Measuring Child Poverty and Deprivation

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Introduction

Ten years ago, UNICEF asked the Townsend Centre for International Poverty Research at Bristol University, UK, to produce a scientifically valid and reliable method for measuring the extent and depth of child poverty in all the developing regions of the world. The methodology had to be socially and culturally appropriate, age and gender specific and allow for the fact that children's needs change as they grow and develop. The methodology also needed to be consistent with agreed international definitions of poverty used for policymaking purposes and within the framework provided by international human rights conventions, particularly the UN Convention on the Rights of the Child (UNCRC).

The resulting methodology to measure child poverty (sometimes referred to as the 'Bristol' method by UNICEF) was briefly described by Gordon *et al* (2003) and was subsequently adopted by UNICEF as a core child poverty measure for the Global Study on Child Poverty and Disparities.

The 'Bristol' method was designed to produce meaningful scientific comparisons of child poverty *between* countries and UNICEF regions. A purpose of this chapter is to show how this methodology can be adapted and applied to produce meaningful and appropriate child poverty analyses *within* countries. The chapter will also clarify some of the myths and misconceptions that have arisen about the 'Bristol' methodology.

This chapter first briefly describes the 'Bristol' methodology. This is followed by a discussion of the relative deprivation theory which underlies the methodology and introduces the requirements for scientific valid and reliable measurement. The following section on 'how not to measure child poverty' looks at the limitations of three other highly regarded methodologies –

1) The World Bank's $1 a day PPP method
2) The Wealth Index method
3) The Multidimensional Poverty Index method of Alkire & Foster

The purpose of these critiques is not to revisit 'old ground' and repeat technical criticisms which are already well known. This section aims to look at the more profound theoretical problems with these prevalent methodologies which are more rarely discussed and understood.

The final section provides a step by step worked example from Mexico showing how multidimensional poverty can be scientifically measured. The paper concludes with a critique of the 'Bristol' method and suggests on how it could be improved in future research.

Child poverty measurement methodology

It is not possible to produce valid and reliable measures of anything, (e.g. speed, mass, evolution or poverty) without a theory and a definition. Validity can only be assessed in relation to a theoretical framework and, without such a framework, all measures of poverty remain merely the opinions of their advocates.

The child poverty measurement methodology of Gordon *et al* (2003) took Peter Townsend's relative deprivation theory (Townsend, 1979) as its theoretical scientific framework (this is discussed in the next section) and the definition of poverty agreed by the governments of 117 countries at the World Social Summit in Copenhagen:

Absolute poverty was defined, for policy purposes, as *"a condition characterised by severe deprivation of basic human needs, including food, safe drinking water, sanitation facilities, health, shelter, education and information. It depends not only on income but also on access to social services."* (UN, 1995, p57)

The World Social Summit definitions of 'absolute' and 'overall' poverty remain to this day as the only internationally agreed definitions of poverty. However, one outcome of this work by UNICEF on child poverty was that in December 2006 the United Nations General Assembly's third committee, which deals with social, humanitarian and cultural affairs, in its report to the 61st Session of the General Assembly on the promotion and protection of children's rights, adopted the first ever internationally agreed definition of child poverty;

"*…children living in poverty are deprived of nutrition, water and sanitation facilities, access to basic health-care services, shelter, education, participation and protection, and that while a severe lack of goods and services hurts every human being, it is most threatening and harmful to children, leaving them unable to enjoy their rights, to reach their full potential and to participate as full members of society.*" (United Nations General Assembly, 2006: para 46)

UNICEF issued a statement, noting that:

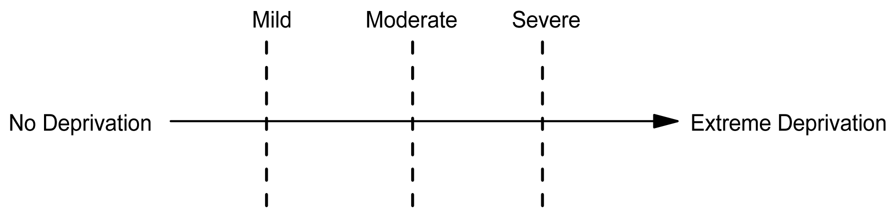
"*Measuring child poverty can no longer be lumped together with general poverty assessments which often focus solely on income levels, but must take into consideration access to basic social services, especially nutrition, water, sanitation, shelter, education and information.*" (UNICEF, 2007, p1)

In order to measure child poverty based on the World Social Summit or UN General Assembly definitions, it is necessary to define the threshold measures of deprivation for each of the component parts of the definition, i.e. to measure absolute poverty, definition thresholds *for severe deprivation* of basic human need are required for:

- food
- safe drinking water
- sanitation facilities
- health
- shelter
- education
- information
- access to services

Relative deprivation theory conceptualises deprivation as a continuum which ranges from no deprivation, through mild, moderate and severe deprivation to extreme deprivation at the end of the scale (Gordon, 2002). Figure 1 illustrates this concept.

Figure 1: Continuum of deprivation



Gordon *et al* (2003) defined 'severe deprivation of basic human need' as those circumstances that are highly likely to have serious adverse consequences for the health, well-being and development of children. Severe deprivations are circumstances which can be causally related to 'poor' developmental outcomes both long and short term. An idealised taxonomy of deprivation was produced identifying deprivation thresholds of different levels of severity and this was subsequently operationalized using widely available data (e.g. Demographic and Health Survey micro data, Multiple Indicator Cluster Survey micro data, etc). Two such operational thresholds levels for each indicator were used in the subsequent Global Study of Child Poverty and Disparities (see Table 1) to measure child poverty at different levels of severity.

Developing evidence-based deprivation thresholds for children that were age and gender specific was a time-consuming process that took several years' work by an experienced research team. It included a semi-systematic review of the relevant literature to produce an evidence based a-priori selection of potential child deprivation indicators i.e. indicators and thresholds which have been shown in previous studies to be good measures of child poverty. Subsequent work can be found in Nandy et al (2005), Pemberton et al (2005, 2007), Nandy and Miranda (2008), Nandy and Gordon (2009) and Nandy (2010).

The purpose of Gordon *et al* (2003) was to measure children's living conditions that are so severely deprived that they are indicative of absolute poverty. Thus, the deprivation thresholds used represent more severe deprivations than the indicators frequently published by international organisations. For example, 'no schooling' instead of 'non-completion of primary school', 'no sanitations facilities' instead of 'unimproved sanitations facilities', 'no immunisations of any kind' instead of 'incomplete immunisation against common diseases', 'malnutrition measured as anthropometric failure below -3 standard deviations from the reference population median' instead of 'below -2 standard deviations from the reference median', etc. In all cases, a concerted attempt was made to err on the side of caution in defining these indicators of deprivation of basic human need in such severe terms that few would question that these living conditions were unacceptable.

Children who suffer from any severe deprivation of basic human need are very likely to be living in absolute poverty because, in the overwhelming majority of cases, the cause of their severe deprivation is invariably a result of lack of resources/income. However, there may also be some children in this situation due to discrimination (e.g. girls suffering severe education deprivation) or due to disease (severe malnutrition can be caused by some diseases). For this reason, Gordon *et al* (2003) assumed that a child is living in absolute poverty *only* if he or she suffers from two or more severe deprivations of basic human need as defined in Table 1 below (second column).

Table 1: Deprivation thresholds used in UNICEF's Global Study on Child Poverty and Disparities

Deprivation	Thresholds for 'less severe deprivation'	Thresholds for 'severe deprivation'
Shelter	Children living in dwellings with 4 or more people per room or living in a house with no flooring (i.e. a mud or dung floor) or inadequate roofing.	Children living in a dwelling with 5 or more people per room or with no floor material.
Sanitation	Children using unimproved sanitation facilities. Unimproved sanitation facilities include: pour flush latrines; covered pit latrines; open pit latrines; and buckets.	Children with no access to a toilet facility of any kind.
Water	Children using water from an unimproved source such as open wells, open springs or surface water or where it takes 30 minutes or longer to collect water (walk to the water, collect it and return).	Children using surface water such as rivers, ponds, streams and lakes, or where it takes 30 minutes or longer to collect water (walk to the water, collect it and return).
Information	Children (aged 3-17 years) with no access to a radio or television (i.e. broadcast media).	Children (aged 3-17 years) with no access to a radio, television, telephone, newspaper or computer (i.e. all forms of media).
Food	Children who are more than two standard deviations below the international reference population for stunting (height for age) or wasting (weight for height) or underweight (weight for age).	Children who are more than three standard deviations below the international reference population for stunting (height for age) or wasting (weight for height) or underweight (weight for age). This is also known as severe anthropometric failure.
Education	Children (aged 7-17) of school age not	Children (aged 7-17) of school age who

	currently attending school or who did not complete their primary education.	have never been to school and who are not currently attending school.
Health	Children who have not been immunised by 2 years of age. If the child has not received eight of the following vaccinations they are defined as deprived: bcg, dpt1, dpt2, dpt3, polio0, polio1, polio2, polio3, measles or did not receive treatment for a recent illness involving an acute respiratory infection or diarrhoea.	Children who did not receive immunization against any diseases or who did not receive treatment for a recent illness involving an acute respiratory infection or diarrhoea.

Source: Annex 1: Detailed Layout for the Statistical Tables, Section V. Policy Template for Country Data Collection, Analysis and Reports*, Global Study on Child Poverty and Disparities 2007-2008 Guide*

The scientific measurement of child poverty

It is still fashionable amongst some economists to repeat the old claim that "*For deciding who is poor, prayers are more relevant than calculation, because poverty, like beauty, lies in the eye of the beholder. Poverty is a value judgement; it is not something that one can verify or demonstrate*" (Orshansky 1969, p37). Mollie Orshansky defended the choices she made when developing the USA poverty line by arguing, somewhat illogically, that "*if it is not possible to state unequivocally 'how much is enough', it should be possible to assert with confidence how much, on average, is too little*" (Orshansky, 1965, p17). More recently, in discussions about poverty measurement in Europe, it has also been claimed that, since poverty is multidimensional, dynamic and relative, it can never by scientifically measured.

However, poverty is a social fact and all cultures have a concept of poverty (Gordon and Spicker, 1999) which is a difficult finding to explain if poverty were solely in the 'eye of the beholder'. In developing countries, poverty is often a murderous social fact that results in the death of millions of children (Black *et al*, 2003). The World Health Organisation has argued that:

> *"The world's biggest killer and greatest cause of ill health and suffering across the globe is listed almost at the end of the International Classification of Diseases. It is given code Z59.5 – extreme poverty."* (WHO, 1995: 1)

Poverty does not kill children as frequently in rich countries because poverty in countries with functioning welfare states is much less severe than in low income, developing countries. Nevertheless, poverty still results in premature death even in countries like the UK where health care is free.

