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Obtaining Spatially Disaggregated Estimates Of Poverty In Low Resource Setting. The Choice Between Using Asset Indices Or Imputed Welfare:
A Case Study Of Azerbaijan

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# OBTAINING SPATIALLY DISAGGREGATED ESTIMATES OF POVERTY IN LOW RESOURCE SETTING. THE CHOICE BETWEEN USING ASSET INDICES OR IMPUTED WELFARE:

# A CASE STUDY OF AZERBAIJAN

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**Abstract**

'Poverty maps', that is graphic representations of spatially disaggregated estimates of welfare, are being increasingly used to geographically target scare resources. The development of detailed poverty maps in many low resource settings is, however, hampered due to data constraints. Data on income or consumption are often unavailable and, where they are, direct survey estimates for small areas are likely to yield unacceptably large standard errors due to limited sample sizes. Census data offer the required level of coverage but do not generally contain the appropriate information. This has led to the development of a range of alternative methods aimed either at combining survey data with unit record data from the Census to produce estimates of income or expenditure for small areas or at developing alternative welfare rankings, such as asset indices, using existing Census data.

This paper outlines the development of a set of poverty maps for Azerbaijan which can be used by different users. The paper contrasts two alternative approaches to the measurement and mapping of welfare. First a map is derived using imputed household consumption. This involves combining information from the 2002 Household Budget Survey (HBS) with 1999 Census data using techniques developed by a team within the World Bank that are now becoming standard practice (see Elbers et *al* 2002). Secondly an alternative map is constructed using an asset index based on data from the 1999 Census to produce estimates of welfare at the district level. This provides a unique opportunity to compare the welfare rankings obtained at the regional level under the two alternative approaches and to assess the different results that the two techniques provide.

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## INTRODUCTION

'Poverty maps', that is graphic representations of spatially disaggregated estimates of welfare, are being increasingly used to geographically target scare resources (Bigman and Deichmann 2002). There is also growing recognition that location itself is an important determinant of welfare, with the local agro-ecological resource endowment, access to input and output markets, and availability of educational and health facilities all influencing the well being of households. Conversely, household welfare may also have an important effect on the locality, for example local levels of consumer demand, patterns of cropping and deforestation. The development of detailed poverty maps in many settings is, however, hampered due to data constraints. Data on income or consumption are often unavailable and, where they are, direct survey estimates for small areas are likely to yield unacceptably large standard errors due to limited sample sizes. Census data offer the required level of coverage but do not generally contain the appropriate information.

Given the well known problems in measuring income and expenditure, researchers have been forced to rely on *ad hoc* use of proxies for measures for living standards (Bollen, Glanville and Stecklov 2001; Kakwani, Wagstaff and Doorslaer 1997; Montgomery et al. 2000; Wagstaff and Watanabe 1999). An increasing use is now being made of alternative wealth rankings based on the household ownership of assets, such as car, refrigerator or television, as well as characteristics of the household dwelling such as type of flooring materials, type of toilet and access to basic services including clean water and electricity. In order to create an index from the information on asset ownership it is necessary to aggregate the individual responses. A number of different techniques have been used. The simplest approach is to assign equal weights to the ownership of each asset or presence of each household dwelling. However, such a simple additive approach assumes the welfare value of each element is equivalent e.g. having a radio has the same welfare impact as having access to a flush toilet. As an alternative to simply calculating an index based on the sum of the assets, it is possible to use statistical techniques to determine the weights in the index. The two most common approaches for doing this are principal components analysis and factor analysis (Bollen, Glanville and Stecklov 2001; Gwatkin et al. 2000).

So far few studies have attempted to verify the extent to which the asset indicator being used is a good proxy for household consumption, the main reason being that such verification requires a data set that contains both metric measure of household consumption and the components of the asset index.

Filmer and Pritchett (1994), using the principal component analysis technique tested this methodology to construct an asset index based on information provided in common demographic surveys. They compared a proxy based on the principal components score of several consumer durable goods and housing quality to a proxy based on household expenditures and showed the household asset index is a good proxy of long run household wealth especially to capture health inequalities. In addition, by using instrumental variable and reverse regression techniques, they found evidence that this composite may be less error-laden when representing long run economic status than expenditures. Filmer and Pritchett (2001) also validated their asset index using data from the Indonesian, Pakistani and Nepalese Living Standards Measurement Survey (LSMS), concluded that the asset index had ‘reasonable coherence’ with current consumption expenditures and worked ‘as well or better, than traditional expenditure-based measures in predicting enrolment status’. They also note that their asset index is a better proxy for long-run household wealth than current per capita consumption.

Other studies have shown that asset indices calculated with principal components analysis technique are a good measure of living standards especially if related to health indicators (Gwatkin et al. 2000). Sahn and Stifel (2003) point it out that expenditure and income data often suffer from a variety of measurement errors, and are expensive to collect on regular basis. Bollen et al. (2001) in their study compared the performance of several alternative proxies for economic status using information from Living Standard Measurement Studies[3]. They conclude that if researchers’ focus is on economic status itself (as is the case when using proxies to identify the poor), then the choice of proxy can make a difference. If, however, attention lies on other variables with economic status being used as a control, then the non-economic status variables are relatively robust to the choice of proxy. In particular, they found that the choice of economic status can affect the assessment of economic status’s impact on fertility, but the estimates of the other covariates exhibit a greater robustness. They also found that an economic index constructed by applying the principal component analysis technique performs better than other economic proxies and there is no improvement with additional information available only in the LSMS.

