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Interrelation between livelihood assets and poverty in rural Vietnam

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Contents

Abstract

Concept of monetary-based poverty is often applied in poverty research worldwide. Nevertheless poverty is not only measured by income or expenditures, but also by indicators of living standards, which imply socio-economic welfare a household obtain. Multi-dimensional poverty approach is now widely used by international agencies. However, selection of relevant indicators for multi-dimensional poverty measure is remained unclear. The Sustainable Livelihoods Approach (SLA) is closely related to multi-dimensional poverty concept in terms of using a complex set of socio-economic indicators to reflect the accessibility to five livelihood assets of household or individual, the human, social, natural, physical and financial assets.

This study therefore aims at exploring interrelations between monetary poverty and other socio-economic characteristics of rural households in Vietnam relying on livelihood approach and searching relevant socio-economic indicators for multi-dimensional poverty measurement.

Various multivariate analysis methods as Principle Component Analysis, Multiple Correspondence Analysis and Cluster Analysis are applied to explore the mentioned issues. Data of 6,837 rural households extracted from VHLSS 2008 dataset are used in this study.

The results confirm that multi-dimensional poverty of rural household is explained by at least ten dimensions representative for four livelihood assets. Several continuous and categorical variables are extracted as relevant indicators for multi-dimensional poverty measurement. Household classification by multi-dimensional poverty is likely more statistically efficient when homogeneity with group is improved in comparison to basing on expenditure per capita.

Key words: *multi-dimensional poverty, livelihood assets, Principle Component Analysis, Multiple Correspondence Analysis, Cluster Analysis*

Acronyms and Abbreviation

CIP	Composite Indicator of Poverty
DFID	Department for International Development – United Kingdom
FAO	Food and Agriculture Organization of the United Nations
GSO	General Statistics Office of Vietnam
HDI	Human Development Index
HPI	Human Poverty Index
MOLISA	Ministry of Labour – Invalids and Social Affairs
MCA	Multiple Correspondence Analysis
MPI	Multi-dimensional Poverty Index
PCA	Principal Components Analysis
SLA	Sustainable Livelihood Approach
TSC	Two-Step Cluster
UNDP	United Nations Development Programme
VASS	Vietnamese Academy of Social Sciences
VHLSS	Vietnam Household Living Standard Survey

1. INTRODUCTION

Identification of poverty's nature and the way to measure poverty are concerns of development economics at the world scale because of their complexity. Appropriate poverty identification and measure would lead to better awareness of the society on the poverty and more efficient response of governments in poverty alleviation. Poverty is defined as "the lack of, or the inability to achieve, a socially acceptable standard of living" (World Bank, 2001, cited in FAO, 2005, p.2). World Bank also considered "poverty is pronounced deprivation in well-being" (World Bank Institute, 2005, p.9). The terminology "well-being" can be explained in different views. Firstly, poverty is measured by comparing individual's or household's income or consumption to a threshold that the society refers as a living standard. This typical view considers an individual or household poor if its standard living is below the threshold living standard set by a society at a point of time. Because income or consumption is the base for measurement, the poverty is seen a monetary term. It means poverty is measured relying on economic indicators, not social ones. This approach can lead to two typical poverty classifications. Absolute poverty is measured by comparing individual or household income or expenditure to a poverty line set by the referred society at a point of time, which is sum of a given level of goods ensuring some form of minimum subsistence. Meanwhile, relative poverty approach refers to "a standard of living defined in relation to the position of other people in the income/expenditure distribution" (FAO, 2005, p.4). This approach is often induced to individual or household classification basing on income or expenditure quintiles.

The second meaning of well-being concept is the extension of monetary term to different specific type of consumption good which can be food, shelter, health care, education and so on, that individual or household most requires. Therefore, other related specific terminologies can be used as nutritional poverty, educational poverty, and so forth Despites of differences in concept and measurement, these two approaches follow uni-dimensional measure, which bases on a uni-dimensional economic indicator as income or expenditure.

However, back to the broader concept as above definition poverty can be explained in multi-dimensional indicators (Anand & Sen, 1977). Poverty is not only measured by income, expenditures, but also by ability to achieve food, shelter, education, health and other social living standards, and even non-physical indicators. In other words, poverty is reflected the deprivation of different socio-economic welfare which can be represent by a set of indicators. The aggregation of these indicators reflects quality of human life. It is easy to find that there must be interrelation among indicators of multi-dimensional poverty, not simple causal relation. Interaction among these multi-dimensions makes the measure more complicated, while cause and effect relation between uni-dimensional poverty and its determinants is often explored in numerous studies. In which uni-

dimensional poverty of an individual or a household is considered dependent variables on other explanatory determinants.

At the present, multi-dimensional poverty measures are mostly applied by the international agencies. The most popular applied indexes are Human Poverty Index (HPI) developed by Anand and Sen (1997), Human Development Index (HDI) used by the United Nations, and the Multi-dimensional Poverty Index (MPI) built by Oxford University and UNDP basing on methodology developed by Alkire and Foster (2007).

Meanwhile, in Vietnam almost studies on poverty have used uni-dimensional approach so far. The most common measure follows income-based and expenditure-based methods, in absolute or relative terms. In addition, these studies aim at finding the socio-economic determinants of poverty. In the other words, the causal relation is seen default, in which, monetary poverty is the results of other socio-economic situation which might vary by individual, household, region or society scales in a given space and time. In the recent years, some poverty studies have started applying multi-dimensional approach, for example, the assessment of urban poverty in Hanoi and Ho Chi Minh City, 2010. However, it is likely that in these studies multi-dimensional poverty is presented as an aggregation of the separate socio-economic aspects. In addition, relations among these socio-economic indicators including monetary income and expenditures are not yet deeply clarified. In the other words, the selection of indicators of each dimension, and the selection of dimensions are not clearly explained in these studies.

From the approach of sustainable livelihoods theory, which was developed by DFID (1999), socio-economic situation of individual or household can be understood as the aggregated results of its accessibility to five livelihood assets, the human, social, natural, physical and financial capitals. The DFID's Sustainable Livelihoods Approach (SLA) is closely related to multi-dimensional poverty concept in terms of using a complex set of socio-economic indicators to reflect the accessibility to means that serve as the base for individual or household survival. Nevertheless, SLA focuses into the complexity of livelihoods, especially the different types of relations among five livelihood assets. From the SLA framework, poor accessibility to five livelihood assets can be understood synonym with a situation of multi-dimensional poverty.

