ASSET INDICES AS A PROXY FOR POVERTY MEASUREMENT IN AFRICAN COUNTRIES: A REASSESSMENT

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(DRAFT – PLEASE DO NOT QUOTE)

INTRODUCTION

The recent debate between Young (2012) and Harttgen et al (2012) on whether Sub-Saharan Africa has experienced a greater or lesser "growth miracle" in the last couple of decades than suggested by aggregate income and output data has brought to the fore the appropriateness of the asset index to measure welfare trends. The use of asset indices as proxies for welfare, wealth, economic status and/or living standards has rapidly become very popular in social epidemiology and development studies following the seminal articles by Sahn and Stifel (2000) and Filmer and Prichett (2001), who introduced the method in the context of the analysis of poverty, wealth and their correlates in low and middle-income countries. The reasons for this popularity include a number of claimed practical and theoretical advantages over more traditional money metrics, the indices' robust association with other outcome data across a range of contexts, and the fact that large data sets on asset ownership have been available for some time for numerous countries and years, namely due to the inclusion of a module on asset ownership and dwelling characteristics in the USAID-sponsored Demographic and Health Surveys, which have been implemented since the 1980s.

In the African context, as we will see below, asset indices have for some time suggested welfare trends quite distinct from those produced by other indicators. Specifically, they have provided a more optimistic picture of welfare improvement than trends based on the data from household surveys or national accounts (Sahn and Stifel 2000, Booysen et al 2008, Young 2012). However, Harttgen et al (2012) argue that the use of asset indices for these purposes is inappropriate, due to several methodological biases that will tend to over-estimate welfare improvements. Equally sceptically, Howe et al (2009) argue that asset indices correlate poorly with consumption data, that they are poor at differentiating cross-sectional distribution of welfare, and that it is in fact not clear what it is that they really measure.

Against this background, this paper discusses what the theoretical foundations of asset indices are and what can be determined about their empirical soundness. Based on an examination of the indices' theoretical underpinnings and an appraisal of the available empirical evidence, we claim that asset indices do seem to hold out advantages to both academic and policy researchers working in African countries. However, we also argue that asset indices must be approached cautiously. Specifically, we argue that, in any one setting, the assets to be included in the index must be selected carefully and the technique used to compile it must be applied with caution. Moreover, we concur with Harttgen et al (2012) in considering the use of asset indices in the context of inter-temporal comparisons to be problematic.

Thus, we begin by setting out what asset indices are, how they are compiled, and what their theoretical underpinnings are (section 1). Section 2 considers the history of their application to African countries and in particular sets the scene for the debate between Young (2012) and Harttgen et al (2012) about recent welfare trends. Section 3 assesses the strengths and weakness of the asset index approach using a broad assessment of the asset index. Section 4 concludes.

SECTION 1: THE BASICS OF THE ASSET INDEX

An asset index is any composite indicator such that the underlying indicators on which it is based reflect an individual's, or more often a household's, ownership (or lack thereof) of a range of assets, with the latter understood in a broad sense. Thus, in abstract terms, an asset index is any indicator A_i computed as a function of a set of underlying variables a_{ij}, where a_{ij} denotes household i's ownership of asset j. [1]

$$A_i = f(a_{ij}) = f(a_{i1}, \ldots, a_{im}) \quad (1)$$

Possibly the simplest possible asset index corresponds to a simple count of the assets j=1,m that households i=1,n own, i.e.,

$$A_i = a_{i1} + a_{i2} + \ldots + a_{im}\text{ , where } a_{ij} = 1 \text{ if household } i \text{ owns asset } j, \text{ and } a_{ij} = 0 \text{ otherwise.} \quad (2)$$

This simple case serves to illustrate the general point that asset indices may differ depending on: i) the range of assets j=1,m considered in the construction of the index; ii) the way in which the ownership (or lack therof) of the assets j=1,m translates into values of the respective variables a_{ij}; and iii) the way in which these variables a_{ij} are then combined to construct the composite index A_i.

The use of asset indices as a proxy for welfare or wealth (and thus poverty, if we focus on the left-hand side of the distribution, beneath a certain cut-off point) has its origins in the availability of standardised data on the ownership of a range of durable household goods for a wide range of countries (and in some cases for several different moments in time) due to the inclusion of questions on this topic in the USAID-sponsored Demographic and Health Surveys.[2] For that reason, the range of assets that have typically been used as the basis for the construction of asset indices has been directly driven or inspired by the set of durable household goods for which questions are asked in the DHS (clock/watch, radio, television, motorcycle, car, and so forth), which also includes "assets" that are more accurately described as dwelling characteristics, such as the type of water source, access to electricity, main source of fuel, type of toilet and so on (Filmer and Pritchett 2001:118). However, asset indices have been computed in the context of later studies which have included underlying variables of a different character, such as the number of years of schooling of the head of the household (Sahn and Stifel 2000), living space per person (Wall and Johnston 2008) or the number of cattle heads owned by the household (Abreu 2012), among other possible examples.

[1] Given that asset indices are almost always computed for households rather than individuals, we shall always henceforth always refer to the former.

[2] The number of DHS exercises has expanded over time (to more than 300 surveys in over 90 countries, http://www.measuredhs.com/ accessed 13/4/13), often in the very settings for which there is limited data on income and consumption.