[3] The World Bank’s Living Standards Measurement Study (LSMS) surveys collect extensive expenditure data. However, the demographic and health data collected in the LSMS survey are far more limited than in the DHS.

Montgomery et al. (2000) evaluated the performance of proxy measures in relation to consumption expenditures per adult, the latter being their preferred measure of living standards. They found that proxy variables were weak predicators of consumption per adult, with extremely low partial $R^2$ values. However, in subsequent analyses of fertility, child schooling and mortality, the proxy–based coefficient estimates compared favourably to those obtained using consumption, providing a generally reliable guide to sign and magnitude of the preferred estimates. Sahn and Stifel (2003) also found the correlation of their asset with household expenditure to be weak.

Previous assessments have primarily concentrated on the comparison of welfare rankings of households within a country. This study intends to add new evidence to the debate by comparing welfare rankings at the spatial level. Two alternative welfare rankings using an asset based measure and a consumption measure are compared at the administrative and district level for the Republic of Azerbaijan. The estimates were developed as part of the World Bank Azerbaijan Poverty and Social Impact Analysis (PSIA) funded by the Norwegian Trust Fund for Sustainable Development as part of the assessment on the effects of raising residential electricity tariffs.

Below we first discuss the derivation a poverty map using imputed household consumption applying a methodology develop by Elbers et al. (2002) and combining information from the 2002 Household Budget Survey (HBS) with 1999 Census data. We then detail the construction of an alternative welfare map. Here principal component analysis is used to derive an asset index based on data from the 1999 Census to produce estimates of welfare at the district (rayon) level. We then compare the welfare rankings obtained at the district and administrative level under the two approaches and we will conclude commenting the results of the study.

## DEVELOPMENT OF A POVERTY MAP OF AZERBAIJAN USING IMPUTED CONSUMPTION

The first method applied to derive a poverty map for Azerbaijan is based on a statistical procedure that combines household survey data with population census data. This technique uses the strength of both the detailed information about living standards available in the household budget survey and the more extensive coverage of a census to derived spatially disaggregated poverty estimates based on a consumption indicator of welfare. The two datasets used in this paper are the 2002 Azerbaijan Household Survey (AHBS 2002) and the 1999 Census collected by the State Statistical Committee of Azerbaijan Republic (Goskomstat). The Census covers around 1.7 million households containing 8 million individuals[4]. Administratively Azerbaijan has 9 economic regions, 73 rayon (districts) and 4,500 villages. Between village and rayon level there is an additional layer of administrative units, usually combining 3-5 villages together. Here, we used Census data at the village level and we limited our analysis to the 65 rayon, as it was not possible to include those rayons in the occupied zone.

The AHBS 2002 survey covers 8,157 households and 33,000 individuals. The survey provides detailed information on a wide range of topics, including food consumption, non-food consumption, labour activities etc. The survey design incorporates stratification by region (economic zones and urban and rural strata).

[4] We consider the present population as it has been the population considered for the sample design of the Household Budget.

Following the standard poverty mapping methodology, as outlined in Elbers et al (2002), data from the AHBS were used to estimate a prediction model for consumption, employing a set of explanatory variables which are common to both the survey and the census. The parameters from this model are then applied to census data to derive an imputed value for consumption. This then allows us to derive a set of welfare indicators based upon consumption, such as headcount poverty. Finally, these welfare indicators are constructed for geographically defined subgroups of the population. Although the approach is conceptually simple, properly accounting for spatial autocorrelation in the first stage model and estimating standard errors for the welfare estimates requires additional elaboration (see Elbers et al. (2002)). The method can thus be thought of as being divided into three stages.

In the 'zero' stage we first carefully compare the questions of household budget and census to identify a set of variables that are common to both sources of data. These variables are then compared on a statistical basis by considering the mean values in the two dataset. This second type of check is important as even when the survey and census questions are identically worded, subtle differences in the way the questions are asked, or different ordering of questions may cause the information content to differ between the survey and the census.

By comparing mean household size in the 1999 census and 2002 HBS during this 'zero' stage it became clear that Azerbaijan had experienced significant fluctuations in fertility during the three years between 1999 Census and 2002 HBS. The mean household size showed a decrease of almost one member per household and this trend was found across all regions. Following further investigation and discussion with experts at the State Statistical Committee, it was determined that the dramatic fall in the number of births between 1999 and 2003 was in part an ‘echo effect’ of the sharp drop in fertility and high death rate during the Second World War. The low fertility and high death rates during WW2 resulted in a much smaller birth cohort during this period. The population pyramids for Azerbaijan have since been marked by a regular drop in the number of births from this cohort (and their offspring) in a 25 years cycle. The period between 1999 and 2002-3 coincided with the second 25 years cycle. Comparison of household size and age structure between the census and the HBS revealed a systematic change in both size and age structure, with a significant drop in the number of young children in the household.

One of the key assumptions inherent in the poverty mapping procedure outlined by Elbers et al. (2002) is that the models estimated from the survey data apply to census observations. Given the sharp drop in fertility between the implementation of the 1999 Census and HBS 2002, it was decided to modify the dependent variable and to use adult equivalent monthly household consumption as the welfare indicator as opposed to the commonly used average per capita consumption (Elbers et al. 2003; Mistiaen et al. 2002). The equivalence scale used gives less weight to young children than other household members and so is less sensitive to changes in the numbers of young children compared to a more straightforward per capita measure[5]. This minimizes the impact of the drop in the number of young children in the household at the time of the 2002 HBS.