It is obviously that multi-dimensional poverty can be measured in different socio-economic, even in cultural aspects and there must be closed relations between monetary poverty and other socio-economic situation of individual or household. However, selection of relevant indicators for poverty measure is remained unclear. The promising indicators probably vary by specific socio-economic context of the society and people in studied location and should meet local culture. If appropriate indicators selected, multi-dimensional poverty measure would be more precise. In order to get most appropriate indicators careful selection must be done and an insight of relation between them must be obtained.

This study therefore aims at finding interrelations between monetary poverty and other socio-economic characteristics of households relying on livelihood approach that on which multi-dimensional poverty can be deeper understood. From these relations, appropriate socio-economic indicators for multi-dimensional poverty can hopefully be found for further poverty measurement. The overall objective of the study is to explore and evaluate poverty in its multi-dimensional nature, in particular the interrelations among main socio-economic aspects. The application of livelihood assets in linking with multi-dimensional poverty concept is the core of this study.

Specific objectives of the study are i) searching appropriate indicators representative for poverty in economic, social and cultural aspects; ii) understanding the interrelations among the multi-dimensional indicators; iii) knowing how household poverty can be classified by application of an aggregated multi-dimensional indicator; and iv) exploring differences in classifications by monetary poverty and multi-dimensional poverty.

This report includes five parts. Part 1 presents the research context, application of multi-dimensional poverty and need of finding relevant indicators of multi-dimensional poverty. Part 2 is devoted to literature review in theoretical aspects and empirical studies. Methods of research and data introduction are presented in Part 3. Part 4 presents all calculation and analysis for selection of relevant indicators of multi-dimensional poverty in rural Viet Nam. Part 5 is devoted to study results and recommendations for further research activities.

2. LITERATURE REVIEW

2.1 Multi-dimensional poverty and livelihood assets

2.1.1 Measuring poverty

Normally, poverty assessment is realized by using dataset collected at national scale through a Living Standards Measurement Survey (LSMS) project, which is extremely careful prepared under supervision of international agencies as World Bank and UNDP. Household questionnaire, the main survey tool, is designed to collect information related to household characteristics. Household composition, consumption patterns including food and non-food, assets including housing, landholding and other durables, income and employment in agriculture, non-agriculture and wage and self-employment, socio-demographic variables including education, health, migration, fertility, and anthropometric information are important information collected. Poverty measure can be done basing on these collected information, but subject to conceptual approaches. The economic welfare approach allows to using per capita consumption expenditures or income to measure poverty. This approach can be extended to other non-monetary welfare using indicators as infant mortality rates in the region, life expectancy, the proportion of spending devote to food, housing conditions, and child schooling (World Bank Institute, 2005).

In Vietnam, the monetary approach is often applied by General Statistics Office (GSO) in conducting the Vietnam Household Living Standards Survey (VHLSS) and by Ministry of Labour – Invalids and Social Affairs (MOLISA). MOLISA usually applied absolute poverty basing on per capita income poverty line. The income poverty lines are separately set for rural and urban regions for different periods as 2001-2005 and 2006-2010[1] then afterwards. Meanwhile GSO often applied both absolute and relative monetary poverty and measured poverty by both per capita household expenditures and income in its VHLSSs. In the most recent report[2], GSO (2010) used per capita income quintiles to classify households by poverty, a relative poverty method. Household characteristics will then be deeply described in terms of other socio-economic indicators, especially comparing the poorest (20% lowest income quintile) to the richest (20% of the highest income quintile). Despite the difference in poverty measure, their reports just provide insight description of poor household and compare characteristics of the poor to the reach one, not showing relations between monetary poverty to other socio-economic indicators.

World Bank (2003) also indicated that poverty measure methods that have been applied in Vietnam can be classified in six categories: 1) household expenditures; 2) poverty mapping; 3) income-based; 4) local classification; 5) self-reporting and 6) wealth ranking. Except the household expenditures and income-based methods using uni-

[1] *Decision No.1143/2000/QĐ-LĐTBXH and Decision No. 170/2005/QĐ-TTg*
[2] *Result of the Vietnam Household Living Standards Survey 2010.*

dimensional indicators, the remainders approached poverty by multi-dimensional indicators. Of which, wealth-ranking method is considered comprehensive and most applied in Participatory Poverty Assessment (PPA). This methodology bases on the rule that household classification is carried out by community composing local authorities and local participants in balanced groups of men and women, young and old, and poor and non-poor. The community defines characteristics of the poor. Household classification is done basing on consensus of all participants. Therefore, this methodology is considered objective and comprehensive. Oxfam and ActionAid (2012) have used similar PPA approach for a five-year survey in ten villages throughout Vietnam. The poor and non-poor classification is based on a poverty framework built and agreed in a participatory manner by representatives of local community.

At international level, some multi-dimensional indicators have been developed and applied by international agencies as HDI, HPI, and MPI. According to Jahan (2002) Human Development Index (HDI), which was first introduced in 1990, is a measure of average achievement in basic human capabilities. The HDI is an aggregation of three dimensions. To represent the dimensions of human well-being included in the HDI, the following variables were chosen – life expectancy at birth for a long and lengthy life, educational attainment in terms of adult literacy rate and combined gross enrolment ratio at primary, secondary and tertiary level for knowledge and GDP per capita (PPP$) for a decent standard of living. The HDI has conglomerative perspective while the HPI is considered deprivational (Anand & Sen, 1997). The HPI is a composite measure of multi-dimensional poverty that measures deprivations in basic human development in the same HDI three dimensions plus the aspect of participation or social inclusion (Anand & Sen, 1997, cited in Jahan, 2002).

Multi-dimensional Poverty Index (MPI) is an international poverty measure developed by the Oxford Poverty and Human Development Initiative (OPHI) for the United Nation Development Programme (UNDP) and officially used in *Human Development Report*, which was launched on 2nd November 2011. MPI is based on methodology developed by Alkire and Foster (2007), which composes three dimensions (education, health and living standards) and ten indicators with different weights. The Alkire Foster method is considered flexible and can be used with different dimensions, indicators, weights and cut-offs to create measures specific to different societies and situations. Following this MPI approach, a study on urban poverty in Vietnam applied an index composing of eight dimensions and 21 indicators with equal weight (People Committee of Hanoi, People Committee of Ho Chi Minh City & UNDP, 2010). GSO (2010) also measured poverty for children through multi-dimensional indicators that include education, health, nutrition, housing, clean water and sanitation, not to work at an early age, entertainment and inclusion, and social protection. Children who do not attain at least two of these eight dimensions are considered multi-dimensional poor children. This approach allows GSO to calculate proportion of child poverty in national and regional scale. However, the

interrelations among these indicators and to household income poverty as well were not explained.