As will be easily apparent, the characteristics of the "assets" in question determine the characteristics of the variables that reflect their respective "ownership" by an household: in the case of most durable household goods usually included in asset indices, it is assumed that either a given household owns the asset or it does not – hence its ownership is represented by a categorical, dichotomous variable a_{ij} that typically, and by convention, takes the value 1 if household *i* does own asset *j*, and the value 0 if it does not. The "ownership" of such assets as the type of water source, type of latrine/toilet or type of fuel source is also usually fitted into a limited number of categories, hence the respective variables a_{ij} might be treated as categorical variables taking on a limited number of possible values (e.g. 1=drinking water from pump; 2=drinking water from open source; 3=drinking water from other source). However, the arbitrary assignment of numerical values to each category renders it impossible to meaningfully use those values in the construction of the asset index, so the standard practice is to unfold the "ownership" of "assets" such as these into a set of dichotomous variables akin to the simpler ones described above (e.g., in the aforementioned example, the categorical variable "type of water source" is unfolded into three dichotomous variables – "pump", "open source", "other source", only one of which takes the value 1 while the others take on the value 0). Finally, the level of "ownership" of such "assets" as the number of years of schooling of the household head, living space per person or the number of cattle heads are usually represented by quantitative variables – depending on the cases, of a discrete or continuous character.

The third relevant aspect that determines the structure of an asset index is the way in which the underlying variables a_{ij} are combined to produce the one-dimensional composite index A_i. Theoretically, any function of a_{ij} can be deemed an asset index. The standard practice, however, is for A_i to be computed as a linear combination of the underlying variables a_{ij}, that is,

$$A_i = v_{i1} x\, a_{i1} + v_{i1} x\, a_{i2} + \ldots + v_{im} x\, a_{im} \qquad (3)$$

, where v_{ij} are the weights assigned to the underlying variables a_{i1}. Again, asset indices may be constructed by assigning any arbitrary weights to each of those variables (including $v_{ij} = 1$ for all $j=1,m$, as in the "simple count" example in the beginning of this section). However, the standard practice is to assign weights based on the variance and covariance of the variables a_{ij} themselves – whether through factor analysis (FA), principal components analysis (PCA) or multiple correspondence analysis (MCA). What these different but similar techniques[3] have in common is that they identify underlying structures in data sets (called *factors* in FA and *components* in PCA and MCA), computed through transformations of the data sets themselves. The output of PCA, MCA and FA is a set of factors or components that are at most equal in number to the original variables, but in standard practice only the first of these (the one which accounts for the largest share of the variance-covariance in the data set) is used to compute the asset index. In the context of computing

[3] Refer to Wall and Johnston (2008:146) or Gordon et al (2012) for a discussion of these various techniques, their uses and their implications. Note, in particular, that MCA is largely analogous to PCA, but the former is appropriate when the original data set is comprised of categorical variables, whereas PCA is a more general technique. MCA also does not presume that variable values are normally distributed. However, Gordon et al (2012: 1210) conclude that '[r]egardless of the choice of weighting method, a key issue is likely to be the selection of a broad and context-appropriate set of assets at the data collection stage'. While agreeing with these authors' point that asset selection is a key issue, we believe that the choice and concrete use of the weighing method can also have important implications.

an asset index, this reflects the assumption that asset ownership is causally determined by many variables (e.g. wealth, availability, cultural norms, individual preferences and so forth), but it is the *main* underlying determinant (assumed to correspond to the underlying unobserved variable that accounts for the largest share of the variance-covariance) that is of interest in computing the index.

The asset index is then constructed by using, as the weights v_{ij} in formula (3) above, the vector of coefficients that transform the original matrix of variables a_{ij} into the *first* principal component (PCA) or into the most important latent factor (FA). These coefficients are called the component scores in PCA and MCA, and factor loadings in FA, are routinely computed by software packages and constitute a part of the output of FA, MCA and PCA exercises. The weights are thus data-driven (Howe et al 2012, p873) instead of theoretically or arbitrarily assigned, but there is an underlying theoretical justification for this: the idea that what we are really trying to measure is not asset ownership *per se*, but rather the main unobserved variable *underlying* the pattern of asset ownership across the sample of households – which is explicitly or implicitly assumed to consist of wealth (Howe et al 2009), long-run economic status (Filmer and Pritchett 2001) or household welfare (Wall and Johnston 2008). Hence the rationale for undertaking poverty analysis based on the use of asset indices: low asset index scores are assumed to correspond to low levels of long-run wealth/welfare/economic status, to the extent that the latter is reflected in the pattern of asset ownership across the sample as the main unobserved variable underlying that data set. And indeed, they have been found to constitute robust predictors of a range of other outcomes, most notably in the health and education domains, across a variety of contexts (Filmer and Scott 2012).

The fact that, when computed thus, asset indices constitute a way of measuring an underlying variable which is not directly observable and which can be interpreted in this way constitutes the chief theoretical argument in favour of using asset indices for analysing wealth, poverty and their respective correlates. However, the validity of the asset index as an indicator of wealth/poverty is contingent on the assumptions outlined above – crucially, the assumption that the underlying variable which account for the largest share of the variance and covariance in the data set can indeed be safely interpreted thus. In fact, exactly what it is that asset indices (thus computed) measure remains a matter of debate in the literature: in their systematic review of previous studies that sought to measure both consumption expenditure and asset ownership, Howe et al (2009) conclude that "the wealth index is at most a poor proxy for consumption expenditure" (id ibid:2) and that "it remains unclear exactly what a wealth index is measuring" (id ibid:12). In our view, however, the latter claim does not necessarily follow from the former: reported consumption expenditure (a flow variable subject to substantial seasonal and other types of variability) does not necessarily correlate strongly with long-run wealth (a stock variable that is subject to much slower change, insofar as fluctuations are smoothened over time). The crux of the matter lies elsewhere: on whether the choice of the assets that are included in the index supports the assumption that their main underlying explanatory variable or factor, as identified through PCA, MCA or FA, does indeed consist of long-run wealth (more on which below, section 3).