[5] Adult Equivalent: children aged below the age of six have been assigned a weight of 0.2, children aged between 7 to 12 have been assigned a weight of 0.3, children age 13 to 17 have been assigned a weight of

The consumption model was derived using only independent variables that were similar in both wording and distribution in both data sets. In some strata, where the selected variables on the strict test of comparability did not yield a reasonable high R square, the criteria for selection of the regression variables were relaxed[6]. A set of three dummies for the quarter in which the household has been interviewed, was included to control for fluctuations in household consumption due to the different quarter of the year[7]. The final specification included only those variables that were significant at least at 90 per cent level and the quarterly dummy variables.

Following this, a set of census means at the village level were then merged with the HBS data. The location residuals were then regressed on a set of census means at village level. A selection criteria of significance at 95 % was applied, along with a ceiling for the maximum number of census means. Following the inclusion of these additional variables the OLS regression was re-estimated in order to reduce the size of the location effect. For the regression models and the relevant diagnostics for the urban and rural strata see Baschieri et *al*. (2005). The regression models quite successfully explained the variation in monthly adult equivalent consumption. The R-Square ranges from 0.29 to 0.56 in urban areas to 0.24 to 0.52 in rural areas.

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0.5, and a weight of 1.0 if the household member is older than 17 years. The equivalence scale is designed to account for differences in 'need' due to age and sex. It does not however account for economies of scale of household size as each adult carries the same weight on 1.0. The World Bank's 2003 Poverty Profile for Azerbaijan undertaken within the Programmatic Poverty Assessment, proposes a different per adult-equivalent consumption measure that assumes a scale parameter of 0.8 and that the cost of a child (individuals of age 18 and below) is 70% of the cost of an adult. This study was completed earlier and therefore did not use this definition.

[6] In few cases we selected variable that were within two standard deviation from the mean value in the census.

[7] When we proceed for the imputation in the census we construct three variables with the value of 0.25.

Using the parameters estimates derived in the first stage modelling, we then proceed with the census imputation[8], as described in Elbers et al. (2002). A relative poverty line of 40 per cent lowest quintile was used which corresponds to 215,235 Manat per month.

Table 1 below presents the results for average adult equivalent consumption, the headcount index (FGT(0)) taking the value of the 40th percentile as the poverty line for both the HBS and the Census for each strata. Comparison of results from the Census and HBS shows that the prediction model seems to perform relatively well at this level, with exception of the rural area of Karabah and the urban areas of Mugan and Shirvan where the census imputation of the adult equivalent consumption is above the one estimated by the HBS and where the headcount measure imputed in the census is below the headcount estimated by the HBS.

**Table: 1 Average adult equivalent, poverty and inequality in Azerbaijan, by regions (strata)**

| | Mean Adult | | Poverty line 40% | |
|---|---|---|---|---|
| | *Census* | *HBS* | *Census* | HBS |
| **Rural** | | | | |
| Nakhchivan | 219146 | 218726 | 0.52 | 0.51 |
| | (6191) | (4575) | (0.038) | (0.038) |
| Absheron-Guba | 239589 | 247547 | 0.40 | 0.36 |
| | (3930) | (5685) | (0.024) | (0.034) |
| Mugan-Salyan | 245288 | 243113 | 0.37 | 0.37 |
| | (3045) | (3927) | (0.016) | (0.027) |
| Ganja-Gazakh | 264507 | 266946 | 0.36 | 0.30 |
| | (6801) | (4273) | (0.023) | (0.024) |
| Sheki | 253816 | 248874 | 0.31 | 0.34 |
| | (5653) | (4156) | (0.023) | (0.029) |
| Lanakaran | 245929 | 241499 | 0.35 | 0.37 |
| | (2679) | (3432) | (0.014) | (0.025) |
| Shirvan | 255715 | 252779 | 0.34 | 0.335 |

[8] For the census imputation we use the application Povmap Version 1.1a developed by Qingua Zhao, from the Development Research Group of The World Bank.

| | Mean | Adult | Poverty | line 40% |
|---|---|---|---|---|
| | *Census* | *HBS* | *Census* | HBS |
| | (3761) | (4922) | (0.014) | (0.032) |
| Karabah | 271245 | 258223 | 0.31 | 0.39 |
| | (6814) | (4111) | (0.025) | (0.021) |
| **Urban** | | | | |
| Nakhchivan | 239444 | 237958 | 0.44 | 0.43 |
| | (4679) | (5993) | (0.020) | (0.040) |
| Absheron-Guba | 242869 | 242368 | 0.42 | 0.41 |
| | (2815) | (4024) | (0.012) | (0.024) |
| Mugan-Salyan | 259218 | 241078 | 0.30 | 0.38 |
| | (10062) | (5398) | (0.046) | (0.038) |
| Ganja-Gazakh | 214910 | 216514 | 0.55 | 0.54 |
| | (2297) | (2766) | (0.015) | (0.027) |
| Sheki | 227578 | 222539 | 0.44 | 0.56 |
| | (8695) | (4516) | (0.065) | (0.037) |
| Lanakaran | 233407 | 232017 | 0.46 | 0.45 |
| | (4238) | (5217) | (0.020) | (0.038) |
| Shirvan | 222600 | 209556 | 0.50 | 0.58 |
| | (4488) | (3843) | (0.027) | (0.041) |
| Karabah | 228797 | 231541 | 0.48 | 0.45 |
| | (3676) | (4218) | (0.019) | (0.031) |
| Baku | 261656 | 253530 | 0.39 | 0.42 |
| | (10782) | (2551) | (0.03) | (0.013) |

Note: Standard errors in parenthesis. Household survey figures are calculated using weights that are the product of household weights and household size. Census-based figures are calculated weighing by household size.

