The Construction of an Asset Index Measuring Asset Accumulation in Ecuador

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Abstract

Development economists have increasingly advocated using assets to complement income and consumption-based measures of welfare and wealth in developing countries, and thus to extend our understanding of the multi-dimensional character of poverty and the complexity of the processes underlying poverty reduction. The objective of this technical paper is to contribute to the debate about the measurement of assets, and the development of asset indices. It describes the particular methodology developed to construct an asset index based on a longitudinal panel data set from Guayaquil, Ecuador. It then outlines its application in terms of the different components of the asset index, before concluding by identifying several continuing methodological problems.

Acknowledgements

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I. Introduction

In the past decade development economists have increasingly advocated the use of assets to complement income and consumption-based measures of welfare and wealth in developing countries (Carter and May 2001; Filmer and Pritchett 2001). Income has long been the favoured unit of welfare analysis, because it is a cardinal variable that is directly comparable among observations, making it straightforward to interpret and use in quantitative analysis. However, by the 1990s this was often superseded by consumption-based measures (Ravallion 1992). The analysis of assets and their accumulation is intended to complement such measures, by extending our understanding of the multi-dimensional character of poverty and the complexity of the processes underlying poverty reduction (Adato, Carter and May 2006).

Closely linked to the asset-based approach is recent methodological work on the measurement of assets with a range of new techniques developed to capture aggregate ownership of different assets into a single variable. The objective of this 'technical' paper is to contribute to the debate about the measurement of assets. It describes the particular methodology developed to construct an asset index based on a longitudinal panel data set from Guayaquil, Ecuador. It then outlines its application in terms of the different components of the asset index, before concluding by identifying several continuing methodological problems.

II. Contextual Background

II.A The Research Methodology

The construction of an asset index is grounded in a research project on 'Intergenerational asset accumulation and poverty reduction in Guayaquil, Ecuador between 1978 and 2004'.[1] A community study such as this, that combines a range of qualitative, participatory and quantitative methodological approaches used over a 26 year research period, poses challenges relating to its statistical robustness, or representativeness. This was also the case in an earlier research phase when the data was included in a World Bank study on the 'social impact' of structural adjustment reforms in four poor urban communities in different regions of the world that included not only Guayaquil, Ecuador, but also Lusaka, Zambia, Budapest, Hungary and Metro Manila, the Philippines (Moser 1996; 1998). At the time the results were dismissed by World Bank economists as neither representative at the national level, nor robust in terms of cross-country comparisons; at best they provided interesting case study 'anecdotal information' on community and household coping strategies in 'crisis situations' (Moser 2002).

To address this challenge the research methodology for this final study builds on earlier cross-disciplinary combined methodologies including the pioneering work of Ravi Kanbur to address the 'qual-quant' divide (Kanbur 2002) but pushes the envelope further by including the econometric measurement of the quantitative data on capital assets. The methodology, which we have called "narrative econometrics", combines the econometric measurements of change with in-depth anthropological narratives that identify the social relations within households, communities and broader institutional structures that influence well-being and assist in identifying the associated causality underpinning economic mobility. In so doing we also seek to develop methodological tools that can bridge the divide in current debates about the limitations of measurement-based poverty analysis that disregards context and therefore 'cannot address the dynamic, structural and relational factors that give rise to poverty' (Harriss 2007; see also Green 2006; Green and Hulme 2005). This paper, however, is limited to the elaboration of the index methodology and therefore complements further analysis that

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seeks to bring together the 'econometric' and the 'narrative' (see for instance Moser and Felton 2007).

II.B Assets and Income

While economists often use income to measure wealth, welfare, and other indicators of well-being, income data has limitations in both accuracy and measurement, particularly in the context of developing countries. For instance, for people living in informal labour markets incomes are often highly variable. Income can be seasonal, such as when earned from farming or the tourist market, or just variable and lumpy for small-business owners. Taking a snapshot of income at one point in time may therefore produce a less reliable picture of these types of workers than those who receive regular paychecks. Furthermore, they may be engaged in barter and other non-monetary forms of trade. In all of these cases there is a high potential for error in data based on the recollection and value of all sources of income. This means that income itself does not necessarily provide a reliable measure of well-being.

Expenditures and consumption are also commonly used to measure well-being (Chen and Ravallion 2000; Ellis 2000). Expenditures solve some of the problems of income, such as seasonality. Households can save their income from flush times as a buffer against bad times. This "consumption smoothing" is both theoretically appealing and has empirical regularity. Households also tend to be more forthcoming about expenditures, which lack the sensitivity, that some have towards divulging income data. However, a number of the same difficulties of income also apply to expenditure, such as measuring the value of bartered good. Work done for oneself, such as house improvement, also tends to be missing from expenditures. In addition, although economists have shown that consumption data provides more robust information on well-being than income data (particularly in rural areas), income data is still used in a number of research studies such as in the Guayaquil study.[2]

When asking people what they own from a list of assets, there is often less likelihood of recall or measurement problems. Furthermore, assets may provide a better picture of long-term living standards than an income snapshot because they have been accumulated over time and last longer. However, a list of assets lacks money's advantages of cardinality and fungibility. The following section explores the theoretical difficulties of creating a set of "asset" variables.

Suppose that a household's capital portfolio can be measured in terms of a number I of types of capital, C^i, where $i \in [1,2,\ldots I]$. Each type of capital C^i is composed of J types of assets $a^{i,1} \ldots a^{i,J}$. Each of these a's may be measured using a binary, ordinal, or cardinal variable. We want to assign a weight w to each item and then sum up the weighted variables to arrive at our estimate of C^i, as in equation 1.

$$C_{n,t}^i = \sum_{j=1}^{J} w_t^{i,j} a_{n,t}^{i,j} \qquad (1)$$

Index notation	Reference	Index notation	Reference
n	Household number	j	Type of asset
i	Type of capital	t	Time period

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[2] Longitudinal anthropological research in this urban context revealed that even people's short-term recall of consumption expenditures was often inaccurate or underestimated. People buying many of their basic consumption items on a daily basis simply did not remember what they spent. Data from expenditure diaries, for instance, proved to be widely inconsistent with expenditure data from anthropological participant observation. In contrast, working in a community where trust had been established, there was a high level of compatibility across the 51 households in the panel data in terms of income relating to both formal and informal sector earnings. For this reason the study used income measures.

The rest of this section describes different ways to measure the *w*'s.

