Money Metric versus Non Money Metric Measures of Well-Being

Abstract

Money metric measures and non-money metric measures provide different household rankings of well-being in South African in the post apartheid period. This paper studies both money metric and non-money metric levels of welling-being at two different points in time in order to establish whether real welfare gains have taken place in South African in the post apartheid period. I find that the two measures provide a relatively tight overlap between household rankings within periods especially within racial groups. Furthermore the distributions of well-being become less bimodal in the post apartheid period indicating that the less segregated a society is, the larger the overlap in distributions. The main results are that real welfare gains have occurred for all population groups in the post apartheid period, especially Africans using both measures of well-being and that the gains measured in non-money metric measures of well-being are larger than gains measured in money metric measures of well-being.

Section 1 Introduction

The analysis of social well-being is typically conducted using money metric measures such as income or expenditure. However in the last decade non-money metric measures of economic well-being have become prominent. The World Bank's Living Standards Measurement Study (LSMS), consisting of over 170 surveys in 70 countries, offers a wealth of information with regards to household assets (Montgomery et al. 2000). Montgomery (2000) was the first to derive a proxy indicator of economic status using asset data from LSMS household surveys. This approach was further developed by Filmer and Prichett (1999), who employed Principal Component Analysis, and later by Sahn and Stifle (2000), who applied Factor Analysis, to derive their respective asset indexes.

Since then a debate surrounding the effectiveness of asset indexes in capturing economic well-being has evolved. In particular asset indexes have been found to be better predictors of nourishment (Sahn, 2003), health status (Lindelow, 2006) and fertility (Bollen et al. 2001) than income and expenditure measures. The aim of this paper is to further the debate between money metric and non-money metric measures of economic well-being in South Africa over the last decade and a half. South Africa not only has sufficient data to address the issue, but also in unique circumstances of interest.

Between the period 1993 to 2008 South Africa has experienced its first decade and a half of democracy. One would expect that the transition to a democratic state has resulted in substantial changes in well-being of South Africans. However the literature paints contrasting pictures of the changes in well-being of South African's during the first years of Democracy based on the metric chosen. Leibbrandt et al. (2010) finds that between 1993 to 2008 South Africa's aggregate income inequality has increased. Furthermore, during the same period aggregate income poverty has fallen slightly but continues at acute levels for certain groups (Leibbrandt et al. 2010). Money Metric measures of well-being thus present a mixed view if changes in economic well-being over the period 1993 to 2008.

Non-money metric measures of well-being tell a different story. Bhorat et al. (2009) shows that the majority of South African's has access to public assets such as formal housing, piped water, electric lighting and electric cooking and certain private assets such as radios and televisions.

Using this specific situation in South Africa, and the respective increase in economic well-being as per non-money metric measures and the ambiguous changes in economic well-being as per money metric measures, this paper aims to draw a comparison between asset-based non-money metric measures and money metric measures of wellbeing. Such a task is completed both within period and across period, in order to contribute to the current understanding of economic well-being and livelihoods in South Africa.

In particular this paper is concerned with three questions, namely what are the differences between money metric and non-money metric measures of well-being within two specific periods; at the start of the post-apartheid period and then in 2008? What are the changes in well-being South Africa over this period as measured by money metric and non-money metrics? Why do these changes exist and what has happened in South Africa to cause these divergent results? Underlying these questions lies the

issue of the interconnections between monetary and assets measures.

In answering these questions I will proceed as follows: After an overview of the debate between money metric and non-money metric measures (Section 2), methodology used (Section 3) and data employed in the analysis (Section 4), I focus attention on the differences between the two metrics within specific periods, namely the start of the post apartheid (Section 5) and then a decade and a half later, in 2008 (Section 6). I then investigate the inter-temporal changes (Section 7) before concluding (Section 8).

1. Literature

Sen (1988) argues that the economic well-being of a person is achieved through a person's capabilities and functioning's such as health, nutrition and opportunities (Sen, 1997). Such functionings not only depend on the commodities owned by the individuals but also the availability of public goods and the ability of the individual to use private goods provided by the state (Sen, 1997). Economic well-being thus is multi-dimensional in character. Generally economists summarize this multi-dimensional character into a single monetary measure by employing money metric approaches to measure well-being, favouring in particular income and expenditure measures. These measures are cardinal, allowing one to make direct comparisons and quantitative analysis and are straightforward to interpret (Moser & Felton, 2007). However by aggregating a household's material living conditions one is able to capture a different dimension of economic well-being (see (Sahn, 2003)(Filmer, 2001)(Bollen et al. 2001)). Assets are purchased and accumulated overtime and thus reflect a longer-term level of economic well-being than the point estimate of expenditure, and particularly income measures (Wall & Johnston, 2008). Sahn (2001) thus points out that asset indexes and expenditure measures do not correlated closely as the former identify long term well-being in a superior way to money metric. However economists have little theoretical grounds to argue such a case and have instead attempted to verify their asset indexes relative to money metric measures of well-being. Such approaches included regressing asset on income or expenditure to determine whether the variation in asset ownership can explain the variation in income or expenditure (Filmer et al. 2008).

For the purpose of this analysis I do not place expenditure measures as the benchmark to beat with regards to welfare analysis, but instead place both money metric and non-money metric measures on equally footing to analysis the welfare implications captured by both measures. Thus the aim is not to determine which metric is the "gold standard" but instead whether the metrics differ within period and across time and, if so, why.

2. Methodology

For the comparison between money metric and non-money metric measures careful attention should be paid to the construction of the respective indexes.

2.1 Money Metric

The study of money metric measures of well-being will centre on income and expenditure measures. However, this is dependent on the comparability in measurement methodology of income or expenditure across the two sources of data. This is discussed further in Section 4, with particular reference to the data employed in my analysis. Throughout this paper income and expenditure will be accessed as a household total that is then adjusted for household size. This approach is preferred as it includes all household members, including members not participating in the labour market and children, before assuming that each member gets an equal share of household income (Leibbrandt et al. 2010). Furthermore the correction for household size is a straightforward way of dealing with changes in household composition during the 15-year period (Leibbrandt et al. 2010). No equivalence scale is applied and thus all household members are treated equally. The natural log of per capita household money measures is taken in order to reduce the influence of outliers on the distribution. Furthermore money metric measures are adjusted too real household per capita incomes and expenditures in order to all for comparison of real well-being over time. Thus, households can be considered economically better off to the extent that real household per capita incomes increase (Leibbrandt et al. 2010).

2.2 Non-Money Metric

The study of non-money measures of well-being will hinge on the construction of an asset index. An asset index attempts to capture household well-being as the weighted sum of indicators of household ownership of or access to certain assets. Most asset indices follow a similar approach. The indicator, A_i is computed by a weighted average of the assets as follows:

$$A_i = b_1 \cdot a_{1i} + b_2 \cdot a_{2i} + ... + b_k \cdot a_{ki}$$

Where (a_{1i}, a_{2i}, ... , a_ki) indicates asset ownership, (b_1, b_2, ... , b_k) are the relative weights assigned to each asset and "i" indicates the specific household.

In order to calculate an asset index, one has to decide on both the assets to include in the index and their respective weights. The weighting used in an asset index can be calculated in several ways. Two common techniques are Principal Components Analysis, as used by Filmer and Pritchett (2001), and Factor Analysis, as used by Sahn and Stifle (2000). The intuition behind these approaches is that asset ownership is correlated to a latent variable; well-being. The weights translate assets owned into the asset index that is the estimate of this latent variable. The two methods derive this relation in a different way.

It should be noted at the start that no per capita adjustment will be made when calculating asset indexes. The rationale

behind this approach is that household assets are non-excludable and thus enjoyed by all members of the household. Furthermore such an approach has the implicated assumption that economies of scale within assets are infinite. Sahn (2000) finds no differences in household rankings when adjusting for household size even when such an adjustment makes use of an equivalence scale. However, one has to be careful when comparing these asset indices to money-metric measures to be clear as to which money-metric measure is being used.

2.2.1 Principal Components Approach

The principal component technique (PCA) is a multivariate technique first used by Karl Pearson (1901). It is employed in welfare analysis with the assumption that household long-run wealth explains the maximum variance in the asset variables (McKenzie, 2005). PCA solicits a linear combination of variables such that the maximum variance is extracted from the variables. The method is applied several times with each application extracting variation, which is unexplained by the previous application, and forming a principal component. This is repeated until all the variation is explained by the principal components. The weightings used in the construction of the asset index are the first principal component as the variation extracted by the first principal component is argued to capture the latent variable well-being (Filmer, 2001). The first principal component, λ, is a linear combination of the asset vector x_i, such that:

$$\lambda = \alpha_1(\frac{x_1 - \overline{x_1}}{\sigma_1}) + \alpha_2(\frac{x_2 - \overline{x_2}}{\sigma_2}) + ... + \alpha_n(\frac{x_n - \overline{x_n}}{\sigma_n})$$

has the greatest sample variation of linear combination subject to the restriction that

$$\alpha^{|}\alpha = 1$$

where α_i is a vector of coefficients, σ_i the sample deviation of the asset x_i, with mean $\overline{x_i}$ (Filmer, 2001). Due to the standardization of the variable, λ has a zero mean and a variance of σ^2, which is the largest Eigen value of the correlation matrix between the various assets (McKenzie, 2005). If the assets are indicated in the form of a dummy variable, $\frac{\alpha_i}{\sigma_i}$ captures the effect of ownership of asset x_i on the asset index λ (McKenzie, 2005).

As a result an asset owned by all households will have a zero weight, as none of the variation between households is explained by this particular asset (McKenzie, 2005). Likewise assets, which vary the most between households, will receive the largest weight.

2.2.2 Factor Analyses Approach

Another commonly used approach is Factor Analysis (FA). The approach is similar to PCA, but overcomes one of its greatest challenges as it allows some degree of error. PCA conducts a variance-maximizing procedure, whereas FA estimates the quantity of variability due to

common factors (Sahn, 2001). Instead of principal components capturing the latent variables, FA produces common factors, which account for variation in at least two of the original variables (the correlation between variables). FA allows one to derive a community variable, which indicates the amount of variation of the original variables explained by the common factors and thus a value for the latent variables. Applying this to asset results in a community variable that captures household well-being (Shan, 2001). The two methods produce the same result if latent variables, which variation is not explained by the common factors, have the same variance (Filmer et al. 2008).

The main advantage of FCA lies in inter-temporal comparisons. Sahn (2000) constructs a method to compare asset indexes inter-temporally. The first factor is obtained by applying factor analysis to a pooled dataset consisting of the two datasets from the periods in questions. The first factor is then applied to each dataset individually in order to construct the asset index for that particular period. It is plausible that the weights of the assets differ between periods as ownership of certain assets have increased, or decreased over the years and thus variability of ownership between years differs. This results in FA placing more weight on an asset in the first period, where asset ownership is low, than in the second due to the decrease in asset ownership variability (McKenzie, 2005). To study the relationship between money and non-money metric measures a different technique is used for within period analysis than inter-temporal analysis. In order to draw comparisons within period, I employ PCA and FCA which is found to yield similar results. However inter-temporal comparisons are constructed using only FCA as per Sahn (2000). The Sahn (2000) technique is employed as well as an alternative application whereby each dataset's asset index is constructed individually using FA instead of pooling the dataset.

3. Data and Definitions

3.1 Data

To sufficiently compare money metric to non-money metric measures pre and post apartheid datasets containing both measures accurately for both periods are crucial. The pre apartheid era has a dim choice of datasets, however on the eve of transition to democracy, the World Bank, in collaboration with the South Africa Labour and Development Research Unit (SALDRU) at the University of Cape Town, conducted a LSMS named the Project for Statistic on Living Standards and Development (PSLSD). Numerous researchers have vetted this dataset. (see (Case and Deaton, 1998) (Duflo, 2003))

The PSLSD was conducted in 1993 as an attempt to overcome the flaws in national dataset collected by the apartheid government as, at the time no nationally representative dataset covering all of the country existed (Wilson, 1995). Sampling was conducted on a two stage self weighting approach, using Census Sub Enumeration

Districts as first stage units and households as second stage units. Approximately 9000 households were sampled across South Africa resulting in a total sample of approximately 40 000 individuals. These can be weighted to be representative of the nation in 1993. This dataset will be used at a benchmark for income and asset measures before democratic transition.

In contrast the Post-apartheid period has a bounty of potential dataset candidates. The General Household Survey has conducted annually between 2002 and 2009, the Income and Expenditure survey was conducted from 1995 and the Labour Force Survey was conducted on a regular basis during 2000 and 2007. Only the Income and Expenditure Surveys have sufficient information to construct money metric measures, but fail to account for household assets. As a result the National Income Dynamics Survey (NIDS) is employed as it adequately contains both money and non-money metric measures. The National Income Dynamics Study is a panel study conducted in South Africa with its first wave being undertaken in 2008. A total of 7305 households were surveyed with the aim of sampling 28 000 individuals. NIDS was conducted in a similar fashion to the PSLSD with a two stage clustering design selecting first on enumeration level before randomly selecting households within the selected EAs. Both survey's complex designs have been taken into account throughout this analysis. However when weighted both provide nationally representative statistics. Thus the advantage of studying changes in well-being in South African in the post apartheid period lies in having two datasets, which can be weighted to be nationally representative, that contain sufficient money metric and non-money metric measures of wellbeing.

3.2 Definitions.

The two datasets provide sufficient and adequate information with regard to income and expenditure as well as household assets. The assets included in the asset index can be grouped into two categories: household durables and public assets. Household durables or private assets consist of consumable items while public assets or household characteristics are generally supplied by the state and require a certain degree of infrastructure.

When conducting inter-temporal analysis using two cross sectional datasets differences in methodology confound the comparison. This is evident in both money and non-money metric measures captured by the PSLSD and NIDS.

On non-money metric front, the two dataset differ in asset registries. In total thirty-one assets categories exist of which NIDS contains twenty-nine and PSLSD contains nineteen. NIDS does not include an electrical kettle or the presence of a geyser in its asset register. Some of the assets not included in the PSLSD are due to technological progress. Assets, such as computers and cell phones, were not as prominent in 1993 as they are now and thus were not included. Furthermore, NIDS includes greater detail with regards to transportation assets (such as motorcycles, boats, donkey carts) as well as agricultural assets (such as tractors, ploughs grinding

mills), which are not included in the PSLSD. However the PSLSD has the advantage of not only including ownership of asset but also quantity of each asset owned. A detailed comparison between assets is contained in Table 1 below.

Both surveys contain sufficient information in the questionnaires with respect to public assets, defined as type of dwelling, piped water, electricity and toilet facilities as proposed by Bhorat (2009).

Provided in Table 2 is an overview of private asset ownership for 1993 and 2008 as a percentage of the entire population. From Table 2 one can see that ownership of asset has changed dramatically between 1993 and 2008. For example the ownership of a Television has increased from 48.61% in 1993 to 67.47% in 2008. The third column is derived from the PSLSD's property of quantity of each asset owned and provides the average number of assets owned per household in 1993. For example, on average each household in South Africa in 1993 owned at least 1 radio with some households owning more than one. Access to public asset for the years 1993 to 2008 is also provided in Table 2 all of which indicate dramatic increase in access to public assets.

With respect to money metric measures, the dataset contains an abundance of money measures. However, the money metric methodologies differ between the two datasets in several ways. Firstly, one individual, on behalf of the entire household, answered the PSLSD questionnaire whereas in NIDS the entire household was questioned (Leibbrandt et al. 2010). As a result NIDS is less prone to measurement error. Secondly, the treatment of implied rent differs between the surveys. NIDS applied a nuanced methodology, derived from several variables, in calculating the opportunity cost of living. On the other hand the PSLDS applied a set rate of return, implying a linear relationship, which is troublesome for the tail ends of the distribution where this might not hold (Leibbrandt et al. 2010). Furthermore the treatment of agricultural income differs between the two datasets. In particular the PSLSD included commercial farmers, resulting in an inflated mean per capita household agricultural income, whereas NIDS excluded all commercial farmers in agricultural income calculation (Leibbrandt et al. 2010). As a result of the discrepancies between the measurement of income and expenditure between the two datasets, I elect to proceed using income as a money metric as a greater similarity between income measurement exists across surveys than the expenditure measures.

Descriptive statistics for income and expenditure measures over the course of the period are provided in Table 3. The mean estimates for changes in income are substantial with household income increasing over the period from R 10 741 in 1993 to a comparable real amount of R 24 409 in 2008. The median, which is less sensitive to outliers, paints a similar picture. However during this period income inequality increased significantly. Furthermore, Foster-Greer-Thorbecke (FGT) poverty indices for the upper and lower bound poverty lines of R949 and

R515 indicate a slight decrease in poverty during the period.

The changes shown in Table 2 and Table 3 between 1993 and 2008 are indicative of the changes in well-being over the period. However from the descriptive statistics one can see that the two metrics paint different inter-temporal changes in well-being. In particular, money measures of well-being provide an ambiguous change over the period as income per capita has increased coupled with an increase in income inequality, while non-money measures have shown an unambiguous positive change in well-being over the period. To unpack this puzzle the analysis begins by studying the difference between the metrics within 1993 and 2008 before studying the changes over time.

4. Within Period Analysis at the dawn of the post- apartheid period (1993)

I start the analysis of the differences between money metric and non-money metric by contrasting differences in well-being between the metrics within 1993. This approach allows me to isolate the differences and dynamics between the measures before introducing the inter-temporal analysis. The within period analysis commences by constructing asset indexes using both PCA and FA and analysing the relative weights attached to the ownership of certain assets. This is followed by the comparison of non-money metric measures to money metric measures, which is contrasted in several ways. Firstly, the kernel density plots of the measures are provided before evaluating the two measures using quantile plots. The analysis is continued by examining row probability tables in order to determine the decile-to-decile ranking overlap for the white and African population. I conclude the comparison by studying the 3D kernel density plots and contour plots of the decile rankings.