In 2011, UNDP released the Vietnam Human Development Report 2011. In the report UNDP applied three methods to measure poverty which are monetary poverty, HPI and MPI. The MPI was built basing on three dimensions which are health, education and living conditions. Nine indicators representative for three dimensions were 1) households have sold their products/assets, taken loans to pay for health care services or quit treatment; 2) household members have not completed primary education; 3) school-age children are not currently enrolled in school; 4) use electricity as the main source of lighting; 5) access to clean drinking water; 6) access to inadequate sanitation; 7) access to standard toilet; 8) living in a permanent house; and 9) durable assets owned. People at risk of suffering multiple deprivations—that is those suffering from overlapping deprivations in any two of nine indicators used are considered poor. However, similar to the above study, there was no any explanation for selected dimensions and indicators.

2.1.2 Livelihood assets and poverty elimination

Livelihood approach now is common practiced in study on socio-economic characteristics of rural household in developing countries. *"A livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living: a livelihood is sustainable which can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to other livelihoods at the local and global levels and in the short and long term."* (Chambers & Conway, 1991, p.6). The livelihood framework identifies five core asset categories or types of capital upon which livelihoods are built. These assets are human capital, natural capital, physical capital, financial capital and social capital. Increasing access –which can take the form of ownership or the right to use – to these assets is considered closely related to support of livelihoods and poverty elimination. DFID mentioned that the sustainable livelihood approach recognises the multiple dimensions of poverty identified in participatory poverty assessments.

The concept of livelihood asset is flexible and subject to local context that it is applied. DFID (1999) clearly defined its features. In general, human capital represents the skills, knowledge, ability to labour and good health that together enable people to pursue different livelihood strategies and achieve their livelihood objectives. At a household level human capital is a factor of the amount and quality of labour available. This varies according to household size, skill levels, leadership potential, health status, and so forth. Human capital can be interpreted in educational indicators, understanding local knowledge, labour quantity and skills, life expectancy, children malnutrition, and so forth.

Natural capital is the term used for the natural resource stocks from which resource flows and services useful for livelihoods are derived. There is a wide variation in the resources that make up natural capital, from intangible public goods such as the atmosphere and biodiversity to divisible assets used directly for production. Natural capital can be interpreted in different indicators such as productivity of the resource (for example, soil fertility for cultivation, fish reserves in seashore for local fisherman).

Physical capital comprises the basic infrastructure and producer goods needed to support livelihoods. Of which the components of infrastructure essential for sustainable livelihoods are usually affordable transport, secure shelter and buildings, adequate water supply and sanitation, clean and affordable energy and access to information (for example, telecommunications). In addition, producer goods as the tools and equipment that people use to function more productively are also appropriate representatives.

Financial capital denotes the financial resources that people use to achieve their livelihood objectives. Two main sources of financial capital are available stocks and regular inflows of money. Savings in cash, bank deposits or liquid assets such as livestock and jewellery, credit, pensions, or other transfers from the state, and remittances are relevant indicators.

The social capital is understood as the involvement of people to networks and connectedness; membership of more formalised groups; and relations of trust, reciprocity and exchanges.

The concept of livelihood assets allows imagining complexity of socio-economic and even socio-cultural factors interpreting multi-dimensional poverty. It means multi-dimensional poverty can be interpreted through indicators of livelihood asset and shows that there would be existing solid relations between monetary poverty indicators and the indicators of livelihood assets. Each livelihood asset therefore can be considered as a dimension of poverty which contains several important indicators. The next section will review this issue through multi-dimensional poverty measures and empirical application.

2.2 Relations between monetary poverty and other socio-economic indicators

The international indexes as HDI, HPI, and MPI are built basing on multi-dimensional approach. The choice of the socio-economic indicators representative for building different dimensions must have some reasons, although they are not mentioned in the reviewed literature. For the HDI, life expectancy, adult literacy rate and combined gross enrolment ratio at primary, secondary and tertiary level and GDP per capita probably correlate. At least longevity, knowledge and a decent standard of living serve as three basic dimensions. Their interrelations can be easily found. If people have higher income through an increase of GDP per capita, their life expectancy and adult literacy rate are expected to be improved. Vice versa, as these latter indicators of people improved,

human development is strengthened and in its turn, contributes to better income for people. For HPI, the people deprivation in income is likely leading to worse social inclusion, less chance in obtaining relevant education and life expectancy reduced due to malnutrition. Meanwhile the MPI focuses in three dimensions as education, health and living standards. Although income-based indicator was not included, but relations between household income and the above ten indicators (years of schooling, school attendance, child mortality, nutrition, electricity, drinking water, sanitation, flooring, cooking fuel and assets) are probably significant.

World Bank (2003) mentioned that poverty in Vietnam has a strong spatial dimension. Regional factors affect significantly to differences in poverty of each socio-economic region. In addition, there is a clear relation between poverty and a variety of geographic, household and community characteristics. In particular, several distinct sets of characteristics emphasized are family size and composition, ethnicity, education of household head and spouse, occupation, housing and assets, community characteristics, and geographical region. Linking with livelihood approach, family size and composition, education and occupation can be seen as specific indicators of human capital. Ethnicity stands partially for social capital. Housing and assets are really representatives of physical and partially financial capitals while community characteristics can stand for public infrastructure, an aspect of physical capital. At last, geographic characteristics probably show aggregated feature of natural capital. Logically, better accessibility to these factors, individual or household livelihood is improved and leads to better livelihood outcomes. Then better livelihood outcomes, in their turns, make accessibility to livelihood assets improved.

A participatory poverty assessment conducted by Vietnamese Academy of Social Sciences (2011) showed that characteristics of the poor closely relate to lack of livelihood assets. The qualitative discussion revealed that land (natural asset), lack of credit, in debt, borrowing for food (financial asset), poor housing and furniture (physical asset), young family, limited working experience, lack of knowledge, school leaving, illiteracy, and old/invalid or ill-being household owner (human asset) are main characteristics of the poor.