Table 2: Male life expectancy in Glasgow and selected countries

Place	**Life expectancy at birth**
Glasgow (Carlton), Scotland, UK	*54*
India	62
Philippines	64
Poland	71

Mexico	72
United States	75
Cuba	75
United Kingdom	77
Japan	79
Iceland	79
Glasgow (Lenzie North), Scotland, UK	*82*

Source: adapted from Commission on Social Determinants of Health (2008)

Table 2 show that life expectancy at birth for men in the Carlton area of Glasgow in the UK is only 54 years, which is lower than the average life expectancy for men in India (or the Gaza Strip). However, only a few kilometres walk north-east of Carlton, in the wealthier area of Lenzie, life expectancy for men is 82 years – higher than average male life expectancy in any country in the world. In a short walk across a city in one of the richest countries in the world, you can travel from one area to another where boys have a 28 year difference in their life expectancy; the underlying cause of this difference is poverty - not differences in health-related behaviours (Galobardes *et al*, 2004; 2008; Davey Smith, 2007; Commission on Social Determinants of Health, 2008; Spencer, 2008; Thomas *et al*, 2010). These deaths are cruel and measurable social facts; they are not in the 'eye of the beholder' and neither is their underlying cause – poverty.

Since poverty has such clear and damaging effects, it should and can be scientifically measured. Poverty may be multidimensional, relative and dynamic but this does not mean it is impossible to measure – the motion of the planets is also multidimensional, relative and dynamic but astronomers can predict their positions with a high degree of accuracy and precision. It might be difficult to scientifically measure poverty but it is far from impossible.

Fortunately, since the work of Orshansky in the 1960s, significant theoretical advances have been made in poverty research. In particular, the research of Peter Townsend resulted in a paradigm shift in poverty measurement methodology. The first paragraph in his seminal work *Poverty in the United Kingdom* is arguably the most important text ever written about poverty. It is now so well known that many researchers and students of social policy can recite it from memory:

"*Poverty can be defined objectively and applied consistently only in terms of the concept of relative deprivation…The term is understood objectively rather than subjectively. Individuals, families and groups in the population can be said to be in poverty when they lack the resources to obtain the types of diet, participate in the activities and have the living conditions and amenities which are customary, or at least widely encouraged or approved, in the society to which they belong*." (Townsend, 1979, p31).

Townsend clearly demonstrated that absolute poverty did not exist as a meaningful concept distinct from relative poverty. Poverty in both rich and poor countries was the same phenomena and what was termed 'absolute' poverty was in reality just more severe/extreme/deeper poverty. The difference between being 'relatively' poor and 'absolutely' poor was simply the difference between the 'poor' and the 'poorest'.

Townsend also argued that poverty was not a static phenomenon but was both dynamic and relative:

"*poverty is a dynamic, not a static concept…Our general theory, then, should be that individuals and families whose resources over time fall seriously short of the resources commanded by the average individual or family in the community in which they live, whether that community is a local, national or international one, are in poverty.*" (Townsend, 1962, p219, 225)

According to Townsend, poverty can be defined as having an 'insufficient command of resources over time' and the consequence of a lack of 'resources' is that a 'poor' person/household will eventually become deprived. Thus, poverty is the lack of resources and deprivation is the consequence/outcome of poverty.

Townsend also argued that deprivation, like poverty, is a relative concept:

"Deprivation may be defined as a state of observable and demonstrable disadvantage relative to the local community or the wider society or nation to which an individual, family or group belongs. The idea has come to be applied to conditions (that is, physical, emotional or social states or circumstances) rather than resources and to specific and not only general circumstances, and therefore can be distinguished from the concept of poverty." (Townsend, 1987, p5)

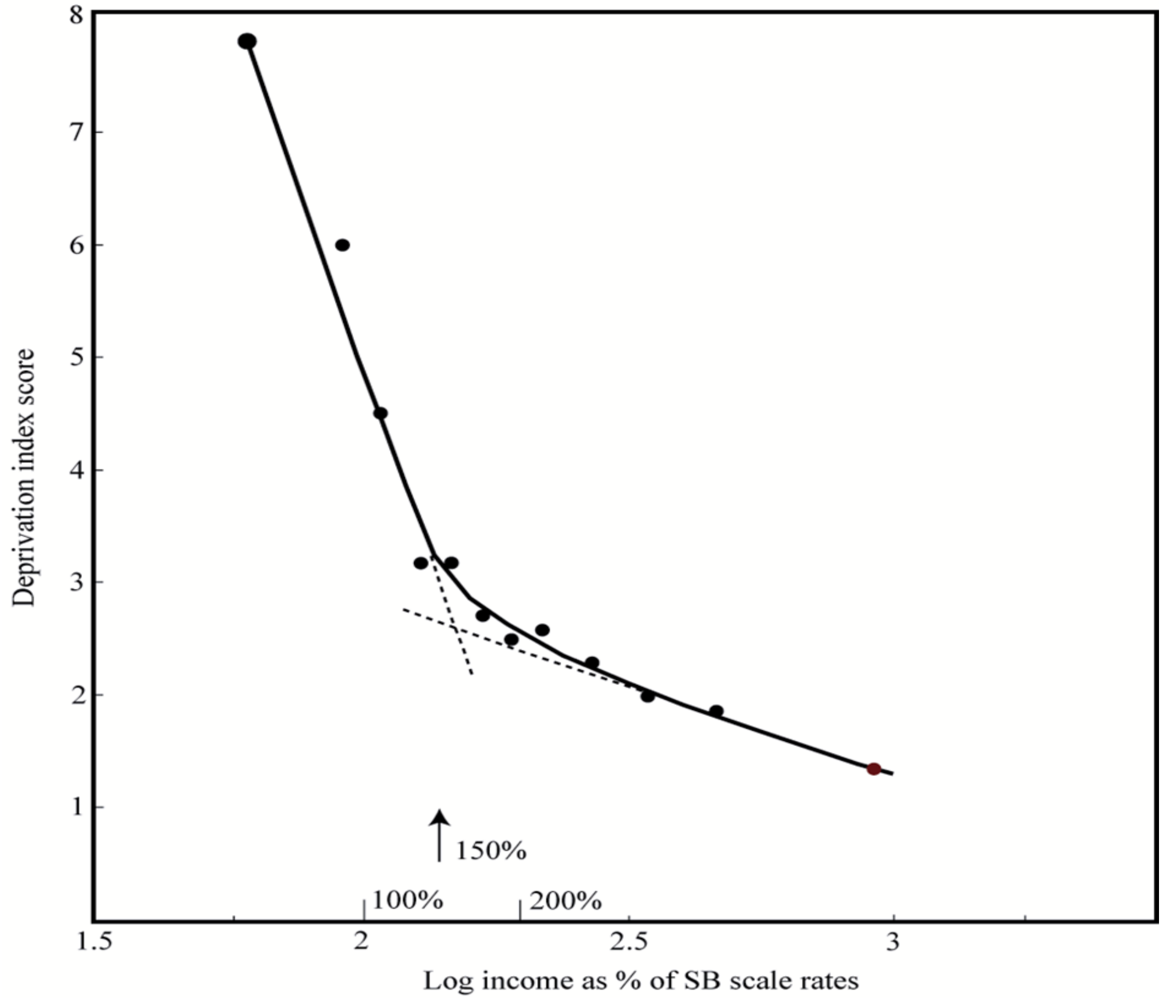
The two concepts of poverty and deprivation are therefore tightly linked. The concept of deprivation covers the various conditions, independent of income, experienced by people who are poor, while the concept of poverty refers to the lack of income and other resources which makes those conditions inescapable or at least highly likely (Townsend, 1987).

The absolute child poverty measurement methodology of Gordon *et al* (2003) is based on age and gender appropriate measures of 'severe deprivation of basic human need'. It does not include measures of low income/inadequate command over resources. This is mainly a result of the lack of good data on income in DHS, MICS and similar surveys. The Gordon *et al* (2003) methodology also extends Townsend's (1987) definition of deprivation and measures 'severe deprivation of basic human need' for children relative to globally-agreed norms and standards which currently prevail, rather than relative to national or local standards. It should be clear from this discussion that, when identifying child deprivation thresholds to be used for national studies, within a country, then nationally appropriate standards should be used (rather than inappropriate international standards). Similarly, where good national micro-data are available on command of resources over time (e.g. income and/or expenditure data) these should also be incorporated into the child poverty measure.

Scientific child poverty measurement using both deprivation and low income

A key problem in scientific studies of poverty is how to identify the 'correct' poverty line/threshold (Gordon and Pantazis 1997). If the line is set too high then children who are not poor will be mistakenly identified as poor. Conversely, if the line is set too low then some children who are poor will not be classified as such. There are many examples of poverty lines that are mainly or wholly arbitrary, for example, the World Bank's $1 per day PPP poverty line, the European Union's <60% median equivalised household income 'at risk of poverty' line, etc. It is the difficulty in identifying the correct poverty threshold that has led some commentators to argue that poverty is 'in the eye of the beholder'.

Figure 2: Modal Deprivation by Logarithm of Income as a Percentage of Supplementary Benefit Scale Rates (Townsend, 1979)



Townsend (1979) argued that, in order to 'objectively' identify the correct poverty line, we require additional information external to income/resources but which varies with income/resources. In the 1968/69 *Poverty in the United Kingdom* survey, he developed a deprivation index and produced a scatter plot (Figure 2) of deprivation index score against a measure of income. Townsend observed a break of slope in the graph (i.e. the point at which deprivation increases rapidly for a small fall in income – marked 150% in Figure 2) and argued that this break point was the optimum position for the poverty line/threshold (Desai and Shah, 1988; Townsend and Gordon, 1993).

There have been considerable advances in computing and statistical methods since Townsend's work in the 1960s and 1970s which allow the identification of the optimal poverty line using multivariate rather than graphical methods. The techniques pioneered by Peter Townsend have been developed and refined by a large number of researchers in many countries over the past 40 years (for example, Mack and Lansley, 1985; Desai, 1986; Callan et al, 1993; Halleröd, 1994; Kaijage and Tibaijuka, 1996; Kangas and Ritakallio 1998; Muffels et al 2001; Short, 2005; United

Nations Expert Group on Poverty Statistics, 2006; Boarini & d'Ercole, 2006; Whelan & Maitre, 2007; Saunders and Naidoo, 2009). Figure 3 illustrates a multidimensional definition of poverty in which the 'poor' are defined as those who suffer from both a low income and a low standard of living (Gordon, 2006). A low standard of living is often measured by using a deprivation index (high deprivation equals a low standard of living) or by consumption expenditure[1] (low consumption expenditure equals a low standard of living). Of these two methods, deprivation indices are more accurate since consumption expenditure is often only measured over a brief period. Deprivation indices are broader measures because they are multidimensional in nature and reflect different aspects of living standards, including personal, physical and mental conditions, local and environmental facilities, social activities and customs.