4.1 Construction of the Index

Asset indexes are constructed using both PCA and FA. The weightings for the asset index from both FA and PCA are provided in Table 4. The correlation between the two methods of construction is 0.9982 as per Table 5b. The high correlation between the two approaches indicates that the error term in FA, the variation left unexplained by the common factors, is zero. The high correlation indicates that despite different approaches, for within period analysis PCA and FA provide similar results in the ranking of households for welfare analysis and as a result I continue the analysis using only the FA asset index. Figures 1 graphically represent the Eigen scores, indicating the virtue of selecting the first Eigen value as weights as it captures the vast majority of variation between assets by achieving the highest Eigen values, given the number of values derived from the analysis.

The squared factor loading, the equivalent of the R-squared in OLS can be calculated by dividing the relevant factor by the number of assets thus providing the percent of variance explained in that asset by the factor. A factor loading of 0.8955 is obtained indicating the

large proportion of variation in asset ownership explained by the first factor. Low Eigen Value scores indicate that the asset in question is contributing little to the explanation of the variance in the collection of assets. The vast majority of the asset weighting's are positive. Thus these assets contribute more to the variation among assets than other assets. As the variation extracted by the first factor is argued to capture the latent variable well-being, possession of these assets indicated greater well-being as per non-money metric. In particular the ownership of kettle, geyser and fridge have greater asset values attached to them than assets such as a bike, a radio or a gas stove and thus indicate greater welfare gains. All public assets receive relatively high weightings. The weighting on education should be interpreted as the weight attached to each year of education, of the head of household, whose education is proxy for total human capital within the household. Thus the completion of high school (12 years) has the largest weight of 0.5 which is the largest weighting assigned to an asset highlighting the importance of human capital accumulation. However the weighting for ownership of a paraffin stove is negative indicating that ownership of such an asset is a signal of asset deprivation and thus only owned by poor households. Households owning a paraffin stove are not as well off as households who cook by means of gas or electricity.

4.2 Comparison Between Money Metric and Non-money metric Measures in 1993

I compare money metric and non-money metric measures in several forms. Firstly I visually contrast the kernel density plots of the asset index and the log of per capita income normalized. Secondly I conduct a quantile-by-quantile comparison of the rankings assigned to each household by the two metrics using quantile plots before contrasting the decile rankings through row probability tables.

Figure 2 provides the kernel density plots of the asset index and the log of per capita income normalized. In order to obtain the representative density plot for the log of per capita income normalized the survey weights are adjusted to include household size by multiplying each household's respective weight by the number of household members. The asset indexes are not normalized, as PCA and FA provide indexes with zero means, nor are they adjusted for household size as previously mentioned. Figure 3 provides the density plot of per capita income. The distribution of per capita income has larger tails than the distribution of the log per capita income, indicating the effectiveness of the natural log as a monotonic transformation reducing the effect of outliers. Both distributions roughly follow a normal distribution. However the distribution of the asset index is a bimodal distribution. This is evident in the occurrence of two distinct peaks or local maximum. Bimodal distributions most commonly arise when two unimodal distributions of different modes are combined. At the time South Africa was a

society divided along racial lines. Therefore Figure 4 and Figure 5 segregates the distribution of each metric according to race. The dissimilarity between population groupings is dramatically prominent using both metrics. The dissimilarity is largest between the African and White population with the Coloured and Indian distributions lying closer to the White distribution. The White and Asian populations are densely situated at the upper end of the distribution, while the Coloured population exhibits a long tail to the left. Africans on the other hand are centred to the lower end of the distribution and exhibit a long tail to the right. From the distribution it can be concluded that in 1993 the asset poor were predominately African, while other population groups in particular the vast majority of the white population were relatively asset affluent. Thus the visually comparison of the kernel density plots of the asset index and the log of per capita income normalized tell a similar story.

Figure 6 provides a quantile plot for the African and White populations. The White population's quantile plot lies above the African's quantile plot for every single quantile indicating that the members of the White population were better off, on a non-money metric measure, in every quantile than their African counterparts. In particular the asset scores of the 20^{th} White quantile is only achieved by the 90^{th} African quantile, indicating the extreme asset inequality between the two population groups. The White population quantile plot is relatively flat, representing the intense density, and thus close similarity between asset scores, depicted in the kernel density for the White population. The African population's quantile plot remains relatively flat until the 40^{th} quantile before increasing in slope. This captures the shape of the kernel density plot where the majority of African households received relatively low asset scores and a long tail to the right existed.

The differences between the metrics are further unpacked by analysing the row probability tables of the money and non-money metric household rankings for the African and White population. These indicate the probability of being ranking in a particular decile for a specific metric given your ranking obtained using the other metric and are thus know as inter decile correlation tables between rankings. Thus this enables a comparison of the household rankings assigned by the two metrics. The tables are interpreted as, given the household's ranking according to the asset index, what is the probability that a household is ranked in a particular decile according to expenditure measures. A perfect correlation between the two rankings would be achieved if all households were situated on the diagonal. Table 6 provides the row probability tables. The majority of households are situated on or close to the diagonal indicating the similarity of the two measures and a tight fit between the rankings. However, the mismatch between the metrics' rankings occurs in the lower and very upper deciles. Generally a household ranked in a particular decile according to the asset index has approximately 20% chance of being ranked in the same decile according incomes measures. The kernel density plots for the asset index and expenditure measures have already provided motivation to include race

in the analysis and as a result Table 7 provides the row probabilities for White households and Table 8 provides the row probabilities for African households. The row probability rankings are extremely tight for White households. No White household ranked in the 1st or 3rd decile according to the asset index and 100% of all households in the 5th decile are ranked in the 1st income decile. The tightness is biased to the left of the table. However a similar mismatch to that of the whole population is achieved between the rankings of money metric to non-money metric measures for African. A possible explanation for the tight overlap for the White population is that access to public assets such as piped water and formal housing have large weightings in the construction of a household indicator. The apartheid government blatantly favoured white households and thus they had privy access to such infrastructure. As a result no white households are ranked in the lower deciles of the asset index and continue to have a tighter overlap for the in higher deciles and thus the bias to the left within the row probability tables. The African population's row probabilities are less tight with little overlap with few cells achieving an inter decile correlation of 20% or greater.

These row probability tables have allowed us to study the overlap between rankings derived from both metrics. However, the row probability tables do not indicate where the distribution of household lies within the decile. Figure 7 provides the kernel density plot for both Assets and Income rankings for Africans and Whites. The Income density is closely situated to the asset density for both the White and African population. This indicates that the majority of households receive similar rankings from both metrics. However, one is not able to determine how tight the rankings are due to the two dimensional nature of the plot. As a result I construct 3D kernel density plots and contour plots. These plots indicate the proportion of the population allocated to each decile by either height, in the 3D plot, or colour intensity in the contour plot. Figure 8 and Figure 9 provide the 3D kernel density plot and contour plot for the White population respectively. The vast majority of the white population is situated in the upper deciles of both income and asset measures. This is indicated by the flat surface and packed peaks of the 3D plot and the intense colour in the top right corner of the contour plot. These figures indicate that the majority of White households receive similar asset and income rankings. Furthermore the White households populate the upper deciles of both rankings.

The 3D density and contour plots for Africans, provided in Figure 10 and 11, tell a different story for Africans. Both plots indicate a relatively tight match between rankings indicated by either several peaks situated near to each other in the 3D plot or the high colour intensity achieved in the contour plot. Unlike the White population, the African households are densely situated in the lower deciles of both distributions. The contour plot does a particularly good job of highlighting this with the large portion of the lower decile dedicated to red.

The plots studied above have shown that both income and asset measures, which have provided relatively tight rankings within

race have shown the large income and asset inequality present in South African society in 1993. Racial divisions heavily characterize the pre apartheid period. This is evident in the comparison of well-being measured by money metric and non-money metric measures. However tight rankings are obtained between each ranking for each particular race. Thus the overlap between household well-being rankings obtained using both metrics is dependent on the divisions within a society. A society less segregated would produce a tighter overlap between rankings.

5. Post apartheid period (2008)

The earlier comparison of the descriptive statistics of asset ownership and income distribution alludes to different well-being in post apartheid South Africa. I analysis the period by studying well-being in 2008 following the same structure as before. I begin by constructing an asset index from the 2008 asset bundle, before analysing the kernel density distribution plots of both income and asset metrics and continue with a quantile-by-quantile comparison before accessing the row probability tables from the African and White population. The 3D kernel density as well as the contour plots is provided in order to study the distribution of households given their rankings.

5.1 Construction of the Asset Index for 2008

An asset index using both PCA and FA approaches is constructed. The correlation between the two approaches is high at 99.83% as reported in Table 5b. This supports the conclusion that both PCA and FA produce similar household rankings in the construction of an asset index, as the error term in FA is close to zero. As before I continue by making use of the FA index only. Figure 12 provides the Eigen value plot for the FA asset index. The weighting for the respective assets are provided in Table 10 yielding similar results to those obtained in the construction of the 1993 index as the majority of assets are positive. However three assets receive negative scores namely paraffin stoves, ox plough and livestock. The explanation of the negative sign for paraffin stoves is similar to the one provided previously. However the reasoning behind the negative sign for livestock differs. Crosoer et al. (2005) notes that the negative sign results in unfairly penalizing households who own livestock as livestock is correlated with rural areas, which is strongly associated with the poor. Thus the negative sign does not capture the wealth associated with the possession of livestock. However the relative weighting of livestock is quite small in comparison to other assets. Public assets still receive relatively higher scores but are no longer at the top of the asset ranking scores. Assets with the largest weightings are now microwaves and washing machines, which were not included in the 1993 index. Despite these assets achieving relatively high asset scores, they will not be included in the inter-temporal analysis, as they are not reported in the 1993 dataset. Inter-temporal analysis is conducted on a pooled dataset and thus the asset registries should be perfectly aligned. As a result microwaves, washing machines

and other asset reported in 2008 will not be included.

5.2 Comparison Between Money Metric and Non-money metric Measures in 2008

As before I visually compare the kernel density of both the money and non-money metric before contrasting the quantile by quantile differences between the metric.

Figure 13 provides the kernel density plot for the asset index and the log of per capita income. The income distribution follows a unimodal distribution, however the asset index follows a bimodal distribution. I again decompose the distributions by segregating by race. The dissimilarity between population groupings is prevalent for both metrics as shown in Figure 14 and 15. The distribution of the asset index by race produces particularly interesting results. The White population distribution is centred to the right of the other distribution, with a small tail to the left, with its upper tail lying to the right of the other curves indicating that the upper portion of the White population has greater asset well-being than any other population groups' upper portion. However, the Asset Index distribution for the African population is a bimodal distribution with two peaks unlike the asset index distribution for Africans in 1993. This leads us to conclude that the African population has segmented since 1993 into two groups where one has relatively greater well-being as measured by an Asset Index. However I cannot simply contrast the African distribution between 1993 and 2008 as they stand, in order to infer whether a segment of the African population has improved their well-being since 1993, as the two asset index metrics were constructed individually. In order to establish real changes in well-being across time the asset of the 1993 population needs to be pooled with the assets of the 2008 population and a joint asset index needs to be constructed (see Section 6 for inter-temporal analysis). It is unclear whether the shift in distribution of the African population has resulted in a tightening of household rankings obtained by the different measures or in a greater mismatch. However I first analysis the inter quantile effects.

The quantile graphs of the two measures (Figure 16) are plotted for both the African and White populations. Just as in 1993, the difference between the African and White plots is stark. The White population lies above the African population highlighting the differences in asset well-being as indicated in the kernel density plot. The shape of the White population's quantile curve in 2008 is similar to that of 1993, however the curve has a marginally steeper slope caused by the left tail of the distribution. Unlike 1993 where the African's quantile curve achieved a positive slope only after the 40th percentile, the 2008 African population's quantile curves achieve a positive slope immediately. I am able to study this further by analysing the row probability tables.

The row probability table is provided in Table 11 for the entire population. When comparing the rankings of households between asset index rankings to that of income rankings for 1993 and 2008 (as per Table 6 and 11) additional households are

situated on the diagonal in 2008 indicating a tighter relationship between income and asset rankings in 2008 than in 1993. Table 12 and 13 provide the row probabilities for the White and African populations respectively. A greater overlap between the two rankings is achieved in 2008 when compared to 1993 for the White population. The upper deciles yield a tighter fit with the 10th decile where 53% of households ranked in the 10th decile according to the asset index is also ranked 10th index according to income. This is however not the case for the African population. A tighter match between the rankings is achieved for middle of the distribution ranked between the 4th and 6th decile. However the mismatch between rankings is again prevalent in the lower deciles with a greater dispersion occurring in the 2nd and 3rd decile with only 14% of households ranked in the 2nd decile according to the asset index being ranked in the 2nd decile for income measures. This is somewhat smaller than the 21% overlap obtained for the 1993 period. African population is less tight than the row probabilities for the white population. Despite this a greater overlap between the metrics in 2008 than in 1993 for the African population is achieved. Unlike the 1993 row probability tables the white population extends over the entire table including all deciles of the asset index, representing the leftward tail of the density curve.

As before the row probability tables have allowed us to study the overlap between rankings derived from both metrics, but did not indicate where the distribution of households lies within the decile of both rankings. To see this I plot the 3D kernel density and contour plots for Africans and White for 2008.

The 3D and contour plot for the White population is provided in Figures 17 and 18. A similar picture to the distributions of White households in 1993 is painted. However notable changes in African distribution is portrayed in Figures 19 and 20. The contour indicates that African households are situated at the bottom of the distribution but have spread out, along the diagonal, to the upper ends of the distribution. However it cannot be said that a significant percentage of African households are located in the upper deciles of both metrics. The 3D kernel density plot highlights this by several peaks in the lower and middle deciles and few in the upper deciles.

Unlike 1993, South African society is no longer legally segregated along racial lines. In the 2008 period there is a subset of the African population, which has segregated from the remainder of the African population and achieved a different welfare ranking as per the kernel density plots of the asset index. There is a tighter match between the rankings of the asset index and that of the income measures for white and non-white members of the population in 2008 than in 1993. Despite these findings I can only evaluate them within period as the non-money metric measure was constructed for each period separately. Thus I construct a new, pooled asset index in order to draw inter-temporal comparison of well-being between 1993 and 2008.

6. Inter-temporal Comparisons

Inter-temporal comparisons of money metrics are traditionally calculated with the help of deflators in order to account for changes in price levels over time. However the comparison of real changes in asset welfare is not so simple. In order to draw conclusions from the inter-temporal analysis I construct an asset index using the method proposed in Sahn (2001) whereby the researcher pools the two cross sectional datasets in order to construct the factor weightings for both periods collectively. FA assigns a weight to an asset according to the variability of ownership of the asset. As ownership is likely to differ between the two periods, having either increased or decreased in popularity, different weights will be assigned to the same asset for different periods. However, by pooling the datasets FA assigns weights based on the collective ownership of both periods resulting in a single weight attached to each asset for both periods. This forces the assets to be included in the inter-temporal asset index to be common to both datasets. I begin the inter-temporal analysis by applying this methodology in the construction of an asset index before drawing inter quantile comparisons between the two periods. I then assess the inter-temporal asset index by comparing it to the asset indexes constructed separately in 1993 and 2008.

6.1 Construction of the Inter-temporal Index

Table 14 provides the weightings for the pooled assets, which are common to both datasets as per Table 1. The weightings tell a similar story to that told earlier; namely that public assets are weighted more heavily than consumer durables in non-money metric measures and the signs of the weightings mimic that of before. The scree plot for the analysis is provided in Figure 21. However unlike before I cannot correlate the FA approach to PCA[1].

Turning the attention to the kernel density plots; Figure 22 provides the kernel density differentiated by year for the national asset scores. The bimodal distribution is prevalent for both 1993 and 2008s distributions. However two areas are of particular interest, namely the lower and upper sections of the distributions. At the lower end of the distribution the 1993 density plot lies to the left of the 2008 density. This indicates an improvement in real welfare from 1993 to 2008 at the lower ends of the distributions as household in the lower ends of the distribution have higher asset scores in 2008 than in 1993. As the analysis is conducted on cross sectional data I cannot infer whether particular households have achieved real welfare gains. Despite this I can conclude that a real welfare gain has taken place, as the lowest ranking household in 2008 is considerably better off than the lowest ranking household in 1993. A different picture is painted in the upper end of the distribution where the 1993 density plot lies to the right of the 2008 density plot implying that at the top end of the distribution a relative real welfare loss has occur.

[1] Sahn (2001) proposes FA instead of PCA for inter-temporal analysis. In recent years some research have attempted to conduct inter-temporal analysis using PCA (See (McKenzie, 2006). However FA has emerged as common practice for inter-temporal analysis as it overcomes one of its greatest challenges of PCA as it allows some degree of error when explaining asset ownership.

In Appendix 1.1 it shown that by incorporating the property of the PSLSD of the quantity of assets owned by a household into the asset index results in an increase in asset scores for the upper ends of the distribution. Unfortunately the 2008 dataset does not include quantity of assets owned and so inter-temporal comparisons incorporating this dimension of asset ownership cannot be made.

Another concern is that only some of the assets included in the 2008 dataset can be incorporated into the inter-temporal analysis. Before assessing the impact of excluding these assets, I analysed by quantile-to-quantile comparisons between the two periods using the inter-temporal asset index.

Figure 23 depicts a quantile plot of the population's assets scores. The lower quantile of the 1993 Indexes lies below the 2008 Index. From this I can conclude that holding asset weighting constant the asset deprived are less deprived in 2008 than in 1993. Similarly one can conclude that the asset wealthy, upper quantiles in Figure 23, is less wealthy in 2008 than in 1993. When contrasting the two indices on an aggregate level a convergence of the two bimodal peaks indicates less asset inequality in 2008 than in 1993, as per Figure 22.