Alongside the theoretical argument, a number of important practical arguments have been put forth in favour of using asset indices in analyses of wealth and poverty, namely when compared to traditional money metrics such as income or consumption expenditure based on survey data. Specifically, it is argued that data collection on asset ownership is quicker, easier, more reliable and less susceptible to voluntary and involuntary bias than collecting data on income or consumption

expenditure (Howe et al 2012). Moreover, it may also be argued *a priori* that in many contexts, asking questions on asset ownership is less culturally sensitive, and thus less prone to non-response and/or to compromising the remainder of the interview, than questions on monetary income or consumption expenditure. *Contra* this general view, Onwujekwe et al (2012), based on empirical testing, caution that asset indices may in fact be less reliable (in terms of both inter-rater and test-rest reliability) than generally presupposed, although they do not make the stronger (and more important) claim that the method is less reliable than the alternatives.

Irrespective of their (non-negligible) practical advantages, the previous discussion should help to render clearer what the advantages and limitations of asset indices are in the analysis of welfare, wealth and poverty, as well as their differences with regard to other indicators. Unlike traditional money metrics such as income and consumption expenditure, which are flow variables, a given household's asset index score is determined by what took place in periods stretching back into a potentially unlimited past, i.e. the asset index is implicitly a cumulative "stock" variable. Asset indices also differ substantially from the Multidimensional Poverty Index (Alkire and Foster 2011; Alkire et al 2013, on which more in the next section), another composite indicator commonly used to undertake poverty analyses and comparisons: unlike the MPI, asset indices do not assign equal weights to the various underlying indicators, and therefore do not seek to simply convey a synthetic picture of welfare/deprivation across a range of dimensions, but rather draw on the observed variables in order to identify and measure an unobserved underlying variable. Finally, the asset indices' more ambitious theoretical underpinnings also constitute their weakest spot: if and when, due to the characteristics of the data set, the first principal component or factor turns out to correspond to something other than 'long-run wealth' (say, location or consumption norms), then the asset index is a not a valid proxy. The latter problem will not be readily apparent in the data, however – one needs to identify it in any one setting by examining how the components/factors correlate with each variable, and triangulating that examination with a qualitative understanding of the meaning of the assets in question in each case.

One implication of the above is that the validity of asset indices in the context of wealth/poverty analyses is not universal: asset indices are most valid when the poverty-wealth spectrum is homogeneous within the sample of households and when the selected assets are able to discriminate between households along that spectrum, but validity will tend to decrease with their application to samples in which other underlying variables play a greater role – e.g. across geographical contexts with very different consumption norms or production structures (where the index may mostly reflect those differences in cultural norms or in the economic role of assets[4]), or in the context of inter-temporal comparisons over long periods of time (where the index may mostly reflect changes in prices, commercial availability or consumption norms). Another caveat, of special relevance in the context of inter-temporal poverty analyses, is that, because asset indices are

[4] See for example the discussion about whether asset indices can be computed to include both urban and rural areas. Many authors suggest that the resulting asset index will be poor at distinguishing rural welfare, as the greater wealth in urban areas will mean that assets important in an urban context will have the greatest weights (see for example Booysen et al 2008, Clarke * and Howe et al 2012:874). Our argument here nuances this to point out that this may not be a simple rural-urban dichotomy, but reflective of more complex patterns in the economic and social implications of possessing certain assets which may even differ within rural or urban areas. Another aspect of this is the concern about asset 'clumping', i.e. the inability for simplistic asset indices to differentiate between the poorest in rural areas or the richest in urban areas. Howe et al (2012) argue that this is because the assets chosen are not discriminating enough to pick up local specificities.

implicitly "stock" variables (which for any given household increase with asset acquisition and decrease with asset disposal or obsolescence), a constant asset index score over time for a given household should not be interpreted as reflecting constant wealth or a constant socioeconomic position, but merely the household's ability to exactly replace obsolescing assets – which is a different thing. The implications of this in the context of the on-going debate on "Africa's growth miracle" are discussed further in section 3. First, however, we undertake a review of the use of asset indices in Africa in section 2.

SECTION 2: THE ASSET INDEX AND AFRICA

Despite the investment to build up depleted statistical knowledge and capacity in African countries, poverty data based on household surveys of consumption or income remain poor. A number of authors point out that not all African countries have regular household surveys and that those that exist contain problems with reliability and comparability. At the heart of the problem are the lack of comparability of survey designs and the quality of price deflators (Hanmer et al 1999, Ali et al 2002, Sahn & Stifel 2000). Hanmer et al (1999) also argue that poverty lines themselves are often set inconsistently and arbitrarily, while Sender and Johnston (1995) have argued that the typical household survey may miss out the very poorest. At the same time, we can have little confidence in the data on consumption that is obtained through the national accounts exercise, as this is usually computed as a residual and subject to a range of empirical errors (Young 2012, Jerven 2013).