Applying an MPI approach, UNDP chose a set of 21 socio-economic indicators representative for eight dimensions to measure multi-dimensional poverty in urban of Hanoi and Ho Chi Minh City. The study found statistically significant correlations between income and housing service, housing area and quality (physical capital), health, education (human capital), security, social inclusion, and social security (social capital). Except negative correlation between income and security, others are positive, of which correlation between income and housing service is the strongest (People Committee of Hanoi, People Committee of Ho Chi Minh City & UNDP, 2010).

The linkage between poverty and other socio-economic indicators can be found in a variety of empirical studies. Asselin (2009) argued that living conditions of individual or

household have 10 dimensions as income, education, health, food/nutrition, safe water/sanitation, labour/employment, housing, access to productive assets, access to market and community participation/social peace. Ki, Faye and Faye (2009, cited in Asselin, 2009) found that education, health, drinking water, nutrition, housing, sanitation, energy, communications, household durables, goods of comfort, and other assets are appropriate indicators to measure multi-dimensional poverty in Senegal in 2000-2001. For Vietnam context, Asselin and Vu developed a five-dimension measurement using dimensions as education, health, water/sanitation, employment and housing (Asselin, 2009). Crooks (1995) found that poverty affects to children's health, growth and school achievement.

It is obviously that multi-dimensional poverty is closely related to accessibility to livelihood asset. In the other words, there are relations between monetary poverty and livelihood asset components. However, because of complexity poverty and the socio-economic context of the specific locations that poverty is measured, there are no fixed exact appropriate indicators that can be used in all cases. Therefore, finding the appropriate indicators representative for poverty in different economic, social and cultural aspects and understanding the interrelations among them are necessary for poverty assessment.

2.3 Problems of data measurement for multi-dimensional poverty

Asselin (2009) has deeply exploited various methods to measure multi-dimensional poverty for building a Composite Indicator of Poverty (CIP). Methods as CIP based on Inequality Indices, CIP based on Poverty Structure Analysis, the Fuzzy Subset Approach are discussed. The second method is chosen due to its advantage of using factorial approach. Asselin also emphasizes that Principal Component Analysis requires quantitative indicators while categorical variables are important in survey dataset. Therefore, Multiple Correspondence Analysis (MCA) is suggested to deal with qualitative or categorical indicators, which should be numerical coded. The numeric code can reflect the ordinal structure of the given poverty indicator. Therefore poverty indicators are required to be ordinal corresponding to ordinal scale of poverty. Pure categorical indicator meets the following conditions: 1) it has an ordinal structure; 2) the lowest category refers to an extreme poverty status in reference to the basic need considered, and 3) the highest category is considered as the non-poverty status.

This Poverty Structure Analysis using MCA was applied by Ki, Faye and Faye (2009, cited in Asselin, 2009) and Asselin and Vu (2009, cited in Asselin, 2009).

The above literature review allows to concluding that nature of poverty is very complicated. Because of its complexity, poverty measurements are interested in by scientific community at world scale. There are several methodologies applied to measure household poverty following uni-dimensional or multi-dimensional

approaches. Multi-dimensional poverty approach is likely to have close linkage with theory of sustainable livelihood. The five livelihood assets of households can be able to reflect household poverty in different aspects through their indicators. The relevant indicators of livelihood assets can be used for multi-dimensional poverty measurement. However, multivariate analysis is required. Principal Components Analysis and Multiple Correspondence Analysis are potentially methods to deal with quantitative and categorical variables, respectively.

3. METHODOLOGY

3.1 Study approach, research objectives and questions

Sustainable livelihood approach in linking with multi-dimensional poverty is applied in this study. The study assumes that livelihood assets can be used to indicate multi-dimensional poverty though specific indicators.

Specific objectives of the study are 1) searching appropriate indicators representative for poverty in economic, social aspects; 2) understanding the interrelations among the multi-dimensional indicators; iii) knowing how household poverty can be classified by application of aggregated multi-dimensional indicators; 3) exploring differences in classifications by monetary poverty and multi-dimensional poverty.

In order to obtain these above specific objectives, there several questions that this study has to answer as followed:

1) What are the appropriate socio-economic indicators representatives for multi-dimensional poverty in linking with livelihood asset?
2) What are the interrelations in these socio-economic indicators?
3) How can the interrelations in these socio-economic indicators be used to classify households by multi-dimensional poverty? and
4) How does multi-dimensional poverty measurement affect to features of rural households in compared to monetary poverty?

3.2 Study scope

The study aims at working on rural households of Vietnam of different socio-economic regions. The data collected at household level in the year 2008 by the Vietnam's GSO.

3.3. Data source

The study uses the survey data set of Vietnam Household Living Standards Survey 2008 conducted by GSO under support of World Bank and UNDP. The data set covers 9,189 households of eight socio-economic regions including income and expenditures are collected in the Questionnaire No.1B-PVH/KSMS08. Only 6,837 rural households are selected for analyses. The surveyed indicators are divided in eight categories including 1) Household structure and demographics, 2) Education, 3) Health and health care, 4) Employment and income, 5) Expenditures, 6) Durable goods; 7) Housing, electricity, water, sanitation facilities; and 8) Participation in poverty reduction programs and credit.

Nearly thirty socio-economic indicators are extracted from VHLSS 2008 dataset for the study. They are divided in four categories of livelihood asset. Indicators of social asset are not extracted. The variables include both quantitative and categorical. Main information of the used variables is summarized in the Table 1 below.

