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CREATING A POVERTY MAP FOR 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 develops a set of poverty maps for Azerbaijan for use in a wider World Bank funded project that is investigating the likely impact of a change in energy tariffs including potential substitution of fuel wood amongst impoverished households and the associated risk of deforestation. Two alternative approaches are adopted. First a map is constructed using an asset index based on data from the 1999 Census to produce reliable estimates of welfare at the raion level. Secondly an alternative map is derived using imputed household consumption, combining information from the 2002 Household Budget Survey (HBS) with 1999 Census data. This provides a unique opportunity to compare the welfare rankings obtained at the regional level under the two approaches.

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1. 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. 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 [2].

This study aims to develop a set of poverty maps for Azerbaijan for use in a wider project that is investigating the likely impact of a change in energy tariffs including potential substitution of fuel wood amongst impoverished households and the associated risk of deforestation. Two alternative approaches are adopted. First a map is constructed using an asset index based on data from the 1999 Census to produce reliable estimates of welfare at the raion level. Secondly an alternative map is derived using imputed household consumption,

[2] http://www.worldbank.org/poverty/health/wbact/health_eq_tn04.pdf.
See also http://www.healthsystemsrc.org/publications/Issues_papers/Measuring_healthpoverty.pdf

combining information from the 2002 Household Budget Survey (HBS) with 1999 Census data. This provides a unique opportunity to compare the rankings obtained at the regional level under the two approaches.

2. Measuring welfare – creating an asset index for use with the Azerbaijan 1999 Census

Given the well known problems in measuring income and expenditure, 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 (Gwatkin et al. 2000; Bollen et al. 2001).

2.1 Data and methods

In the first section of this study we apply principal component analysis to create an asset index based on data from the 1999 Azerbaijan Census collected from the State Statistical Committee of Azerbaijan. 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 1 presents some basic descriptive statistics of the potential components of the asset index.

Table 1: Ownership of assets and household characteristics, Azerbaijan 1999

	Mean	*Standard Deviation*	*Min*	*Max*
1. Gas Line	0.43	0.495	0	1
2. Gas Cylinder	0.209	0.4071	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 room	2.371	1.498	0	96
13. Dwelling Structure(separate house, no)	0.637	0.48	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 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 include 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. An illustration of PCA is presented below.

Suppose we have *p* variables (in our case *p* data on household asset), X_1, X_2,…, X_p, for *n* individuals.

The first principal component is the linear combination of these variables

$$Z_1 = a_{11}X_1 + a_{12}X_2 + a_{13}X_3 + ... + a_{1p}X_p$$

The coefficients a_{11}, a_{12},…, a_{1p} are chosen such that the variance of Z_1 is maximised.

The coefficients are subject to the constraint that:

$$a_{11}^2 + a_{12}^2 + ... + a_{1p}^2 = 1$$

If this constraint is not introduced then the variance of Z_1 can be increased simply by increasing any one of the coefficient.

The second principal component is the linear combination

$$Z_2 = a_{21}X_1 + a_{22}X_2 + a_{23}X_3 + ... + a_{2p}X_p$$

such that the variance of Z_2 is maximised subject to the constraint that

$$a_{21}^2 + a_{22}^2 + ... + a_{2p}^2 = 1$$

and also that Z_1 and Z_2 are uncorrelated.

The third principal component is the linear combination

$$Z_3 = a_{31}X_1 + a_{32}X_2 + a_{33}X_3 + ... + a_{3p}X_p$$

such that the variance of Z_3 is maximized subject to the constraint that

$$a_{31}^2 + a_{32}^2 + ... + a_{3p}^2 = 1$$

and also that Z_3 is uncorrelated with Z_1 and Z_2.

Further principal components (up to the maximum of *p*) are defined in a similar way. Each principal component is uncorrelated with all the others and the squares of its coefficients sums to one.

The principal components analysis involves finding the eigenvalues and eigenvectors of the covariance matrix. These are just special function of the covariance matrix.

If we consider the ith principal component (PC),

$$Z_i = a_{i1}X_1 + a_{i2}X_2 + a_{i3}X_3 + \ldots\ldots\ldots + a_{ip}X_p$$

the variance of Z_i is the ith eigenvalue ,i.e. Var(Z_i)=λ1;

One important property of PCs is that the total variation in the data is preserved. The sum of the variances of the PCs is equal to the sum of the variance of the original variables,

$$\mathrm{var}(X_1) + \mathrm{var}(X_2) + \ldots + \mathrm{var}(X_p) = \mathrm{var}(Z_1) + \mathrm{var}(Z_2) + \ldots. + \mathrm{var}(Z_p)$$

$$=\lambda 1+\lambda 2+\ldots+\lambda p$$

The variables used in this analysis are measured in different scales (some of the variables are binary, some other categorical and some other continuous). This can lead to one variable having an undue influence on the principal components simply because of the scale of measurement. To avoid this problem usually the original variables are $X_1,\ X_2,\ldots,\ X_p$ are standardized before performing PCA.

The covariance matrix of the standardised variables, which we shall label $X_1^*,\ X_2^*,\ldots\ X_p^*$ is simply the correlation matrix of the original variables $X_1,\ X_2,\ldots,\ X_p$. In other words we could carry out PCA by obtaining the eigenvalues and eigenvectors of the correlation matrix (rather than covariance matrix).

Therefore the sum of the variance of the standardized variables is

$$\mathrm{var}(X_1^*) + \mathrm{var}(X_2^*) + \ldots.. + \mathrm{var}(X_p^*) = 1 + 1 + 1 + \ldots. + 1 = p$$

which means that the sum of the variances of the PCs is

$$\lambda 1 + \lambda 2 + \ldots + \lambda p = p$$

One important thing to consider is that the proportion of variance explained by the first principal component will depend on the number of variables included in the analysis. As our aim is to explore the maximum variation amongst household score in order to obtain a “better measure of wealth inequalities” we will try in this analysis to include all the variables related to household economics for constructing an household asset, as in this way we will obtain a more regular distribution of households across quintiles.

2.2 Results

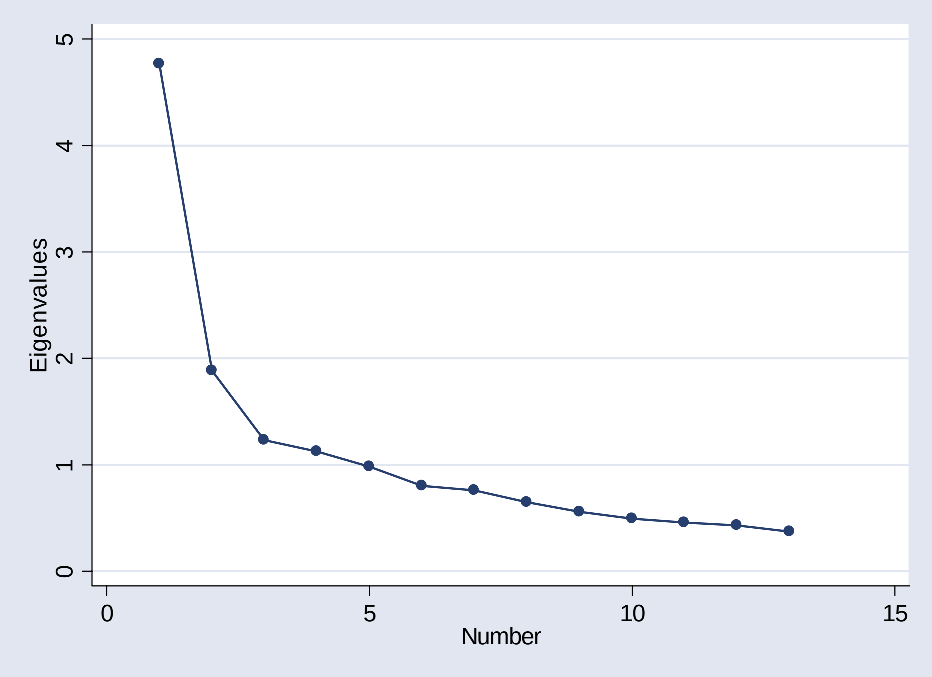
Including all the variables that are related to household economics in the 1999 Census dataset presented in Table 1 above results in an asset index with 15 components. Thus when we perform the PCA the dimension of the variable will be 15, and the proportion of variance explained from the first PC will 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. Table 2 presents the result of the variance of the principal components analysis.

Table 2: Total variance explained by each component.

Component	*Eigenvalues*	*Differences*	*Proportion*	*Cumulative*
1	4.767	2.881	0.3178	0.3178
2	1.885	0.653	0.1257	0.4436
3	1.231	0.105	0.0821	0.5257
4	1.125	0.143	0.0751	0.6008
5	0.982	0.180	0.0655	0.6662
6	0.801	0.040	0.0534	0.7197
7	0.760	0.115	0.0507	0.7704
8	0.645	0.088	0.0430	0.8134
9	0.556	0.064	0.0371	0.8505
10	0.491	0.036	0.0328	0.8833
11	0.455	0.023	0.0303	0.9136
12	0.431	0.059	0.0288	0.9424
13	0.371	0.097	0.0248	0.9672
14	0.274	0.057	0.0183	0.9855
15	0.217	.	0.0145	1.0000

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. The scree plot shown in Figure 1 display the proportion of variance explained by each principal component; on the x-axis are the components and on the y-axis are the eigenvalues of each components.

Figure 1: Scree-plot for results of principal component using household variable in 1999 Azerbaijan census household questionnaire.



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:

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

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 2.70 since all asset variables (except "number of household member per sleeping room") 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 own a telephone has an asset index higher by 0.80 than that one that does not. Being a rural household lowers the index by almost 50 per cent (see column 5 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 owed 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	0.43	0.495	-0.367	-0.741	-0.85375	0.644057
2. Gas Cylinder	0.209	0.4071	0.299	0.734	1.427071	-0.37706
3. Electric Oven	0.245	0.430	-0.176	-0.409	-0.71866	0.233207
4. Heating System (private, public)	0.09	0.286	-0.143	-0.500	-1.59091	0.157343
5. Stove	0.391	0.487	0.078	0.160	0.200288	-0.12859
6. Water	0.588	0.492	-0.308	-0.626	-0.52422	0.748166
7. Hot water	0.04	0.196	0.327	1.668	8.171595	-0.34048
8. Sewage System	0.412	0.492	0.132	0.268	0.320642	-0.22467
9. Bathroom	0.385	0.486	0.391	0.805	1.018074	-0.63733
10. Telephone	0.269	0.443	0.355	0.801	1.322325	-0.4866
11. Total living area (square meters)	65.24	47.929	0.233	0.005	-0.00652	-0.00662
12. Number of room	2.371	1.498	-0.114	-0.076	0.06965	0.120452
13. Dwelling Structure (separate house, no)	0.637	0.48	-0.009	-0.019	-0.01418	0.024883
14. Ownership of dwelling	0.739	0.438	-0.301	-0.687	-0.4095	1.159479
15. Rural household	0.430	0.495	-0.243	-0.491	-0.56529	0.426446

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.

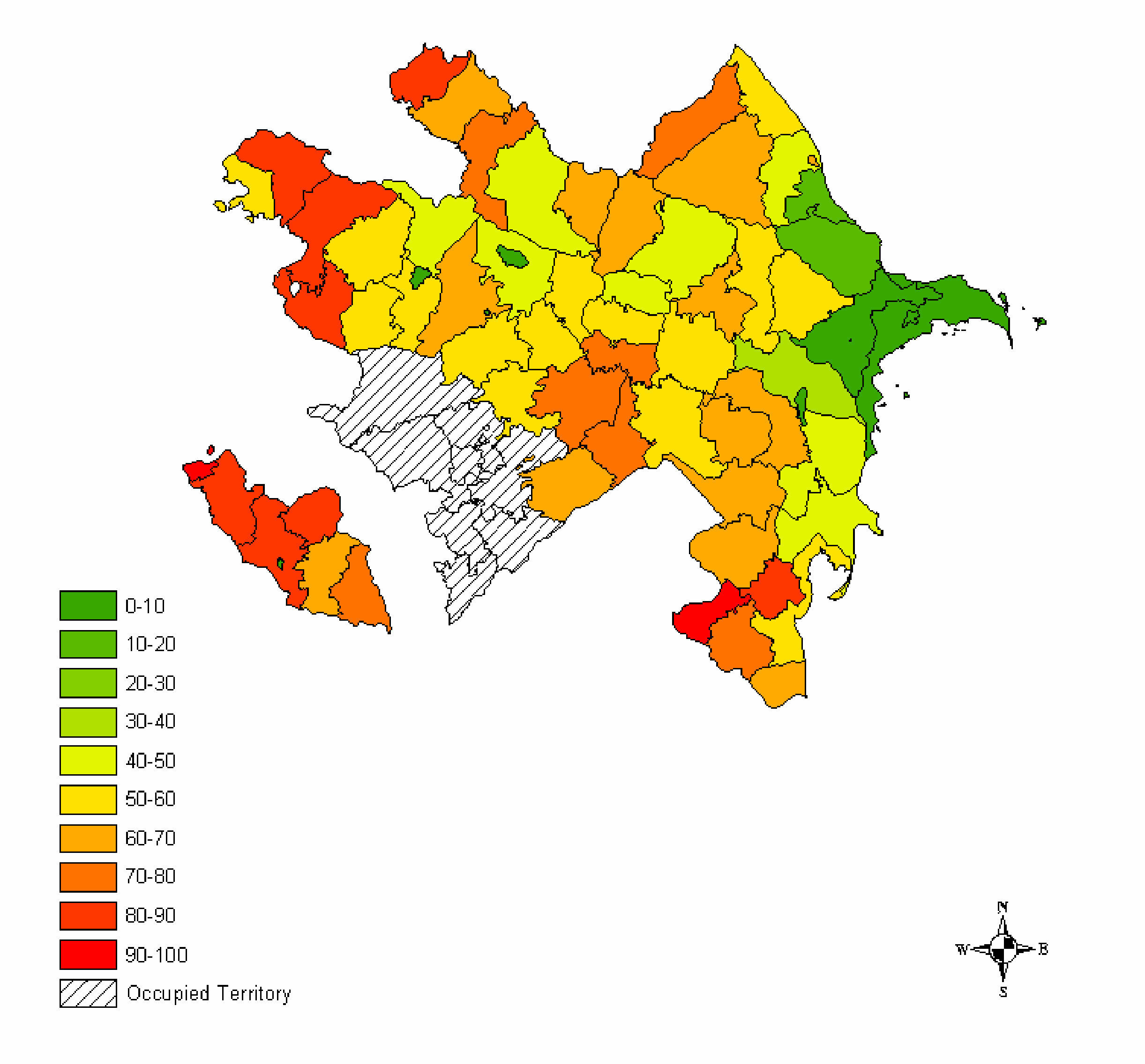
Table 4: Quintile of asset index, 1999 Azerbaijan Census.