Figure 3: Multidimensional definition of poverty

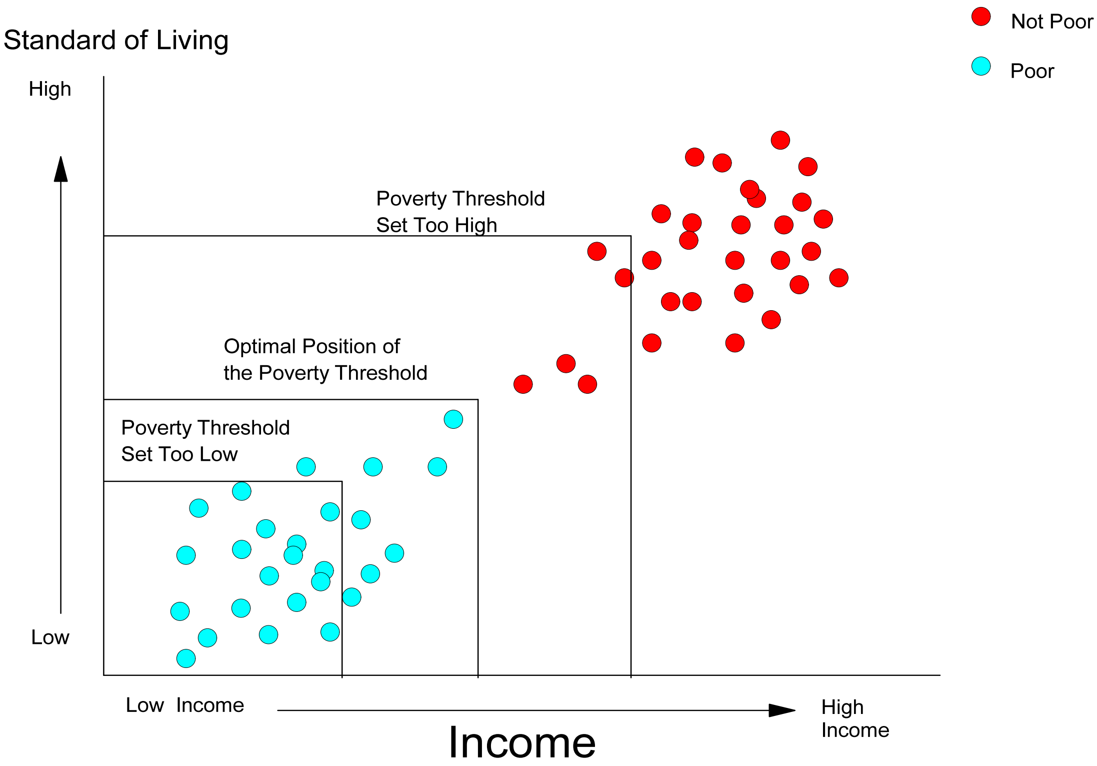


Figure 3 provides an illustration of poverty based on two dimensions (Income and Standard of Living), however, the same principles can be used to separate the 'poor' group from the 'not poor' group in many dimensions. It shows an 'objective' poverty line/threshold that can be defined as the point that maximises the differences *between* the two groups ('poor' and 'not poor') and minimises the differences *within* the two groups ('poor' and 'not poor'). An illustrated step-by-step example of how to do this is discussed later in this chapter. For scientific purposes, broad measures of both income and standard of living are desirable. Standard of living includes both the

[1] The United Nations defines household final consumption expenditure as 'the expenditure, including imputed expenditure, incurred by resident households on individual consumption goods and services, including those sold at prices that are not economically significant.' See http://unstats.un.org/unsd/cdb/cdb_dict_xrxx.asp?def_code=165

material and social conditions in which people live and their participation in the economic, social, cultural and political life of the country/society in which they live (Gordon, 2000).

Dynamics of poverty

From the previous discussion, it is clear that those people/households with a high income and a high standard of living are 'not poor' whereas those with a low income and a low standard of living are 'poor' (see Beccaria and Minujin 1988; and Boltvinik, 1992, 1997 for alternative interpretations). However, two other groups of people/households that are 'not poor' can also be identified in a cross-sectional (one point in time) survey.

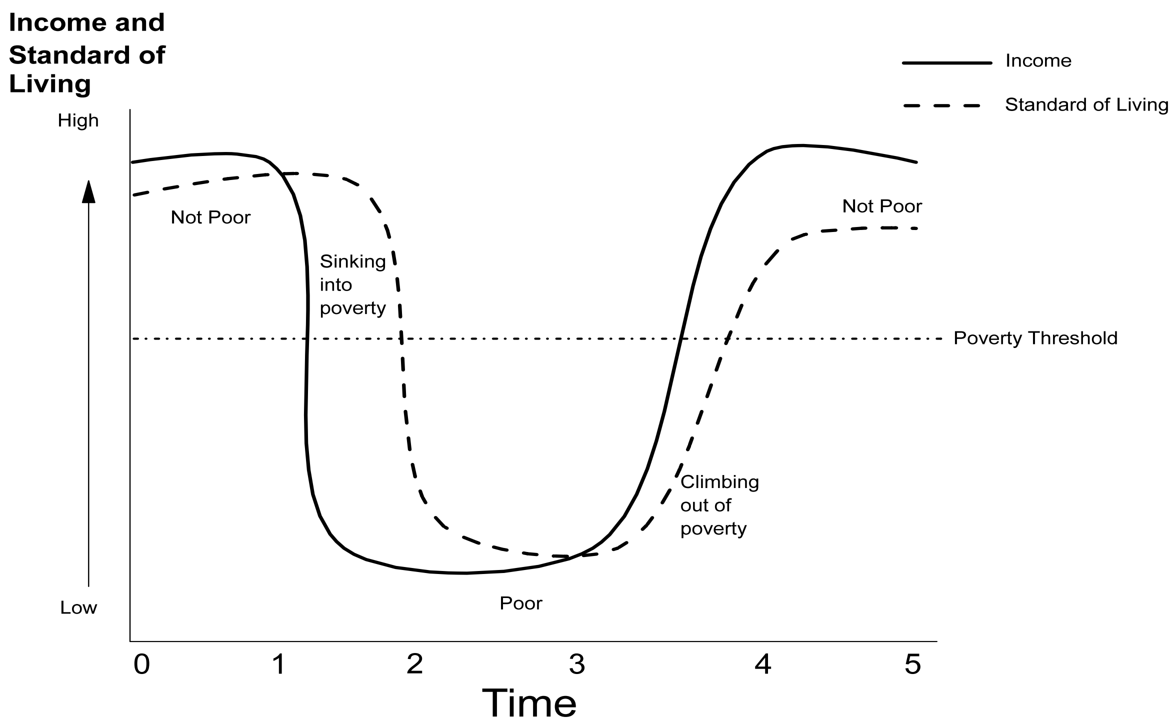
People/households with a low income but no deprivation. This group is not currently poor but if their income remains low they will become poor - they are currently vulnerable to sinking into poverty. This situation often arises when income falls rapidly (e.g. due to job loss) but people manage to maintain their lifestyle, for at least a few months, by drawing on their savings and using the assets accumulated when income was higher. This group is sometimes referred to as vulnerable (Kaztman, 1999) or recently poor (ECLAC/DGEC, 1988; Kaztman, 1996).

People/households with a high income but a low standard of living. This group is currently 'not poor' and if their income remains high their standard of living will rise – they will rise out of poverty. This group is in the opposite situation to the previous group. This situation can arise when the income of someone who is poor suddenly increases (e.g. due to getting a job). However, it takes time before they are able to buy the things that they need to increase their standard of living. Income can both rise and fall faster than standard of living. Kaztman has referred to this group as being in inertial poverty (ECLAC/DGEC, 1988).

A cross-sectional 'poverty' survey can provide some limited but useful information on the dynamics of poverty since it is possible not only to identify the 'poor' and the 'not poor' but also those likely to be sinking into poverty (i.e. people/households with a low income but a high standard of living) and those escaping from poverty (i.e. people/households with a high income but a low standard of living).

Poverty is, by definition, an extremely unpleasant situation to live in so it is not surprising that people go to considerable lengths to avoid it and try very hard to escape from poverty once they have sunk into it. Therefore, a cross-sectional survey ought to find that the group of households sinking into poverty was larger than the group escaping from poverty since, when income falls, people will try to delay the descent into poverty but, if the income of a poor person increases, they will quickly try to improve their standard of living. Figure 4 illustrates this concept:

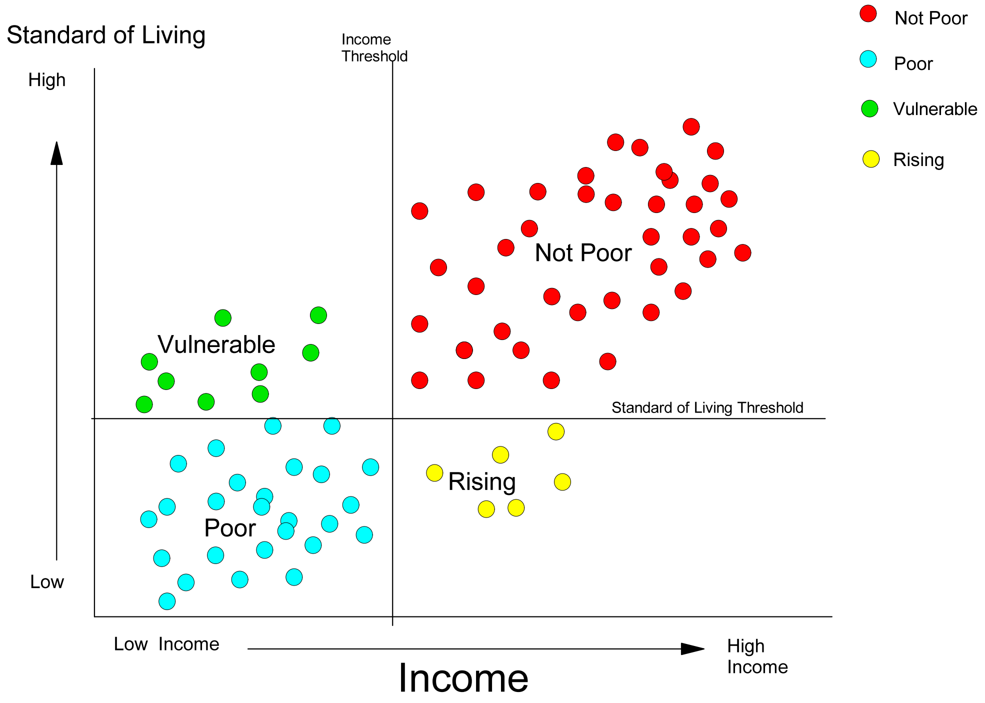
Figure 4: Dynamics of poverty



Between time periods 0 and 1 the household has both a high standard of living (dotted line) and a high income (solid line): it is 'not poor'. At time 1, there is a rapid reduction in income (e.g. due to job loss, the end of seasonal contract income, divorce or separation, etc), however, the household's standard of living does not fall immediately. It is not until time 2 that the household's standard of living has also fallen below the 'poverty' threshold. Therefore, between time 1 and time 2, the household is 'not poor' but is sinking into poverty (i.e. it has a low income but a relatively high standard of living). At time 3, income begins to rise rapidly, although not as fast as it previously fell. This is because rapid income increases usually result from gaining employment but there is often a lag between starting work and getting paid. Standard of living also begins to rise after a brief period as the household spends its way out of poverty. However, this lag means that there is a short period when the household has a high income but a relatively low standard of living. By time 5, the household again has a high income and a high standard of living (Gordon *et al*, 2000).