It is important to note that the standard errors associated with those estimates do not account for any possible model errors due to a misspecification of the model we have used for the imputation in the census. Estimates based on area units below 1,000 households will also have an error associated with them due to the low number of observations in each area.

Two indicators of community welfare are computed: i) mean adult equivalent monthly consumption of the region – giving an indication of the average level of living standards the population of the region enjoys; and ii) the proportion of individuals living in poverty, where poverty is defined as living in a household with consumption in the bottom two quintiles of the population (i.e. with adult equivalent incomes below the 40$^{th}$ percentile or 215,235 Manat per month). This gives a measure of relative poverty.

The 'imputed welfare' poverty mapping procedure produces estimates of welfare at the rayon, administrative level and enumeration area. However, the estimates are only considered to be reliable for areas containing more than 1,000 households. Estimates at both the rayon level and administrative level could be potentially useful for geographical targeting; however there are some issues regarding the reliability of those estimates for purpose of geographical targeting in the special case of Azerbaijan.

The 2002 Household Budget Survey allows spatial analysis of poverty only at oblast (economic region) level with a further breakdown between urban and rural areas. According to the annual report of Azerbaijan's progress toward the MDGs (SPPRED 2004), poverty rates (using the monthly per capita consumption measure of welfare) are higher in urban areas compared to rural areas, the highest poverty incidence being found in Nakhchivan AR. Poverty in the Shaki-Zagatala region is close to the average level and poverty in large cities is noticeably less than in smaller towns.

Our findings confirmed those results and previous findings from the recent Azerbaijan Poverty Assessment (Dowsett-Coirolo, 2003). However, comparing the regional poverty measures from the AHBS 2002 and the estimates of welfare obtained from the census, we also find marked geographical variation in poverty rates at the rayon level *within* each major region, as well as at administrative areas *within* rayons. We derived a number of maps at rayon level for both urban and rural areas.

Moving below the rayon level, the standard errors become wider and the estimates of headcount poverty become unreliable. However the analysis suggests that the estimates of mean adult equivalent consumption remain fairly robust at the level of administrative districts, but not at the level of individual census enumeration areas. Although the results are available for all the administrative units for both urban and rural areas, we only visually plot the results for administrative units which contain at least 1000 households.

**Figure 1: Average Monthly Consumption per Adult Equivalent in Manat, rural area.**

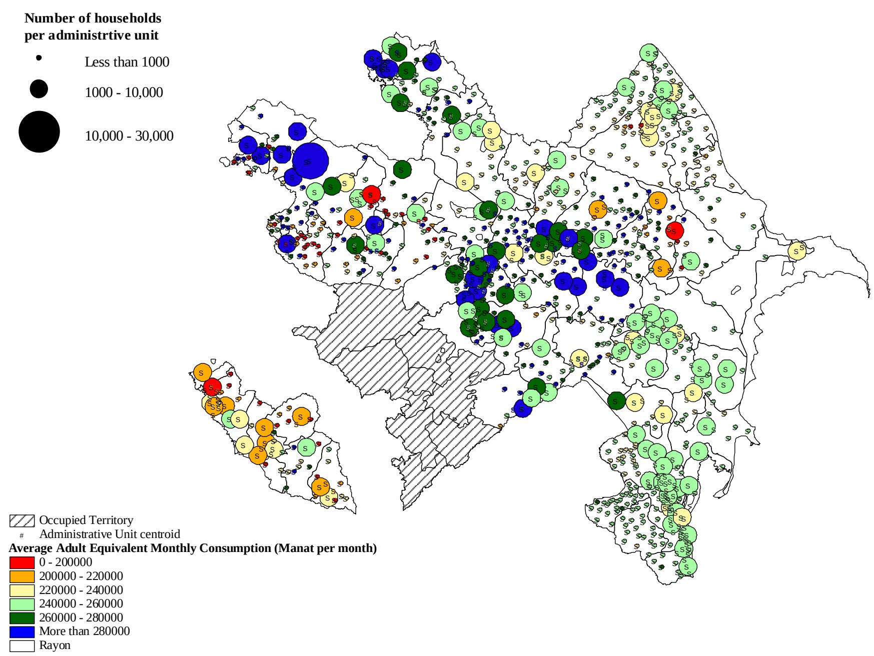
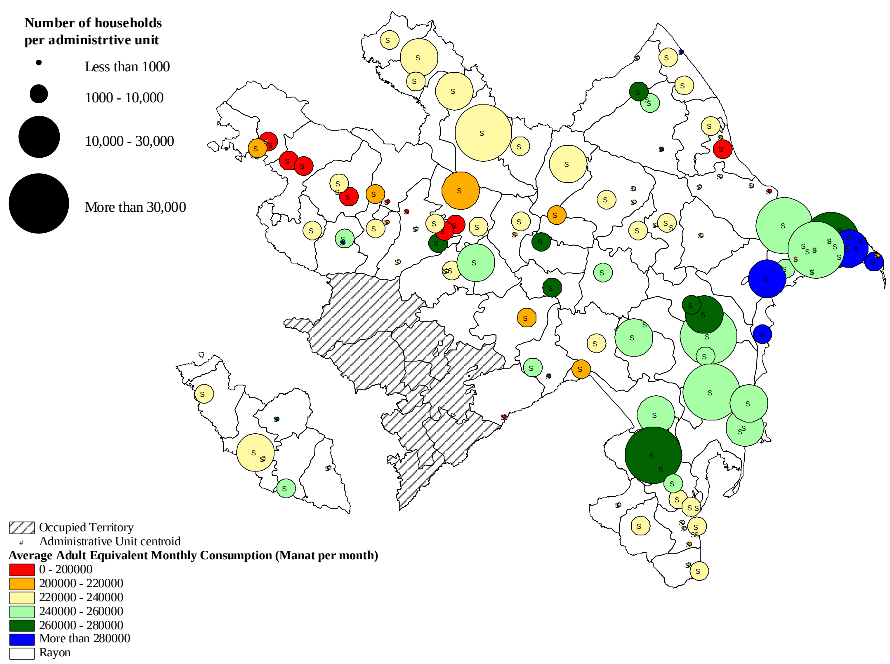