Asset indices then provide an attractive alternative to measuring changes in either poverty (as done by, for example, Sahn & Stifel 2000) or consumption (Young 2012). Asset indices have been used for some time in sub-Saharan Africa, but it is with the advent of the USAID-funded Demographic and Health Survey (discussed in section 1), that its use became widespread. Given the provision of data of household level welfare for countries where there was previously limited and/or unreliable data, the use of asset indices calculated from the DHS data to measure development outcomes has gain steady acceptance, not least because of the Sahn & Stifel (2000) work discussed below and the work of Filmer and Pritchett (2001).

Asset indices have been used for two purposes. The first and most common is to describe inequalities in various welfare outcomes among households. The list of welfare outcomes includes the experience of fever and malaria, child nutritional status, child mortality, and educational outcomes (Filmer and Scott 2012:2). The second use has been the most controversial and is the subject of this article – to chart welfare trends over time. The starting point was the work by Sahn and Stifel (2000:2123), who expressly argue that asset data should be used to calculate welfare trends in the absence of reliable and comparable data on poverty in African countries. Importantly, trend investigations of welfare using asset indices have generally produced more optimistic findings than those using poverty or consumption data, although the first two attempts did not produce the controversy of the Young (2012) work. We will describe why below.

The first attempt at a large scale welfare assessment using an asset index, Sahn & Stifel (2000), was however very influential in promoting the asset index methodology.[5] Sahn and Stifel (2000: 2127) calculate asset index trends for 11 sub-Saharan African countries for which there were at least two observations at the time of writing: Cameroon, Ghana, Kenya, Madagascar, Mali, Senegal, Tanzania, Togo, Uganda, Zambia and Zimbabwe. Most observations are five years apart, although there is a longer trend of data for some countries, such as Kenya, Senegal and Togo (ibid: 2130). They calculate an asset index for each country using pooled data (i.e. from all the available surveys), and utilising factor analysis. The assets include: radio, TV, bicycle, motorised transport, water source, type of toilet, and floor quality[6]. Interestingly, the education of the household head is also added to the index, making it more multidimensional in character by including a non-physical asset. Two poverty lines are set using the bottom 25% and 40%, respectively, of the first survey.

Considering the lowest poverty line, Sahn and Stifel (2000: 2130) find that only Zimbabwe did not experience statistically significant reductions in poverty. They suggest that their results are cause for optimism of the results of economic and social policy in Africa (2000:2152). This was somewhat contrary to the trends found in poverty surveys using standard income/expenditure data, where the consensus was that there was stagnation in poverty levels from the late 1980s through to the 1990s.[7] Chen and Ravallion (2004), using a $1 a day poverty line and household consumption data, calculate that poverty in Sub-Saharan Africa declined slightly between 1987 and 1999 but then returned to previous levels between 1999 and 2001.

Interestingly though, the Sahn and Stifel paper was not perceived as controversially as the Young paper. One reason might be the extremely short time periods under consideration, with only five years for most observations. Of the two countries with longer observations, only Togo had an unambiguous improvement in welfare. Both Ghana and Senegal (which also had three observations) had complex trends, in the sense that they experienced welfare improvements only for part of the period. More fundamentally perhaps is the fact that the paper itself eschews comparisons with other data on poverty trends – this is because the authors argue that, at the time, the household data was so poor that there was little reliable trend data from other sources.

The second attempt at assessing large-scale poverty trends, Booysen et al (2008), was an explicit attempt to extend and improve the Sahn and Stifel analysis. Although they had to reduce the number of countries, they use a longer track of data (10 to 15 years) for seven sub-Saharan African countries that had all previously been analysed by Sahn and Stifel: Ghana, Kenya, Mali, Senegal, Tanzania, Zambia and Zimbabwe.[8] To obtain a longer time series, they use at least three observation points. In addition, they refine Sahn and Stifel's methodology for the construction of the index. First, they use multiple correspondence analysis (MCA) to construct the asset index (see section 1 above).

[5] As proof of this, a google search of citations suggests twice as many citations as those for other articles in this article.

[6] Although some of these are dropped for particular countries as either the data is not available or the variable violates the characteristics necessary for its use in the index (2000:2128).

[7] The periods covered by the DHS data vary in the Sahn & Stifel paper (2000:2130). The data for Ghana, Mali, Uganda and Zimbabwe covers the late 80s to the early 90s, while the data for Cameroon, Madagascar, Tanzania and Zambia run from the early 1990s to the mid 1990s. There are three countries with a slightly longer run of data, from late 1980s to late 1990s: Kenya, Senegal and Togo.

[8] Their results are for: Ghana 1988-98; Kenya 1989-98; Mali 1987-2001; Senegal 1986-1997; Tanzania 1992-99; Zambia 1992-2001; and Zimbabwe 1988-99.

They use baseline weights for each country – i.e. the asset index weights are computed for the first year of the survey only, effectively baseweighting trends, rather than being pooled as in the Sahn and Stifel work.

As they were trying to use a consistent set of assets over the sweep of history of the DHS surveys, Booysen et al (2008) were constrained both by the shortness of the asset questions asked in the earlier surveys and somewhat by changes in the way questions were asked. As such they had a reasonably reduced list (radio, TV, fridge, bicycle, type of toilet facilities, type of flooring and main water source). Booysen et al (2008) set the poverty lines at 40% and 60% of the initial distribution to chart trends over time. They also set a third poverty line trying to illustrate absolute (rather than relative) poverty – this is the weighted sum of categories that are deemed as representing an adequate standard of living: radio, bicycle, no refrigerator, no TV, cement floor, public water and a pit latrine.