By removing certain assets and reconstructing the asset index as per the Sahn (2001) methodology one can isolate the various assets responsible for the difference of 1993 asset index and the 2008 index in the lower and upper quantiles. Table 15 lists the assets responsible for the differences in the lower quantiles of 1993 and 2008. The majority of assets are all public assets indicating that households in the lower quantiles are better off in 2008 than households in the lower quantile than in 1993 due to access to public assets such as piped water, formal housing and electricity. This confirms studies by van der Berg (2005), Bhorat and Kanbur (2006) and Bhorat (2007). From this I can conclude that economic well-being of the lower quantile has increased during the first 15 years of South Africa's democracy due to an increase of public assets. Following the same approach I cannot detect any assets responsible for the difference in the upper quantiles. As a result I contrast the inter-temporal index to the individual indexes constructed for within period analysis.

By juxtaposing the inter-temporal asset index to the individual asset index drawn within period I can analyse the difference in the upper quantiles for the inter-temporal index. For the 1993 period the inter-temporal asset index and individual asset index are both constructed from almost identical asset registries with the only difference being that the individual asset index of 1993 includes a kettle while the inter-temporal index does not due it a kettle not being included in the 2008 dataset. However as Table 2 indicates 37% of households in 1993 owned kettle and as a result a kettle is weighted rather heavily at 0.12 as per Table 4, which is the largest weight allocated to an asset second only to electric cooking. Despite the large weight, comparing the inter-temporal asset index to the individually constructed asset index for the 1993 period results in a 99.2%

correlation between the indexes. Thus indicating that the exclusion of a kettle in the construction of the inter-temporal index did not result in different household rankings when contrasted to the individual asset index for 1993.

However when comparing the inter-temporal asset index to the individually constructed asset index for the 2008 period receives a slightly lower correlation of 91% reported in Table 5b. The high correlation is achieved despite the two indexes having dramatic differences in their asset registries as the individual asset index for the period 2008 contains 18 more assets than the inter-temporal asset index. To unpack where the mismatch between the two indexes for the 2008 period occurs I conduct a quantile-by-quantile comparison.

Figure 24 provides the quantile graphs for inter-temporal asset index and individually constructed asset index for the period 2008. A correlation of 0.91 is obtained for the correlation betweenthe 2008 pooled asset index and the alternative 2008 asset index (See Table 5b). The inter-temporal index lies above the individualindex for all quantiles except the upper most quantile as per Figure 24. By removing certain asset from the index and drawing comparisons one is able to determine which assets are responsible for the upper quantile difference. Table 16 indicates assets such as washing machines, microwaves, DVD players and computers are responsible. This provides a possible and plausible explanation for the 1993 lying to the right of the 2008 in the upper quantile for the inter-temporal asset index as these asset are not included in the 1993 dataset. The inter-temporal asset index is unable to capture technological progress and thus the upper quantile, which are more likely to own the latest technological appliances, are penalized. Between 1993 and 2008 households in the upper quantiles were the first and in some cases, the only to purchase new technological assets such as computers and DVD players. The inter-temporal asset index does not take such assets into account and as a result the upper quantile in 2008 is penalized to such an extent that the 1993 upper quantile receives relatively higher asset scores.

Thus, I cannot infer that the asset wealthy, upper quantiles in Figure 24, are less wealthy in 2008 than in 1993. Furthermore the convergence of the two indexes does not indicate a decrease inequality, as the upper quantile's full asset welfare is not fully represented.

To overcome this difficultly I create a third asset index by combining the 1993 and 2008 individual constructed indexes. This is not standard inter-temporal practice, however as reported the correlations between the indexes is sufficiently high to conclude that such an approach does not distort the household rankings dramatically except for the households in the upper quantile of 2008, which the inter-temporal index misrepresents.

Figure 26 plots the kernel densities of the combined asset index and the inter-temporal asset index differentiated by year. For the combined index's lower quantiles a similar situation to that inter-temporal indexes is shown. For this I can conclude that real

welfare has increased for the lower quantiles even when taking into account technological progress of assets. For the upper quantiles the combined index for 2008 lies to the right the combined index for 1993 indicating a welfare gain for the upper quantiles. Comparing only the 2008 indexes I can deduce that the combined index for 2008 lies above the inter-temporal index for 2008 as technological progress of asset have been taken into account.

I conclude that in general South Africa experience a welfare gain in the first 15 years of democracy measured in non-money metrics. In particular the gains are established for the upper and lower quantiles and a convergence in the bimodal peaks, prevalent in the pre apartheid era, has occurred.

6.2 Comparison Between Money Metric and Non-money metric Measures

I compare the two metrics between the periods in two ways. Firstly I plot the distributions before making use of row probability tables. Secondly, I make use of row probability tables. [2]

Figure 27 presents the kernel density plots for the combined asset index and the income measures differentiated by year. The money metric measures roughly follow a normal distribution however the 2008 measure contains a larger tail to the right than the 1993 measure. Although the entire 2008 density plot does not lie to the right of the 1993 plot, the majority of the upper quantiles are better off in 2008. However, the lower quantiles of the money metric distribution's in 1993 and 2008 curves lie close to one another indicating marginal changes in money metric in the lower end of the distribution. The non-money metric distribution paints a similar picture to changes in well-being for the upper deciles as the 2008 curve lies far to the right of the 1993 curve. However a greater increase in well-being is shown for the upper deciles using non-money metric than money metric. The non-money metric also shows considerably larger welfare gains for the lower deciles than the money metric measures. Thus money metric density curves paints a similar picture to the combined asset index density curves except for the lower end of the distribution where the asset index indicates larger gains in welfare.

Figure 28 segregates the combined asset index by year for the White and African population groups. The high density, with a tail to the left, of the 1993 White population is substituted with a more dispersed distribution in 2008. In particular the majority of the white population has experienced a real welfare gain measured by non-money metrics as the 2008 distribution lies to the right of the 1993 distribution. Unlike the 1993 distribution for Africans, the 2008 distribution is bimodal. As a whole the African population has experienced a real welfare gain, measured by non-money metric measures, since the fall of apartheid. However, a segmented of the African population has made larger increases in real welfare than others. This is evident by

[2] Unfortunately the 3D density and contour plots cannot be compared between the two periods. This is due to the relative height in the 3D plots and the colour intensity in the contour plots, are determined within each year and not intertemporal. Thus a comparison of the figures will results in incorrect conclusions.

studying the peaks of the bimodal 2008 African distribution. The right most peak represents a group of African households who have made substantial welfare gains, whereas the left most peak has made welfare gains, but not on the same scale as the households in the right most peak. Thus by studying the African asset distribution changes from 1993 to 2008 an emerging group of African's can be traced, while a group of African households have made some gains, but in general have been "left behind" by their African.

Comparing the row probability tables (Tables 6-8 and 11-13), I can now conclude that the changes have resulted in a greater overlap between the rankings of money and non-money metrics. In particular, more African households are allocated in the upper deciles of both measures in 2008 than in 1993. On the other hand some white households have shifted down the asset index rankings resulting in the white population spreading out across the asset index ranking's distribution. This implies that over the 15 year period, African households have not only moved up the asset distribution but that this move has been matched with a similar move up the income distribution.

The fall of apartheid was accompanied by the removal of several obstacles to non-white members of society and resulted in South Africa becoming legally equal. These changes and others, which took effect in the first 15 years of democracy, have lead to a greater overlap of money metric and non-money metric measures post apartheid. Comparing the asset indexes between the periods indicate that there is a mean shift in that all African households are better off in terms of assets while white households have remained densely situated at the upper end of the distribution. Furthermore a group of African households have been left behind by the emerging African households. Finally a real welfare gain measured on both money metric and non-money metric measures have occurred for the lower and upper quantiles of the distributions as whole.

7. Conclusion

The aim of this paper has been to analyse changes over time between money metric and non-money metric measures of well-being. The two measures indicate similar changes in well-being over the post apartheid period. The within period analysis of the metrics have shown that a tighter match between the rankings obtained from both measures is achieved in 2008 compared to 1993. Thus there is the change in the relationship between assets and income across the two periods as a tighter fit between the two metrics in the later period is achieved. While it has been outside of the purpose of this paper to explore the development implications of this, it is clearly important to note that they are now very closely correlated.

Comparing the two periods between Africans and Whites have shown that African households have made significant welfare gains, as measured by non-money metric and money metric measures, in the

post apartheid period with a subgroup of the African population achieving greater welfare gains, in terms of asset accumulation, than the rest of the African population. The distribution of the White population is more spread out in the post apartheid period than before. On an aggregate level the central tendencies of the asset index have moved further to the right than income but the dispersion of the index follows the same as income. Indicating a greater gain in well-being when measured by non-money metric measures than by money-metric measures.

Thus little differences between money metric and non-money metric measures of well-being within two specific periods exist when one includes race into the analysis. Furthermore real welfare gains have occurred in South Africa over the period as measured by both money metric and non-money metrics. A tighter overlap of rankings obtained from both money and non-money metrics the less segregated the society is, and in the case of South Africa, the less racial segregation as evident in the 2008 period analysis. The first 15 years of democracy in South Africa has resulted in an aggregate real welfare gain as measured by both money metric and non-money metric measures of wellbeing.

Appendixes

1. Quantity of variables

Several authors have levelled criticisms against asset indexes as only ownership of assets are taken into account are not the quantity or quality of the assets ((Wall & Johnston 2008)(Brandolini et al. 2010)). However, the PSLSD has the quantity of asset owned recorded for each household. This can be incorporated into an asset index. This is uncommon for construction of asset indexes as the majority of asset indexes are constructed using Demographic and Health Survey's, which do not contain such information. I follow the same structure as previously used to study the effect of incorporating such a quality into an asset index.

I continue by constructing an asset index including the quantity of assets owned. The inclusion of quantity of asset owned results in including a variable, which is longer, a dummy variable as asset ownership. Thus the quantity is treated similar to education, abounded categorical variable. Table 18 provides the weightings for the asset index. These yield similar weightings to that obtained from constructing an asset index without including quantity of assets owned. The correlation between the two indexes is relatively high at 98% as per Table 5b indicating that household rankings do not change substantially. Plotting the kernel density distributions for the asset index including quantity and for the asset index not including quantity in Figure 29. From this I can see a stark difference. The asset index including quantity has a substantially

longer upper tail while the rest of the index traces the index excluding quantity owned almost perfectly. Figure 30 divides the distribution into whites and Africans. As before a similar result is achieved, however the difference between the non-white and white population is greater.

Unpacking this situation further by the use of quantile graphs provides further insight and displayed in Figure 31. The curves provide similar results for the lower quantiles however a dominance of the index including quantity of asset owned is visible in the latter quantiles. From this I can deduce that when taking quantity of asset into account the upper quantile receives relatively lower scores than if not taken into account. Furthermore what distinguishes members from the upper quantiles is not necessarily ownership of a particular asset but rather quantity of the asset owned. The inclusion of quantity has no affect on the lower quantiles. Figure 32 provides the quantile comparison for quantity of asset owned per race. This clearly indicates that white households are not only the households in the upper quantiles by asset rankings but are also penalized the most when quantity of assets are not included.

Although I can not answer questions regarding the effect of taking quality of asset into account such as the difference between a black and white television and a colour television, I can state that by not taking into account the quantity of assets owned individuals who own multiple assets of one kind are heavily penalized. As these individuals tend to be near the upper end of the distribution exclusion of quantity of assets owned result in penalizing the upper quantiles. However the rankings of household do not change substantially when taking quantity into account, however the relative asset scores obtained by each household changes and thus, by using a density plot, asset inequality within a population is understated when excluding quantity of assets owned.

2. Asset Inequality

Traditional methods of inequality such as the Gini, Theil and Atkinson measure cannot be applied to Asset Index to calculate Asset Inequality. This is due to two reasons. Firstly, the mean of an Asset Index constructed with PCA is zero. The traditional methods all divide by the mean and thus application of these measures to asset indexes fail (McKenzie, 2005). Secondly Asset index tend to have negative values. These measures fail to take into account negative values appropriately. As a result I employ an asset inequality measure as proposed by McKenzie (2005). The McKenzie is calculated as follows:

$$I_c = \frac{\sigma_c}{\sqrt{\lambda}}$$

Where I_c is the inequality measure for a particular subgroup, σ_c the standard deviation of asset scores for subgroup c and λ the First Eigen value related to the First principal component (McKenzie, 2005). I_c can be greater than one if the standard

deviation of a subgroup c is greater than the standard deviation of the sample population thus indicating that subgroup contains greater inequality than the sample population (McKenzie, 2005). Thus the measure is always positive. Several limitations should be noted. Firstly, the method is only proposed for PCA thus can only be applied to PCA. FA produces each component of the measure and thus can be used to calculate asset inequality, however McKenzie (2005) only derives the measure for PCA. Secondly, the measure is derived for inequality present in subgroups not in the entire population. It is thus possible to determine inequality present within each race given a point of time, but not the entire population at a given point in time. Furthermore, inter-temporal comparison of Asset Inequality can be conducted using the measure. However, like Sahn (2001), the datasets are pooled, the principal components are derived collectively and then applied separately to each dataset in order to construct an asset index (McKenzie, 2005). The Eigen value of the collectively derived principal component is used as λ and σ_c is the standard deviation within a particular year. Thus the "subgroup" now becomes the year (McKenzie, 2005). These limitations present certain difficulties in analysis of welfare changes overtime in South African. It has been shown that the pooled method does not fully capture the welfare especially that of the upper most quantile in 2008. From the density curves a convergence between the two bimodal peaks of the pooled method for 2008 is evident and thus it appears that asset inequality has decreased. However comparing the pooled index to the combined index indicates that a real welfare gain has been achieved at the upper quantiles and no convergence is present. As a result applying the McKenzie (2005) method to the pooled asset index will indicate a decrease in asset inequality over time. However this is inaccurate, as the index does not take into account welfare gains of the upper most quantile in 2008. Furthermore one cannot make use of the combined asset index to calculate asset inequality as the indexes was not derived collectively and thus does not yield an Eigen Value.

Despite these challenges, the method can be used to calculate asset inequality present within each race at a given point in time, such as 1993 and 2008. These measures cannot be compared over time to deduce whether asset inequality has decreased or increased over time as the two indexes, 1993 and 2008, yield separate Eigen values. The virtue of this exercise thus lies in comparing asset inequality within racial groups to income inequality within racial groups at a given point in time. This allows us to analysis whether Asset inequality is shared similarly to Income inequality for 1993 and 2008. As a result one is able to determine whether non-metric measures of wellbeing and money measures of wellbeing yield similar inequality description at a given point in time. As a result, I employ Thiels T as an income inequality measure as the approach allows one to decompose income inequality between race groups.

The within period analysis can decompose

asset inequality between race. However in order to conduct intertemporal analysis, the pooled asset index needs to be employed. As previously discussed the index penalized the upper 2008 quantiles thus indicating a reduction of inequality shown by the comparison of the density curves. Unfortunately the combined index cannot be used for intertemporal inequality comparison. The supporting measures are found in Table 21.

In 1993 the population group with the most asset inequality was Coloureds, followed by Africans, Asians and finally Whites. Relating this to Figure 4 one can see the asset distribution of the Coloured population is most stretched out over the range whereas the White population is densely situated at the upper quantile. This is contrary to the income inequality findings using Thiel's T, which place Africans as the most unequal income race, followed by Coloured, Asians and finally Whites. In 2008 the two measures of inequality paint a different picture again, as Africans, followed Asians, Coloureds and finally Whites are the have the most income inequality. Asset inequality is most prevalent in the African and Asian population, with Whites and finally Coloureds as the least asset unequal population groups. Thus money metric measures of inequality provide a different picture of inequality within race than non-money metric measures. Money metric measures of inequality employed calculates inequality based on the log of per capita income of a subgroup relative to the mean. However, the non-money metric measure is heavily dependent on the variances within a subgroup relative to the total variance. As a result money metric measures paint a different picture of inequality than non-money metric measures.