**Figure 2: Average Monthly Consumption per Adult Equivalent in Manat, urban area.**




## DERIVING POVERTY MAPS USING ASSET INDEX METHOD

Using the 1999 Census of Azerbaijan collected from the State Statistical Committee of Azerbaijan, we apply the principal component technique to derive a asset index score for district welfare. With this technique the socio-economic status of households is defined in terms of assets or wealth, rather than in terms of income or consumption. The 1999 Census included several questions regarding the ownership of consumer durables and the materials used in the construction of the household, along with basic demographic information concerning household size and composition. Table 2 presents some basic descriptive statistics of the potential components of the asset index.

**Table 2: Ownership of assets and household characteristics, Azerbaijan 1999.**

| | *Mean* | *Standard Deviation* | *Min* | *Max* |
|---|---|---|---|---|
| 1. Gas Line | 0.584 | 0.492 | 0 | 1 |
| 2. Gas Cylinder | 0.209 | 0.407 | 0 | 1 |
| 3. Electric Oven | 0.245 | 0.430 | 0 | 1 |
| 4. Heating system (private, public) | 0.09 | 0.286 | 0 | 1 |
| 5. Stove | 0.391 | 0.487 | 0 | 1 |
| 6. Water | 0.588 | 0.492 | 0 | 1 |
| 7. Hot water | 0.04 | 0.196 | 0 | 1 |
| 8. Sewage System | 0.412 | 0.492 | 0 | 1 |
| 9. Bathroom | 0.385 | 0.486 | 0 | 1 |
| 10. Telephone | 0.269 | 0.443 | 0 | 1 |
| 11. Total living area (square meters) | 65.24 | 47.929 | 0 | 2000 |
| 12. Number of rooms | 2.371 | 1.498 | 0 | 96 |
| 13. Dwelling Structure(separate house, no) | 0.637 | 0.480 | 0 | 1 |
| 14. Ownership of dwelling | 0.739 | 0.438 | 0 | 1 |
| **15. Rural household** | 0.430 | 0.495 | 0 | 1 |

Each household asset for which the information was collected though the 1999 Azerbaijan Census was assigned a weight or factor score generated through principal components analysis. The principal components analysis (PCA) is a dimension reduction technique (Chatfield and Collins, 1980). This multivariate statistical technique is used to examine the relationships between a set of correlated variables.

In this analysis it was decided to include a dummy for urban and rural area, the idea being that the inclusion of this extra dummy variable will capture part of the local variation due to differences in durable ownership and housing characteristics due to the place of residence. To our knowledge no other previous studies have included such locational dummies in the model.

Given that the Census collects information on 15 asset type variables, the potential range of combinations is $2^{15}$ (i.e. 15 dimensions). As it is not straightforward to visualize any data with more than three dimensions, the PCA allows the reduction of the number of variables, and thus dimensionality without losing too much information in the process.

The PCA technique achieves this by creating a smaller number of variables which explain most of the variation in the original variables. The new variables (which are created such that they are uncorrelated with each other) are linear combinations of the original variables (factor score). They are derived in decreasing order of importance so that, for example, the first new variable will account for as much as possible of the variation in the original data (for an illustration of the PCA analysis see Technical note 2 in Baschieri et al. 2005).

Including all the asset variables of the 1999 Census dataset that are related to household economics (see Table 2 ) results in an asset index with 15 components. Thus when we perform the PCA the dimension of the variable will be 15, and the proportion of variance explained from the first PC will be compared with the total variance with 15 variables. If a smaller number of variables are used, the proportion of the variance explained from the first PC will be higher, but this PC will be based on a small number of variables with supposedly smaller variance, but also with less information about the household. In this paper we apply the PCA to the full correlation matrix of all 15 variables.

The principal components is a technique for extracting from a large number of variables those few orthogonal linear combinations of the variables that best capture the common information. The first principal component is a linear index of variables with the largest amount of information common to all of variables. In the present analysis, the first principal component explains more than 30 percent of the variation of the original variables and each subsequent component explains a decreasing proportion of variance.

In calculating the household index, only the factor score (eigenvectors) of the first principal component were considered. Table 3 column (4) shows the results of the principal component on the correlation matrix of the 15 variable considered.

The asset score (A) for the jth household considering N variables is given by:

$$A_j = f_1(a_{j1} - a_1)/(s_1) + ... + f_N(a_{jN} - a_{jn})/(s_N)$$

where $f_1$ is the eigenvector for the first asset as determined by the procedure, $a_{j1}$ is the jth household's value for the first asset and $a_1$ and $s_1$ are the mean and standard deviation of the first asset variable over all households.