Booysen et al (2008) find that from the mid-80s to early 2000s, poverty had fallen in Ghana, Kenya, Mali, Senegal and Zimbabwe, regardless of the poverty line used. However, in Zambia, it had risen regardless of the line used. Finally, trends were unclear in Tanzania. Using the 40^{th} or 60^{th} centile line, poverty had fallen, but using the absolute line, poverty had risen. Further, and importantly, Booysen et al (2008) compare the detailed results for various countries and find some agreement with standard poverty measures.

Much of the comparable data finds similar trends for Ghana and Zambia. World Bank estimates in Ghana for a sub-period (1992-98) suggest that poverty declined from 50% to 39.5% using household expenditure measures (World Bank, 2005). Teal (2001) also reports that poverty has declined from 53% to 45% in Ghana over the same period as the asset data (1988-98). Partial data for the period is available for Zambia, which suggests that the percentage of the population living under the poverty line increased from 69.2% to 72.9% between 1996 and 1998 based on expenditure data (World Bank 2005). In these cases, the asset index showed a more or less similar trend.

However, contrary results were found for Zimbabwe, Tanzania and Kenya, with the asset index showing more improvement in poverty than the alternative measures. In Zimbabwe's case, the incidence of poverty also increased between 1990 and 1995, rising from 25.8% to 34.9% (World Bank, 2005). Likewise, poverty in Tanzania declined from 38.6% to 35.7% between 1991 and 2000 (Teal 2001). In Kenya's case, other data sources suggest that poverty has been on the rise in the 1990s (Republic of Kenya, 2004; World Bank, 2005). However, Booysen et al (2008) are deliberately restrained about what their trend data suggest. Their arguments will be assessed in more detail in the next section, but here it suffices to say that they argue that asset measures identify only one aspect of (multidimensional) poverty, is slow to reflect changes in income and that there is some evidence that the DHS surveys have a degree of comparability problems.

The most recent work, by Young (2012), is then the most assertive use of the asset index in place of more traditional measures. Young uses DHS data to construct estimates of real consumption growth that he argues are superior to estimates from the national accounts. The controversial result of this paper is that real household consumption in sub-Saharan Africa is growing between 3.4 and 3.7 percent per year, which is three and a half to four times the 0.9–1.1 percent reported in international data sources (Young 2012:698). Specifically, Young (2012, table 1) uses DHS data to

derive 26 measures of real consumption using four types of data (only the first two of which are 'typical' assets):

- ownership of durables (radio, television, refrigerator, bicycle, motorcycle, car, telephone);
- housing conditions (electricity, tap drinking water, flush toilet, constructed floor, log of number of sleeping rooms per person);
- children's nutrition and health (log height, log weight, diarrhoea, fever, cough, alive); and
- household time and family economics (attending school for children and young adults, women working, gave birth in previous year, women ever married).

Changes in these variables between 1990 and 2006 are estimated and related to real consumption growth via estimates of the relationship to education, and then of the returns to education. A group of 29 African countries are used, although only 23 have more than one observation, with the other 6 being used to produce an Africa-wide estimate. This is a very different approach to the standard asset index – with the assets being related to consumption growth and the overall picture being produced by combining individual product estimates according to the elasticity to education. The variables above are estimated in terms of their relationship to educational attainment. At the same time, Young estimates the relationship of educational attainment to earnings. As a result, he can relate the change in durables, housing characteristics, child health and household time/family economics to consumption growth. He argues that these are preferable to the official growth rate data, which have poor statistical foundations (721, 722). The Young (2012) approach is complex and involves a heroic number of assumptions in terms of the relationship between asset growth and educational change, and then between education and income (see Harttgen et al 2012 for a critique, of which more below).

However, as well as being a controversial entry into the debate on African welfare trends, it is also emblematic of a move to a wider conception of welfare than a narrow focus on expenditure changes. Young (2012:698) explicitly states that he takes 'a broader view of consumption than is typically used in the national accounts, including health outcomes and the use of family time'. In many ways this is similar to the use of asset indices in combination with other variables to produce the Foster-Alkire multidimensional poverty index (MPI) used in the UNDP Human Development Report since 2010 (UNDP 2010). The MPI is calculating by assigning each person a deprivation score according to his/her household's deprivations in each of the 10 component indicators. These are grouped under three dimensions: education; health; and the standard of living. It is in the latter that assets are included (UNDP 2013). The standard of living dimension has six indicators, so each component is worth 33.6/6, or 5.6%. The thresholds for the living standards component are as follows: not having electricity, not having access to clean drinking water, not having access to adequate sanitation, using "dirty" cooking fuel (dung, wood or charcoal), having a home with a dirt floor, and owning no car, truck or similar motorised vehicle while owning at most one of these assets: bicycle, motorcycle, radio, refrigerator, telephone or television.

Thus the MPI approach shares a link with Young in the use of data on assets combined with other indicators of welfare to reflect overall welfare. It has generally been used to create poverty rankings across developing countries (see UNDP 2010) but has also been used to determine trends over time for countries where there is comparable data (Alkire and Santos 2010, p53-7). Alkire and Santos

(ibid: 53-7) are able to calculate changes for three countries, two of which are African: Ethiopia and Ghana. Looking over a five year period,[9] they find that poverty decreased in both, but the reduction in Ethiopia was small (at 16 percent) compared to Ghana, where poverty was halved (ibid: 54).