Percentile	*Centile value*	*Lower Bound 95% CI*	*Upper Bound 95% CI*
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.

Figure 2 below show the proportion of individuals in each raion that are living in households ranked in the lowest two quintiles (i.e. poorest 40 percent).

Figure 2: Raion map of the proportion of people living in the poorest 40 percent of households as ranked using an asset index, 1999 Azerbaijan Census



3. Poverty mapping using imputed welfare

As an alternative to the asset index described above, in this section we use the methodology developed by (Elbers et al. 2002) to produce a poverty map based on money metric indicators of household welfare. The 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 derive spatially disaggregated poverty estimates based on a consumption welfare indicator.

3.1 Overview of Methodology

Survey data are first used to estimate a prediction model for consumption and then the parameters are applied to census data to derive an imputed value for consumption, employing a set of explanatory variables which are common to the survey and the census. This allows us to then define a set of welfare indicators based upon consumption such as headcount poverty. Finally, the welfare indicators are constructed for geographically defined subgroups of the population using these predictions.

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. The method can be thought of as being divided into three stages. There is a commonly defined “zero stage”, which involves the careful selection of a set of comparable variables common to both the survey and census (this stage is discussed further under implementation in section 3.2.2). The first stage of analysis then involves the use of survey data to derive a model for predicting household welfare. This model is then applied to the census dataset in the final stage. Stages one and two are further elaborated below.

First Stage

In the "first stage" of analysis a model of consumption is developed using household survey data and those variables that have been selected in the zero stage. In previous application of this methodology the log of per capita consumption has commonly been used as dependent variable; in this application we modify the definition of the dependent variable and use the log of per adult equivalent consumption (see Section 3.3 for a detail explanation).

The log of adult equivalent household consumption, y_{ch} is related to a set of observable characteristics, x_{ch}[3]:

$$\ln y_{ch} = E[\ln y_{ch} \mid x_{ch}] + u_{ch} \quad (1)$$

Using a linear approximation, we model the observed log per adult equivalent consumption per household h as:

$$\ln y_{ch} = x_{ch}^{'}\beta + u_{ch} \quad (2)$$

where β is a vector of parameters, and $\mathbf{u}$ a vector of disturbances, is distributed $F(0,\Sigma)$. The model (2) is estimated by Generalized Least Squares using data from the 2002 Azerbaijan household budget survey. In order to estimate by GLS model, it is first necessary to produce an estimate of Σ, the associated error covariance matrix. We model individual disturbances as:

$$u_{ch} = \eta_c + \varepsilon_{ch}$$

where η_c is a location component and ε_{ch} is a household component. This error structure allows for both spatial autocorrelation, i.e. a "location effect" for households in the same area, and heteroskedasticity in the household component of the disturbance. The two components are independent of one another and uncorrelated with observable characteristics.

[3] This section summarizes the discussion in Elbers et al. (2002).

In order to estimate $\sum$, we need to calculate the variance of the location component $\hat{\sigma}_{\eta}^{2}$,

the location component η_c, variance of the household residuals $\hat{\sigma}_{\varepsilon,ch}^{2}$ and household residuals

ε_{ch})[4].

To obtain those parameter we first estimated a OLS, and the residuals from this regression serve as estimates of overall disturbances, given by $\hat{u}_{ch}$. We decompose these into uncorrelated household and location components:

$$\hat{u}_{ch} = \hat{\eta}_c + e_{ch}$$

where $\hat{\eta}_c$ are the within-cluster means of the overall residuals, e_{ch}, household component estimates are the overall residuals net of location components.

Elbers *et al*. (2002) procedures allows for heteroskedasticity in the household component. In the case of Azerbaijan, heteroskedasticity was found not to be a problem. Given this, we then decide to model only the location component where possible (see Section 3.3 below)[5].

Second Stage

In the "second stage" the parameter estimates of the consumption model developed in the first stage are applied to data from the 1999 Census of Azerbaijan to obtain predicted consumption for each household within the Census.

We construct a series of simulations, where for each simulation r we draw a set of first stage parameters from their corresponding distribution estimated in first stage.

Thus we draw a set of beta and, $\tilde{\beta}^{r}$ from the multivariate normal distributions described by the first stage point estimates and their associated variance–covariance matrices.

[4] See Appendix 2 of Elbers *et a*l(2002) for details
[5] In the implementation of this methodology, we use an application Povmap Version 1.1a developed by Qingua Zhao, from the Development Research Group of The World Bank. At the time of the writing of this report, PovMap application did not provide an option to not model heteroskedasticity. In practice, we only consider the predicted value of the log of adult equivalent consumption as an explanatory variable of the heteroskedasticity model (see Elbers and al (2002) for details on the heteroskedasticity model).

Additionally we draw $\left(\tilde{\sigma}_{\eta}^{2}\right)^{r}$ a simulated value of the variance of the location error component.

For each household we draw simulated disturbance terms, $\tilde{\eta}_{c}^{r}$ and $\tilde{\varepsilon}_{ch}^{r}$, from their corresponding distribution. We simulate a value of expenditure for each household, $\hat{y}_{ch}^{r}$, based on both predicted log expenditure, $x_{ch}^{'}\tilde{\beta}^{r}$ and their disturbance terms:

$\hat{y}_{ch}^{r} = \exp\left(x_{ch}^{'}\tilde{\beta}^{r} + \tilde{\eta}_{c}^{r} + \tilde{\varepsilon}_{ch}^{r}\right)$. Finally, the full set of simulated per adult equivalent expenditures, $\hat{y}_{ch}^{r}$ are used to calculate the estimate of the welfare measure for each spatial subgroup. We repeat this procedure 100 times drawing a new $\tilde{\alpha}^{r}$, $\tilde{\beta}^{r}$, $\left(\tilde{\sigma}_{\eta}^{2}\right)^{r}$ and disturbance terms for each simulation. For each subgroup, we take the mean and standard deviation of each welfare measure over 100 simulations.

For any given location, these means constitute our point estimates of welfare measure, while the standard deviations are the standard errors of these estimates.

3.2 Data and Implementation

3.2.1 Data

The technique combines data from the 2002 Azerbaijan Household Survey (AHBS 2002) and the 1999 Census collected by the State Statistical Committee of Azerbaijan (Goskomstat) Republic. The Census covers around 1.7 million households containing 8 million individuals[6]. Administratively Azerbaijan has 9 economic regions, 73 raion and 4500 villages. Between village and raion level there is an additional layer of administrative units, usually combining 3-5 villages together. It has been possible to combine the Census data and AHBS at the village level. The present analysis is limited to the 65 raion, as it was not possible to include raion 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). The HBS in its current format and sample design it is relatively new to the SSC, being introduced in its new format in January 2001. Although the State Statistical Committee of Azerbaijan has carried out a regular household budget survey since independence in 1991, the survey design which it inherited from the Soviet period did not allow it to supply reliable data on living standards. Since 1999 a group of international technical experts have been working on improving the HBS design in order to produce nationally representative data (Marnie et al. 2001).In designing the new survey, the team has attempted to rectify the faults of the old HBS, while limiting the additional human and financial resources required, since the survey has to be sustainable for the future. For these reasons the new HBS adopts a full quarterly rotation of households. The interviewers, instead of being involved in the collection of data from the same household over a year period, follow a group

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

of households over a quarter and interview a new group of households at the beginning of each quarter. Each quarter around 2000 households are selected; resulting in a total sample of 8,157 households in the 2002 AHBS.

Following the redesign of the HBS, the total number of permanent staff employed as interviewers has risen from 64 to 84. The new design allows the selection of 84 territorial unit (or Primary Sampling units), and a single interviewer is responsible for the conduct of all household interviews within a particular area. Unfortunately the dependence upon a single interview has the potential to introduce an 'interviewer effect' that is impossible to isolate from other 'location effects'. This may be particularly significant for the production of spatially disaggregated statistics of the kind employed in this study.

3.2.2 Implementation

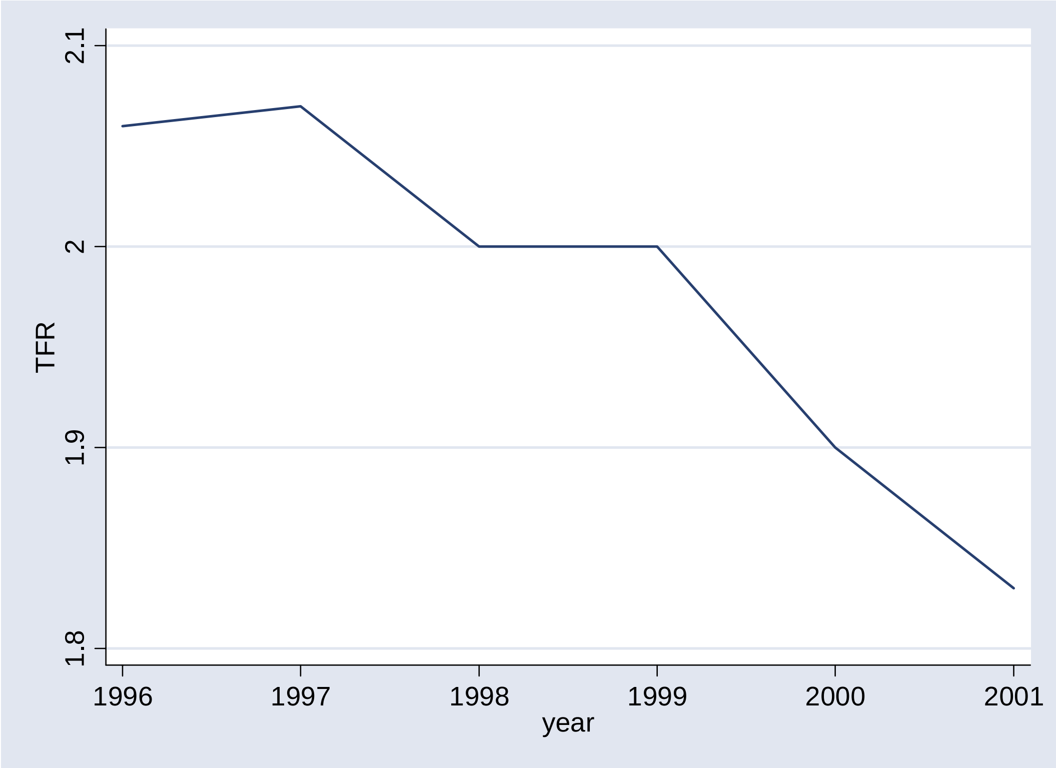
In the 'zero' stage we first carefully compare the questions of household budget and census to identify a set of variables that are common to both sources of data. These variables are then compared on a statistical basis by considering the mean values in the two dataset. This second type of checks is 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. Table1 and 2 in the Appendix show the tabulation of the mean value in the HBS and the Census. Those variables for which the census mean was within the 95 confidence interval of the mean in the HBS were then selected for inclusion in the model.

In comparison of mean household size 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 with the SSC, 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. As we can see from Figure 3, there has been a sharp decline in the Total Fertility Rate from 1999 to 2001.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 (Mistiaen et al. 2002; Elbers et al. 2003). 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[7]. This minimizes the impact of the drop in the number of young children in the household at the time of the 2002 HBS.

[7] 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 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.

Figure 3: Total Fertility Rates in Azerbaijan, 1996-2001



Source: Unicef (2003) Transmonee Project, Social Monitor 2003, Table 2.9 page 62

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[8]. 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[9]. The final specification included only those variable that were significant at least at 95 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. Again a selection criteria of significance at 95 % was applied, along with a ceiling for the

[8] In few cases we select variable that were within two standard deviation from the mean value in the census.
[9] When we proceed for the imputation in the census we construct three variables with the value of 0.25.

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. These regression models and the relevant diagnostics for the urban and rural strata are summarized in Table 3 and 4 in the Appendix respectively. Examining those tables, we find the regression models quite successfully explain the variation in household expenditure. The R-Square ranges from 0.26 to 0.53 in urban areas to 0.23 to 0.39 in rural areas.

Using the parameters estimates derived in the first stage modelling, we then proceed with the census imputation, as describe in the methodology section above (see table 3 and 4 in the appendix for results of OLS regression for stage 1). Two relative poverty lines were used: 50 per cent of the median adult equivalent consumption and threshold for the 40 per cent lowest quintile. These were 190048.7 and 215235.2 Manat per month respectively.

3.2 Results

Table 3.5 below present results for average adult equivalent consumption and for the headcount index (FGT(0)) for the two relative poverty line from 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 for imputed adult equivalent consumption, but less well for headcount poverty.

Table: 3.5 Average adult equivalent, poverty and inequality in Azerbaijan, by regions (strata).