Method 1:   Prices

One intuitive way to weight the assets is to use monetary values, so that $w_t^{i,j} = p_t^{i,j}$ where $p_t^{i,j}$ is the price (or some other monetary measure of value) of asset (*i,j*) at time *t*. The sum $\sum_{j=1}^{J} w_t^{i,j} a_{n,t}^{i,j}$ would then be the total monetary value of the household's asset wealth. However, this approach is problematic for some of the same reasons that apply to income data. Price data can be difficult to obtain in some contexts, especially in economies that have high levels of barter. Even more fundamental is the problem that it is difficult or impossible to assign prices to intangible assets, such as human or social capital. Of course, assigning any number to those types of capital is tenuous, but the ordinal scale that we develop in this paper seeks to overcome the implied fungibility of prices.

Method 2:   Unit values

Another method is to simply sum up the number of assets owned, which is equivalent to setting $w = 1$ for each *w*. This method has the virtue of simplicity, but also has the limitation of assigning equal weight to ownership of each asset. For example, this method would assign equivalent worth to owning a radio and a computer, although in reality their contributions to the capital variable are surely different.

Method 3:   Principle components analysis

Recently, development economists have followed the recommendation made by Filmer and Pritchett (2001) to use principle components analysis (PCA) to aggregate several binary asset ownership variables into a single dimension. PCA is relatively easy to compute and understand, and provides more accurate weights than simple summation.

The intuition underlying this method is that there is a latent (unobservable) variable $\widetilde{C}^i$ for each type of capital C^i that manifests itself through ownership of the different assets $a^{i,1} \ldots a^{i,J}$. For example, suppose household *n* owns asset $a^{i,1}$ if $\widetilde{C}^i > w^{i,1}$. It turns out that the maximum likelihood estimators of the *w*'s are the eigenvectors of the covariance matrix, also known as the *principle components* of the data set.[3] Usually only the eigenvector with the highest eigenvalue is used, because it is the vector that provides the most "information" about the variables.[4] The first eigenvector is the vector that minimizes the squared distances from the observations to a line going through the various dimensions.

This is an appealing method for combining variables for two reasons. First, it is technically equivalent to a rotation of the dimensional axes, such that the variance from the observations is minimized. This is equivalent to calculating the line from which the orthogonal residuals are minimized. This is similar to a regression in terms of minimizing residuals, but in this case the residuals are measured against all of the variables, not just one "dependent" variable. Figure 1 demonstrates how regression minimizes the squared residuals from a dependent variable to a line, while PCA minimizes the distances from points in multidimensional space to a line.

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[3] In fact a correlation matrix is usually used to equally scale the variables and avoid problems stemming from which measurement units are used.

[4] It is also possible to use the sum of a number of eigenvectors, based on some criteria. Using the sum of all the eigenvectors is equivalent to using unit coefficients for each variable. Some statisticians recommend using all eigenvectors with eigenvalues greater than one; others suggest the "scree test". However, these are more complicated to interpret than using just the first eigenvector (Jolliffe 2002).

Figure 1: Difference between regression and PCA
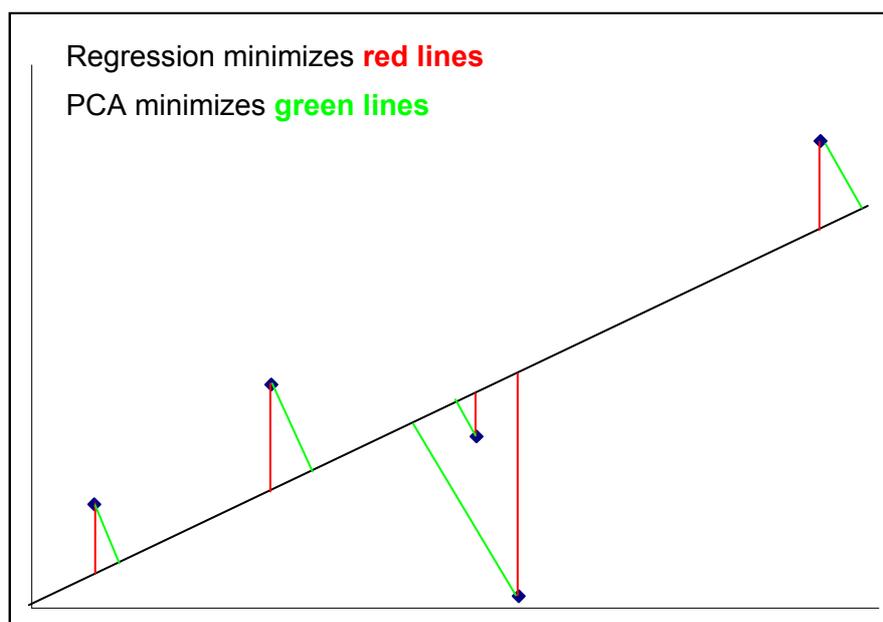
The second reason that PCA is a valuable approach is that the coefficients have a fairly intuitive interpretation. The coefficient on any one variable is related to how much information it provides about the other variables.[5] If ownership of one type of asset is highly indicative of ownership of other assets, then it receives a positive coefficient. If ownership of an asset contains almost no information about what other assets the household owns (its correlation coefficient is near zero), then it receives a coefficient near zero. And if ownership of an asset indicates that a household is likely to own few other assets, then it receives a negative coefficient. Higher and lower coefficients mean that ownership of that asset conveys more or less information about the other assets.

This makes PCA excellent for modelling a presumed underlying continuous variable, such as wealth. If ownership of a certain asset is highly correlated with owning the other assets that were asked about in the survey, then it is likely also correlated with owning other types of assets that were not in the survey. To return to the earlier example, wealthy households are more likely to own a computer than poor ones, but radio ownership is spread evenly across the spectrum. Therefore, knowing that one household owns a computer provides us with more information about that household's wealth than a radio does, and it receives a higher weighting.

Filmer and Pritchett (2001) fail to adequately address the important methodological issue that the variables must positively correlate with the latent variable, and with each other. If all the variables are positively correlated, then the estimates will all be greater or equal than 0 and bounded at the top by the value of the first eigenvalue (which is itself less than or equal to the number of variables in the matrix). If they are not, then the first eigenvector may have negative values, which means that the estimated latent variable would be *reduced* from ownership of an asset. This is only remedied by interpreting ownership of those assets as a sign of lower wealth. If this is plausible, then even negative values of estimated wealth are acceptable because the estimated variable is ordinal and can either be used as is or rescaled so that they are all positive.