Thus the MPI approach is also similar to that of Young (2012), Sahn & Stifel (2000) and Booysen et al (2008), in that it amalgamates changes in assets and changes in other indicators of health and education to show trends in welfare over time. However, despite a similarity in methodology with other asset approaches (a composite index that encapsulates multidimensional information), a key assumption of the earlier work by Sahn and Stifel and by Booysen is that in the PCA-based asset index method the first principal component accounting for the greatest share of the variance in asset ownership is assumed to be "wealth" – so in the end this is the only (latent) variable that is being measured, whereas the MPI gives equal weights to three dimensions, only one of which is "living standards" (the other two being education and health, very much in line with the HDI approach). Thus, the MPI approach relies on an external set role for particular assets, rather than generating weights from the data itself.

The discussion in this section has set out the use of the asset index as an indicator (usually in conjunction with other measures of development outcome) of welfare, both at a single point and to assess trends over time. While Young (2012) uses it as a proxy for average consumption growth, other authors focus on the left-hand side of the distribution, i.e. on poverty. It is difficult to compare trends obtained from asset-based indices with those from traditional sources (i.e. household expenditure surveys and/or national accounts measures of consumption), given that there is only partial availability of other data, which are often collected for different time periods to the asset data. However, it does appear that the asset-based approach tends to either produce the same or more optimistic estimates as those obtained from household expenditure surveys or from the consumption measure in national accounts data.

SECTION 3: THE ASSET INDEX: A BROAD ASSESSMENT OF ITS POTENTIAL AND LIMITATIONS

Although this is seldom if ever highlighted in the literature, at the core of every PCA-, MCA- or FA-based asset index exercise lies an empirically-derived *model* of what the poverty-wealth spectrum looks like in terms of the pattern of asset ownership: many households own radios, only those that are relatively better-off own bicycles, only the relatively rich own cars or trucks. How the various assets relate to poverty/wealth is not imposed *a priori*: it is derived empirically from the data set, based on how each asset variable varies and co-varies with the other variables (assets). Provided that "long-run wealth" is indeed the main determinant of asset ownership and that the assets have been adequately selected to discriminate between households in terms of that underlying determinant, then, as an example, the PCA/MCA/FA exercise will detect that few households own trucks and those households that do own trucks also tend to own all the other assets – so truck ownership will exhibit a strong and positive component score/factor loading, hence a relatively large positive weight in the construction of the PCA-, MCA or FA-based asset index. This is quite distinct from the MPI methodology, in which the weights are all equal and positive. Similarly in the Young

[9] For Ethiopia, this is 2000 to 2005 and for Ghana, this is 2003 to 2008.

(2012) approach, the weights are calculated from the elasticities of assets to education, which are assumed to be fixed over time.[10]

In the standard asset index methodology, the data, not the researcher, establish how ownership of each asset is to be weighed to compute the overall index score, through a purely mathematical transformation of the original variables. As a consequence, contrary to what is the case with the MPI, in a PCA-, MCA- or FA-based asset index an inferior good (whose demand tends to decrease with household wealth – e.g. a black and white television, in the data set analysed by Johnston and Wall 2008:139) will exhibit a negative component score/factor loading, thus ownership of that asset will contribute *negatively* to the overall asset index score of a given household. This seemingly counter-intuitive property of asset indices (given that people will have spent a positive amount to acquire the asset in question) enables us to better grasp its differences vis-à-vis consumption expenditure data. The underlying rationale in asset index construction is not simply that assets contribute to household welfare, nor that they constitute a direct reflection of income or consumption, but that the patterns of asset ownership across the sample allows us to place households along a poverty-wealth spectrum that is reflected in the variance and covariance of the asset ownership variables. This is a powerful methodology, as apparent in the indices' robust association with other outcome variables in various contexts. However, it is built on two key assumptions: first, that there is a *unique* poverty- wealth pattern across the sample; second, that the weights used in the construction of the asset index (i.e. the implicit "model" of poverty and wealth) indeed reflect that pattern (i.e., that the model is a good model of poverty-wealth, rather than of some other underlying variable). Either of these assumptions may fail to apply, however, and if that is the case then the validity of the asset index as a proxy for wealth and poverty is compromised.

Among the assets that are typically included in asset indices, some are significantly cheaper than others and, as a consequence, more households, including poorer ones, will tend to own them. However, there is seldom a neat correspondence whereby asset 1 is only owned by the wealthiest households (and owned by all of those households), asset 2 by the wealthiest as well as the slightly less wealthy, asset 3 by the wealthiest, the slightly less wealthy and the relatively well-off, and so on. Because many other underlying variables co-determine asset ownership, the actual pattern of asset ownership is much more "noisy" than the ideal situation described above (which constitutes the ideal setting for applying an asset index). In a real-life setting, the actual asset ownership pattern inevitably deviates from this one-dimensional continuum due to the effect of many other underlying factors: prices, commercial availability, consumption norms, productive structures (for those assets that serve an economic purpose), individual preferences, and access to credit, to name just a few. And of course to the latter intervening factors, which co-determine asset acquisition through household consumption decisions, we must add a series of factors that make themselves manifest at an "ecological" level, through public or communal provision, or provision by third parties: this obviously applies to such "assets" as access to electricity or the type of water source, which are

[10] Interestingly Young (2012:726-30) does recognise that the demand for a particular asset in relation to education or income may not always be the same in all places. Thus, in his article, he provides two sets of estimates: one is based on the pooled data for all developing countries in his study; the other is carried out country by country. He provides this latter analysis as he recognises that levels of development is likely to affect the income elasticity of demand (ibid 276). However, this is only allowing the relationship between any one asset and income to varying for different *places*. We argue that income elasticity of demand might change over time for the same country, and also within any one country.

significantly dependent on location and public policy, but in some cases even to more strictly household-level assets: in a given region, cell phones or bicycles may have been distributed or heavily subsidised in the context of development interventions, for example. The more each of these additional intervening variables exerts an impact upon the pattern of asset ownership, the more actual poverty-wealth patterns will diverge from the underlying model estimated through PCA, MCA or FA.