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Figure 1: Scree of Factor Analysis for 1993

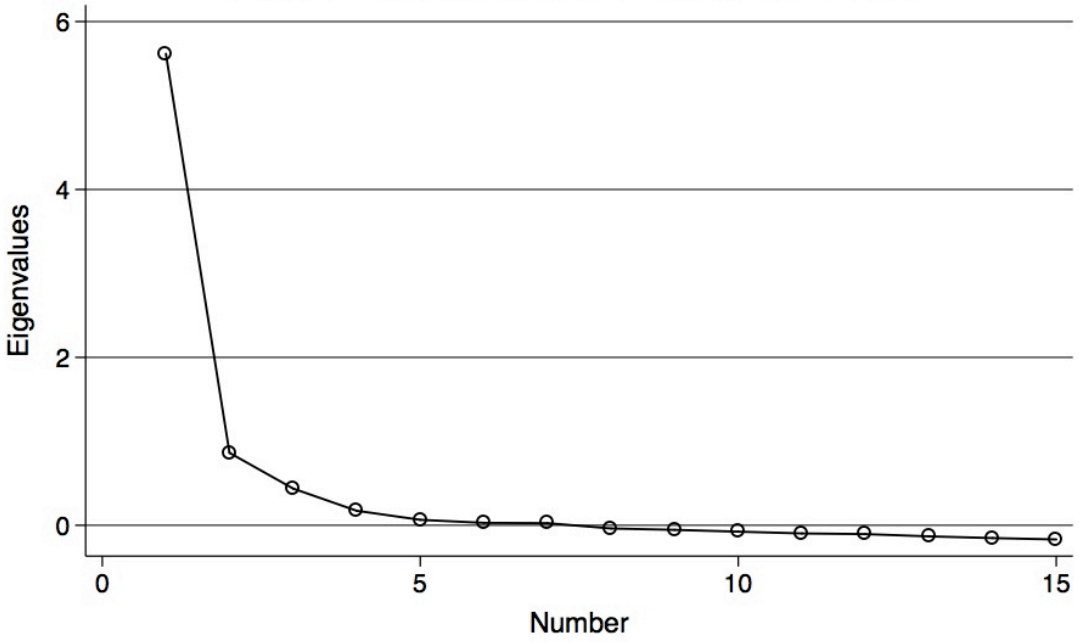


Figure 2: Log Income Per Capita Normalized Density And Asset Density Curves For 1993

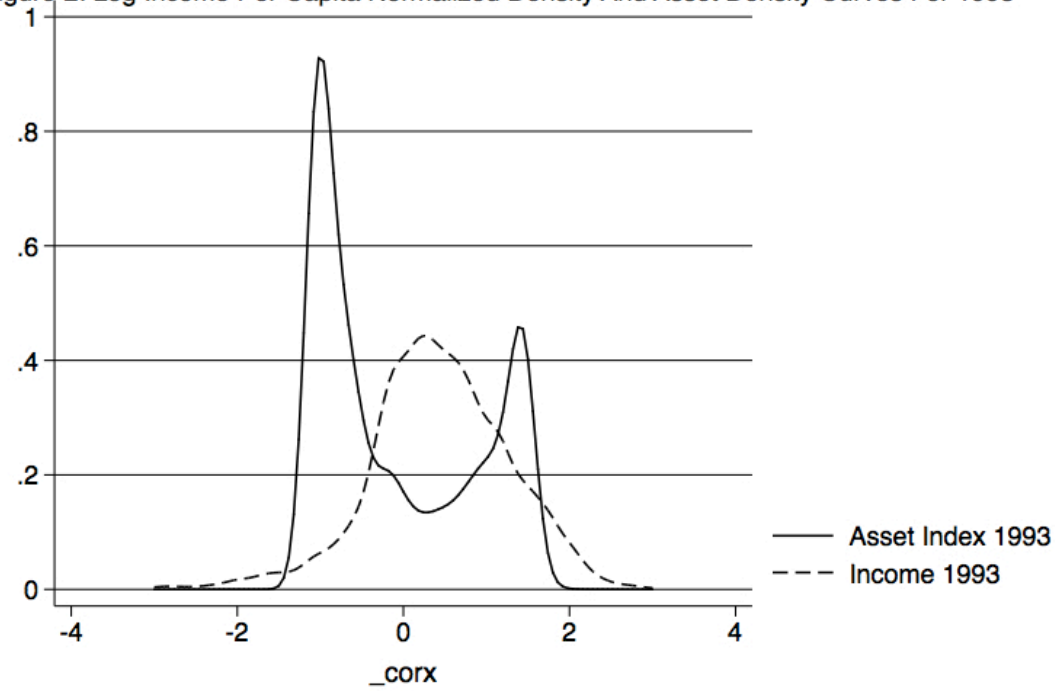


Figure 4: Density Curves of Asset Index by Race for 1993

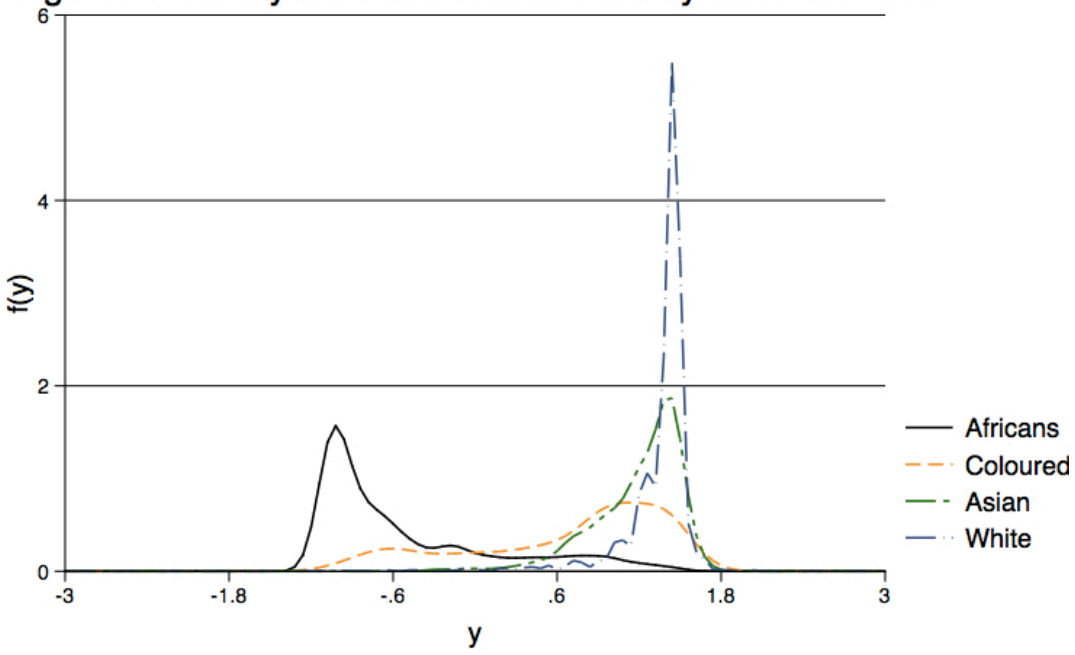


Figure 3: Density Plot of Income Per Capita Normalized For 199

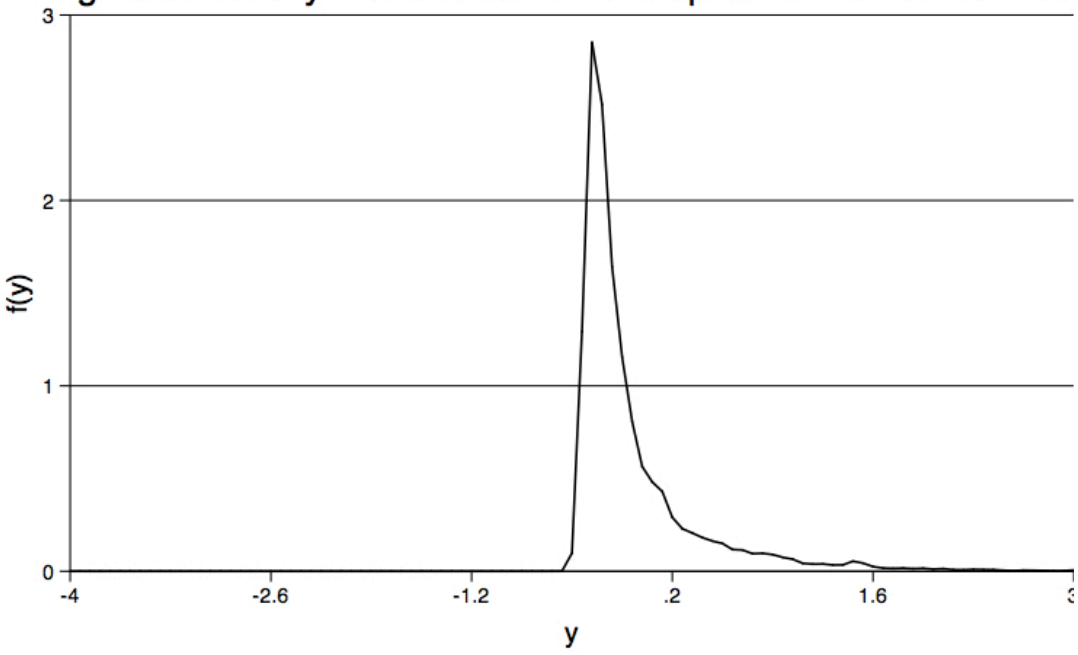


Figure 5: Density Plot Of Log Income Per Capita Normalized In 1993 Per Race

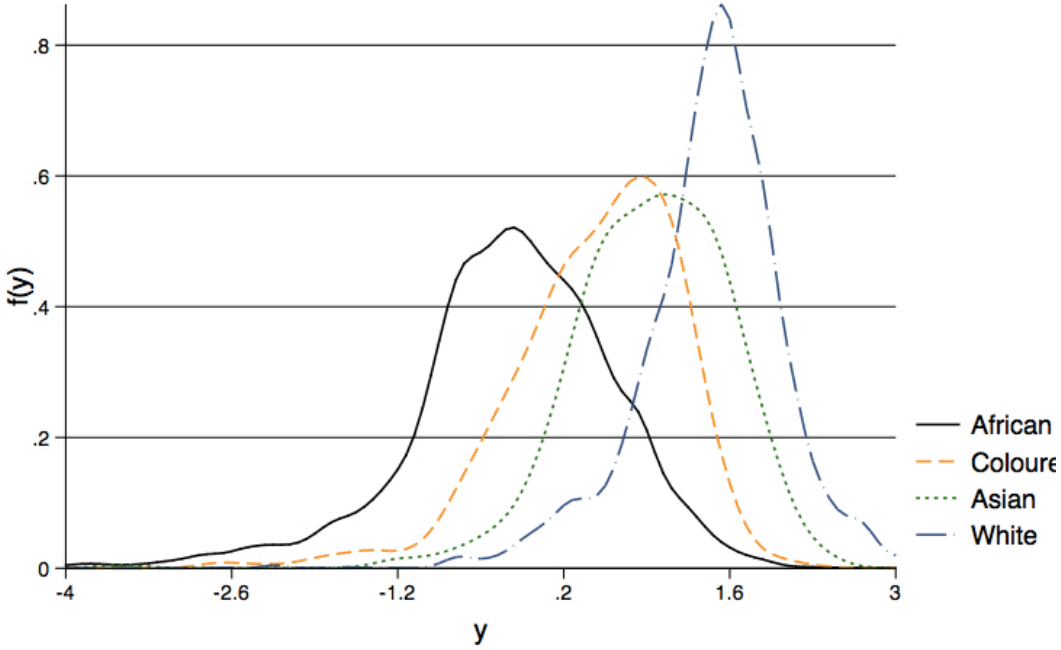


Figure 6: Quantile Plot For The Africans And White Population

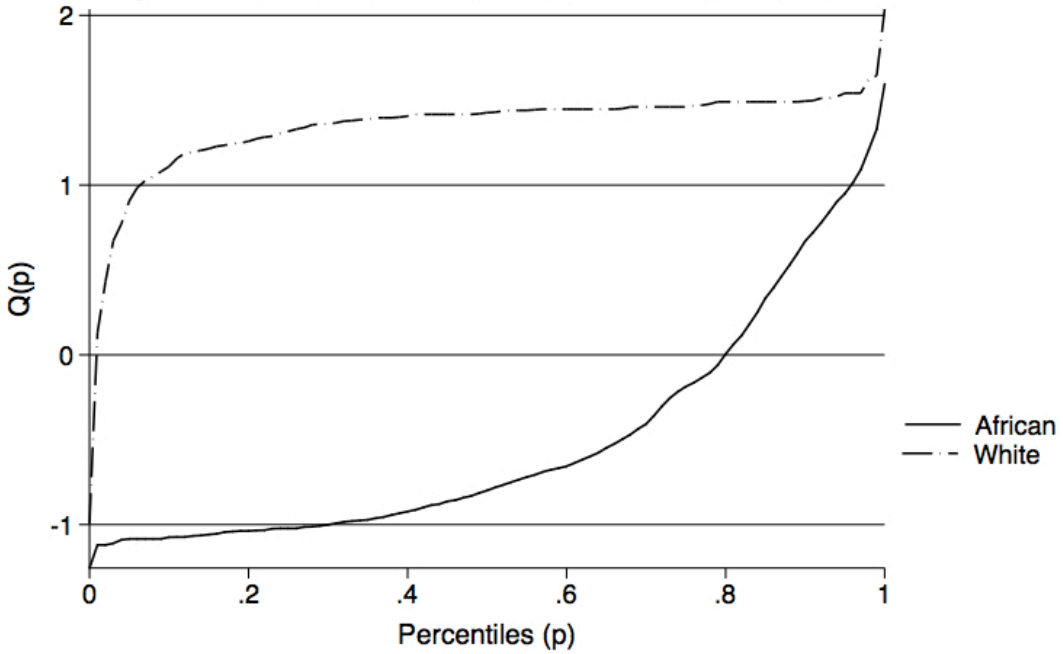


Figure 7: Asset and Income Density for Africans and Whites for 1993

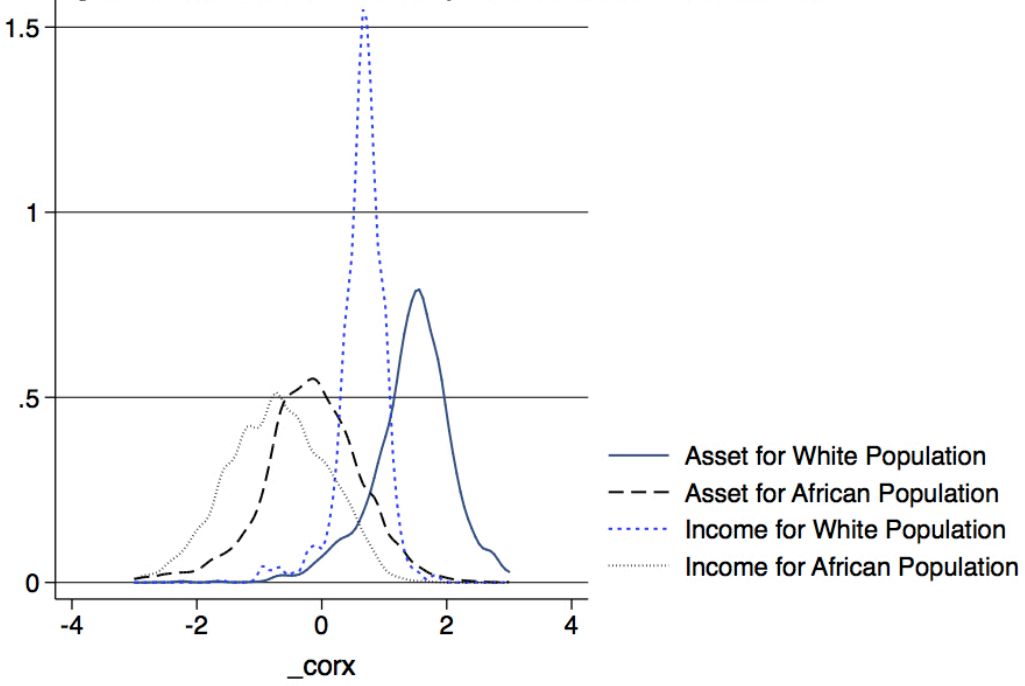
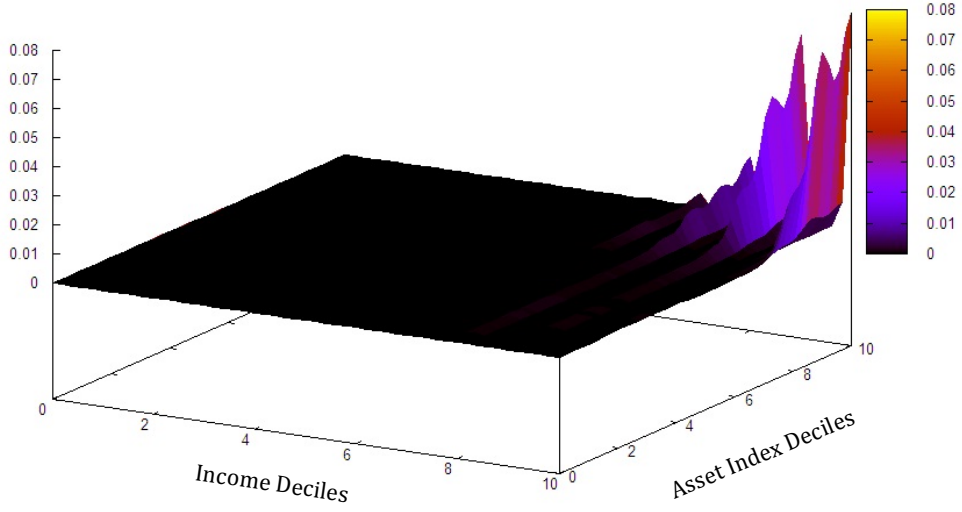