Filmer and Pritchett (2001) use 21 types of assets from the Demographic and Health Surveys, covering both consumer durables and housing stock, to create a single "wealth"

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[5] This has a precise mathematical definition in terms of Kullback-Leibler (1951) information.

variable. They show that the resulting variable has empirically plausible consequences and predicts school enrolment better than expenditure. The robustness tests on asset indices conducted by Sahn and Stifel (2003) demonstrate that the asset index reliably predicts poverty and serves as a proxy for long-term wealth with less error than data on expenditures.

Other papers advocate a variety of techniques. Sahn and Stifel (2003) use factor analysis, which is designed more for data exploration than dimensional reduction. Booysen *et al* (2005) use multiple correspondence analysis (MCA), which they promote as better at dealing with categorical variables than PCA. Finally, Kolenikov and Angeles (2004) very recently describe a new technique, polychoric principle components analysis, which improves on regular PCA and is designed specifically for categorical variables. Unlike MCA it can also be used for continuous variables and is especially appropriate for discrete data. It supposes that the discrete data are observed values of an underlying continuous variable. Similar in spirit to an ordered probit regression, polychoric PCA uses maximum likelihood to calculate how that continuous variable would have to be split up in order to produce the observed data.

Polychoric PCA has a number of advantages over regular PCA. For instance, its coefficients are more accurately estimated than with regular PCA.[6] The main advantage, however, come from its use of ordinal data. Many assets can be described as ordinal. Researchers often ask about the quality of construction of a home, for example, which might be recorded on a 1-4 scale. While Filmer and Pritchett (2001) advocate splitting this into four binary variables, this introduces a large amount of distortion into the correlation matrix, as the variables are automatically perfectly negatively correlated with each other. Furthermore, the knowledge that the researcher brings – that some values are better than others – is lost, as the PCA treats every variable as the same. Polychoric PCA solves these problems by assigning each the value of a discrete variable and ensuring that the coefficients of an ordinal variable follow the order of its values.

Another advantage of polychoric PCA is that it allows us to compute coefficients of both owning and not owning an asset. This is desirable because sometimes not owning something conveys more information than owning it. If almost every household owns indoor plumbing except for the very poorest, then the coefficient on owning indoor plumbing will be around zero (since it does not help distinguish household wealth among those that own it). However, not owning indoor plumbing will be negatively correlated to ownership of other assets and the coefficient of not owning it will be highly negative. This further distinguishes among wealth levels.

III. Multivariate analysis

Most research so far has only used PCA and its related techniques to model ownership of a single type of asset, usually a variant of "wealth." However, social scientists are often interested in examining portfolios that include different asset types in order to better understand the specific root causes of poverty. Hulme and McKay (2005) provide an overview of techniques used for multivariate asset analysis, briefly mentioning index construction methods like PCA before moving on to a variety of other methods used by economists, sociologists, and anthropologists. Most of the examples of multivariate asset analysis cited do not use PCA or other sophisticated techniques of aggregating assets. For example, Klasen (2000) identifies 14 components of well-being and sums up the number that are unsatisfactory for a given households to arrive at a "deprivation index." However, as Hulme and McKay point out,

> "…..while giving all components the same weight might appear to be 'fair', there is a complex set of value judgments built into such an assumption. For example, can nutrition (child stunting that may reduce an individual's

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[6] Kolenikov and Angeles (2004) run a Monte Carlo exercise on simulated data and find that polychoric PCA predicts the "true" coefficients more accurately than regular PCA.

capabilities over her lifecourse) be weighted the same as transport/mobility (where a low score may be a temporary inconvenience)?

They identify similar issues with multidimensional frameworks by Clark and Qizilbash (2002; 2005) and Barrientos (2003).

Among the papers that use PCA or similar methods, Sahn and Stifel (2003) come closest to implementing a multidimensional approach. They categorize their index components into three types of capital (household durables, household characteristics, and human capital) but they then combine them all together into a single index. Asselin (2002) also groups his variables into categories (economy and infrastructure, education, health, and agriculture) but then combines them all before his analysis. To the best of our knowledge, no paper so far uses PCA on the components of each type of capital before undertaking their analysis.

IV. The empirical application of polychoric PCA: The Guayaquil panel data set

Below we present an application of multivariate analysis on a panel data set of 51 households in a neighbourhood of Guayaquil, Ecuador between 1978 and 2004. The analysis is based on the research presented in detail in Moser and Felton (2007) on the measurement and analysis of four dimensions of the five-dimensional asset framework (see for instance Carney 1998; Moser 1998; World Bank 2000) in order to implement a quantitatively rigorous, multidimensional approach to asset accumulation and poverty dynamics.

While the asset index is grounded in an extensive literature review on livelihoods and asset accumulation (Moser 2007), the specific assets chosen were determined by the questions available in the data set. Here it is necessary to recognize constraints relating to the fact that this was not originally defined as a study of asset accumulation when the first stage of field research was undertaken living in the community. (This applies particularly to the social capital variables and employment data.)

IV.A   Data and contextual background

The data comes from a research project that focused on household asset accumulation strategies using twenty-six years of anthropological and sociological research in a poor urban community, Indio Guayas, in Guayaquil, Ecuador. Named after its community committee, this is an eleven-block neighbourhood area within the barrio of Cisne Dos, which in 2004 had an estimated 75,364 inhabitants (Municipality of Guayas 2005, pers. comm.). Cisne Dos itself is one of a number of working class suburbs in the *parroquia* of Febres Cordero located on the south west edge of the city. This area, about seven kilometres from the central business district, was originally a mangrove swamp.

In 1978, when the research began, recently arrived settlers were consolidating the 10 by 30 meter waterlogged plots (*solars*) they had purchased cheaply from professional invaders. Households lacked not only dry land, but also basic physical services such as electricity, running water, plumbing, as well as adequate social services like education and health facilities. At this time it was a young population, struggling to make their way in the city, many just starting families. By 2004, Indio Guayas was a stable urban settlement with physical and social infrastructure, and due to the city's rapid expansion, a community no longer on the periphery. By this time, children of the original settlers had reached adulthood and started families of their own, either in the same community or elsewhere. The study is contextualized within the broader macro-economic and political structural context during different phases of Ecuador and Guayaquil's history; in brief these can be summarized as the 1975-1985 democratization process, the 1985-95 economic structural adjustment policies, and the 1995-2005 globalization and dollarization period.