Table 1. Description of selected socio-economic indicators

Livelihood asset	Category in VHLSS	Indicators	Scale/Indicators	Questionnaire No.
Human asset	1	Household size	Ratio: total number of household members	tsnguoi, Muc01_1B
	2	Average schooling year of a household member	Ratio: average schooling year of household members	m2ac1, Muc02_1B
	2	Highest diplomas	Ordinal: average code number of highest diplomas of household members	m2ac3, Muc02_1B
	3	Number of sick persons within year	Ratio: total number of households members who get sick with 12 months	m3ac2, Muc03_1B
	3	Average days in sickness with year	Ratio: average days in sickness of household member	m3ac3b, Muc03_1B
	3	Average time of getting medical examination and treatment within year	Ratio: average times of getting medical examination and treatment of household members within 12 months	m3bc10a, Muc03_1B
		Number of labourers in household	Ratio: number of household members having main job from (1) working for others, (2) on-farm activities; (3) non-farm activities	m4ac1a,m4ac1b, m4ac1c,m4ac4 Muc04_1B
Natural asset	4	Agricultural land	Ratio: agricultural land area of household	m4bc3, Muc04_1B
	4	Irrigation	Nominal: land can be irrigated or not	m4bc5,Muc04_1 B
	4	Crop land by kinds	Ratio: agricultural land area used for (1) annual crops; (2) perennial crops; (3) forestry; (4) water surface; (5) pasture; (6) garden; (7) flash & burn; (8) others	m4bc4, Muc04_1B
Physical asset	6	Physical productive assets	Nominal: (1) perennial garden; (5) cart-animals; (8) animal cage; (17) tractor; (23) engine-boat; (29) water pump;	m6c1, Muc06_1B
	6	Physical consumption assets	Nominal: (20) motorbike; (34) mobile phone; (41) colour-television; (43) HF chain; (46) computer; (48) refrigerator; (49) air-conditioner;	m6c1, Muc06_1B
	7	Housing area	Ratio: area of housing	m7c2, Muc07_1B
	7	Housing type	Ordinal: type of house	m7c2, Muc07_1B
	7	House value	Ratio: value of house	m7c12, Muc07_1B
	7	Consumption water sources	Ordinal: (6) tap water; (5) drilled water well; (4) dug-water well; (3) spring water; (2) rainy water; (1) river water	m7c26, Muc07_1B
	7	Consumption water	Nominal: (1) tap water; (0) not tap water	m7c26, Muc07_1B

Livelihood asset	Category in VHLSS	Indicators	Scale/Indicators	Questionnaire No.
	7	Toilet	Ordinal: type of toilet	m7c33, Muc07_1B
	7	Electricity for light	Ordinal: electric source (wired, engined, oil lamp, others)	m7c34, Muc07_1B
Financial asset	8	Having credit	Nominal: yes:no	m8c7, Muc08_1B
	8	Credit loan value	Ratio: value of credit loan at borrowing time	m8c10a, Muc08_1B
	1	Remittance from household members	Ratio: remittance value within year	m1cc10, Muc01_1B
	5	Expenditure per capital	Ratio: household expenditures dived by number of capita	
	5	Expenditure -based quintiles	Ordinal: households are classified in five groups basing on quintiles of per capita expenditures	

3.4 Data analysis

Data will be analysed by the following steps:

Step 1. Describe the general socio-economic features of rural households. Descriptive statistics and correlation analysis will be used in the first step to describe general poverty situation and explore the relations among potential indicators of multi-dimensional poverty. Correlations between per capita expenditure-based monetary poverty and livelihood asset indicators of households are also identified.

Step 2. Identify appropriate variables representatives for 4 livelihood asset components that can be used as aggregated indicators for multi-dimensional poverty. Principal Components Analysis and Multiple Correspondence Analysis will be applied to identify components representative for livelihood asset.

Step 3. Classify rural household by multi-dimensional poverty basing on 4 livelihood asset components identified in Step 2. Clustering Analysis will be used to group observations into different socio-economic groups basing on multivariate analysis manner.

Step 4. Compare household distributions by monetary poverty and multi-dimensional poverty. Descriptive statistics analysis and Analysis of Variance will be applied to explore advantages and disadvantages of multi-dimensional poverty measurement.

PASW Statistics 18.0 is the software used for statistical analyses in this study.

4. RESULTS AND DISCUSSION

4.1 Main features of livelihood assets of rural households in Vietnam

Total observations extracted from the VHLSS 2008 dataset are 6,837 rural households of 8 different socio-economic regions of the countries. Red River Delta and Mekong River Delta occupied more than 20% of observation each (22.1% and 21.4%, respectively). The North Central and North Eastern contributed 12.4% and 15% of total observations (Table 2). The remaining regions had less than 10% of total observation per each. However, the observations of each variable are adjusted after eliminating outliers and extreme values. The elimination helps to correct the average values and the population estimator as well in the description. Therefore, valid observations vary depending by each indicator. However, the dataset does not allow to calculating appropriate indicators of household's social asset as expected.

Table 2. Sample distribution by socio-economic regions

	Frequency	Percent	Valid Percent	Cumulative Percent
Red River Delta	1,509	22.1	22.1	22.1
North-Eastern	1,026	15.0	15.0	37.1
North-Western	360	5.3	5.3	42.3
North Central	846	12.4	12.4	54.7
South Central	579	8.5	8.5	63.2
Central Highland	417	6.1	6.1	69.3
South Eastern	636	9.3	9.3	78.6
Mekong River Delta	1,464	21.4	21.4	100.0
Total	6,837	100.0	100.0	

Source: calculated from VHLSS 2008 dataset

4.1.1 Human asset

In average, each rural household composed of 4.1 members and 3.27 labours. Living in rural areas, agricultural production is the main activity of household labours. There were 1.89 labours devoted to on-farm activities as cultivation and husbandry, in average (Table 3). Meanwhile labours working for others and in non-farm activities occupied only 1.37 persons. These figures also showed that non-farm activities were carried out by only 14.4% of total household's labours (0.47 labours compared to total 3.27 labours). It revealed that agricultural activities are still dominant for rural household and diversification of livelihood activities, especially in non-farm activities is still limited in rural regions.

Most of surveyed households had education at moderate level. A typical household member completes primary school in average. It revealed that education is still limited for rural communities. The distribution of households by their highest attained diploma was relatively equal distributed among primary, secondary and high school. 24.2% surveyed households obtained primary level as the highest diploma. The figures for

secondary and high school were 37.7% and 32.4%, respectively. However, university degree was much rarely found. Households with under-graduated or graduated degrees were only 2.1% and 2.9% (Table 4).

Health care is likely a problem in rural regions of Vietnam. Although the number of household members got sickness within 12 months prior to the survey was rather high (1.35 persons in average) but average day of using health care services was only 0.86 day per person. The data revealed that health care service was probably not common used by rural people, might be either due to poor quality service or lack of payment ability of local people.

In general human asset of rural households in Vietnam are not rich as expected. Low education level, lack of health care and lack of diversification in job are their main features.

4.1.2 Natural asset

Although agriculture is the main working sector of rural communities, land availability is also very limited for them. In average, each household had only 0.712 ha for agriculture. For the one who grow annual crops, average land was only 0.55 ha. Income from forest land is rather important for households living in mountainous areas when they had an average area of forest land of 1.26 ha. Vice versa, water surface for aquaculture is important in lowland areas, with 0.52 ha per household in average. Other land area used for pastures and flash and burn cultivation is rare in comparison to other common agricultural activities (Table 3).