	Mean Adult equivalent monthly household consumption		Poverty line 50% of median *FGT(0) PL:190048.7*		Poverty line 40% lowest quintile *FGT(0) PL:215235.2*	
	Census	*HBS*	*Census*	HBS	*Census*	HBS
Rural						
Nakhchivan	224687.8	226592.3	0.185	0.29	0.407	0.47
	(3515.0)	(59998.2)	(0.034)	(0.027)	(0.029)	(0.029)
Absheron-Guba	236329.2	250548.6	0.281	0.22	0.090	0.34
	(3432.8)	(82690.5)	(0.042)	(0.024)	(0.029)	(0.028)
Mugan-Salyan	255468.8	244552.1	0.084	0.22	0.244	0.37
	(3643.4)	(71629.7)	(0.020)	(0.021)	(0.024)	(0.024)

Ganja-Gazakh	291181.8	282484.4	0.018	0.13	0.084	0.26
	(7009.6)	(103821.7)	(0.011)	(0.014)	(0.024)	(0.018)
Sheki	250245.5	257531.0	0.003	0.17	0.124	0.31
	(6581.0)	(75363)	(0.008)	(0.019)	(0.080)	(0.023)
Lanakaran	246568.1	2466842	0.009	0.20	0.238	0.34
	(2506.1)	(68430.0)	(0.010)	(0.018)	(0.038)	(0.021)
Shirvan	249376.2	259780.1	0.115	0.17	0.270	0.30
	(12241.9)	(78274.5)	(0.064)	(0.021)	(0.092)	(0.026)
Karabah	276815.5	261745	0.090	0.23	0.197	0.38
	(4013.9)	(97200.3)	(0.014)	(0.016)	(0.018)	(0.018)
Urban						
Nakhchivan	246290.4	248446.1	0.189	0.28	0.327	0.40
	5274.4	(90362.7)	(0.025)	(0.033)	(0.023)	(0.035)
Absheron-Guba	249316.0	261451.3	0.155	0.22	0.286	0.34
	3316.2	(96705.9)	(0.015)	(0.017)	(0.018)	(0.019)
Mugan-Salyan	254547.7	255074.0	0.033	0.18	0.191	0.32
	8055.9	(77081.3)	(0.022)	(0.022)	(0.037)	(0.027)
Ganja-Gazakh	201823.9	226445.3	0.345	0.33	0.694	0.51
	6930.1	(93368.6)	(0.092)	(0.021)	(0.095)	(0.022)
Sheki	225706.4	230459.3	0.150	0.29	0.376	0.51
	3624.1	(66090.1)	(0.035)	(0.032)	(0.041)	(0.035)
Lanakaran	240411.0	242724.3	0.204	0.25	0.345	0.38
	3932.8	(73515.7)	(0.020)	(0.031)	(0.023)	(0.035)
Shirvan	216249.7	223926	0.237	0.32	0.454	0.50
	3858.2	(66229.3)	(0.036)	(0.032)	(0.041)	(0.034)
Karabah	230604.8	237799.2	0.213	0.29	0.380	0.42
	5958.3	(80496.5)	(0.040)	(0.022)	(0.048)	(0.024)
Baku	264870.8	275879.1	0.120	0.21	0.217	0.34
	6283.2	123717.1	(0.014)	(0.008)	(0.025)	(0.010)

Note: Standard errors in parenthesis

Several other indicators of inequality and poverty at raion level are presented here in graphic form in a series of maps. These results are also available for both village level and administrative level, though at the time of writing, an up to date boundary village map for Azerbaijan does not exist and so the results could not be plotted at this level of disaggregation.

Results confirm previous finding from the recent Azerbaijan Poverty Assessment that the incidence of poverty among urban households is greater than that among rural households (Dowsett-Coirolo 2003). Furthermore, comparing the proportion of people below the poverty line of 50% median adult equivalent expenditure in urban and rural area, there is not only a higher incidence of poverty in urban areas as compared to rural areas, but urban areas also show a higher degree spatial variation in headcount poverty - with the more than half of urban population in Ganja-Gazakh region and Davachi and Shamakhy raion below the poverty line of 50 per cent of the median compared to less than ten per cent of household below the poverty line in Mugan region. Urban areas in the central part of Azerbaijan also show substantial variation, with headcount poverty ranging between 10 and 30 per cent. (Figures 4 and 5).

Figure 4: Headcount – FGT(0) Poverty line: 50% of the median (190048.7 Manat- rural area.

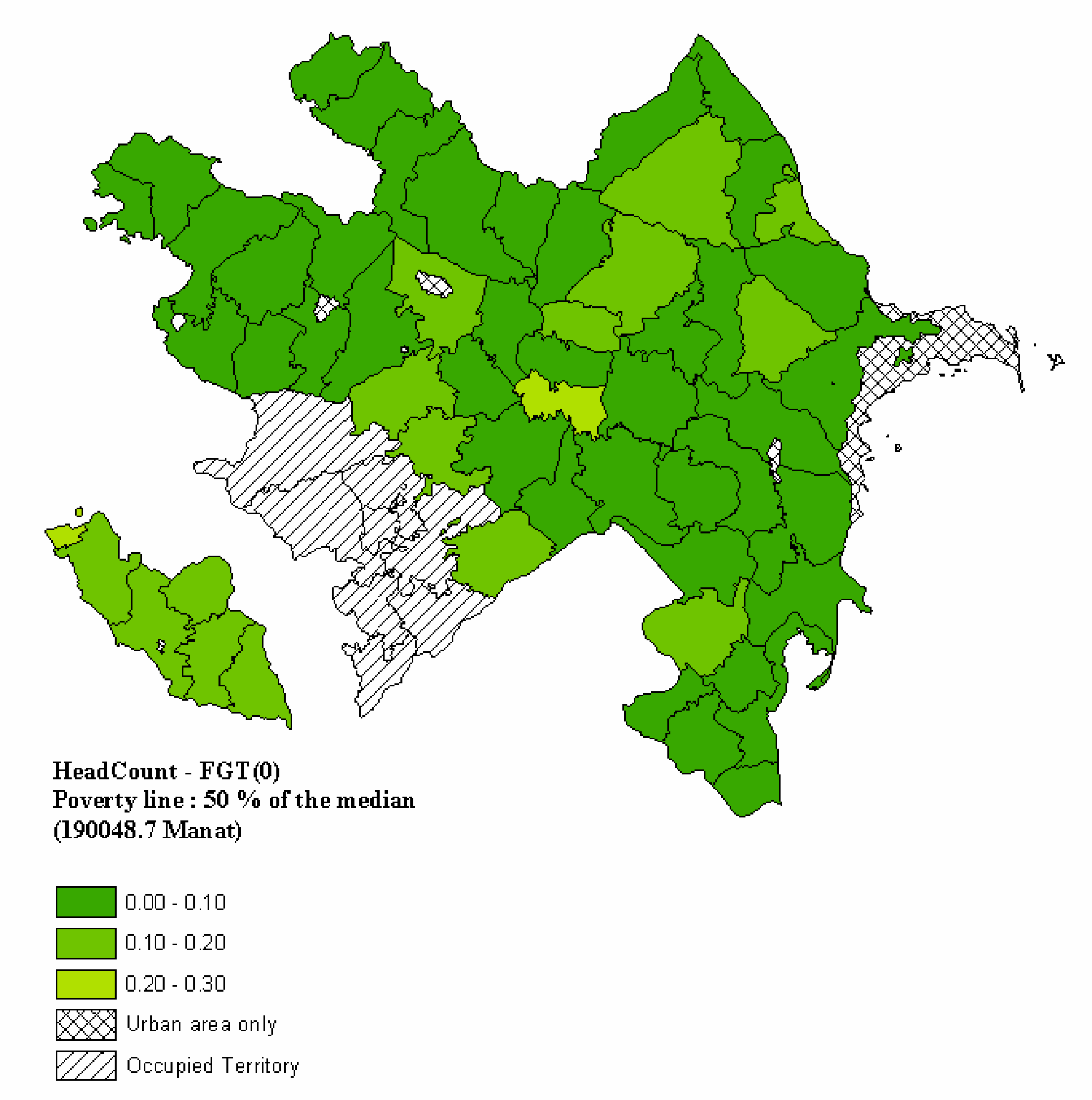
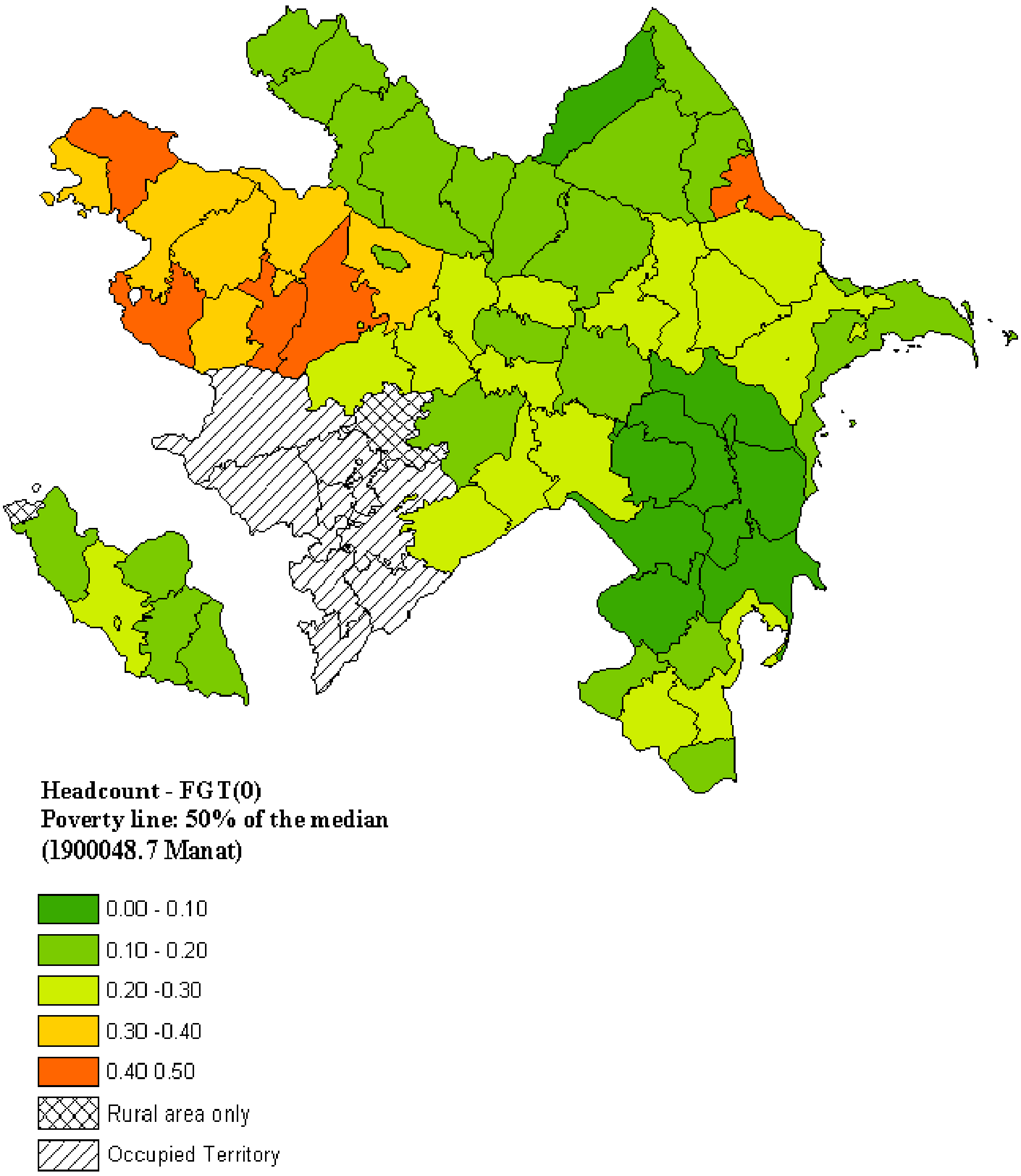
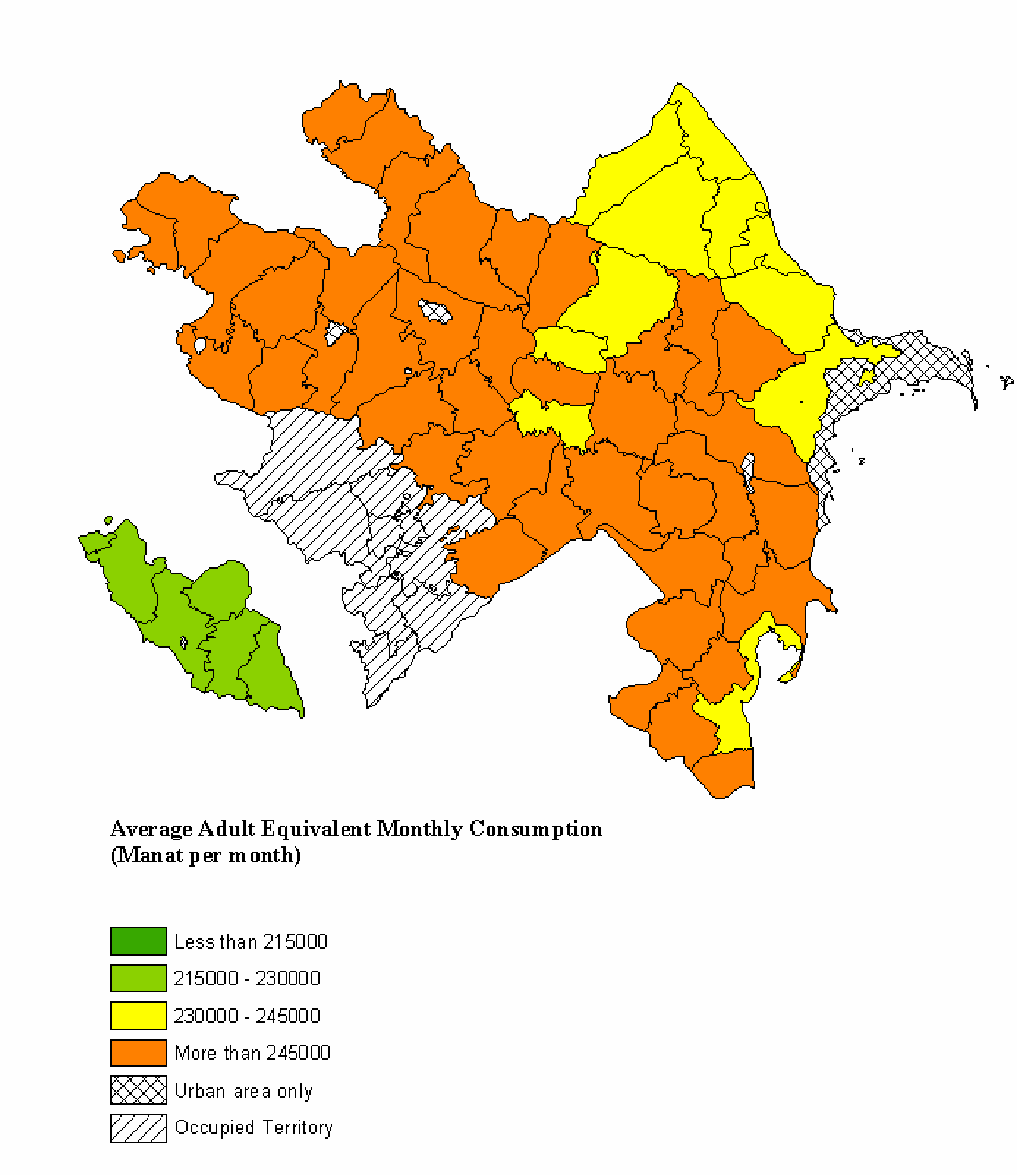


Figure 5: Headcount – FGT(0) Poverty line: 50% of the median (190048.7 Manat- urban area.