Three quantitative household surveys were undertaken in 1978, 1992 and 2004 that comprise a panel data set of the inhabitants of 51 family plots. In 1978, a universe survey of

244 households was undertaken over the 11 block area; in 1992 a random sample survey of 263 household undertaken in exactly the same spatial area picked up 56 households that had also been in the 1978 universe survey. In 2004, these same 56 households were tracked and 51 were re-interviewed (indicating a 9% attrition rate).

IV.B Analysis

The Indio Guayas household asset index is based on the following sources: those defined in the literature, research based on local anthropological knowledge of asset vulnerability in the community (Moser 1996; 1997; 1998), and the empirical data available from the panel data. The variables were adapted from the questionnaire data from the 1978-2004 panel data. Two types of physical capital were identified: housing and consumer durables. Financial capital was extended to incorporate productive capital, while human capital was limited to education because of a lack of panel data on health. Finally, social capital was disaggregated in terms of household and community social capital.[7]

Table 1 outlines each type of asset analysed, the category of capital that it belongs to, and the specific components that make up its index. The following section describes in detail the construction of the index to measure each of these capital types and the associated challenges. Polychoric PCA was used for many but not all of the asset categories; as we elaborate in the subsequent sections, its advantages and limitations become clearer when moving from theory to practice. As with any statistical technique, the devil is in the details and we lay out below exactly how and why we chose specific variables out of this detailed data set for use with different techniques.

i. Physical capital

Physical capital is generally defined as comprising the stock of plant equipment, infrastructure and other productive resources owned by individuals, businesses and the public sector (see World Bank 2000). In this study, however, physical capital is more limited in scope. It is subdivided into two and includes the range of consumer durables households acquire, as well as their housing (identified as the land, and the physical structure that stands on it).

Housing is the more important component of physical capital. In Indio Guayas households squatting in severe conditions on a mangrove swamp rapidly constructed wooden stilts and a platform, and then incrementally built very basic houses with bamboo walls, wood floor and corrugated iron roofs. However such houses were insecure – bamboo walls could easily be split by knives, and the materials quickly deteriorated. Consequently, as soon as resources were available, households upgraded their dwellings. This started with in-fill to provide land, followed by permanent housing materials such as cement blocks and floors. This very gradual incremental upgrading took place over a number of years.

This process is reflected in the econometric findings on housing based on the four indicators: type of toilet, light, floor, and walls. These are ordered in terms of increasing quality (for instance "incomplete" walls are those in the process of being upgraded from bamboo to either wood or brick/concrete), with the data showing a high degree of inter-household correlation. The ordinal nature and positive correlation of the variables makes this part of the data highly suitable for analysis using the polychoric PCA technique (see Table 2).

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[7] A fifth type of capital, natural capital, is commonly used in the assets and livelihoods literature. Natural capital includes the stocks of environmentally provided assets such as soil, atmosphere, forests, water and wetlands. This capital is more generally used in rural research. In urban areas where land is linked to housing this is more frequently classified as productive capital as is the case in this study. However since all households lived on similar plots, this was not tracked in the data set.

Table 1: Types of capital, asset categories and components

Capital type	Asset index categories	Index components
Physical capital	Housing	Roof material Walls material Floor material Lighting source Toilet type
	Consumer durables	Television (none, b/w, colour, or both) Radio Washing machine Bike Motorcycle VCR DVD player Record player Computer

Financial/productive capital	Labour security	Type of employment:
		    State employee
		    Private sector permanent worker
		    Self-employed
		    Contract/temporary worker

	Productive durables	Refrigerator Car Sewing machine
	Transfer/rental income	Remittances Rental income

Human capital	Education	Level of education:
		    Illiterate
		    Some primary school
		    Completed primary school
		    Secondary school or technical degree
		    Some tertiary education

Social capital	Household	Jointly headed household Other households on solar "Hidden" female-headed households

	Community	Whether someone on the solar:
		    attends church
		    plays in sports groups
		    participates in community groups

Table 2: Housing stock polychoric PCA coefficients

Asset	Coefficient
toilet: Hole	-0.5629
toilet: Latrine	-0.0735
toilet: Toilet	0.4541
light: None	-0.8869
light: Illegally tapped electricity	-0.2605
light: Mains electricity	0.4063

Asset	Coefficient
floor: Earth/Bamboo	-0.8672
floor: Wood	-0.3052
floor: Brick/Concrete	0.3658
walls: Earth/Bamboo	-0.5687
walls: Incomplete	-0.1847
walls: Wood	-0.1340
walls: Brick/Concrete	0.3631

The estimated coefficients rise with the increasing quality of each asset, and greater numbers (either positive or negative) mean that the variable provides more "information" on the household's housing stock. For example, the greatest negative coefficient is on having no electric lights. This means that a household that lacks electric lighting is extremely likely to fall into the lowest categories of the other types of assets: toilet, floor, and walls. Similarly, a household with a flush toilet (the highest level within the toilet category) is likely to have scored highly on the other items as well. This is because flush toilets were owned by the fewest people, and it was only in 2004 that almost all households acquired one. In contrast, many people had connected to the main electrical grid, and upgraded their floors and walls to brick/concrete, by 1992.

The consumer durables variable illustrates a new type of difficulty with PCA. Because the data covers multiple time periods, the "values" of many of these assets have changed between observations. For example, a black-and-white television was relatively more valuable in 1978 than in 2004. In 1978, it was a sign of wealth to own a black-and-white television, but in 2004, a sign of poverty, as colour televisions had become available. By 2004, a number of electronic items that had become available were simply not on the market previously.

This issue can be addressed either by conducting a separate analysis for each year, or by aggregating the data across time. The first three columns of Table 3, which calculate values for each item in each year, illustrate the changing values of many of the variables. In 1978, a black-and-white television had a strongly positive coefficient, as it was a sign of wealth. Its coefficient decreased during each time period as it became less indicative of wealth. This demonstrates that in addition to its ability to create a single variable, asset index construction is useful for tracking the relative value of items.

Aggregating the time periods proved to be the most efficacious method of combining the variables, as it allows relative comparisons across, as well as within, time periods. Items that were once luxury items can receive a negative score in later time periods, which means they are on average indicative of poverty. However, because we estimate the value of not owning the asset as well as the value of owning it, a household with a black-and-white TV in 1978, although receiving a "negative" score in aggregate, still ranks much higher in 1978 than a comparable household that does not own a TV at all. In fact, the average household in 1978 had a negative score for their consumer durables capital, but the ordinal rankings remain the same as the coefficients were calculated separately for each year. Therefore, the rankings make sense both within and across time periods.