Figure 8: 3D Kernel Density Plot For The White Population Distribution In 1993



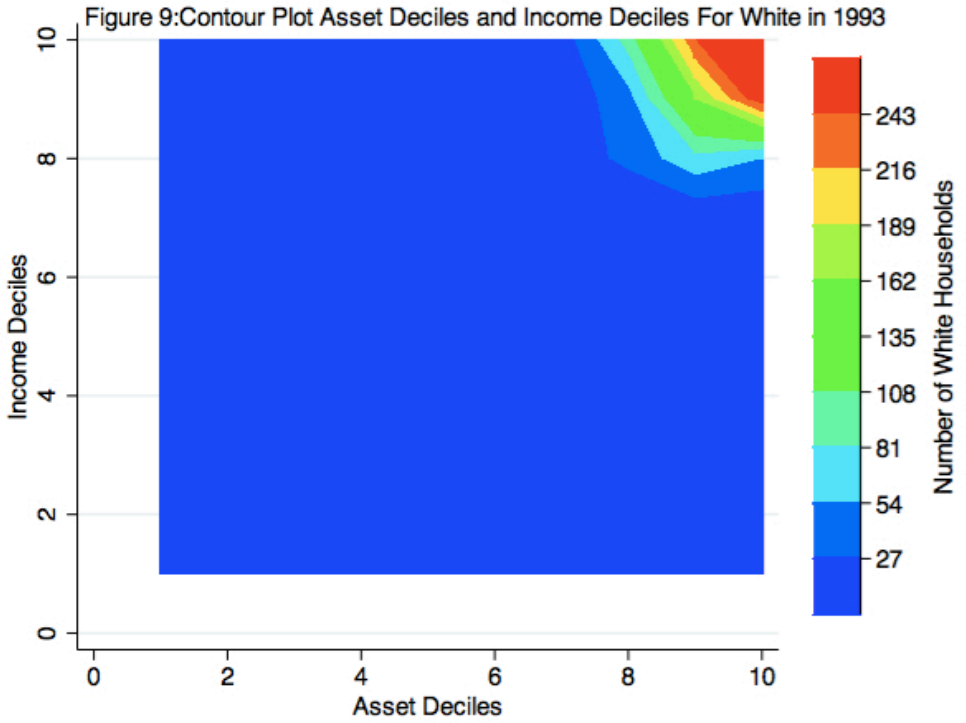
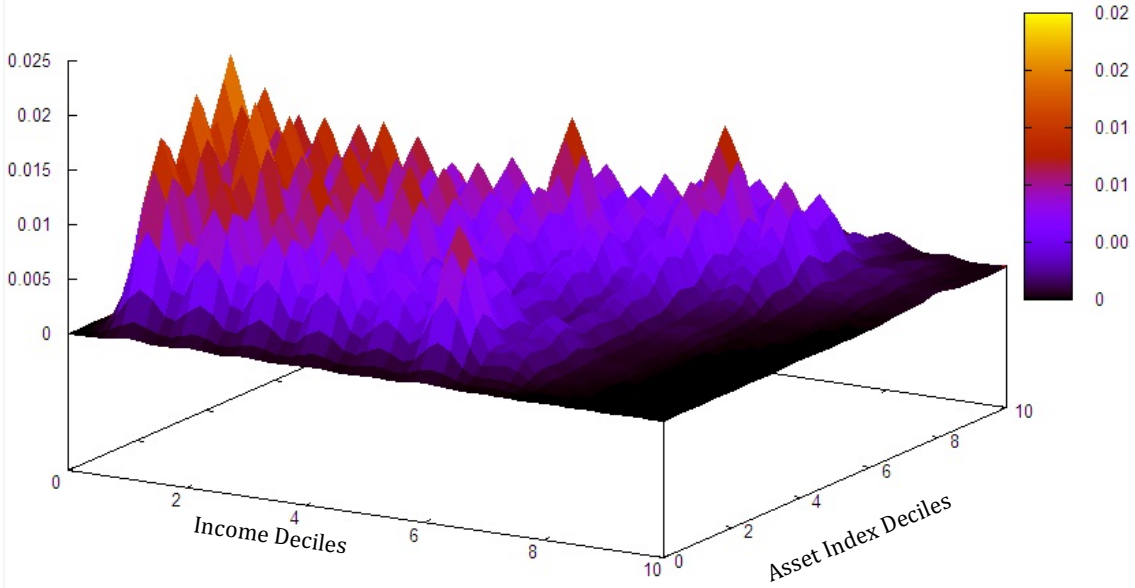
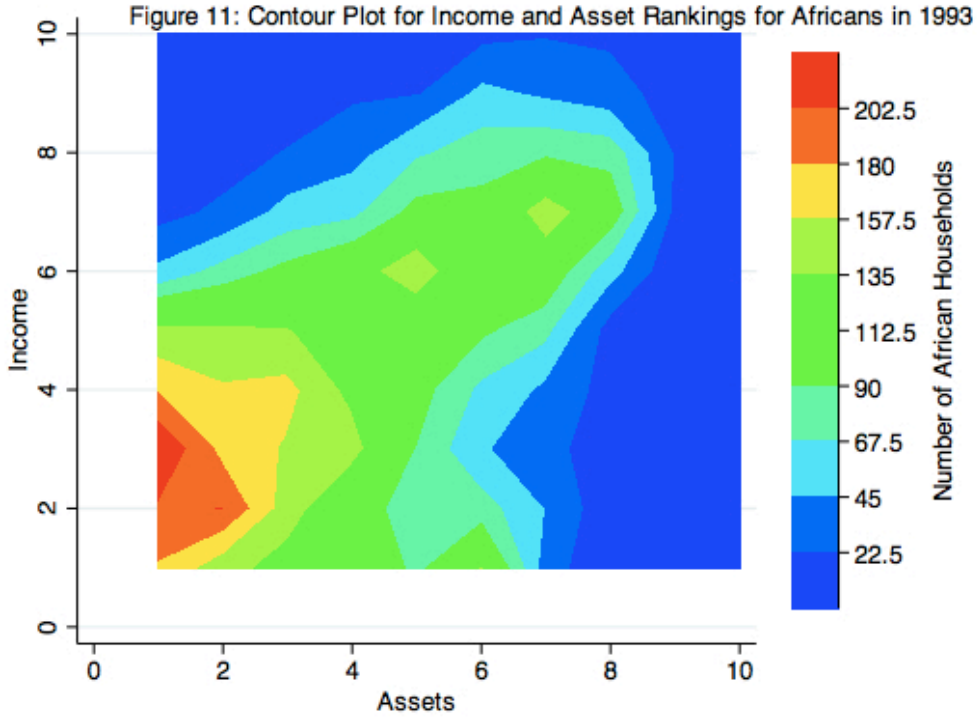


Figure 10: Contour Plot For The White Population Distribution In 1993





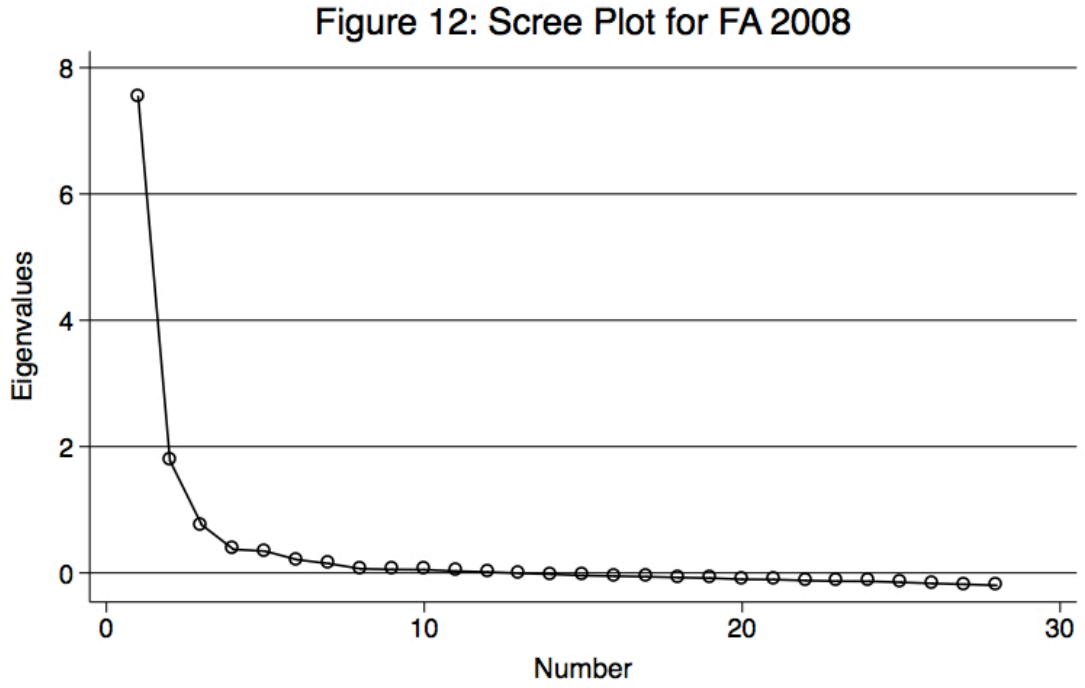


Figure 13: Log Income Per Capita Normalized Density And Asset Density Curves For 2008

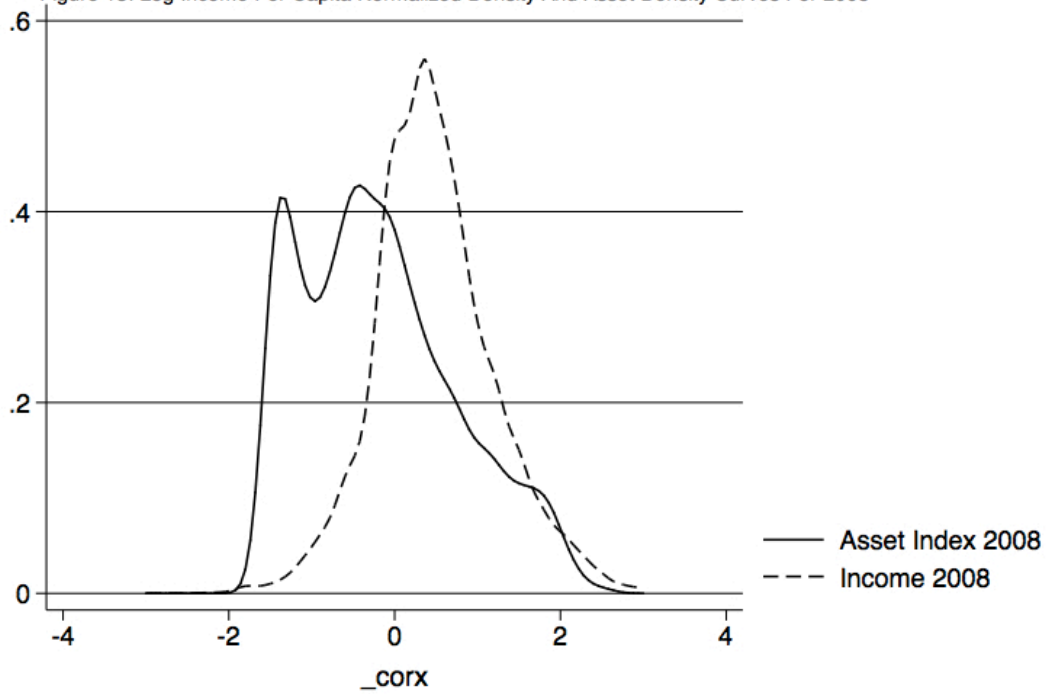
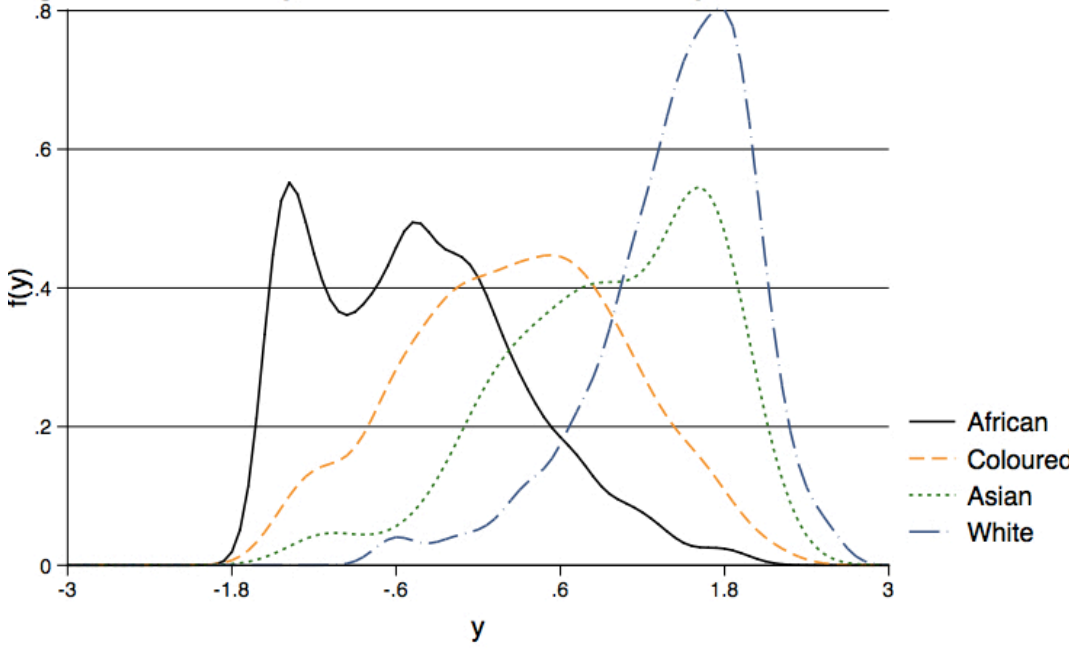


Figure 14: Density Curves of Asset Index by Race for 2008



igure 15: Kernel Density Of Log Income Per Capita Normalized In 2008 Per Race

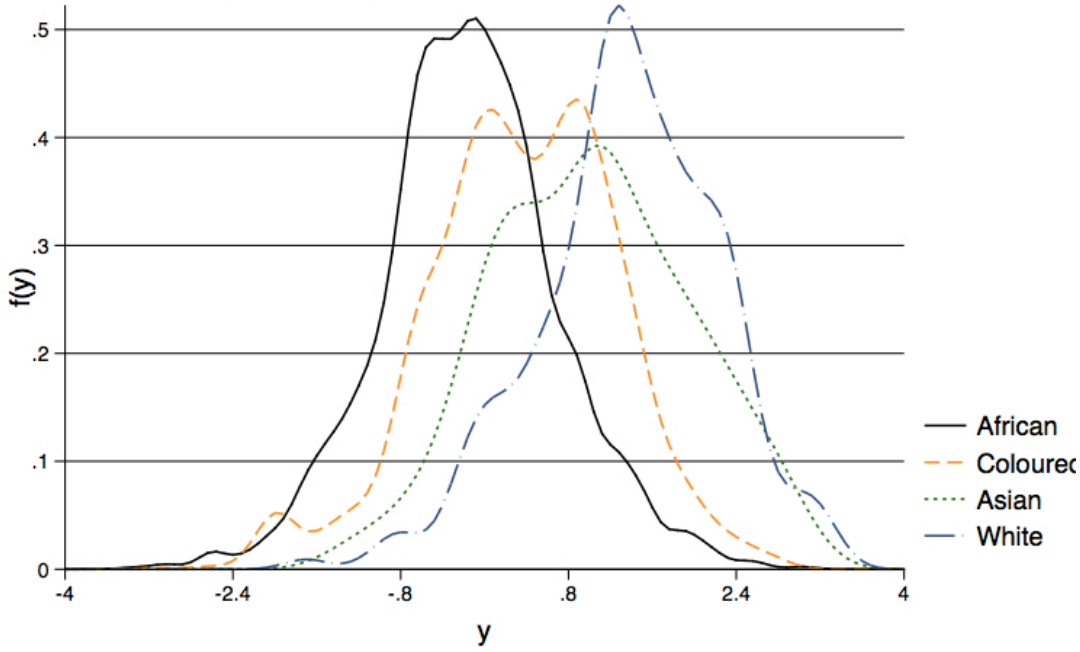


Figure 16: Quantile Plot For The Africans And White Population

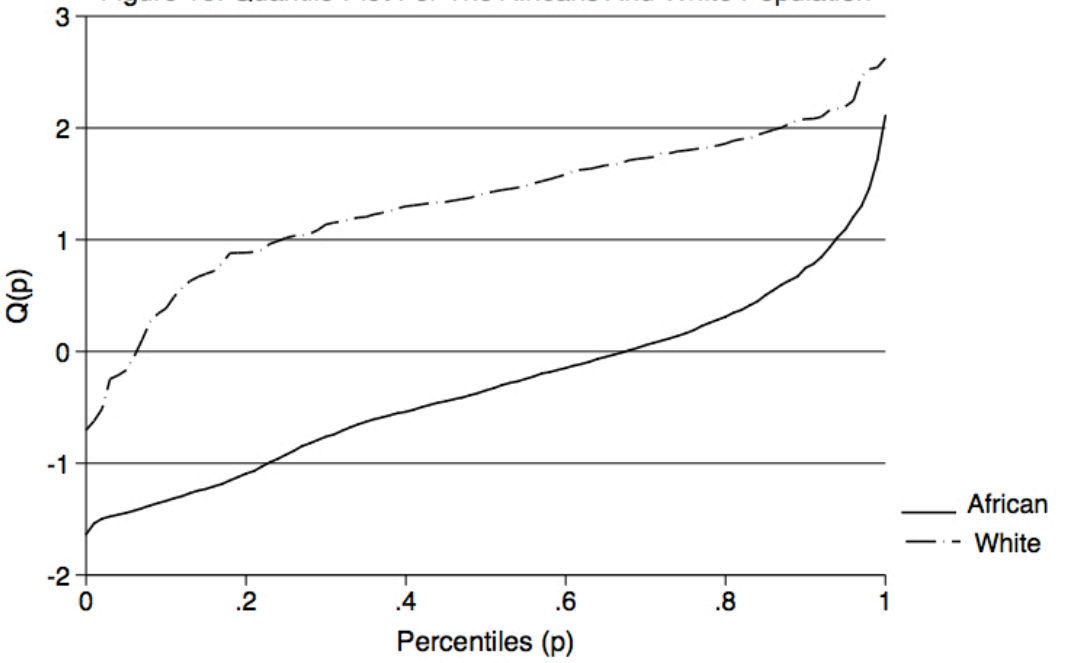
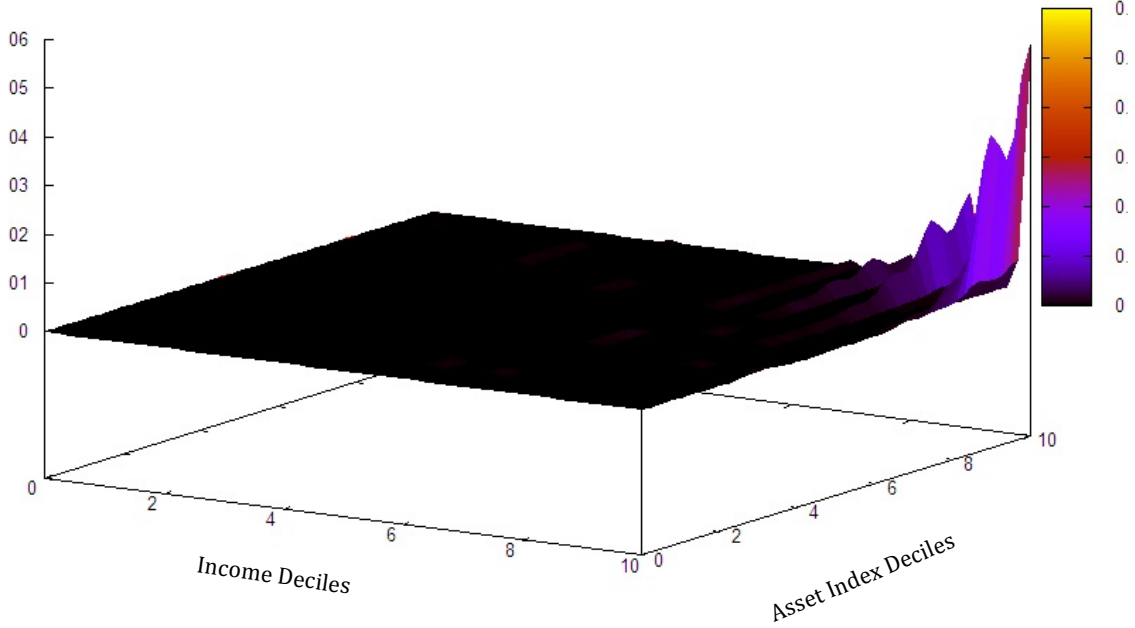