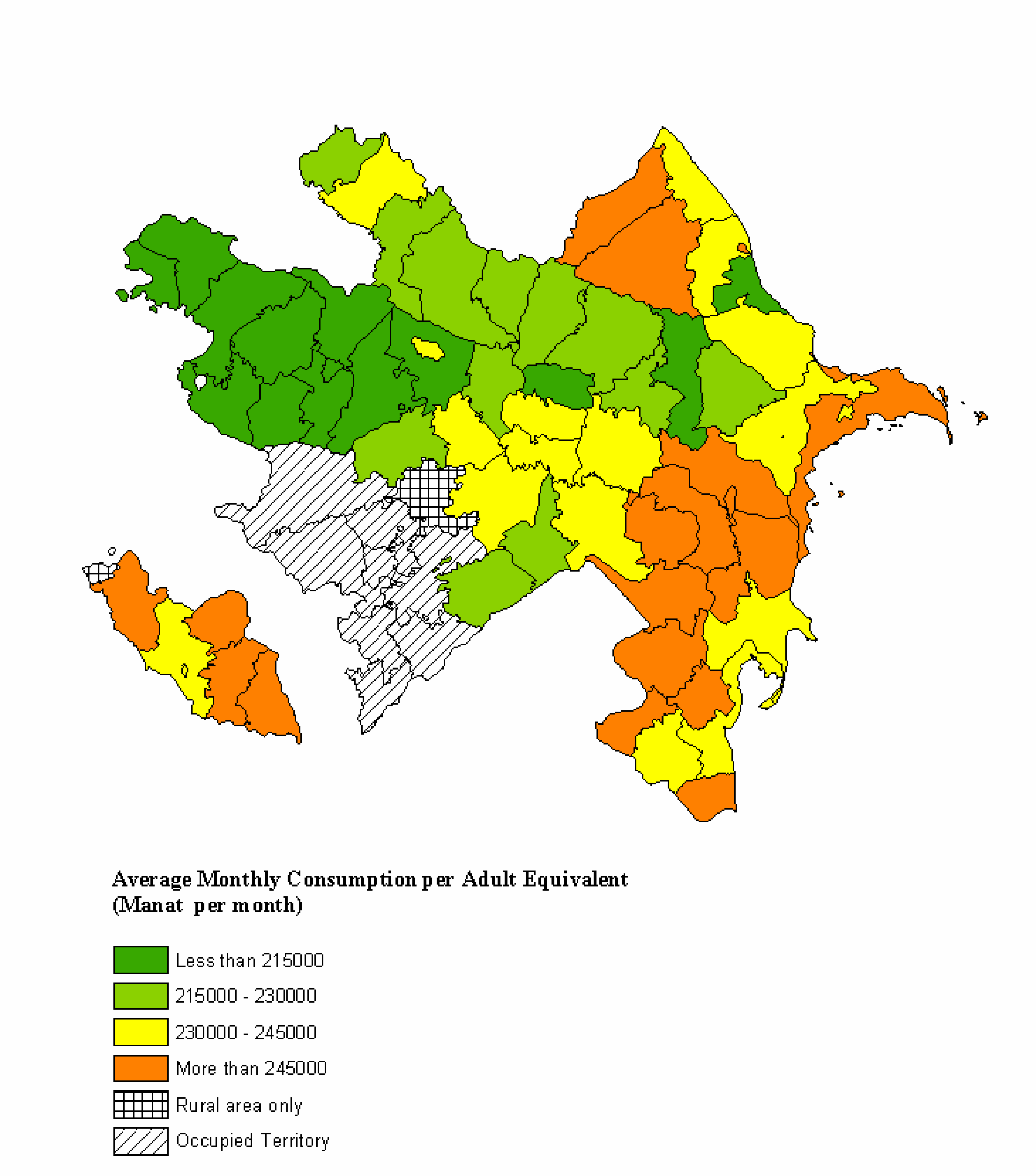
Similar findings emerge from the imputed average monthly consumption (see Figures 6 and 7). Interestingly, higher values of average adult equivalent consumption are recorded in rural areas than in urban areas. This is despite the fact that rural households are, on average, larger than urban ones. This may be explained in part by the equivalent scale used, which gives a lower weighting to children than adults, resulting in higher average equivalent consumption in households with many children than that given by a per capita measure. Alternatively, it may be that this is a function of the way in which the value of consumption of home production was imputed, in particular the prices used[10]. Thirdly, the difference may reflect real urban-rural differentials in welfare. Such urban-rural differences are worthy of further investigation

Figure 6: Average Monthly Consumption per Adult Equivalent in Manat, rural area.



[10] This study employed the derived total household consumption variable created by the Azerai State Statistical Committee and used in the recent World Bank Poverty Assessment Update.

Figure 7: Average Monthly Consumption per Adult Equivalent in Manat, urban area.



Once again, Figure 7 confirms substantial spatial variation in average levels of adult equivalent consumption across raions within urban areas.

Figures 8 and 9 show the spatial distribution of the Gini coefficient[11] in rural and urban areas respectively. The results indicate a surprisingly equal distribution of expenditure across

[11] The Gini coefficient is the area A between the 45-degree line and the Lorenz curve divided by 1/2, the total area under the 45-degree line. The Gini coefficient may be given as a proportion or percentage. From this it is clear that the Gini coefficient will be equal to 0 when the distribution is completely egalitarian. If the society's total expenditure accrues to only one person/household unit, leaving the rest with no income at all, then the Gini coefficient will be equal to 1.0.

households within raions in both urban and rural areas of Azerbaijan, with a Gini coefficient below 0.16. Not surprisingly, the highest levels of inequality are found in Baku and surrounding urban area and in the urban area of Nakhchyvan region , Saatly and Lankaran raion, whereas inequality is lowest in Ganja-Gazakh and Shaki-Zagatala raions. In rural area the highest level of inequalities is recorded in Garabagh-Mil-orta region.

Figure 8: Inequality in adult equivalent consumption (Gini coefficient) – urban areas

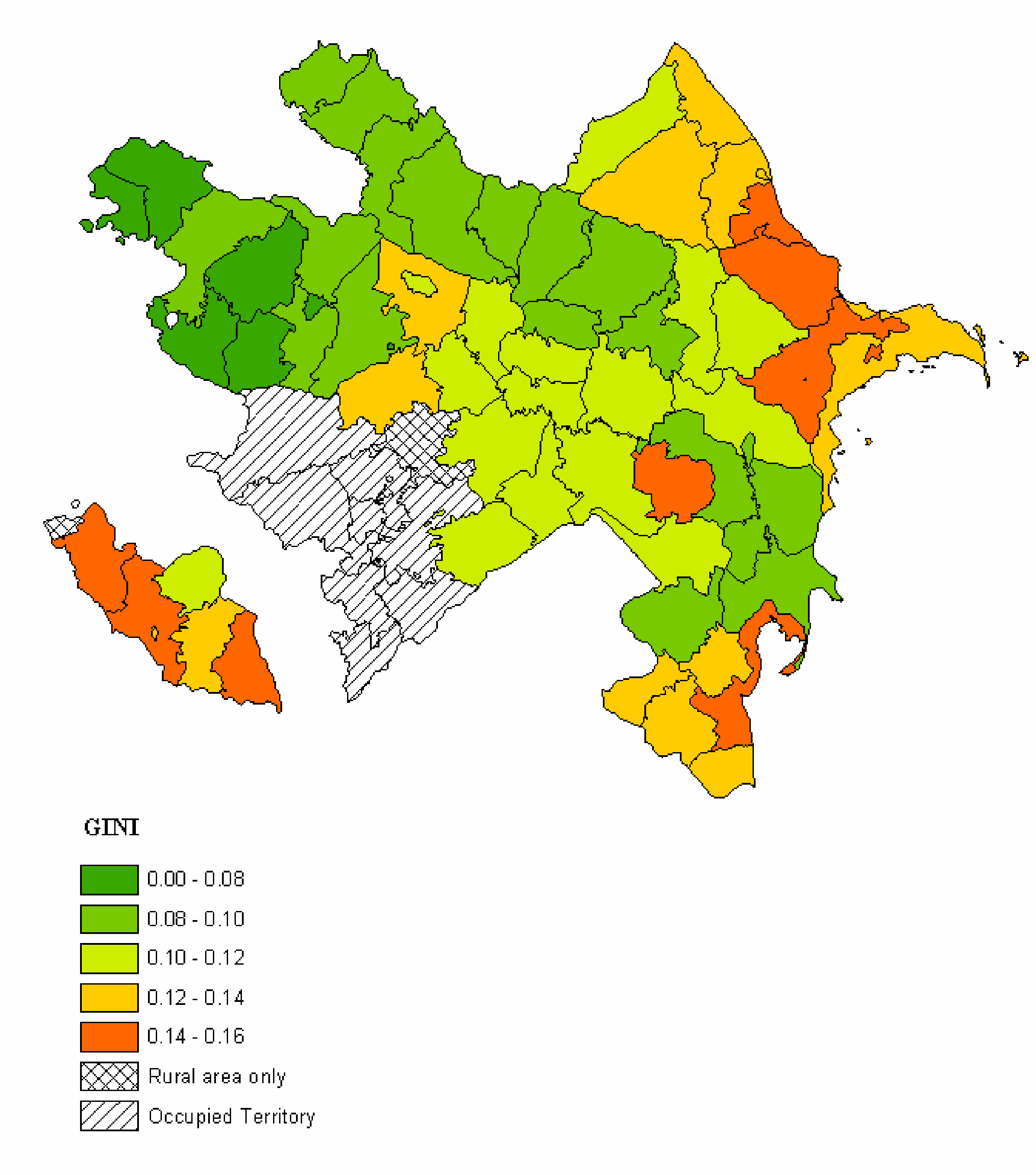
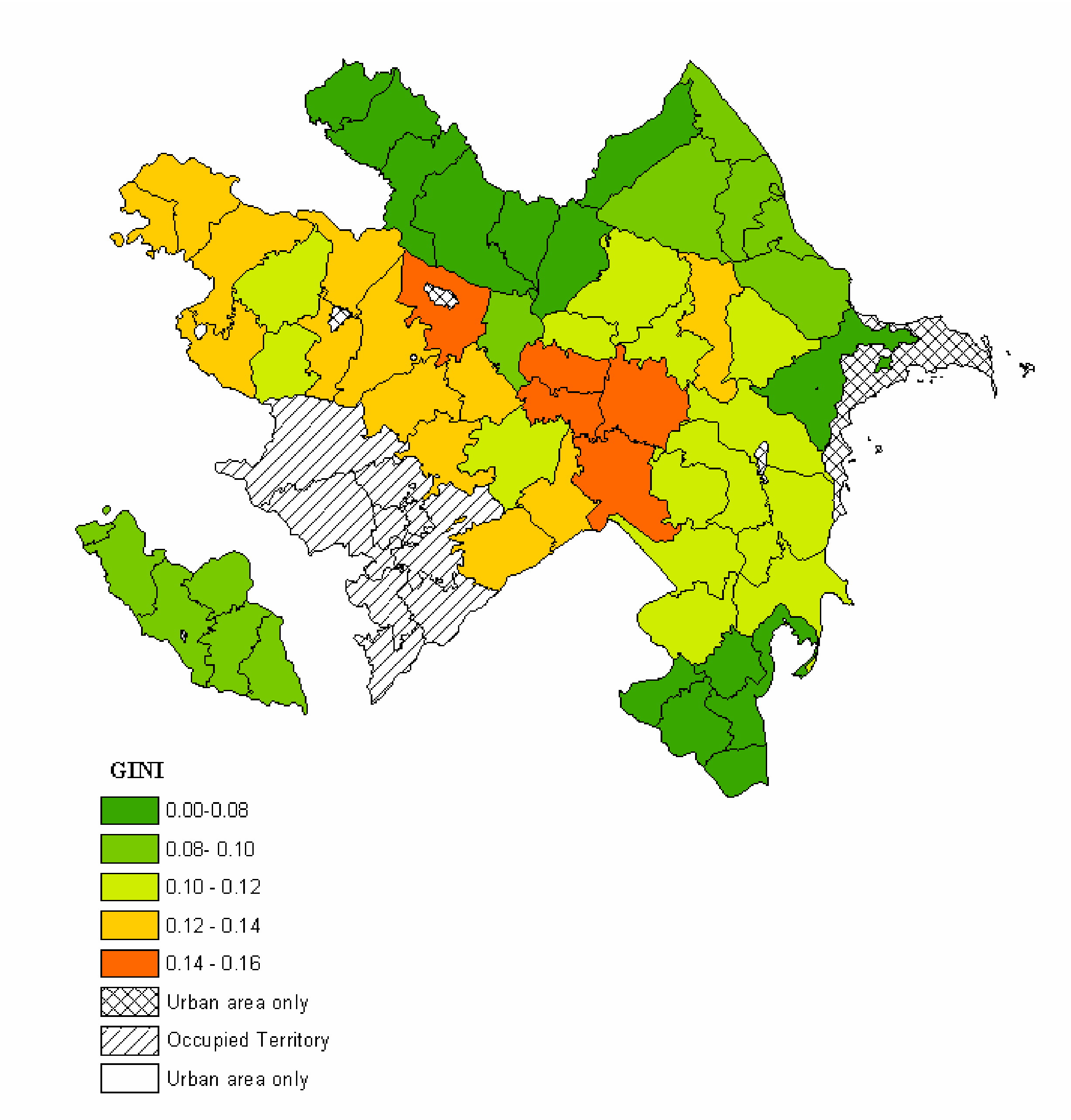


Figure 9: Inequality in adult equivalent consumption (Gini coefficient) – rural areas



4 Comparing alternative indicators of welfare at the spatial level

In recent years, growing attention has been given to derivation of alternative measures of household welfare. Expenditure and income data often suffer from a variety of measurement errors (Sahn and Stifel 2001), and are expensive to collect on regular basis. One practical alternative that has been growing in popularity is the use of data on the ownership of assets and dwelling characteristics to create an asset index.