On the basis of this discussion, it is possible to update Figure 3 to give a more realistic picture of movements into and out of poverty. Figure 5 illustrates this (Pantazis, Gordon and Levitas, 2006, p39).

Figure 5: Revised multidimensional definition of poverty



In both industrialised and developing countries, some children live in households which occasionally can suffer from dramatic losses in income due to adverse life events (e.g. death of a parent, family breakdown, etc.). However, in welfare states, the effective social safety net prevents such households falling too deeply into poverty and higher wages mean that there are fewer families close to the poverty line in the first place, i.e. households in rich countries have further to fall before they become 'poor' and the social safety net prevents them from falling too far when disaster strikes. Thus poverty in both rich and poor countries is the same phenomena but poverty in poor countries tends to be both deeper and more prolonged than in rich countries.

The previous sections have examined the scientific theory which underlies the measurement of child poverty used in the UNICEF Global Study on Child Poverty and Disparities, before providing a worked example on how this can be adapted at a country level it is important to examine what is wrong with other leading poverty measurement methodologies.

How not to measure child poverty

This section examines three commonly used methods for measuring poverty and argues that each is currently inappropriate for measuring child poverty. The three methods discussed are the World Bank's $1 a day method, the Wealth Index method and the recently developed Multidimensional Poverty Index (MPI) method of Alkire and Foster. For a review of other methods see Minujin et al, (2006) and Roelen and Gassmann, (2008)

World Bank Method

The World Bank's $1 a day PPP methodology has been widely used (World Bank, 1990; 1996, 2000; Ravallion et al 1991; 2008) and is incorporated into the Millennium Development Goals. The $1 a day PPP method was not designed to measure child poverty and the World Bank has never attempted to use the methodology for this purpose. There are a large number of critiques of the $1 a day methodology (Townsend 1997, Townsend and Gordon 2002; Kakwani and Son, 2006; Himanshu 2008; UNDESA 2010) and interested readers should read the debate between Reddy & Pogge and Ravallion recently published in Anand, Seagl and Stiglitz (2010). Similarly, there are a range of reasons why the $1 a day PPP methodology is not suitable for measuring child poverty and interested readers should see Gordon *et al* (2003) for a discussion (or Pemberton *et al* 2010, Chapter 6, this volume). However, the purpose of this discussion is to examine the deeper theoretical reasons why the $1 a day PPP methodology is unsuitable for measuring child poverty in developing countries even if all the 'technical' problems could be resolved.

A key problem with the World Bank's method is that it adjusts the poverty line using Purchasing Power Parities (PPP). The international dollar PPP is not a real currency - you cannot buy or hold one - it is a concept. The idea is that, in order to compare the purchasing power of different currencies, a conversion factor (based upon the cost of a basket of goods and services) is required. However, rather than use the exchange rate of money bought and sold in the global currency markets, the World Bank and IMF argue that PPPs should be used as the market exchange rates do not reflect the 'true' value of each currency i.e. they are subject to distortions, even if average monthly or yearly rates are used.

There are a great many criticisms about both the reliability and representivity of PPPs (Rogoff, 1996) but its advocates argue they:

"*are the correct converters for translating GDP and its components from own currencies to dollars (the usual numeraire); the alternative measure, exchange rates, obscures the relationship between the quantity aggregates of different countries… exchange rates systematically understate the purchasing power of the currencies of low-income countries and thus exaggerate the dispersion of national per capita incomes*" (Kravis, 1986)

Conversely, Freeman (2007, p1435) has argued that this claim is an ideological assertion rather than evidence-based and that:

"*We might with equal validity say that PPP 'obscures' the underlying monetary reality, 'exaggerates' the purchasing power of low-income currencies and 'understates' the dispersion of per capita incomes*"

This is an interesting argument, particularly as both the IMF and the World Bank were strong supporters of the Washington Consensus and believers in free markets. Free and efficient markets were advocated as they were meant to be able to determine 'correct' prices. Therefore, it is somewhat inconsistent for these organisations to argue that the 'free' money markets are unable to determine the 'true' price of national currencies.

PPP and currency exchange rates produce significantly different results when used to compare the incomes of the poor in different countries. In developing countries, consumer goods tend to be relatively cheaper and capital goods relatively more expensive compared with industrialised countries. The PPP conversion reduces/understates the cost of capital goods compared with market exchange rate conversion (Freeman, 2007).

The differences in the extent and depth of child poverty in rich and poor countries are not just a result of households in rich countries having more money. Children in rich countries also have access to an extensive range of capital goods, e.g. schools, hospitals, roads, electricity distribution, water supply infrastructure, sewerage systems, etc. In developing countries, millions of children do not have access to schools, hospitals, safe water, etc. because these capital goods simply do not exist close to where they live. This is important because, by understating the monetary cost of capital goods in developing countries, the PPP conversion, which is an integral part of the $1 a day poverty methodology, obscures the costs of providing children with the services they need to escape from absolute poverty.

Wealth Index

The Wealth or Asset Index is a standard part of recent DHS and MICS survey micro data and children in households with the lowest asset index scores (e.g. bottom 10% or 20%) are sometimes defined as 'poor', the wealth index has also been used to measure disparities amongst households with children. The method is based on the work of Filmer and Pritchett (1998; 1999; 2001) who used Principal Components Analysis (PCA) to produce a weighted index of household assets. The lack of an adequate theory to underlie the index and the parochial nature of the literature reviewed resulted in not just a 'reinvention of the wheel' but a 'reinvention of the mistakes made when the wheel was first invented'. To paraphrase George Santayana, it seems that "*those who cannot learn from history are doomed to repeat it*".

The Dutch Leefsituatie (Life Situation) index was developed in 1974 by the Social & Cultural Planning Office (SCP) and subsequently used for resource allocation. It is still in use to this day (Boelhouwer, 2010). Weights were initially derived using PCA but this statistical mistake was quickly corrected and, subsequently, non-linear canonical correlation analyses were used to derive weights (Boelhouwer and Stoop, 1999). Filmer and Pritchett (1998) and the current asset index make exactly the same statistical mistake the Dutch corrected over 30 years ago. The problem is that almost all the asset indicators are binary variables (e.g. owning a radio – 'yes' or 'no') whereas it is an assumption of PCA that data are continuous. If this assumption is violated (e.g. by including binary variables) then the weights produced (factor loadings) will be incorrect. One technical solution to correct the statistical error of including binary variables in a PCA analyses is to calculate the tetrachoric (or polychoric) correlation coefficients for the binary variables and then use the resulting correlation matrix in the PCA analysis (Kolenikov and Angeles, 2009).

Unfortunately, the asset index also makes the even more severe 'Area Poverty' error by combining a lack of household durables with a lack of community facilities in an atheoretical manner, thereby misclassifying 'rich' households who live in 'poor' rural areas as relatively impoverished.

There are a range of technical problems with the current wealth index method, which have been well documented (Falkingham and Namazie, 2002, Vyas and Kumaranayake, 2006; Howe *et al,* 2008, 2009). However, the purpose of this discussion is to look at the more profound philosophical problems that are seldom discussed.

Many of the statistical methods that are widely used today were invented in the late 19th Century and the first half of the 20th Century by a group of accomplished British Statisticians. Francis

Galton invented regression, Karl Pearson, consolidated Galton's work into a general theory of correlation and regression, Charles Spearman and Cyril Burt, who made significant contributions to both correlation and factor analysis and Ronald Fisher, who pioneered analysis of variance (MacKenzie, 1981). All of these statisticians believed in Eugenics, a term invented by Francis Galton — literally meaning "well-born" — to characterise his 'moral philosophy' belief that the human species could be improved by encouraging society's brightest and best to have more children and by reducing the number of children produced by people who were physically or mentally 'deficient' (Kevles, 1985). These white male statisticians were from the upper middle class in England and firmly believed they owed their place at close to the top of the class, race and gender structure of the British Empire to their own innate superiority to virtually everyone else on the planet (Mazumdar, 1992). Many of these statistical techniques, particularly tetrachoric correlation, were invented in order to help scientifically 'prove' these Eugenic beliefs (Mackenzie, 1999).

Many of the characteristics that were important to the eugenics arguments about the strength of heredity were binary or categorical e.g. gender, eye colour, etc. However, a correlation coefficient was needed that was directly comparable with those used with continuous variables such as height and weight, so that binary and continuous variables could be compared in the same analysis. Tetrachoric correlation is a complex approximation to a Pearson's Product Moment correlation for binary variables (Pearson 1901). However, it assumes that there is no such thing as a 'true' binary variable as all binary variables are really cut-offs of an underlying normally distributed continuous variable. Thus, the categories 'dead' or 'alive' were argued to be really measures of a continuous variable 'severity of attack' (MacKenzie, 1999). So, if for the sake of argument, we assume that Brad Pitt and Angelina Jolie are the 'perfect' couple with Brad Pitt being 100% 'Male' and Angelina Jolie being 100% 'Female' – then everyone else on the planet would rank somewhere on a normally distributed interval scale between 100% male Brad and 100% female Angelina and the categories 'male' and 'female' would be binary measures of this underlying interval scale.

This idea is, of course, unproveable nonsense which was necessary for the Eugenics research agenda (Mackenzie, 1999) but there is no need to make these kinds of assumptions when measuring child poverty or constructing a wealth index. It should also, of course, be remembered that Eugenics ideas resulted in mass forcible sterilisation of hundreds of thousands of poor people in Germany, Japan, Sweden and the USA and the mass murder of disabled children in Nazi Germany.