Several authors have pointed out that, for precisely this reason, goods that are provided publicly, communally or which mostly depend on location should be excluded from the asset index (Johnston and Wall 2008). However, the reasons that underlie this sensible advice, which refers to relatively extreme cases where long-run wealth has little to do with asset ownership, in fact apply, to a greater or lesser extent, to *any* asset – given that, to a greater or lesser extent, ownership of any asset is co-determined by factors other than long-run wealth. Booysen et al (2005:24-5) describe the fact that over the period, and for the pooled sample, there had been significant improvement in private assets for households, with increases in radio ownership (12.4 percentage points), TV ownership (9.6 percentage points), fridge ownership (1.9 percentage points) and bicycle ownership (8.3 percentage points). In contrast, government-provided assets tended to exhibit a relative decline, with access to piped water and flush toilets declining (piped water in the home fell by 4.7 percentage points and access to flush toilets or pit latrines were 2.9 percentage points lower).[11] Thus, changes in the provision of services by the public sector are seen to have a significant impact on changes in the asset index over time[12], and so the index cannot be thought to have a perfect relationship with private wealth.

An especially problematic example which nicely illustrates this feature of asset indices is the case of goods that are "inferior" across the data set as a whole but "normal" within one or more sub-samples. The results of a PCA-based analysis by Johnston and Wall (2008:139), for example, show "living space per person" to be such an inferior good in a sample made up of Russian households – a seemingly puzzling conclusion that is explained by the fact that both less living space per person and ownership of most other assets are positively associated with urban living. Amongst each of the "urban" and "rural" sub-samples, however, living space per person is a normal, not inferior, good. Another pertinent example comes from an asset index computed for two villages in Guinea-Bissau by Abreu (2012): portable gas stoves were found to be highly valued in one of the villages but not in the other (for locally-specific cultural reasons having to with the value assigned to added privacy compared to cooking outdoors), but the village where they were highly valued was also much poorer overall, so in the overall sample the gas stove appeared as an inferior good, whereas it is a normal good in the poorer village. This effect, which plausibly accounts for 'clumping' in many asset indices exercises, serves to illustrate two more general points: first, that asset ownership is often very strongly influenced by factors other than household wealth; second, that there are may be quite

[11] There were divergences to this overall picture when results are disaggregated by country. Thus, in Mali and Tanzania, while it is true that access to piped water deteriorated, access to improved sanitation rose and this contributed significantly to the increase in the mean asset index over time (Booysen et al 2005: 26).

[12] Another example can be drawn from trends in the MPI as discussed above in section 2. Alkire and Santos' (2010) work show that the improvement in the MPI in Ethiopia and Ghana was significantly affected by changes in components that reflect public and private service provision. Thus, in Ethiopia, the main drivers of the reduction in the MPI were the improvement in nutrition and access to drinking water. In Ghana, there was more balanced progress across a range of components, but the main improvements were in child enrolment, mortality, and nutrition.

different consumption norms or "idioms of wealth"[13] among even quite proximate geographical settings. This is most obvious across the rural-urban divide, but, as the latter example from Guinea-Bissau illustrates, it may also apply within rural or urban samples.

To sum up, the more asset ownership is co-determined by factors other than long-run wealth, the less the latter underlying variable accounts for variance and covariance in the sample, hence the less obviously it will be identifiable as the main principal component or factor in the analysis and the less valid the asset index will be as a proxy for poverty and wealth. This general theoretical limitation of asset indices may be minimised in practice in two ways: the first way is through the exclusion of assets whose "ownership" can be immediately identified as depending primarily on factors other than household wealth, such as location or public/communal provision, as well as assets for which there is strong evidence of different social meanings among different sub-samples (such as normal vs. inferior). However, because it will not be readily apparent in any one setting, especially from a macroscopic vantage point, what the social meaning of an asset is across the sample as a whole and in the various sub-samples, the second – and in our view unavoidable – way to minimize this problem is to apply this method cautiously, i.e. only in relatively circumscribed settings where all of the non-wealth "noise" factors are likely to have less of an impact, and where it is possible to control for that impact through triangulation based on qualitative evidence. Hardly the case of cross-country comparisons.

The same problem applies to inter-temporal comparisons, in which, again, not only long-run wealth but also prices, commercial availability, consumption norms, productive structures, individual preferences, public/communal provision and access to credit (among other factors) can change over time, sometimes quite rapidly. Unless these are controlled for – which is often not possible, especially from a macroscopic vantage point –, the likelihood of the asset index's component scores being affected by extraneous factors can be quite significant, rendering the asset index invalid (or at least less valid) as a proxy for poverty and wealth. This general caveat constitutes a more general formulation of three of the four arguments against using asset indices in inter-temporal comparisons put forth by Harttgen et al (2012:6):

> *"(…) we argue that asset indices to proxy for levels and trends household consumption are subject to four biases. First, preferences for certain assets might rise over time as assets become more prevalent and part of "normal" living conditions. (…) Second, changing relative prices can lead to a demand shift favoring some assets at the expense of other household expenditures. (…)Lastly, the provision of some assets (such as access to piped water and electricity) are in many poor countries a result of specific government policies*".