This method produces a feasible and accessible continuous variable representing ownership of consumer durables.

Figure 2 shows the kernel density distributions for the consumer durables variable in each round. In 1978 and 1992, the variable is roughly normally distributed (when the households are just beginning to diverge from their equal starting points), but by 2004 it resembles the

lognormal distribution commonly found in studies of income distribution (which parallels the actual growth of income and asset inequality in Guayaquil).

Table 3: Consumer durables polychoric PCA coefficients

Asset	1978	1992	2004	All years combined
No TV	-0.5358	-0.4168	-0.4687	-0.4616
B/W TV	0.5797	-0.0317	-0.2939	-0.0564
Colour TV		0.2782	0.0194	0.3093
Both B/W and colour TV		0.5229	0.3778	0.7321
No radio	-0.8888	-0.6856	-0.2631	-0.1069
Radio	0.1761	0.1358	0.0943	0.0277
No washing machine		-0.0402	-0.0914	-0.0492
Washing machine		1.4188	0.7685	0.7507
No bike		-0.1190	-0.1802	-0.1428
Bike		0.3009	0.1665	0.3973
No motorcycle		-0.0949	-0.0240	-0.0253
Motorcycle		0.7978	0.2020	0.3464
No VCR			-0.0623	-0.0258
VCR			0.6574	0.8706
No DVD player			-0.1477	-0.0580
DVD player			0.6507	0.8844
No record player	-0.1738		-0.1236	-0.0639
Record player	0.4394		0.6239	0.3718
No computer			-0.1100	-0.0519
Computer			0.4843	0.7910

Figure 2: Consumer durables capital density estimates
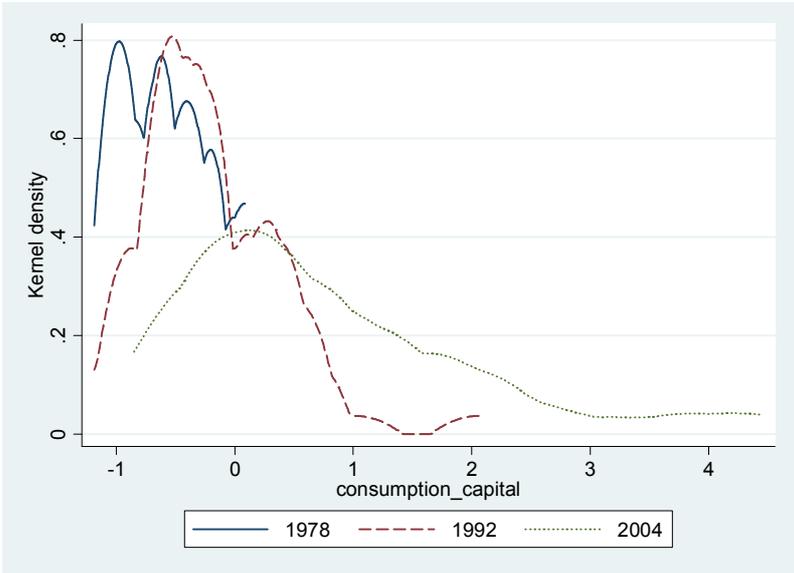
ii. Human capital

Human capital assets refer to individual investments in education, health and nutrition, which affect people's ability to use their labour and changes the nature of their returns from their labour. Education is the only component in this index and therefore provides only a partial picture of human capital.[8]

Human capital presents a different challenge from previous categories because it is usually measured at the individual, not household level. If we want to measure human capital at the household level, we need to develop a method of aggregation. Furthermore, we have only one key measure of human capital at the individual level: years of education (or, alternatively, level of completed education). Since there is only one variable, we cannot use any of the varieties of PCA at the individual level because PCA measures the correlation between two or more variables. We could assign an equal weight to every year of education and add them up—but this brings us back to the earlier methods described above, with the same attendant problems. Instead, we make use of the fact that the survey contains the income earned by every individual so are able to estimate the monetary return to education. The education variable was split into five levels: none, some primary, completed primary, completed secondary, and some tertiary (see Table 4).

Income earned from wages is regressed on the level of education, age, and age squared to proxy for experience, and a gender dummy variable. The regression is estimated separately for each year because the value of each type of degree changes every year as the job market changes. Therefore, the value of the education capital of a household can change even though the composition of the household did not. Results show that in 1978, there was very little difference in terms of wages in the value of being illiterate, having some primary education, or having completed primary school. These accounted for almost 90% of the young settlers of Indio Guayas population at the time. Those few that had higher education earned considerably more in the labour market. Over time, however, being illiterate or without a primary degree became more disadvantageous because less educated people earned lower wages. Meanwhile, the macroeconomic instability of 1992 decreased wages for every educational group.

Table 4: Value of educational levels

Educational level	1978	1992	2004
Illiterate	3.52	2.15	3.18
Some primary	3.20	2.47	3.09
Completed primary	3.31	2.51	3.19
Completed high school or technical school	3.09	2.66	3.21
Tertiary education	3.98	3.12	3.37
Coefficients for age, age squared, and gender not shown.			

Human capital is usually valued for its use in the labour market, so it is one type of capital that may be measured in monetary terms relatively easily using techniques similar to those described above. Years of education and salary are frequently available in surveys. On the other hand, endogeneity and other issues are problematic in this methodology. For example,

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[8] The study contains detailed information on health status, particularly in terms of shocks relating to serious illnesses or accidents, as well as the use and cost of health services. However the lack of an adequate methodology to translate these into a health asset index means that the information remains at the narrative level.

many people with low education are not in the workforce – neither including them as zero income nor not including them is wholly satisfactory. If low-educated people are disproportionately absent from the formal economy, then the estimation of returns form low levels of education might be biased up, because only the most talented of the poorly-educated have income. Table 4 shows that illiterate people often earn more than those with more education, suggesting that this problem may indeed exist in our data.

Furthermore, the use of other variables like age and gender, while important, also leads to complications. Younger generations on average had more educational opportunities, and the importance of education changes over the years as the economy develops. By using income as the dependent variable, we are measuring the market value of education, rather than some level of inherent human capital specific to the individual. Finally, we may disagree with the values the labour market places on human capital. For example, people with no education at all in 1978 earned more than any other group except those with a college education (only one person). However, we want to assign those people the lowest level of human capital. For these reasons, estimating the level of human capital using other variables may produce worse results than an arbitrary ranking.