It would seem preferable to use non-linear canonical correlation analyses to derive weights for any wealth/asset index designed to measure disparities (or poverty depth) amongst children rather than using Principal Components Analysis with tetrachoric correlation, which has such problematic statistical assumptions and historical connotations.

The Alkire and Foster Method (Multidimensional Poverty Index)

Sabina Alkire and James Foster (2007; 2009) have recently developed a method designed to produce a Foster, Geer and Thorbecke (FGT) index (Foster, Greer and Thorbecke, 1984; 2010) using child deprivation measures. Alkire and Santos (2010) have produced a Multidimensional Poverty Index (MPI) consisting of ten indicators grouped into three domains and based on household micro-data from 104 countries. Additionally, Roche (2009) and Alkire and Roche (2010) suggest a 12 step child poverty measurement methodology that builds upon the work of Gordon *et al* (2003). They illustrate this methodology using an example from Bangladesh for children under five years of age and eight deprivation indicators (Roche, 2009).

All this work provides a significant advance in multidimensional poverty measurement and the mathematical solution for producing a multidimensional FGT using an intersection approach is an elegant and a welcome advance. Unfortunately, the rest of their child poverty measurement methodology suffers from several serious flaws. In particular, they do not have an explicit definition or theory of poverty. The absence of a definition means that it is impossible to determine the validity of their worked example from Bangladesh. For example, they include absence of vitamin A supplementation and a lack of salt iodisation as indicators of deprivation amongst children under five and report that "*deprivation in salt iodisation accounts for 15% of total child poverty in Chittagong, and also has an important contribution to child poverty in Rajshahi (11%), and Dhaka (9%)*" (Roche, 2009:p19). To our knowledge, no previous measure of poverty amongst children under five has used salt iodisation or vitamin A supplementation as deprivation indicators. These indicators may or may not be valid and reliable measures of poverty amongst young children but the authors' 12 step methodology does not provide for tests of the accuracy or precision of either the deprivation indictors or domains. In the absence of any definition of poverty, validity and reliability analyses, the results could be viewed as a collection of things the authors think are 'bad' added together in an essentially arbitrary manner. Of course, the results might correctly identify poor children in Bangladesh; the problem is that there appears to be no way of knowing if this is the case using the 12 step methodology proposed.

Scientific measurement of child poverty requires a methodology that allows the 'best' set of deprivation indicators to be selected and for rejection of inadequate indicators. It also should facilitate the interpretation of meaningful findings from the analyses. For example, Roche (2009) compares the deprivation headcount (H) with the FGT modified headcount (Mo) for 12 regions in Bangladesh (see Roche, 2009, Table 6) and argues that "*while the first four positions remain invariant in the ranking according to H and Mo (column 13), there are important rearrangements in the rankings among the rest of the regions when the headcount ratio is adjusted by the average deprivation among the poor*" (Roche, 2009, p18). He interprets these 'important' differences in rank order to demonstrate that: "*Adjusting the headcount ratio by breadth of deprivation as in the Alkire-Foster approach is clearly a value added to the conventional headcount ratio.*" (Roche, 2009, p18)

This interpretation would only be a 'correct' if the two rank orders differed significantly rather than due to random variation. We do not have the raw micro data used by Roche (2009) so we can only perform some limited testing of their claim. However, just looking at the rank differences H-Mo (Roche, 2009, Table 6 column 13) shows:

Rank Difference
6 are zero (six regions have identical ranks on both H and Mo)
4 regions have 1 rank place different
2 regions have 2 rank places different

The Spearman Rho correlation for the 12 Bangladesh regions for H and Mo is 0.956

The Sign test for differences in rank between H and Mo significance is 0.688

The Wicoxon signed rank test for differences in rank between H and Mo significance is 0.916

Both the Kendall's concordance and Friedman's test for differences in rank distribution have a significance of 0.414

Therefore, none of these non-parametric tests on the ranks of H and Mo approach statistical significance. There is, therefore, no reason to reject the null hypothesis that the differences in the ranks of H and Mo for the 12 regions of Bangladesh are due to anything but random fluctuations. It would seem unwise to claim 'value added' for the Mo measure on the basis of random changes of position in ranked data. This, of course, does not mean that there is no value added in the Mo measure proposed by Alkire and Foster (2007), however, their example does not provide any *evidence* for added value. In the large majority of situations, as the proportion of children in poverty increases (i.e. H – the headcount), so does the depth of child poverty (e.g. Mo – adjusted headcount). We know of no two countries or regions which have identical headcount rates of child poverty but where the depth of child poverty differs significantly. Thus, it is possible that there may be little additional value added in the adjusted headcount measure (Mo) proposed by Alkire and Foster (2007; 2009). It is of course possible to measure depth/intensity of child poverty at the household level using the 'Bristol' method by simply comparing the aggregated deprivation index score across all children in the household. This methodology has been used in several studies, for example Gordon et al (2003), Delamonica and Minujin (2007), Minujin and Delamonica (2010, Chapter 18, this volume) and it is yet to be shown how much added value the Alkire and Foster method provides over this much simpler method.

However, the purpose of this discussion is not to dwell on technical problems with the work of Alkire and Foster but to examine the more profound theoretical issues. They argue that their methodology can measure the breadth, depth and severity of dimensions of child poverty and also that the modified headcount measure can be broken down by dimension to uncover the components of child poverty in different regions or age groups or by gender (Alkire and Roche, 2009). We have argued above that child poverty measurement is not in the 'eye of the beholder' and that relative deprivation theory provides a scientific basis for measuring multidimensional child poverty. Scientific method requires that both deprivation indicators and the dimensions of a multidimensional poverty index need to be tested to demonstrate that they reliable, valid and additive. Furthermore, a scientific methodology requires the ability to identify and reject deprivation indicators and dimensions which were initially selected for an analysis but which are shown to not be good measure of multidimensional poverty, i.e. the methodology must provide for researchers who begin an analyses with different sets of deprivation indicators and dimensions to end up with the same (or very similar) final sets of indicators and dimensions – there is a 'correct'/'best'/'optimal' sub-set of multidimensional child poverty indicators and dimensions of deprivation in any given dataset.

The problem with the MPI method is that there remains uncertainty about the following:

1) **How many dimensions there are** – three? (Education, Health and Standard of Living) or six? (Food, Education, Health, Dwelling Conditions, Water & Sanitation, Standard of Living)

2) **How these dimensions are related** – i.e. are the Education and Health dimensions orthogonal – at 90^0 to each other with correlation=0? Or are these two dimensions correlated i.e. at 45^0 with correlation= 0.5?
3) **The indicators are imperfect** and it is not known how they correlate with each dimension, e.g. children not attending school may have a high correlation with the Education dimension (e.g. 0.8) but since some of these children may not attend school due to ill health this indicator may also correlate with the health dimension (e.g. 0.2)

There are solutions to these problems. For example, the methodology discussed below shows how the validity, reliability and additivity of multidimensional poverty indicators can be measured. Structural Equation Modelling (SEM) or confirmatory factor analysis or Latent Class Models can be used to 'test' the dimensional structure of a multi-dimensional poverty or standard of living index (Shelvin *et al*, 2000; Fergusson *et al*, 2001; Jensen *et al*, 2002).

It is possible to produce a reliable and valid multidimensional child poverty index without knowing the dimensional structure of the data e.g. the 'correct'/'optimal' number of dimensions. Chronbach's Alpha (see below) is a measure of the reliability of an index in both uni-dimensional and multi-dimensional space (Cortina, 1993). By aggregating across dimensions to create a single deprivation index, you do not reduce five or six dimensions to one dimension, all that has happened is that indicators have been summed across dimensions, i.e. the deprivation index is still multidimensional.

For example, Green *et al* (1977) generated 10 indicators in five dimensional space using Monte Carlo methods. The five dimensions were all orthogonal (uncorrelated) and each indicator loaded 0.45 on two dimensions. No indicator loaded on the same two dimensions – the Chronbach's Alpha was 0.81 (i.e. a highly reliable five dimensional index).

Most of the theoretical problems concerning the construction of reliable and valid multidimensional poverty and standard of living indices have been extensively discussed (and solved?) over the past 50 years of research in the social policy and standard of living/social indicator literature. It is unfortunate that these extensive literatures appear to have been virtually ignored by many researchers who have attempted to measure child poverty in developing countries.

To conclude this section, there are a range of technical problems with the World Bank's $1 a day method, the Wealth Index method and the Multidimensional Poverty Index method of Alkire and Foster. However, there are also more profound theoretical issues with these three methods which currently render them as inadequate methodologies for measuring child poverty. The use of Purchasing Power Parity in the $1 a day method obscures the costs of providing children with the services they need to escape from absolute poverty. The current Wealth/Asset Index method requires statistical assumptions about the nature of binary/categorical variables which are untenable and relate to Eugenic arguments which could and should be consigned to history. The current Multidimensional Poverty Index method of Alkire and Foster represents a significant advance. However, the fundamental theoretical problem with the Alkire and Foster modified headcount method (Mo) is that although the mathematics are elegant and it has desirable axiomatic properties, this cannot possibly compensate for a methodology which may not produce valid and reliable deprivation indicators and a dimensional structure which may be highly biased.

A worked example from Mexico

The worked example below is for both adults and children, however, the same principles can be applied to scientifically measuring child poverty using only child specific deprivation indicators, such as those used by Gordon *et al* (2003) and in the Global Study on Child Poverty and Disparities (see Table 1).

The Mexican legislature ratified unanimously the General Law of Social Development (LGDS) on 20th January 2004. The law requires that poverty must be officially measured multi-dimensionally. Article 36 of the LGSD requires that the multi-dimensional poverty measure must include (at least) the following eight dimensions:

I. Per capita current income
II. Average gap between compulsory education and actual education at the household level (educational gap)
III. Access to health services
IV. Access to social security
V. Dwelling characteristics, space and quality
VI. Access to basic dwelling related services (water, sewerage, electricity, etc)
VII. Access to food
VIII. Level of social cohesion

An independent parastatal (CONEVAL - www.coneval.gob.mx) was established to develop the best possible scientific methodology for multidimensional poverty measurement and it consulted both national and international experts to help with this policy research (CONEVAL, 2009). This worked example is based upon some initial research for CONEVAL produced by Gordon (2007) using the 2005 ENIGH microdata (the Mexican National Household Expenditure and Income Survey). CONEVAL initially produced a preliminary set of eight indicators as an aid to facilitating a comparison of the results from the different methodologies that have been proposed by all the experts participating in this research:

1. p_income - Per capita current income
2. p_educatio - Educational gap
3. p_health - Access to health services
4. p_socsec - Access to Social Security
5. p_dwelling – Dwelling quality & space deprivation
6. p_services – Basic service deprivation
7. p_foodlp2 – Access to food
8. p_cohesion – Social cohesion

In the model, the components will be summed to produce a deprivation index, this will be plotted against equivalised household income and an optimal threshold which best separates the 'poor' from the 'not poor' identified using standard statistical methods (i.e. maximising the between group difference and minimising the within group difference). In order to identify the optimal poverty threshold for income and deprivation, it is first necessary to construct a valid, reliable and additive deprivation index.