Although land stock is not abundant for rural regions of Vietnam, good water supply through irrigation systems can significantly improve land productivity and agricultural income. It seems that irrigation was commonly applied in rural regions when 95.7% of households' land was irrigated.

In general, it is obviously that the limitation of land stock for rural households in Vietnam is a critical factor of rural poverty. Nevertheless, irrigation system seems to be well developed and farmers can be able to increase agricultural output by intensification and land use rotation.

4.1.3 Physical asset

With the variables extracted from the VHLSS 2008 data set, physical asset of rural households is divided in two main categories, the productive and consumption assets and other indicators as housing condition, electricity, tap water and toilet condition. Housing area, house value, and housing type are representatives of housing condition. Presence of perennial garden, cart animals, animal cage, tractor, engine boat and water pump is used as indicators of productive asset while vehicle, motorbike, mobile phone, colour television, Hi Fi chain, computer, refrigerator, air-conditioner, standard toilet, and so forth are used as indicators of consumption assets.

Table 3. Main socio-economic features of rural households in Vietnam

	N	Min	Max	Mean	Std. Error	Std. Deviation
Indicators of human asset						
household size[1] (people)	6,733	1	8	4.1	0.019	1.5
average schooling year of a household member (year)	6,837	0	12	6.2	0.0	2.8
number household member working for others[4] (people)	6,637	0	6	0.9	0.012	0.987
number household member working on farm[4] (people)	6,637	0	7	1.89	0.015	1.245
number household member working non farm[4] (people)	6,637	0	6	0.47	0.010	0.793
total number of household labours[4] (people)	6,637	0	7	3.27	0.019	1.564
number of household's sick person[2] (people)	6,738	0	5	1.35	0.017	1.4
average day of treatment of a household member[3] (day)	6,512	0	5	0.86	0.014	1.1
Indicators of natural asset						
total agricultural cultivated area[5] (m^2)	6,805	0	100,000	7,127.6	132.8	10,956.6
land area for annual crops[5] (m^2)	5,009	20	90,000	5,533.7	114.7	8,115.3
land area for forestry[5] (m^2)	558	200	83,000	12,654.6	608.1	14,364.9
water surface[5] (m^2)	512	18	72,000	5,231.9	428.1	9,685.8
land area for pasture[5] (m^2)	25	100	20,000	2,025.9	847.4	4,237.1
land area for garden[5] (m^2)	2,282	15	30,000	960.3	36.0	1,720.3
land area for flash burn[5] (m^2)	21	237	15,500	4,830.3	1,025.4	4,698.8
land area for others[5] (m^2)	34	21	25,200	3,071.3	932.8	5,439.2
Indicators of physical asset						
area of housing[6] (m^2)	6,651	10	150	61.1	0.3	27.047
value of house[6] (1,000 VND)	6,651	0.0	6,900,000	141,279.5	2,928.3	238,813.4
Indicators of financial asset						
value of credit loan at borrowing time[7] (1,000 VND)	2,435	8	1,500,000	17,365.7	977.7	48,244.3
remittance value within year[8] (1,000 VND)	684	200	300,000	13,223.3	933.3	24,408.2
per capita expenditures (VND)	6,837	1,045	9,990,197	3,989,517.1	32,935.3	2,723,295.9

Source: calculated from VHLSS 2008 dataset

Note: the observations adjusted by eliminating outliers and extreme values by following standards:

1: not more than 8 persons; 2: not more than 5 persons; 3: not more than 5 days a year

4: total number of household labours is not higher than 7 persons

5: total agricultural cultivated area is not more than 100,000 m^2 per household

6: housing area is higher than 0 m^2 and not more than 150 m^2; 7: for the ones who had a loan only

8: for the ones who received remittance only

Housing condition of rural household is still poor in general. There were 63.4% of surveyed households living in fair constructed houses, which mostly made of brick, cement, and wooden materials in simple types. 17.1% households live in poor constructed houses, which commonly made of wood, wild plant leaves or other very

simple materials (Table 5). Meanwhile percentages of households living in better housing as good constructed, very good constructed houses and villa were much lesser (14.4%; 4.9% and 0.2%, respectively). With such poor condition, house value in rural regions was low, only 141 million VND in average (Table 3).

Table 4. Highest diploma attained by rural household

	Frequency	Percent	Valid Percent	Cumulative Percent
no diploma	25	0.4	0.4	0.4
primary	1,508	22.1	24.2	24.6
secondary	2,351	34.4	37.7	62.4
high school	2,019	29.5	32.4	94.8
college	132	1.9	2.1	96.9
bachelor	182	2.7	2.9	99.8
master	4	0.1	0.1	99.9
others	7	0.1	0.1	100.0
Total	6,228	91.1	100.0	100.0

Source: calculated from VHLSS 2008 dataset

Table 5. Type of house

	Frequency	Valid Percent	Cumulative Percent
villa	12	0.2	0.2
very good constructed	334	4.9	5.1
good constructed	984	14.4	19.5
fair constructed	4,334	63.4	82.9
poor constructed	1,169	17.1	100.0
Total	6,833	100.0	

Source: calculated from VHLSS 2008 dataset

For productive assets, quantitative data are limited. Only asset-owned percentages are obtained. In general, the figures showed that rural households were very low equipped for agricultural activity. Percentages of households having tractor, engine boat and water pump were extremely low, at levels of 1.5%, 3.1% and 9.8%, respectively. Although back-yard animal husbandry is common for rural households, there are less than one third of them having animal cage and cart animals. Only 18.3% of surveyed households had perennial garden (Table 6). It is evident that poor equipment for agricultural activities at household level is an important feature of rural community in Vietnam.

For consumption assets, motorbike was much common owned by rural households at percentage of 22.3%. Due to lack of cable system, mobile phone is likely broadly used in rural areas. There was 31.5% of surveyed household used mobile phone for telecommunication. Percentages of households owning other luxury goods as colour television, HF chain, computer, refrigerator, air conditioner were less than 10% (Table 6). Lack of luxury goods can be explained by limitation in both electricity supply and poor accessibility in rural regions.