Ideally, PCA or a similar technique can be used, given a variety of data on individuals assumed to be correlated with the unmeasurable "human capital," such as test scores, grades, education, etc. In fact, the literature on measuring intelligence often uses PCA to collapse scores along a number of dimensions into one variable (Jensen 2002). However, data of this nature is not usually available, especially in developing countries.

iii. Financial/productive capital

Financial/productive capital comprises the monetary resources available to households. In developed countries, this usually translates into financial assets such as bank holdings, stock and bond investments, house equity, etc., that can be drawn on in case of need. However, few citizens of developing countries have any of these. In this case, a monetary measure is actually less useful than an asset index, because the assets are likely to be intangible and not easily quantified in monetary terms.

The financial/productive capital asset index comprises three components: labour security, which measures the extent to which an individual has security in the use of their labour potential as an asset; transfer/rental income which are non-earned monetary resources; and productive durables, which are durable goods with an income-generating capability.

Labour security is undoubtedly the most challenging component in the index. However it represents an effort to include labour as an asset – omitted so far in the work on asset indices, and to include employment vulnerability as linked to stability of job status. The composite component derives from combining two ILO work categories on employer type and work status, and are ranked in terms of vulnerability in the Guayaquil context through local anthropological knowledge: the most secure type of job is working for the state, the second is as a "permanent worker" (with a formal, stable job) in the private sector, the third is self-employment, and the least secure is contract/temporary work. The ordering of the top two job types should be uncontroversial, but the latter two require some explanation. Entrepreneurs, even on a small scale, build up business knowledge, contacts, and habits that can help sustain them through a downturn. They can continue in their business even during times of reduced demand (Moser 1981). Temporary workers, however, have less to fall back on when they are let go. Consequently we make the judgment that the self-employed have more job security than contract workers. Unfortunately, we must still arbitrarily assign weights to each type of job; we give temporary work a four on the vulnerability scale and move down to government work, which gets a weight of one. We then aggregate up to the household level by computing the average vulnerability of each household. Although this method retains some of the arbitrariness that we have been trying to avoid, we at least manage to turn labour security into an ordinal variable that can be used for polychoric PCA.

The main sources of unearned income are remittances, government transfers, and rent. The first two are transfers of income within society and the latter is a return on capital – similar to income from physical goods as analyzed above. Non-wage income has increasingly played an important role in household income. Remittance income has risen most dramatically, linked to the explosion of Ecuadorian migrants in the late 1990s following dollarization and the banking crisis. The fact that this accounted for over 50% of non-wage income in 2004 shows that having someone abroad is a real household asset. Remittance income comprised more than half total income for some households. Rental income is much smaller and more recent as households have specifically built on extra rooms to accommodate renters at either at the back of their plots, or additional floors to their house.

Finally, productive durable goods count as financial/productive capital because they represent a current or potential income stream. In the context of Guayaquil, sewing machines, refrigerators and cars were popular examples of this type of goods, with each predominating during different time periods. Numerous families acquired sewing machines in the 1970s. Men primarily used them in their work as tailors, either as self-employed or as sub-contracting outworkers. A lesser number of women had sewing machines for use both within the family but also to generate income through work as dressmakers (Moser 1981). Refrigerators are generally used as the basis of a small enterprise selling ice, frozen lollies and cold drinks such as Coca Cola. Car ownership is a more recent phenomenon and one that requires far more capital (usually based on credit loans). Almost all local men who own cars use them as taxis to generate an income. While in some cases these are full-time occupations, in other cases they supplement other jobs particularly when there is high demand – such as weekend nights.

Table 5: Financial/productive capital polychoric PCA coefficients

Asset	Coefficient (all years combined)	Asset	Coefficient (all years combined)
Sewing machine: no	-0.0158	Home business income: no	-0.1036
Sewing machine: yes	0.0173	Home business income: yes	0.4999
Refrigerator: no	-0.3344	Rental income: no	-0.1152
Refrigerator: yes	0.3133	Rental income: yes	0.9031
Car: no	-0.1351	Remittances: no	-0.1326
Car: yes	0.8356	Remittances: yes	0.4779
		Job vulnerability	-0.1606

iv. Social capital

Social capital, the most commonly cited intangible asset,[9] is generally defined as the rules, norms, obligations, reciprocity and trust embedded in social relations, social structures and societies' institutional arrangements, that enable its members to achieve their individual and community objectives. Social capital is generated and provides benefits through membership in social networks or structures at different levels, ranging from the household to the market place and political system. The index differentiates between community level social capital and household social capital. The latter is based on detailed panel data on changing intra-household structure and composition (see Moser 1997; 1998). Social capital is usually considered extremely difficult for social scientists to measure because the assets are nonphysical and difficult to translate into monetary terms. In the asset index framework,

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[9] Social capital is the most contested type of capital (Bebbington 1999). The development of the concept is based on the theoretical work of, for instance, Putnam (1993) and Portes (1998).

however, they are measured in terms of binary variables such as household participation in various different activities and groups.[10]

This data set uses three variables to determine household social capital as identified in Table 1. The index was constructed using polychoric PCA. The three variables are positively correlated with each other, and participation in a sports league was the best indicator of social capital. Not attending church was the best indicator of a lack of social capital, garnering a large negative coefficient. Of the 12 observations in which a household had a member participating in a sports club, only one of those did not also have someone who either went to church or participated in community activities.

Table 6: Community social capital polychoric PCA coefficients

Asset	Coefficient
Don't attend church	-0.7449
Attend church	0.2744
Don't participate in community activities	-0.3511
Participate in community activities	0.3650
Don't participate in sports league	-0.4358
Participate in sports league	0.6050

Household social capital as an asset is complex because it is both positive and negative in terms of accumulation strategies. On one hand, households act as important safety nets protecting members during times of vulnerability and can also create opportunities for greater income generation through effective balancing of daily reproductive and productive tasks (see Moser 1993). On the other hand, the wealth of a household may actually be reduced by having to support less-productive members. Over time, households change in size and restructure their composition and headship in order to reduce vulnerabilities relating both to life cycle and wider external factors.