Step 1 – creating a 'scientifically' valid deprivation index

In order to construct a valid deprivation index, it is necessary to demonstrate that each component in the index is a valid measure of deprivation. This can be complex, however since the domains measured by the CONEVAL indicators are considered by the legislature to be important components of multidimensional poverty this provides a-priori evidence for 'face validity'. The 'criterion validity' of the deprivation index can be demonstrated by ensuring that the individual components of the index all exhibit statistically significant relative risk ratios with independent indicators or correlates of poverty. There are a limited number of external validators available in the ENIGH dataset, however, it would be expected that each component of a valid index should have a statistically significant correlation with the three measure of poverty developed by the Technical Committee for the Poverty Measurement (i.e. Alimentary/Food Poverty, Capacities/Capabilities Poverty and Patrimony Poverty[2]) (Cabrera and Miguel, 2002).

Table 3: Relative risk ratios for CONEVAL indicators by poverty measures

CONEVAL Deprivation Measure	Food Poverty	Capacities	Patrimony
p_income	∞	∞	∞
p_health	50.8	48.2	-
p_dwelling	8.7	7.8	6.4
p_foodlp2	8.7	7.7	6.9
p_socsec	8.1	6.1	3.4
p_educatio	6.9	5.9	4.6
p_services	4.6	4.2	3.4
p_cohesion	**0.3**	**0.3**	**0.4**

Table 3 shows the relative risk ratios (approximately the odds ratios) of being Food, Capacities and Patrimony poor for households which also suffer from each of the eight CONEVAL deprivations. All the risk ratios in Table 3 are highly statistically significant (<0.001) and a number of things are also clear from this table. Firstly, those who are Food, Capacities and Patrimony poor also have a 100% chance of suffering from income deprivation (p_income) – their relative risk is effectively infinite (i.e. ∞). In fact, the variable p_income is identical to the Patrimony poverty variable. Similarly, the p_health variable is also very highly correlated with both p_income and all the poverty validation variables (risk ratios of 50.8, 48.2 and almost infinity). Lastly, the social cohesion indicator has statistically significant risk ratios of less than 1, i.e. it is inversely correlated with the three poverty measures.

Figures 6 and 7 show the average equivalised household incomes and expenditures in Mexican Pesos by the eight CONEVAL indicators.

[2] Alimentary poverty refers to households with insufficient resources to obtain their basic food and nutritional needs. Capacities poverty - are those households who are Food Poor, plus those that cannot cover the necessary expenses for health and education. Patrimony Poverty - is the third threshold and include those who are Food and Capacities Poor plus those households which cannot meet basic dwelling, transport and clothing costs (Delgado, 2006)

Figure 6: Main Effects Plot of equivalised household income by CONEVAL indicators

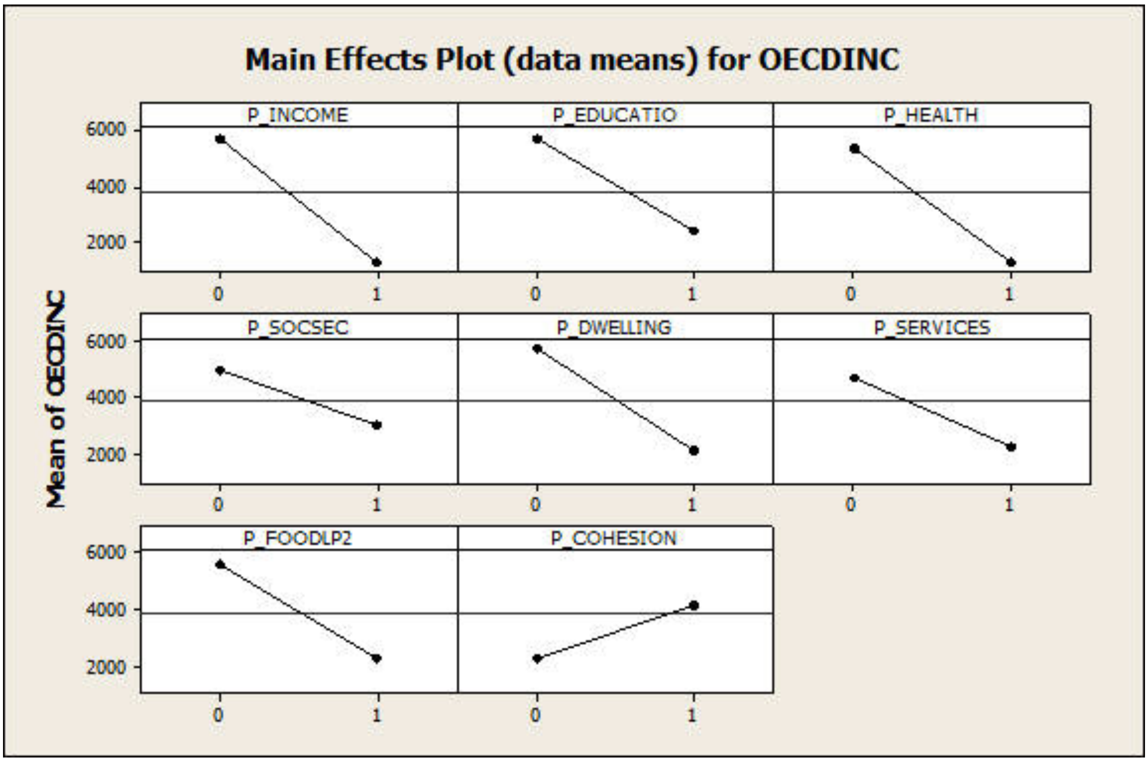
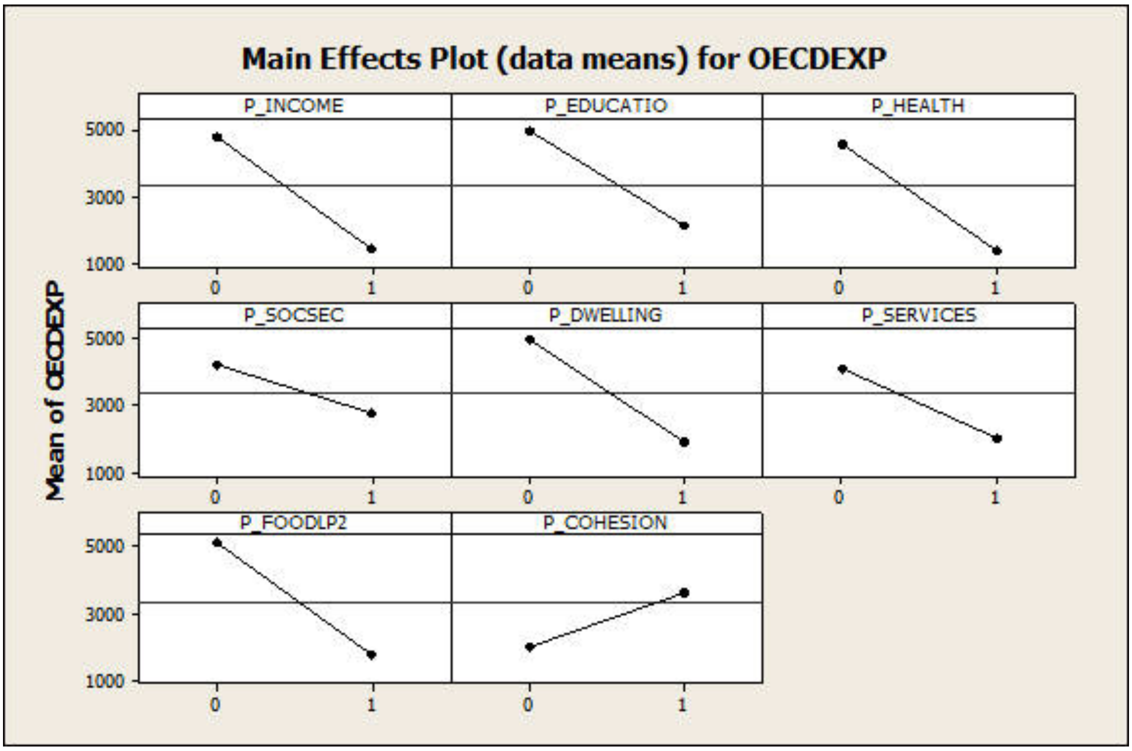


Figure 7: Main Effects Plot of equivalised household expenditure by CONEVAL indicators



The incomes and expenditures of those suffering from each deprivation are marked as '1' on each graph. The horizontal line on each graph shows the average equivalised income and expenditure for the whole sample. It can be clearly seen that for all CONEVAL indicators except Social Cohesion (p_cohesion) those who suffer from deprivation have much lower average equivalised incomes and expenditures than those households which do not suffer from these deprivations. This provides good evidence that all the CONEVAL indicators are valid measures of deprivation except the Social Cohesion measure.

Step 2 - creating a reliable index of deprivation

After establishing that the individual deprivation index components are all 'scientifically' valid, it is necessary to establish that they also form a reliable scale. A deprivation scale was constructed by simply summing the eight CONEVAL indicator scores (i.e. each indicator had a weight of 1). The reliability of an index/scale can be assessed using a classical test theory model by calculating Cronbach's Alpha (SPSS Reliability) for each deprivation item and removing all items in the index that would increase Alpha if the 'Item was deleted'. Unreliable items (e.g. those that do not decrease alpha) are highlighted in bold in Table 4.

Table 4: Reliability analysis of the CONEVAL deprivation indicator index

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Per capita current income CONEVAL	3.58	3.162	.684	.823	.591
Educational gap at the household CONEVAL	3.42	3.545	.427	.205	.655
Access to health services CONEVAL	3.63	3.171	.707	.830	.587
Access to social security CONEVAL	3.40	3.730	.323	.239	.680
Dwelling quality and spaces CONEVAL	3.49	3.479	.463	.260	.647
Dwelling basic service access CONEVAL	3.69	3.786	.344	.182	.674
Access to food CONEVAL	3.47	3.577	.405	.218	.661
Social Cohesion CONEVAL	**3.15**	**4.903**	**-.272**	**.090**	**.772**

Reliability Coefficients
N of Cases = 23,174 N of Items = 8
Alpha = .695

The Cronbach's Alpha (Cronbach, 1951; Cronbach and Shavelson, 2004) for the eight item CONEVAL deprivation scale is 0.695 which is slightly less than the recommended minimum of 0.7 (Nunnally, 1981). However, if the Social Cohesion indicator is removed from the index then the Chronbach's Alpha increases to 0.772, which is a reasonable level of reliability for an index of only 7 items.

