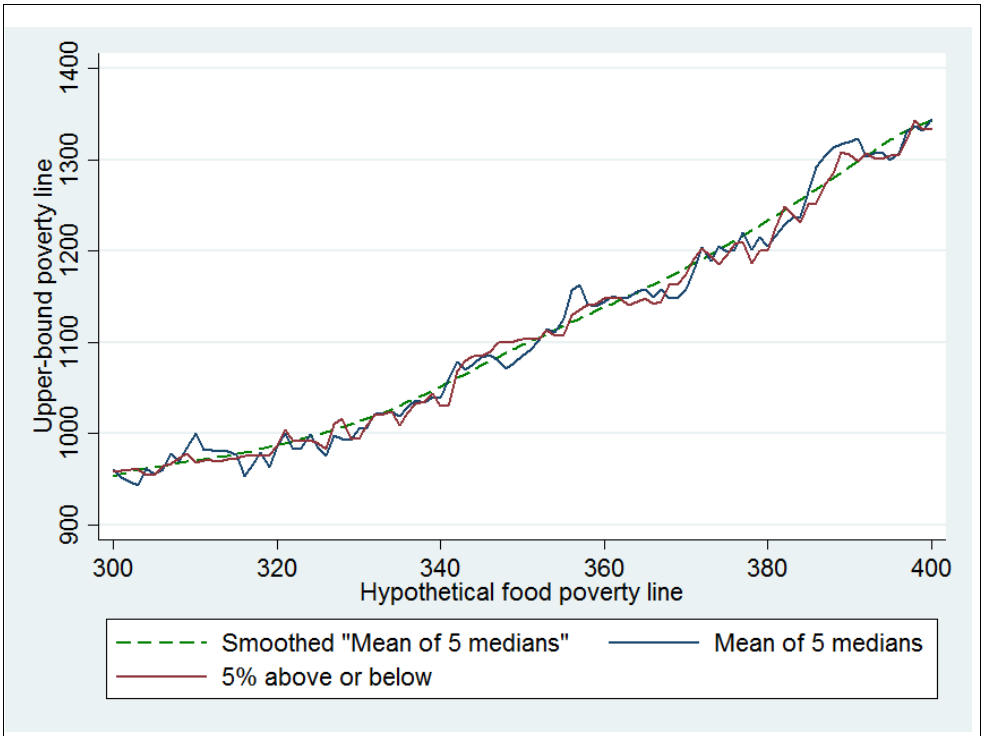
There is one important item for which kilocalories per Rand cannot be calculated as above. This is the IES item "Burger".[60] Despite the perhaps somewhat misleading description, this item represents all expenditures on prepared meals bought outside the home, such as at restaurants, hotels and supermarkets (Statistics South Africa, 2012c). Given the wide variety of foods this item encapsulates, it is not possible to calculate a cost-per-calorie as per the detailed process above. Following Rose, Bourne and Bradshaw's (2002) tentative suggestion, we assume that the cost of a calorie consumed away from home is twice as high as the average cost of home-produced calories. This is a rough assumption, but is unfortunately the best that can be done in the circumstances. As Appendix 2 shows, our poverty line estimates are in any case quite robust to changes in this assumption, such as assuming that "Burger" calories are four times more expensive than home-produced calories.