Figure 17: 3D Kernel Density Plot For The White Population Distribution In 2008



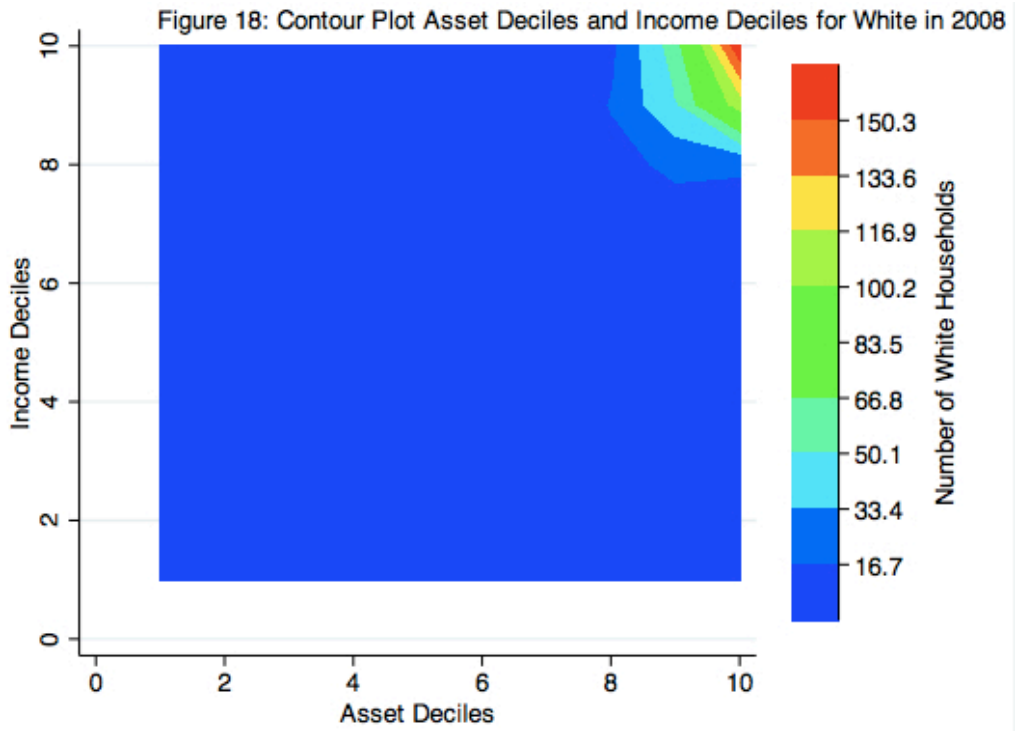
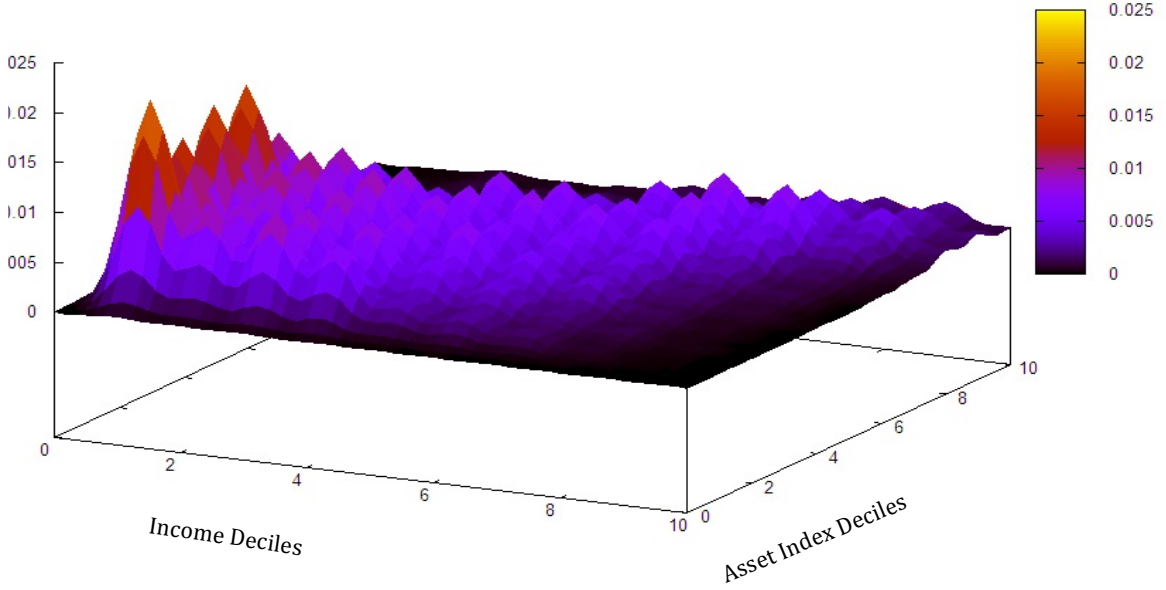


Figure 19: 3D Kernel Density Plot For The African Population Distribution In 2008



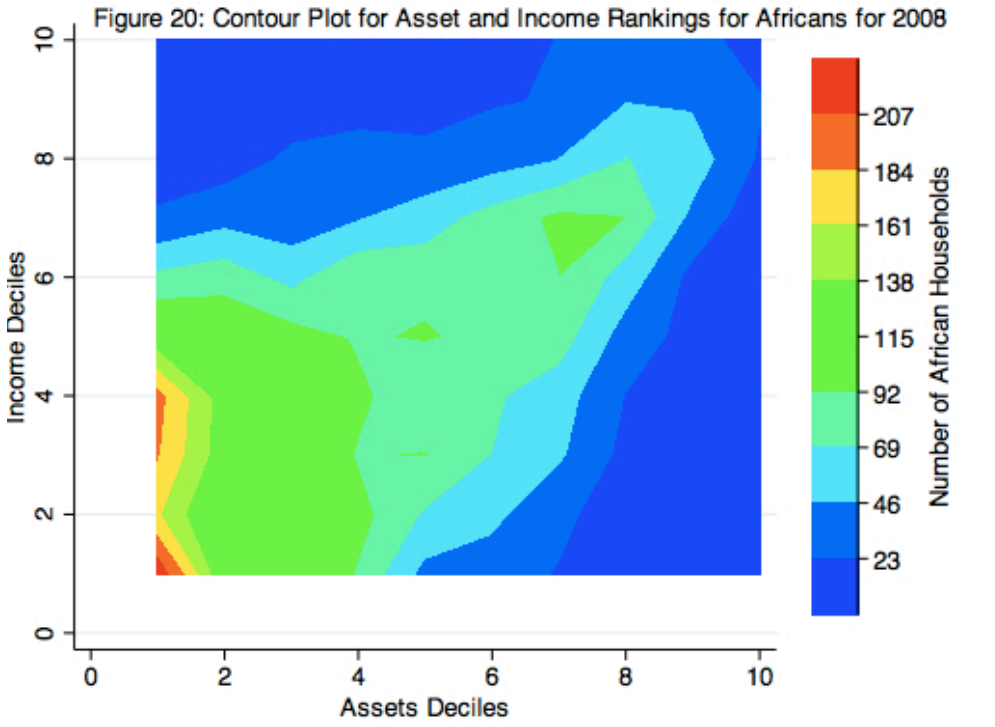


Figure 21: Scree Plot From Intertemporal Asset Index

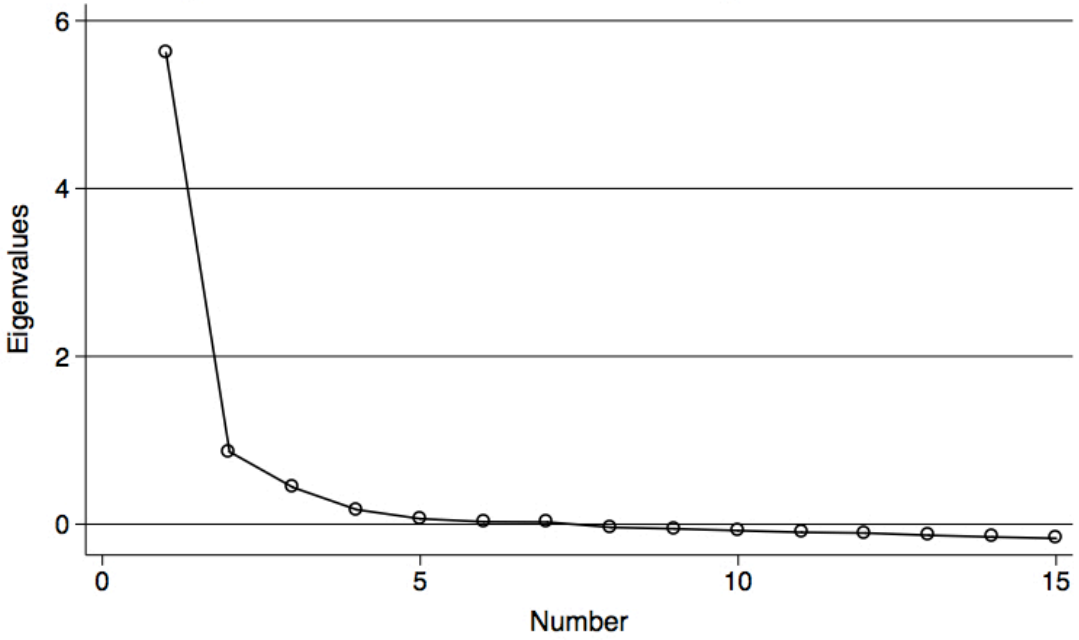


Figure 22: Density curves for Intertemporal Asset Index

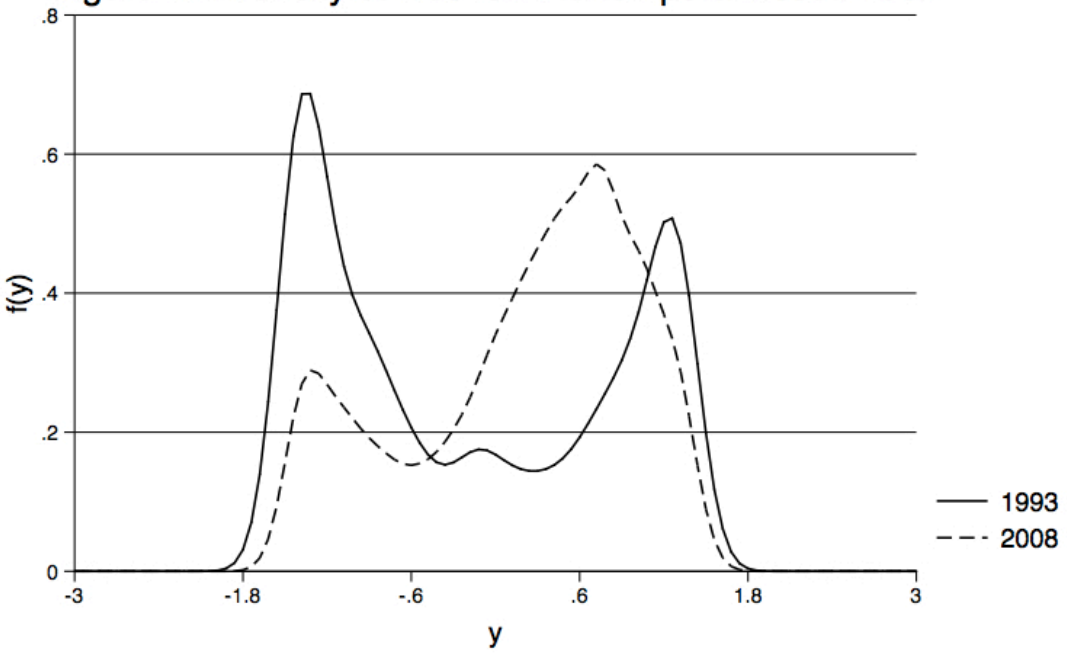


Figure 23: Quantile Curves for Intertemporal Asset Index

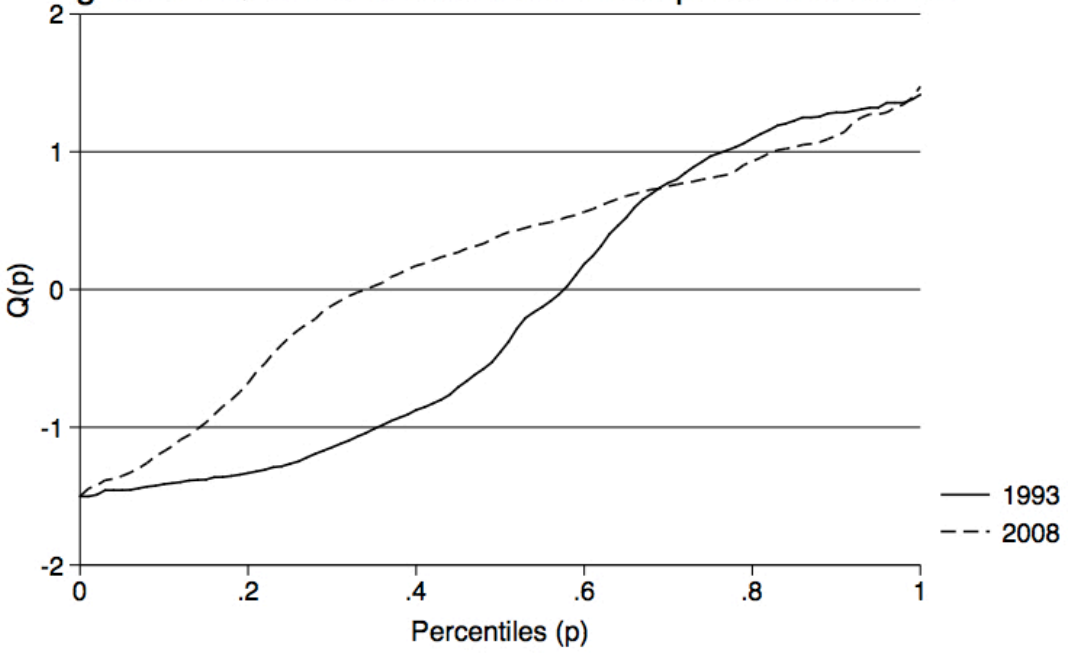


Figure 24: Quantile Curves of Intertemporal and Individual Asset Index 200

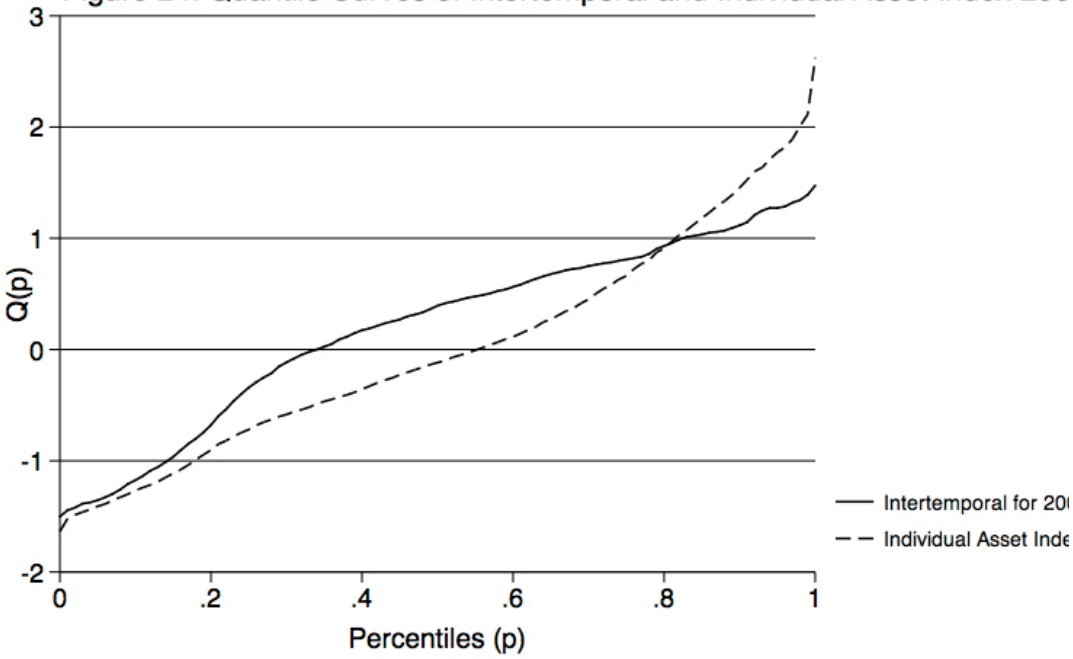
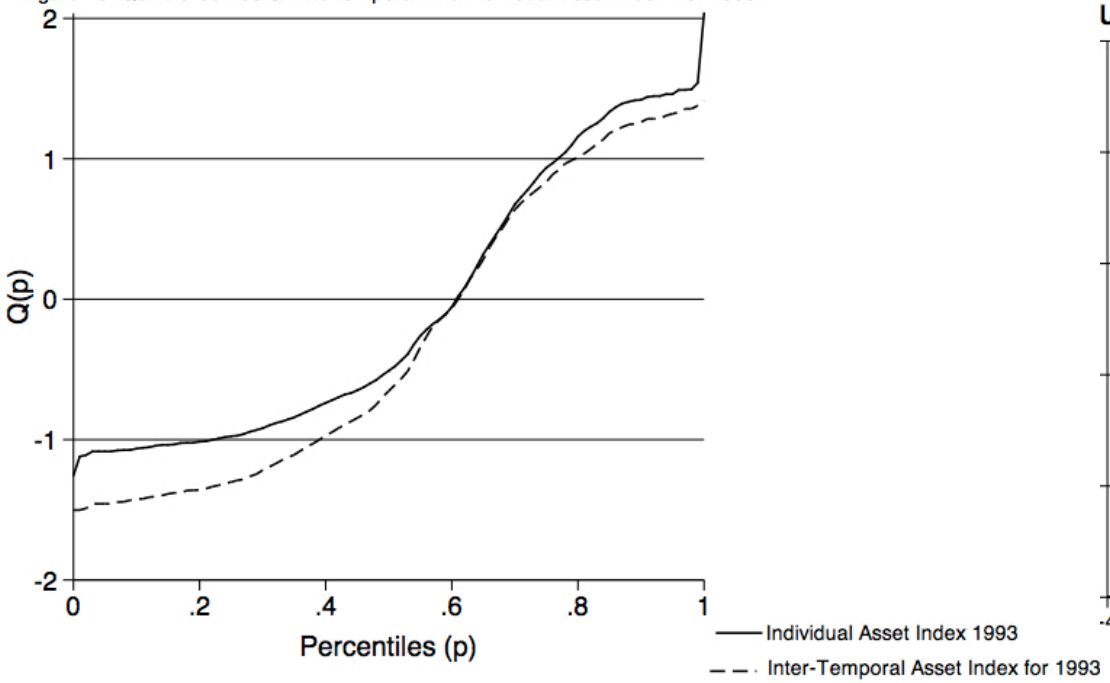