The mean value of the index is zero by construction. The standard deviation in this case is 1.90 since all asset variables (except "number of room", and "total living area") take only the values of zero or one, the weights have an easy interpretation. A move 0 to 1 (if household not owns or owns an asset) changes the index by $f_1 / s_1$ , for example a household that owns a telephone has an asset index higher by 0.38 than that one that does not. Being a rural household lowers the index by 0.40 per cent (see column 6 and 7 to see the change in the index due to each asset variable).

Each household was assigned a standardized score for each asset, where the scores differed depending on whether or not the household owned that asset. Column 6 of Table 3 below shows the value of score if household owned the asset, and Column 7 shows the value of score if the household does not have the asset.

**Table 3: Result of household economic index.**

| | *(2) Mean* | *(3) Standard Deviation* | *(4) Eigenvectors of first principal components* | *(5) Scoring factor/ Std. Dev.* | *(6) Score if they have asset* | *(7) Score if they don't have asset* |
|---|---|---|---|---|---|---|
| 1. Gas Line | 0.584 | 0.492 | 0.299 | 0.608 | 0.253 | -0.355 |
| 2. Gas Cylinder | 0.209 | 0.407 | -0.176 | -0.432 | -0.342 | 0.090 |
| 3. Electric Oven | 0.245 | 0.430 | -0.143 | -0.333 | -0.251 | 0.081 |
| 4. Heating System (private, public) | 0.09 | 0.286 | 0.078 | 0.273 | 0.248 | -0.025 |
| 5. Stove | 0.391 | 0.487 | -0.308 | -0.632 | -0.385 | 0.247 |
| 6. Water | 0.588 | 0.492 | 0.327 | 0.665 | 0.274 | -0.391 |
| 7. Hot water | 0.04 | 0.196 | 0.132 | 0.673 | 0.647 | -0.027 |
| 8. Sewage System | 0.412 | 0.492 | 0.391 | 0.795 | 0.467 | -0.327 |
| 9. Bathroom | 0.385 | 0.486 | 0.355 | 0.730 | 0.449 | -0.281 |
| 10. Telephone | 0.269 | 0.443 | 0.233 | 0.526 | 0.384 | -0.141 |
| 11. Total living area (square meters) | 65.24 | 47.929 | -0.114 | -0.002 | ** | ** |
| 12. Number of room | 2.371 | 1.498 | -0.009 | -0.006 | ** | ** |
| 13. Dwelling Structure (separate house, no) | 0.637 | 0.48 | -0.301 | -0.627 | -0.228 | 0.399 |
| 14. Ownership of dwelling | 0.739 | 0.438 | -0.243 | -0.555 | -0.145 | 0.410 |
| 15. Rural household | 0.430 | 0.495 | -0.367 | -0.741 | -0.423 | 0.319 |
| | 0 | 1.90 | | | | |

**: Household score for number of room are calculated as follow: {#number of room-unweighted mean)/unweighted Standard deviation}/*asset factor score. The same applies for total living area.

These score were summed by household, and individuals ranked according to the total score of the household in which they resided. These standardized scores were then used to create the breakpoint that defines wealth quintiles as follows. The sample of household has been then divided into population quintiles (five groups with same number of individual each). Wealth quintiles are expressed in terms of quintiles of *individuals* in the population. In Table 4 below are shown the quintile boundaries of the asset index.

**Table 4: Quintile of asset index, 1999 Azerbaijan Census.**

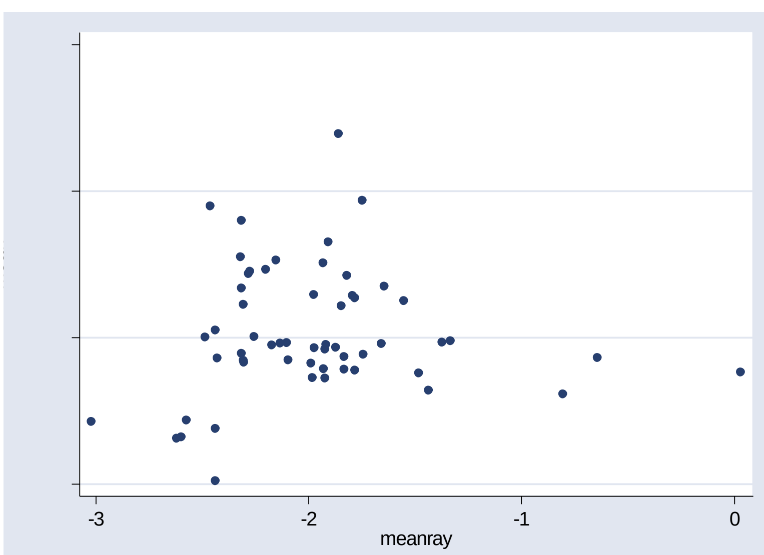
| *Percentile* | *Centile value* | *Lower Bound* | **Upper Bound** |
|---|---|---|---|
| 20 | -2.387 | -2.389 | -2.387 |
| 40 | -1.329 | -1.331 | -1.327 |
| 60 | 0.313 | 0.306 | 0.318 |
| 80 | 2.184 | 2.184 | 2.185 |

Note: Total number of present population 7.798.578 according to 1999 Azerbaijan Census.