[60] COICOP code: 11121110

Appendix 4: Methods for determining the non-food components

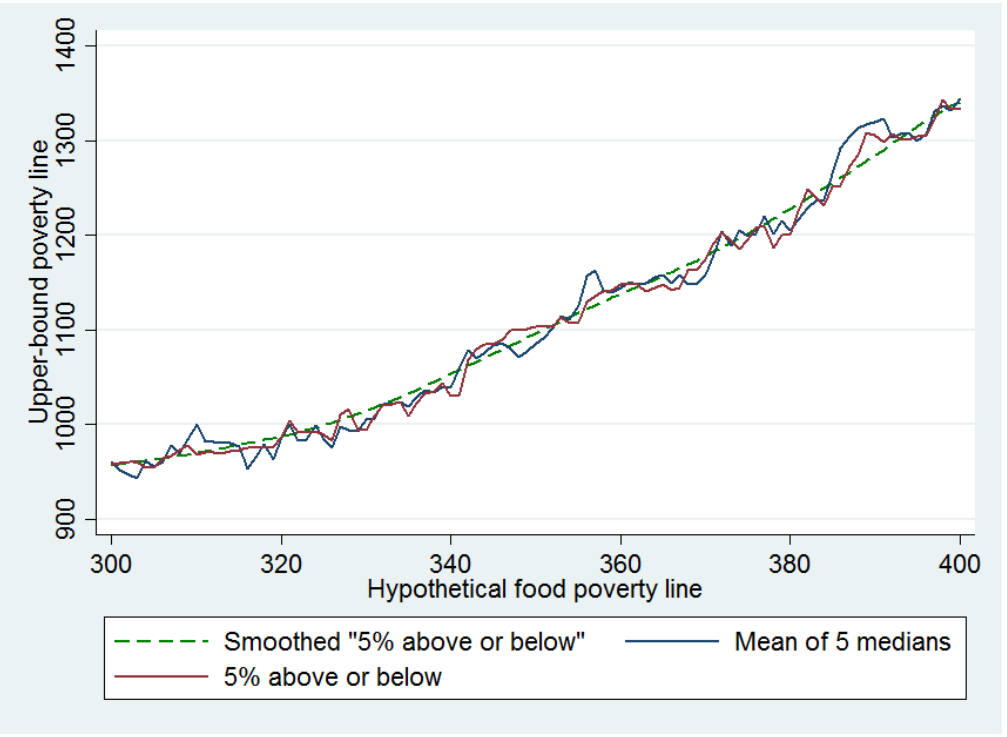
Similarly to Figure 1 in Section 4.8, Figures A4.1 and A4.2 relate the upper-bound poverty line to hypothetical values for the food poverty line. The blue and red solid lines show the upper bound values calculated by the "Mean of 5 medians" and "5% above or below" methods respectively. Unlike Figure 1, the figures below also incorporate smoothed versions of these estimates. Figure A4.1 smooths the values associated with the "Mean of 5 medians" approach, while Figure A4.2 smooths the values associated with the "5% above or below" method. In both figures, it is clear that the unsmoothed "5% above or below" line more consistently represents the trend-line than the unsmoothed "Mean of 5 medians" line. This motivates our use of the "5% above or below" method for determining the upper- and lower-bound poverty lines. Smoothing is performed using Stata's Lowess smoother, with the bandwidth set at 0.5. As discussed in Section 4.8, the use of this smoother on the underlying data directly would be inappropriate, due to its sensitivity to outliers.

Figure A4.1



Source: own calculations using 2011 IES. Poverty lines are monthly and per capita, in March 2011 Rands. Smoothing is Lowess, with bandwidth of 0.5.

Figure A4.2



Source: own calculations using 2011 IES. Poverty lines are monthly and per capita, in March 2011 Rands. Smoothing is Lowess, with bandwidth of 0.5.

southern africa labour and development research unit

The Southern Africa Labour and Development Research Unit (SALDRU) conducts research directed at improving the well-being of South Africa's poor. It was established in 1975. Over the next two decades the unit's research played a central role in documenting the human costs of apartheid. Key projects from this period included the Farm Labour Conference (1976), the Economics of Health Care Conference (1978), and the Second Carnegie Enquiry into Poverty and Development in South Africa (1983-86). At the urging of the African National Congress, from 1992-1994 SALDRU and the World Bank coordinated the Project for Statistics on Living Standards and Development (PSLSD). This project provide baseline data for the implementation of post-apartheid socio-economic policies through South Africa's first non-racial national sample survey.

In the post-apartheid period, SALDRU has continued to gather data and conduct research directed at informing and assessing anti-poverty policy. In line with its historical contribution, SALDRU's researchers continue to conduct research detailing changing patterns of well-being in South Africa and assessing the impact of government policy on the poor. Current research work falls into the following research themes: post-apartheid poverty; employment and migration dynamics; family support structures in an era of rapid social change; public works and public infrastructure programmes, financial strategies of the poor; common property resources and the poor. Key survey projects include the Langeberg Integrated Family Survey (1999), the Khayelitsha/Mitchell's Plain Survey (2000), the ongoing Cape Area Panel Study (2001-) and the Financial Diaries Project.

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