The fourth argument put forth by Harttgen et al (ibid:6) against using asset indices in the context of inter-temporal comparisons is one that we have already alluded to above (Section 1): the fact that simplistic inter-temporal comparisons of a stock variable are inherently problematic when one tries to draw conclusions in terms of the period/"flow". Harttgen and his associates formulate it thus (ibid:6): "(…) *the DHS surveys do not record age and depreciation of assets and thus might overestimate the value of assets. This might particularly be a problem if households are reluctant to*

[13] By analogy to Cheater's (1975) "idioms of accumulation".

dispose of older assets and thus one can observe an accumulation of assets with rising average age, thus overestimating the rise in asset values over time." But we can make this even clearer by drawing on the imaginary extreme case of a set of assets subject to no obsolescence assessed across the same set of households five years apart: the households will exhibit exactly the same asset index scores, when in fact they have gone for five years without the ability to purchase any new assets (hence having undergone a decrease in wealth/economic status/welfare).[14]

Because both inter-temporal and cross-country comparisons are especially prone to bias due to the effect of uncontrolled-for intervening variables, we conclude that the use of asset indices, which can be very robust tools and illuminate aspects of social reality which are invisible using the other tools in the social scientist's toolbox, is best reserved for cross-sectional analyses of relatively local settings, where the impact of those variables is likely not only to be lesser, but also more easily controlled-for using triangulation with other evidence. This is the exact opposite of what Sahn and Stifel (2000), Booysen et al (2008) and Young (2012) do. Regardless of whether the asset index is weighed based on pooled data (Sahn and Stifel: 2000) or baseweighted (Booysen et al: 2008), it is likely to be subject to significant bias: the changes in the average asset index scores may just as well be measuring changes in the other co-determinants of asset ownership, which we generally know to have been changing rapidly and in a way conducive to greater asset ownership across Africa. And when the same implicit model is applied to vastly different settings in addition to different moments in time, the various sources of bias add up – and the asset index, as well as the interpretation of its changes, becomes even less valid as a proxy for poverty and wealth.

SECTION 4: CONCLUSION

In this article we have explained the popularity of asset indices to describe two aspects of welfare in African countries. First, and most controversially, asset indices have been used to assess trends in welfare over time. We have argued that this has often involved drawing unsound conclusions about a 'flow' variable, income/consumption, based on tracking a 'stock' variable, assets; and that even when the asset index is more correctly interpreted as reflecting the underlying unobserved variable 'long-run wealth', the likelihood of other underlying variables (changes in prices, commercial availability, consumption norms, public policy, access to credit, and so on) creeping in and confounding the identification of that chief underlying variable rapidly increases. Second, asset indices have been used in cross-sectional assessments of long-run wealth/economic status, and in that context as predictors of a variety of other welfare outcomes within a population. We find that there is significantly more theoretical and empirical support for this, even though, as we have seen, the validity of asset indices as a proxy for wealth is contingent upon the characteristics of the data set.

Provided that asset selection is accurately made, so that assets are able to discriminate along the actual poverty-wealth spectrum, and that there is relative homogeneity of that spectrum within the population, asset indices provide good proxies of long-run wealth. However, the less the selected

[14] There is a related empirical problem due to the inability of the asset index approach to determine the 'quality' of an asset. So surveys generally ask about the presence of an asset of a general type, rather than distinguishing between varying asset qualities – for example, a 20 year old Datsun would be accounted for in the same way as a 1 year old Volkswagen.

assets are good discriminators and the more actual poverty-wealth patterns within the set of households differ from the asset index 'model', the less valid as a proxy for poverty/wealth the asset index score becomes. With more heterogeneous sets of households (e.g. over long periods of time or across significantly different geographical settings), non-wealth explanatory variables take on greater weight.

While it is not possible to indicate *a priori* what the maximum reasonable geographical scale is for using asset indices, it is clear that they are most valid at the local and perhaps regional/national level (though in every case one needs to triangulate with additional empirical evidence) and in cross-sectional analyses, as opposed to inter-temporal comparisons. This, however, does not render them any less useful as part of the social scientists' toolbox, given that in addition to their practical advantages (availability of asset data in already-existing data sets; quickness, cheapness and reliability of data collection) and strong theoretical underpinnings (compared to more arbitrary composite indices), there is also abundant evidence of their robust association with a range of other outcome variables across many settings.

As regards the practicalities of undertaking asset-index-based analyses, our theoretical and empirical assessment suggests that one should: i) generally refrain from using asset indices in inter-temporal comparisons; ii) use asset indices at relatively modest scales and seek to control for heterogeneity of consumption norms and other intervening factors through triangulation; iii) select assets that, based on ex-ante and ex-post analysis, seem to discriminate well along the poverty-wealth spectrum; iv) exclude assets that reflect public/communal provision or which mostly depend on location; and v) check the identified underlying patterns (share of variance and covariance explained by principal components and/or factors, association between components/factors and variables) in order to assess whether the results are consistent with the key assumption of the 'asset index model' (i.e. that the main principal component/factor can be safely interpreted as 'long-run wealth').

Whether or not there is an African growth miracle does not seem to be the sort of question that asset indices can possibly answer, but if carefully used they can illuminate aspects of African socioeconomic reality that are not visible under the light of other methods and indicators.

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