Figure 25: Quintile Curves Of Intertemporal And Individual Asset Index For 1993



ure 26: Density Curves Of Combined Asset Index By Year

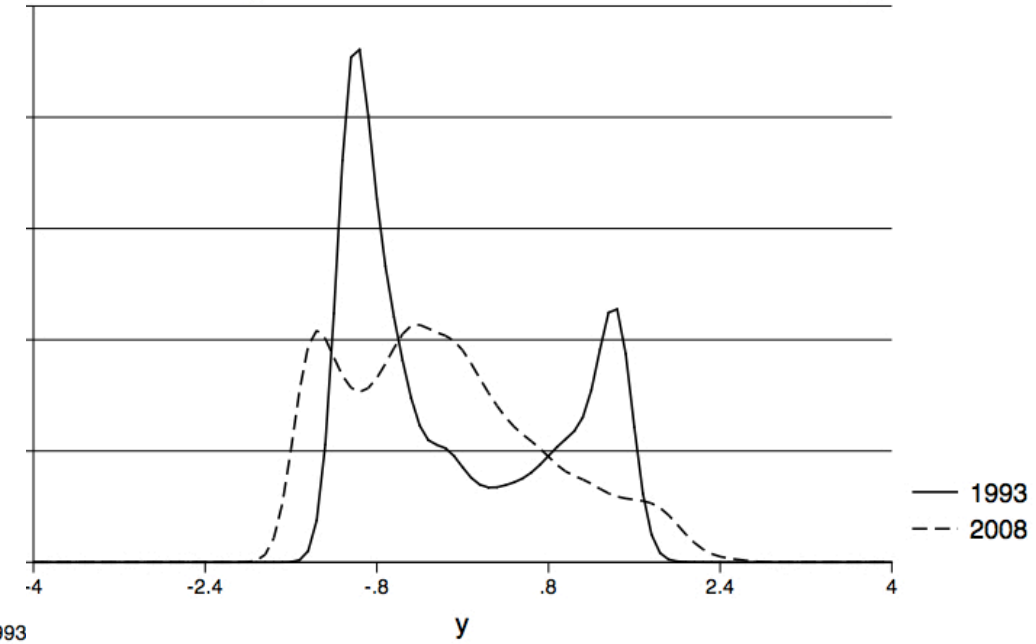


Figure 27: Income And Asset For 1993 and 2008

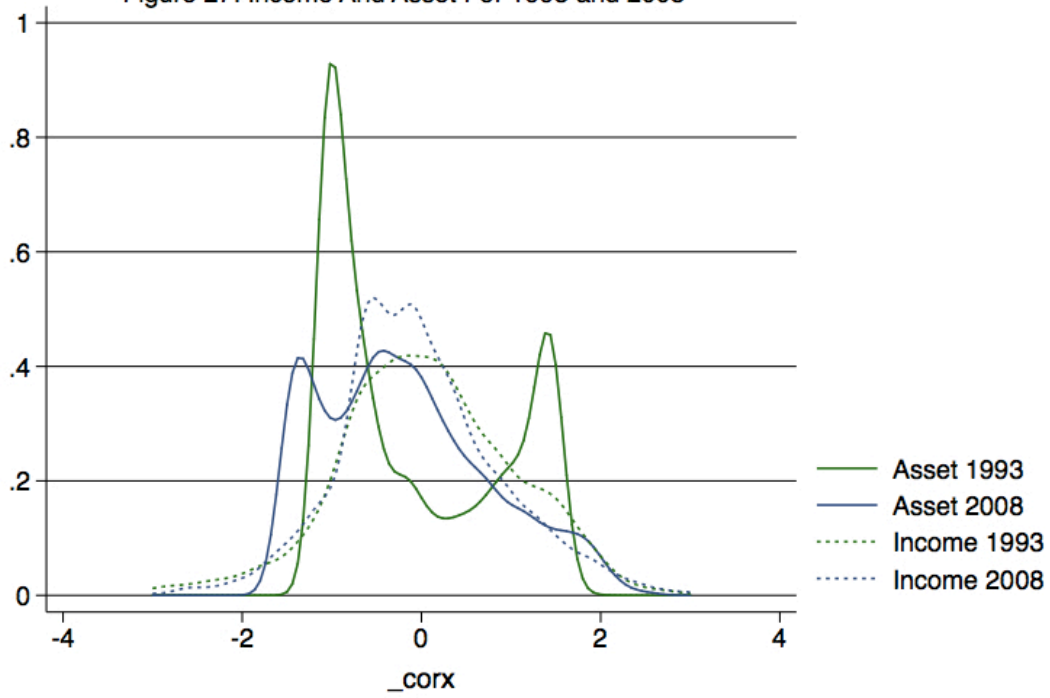
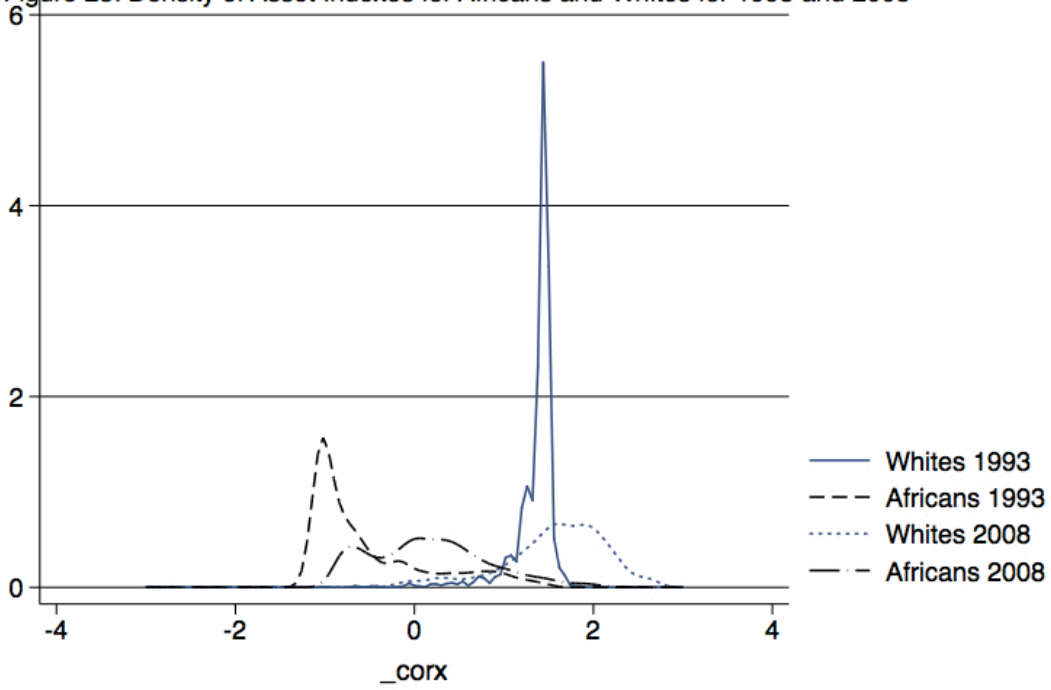


Figure 28: Density of Asset Indexes for Africans and Whites for 1993 and 2008



gure 29: Kernal Density for Asset Index and Asset Index Including Quantity for 1993

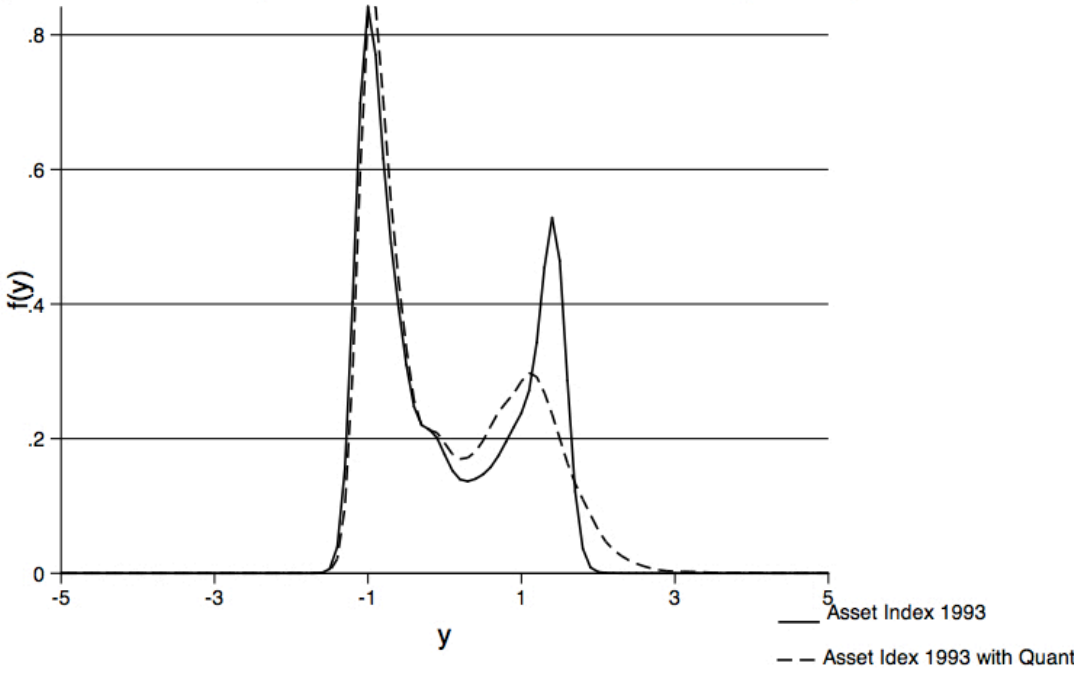


Figure 30: Density Curves For Asset Index Including Quantity For 1993 For Africans And Whites

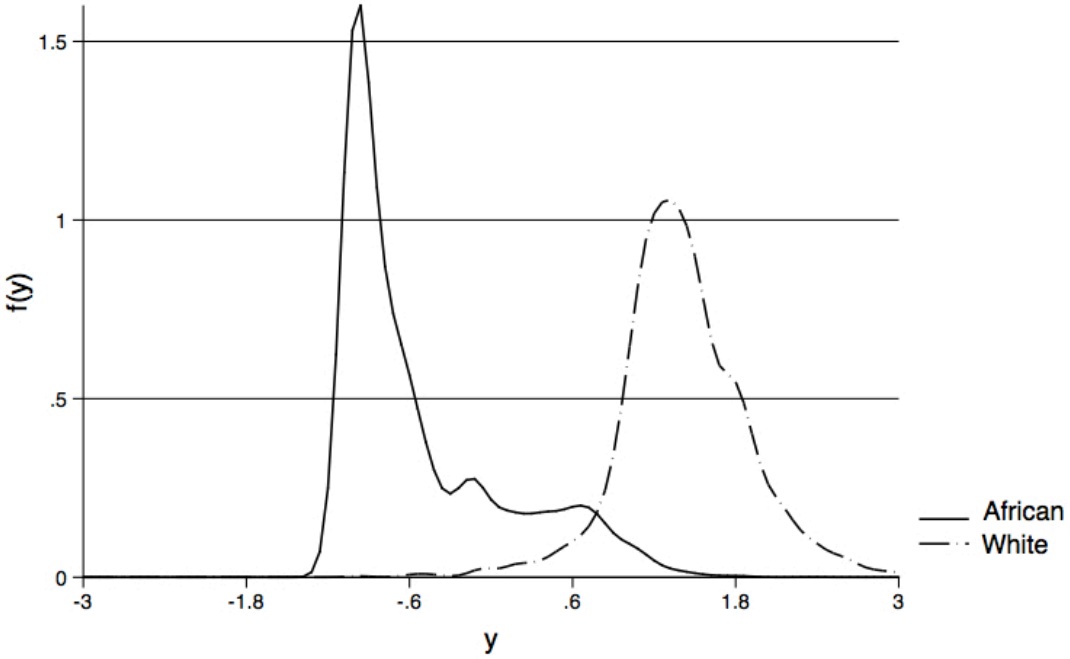


Figure 31: Quantile Curves for Asset Index including Quantity for 1993

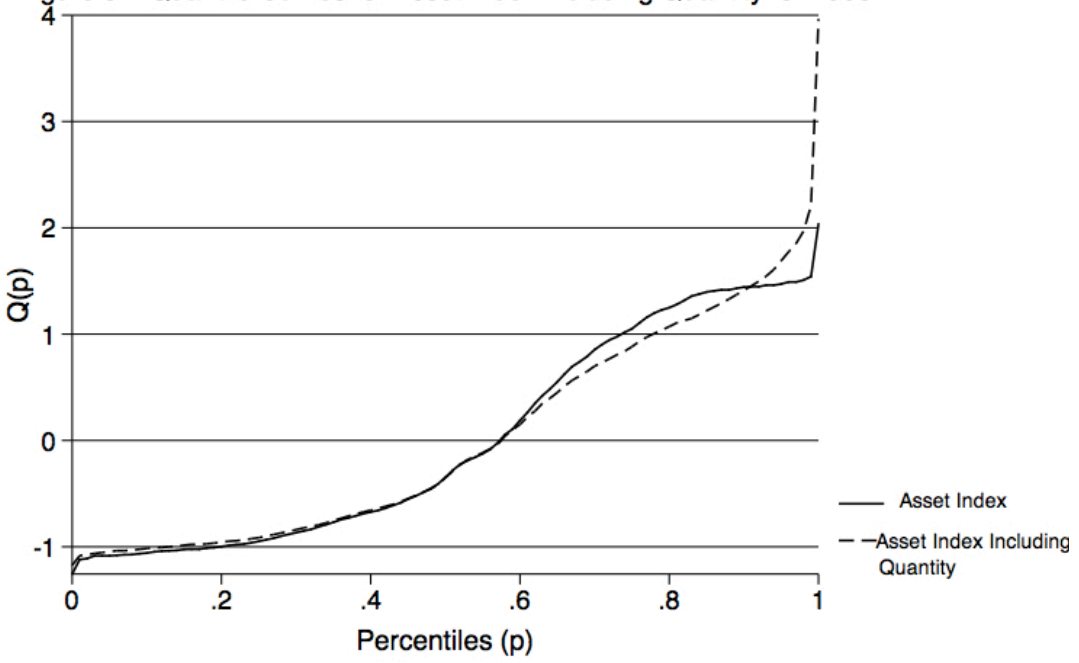


Figure 32: Quintile Curves For Asset Index Quantity For 1993 Per Race

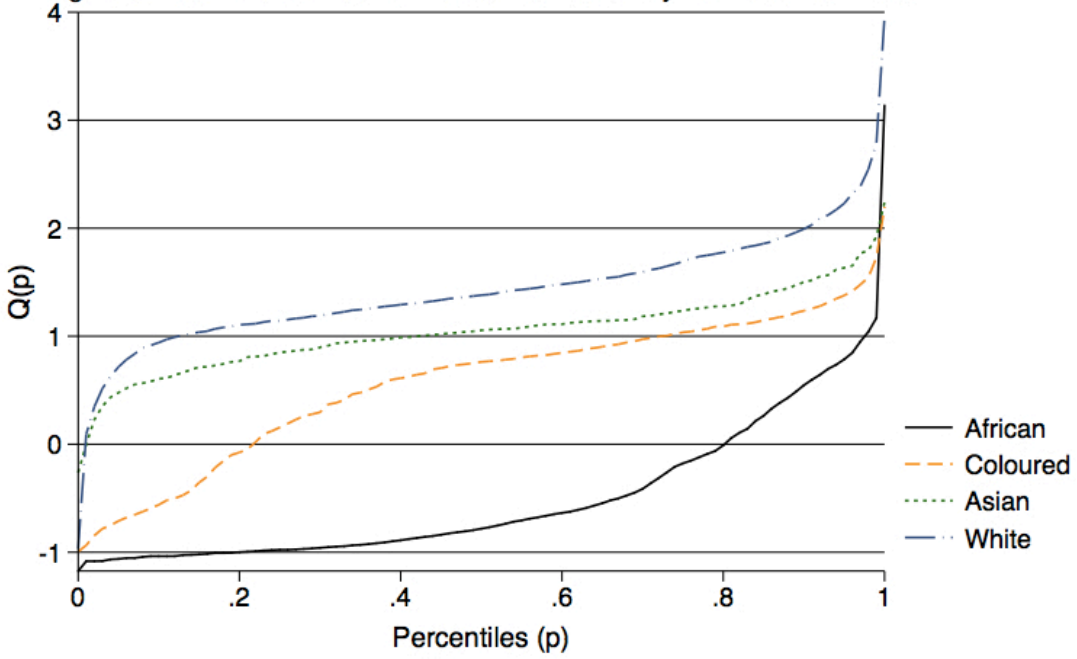


Table 1:
Asset Registry Comparison Of PSLSD And NIDS

2008 (NIDS)	1993 (PSLSD)
Radio	Radio
HiFi	
Satellite Dish	
DVD Player	
Computer	
Camera	
Cellphone	
Microwave	
Washing Machine	
Sewing Machine	
Lounge	
Commercial Vehicle	
Motorcycle	
Non-motorised Boat	
Boat	
Donkey Cart	
Ox Plough	
Tractor	
Wheelbarrow	
TV	TV
Electric Stove	Electric Stove
Gas Stove	Gas Stove
Paraffin Stove	Paraffin Stove
Fridge	Fridge
Motor	Motor
Bicycle	Bicycle
Landline	Landline
Livestock	
	Kettle
	Geyser
Piped Water	Piped Water
Electric Lighting	Electric Lighting
Electric Cooking	Electric Cooking
Toilet	Toilet
Housing	Housing
Education	Education