Presence of wired electricity system for lighting was extremely limited. Only 1.7% of surveyed households had electricity supplied through wired system. Meanwhile, accessibility to clean and hygiene water is still another challenge for rural households. Only 10.4% of surveyed households used tap water. Certainly, they had to use water from other unsafe sources as drilled water well, dug-water well; rainy water, spring and river. Standard toilet was not commonly equipped at home. Less than a half of surveyed households had standard toilet (for example, septic tank toilet, sulabh flush toilet and two-compartment latrine) while 51.8% of households had no toilet (Table 6).

The data set revealed that in broad scale, rural households had low accessibility to electricity and tap water, which reduces their opportunity to better education, diversification of job and better health. Poorness in owning productive assets of rural households in combination to agricultural land area can be critical obstacle for income improvement in rural regions of Vietnam.

4.1.4 Financial asset

Data concerning financial asset is not enough provided in the VHLSS 2008 dataset. Only three indicators that can be used to represent household financial asset are value of house, value of credit loan at borrowing time and remittance value within year (Table 3). Other valuable assets as saved money in cash or in gold, number of cart animal, vehicle and luxury goods are not indicated in terms of both quantity and value.

There was 35.6% of surveyed households borrowed money from different sources. They had 17.36 million VND of loan in average. This loan is a significant financial source for household productive and consumption activities. In addition, only 10% of survey households could receive remittance from their family members domestically or abroad with average amount of 13.2 million VND a year. Data also showed that percentages of households who owned valuable physical assets were very low as mentioned above (Table 6). Obviously, it is likely that rural households were weak at financial asset.

4.1.5 Section remarks

In general, poorness of Vietnam rural households in terms of livelihood assets is evident. Four livelihood assets can be understood through different quantity and categorical indicators. Lack of critical natural asset as agricultural land and productive physical asset, lack of other financial asset, low education level, lack of health care facilities and lack of job diversification are main their constraints.

The descriptive statistics also reveal that there might be relation between livelihood assets and monetary-based poverty of rural households. Differences in owning livelihood assets can reflex in some respect the differentiation in multi-dimensional poverty, of which monetary-based poverty is only a noticeable aspect. Therefore, these potential relations must be clarified.

Table 6. Presence of livelihood capitals of households by categorical indicators (%)

	No	Yes
Indicators of natural capital		
Land irrigated	4.3	95.7
Indicators of productive physical asset		
Perennial garden	81.7	18.3
Cart animals	77.7	22.3
Animal cage	68.5	31.5
Tractor	98.5	1.5
Engine boat	96.9	3.1
Water pump	90.2	9.8
Vehicle	81.7	18.3
Motorbike	77.7	22.3
Mobile phone	68.5	31.5
Colour television	98.5	1.5
Hi Fi chain	96.9	3.1
Computer	90.2	9.8
Refrigerator	90.2	9.8
Air conditioner	90.2	9.8
Tap water	89.6	10.4
Wired electricity	98.3	1.7
Standard toilet	51.8	48.2
Financial asset		
Having formal credit	44.7	54.6
Receiving remittance	90.0	10.0

Source: calculated from VHLSS 2008 data set

4.2 Relations among indicators of household livelihood assets and monetary-based poverty

4.2.1 Preliminary exploration of interrelations among socio-economic indicators

In this study, indicator of monetary-based poverty is measured by expenditure per capita and its quintiles. The indicators of household livelihood assets are both quantitative and categorical. Pearson correlation coefficient is therefore used to measure relations between quantitative indicators while Pearson Chi-square, Likelihood Ratio, Kendall's Tau-b and Spearman Correlation are applied to measure relation between categorical indicators. The preliminary exploration of these relations is summarized Table 7 below (see details in the Annex 1, 2, 3).

It is likely that there exist close correlation among indicators of human asset. Household size had positive correlation to household labour indicators. It means having enough labour force is advantage of big household. However, increase in household size led to increase in sickness person while reduce average treatment day and average schooling year of a household member. Big household was disadvantageous in health care and education in compared to the small ones.

Related to natural capital, especially agricultural land, big households often had larger farm scale and abundant labour quantity for on farm activity. Vice versa, households with smaller farm scale often had more labour working in non-farm sector or working for others. It can be seen that farm scale and distribution of labour in household are closely related. Farm scale also had the positive correlation to the accessibility to credit loan of household.

Table 7. Relations between expenditure per capita quintiles and categorical indicators of household livelihood assets

	Pearson Chi-Square Sig. (2-sided)	Likelihood Ratio Sig. (2-sided)	Kendall's tau-b	Spearman Correlation
Highest diploma	622.087**	631.938**	0.071**	0.082**
Presence of perennial garden	61.94**	63.95**	0.031**	0.034**
Presence of cart animal	242.74**	238.35**	-0.065**	-0.072**
Presence of animal cage	79.85**	80.05**	0.047**	0.052**
Presence of tractor	10.45*	10.37*	0.029*	0.032**
Presence of engine boat	27.95**	33.29**	0.030*	0.033**
Presence of water pump	89.10**	97.03**	0.051**	0.057**
Presence of vehicle	61.94**	63.95**	0.031**	0.034**
Presence of motorbike	242.74**	238.35**	-0.065**	-0.072**
Presence of mobile phone	79.85**	80.05**	0.047**	0.052**
Presence of colour television	10.45*	10.37*	0.029**	0.032**
Presence of HF chain	27.95**	33.28**	0.030*	0.033**
Presence of computer	89.10**	97.03**	0.051**	0.057**
Presence of refrigerator	89.10**	97.03**	0.051**	0.057**
Presence of air conditioner	89.10**	97.03**	0.051**	0.057**
Type of house	356.95**	383.06**	-0.048**	-0.056**
Source of consumption water	619.82**	554.36**	0.028**	0.035**
Presence of tap water	77.62**	80.29**	0.009^{ns}	0.010^{ns}
Type of toilet	1084.05**	1090.51**	0.093**	0.110**
Electricity source	310.10**	254.76**	0.077**	0.086**
Presence of credit loan	34.46^{ns}	34.29^{ns}	-0.009^{ns}	-0.010^{ns}

Source: calculated from VHLSS 2008 dataset

Concerning relation between physical asset and financial asset, housing area and value of house had important role for household in access to credit loan. In addition, although housing area also had close relations to household size and number of labour but value of house likely positively related to education level of household members, and number of non-farm labour. These relations suggest that better education and non-farm activity would contribute better to household income.

Expenditure per capita had negative correlation to household size, positive correlations to average schooling year, and number of non-farm labour. Meanwhile farm scale and number of on-farm labour were negative correlated to expenditure per capita. These results suggest that monetary-based poverty of household had close relation to quality

of human asset. Better education and job diversification, less dependency on on-farm activity would be the key factors to improve farm income.