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.

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 (2001) also found the correlation of their asset with household expenditure to be weak.

In contrast Filmer and Pritchett(2001), who validated their asset index using data from the Indonesian , Pakistani and Nepalese 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 better though of as acting as a proxy for long-run household wealth rather than current per capita consumption.

Bollen at al.(2001) examined the performance of several alternative proxies for economic status. 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.

This study has the unique opportunity to evaluate the ranking at a regional level using both an asset index derived using census data and imputed consumption. Using the urban and rural dummies used in the asset index, it is possible to construct separate maps for the proportion of household in the poorest 40 per cent quintile as ranked by the asset index (Figures 10 and 12). Those maps are directly comparable with the headcount FGT(0) using the Poverty line as the 40 per cent of the median (215235.2 Manat per months) (Figures 11 and 13). From a simple comparison of the maps it is clear that that the two approaches produce significantly different rankings at the raion level.

Figure 10: Raion map of the proportion of household in the poorest 40 percent quintile as ranked using an asset index, rural area, 1999 Azerbajian Census.

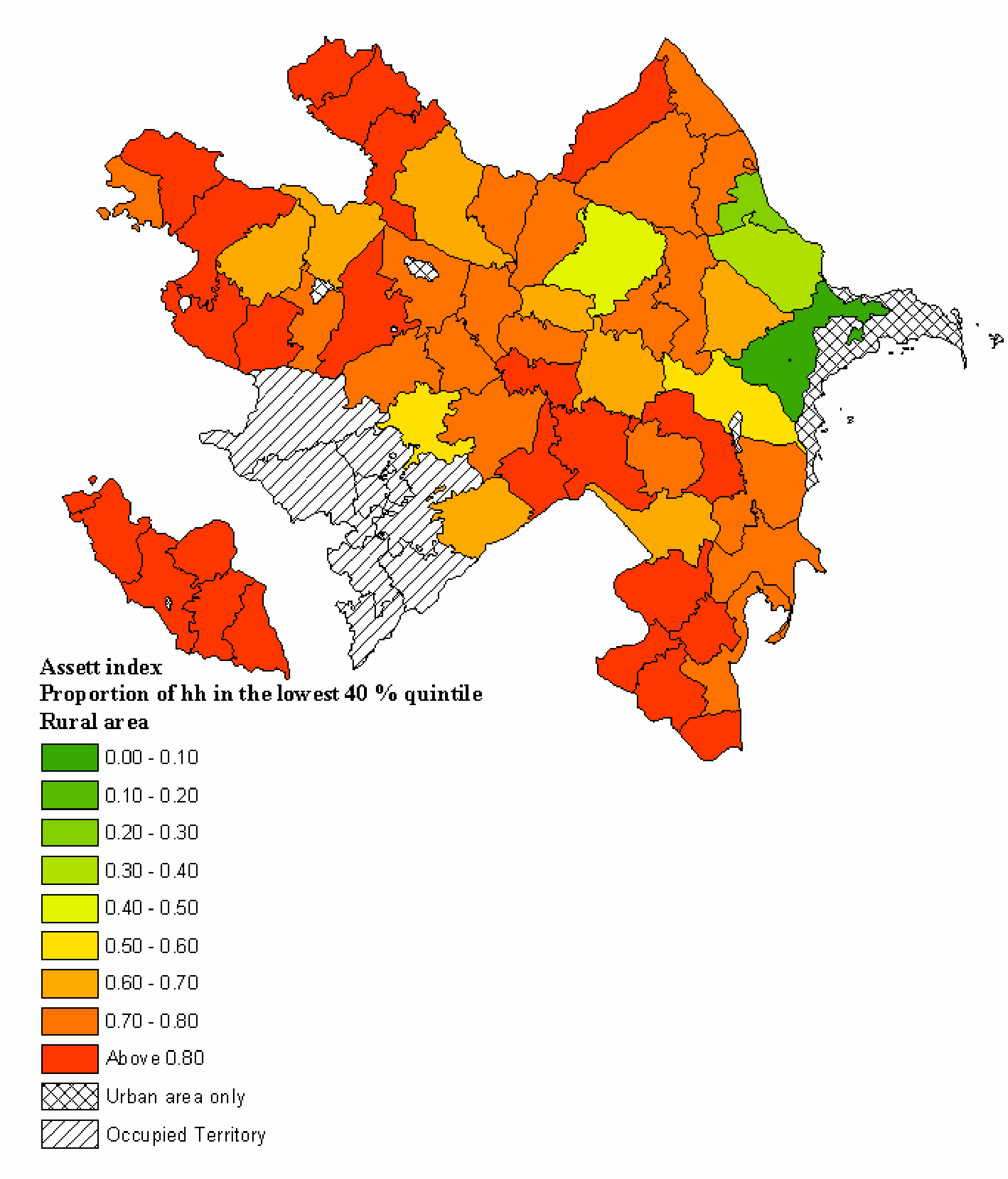


Figure 11: Headcount – FGT(0) Poverty line: 40 % lowest quintile (215235.2 Manat) - rural area.

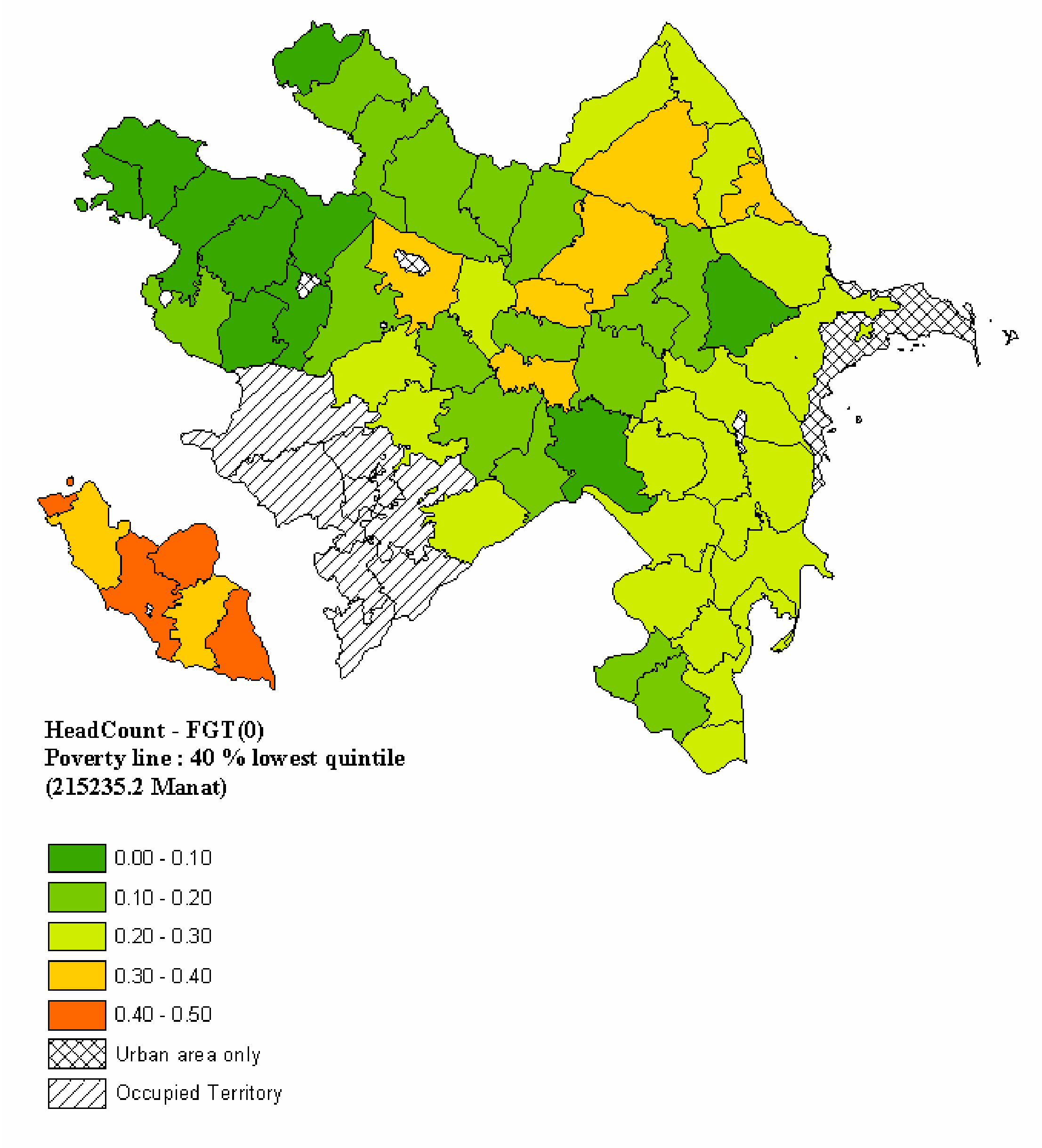


Figure 12: Raion map of the proportion of household in the poorest 40 percent quintile as ranked using an asset index, urban area, 1999 Azerbajian Census.