Table 2:
Percentage Asset Ownership In 1993 And 2008 In South Africa

		2008 (NIDS)	1993 (PSLSD)	Average Quantity of Assets Owned in 1993
Private Assets	Radio	68.98%	79.09%	1.12
	HiFi	46.37%		
	Satellite Dish	13.25%		
	DVD Player	36.16%		
	Computer	15.35%		
	Camera	18.26%		
	Cellphone	79.12%		
	Microwave	37.59%		
	Washing Machine	27.94%		
	Sewing Machine	13.03%		
	Lounge	38.89%		
	Commercial Vehicle	4.33%		
	Motorcycle	3.28%		
	Non-motorised Boat	0.59%		
	Boat	0.84%		
	Donkey Cart	0.45%		
	Ox Plough	2.88%		
	Tractor	0.74%		
	Wheelbarrow	18.44%		
	TV	67.47%	48.61%	0.61
	Electric Stove	63.57%	40.24%	0.41
	Gas Stove	14.04%	14.31%	0.15
	Paraffin Stove	26.37%	49.84%	0.58
	Fridge	57.89%	42.27%	0.53
	Motor	22.87%	28.30%	0.45
	Bicycle	8.47%	22.36%	0.34
	Landline	15.35%	28.09%	0.33
	Livestock	6.22%		
	Kettle		37.82%	0.41
	Geyser		28.52%	0.32
Public Assets	Piped Water	72.98%	60.94%	
	Electric Lighting	81.98%	52.99%	
	Electric Cooking	71.34%	46.36%	
	Toilet	60.30%	54.37%	
	Housing	65.92%	59.90%	
	Education	8.055628	5.22451	

Table 3:
Overview Of Income And Inequality In South Africa For 1993 And 2008

	1993	2008
Annual Per capita Income in 2000 values		
Africa	R5 073.00	R9 790.00
Coloured	R8 990.00	R16 567.00
Indian	R19 357.00	R51 457.00
White	R46 486.00	R75 297.00
Gini Coefficient	0.66	0.7
FGT: Poverty Line R949		
Population	40 147 932	48 687 000
p_0	0.72	0.7
p_1	0.47	0.44
p_2	0.36	0.32

Table 4:
Factor Scores: Individual Method 1993: Factor Analysis

	FA	PCA
Motor Vehicle	0.07583	0.2463
Bike	0.01818	0.1091
Radio	0.01461	0.1754
Electric Stove	0.09401	0.2893
Gas Stove	0.01788	0.0684
Prim Stove	-0.02345	-0.2109
Fridge	0.11121	0.2822
TV	0.07052	0.2537
Geyser	0.11675	0.282
Kettle	0.12524	0.2973
Telephone	0.09095	0.2739
Piped water	0.0788	0.2425
Electric lighting	0.09018	0.2779
Electric cooking	0.16491	0.2919
Toilet	0.09148	0.2598
Housing	0.03029	0.1871
Education	0.04238	0.2307

Table 5a:
Correlation Between Asset Index and Income For 1993

	Income	Asset Index (PCA)	Asset Index (FA)
Income	1	0.5387	0.5296
Asset Index (PCA)	0.5387	1	0.996
Asset Index (FA)	0.5296	0.996	1

Table 5b
Correlations Between Asset Indexes

	Intertemporal FA	2008 FA	2008 PCA	1993 FA	1993 PCA	1993 Quantity FA	1993 Quantity PCA
Intertemporal FA	1	0.9177	.	0.9921	.	.	.
2008 FA	0.9177	1	0.9983	.	.	.	.
2008 PCA	.	0.9983	1	.	.	.	.
1993 FA	0.9921	.	.	1	0.996	0.9837	.
1993 PCA	.	.	.	0.996	1	.	0.9867
1993 Quantity FA	.	.	.	0.9837	.	.	0.9974
1993 Quantity PCA	.	.	.	.	0.9867	0.9974	1

Table 6:
Row Probability Table Of Income And Asset Index Deciles For Entire Population In 1993

	Income Rankings										
Asset Index Rankings	1	2	3	4	5	6	7	8	9	10	Total
1	**17.8**	20.1	22.5	17.9	14.2	5.1	1.5	0.7	0.1	0.1	100
2	15.38	**21.5**	18.44	16.97	14.86	8.11	2.95	1.26	0.42	0.11	100
3	13.62	16.22	**16.97**	18.05	14.92	10.81	5.84	2.7	0.32	0.54	100
4	13.49	12.04	16.95	**14.94**	13.6	13.15	7.58	4.24	2.34	1.67	100
5	10.78	9.73	10.78	13.09	**12.63**	19.47	12.05	8	2.55	0.93	100
6	17.24	10.11	6.9	8.92	12.72	**12.25**	12.49	10.23	6.66	2.5	100
7	5.28	6.21	5.39	7.03	11.14	17.12	**22.74**	13.6	6.8	4.69	100
8	1.45	2.17	1.69	2.9	4.35	12.2	25.6	**24.28**	12.92	12.44	100
9	0.14	0.41	0.27	55	1.36	2.46	9.41	22.92	**28.92**	33.56	100
10	0	0.29	0.29	0.44	0	0.88	2.19	16.52	39.62	**39.77**	100
Total	10.11	10.59	10.78	10.73	10.5	10.36	10.08	9.74	8.81	8.31	100

Table 7:
Row Probability Table Of Income And Asset Index Deciles For Whites In 1993

	Income Rankings										
Asset Index Rankings	1	2	3	4	5	6	7	8	9	10	Total
3	0	0	**0**	0	100	0	0	0	0	0	100
4	100	0	0	**0**	0	0	0	0	0	0	100
5	0	0	0	0	**33.33**	0	0	0	66.67	0	100
6	0	0	0	0	0	**0**	0	11.11	22.22	66.67	100
7	0	0	0	0	0	4.26	**10.64**	10.64	23.4	51.06	100
8	1.01	0.5	0	1.01	0	6.03	13.57	**14.07**	34.67	29.15	100
9	0.59	0.39	0.39	1.58	2.56	8.48	11.24	23.08	**31.16**	20.51	100
10	1.01	0.5	0.5	2.35	4.6	13.09	14.26	20.3	22.48	**20.81**	100
Total	0.88	0.44	0.37	1.76	3.15	9.9	12.77	19.96	27.59	23.18	100

Table 8:
Row Probability Table Of Income And Asset Index Deciles For Africans In 1993

	Income Rankings										
Asset Index Rankings	1	2	3	4	5	6	7	8	9	10	Total
1	**17.8**	20.1	22.5	17.9	14.2	5.1	1.5	0.7	0.1	0.1	100
2	15.34	**21.48**	18.41	16.93	14.92	8.15	2.96	1.27	0.42	0.11	100
3	13.65	16.16	**16.92**	18.01	14.96	10.81	5.9	2.73	0.33	0.55	100
4	13.76	12.25	16.76	**14.91**	13.87	12.95	7.28	4.28	2.31	1.62	100
5	10.51	9.39	11.12	12.48	**12.98**	19.53	12.24	8.03	2.72	0.99	100
6	18.19	10.34	6.28	8.25	12.43	**12.04**	12.96	10.47	6.81	2.23	100
7	5.43	6.98	5.12	6.36	11.63	17.52	**23.72**	13.49	6.51	3.26	100
8	0.88	1.77	1.77	4.13	3.83	16.22	32.15	**24.19**	9.44	5.6	100
9	0	0	0	1.41	4.23	8.45	26.76	30.99	**19.72**	8.45	100
10	0	0	0	4.76	0	4.76	19.05	38.1	14.29	**19.05**	100
Total	13	13.55	13.74	13.4	13.04	11.98	10.09	6.67	3.03	1.51	100

Table 9:
Correlation Between Asset Index and Income For 2008

	Income	Asset Index (PCA)	Asset Index (FA)
Income	1	0.5273	0.5248
Asset Index (PCA)	0.5273	1	0.9983
Asset Index (FA)	0.5248	0.9983	1

Table 10:
Factor Scores: Individual Method
2008: Factor Analysis

	FA	PCA
Radio	0.01922	0.0837
Hifi	0.06337	0.2179
Dish	0.05939	0.1972
Dvd	0.08011	0.2387
Computer	0.08969	0.2231
Camera	0.05901	0.1948
Cellphone	0.0251	0.1186
Microwave	0.09716	0.2555
Washing machine	0.1142	0.2596
Sewing machine	0.03475	0.153
Lounge suite	0.06514	0.222
Company motor	0.02578	0.1138
Motorcycle	0.0304	0.1155
Non motorized boat	0.00956	0.0388
Boat	0.02369	0.0733
Donkey cart	0.00299	0.0067
TV	0.06786	0.214
	-	-
Ox	0.00667	0.0284
Wheelbarrow	0.02083	0.0636
Electric stove	0.06447	0.2104
Gas stove	0.0152	0.0672
	-	
Paraffin stove	0.01151	-0.096
Fridge	0.08728	0.2377
Motor Vehicle	0.09712	0.2414
Bicycle	0.02958	0.1195
Landline	0.05557	0.1998
Piped water	0.06692	0.1992
Electric lighting	0.07678	0.1966
Electric cooking	0.09628	0.2091
Toilet	0.07672	0.2108
Housing	0.03366	0.1567
Education	0.04828	0.1867
	-	-
Livestock	0.01385	0.0756
Tractor	0.00442	0.0098

Table 11:
Row Probability Table Of Income And Asset Index Deciles For Entire Population In 2008

	Income Rankings										
Asset Index Rankings	1	2	3	4	5	6	7	8	9	10	Total
1	**21.9**	17.24	18.36	18.64	12.12	7.55	2.42	1.21	0.37	0.19	100
2	15.61	**15.49**	16.71	16.46	15.24	11.22	5.37	1.46	1.34	1.1	100
3	16.73	15.22	**16.48**	16.98	14.21	9.56	4.28	4.15	1.76	0.63	100
4	13.34	15.06	13.74	**15.06**	12.27	14.27	6.61	4.1	2.25	1.32	100
5	7.6	11.76	15.21	14.06	**17.07**	15.06	9.9	4.73	2.15	2.44	100
6	7.44	9.67	11.31	13.84	16.82	**14.43**	14.58	6.25	3.42	2.23	100
7	4.39	5.1	8.5	11.33	15.3	17.71	**19.83**	9.21	4.53	4.11	100
8	1.29	3.74	4.03	5.18	9.64	15.58	25.61	**17.12**	10.5	7.34	100
9	0.54	0.9	2.15	1.97	4.48	6.27	17.03	24.55	**23.3**	18.82	100
10	0	0.2	0.39	0.39	0.39	1.18	4.71	17.25	36.67	**38.82**	100
Total	10.2	10.46	11.71	12.41	12.49	11.44	10.41	7.87	6.95	6.06	100

Table 12:
Row Probability Table Of Income And Asset Index Deciles For Whites In 2008

	Expenditure Rankings										
Asset Index Rankings	1	2	3	4	5	6	7	8	9	10	Total
1	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100
2	0.00	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100
3	0.00	0.00	**0.00**	16.67	0.00	0.00	16.67	33.33	33.33	0.00	100
4	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	33.33	0.00	66.67	100
5	20.00	0.00	0.00	0.00	**0.00**	20.00	40.00	20.00	0.00	0.00	100
6	40.00	20.00	20.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	100
7	9.52	0.00	0.00	19.05	4.67	4.76	**14.29**	9.52	19.05	19.05	100
8	0.00	1.89	1.89	0.00	3.77	1.89	11.32	**20.75**	33.96	24.53	100
9	0.00	0.00	1.37	0.00	2.05	2.05	5.48	14.38	**33.56**	41.10	100
10	0.00	0.00	0.65	0.00	0.32	0.32	2.26	6.45	36.13	**53.87**	100
Total	0.91	0.36	1.09	1.09	1.28	1.28	4.92	10.56	33.7	44.81	100

Table 13:
Row Probability Table Of Income And Asset Index Deciles For Africans In 2008

	Expenditure Rankings										
Asset Index Rankings	1	2	3	4	5	6	7	8	9	10	Total
1	**22.53**	16.26	18.32	19.00	12.05	7.44	2.55	1.27	0.39	0.20	100
2	15.79	**14.04**	16.87	17.00	15.38	11.20	5.40	1.62	1.48	1.21	100
3	17.13	15.24	**15.97**	16.69	14.80	9.14	4.64	4.06	1.60	0.73	100
4	13.83	15.20	13.83	**14.74**	13.68	13.68	6.84	4.56	2.43	1.22	100
5	6.96	11.65	16.17	13.22	**16.35**	15.13	9.91	5.04	2.61	2.96	100
6	6.11	9.81	12.78	13.52	16.11	**14.07**	14.81	6.48	3.89	2.41	100
7	4.21	5.17	9.58	10.92	15.52	17.62	**18.58**	9.00	4.79	4.60	100
8	2.02	3.78	4.28	5.79	9.07	15.37	23.43	17.63	11.34	7.30	100
9	0.87	1.74	2.17	4.35	6.52	7.39	18.26	**25.65**	**18.70**	14.35	100
10	0.00	0.00	0.00	1.41	0.00	5.63	9.86	29.58	35.21	**18.31**	100
Total	12.14	11.77	13.72	14.18	13.63	11.92	9.53	6.32	3.97	2.81	100

Table 14:
Factor Scores For Intertemporal Method: Factor Analysis

	FA
Radio	0.01965
TV	0.09805
Electric stove	0.12924
Gas stove	0.02051
Paraffin stove	-0.03755
Fridge	0.13507
Motor	0.10278
Bicycle	0.02566
Landline	0.0889
Piped water	0.11325
Electric lighting	0.14917
Electric cooking	0.21015
Toilet	0.12371
Housing	0.04642
Education	0.05509

Table 15:
Assets Responsible For The Differences In The Lower Quantiles Of 1993 And 2008

1. Piped Water
2. Electric Stove
3. Fridge
4. Electric Lighting
5. Electric Cooking
6.Toilet
7. Electric Cooking

Table 16:
Asset Responsible For Upper Quantile Difference Between Intertemporal And Individual Asset Indexes For 2008

1. DVD
2. Computer
3. Microwave
4. Washing Machine
5. Motor
6. Electric Cooking
7. Fridge

Table 19:
Factor Scores Individual Method Including Quantity For 1993

	FA	PCA
Motor Vehicle	0.08491	0.2436
Bike	0.02922	0.1443
Radio	0.04641	0.1949
Electric Stove	0.09606	0.2889
Gas Stove	0.0169	0.0701
Prim Stove	-0.01971	-0.1919
Fridge	0.0993	0.2769
TV	0.08799	0.2652
Geyser	0.11462	0.2807
Kettle	0.10642	0.2918
Telephone	0.08983	0.2701
Piped water	0.07854	0.2403
Electric lighting	0.08918	0.2747
Electric cooking	0.16429	0.2887
Toilet	0.09268	0.2579
Housing	0.02916	0.1853
Education	0.04415	0.2351

Table 20:
Summary Of Household Size By Race And Year

Race	1993	2008
African	5.20	3.68
Coloured	4.88	3.78
Indian	4.38	3.76
White	3.11	2.62

Table 21:
Asset And Income Inequality In 1993 And 2008

	1993		**20008**	
	Asset Inequality Using McKenzie (2005)	Income inequality Using Theils T	Asset Inequality Using McKenzie (2005)	Income inequality Using Theils T
African	0.11328	0.01608	0.07099	0.00937
White	0.05176	0.00426	0.04112	0.00557
Coloured	0.12097	0.00821	0.03395	0.00714
Asian	0.06099	0.00581	0.04764	0.00842