Household social capital was defined as the sum of three indicator variables. The first component, jointly headed households, serves to indicate trust and cohesion within the family between partners, and is applied to both nuclear and couple-headed extended household. In 1978 when the community comprised young families nearly two-thirds were nuclear in structure.[11] By 1992 this had dropped to a third and in 2004 was only one in ten households. In contrast, the reverse was true for couple headed extended households growing from one fifth in 1978 to two fifths by 1992 and levelling off to slightly more by 2004. Within many extended households there are also 'hidden' female heads of household: unmarried female relatives raising their children within the household to share resources and responsibilities with others. This has grown from less than one in ten in 1978 to more than one in four in 2004. The third component is the presence of other family-related households living on the solar – usually the households of sons or daughters.

Unfortunately, none of the varieties of PCA could be used here because the variables are not all positively correlated, but we wanted to give them all a positive value. PCA or a similar

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[10] Again it important to note that the original study in 1978 was not designed to 'measure' social capital; consequently the groups identified do not represent the universe but are those for which comparative data is available.

[11] A nuclear household comprises a couple living with their children; an extended household comprises a single adult or couple living with their own children and other related adults or children; a female headed household comprises a single-parent, nuclear or extended household headed by a woman; if married she identifies herself as the head usually because her husband is not the main income earner; a woman is counted as a "hidden" head of household if she: (1) lives on the family plot, (2) is unmarried, and (3) has at least one child.

technique would have given at least one of the coefficients a negative value. We therefore had to give them all equal weight (or some other arbitrary weight). This is an area where more research is needed.

IV.C   Preliminary Analysis

Longitudinal analysis of changing poverty levels based on income alone provides one measure of well-being, and shows movement between poverty levels. A more comprehensive understanding of household assets accumulation complements income data in helping to identify why some households are more mobile than others and how some households successfully pull themselves out of poverty while others fail.

Figure 3: Household asset accumulation in Guayaquil, Ecuador - 1978-2004
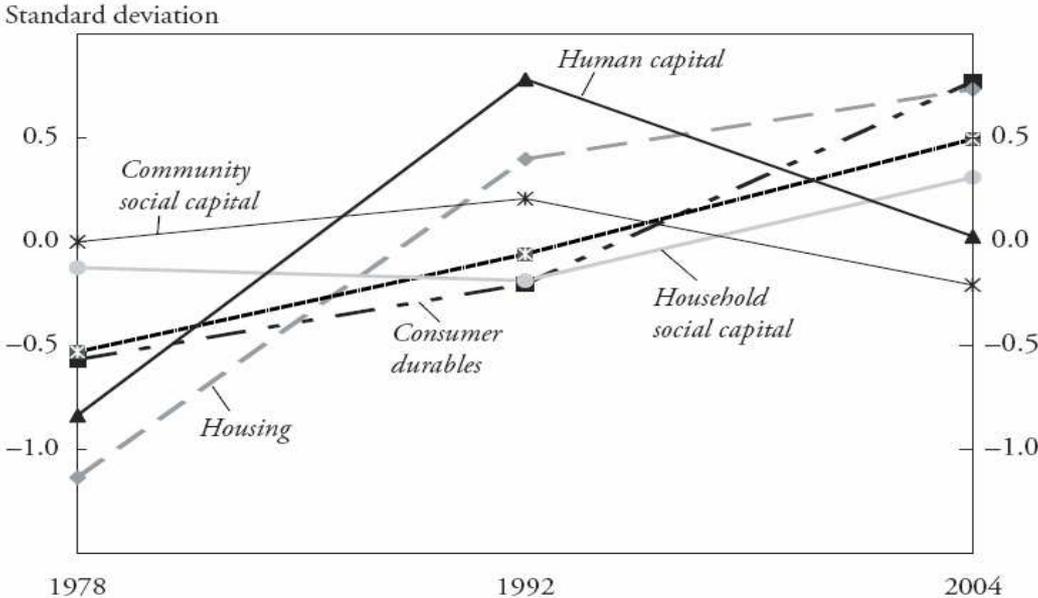

Source: Authors' calculations.
a. 0 = mean across the time periods.

Most assets increased fairly steadily between 1978 and 2004. The greatest difference between households in the first and last periods was in housing: the average household improved its housing stock by over two standard deviations. Community capital actually decreased from 1992 to 2004. These quantitative observations are supported by the anthropological research.

Asset analysis can be particularly useful when used in conjunction with income data. The following charts (Figure 4) display the level of housing and consumer durables owned by income group during each time period and demonstrate that households of all income levels have similar average levels of housing, but very different levels of consumer durables (especially in 2004). This implies that poor households place a much greater emphasis on accumulating housing than consumer durables.

These numbers are not adjusted for household size, although size is obviously significant. Poorer households tend to be larger households, with greater needs for housing space and physical infrastructure. Also, larger households, *ceteris paribus*, tend to have more people working and greater total income than smaller households, although large households tend to have lower per capita incomes than small households. This means that the larger household may have an advantage in accumulating assets and therefore look wealthier, but those assets have to be shared among a greater number of people. Some assets can be

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Figure 4: Patterns of housing and consumer durables investment over time by income group
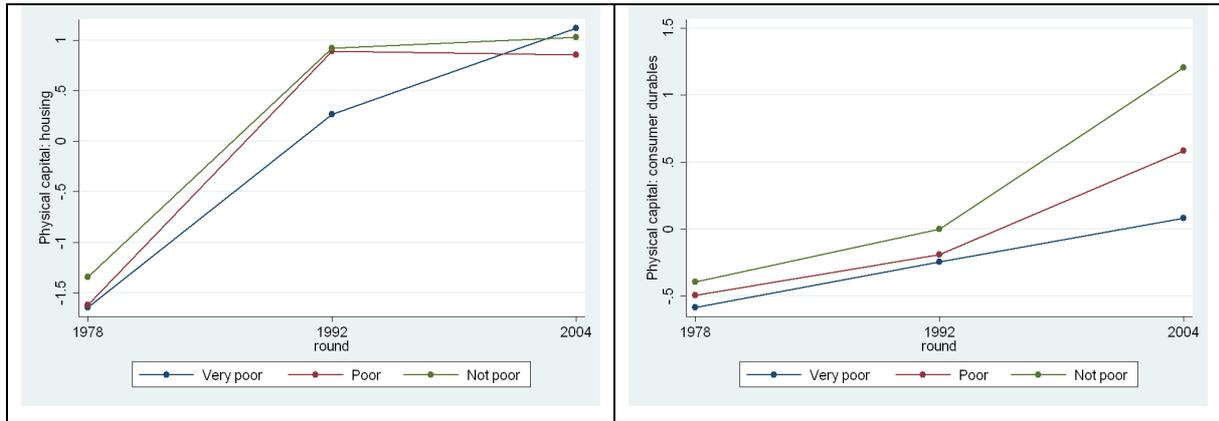
shared without diminishing their utility for any one person. A radio, for example, can be listened to by multiple people at once. Cars can be shared to some extent, but they cannot be driven by more than one person at the same time. Even though jobs and education are held by individuals, they too may have spill-over effects onto other family members. Finally, the index is not adjusted for household size because PCA techniques used to calculate the asset indices do not have units, and would therefore be unsuitable for interpreting variables on a per capita basis.