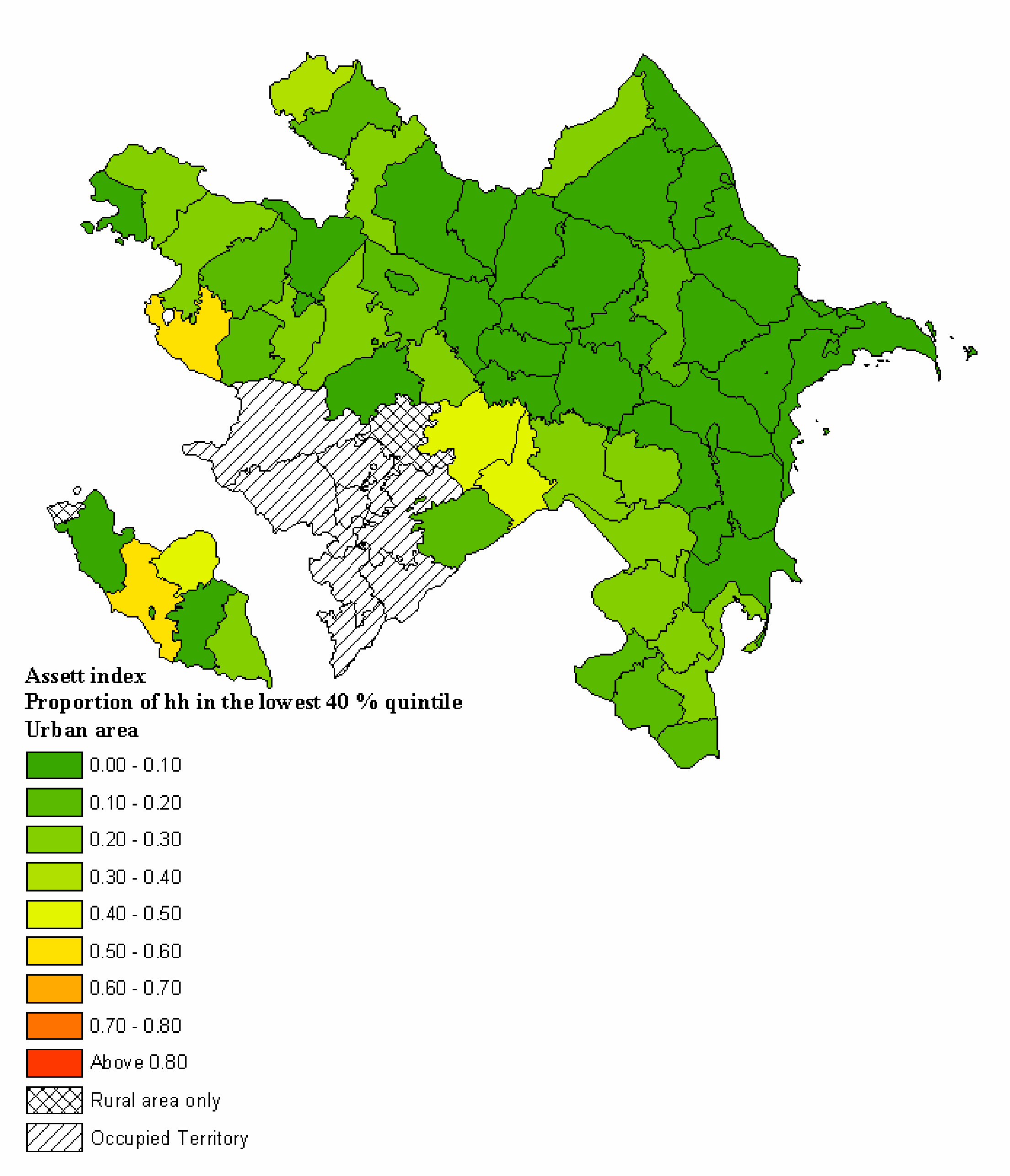
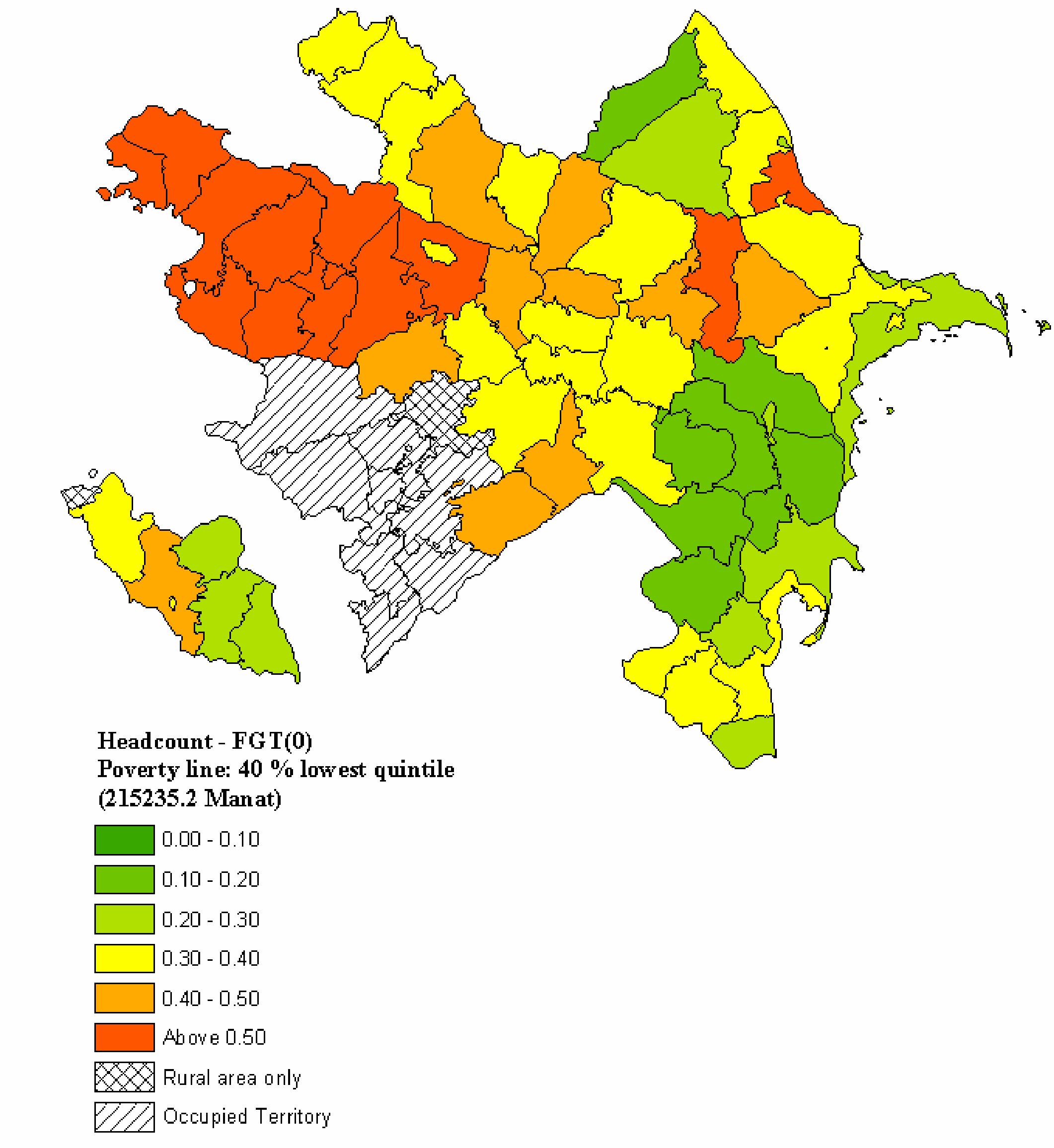
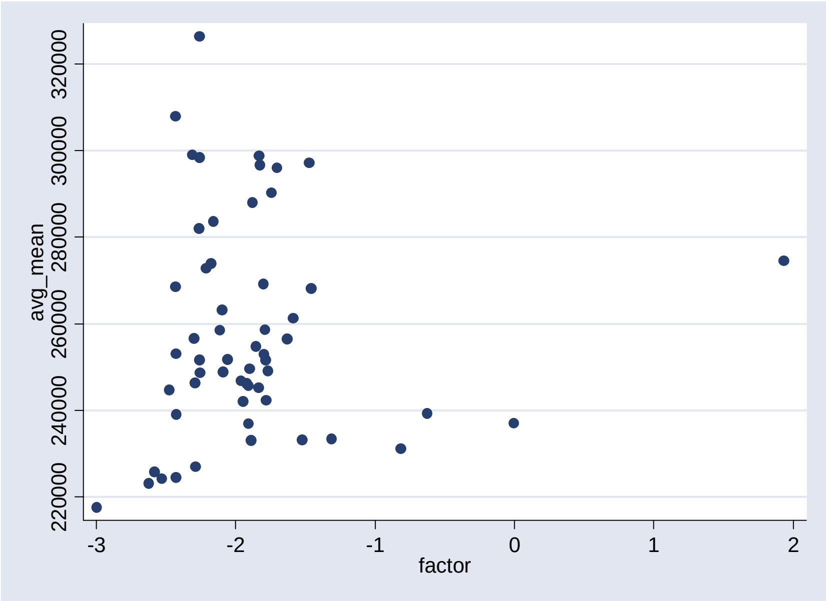


Figure 13: Headcount – FGT(0) Poverty line: 40 % lowest quintile (215235 Manat) - urban area.



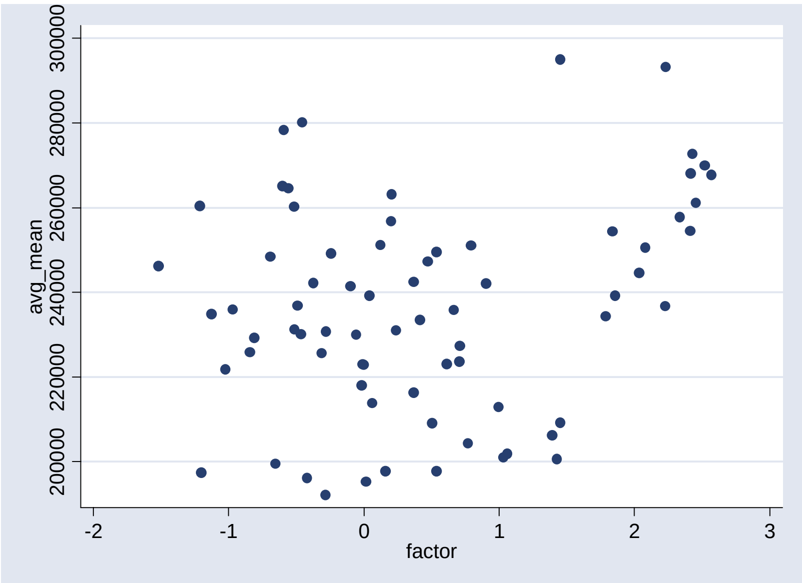
In order to investigate this further, Figures 14 and 15 present scatter diagram of the welfare indicators at the raion level by the two different methodologies, along with the spearman rank correlations. It is clear that there is no significant correlation between the welfare ranking by the two methods. 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.

Figure 14: Scatter plot between average adult equivalent consumption per month in Manat and factor score, rural area.



Note: Number of obs = 56, Spearman's rho = 0.1228, Test of Ho: avg_mean and factor are independent, Prob > t =0.3674

Figure 15: Scatter plot between average adult equivalent consumption per month in Manat and factor score, urban area.



Note: Number of obs = 72, Spearman's rho = 0.1928, Test of Ho: avg_mean and factor are independent, Prob > t = 0.1047

These results, though, do not rule out the possibility that an asset based index might be a good measure of welfare in different countries. Our finding suggest that in countries where there is a considerable difference in socio-economic organization within a country , the asset index tends to capture localities, and therefore is a less appropriate measure of welfare in spatial poverty analysis.

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Appendix

Table 1: Descriptive statistisc-urban strata

	Nakhchivan-AR					Absheron-Guba					Mugan-Salyan-Urban					Ganja-Gazakh-urban				
	Census	HBS	l95b	u95b		Census	HBS	l95b	u95b		Census	HBS	l95b	u95b		Census	HBS	l95b	u95b	
HH_size	4.59	4.20	3.96	4.44	0	4.72	4.00	3.59	4.13	0	5.13	4.09	3.90	4.27	0	4.94	4.12	3.96	4.28	0
Hh_female	0.28	0.21	0.15	0.27	1	0.24	0.27	0.24	0.31	1	0.23	0.23	0.18	0.28	0	0.29	0.32	0.28	0.36	1
num_rom	2.52	2.81	2.67	2.95	0	2.43	2.59	2.51	2.67	0	2.61	2.51	2.41	2.62	1	2.50	2.82	2.73	2.91	0
strdwe	0.58	0.57	0.53	0.67	1	0.32	0.41	0.37	0.45	0	0.66	0.44	0.38	0.50	0	0.58	0.77	0.74	0.81	0
owndwe	0.72	0.96	0.94	0.99	0	0.50	0.56	0.52	0.60	0	0.73	0.84	0.79	0.88	0	0.70	0.97	0.95	0.98	0
eleove	0.66	0.55	0.48	0.62	0	0.11	0.32	0.28	0.36	0	0.29	0.16	0.12	0.20	0	0.53	0.50	0.46	0.55	1
telep	0.42	0.70	0.63	0.76	0	0.30	0.58	0.54	0.62	0	0.27	0.47	0.41	0.52	0	0.34	0.71	0.67	0.75	0
gascyl	0.48	0.80	0.74	0.85	0	0.07	0.05	0.03	0.06	0	0.19	0.07	0.07	0.04	0	0.43	0.43	0.39	0.47	1
gasline	0.26	0.11	0.06	0.15	0	0.87	0.99	0.98	1.00	0	0.72	0.85	0.81	0.89	0	0.68	0.91	0.88	0.93	0
haeti	0.11	0.13	0.08	0.18	1	0.07	0.26	0.23	0.30	0	0.08	0.02	0.00	0.03	0	0.03	0.03	0.02	0.05	0
water	0.75	0.56	0.48	0.63	0	0.90	0.98	0.96	0.99	0	0.73	1.00	0.99	1.00	0	0.81	0.82	0.79	0.86	1
hotwa	0.04	0.20	0.14	0.26	0	0.07	0.65	0.61	0.69	0	0.02	0.31	0.26	0.37	0	0.03	0.67	0.62	0.71	0
sewa	0.63	0.61	0.54	0.68	1	0.73	0.29	0.25	0.33	0	0.36	0.41	0.35	0.46	1	0.61	0.66	0.62	0.70	0
bath	0.60	0.55	0.48	0.62	1	0.65	0.85	0.82	0.87	0	0.38	0.88	0.84	0.92	0	0.54	0.79	0.75	0.83	0
under15	0.28	0.23	0.20	0.27	0	0.28	0.24	0.22	0.26	1	0.31	0.26	0.24	0.29	0	0.29	0.24	0.22	0.26	0
b15to59	0.61	0.62	0.58	0.66	1	0.61	0.61	0.58	0.63	1	0.59	0.59	0.56	0.62	1	0.60	0.58	0.55	0.60	1
aboave60	0.10	0.15	0.11	0.19	1	0.11	0.15	0.13	0.18	0	0.11	0.15	0.12	0.18	0	0.12	0.19	0.16	0.22	0
prun15	0.14	0.13	0.10	0.15	1	0.15	0.13	0.12	0.14	0	0.16	0.14	0.12	0.16	0	0.15	0.12	0.11	0.14	0
pr15to59	0.31	0.28	0.25	0.31	0	0.29	0.27	0.25	0.29	1	0.28	0.26	0.24	0.28	1	0.28	0.26	0.24	0.28	0
pr60ab	0.04	0.06	0.04	0.09	1	0.05	0.06	0.05	0.07	1	0.04	0.05	0.04	0.07	1	0.04	0.07	0.05	0.08	0
practive	0.35	0.44	0.40	0.48	0	0.30	0.37	0.35	0.39	0	0.32	0.41	0.38	0.44	0	0.32	0.39	0.36	0.41	0
tot_area	60.40	78.69	74.42	82.96	0	59.00	61.18	59.3	63.11	0	70.76	65.92	62.95	68.88	0	69.46	80.79	78.5	83.0	0
thh6	0.51	0.30	0.21	0.39	0	0.47	0.26	0.22	0.31	0	0.60	0.42	0.33	0.50	0	0.55	0.25	0.20	0.31	0
thh7_12	0.65	0.58	0.46	0.71	1	0.66	0.51	0.45	0.58	0	0.75	0.53	0.44	0.62	0	0.70	0.50	0.43	0.56	0
thh13_17	0.39	0.34	0.25	0.44	1	0.41	0.39	0.33	0.44	1	0.45	0.34	0.27	0.42	0	0.43	0.48	0.42	0.54	1
thhabo60	2.91	2.96	2.77	3.14	1	3.04	2.81	2.71	2.92	0	3.17	2.78	2.63	2.93	0	3.13	2.87	2.76	2.99	0
ae	3.41	3.37	3.18	3.56	1	3.55	3.22	3.11	3.33	0	3.75	3.20	3.04	3.35	0	3.67	3.32	3.19	3.44	0
mar	0.74	0.73	0.67	0.80	1	0.78	0.70	0.67	0.74	0	0.78	0.74	0.69	0.79	1	0.73	0.71	0.66	0.75	1
hh_sec	0.91	0.80	0.74	0.85	0	0.86	0.82	0.79	0.85	0	0.85	0.89	0.86	0.93	1	0.89	0.83	0.80	0.86	0
hh_high	0.22	0.14	0.09	0.19	0	0.17	0.20	0.17	0.23	1	0.13	0.18	0.13	0.22	1	0.19	0.16	0.13	0.19	1
Number of hh	20661	187			14	113997	574			7	56407	287			8	104279	486			8

Table 1: Continued, urban strata.