Step 3 – checking the revised index is additive

The components of any deprivation index should be additive, e.g. a person or household with a deprivation score of three should be poorer than a person or household with a deprivation score of two. Some components of the index may not be additive, for example, it is necessary to check that a respondent who is both Health Service (p_health) and Dwelling Basic Service (p_service) deprived is poorer than a person who is just Health Service deprived but has Basic Dwelling services in their home. There is no easy way to do this as the number of possible combinations with an 8 component index is huge (8 factorial) but it is possible to check that any two components are additive by looking at the second order interaction effects in a ANOVA with equivalised income as the dependent variable and all the components of the index as the 8 independent variables.

Figure 8: Second order interaction plots for CONEVAL indicators and OECD equivalised household income

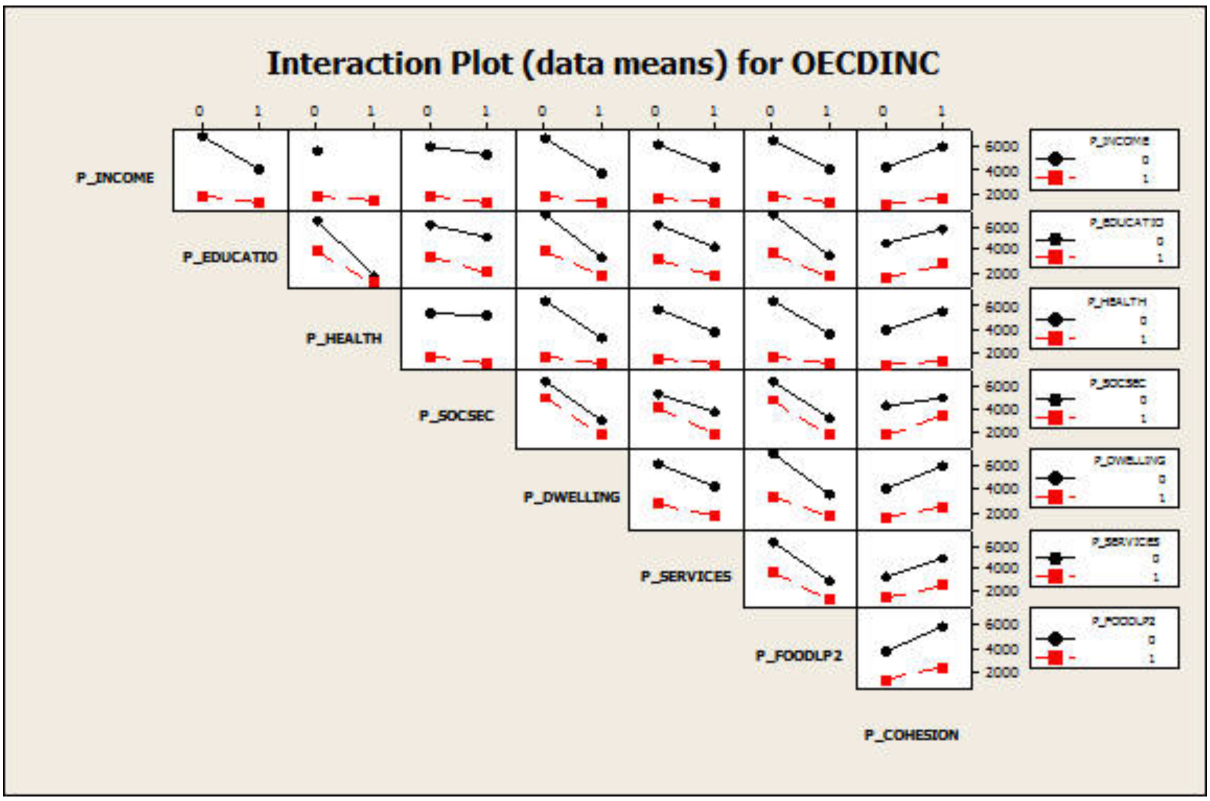
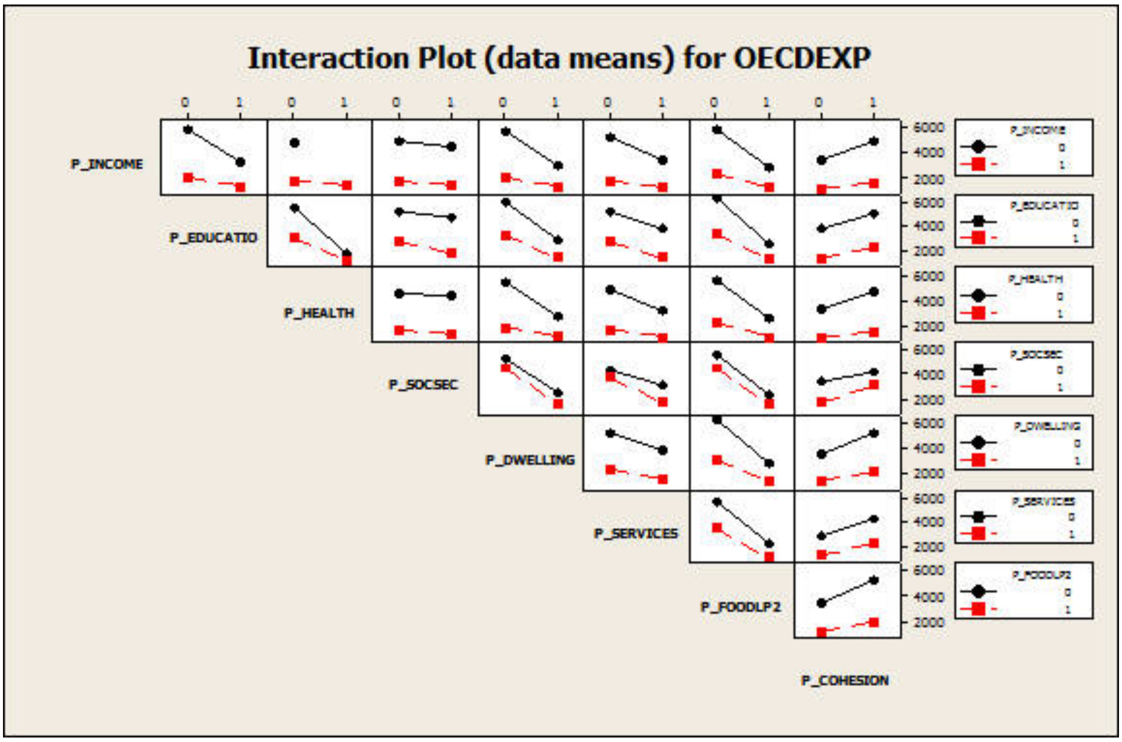


Figure 8 shows the second order interaction plots for the eight CONEVAL indicators and OECD equivalised household income. The first graph (top left of Figure 8) shows the interaction between the Per Capita income indicator (p_income) and the Educational Gap indicator (p_education). The vertical scale on each graph is equivalised household income which ranges between 2,000 and 6,000 and the horizontal scale is deprived= 1 or 'not deprived'= 0. There are two lines on the each graph – a solid black line and a dotted red line. The first black dot on the solid line (top left) shows the average equivalised household income of those respondents who were neither income nor educationally deprived. The first red dot on the dotted line (on the left just below the black dot) shows the income of those who are education gap deprived but not per capita income deprived e.g. its less. The second black dot on the solid line (top right) shows the income of those who are per capita income deprived but who had an acceptable education and the second red dot on the dotted line shows the average equivalised household incomes of respondents who are deprived on both indicators (i.e. both per capita income and educational gap deprived). Therefore, respondents who are both per capita income and educational gap deprived are likely to be 'poorer' than respondents who are deprived of just one of these items.

Two parallel lines slanting from top left to bottom right indicate that the variables are additive. However, if the lines cross or slope upwards (i.e. bottom left to top right) there may be problems, e.g. the Social Cohesion indicator is not additive with any of the other variables.

Figure 9 below, shows the second order interaction plots for the eight CONEVAL indicators and OECD equivalised household expenditure. The results for equivalised expenditure are very similar to those for equivalised income.

Figure 9: Second order interaction plots for CONEVAL indicators and OECD equivalised household expenditure



Step 4 – producing a valid, reliable and additive deprivation index
It is clear, from the results obtained in the previous three steps, that the CONEVAL Social Cohesion indicator is not valid, reliable or additive with the other seven indicators and so it should be excluded from any deprivation index.

Table 5 below shows the final reliable, valid and additive deprivation index constructed by summing the scores of the seven CONEVAL deprivation indicators. The index ranges from a score of zero (i.e. no deprivation) to a maximum score of seven (i.e. deprived on all seven indicators).

Table 5: CONEVAL deprivation index frequencies and average equivalised household incomes and expenditures

		Frequency	Percent	Cumulative Percent	Average OECDINC	Average OECDEXP
Score	0	2633	11.4	11.4	8,218	6,916
	1	4307	18.6	29.9	7,389	6,229
	2	3676	15.9	45.8	4,650	3,982
	3	2951	12.7	58.5	3,266	2,679
	4	2493	10.8	69.3	2,181	1,992
	5	2475	10.7	80.0	1,675	1,619
	6	2444	10.5	90.5	1,249	1,310
	7	2195	9.5	100.0	889	874
	Total	**23174**	**100.0**		**4,090**	**3,525**

There are only around 11% of households that have a deprivation score of zero, indicating that almost 90% of Mexican households suffer from one or more CONEVAL deprivations. The average equivalised household incomes and expenditures of the households scoring zero on the index are 8,218 and 6,916 respectively. By contrast, the average equivalised household income and expenditures of the 9.5% of households scoring 7 on the index (i.e. deprived on every CONEVAL dimension) are 889 and 874 – almost an order of magnitude lower than the no deprivation households.