We can also use asset indices to examine how individual households make "portfolio" choices between types and amounts of assets to accumulate. Figure 5 illustrates a trade-off between the level of consumer durables in a household in 1992 and the total amount of education that the household's children receive in 2004. By 1992 the original generation of settlers had reached middle age and most had school-age children. By 2004 many of the second-generation children had finished school and moved out on their own. The data in Figure 5 is adjusted for household income because wealthier households may be able to afford more consumer durables *and* educate their kids better. The kids' education is not per capita – it represents the total investment that households have put into their kids' human capital and is parallel to consumer durable ownership, which is also not per capita. The figure quantifies the stark choices that households – especially those with large numbers of children – make between acquiring two types of assets.

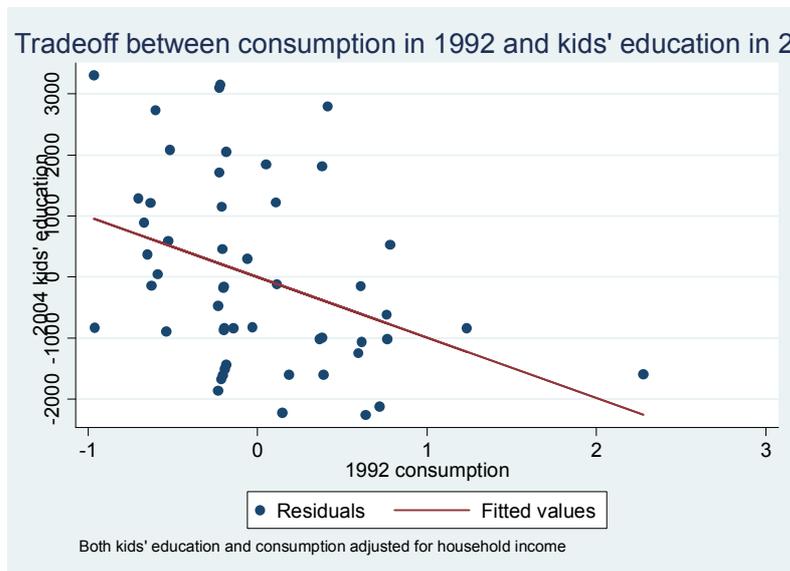**Figure 5: Trade-off between consumption and kids' education**

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Figure 6 uses "star graphs" to display the changing composition of household portfolios over time. Because this type of graph cannot display negative numbers, the estimated levels of assets were scaled so that the minimum score was 0 and average score was 1. The graphs display how the average portfolios increased in size and changed in shape. For example, there is a clear outward shift of financial capital and consumer durables by 2004, as well as a noticeable increase in variation.

Figure 6: Star graphs of household asset portfolios
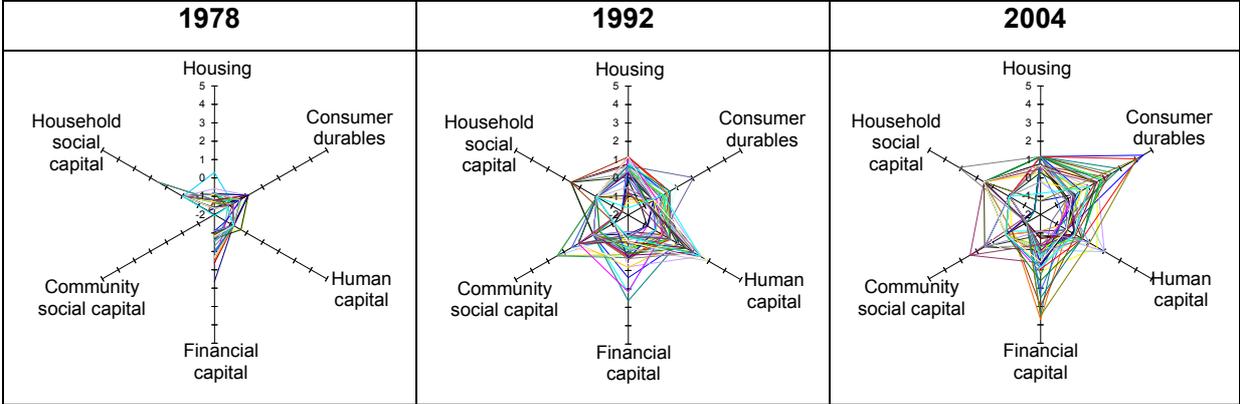
These simple diagrams suggest several directions in which the work could go. One would be the use of mathematical techniques to sort observations into groups based on a number of variables, such as cluster analysis and fuzzy set theory. By 2004, there is enough differentiation among the households that they may have sorted themselves into identifiable groups. One of the advantages of the asset-based analysis presented above is that it enables enough dimensional reduction to make other techniques more intuitive and easier to apply, because they can incorporate fewer key variables.

V. Conclusion

This study of assets provides an overview of recent research on the use of asset indices as well as illustrating a particular way of constructing an asset index. Much progress has been made over the last five years, but a number of issues remain. For example, principle components analysis, in all its variations, is still dependent on the observed variables being positively correlated. Another unresolved issue is how best to aggregate assets from the individual level to the household level without involving arbitrary methods like summation or averaging. Similarly, there is no clear way to adjust levels of assets for household size. Finally, this is obviously not a methodology that can be immediately applied to many data sets. It requires considerable knowledge of the different variables in order to select and transform them into appropriate subjects for polychoric PCA.

Nevertheless, existing techniques contribute to the accuracy and robustness of asset accumulation analysis. This paper has demonstrated how grouping a large number of assets into a smaller number of dimensions facilitates an intermediate level of analysis. By examining how households allocate their resources using an asset index, the analysis of specific poverty mechanics is possible without examining an overwhelming quantity of individual variables. Asset indices are an important complement to pure income data because they paint a clearer picture of the strategies households in various income groups have employed to acquire different types of assets, and because they provide clues to poverty alleviation. The next step is to use these indices to understand poverty dynamics in greater detail.

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