	Sheki					*Lankaran*					*Shirvan*					*Karabah*				
	Census	HBS	l95b	u95b		Census	HBS	l95b	u95b		Census	HBS	l95b	u95b		Census	HBS	l95b	u95b	
HH_size	4.57	4.44	4.19	4.69	1	4.96	4.64	4.40	4.88	0	5.02	4.30	4.05	4.55	0	4.71	4.11	3.97	4.25	1
Hh_female	0.28	0.28	0.22	0.35	1	0.26	0.20	0.14	0.26	0	0.26	0.25	0.19	0.31	1	0.25	0.23	0.18	0.27	1
num_rom	2.44	3.32	3.18	3.46	0	2.57	2.65	2.54	2.78	1	2.49	2.95	2.77	3.13	0	2.08	2.85	2.75	2.96	0
strdwe	0.81	0.94	0.90	0.97	0	0.69	0.82	0.77	0.87	0	0.83	0.54	0.49	0.59	0	0.50	0.54	0.49	0.59	0
owndwe	0.87	0.10	0.95	1.00	0	0.79	0.93	0.89	0.96	0	0.87	0.72	0.67	0.76	0	0.59	0.72	0.67	0.76	0
eleove	0.25	0.93	0.90	0.97	0	0.28	0.93	0.89	0.96	0	0.10	0.41	0.36	0.46	0	0.35	0.41	0.36	0.46	0
telep	0.37	0.78	0.73	0.84	0	0.48	0.33	0.26	0.39	0	0.40	0.45	0.40	0.50	1	0.29	0.45	0.40	0.50	0
gascyl	0.43	0.16	0.11	0.21	0	0.50	0.33	0.26	0.39	0	0.05	0.45	0.40	0.50	0	0.25	0.45	0.40	0.50	0
gasline	0.55	0.87	0.82	0.92	0	0.38	0.55	0.48	0.62	0	0.89	0.87	0.84	0.90	1	0.44	0.87	0.84	0.90	0
haeti	0.11	0.01	0.00	0.02	0	0.05	0.48	0.41	0..552	0	0.05	0.19	0.15	0.23	0	0.07	0.19	0.15	0.23	0
water	0.75	0.80	0.74	0.86	1	0.46	0.15	0.14	0.16	0	0.71	0.77	0.73	0.81	0	0.62	0.77	0.73	0.81	0
hotwa	0.00	0.26	0.20	0.32	0	0.01	0.34	0.27	0.41	0	0.01	0.50	0.45	0.55	0	0.05	0.50	0.45	0.55	0
sewa	0.25	0.75	0.69	0.81	0	0.21	0.54	0.47	0.61	0	0.44	0.58	0.53	0.62	0	0.42	0.58	0.53	0.62	0
bath	0.31	0.58	0.51	0.65	0	0.26	0.70	0.63	0.76	0	0.40	0.61	0.56	0.66	0	0.37	0.61	0.56	0.66	0
under15	0.27	0.20	0.17	0.23	0	0.28	0.26	0.23	0.29	1	0.30	0.23	0.21	0.25	0	0.29	0.23	0.21	0.25	0
b15to59	0.59	0.64	0.60	0.68	0	0.62	0.61	0.57	0.65	1	0.58	0.65	0.63	0.68	1	0.59	0.65	0.63	0.68	0
aboave60	0.14	0.16	0.12	0.19	1	0.11	0.13	0.09	0.17	1	0.13	0.11	0.09	0.14	1	0.12	0.11	0.09	0.13	1
prun15	0.14	0.10	0.08	0.12	0	0.15	0.13	0.10	0.15	1	0.16	0.11	0.10	0.13	0	0.15	0.11	0.01	0.10	0
pr15to59	0.28	0.30	0.27	0.33	1	0.29	0.29	0.26	0.31	1	0.27	0.31	0.29	0.33	0	0.28	0.31	0.29	0.33	0
pr60ab	0.05	0.06	0.04	0.07	1	0.04	0.05	0.03	0.06	0	0.05	0.05	0.04	0.06	1	0.05	0.05	0.04	0.06	1
practive	0.34	0.48	0.44	0.52	1	0.33	0.40	0.37	0.43	0	0.31	0.38	0.36	0.41	0	0.29	0.38	0.36	0.41	0
tot_area	66.57	85.37	81.83	88.91	0	70.41	71.35	67.74	74.90	1	77.04	69.98	67.40	72.56	0	55.41	69.97	67.40	72.55	0
thh6	0.46	0.23	0.15	0.30	0	0.54	0.44	0.34	0.54	1	0.55	0.34	0.24	0.43	0	0.50	0.30	0.23	0.36	0
thh7_12	0.60	0.52	0.41	0.62	1	0.64	0.57	0.45	0.70	1	0.70	0.40	0.30	0.49	0	0.68	0.44	0.37	0.52	0
thh13_17	0.36	0.31	0.23	0.40	1	0.41	0.37	0.27	0.47	1	0.44	0.30	0.22	0.38	0	0.43	0.39	0.33	0.46	1
thhabo60	3.03	3.36	3.17	3.55	0	3.25	3.23	3.02	3.45	1	3.19	3.25	3.07	3.43	1	2.97	2.95	2.83	3.08	1
ae	3.49	3.72	3.52	3.92	0	3.76	3.68	3.47	3.90	1	3.74	3.59	3.40	3.78	1	3.49	3.35	3.23	3.47	0
mar	0.74	0.65	0.58	0.72	0	0.75	0.75	0.69	0.81	1	0.74	0.70	0.64	0.76	1	0.77	0.76	0.72	0.81	1
hh_sec	0.82	0.83	0.78	0.88	1	0.82	0.71	0.64	0.77	0	0.80	0.92	0.88	0.95	0	0.86	0.88	0.85	0.91	1
hh_high	0.14	0.10	0.05	0.14	1	0.14	0.08	0.04	0.12	0	0.13	0.18	0.13	0.24	1	0.13	0.19	0.15	0.22	0
Number of hh	28705	193			11	24069	195			13	26095	206			10	88702	344.00			8

Table 1: Continued, urban strata.

	Baku				
	Census	2002 HBS	l95b	u95b	
HH_size	4.14	3.64	3.57	3.71	0
Hh_female	0.32	0.27	0.25	0.29	0
num_rom	2.33	2.48	2.44	2.52	0
strdwe	0.33	0.28	0.27	0.30	0
owndwe	0.52	0.74	0.72	0.76	0
eleove	0.06	0.24	0.23	0.26	0
telep	0.50	0.74	0.72	0.75	0
gascyl	0.02	0.04	0.04	0.05	0
gasline	0.92	0.97	0.96	0.98	0
haeti	0.15	0.49	0.47	0.51	0
water	0.91	0.91	0.90	0.92	1
hotwa	0.10	0.71	0.69	0.73	0
sewa	0.86	0.17	0.15	0.19	0
bath	0.76	0.86	0.84	0.87	0
under15	0.23	0.19	0.18	0.20	0
b15to59	0.64	0.64	0.63	0.65	1
aboave60	0.13	0.16	0.15	0.17	0
prun15	0.13	0.10	0.09	0.11	0
pr15to59	0.31	0.30	0.29	0.31	1
pr60ab	0.04	0.06	0.05	0.07	0
practive	0.33	0.41	0.40	0.43	0
tot_area	51.47	54.65	53.81	55.49	0
thh6	0.36	0.23	0.21	0.25	0
thh7_12	0.53	0.37	0.34	0.40	0
thh13_17	0.33	0.30	0.28	0.33	1
thhabo60	2.81	2.72	2.67	2.78	0
ae	3.21	3.03	2.98	3.09	0
mar	0.72	0.68	0.66	0.70	0
hh_sec	0.91	0.92	0.91	0.93	1
hh_high	0.29	0.31	0.29	0.33	1

Number of hh	2192	6

Table 2: Descriptive statistics, rural strata.

rural	Nakhchivan-					Absheron					Mugan-					Ganja-				
	Census	HBS	l95b	u95b		Census	HBS	l95b	u95b		Census	HBS	l95b	u95b		Census	HBS	l95b	u95b	
HH_size	4.59	4.03	3.84	4.23	0	5.05	4.33	4.11	4.55	0	5.42	4.89	4.72	5.06	0	4.88	4.08	3.94	4.23	0
Hh_female	0.28	0.20	0.16	0.25	1	0.22	0.22	0.17	0.27	1	0.19	0.17	0.14	0.21	1	0.25	0.22	0.18	0.25	1
num_rom	2.52	2.49	2.39	2.60	1	2.75	2.99	2.86	3.12	0	2.57	3.09	2.97	3.20	0	2.17	2.58	2.49	2.67	0
strdwe	0.58	0.96	0.94	0.98	1	0.93	0.95	0.93	0.98	1	0.86	0.68	0.63	0.72	0	0.95	0.97	0.95	0.98	1
owndwe	0.72	0.96	0.94	0.98	1	0.94	0.94	0.91	0.97	1	0.92	0.65	0.60	0.70	0	0.95	0.97	0.95	0.98	1
eleove	0.64	0.87	0.83	0.91	0	0.09	0.64	0.58	0.70	0	0.50	0.72	0.67	0.76	0	0.41	0.95	0.93	0.96	0
telep	0.07	0.19	0.14	0.23	0	0.06	0.15	0.11	0.19	0	0.05	0.07	0.05	0.10	0	0.08	0.10	0.08	0.13	1
gascyl	0.59	0.71	0.66	0.76	0	0.14	0.13	0.10	0.17	1	0.28	0.25	0.21	0.30	1	0.38	0.74	0.71	0.78	0
gasline	0.09	0.00	0.00	0.00	0	0.44	0.34	0.28	0.39	0	0.28	0.01	0.00	0.01	0	0.39	0.01	0.00	0.01	0
haeti	0.09	0.00	0.00	0.00	0	0.05	0.00	0.00	0.00	0	0.04	0.00	0.00	0.00	0	0.06	0.01	0.01	0.01	0
water	0.19	0.26	0.21	0.31	0	0.36	0.38	0.33	0.44	1	0.28	0.44	0.39	0.49	0	0.24	0.23	0.19	0.26	1
hotwa	0.01	0.00	0.00	0.10	0	0.01	0.29	0.24	0.34	0	0.00	0.01	0.00	0.02	0	0.00	0.05	0.03	0.07	0
sewa	0.07	0.73	0.68	0.79	0	0.05	0.69	0.64	0.75	0	0.03	0.59	0.54	0.64	0	0.05	0.70	0.66	0.74	0
bath	0.10	0.01	0.00	0.02	0	0.08	0.31	0.25	0.36	0	0.07	0.27	0.23	0.32	0	0.09	0.21	0.18	0.24	0
under15	0.31	0.23	0.21	0.26	0	0.31	0.23	0.20	0.25	0	0.33	0.28	0.25	0.30	0	0.29	0.24	0.22	0.25	0
b15to59	0.56	0.53	0.49	0.56	1	0.54	0.54	0.51	0.58	1	0.55	0.56	0.53	0.58	1	0.55	0.55	0.53	0.58	1
aboave60	0.12	0.23	0.10	0.13	1	0.14	0.54	0.51	0.58	0	0.10	0.15	0.13	0.18	0	0.15	0.20	0.17	0.22	0
prun15	0.16	0.12	0.10	0.13	0	0.16	0.21	0.18	0.25	0	0.17	0.13	0.12	0.15	0	0.15	0.11	0.10	0.13	0
pr15to59	0.28	0.24	0.22	0.26	0	0.26	0.27	0.25	0.30	1	0.26	0.27	0.25	0.29	1	0.27	0.28	0.26	0.29	1
pr60ab	0.04	0.09	0.07	0.12	0	0.05	0.08	0.06	0.10	0	0.04	0.06	0.05	0.07	0	0.06	0.07	0.06	0.09	0
practive	0.41	0.40	0.37	0.43	1	0.39	0.40	0.37	0.43	1	0.38	0.43	0.41	0.46	0	0.46	0.49	0.47	0.52	0
tot_area	79.62	83.44	80.41	86.48	0	78.12	94.00	0.90	0.97	0	81.33	94.00	90.91	97.27	0	74.70	74.40	72.69	76.12	1
thh6	0.69	0.33	0.25	0.41	0	0.65	0.34	0.26	0.42	0	0.61	0.41	0.34	0.49	0	0.61	0.32	0.26	0.37	0
thh7_12	0.74	0.55	0.45	0.65	0	0.75	0.54	0.45	0.64	0	0.67	0.67	0.58	0.76	1	0.67	0.53	0.47	0.59	0
thh13_17	0.42	0.41	0.33	0.50	1	0.41	0.43	0.34	0.51	1	0.38	0.51	0.43	0.58	0	0.38	0.43	0.37	0.49	1
thhabo60	3.13	2.72	2.59	2.86	0	3.10	3.00	2.85	3.15	1	3.09	3.29	3.14	3.43	0	3.09	2.79	2.69	2.89	0
ae	3.71	3.17	3.03	3.30	0	3.67	3.45	3.29	3.61	0	3.62	3.83	3.68	3.97	0	3.62	3.23	3.13	3.34	0
mar	0.77	0.77	0.72	0.82	1	0.76	0.73	0.68	0.78	1	0.74	0.80	0.77	0.84	0	0.74	0.71	0.68	0.75	1
hh_sec	0.87	0.78	0.73	0.83	0	0.78	0.74	0.69	0.79	1	0.83	0.71	0.67	0.76	0	0.83	0.75	0.71	0.78	0

hh_high	0.09	0.07	0.04	0.10	1	0.07	0.08	0.05	0.11	1	0.10	0.06	0.03	0.08	0	0.09	0.07	0.05	0.09	1
	50327	284			10	66346	287			13	100264	389			5	121691	591			11