Figure 10: Average equivalised household income (with 95% Confidence Intervals) by CONEVAL deprivation index score

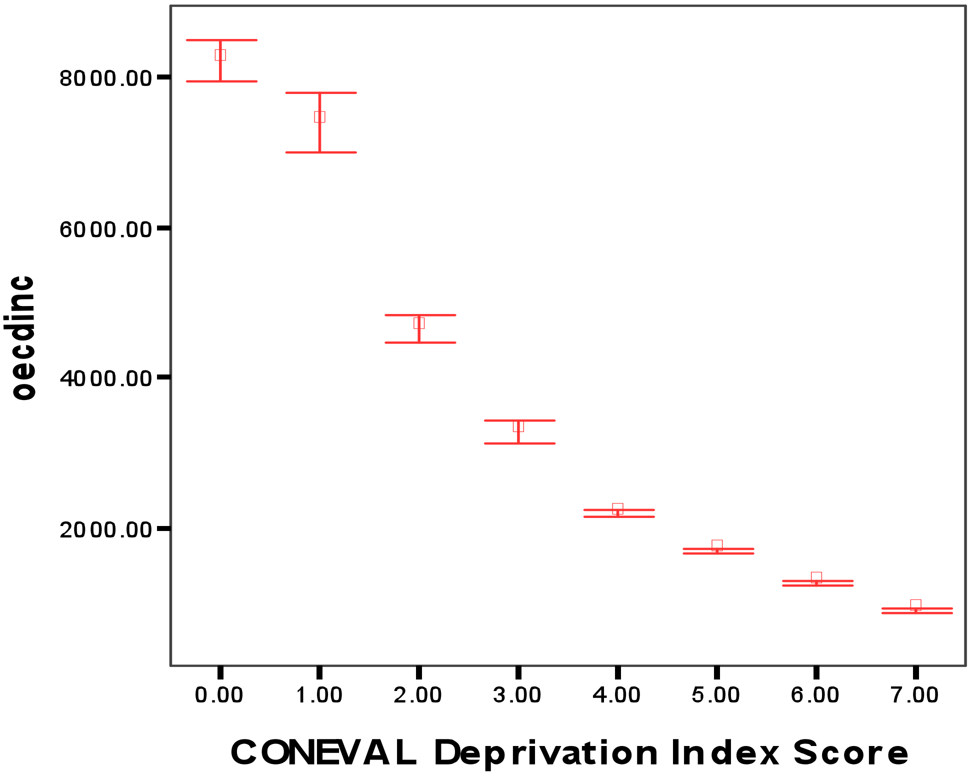


Figure 10 shows the average equivalised household incomes for each CONEVAL deprivation index score – income clearly fall with increasing deprivation. There are two breaks of slope on the graph, between a score of 1 or less and 2 or more and also between a score of 4 or more and 3 or less. In order to determine the optimum poverty threshold, it is first necessary to remove any income outliers (i.e. the very rich).

Figure 11: Univariate statistical summary of OECD equivalised income variable

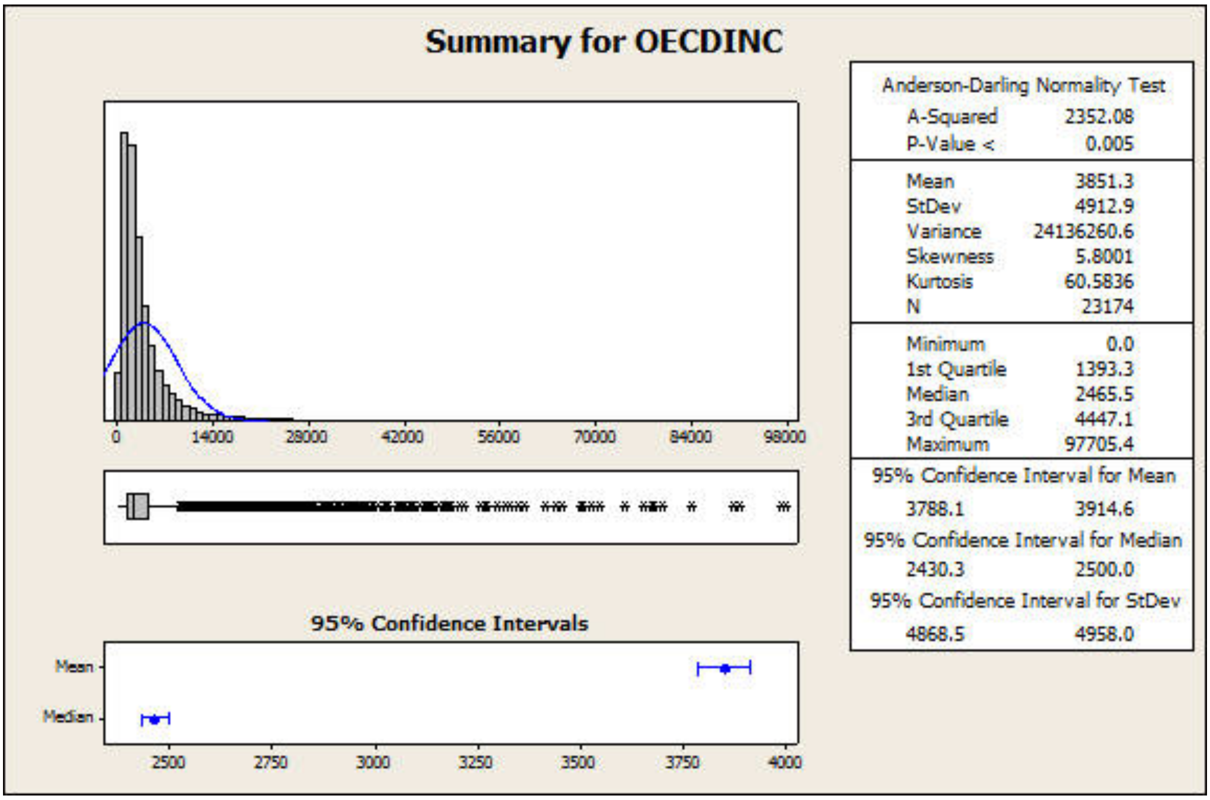


Figure 11 shows a univariate summary of the OECD equivalised household income variable (unweighted). It is clear that the distribution has a strong right skew (skewness=5.8) with many 'extremely' high incomes. Since the purpose of this exercise is to identify the poverty threshold rather than study the very wealthy, those with equivalised incomes over 8,000 have been excluded from the modelling exercise below (although the 'rich' are of course added back to calculated the poverty prevalence rate).

Step 5: Identifying the combined income and deprivation poverty line

The 'objective' combined poverty line can be defined as the division between the 'poor' group and the 'not poor' group that maximises the *between* group sum of squares and minimises the *within* group sum of squares. This can be identified using the General Linear Model (in one of its forms e.g. ANOVA, Discriminant Analysis or Logistic Regression), controlling for income, deprivation and household size and composition.

General Linear Models (both ANOVA and Logistic Regression) were used to determine the scientific poverty threshold e.g. the deprivation score that maximises the between group differences and minimises the within group differences (sum of squares). These techniques were applied to a succession of groups created by increasing the number of items that respondents were deprived of. Thus, the first analysis was undertaken on groups defined by households lacking no items compared with households lacking one or more items (a deprivation score of one or more). Similarly, the second analysis was undertaken on a group comprised of households lacking one or no items against two or more items, and so forth.

The dependent variable in the ANOVA model was net household income and the independent variables were deprivation group (constructed as described above), number of adults in each household and the number of children in each household. With the Logistic Regression models the dependent variable was the deprivation group and the independent variables were net household income, number of adults and number of children. Both the ANOVA and Logistic Regression models yielded the same final result – that a score of four or more on the deprivation index was the optimum position for the poverty line. Summary results are shown in Table 6 below.

Table 6: ANOVA and logistic regression models of optimum position for the poverty threshold

Model	F Statistic for corrected ANOVA Model	Logistic Regression Model Chi-square
Null Model[3]	1,176	
Deprivation score of 1 or more	1,760	2,575
Deprivation score of 2 or more	3,526	6,808
Deprivation score of 3 or more	5,252	11,385
Deprivation score of 4 or more	**5,281**	**13,903**
Deprivation score of 5 or more	4,032	13,597
Deprivation score of 6 or more	2,625	10,762
Deprivation score of 7	1,488	5,954

The summary table shows that the optimum position for the poverty threshold is a deprivation score of four or more.

It is hard to identify the exact equivalised income threshold which would constitute the optimal poverty line as the deprivation score contains two indicators (Per Capita income and Access to Health Services) which are a form of income measure. Therefore, the deprivation and income axes will not be orthogonal and so identifying a 'perfect' ordering is impossible. An additional problem is that the OECD equivalisation scale is probably not optimal for Mexico and this will add statistical 'noise' to the analysis. For these reasons, no attempt has been made to identify the proportion of people in the 'rising' and 'vulnerable' groups. However, an initial estimate of the equivalised household income poverty threshold is 2,230. This is the upper bound of the 95% Confidence Interval of the mean incomes of those households scoring four of the CONEVAL deprivation index.

If we assume that the 'truly' poor (to use Bjorn Halleröd's 1995 term) in Mexico are those who have incomes below the poverty threshold and also suffer from 4 or more deprivations then the poverty prevalence rate using the CONEVAL seven item deprivation index is approximately 36% of households.

[3] The null model only contains the number of adults and the number of children in the household as independent variables.

Conclusion

Eradicating child poverty during the 21st Century is the greatest policy challenge of the era. If this can be accomplished, then millions of children will not die needlessly and untold suffering will be prevented. Valid and reliable measurement is a prerequisite for effective and efficient evidence-based policy interventions to end child poverty. Without good measurement of child poverty, resources may not be targeted at the groups of children in greatest need and it will prove impossible to evaluate the cost effectiveness of anti-poverty policies. This chapter has shown how a scientific theory of poverty measurement can produce valid and reliable estimates of the extent and depth of child poverty. The worked example using data from Mexico demonstrates how statistical criteria can be used to identify a best sub-set of deprivation indicator variables that can be used to identify and reject inadequate indicators in a consistent rather than arbitrary manner. Of equal importance, the methodology can identify 'problems' in the micro data and thereby assist improvements in questionnaire design and data collection.

It is important to understand the use of the term 'scientific' in this chpater is a claim to 'method' and not a claim to 'truth' (i.e. our method must be correct because it is 'scientific') – we are advocating science not scientism[4]. Scientific method is preferable as two researchers who follow the methodology using the same data will produce the same results, even when they begin from different initial starting points. This is unlikely to be true for either the Wealth/Asset Index or the Alkire and Foster (2007) child poverty measurement methodology as two different researchers might select different sets of deprivation/asset indicators and/or dimensions and these methods provide no mechanism to determine which one is 'correct'.

There are of course many limitations in the child poverty measurement methodology of Gordon *et al* (2003). In particular, the normative definition of absolute poverty agreed by 117 governments at the World Social Summit, which underlies the methodology, does not include the social needs of children. Children are social beings who in all societies have social roles and obligations to their family and friends. Fulfilling these roles and obligations is an integral part of childhood and children who are seriously deprived of social interactions become disturbed and fail to thrive. The methodology of Gordon *et al* (2003) could be improved upon by adopting a more comprehensive definition of child poverty which acknowledged children's social needs. Indicators of social deprivation should be incorporated into the poverty measure. An excellent example of how this can be achieved in developing countries can be found in the work of the South African *Measures of Child Poverty* project (Barnes, 2009a; 2009b).

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[4] Scientism is the idea that natural science is the most authoritative/correct worldview.

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