## COMPARING SPATIAL WELFARE RANKINGS USING AN ASSET BASED MEASURE AND IMPUTED CONSUMPTION

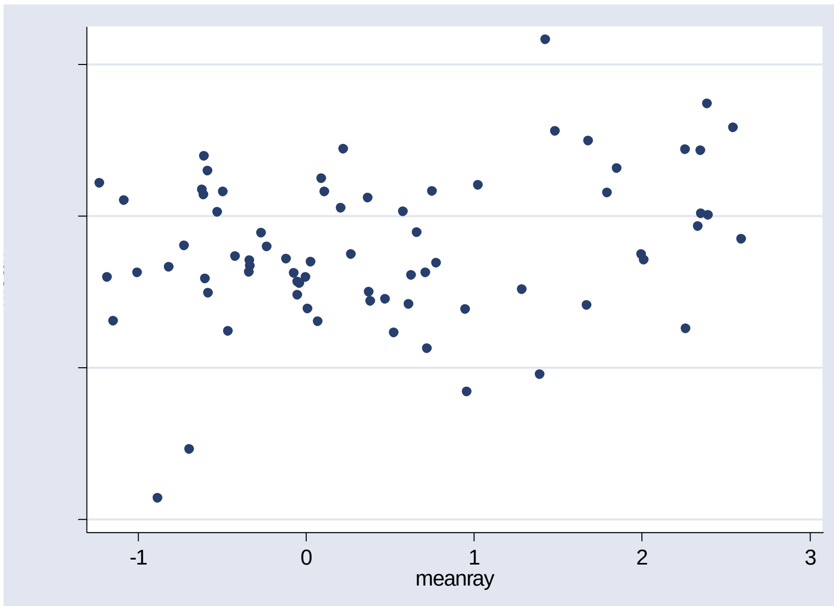
Figures 3 and 4 present scatter diagrams of the welfare indicators at the rayon level by the two different methodologies, along with the spearman rank correlations. It is clear that there is no significant correlation between the welfare rankings produced by the two methods. This is especially true for rural areas, where it appears that the asset index does not reflect the same heterogeneity between regions that is captured by the imputed consumption. This is because many of the components of the asset index are directly related to rural-urban location. It may also be that patterns of ownership of assets and access to services reflect patterns of ownership and infrastructure development laid down during the soviet era. Given this is it not surprising that the asset index appears to be only weakly associated with current levels of consumption

**Figure 3: Scatter plot of average adult equivalent consumption per month in Manat and factor score, rural rayon**




Note: Number of observation=56, Spearman's rho=0.044, Test of Ho: mean consumption and factor score are independent Prob>0.6343

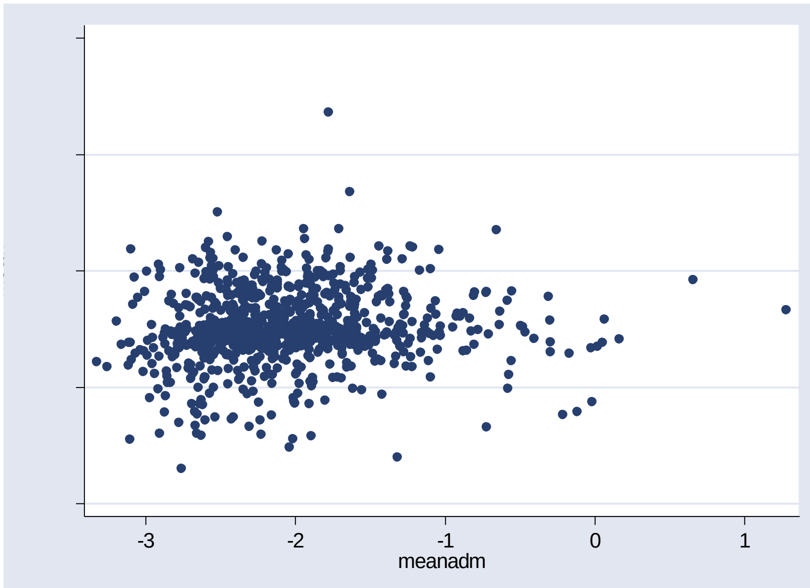
**Figure 4: Scatter plot and average adult equivalent consumption per month in Manat and factor score, urban rayon**




Note: Number of observation=73, Spearman's rho=0.2034, Test of Ho: mean consumption and factor score are independent Prob>0.0843

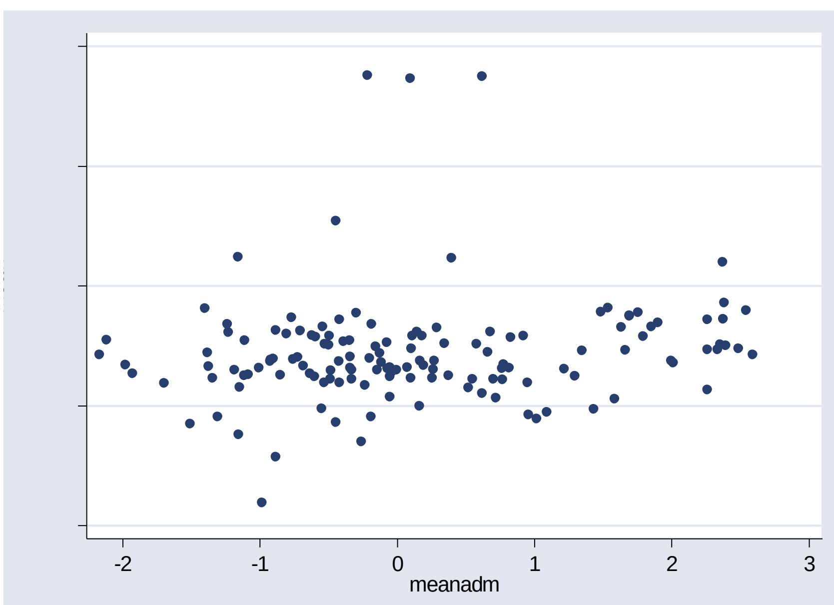
Figure 5 and 6 show the scatter diagrams for the welfare rankings at the administrative level. The correlation coefficient is again low. The results indicate that an asset index may be a poor indicator of welfare in spatial poverty analysis in Azerbaijan. These results, though, do not rule out the possibility that an asset based index might be a good welfare measure in other countries.