Table 2: Continued, rural strata.

rural	**Sheki**					**Lankaran**					**Shirvan**					**Karabah**				
	Census	HBS	l95b	u95b		Census	HBS	l95b	u95b		Census	HBS	l95b	u95b		Census	HBS	l95b	u95b	
HH_size	4.98	4.25	4.08	4.43	0	5.66	4.74	4.57	4.91	0	5.16	4.68	4.46	4.90	0	4.93	4.28	4.15	4.40	0
Hh_female	0.20	0.21	0.17	0.25	1	0.20	0.23	0.19	0.27	1	0.23	0.20	0.15	0.24	1	0.19	0.21	0.18	0.24	1
num_rom	2.37	2.66	2.56	2.76	0	2.58	2.93	2.84	3.02	0	2.34	2.49	2.39	2.59	0	2.04	2.58	2.50	2.66	0
strdwe	0.95	0.91	0.89	0.94	0	0.94	0.97	0.96	0.98	0	0.93	0.93	0.90	0.96	1	0.77	0.73	0.70	0.77	1
owndwe	0.97	0.97	0.96	0.99	1	0.98	0.97	0.96	0.99	1	0.95	0.97	0.95	0.99	1	0.83	0.72	0.69	0.75	0
eleove	0.10	0.98	0.97	0.99	0	0.16	0.99	0.99	1.00	0	0.11	0.98	0.96	0.99	0	0.39	0.68	0.64	0.71	0
telep	0.07	0.15	0.11	0.18	0	0.17	0.41	0.37	0.46	0	0.11	0.25	0.20	0.30	0	0.04	0.12	0.10	0.15	0
gascyl	0.23	0.30	0.25	0.34	0	0.36	0.61	0.57	0.65	0	0.13	0.51	0.45	0.56	0	0.29	0.58	0.54	0.62	0
gasline	0.21	0.01	0.00	0.01	0	0.34	0.00	0.00	0.01	0	0.60	0.06	0.03	0.09	0	0.17	0.18	0.15	0.21	1
haeti	0.17	0.00	0.00	0.00	0	0.03	0.00	0.00	0.01	0	0.05	0.00	0.00	0.01	0	0.04	0.03	0.02	0.05	1
water	0.37	0.52	0.47	0.57	0	0.24	0.01	0.00	0.02	0	0.27	0.24	0.19	0.29	1	0.17	0.30	0.27	0.34	0
hotwa	0.00	0.02	0.01	0.03	0	0.00	0.09	0.06	0.11	0	0.00	0.08	0.05	0.11	0	0.00	0.20	0.17	0.23	0
sewa	0.02	0.70	0.66	0.75	0	0.04	0.64	0.60	0.68	0	0.04	0.85	0.81	0.89	0	0.02	0.67	0.64	0.71	0
bath	0.06	0.22	0.18	0.27	0	0.06	0.36	0.31	0.40	0	0.07	0.33	0.28	0.39	0	0.04	0.37	0.33	0.41	0
under15	0.30	0.25	0.23	0.28	0	0.32	0.26	0.24	0.29	0	0.30	0.27	0.24	0.30	1	0.30	0.24	0.22	0.26	0
b15to59	0.56	0.56	0.53	0.59	1	0.56	0.57	0.55	0.60	1	0.54	0.53	0.50	0.56	1	0.56	0.56	0.54	0.58	1
aboave60	0.13	0.17	0.14	0.20	0	0.11	0.15	0.13	0.18	0	0.15	0.18	0.15	0.21	1	0.13	0.18	0.16	0.21	0
prun15	0.15	0.12	0.10	0.13	0	0.17	0.13	0.12	0.15	0	0.16	0.16	0.14	0.18	1	0.16	0.12	0.11	0.13	0
pr15to59	0.27	0.27	0.25	0.29	1	0.27	0.26	0.25	0.28	1	0.26	0.24	0.22	0.27	1	0.27	0.26	0.24	0.27	1
pr60ab	0.05	0.07	0.05	0.08	1	0.04	0.06	0.04	0.07	0	0.06	0.07	0.05	0.08	1	0.05	0.07	0.05	0.08	1
practive	0.44	0.51	0.48	0.53	0	0.43	0.47	0.44	0.49	0	0.41	0.43	0.40	0.46	1	0.41	0.42	0.40	0.44	1
tot_area	73.89	79.82	77.31	82.33	0	83.27	89.78	87.55	92.01	0	75.55	88.55	85.39	91.70	0	64.51	80.36	78.18	82.53	0
thh6	0.64	0.40	0.33	0.47	0	0.73	0.40	0.34	0.46	0	0.66	0.47	0.38	0.56	0	0.62	0.37	0.31	0.42	0
thh7_12	0.71	0.53	0.46	0.61	0	0.84	0.67	0.59	0.75	0	0.73	0.73	0.63	0.84	1	0.71	0.54	0.48	0.61	0
thh13_17	0.39	0.45	0.37	0.52	1	0.50	0.47	0.40	0.54	1	0.41	0.39	0.31	0.46	1	0.41	0.42	0.36	0.47	1
thhabo60	3.12	2.86	2.73	2.90	0	3.43	3.18	3.05	3.31	0	3.22	3.08	2.92	3.23	1	3.06	2.93	2.83	3.03	0
ae	3.66	3.33	3.19	3.46	0	4.09	3.70	3.57	3.83	0	3.78	3.59	3.43	3.75	0	3.61	3.38	3.28	3.49	0
mar	0.78	0.72	0.68	0.76	0	0.80	0.75	0.72	0.79	0	0.76	0.75	0.70	0.80	1	0.79	0.77	0.74	0.80	1

hh_sec	0.76	0.72	0.68	0.77	1	0.79	0.78	0.75	0.82	1	0.76	0.77	0.72	0.82	1	0.79	0.80	0.77	0.83	1
hh_high	0.07	0.07	0.04	0.09	1	0.10	0.17	0.14	0.21	0	0.06	0.07	0.04	0.11	1	0.08	0.11	0.09	0.14	0
Number of hh	78286	393			8	6103	497			6	61034	294			17	149777	672			11

Table 3: Urban Strata

	Nakhchi rvan AR	*Absheron-Guba*	*Mugan - Salyan*	*Ganja-Gazakh*	*Sheki*	*Lankaran*	*Shirvan*	*Karabah*	*Baku*
Period 2	-0.016	0.112	0.076	0.019	-0.078	0.003	-0.082	0.026	0.018
	(0.29)	(3.43)***	(1.74)*	(0.58)	(1.62)	(0.08)	(1.72)*	(0.65)	(0.91)
Period 3	0.127	0.175	0.207	0.117	0.065	0.088	-0.003	0.099	0.045
	(2.29)**	(5.41)***	(4.69)***	(3.56)***	(1.35)	(2.06)**	(0.06)	(2.46)**	(2.28)**
Period 4	0.086	0.200	0.242	0.070	0.040	0.070	0.056	0.061	0.111
	(1.65)	(6.16)***	(5.57)***	(2.11)**	(0.84)	(1.62)	(1.20)	(1.51)	(5.69)***
Demographic									
Proportion of hh member b/w 15 to 59	-0.474	0.234	-0.539						0.104
	(5.29)***	(5.15)***	(7.25)***						(3.23)***
Proportion of hh member above 60 years old	-0.606		-0.514				-0.157		
	(6.48)***		(6.68)***				(2.18)**		
Household Adult Equivalent	-0.125			-0.070		-0.122	-0.103		-0.125
	(8.03)***			(7.71)***		(10.47)***	(8.22)***		(22.87)***
Household head married	-0.084							-0.115	
	(1.86)*							(2.00)**	
Total living area (meter square)		0.001	0.002			0.002			
		(1.37)	(2.36)**			(2.90)***			
Number of hh member b/w 13 to 17		-0.059		0.059	0.053				-0.049
		(3.26)***		(3.52)***	(1.83)*				(3.83)***
Female household head			0.127	0.058				-0.155	
			(3.28)***	(2.12)**				(2.67)***	
Total household member above 17 years old		-0.122						-0.080	
		(12.85)***						(6.31)***	
Proportion of hh member under 15		0.367				0.480		0.419	0.449
		(6.13)***				(6.74)***		(6.00)***	(11.89)***
Household head with higher education		0.093	0.115	0.060					0.102

		(3.27)***	(2.85)***	(1.92)*					(6.67)***
Proportion of hh member economically active						0.281			0.227
						(3.18)***			(6.10)***
Household size					-0.081				
					(7.43)***				
Total number of hh member b/w 7 and 12					0.137				
					(5.63)***				
Household head with secondary education				0.159	-0.078				
				(4.91)***	(1.72)*				
Household characteristics and appliances									
Bath	-0.092								
	(2.34)**								
Electrict oven								0.112	
								(3.86)***	
Number of room			-0.085						
			(3.10)***						
Water				0.096					
				(2.94)***					
Gas cylinder		0.147		0.083					
		(2.57)**		(3.44)***					
Village mean									
Proportion of hh with heating system in village									2.342
									(6.26)***
Mean number of room per hh per village									-0.190
									(4.04)***
Total number of household per village									-0.000
									(4.08)***
Mean household size per village		-0.122							
		(4.92)***							
Constant	13.231	12.933	12.676	12.156	12.638	12.429	12.680	12.495	12.954
	(140.27)***	(106.29)***	(169.47)***	(200.70)***	(183.52)***	(195.01)***	(225.59)***	(159.01)***	(115.00)***
Observations	187	601	287	490	194	195	206	398	2192
Number of cluster in HBS	2	6	3	5	2	3	2	5	19
Location Effect modelled	NO	NO	NO	YES	NO	NO	NO	YES	YES
R-squared	0.43	0.38	0.30	0.26	0.29	0.53	0.29	0.30	0.29

Absolute value of t statistics in parentheses
significant at 10%; ** significant at 5%; *** significant at 1%

Table 4: Rural Strata

	Nakhchirvan AR	*Absheron-Guba*	*Mugan - Salyan*	*Ganja-Gazakh*	*Sheki*	*Lankaran*	*Shirvan*	*Karabah*
Period 2	-0.066	-0.023	0.051	-0.037	0.094	-0.006	0.041	-0.019
	(1.77)*	(0.54)	(1.52)	(1.05)	(2.68)***	(0.21)	(1.00)	(0.56)
Period 3	0.100	0.272	0.134	0.138	0.257	0.166	0.219	0.103
	(2.63)***	(6.25)***	(3.95)***	(3.91)***	(7.40)***	(5.54)***	(5.31)***	(3.00)***
Period 4	0.116	0.292	0.063	0.164	0.272	0.118	0.202	0.114
	(3.06)***	(6.87)***	(1.89)*	(4.72)***	(7.93)***	(3.93)***	(4.92)***	(3.31)***
Demographic								
Proportion of hh member b/w 15 to 59	-0.681	-0.289				-0.115		
	(8.82)***	(4.78)***				(2.36)**		
Proportion of hh member above 60 years old	-0.333							
	(5.34)***							
Proportion of hh member economically active	0.129		0.183					0.124
	(1.85)*		(3.46)***					(2.64)***
Number of hh member b/w 13 to 17	-0.049			-0.071	-0.039	-0.030	-0.063	
	(2.43)**			(3.68)***	(2.18)**	(1.90)*	(2.80)***	
Household head with higher education	0.146		0.106	0.118				
	(2.95)***		(2.04)**	(2.39)**				
Household Adult Equivalent		-0.056	-0.052					-0.066
		(4.50)***	(6.19)***					(7.10)***
Household head with secondary education		0.149				0.092	0.158	
		(4.05)***				(2.87)***	(3.89)***	
Mean number of room per hh per village		0.098			0.146			-0.104
		(1.97)**			(3.81)***			(3.55)***
Female household head			-0.085	-0.160				
			(2.72)***	(3.26)***				
Proportion of hh member under 15			0.634	0.425	0.462	0.436	0.477	0.496
			(11.51)***	(7.31)***	(8.00)***	(7.63)***	(7.18)***	(9.37)***
Proportion of population b/w 15 to 59 per village				1.414				-1.441
				(1.92)*				(2.37)**
Proportion of population b/w 15 to 59 per village								-6.650
								(5.63)***
Household head married				-0.266		-0.084	-0.118	

				(5.74)***		(2.89)***	(3.06)***	
Household characteristics and appliances								
Gasline								0.071
								(1.99)**
Telephone			0.095					
			(2.08)**					
Gas cylinder					0.067			
					(2.27)**			
Village mean								
Proportion of gas cylinder per village			-0.521				0.941	
			(3.21)***				(4.21)***	
Proportion of telephone per village						-0.461		
						(1.91)*		
Average hh sixe per village							0.231	0.187
							(5.91)***	(6.02)***
Total number of household per village				0.000				
				(3.26)***				
Average proportion of hh member economically active per village				-0.562				
				(3.52)***				
Proportion of electric oven per village				-0.426				
				(2.04)**				
Constant	12.656	12.202	12.291	12.023	11.789	12.283	10.912	13.216
	(210.87)***	(82.56)***	(231.83)***	(29.90)***	(125.30)***	(287.15)***	(51.73)***	(27.91)***
Observations	284	287	389	591	393	497	294	672
Number of cluster in HBS	9	3	9	15	6	10	5	16
Location effect modelled	YES	NO	NO	NO	YES	NO	YES	NO
R-squared	0.32	0.38	0.39	0.23	0.31	0.27	0.36	0.28

Absolute value of t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%