**Figure 5: Scatter plot and average adult equivalent consumption per month in Manat and factor score, rural administrative units**




Note: Number of observation=876, Spearman's rho=0.132 ,

**Figure 6: Scatter plot and average adult equivalent consumption per month in Manat and factor score, urban administrative units**




Note: Number of observation=140, Spearman's rho=0.1752

## CONCLUSION

This paper illustrates the application of two alternative methodologies to derive poverty maps for Azerbaijan. By combining information from the 2002 Household Budget Survey and the 1999 Census to produce spatially disaggregated estimates of welfare based on imputed consumption, we found that there is a higher incidence of relative poverty in urban areas as compared to rural areas. There is also a high degree of spatial heterogeneity within urban areas, with the proportion of the population living below the relative poverty line varying between 20 and 60 per cent. The picture in rural areas is more homogeneous, with relative poverty rates in most rayons varying between 30 and 40 percent. We also found that there is a significant degree of variation *within* rayons, with some pockets of deprivation within more affluent areas. This adds significantly to our knowledge on the spatial distribution of poverty in Azerbaijan, going beyond what is known from the simple analysis of the AHBS.

Comparison of the spatial estimates of welfare derived using consumption with those derived using an asset index highlights that the two measures are capturing different dimensions of welfare. The asset index largely reflects patterns of ownership of household assets and access to services laid down during Soviet era and thus is not a good proxy for current levels of welfare in Azerbaijan. In addition, this results call for caution in using asset index measures of welfare when comparing geographical areas especially if used for geographical targeting.

## REFERENCES

Baschieri, A., Falkingham, J., Hutton, G., Duncan, H. 2005. “Creating a Poverty Map for Azerbaijan”. *World Bank Policy Research Working Paper*, WPS3793.

Bigman, D.and U. Deichmann. 2002. "Geographical targeting: a review of methods and approaches." in *Geographical Targeting for Poverty Alleviation: Methodology and Applications*, edited by D. Bigman and H. Fofack: The World Bank.

Bollen, K.A., J. Glanville, and G. Stecklov. 2001. "Economic Status Proxies in Studies of Fertility in Developing Countries: Do the Measure Matter?" *Measure Evaluation Working Papers* WP-01-38.

Chatfield, C.and A.J. Collins. 1980. *Introduction to Multivariate Data Analysis*. London: Chapman and Hall.

Dowsett-Coirolo, D. 2003. "Azerbaijan Republic Poverty Assessment Volume I: Summary and Conclusions." in *Human Development Sector unit South Caucasus Unit Europe and Central Asia*: The World Bank.

Elbers, C., J.O. Lanjouw, and P. Lanjouw. 2002. "Micro-level Estimation of Welfare." *World Bank Policy Research Working Paper*. WPS2911

Elbers, C., P. Lanjouw, J. Mistiaen, B. Özler, and K. Simler. 2003. "Are Neighbours Equal? Estimating Local Inequalities in Three Developing Countries." *WIDER DP #2003/02*.

Filmer, D.and L. Pritchett. 1994. "Estimating wealth effects without expenditure Data - or Tears." *Policy Research Working Paper 1994* WPS1994.

Filmer, D.and L. Pritchett. 2001. "Estimating Wealth Effects without expenditure Data or Tears: Educational enrolment in India." *Demography* 38(1).

Gwatkin, D.R., S. Rustein, K. Johnson, P.P. Rohini, and A. Wagstaff. 2000. "Socio-Economic Differences in Health, Nutrition, and Population." *HNP/Poverty thematic Group of the World Bank*.

Kakwani, N., A. Wagstaff, and E.v. Doorslaer. 1997. "Socioeconomic inequalities in health: measurement, computation, and statistical inference." *Journal of Econometrics* 77:87-103.

Mistiaen, J., B. Özler, T. Razafimanantena, and J. Razafindravonona. 2002. "Putting Welfare on the Map in Madagascar." *Africa Region Working Paper Series No. 34.*

Montgomery, M., M. Gragnolati, K. Burke, and E. Paredes. 2000. "Measuring living standards with proxy variables." *Demography* 37(2):155-174.

Morris, S.S., C. Calogero, J. Hoddinot, and L.J.M. Christiaensen. 2000. "Validity of rapid estimates of household wealth and income for health surveys in rural Africa." *Journal of Epidemiology and Community Health* 54:381-387.

Sahn, D.E.and D. Stifel. 2003. "Exploring Alternative Measure of Welfare in the Absence of Expenditure Data." *Review of Income and Wealth*. 49(4): 463-489.

SPPRED. 2004. "Annual Report 2003. Azerbaijan Progresses Toward the achievement of the MDGs." Baku.

Wagstaff, A. and N. Watanabe. 1999. "Inequalities in childhood malnutrition and mortality: does the measure of living standards matter?" in *Mimeo*: The World Bank.