Quintiles of expenditure per capita also had very close correlations to almost categorical indicators representative for household human, and physical assets as indicated in Table 7. All correlations as Pearson Chi-squared, Likelihood Ratio, Kendall's Tau-b and Spearman correlation proved obvious relations between monetary-based poverty and household assets.

For human asset, the better-off and rich quintiles had better level of highest diploma that their household member attained. Similarly, owning percentages of physical assets increased by richness increase in expenditure per capita. Housing quality and better source of consumption water were also improved towards better quintiles. Only presence of credit loan had no relation to quintiles of expenditure per capita. In fact, relation between these two indicators probably complicated. Richness means better physical assets' quantity and value and leads to better opportunity to obtain credit loan because house is considered a kind of mortgage asset. However, credit loan demand of a household might is likely reduced as its richness increases. Therefore, credit loan demand depends mostly on presence of household business project, its capital size and capital provision capacity of household.

4.2.2 Section remarks

These above analyses on relations between expenditure per capita of household and other household assets' indicators allow to concluding that monetary-based poverty of rural household obviously close relations to household livelihood assets. In the other words, household poverty can be reflected by quantity and quality of livelihood assets. As the results, measure of rural household poverty can base on a set of indicators representative for livelihood assets at the same time with monetary-based indicators as income or expenditure. Such a multi-dimensional poverty measure can provide an integrated and comprehensive insight of poverty in rural regions of Vietnam.

4.3 Indicators of multi-dimensional poverty

4.3.1 Application of factor analysis to detect quantitative indicators of multi-dimensional poverty

In order to explore potential quantitative indicators of multi-dimensional poverty for rural household in Vietnam factor analysis is applied. A set of 14 quantitative variables is used including household size, number of sick person, number of sickness day, average day of getting health treatment, average schooling year, total labour, labour working for others, working on-farm, working non-farm, total agricultural cultivated area, housing area, house value, credit loan value and remittance with a year. Extraction method is Principal Component Analysis. Rotation method with Varimax and Kaiser Normalization is applied. The loadings with absolute values less than 0.4 are suppressed

from rotation. The results showed that there are six components detected with eigenvalues greater than 1.0. 63.84% of total variance can be explained by these six components (Figure 1, Table 8 and Annex 4).

The first component composes of four variables which are household size, total household labour, number of household member working on farm, and number of household member working for others. Except the last variable which has its possible distribution in three components 1, 4 and 5, three first variables concentrate only in the first component. This component refers to human resource of a rural household in term of quantity and relates closely to agricultural activity. So it can be named as "human resource for agriculture".

The second component includes two main variables housing area and house value. It likely indicates physical asset of household through the most important asset, the house. It can be named as "housing condition". Nevertheless, this component should be supplemented by other quantitative or categorical variables of physical assets if data available.

The third component includes all three variables indicating health condition of rural household's members which are number of household's sick person, number of sickness day, and average day of treatment of a household member. Therefore it can be representative for a meaning as "health status" of rural household. In combination with the component "human resource for agriculture" it reflects household's human asset in terms of labour quantity and health condition of household labour.

Total agricultural cultivated area is representative for the fourth component. This variable indicates clearly the natural asset of a typical rural household in Vietnam which mainly bases on cropping activity. This component can be named as "land resource".

The fifth component includes variable "number household member working non-farm" with very high loading value. The variable "number of household member working for others" has negative loading values in the component 4 and 5. These also indicate household labour distribution among working types as non-farm, on-farm and working for others. Therefore it should be better located in the fifth component. The distribution of these two variables likely reveals another side of human asset which inclines to "job diversification ability" of rural household.

The sixth component only relates to the variable "remittance received within year". Although there is only 10% of surveyed household received remittance domestically or abroad, it can be an independent supplemented income source for rural households, especially since migration from rural to urban has sharply risen during the recent decades. This component can be named as "additional income" and considered as representative for the financial asset.

Unexpectedly, variable "average schooling year of household member" does not meet human asset when it falls into the component "housing value". It's is difficult to explain

such a relation. Meanwhile variable "value of credit loan at borrowing time" has not any close relation to identified components. Therefore, these two variables should be dropped out of the analysis.

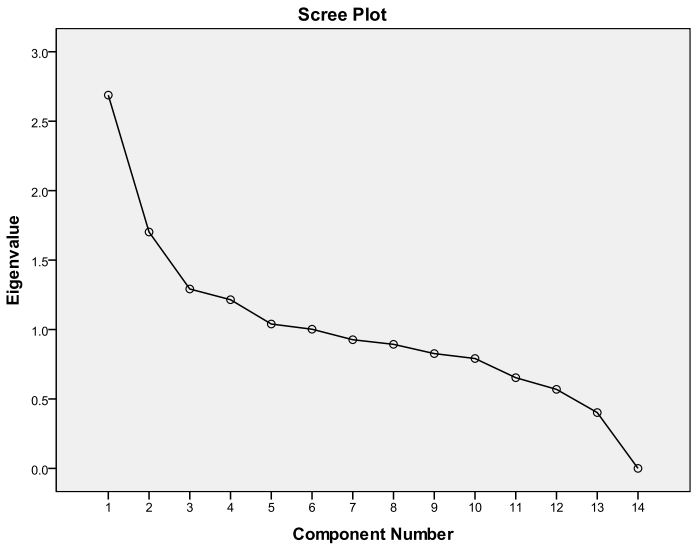


Figure 1. Scree plot of eigenvalues by components

Table 8. Rotated Component Matrix[a]

	Component					
	1	2	3	4	5	6
total number of household labours	0.943					
household size	0.782					
number of household member working on farm	0.747					
number of household member working for others	0.558			-0.494	-0.441	
value of house		0.796				
area of housing		0.751				
average schooling year of a household member		0.460				
average day of treatment of a household member			0.702			
number of sickness day			0.673			
number of household's sick person			0.460			
total agricultural cultivated area				0.788		
number of household member working non farm					0.908	
remittance value within year						0.922

Note: calculated from VHLSS 2008 dataset
Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization
a. Rotation converged in 9 iterations

Results of factor analysis allow to selecting six dimensions representing different aspects of rural household livelihood assets (Table 9).

The human asset can be decomposed in three components as "human resource for agriculture", "health status", and "job diversification ability". It's important to emphasize that these three components are statistically independent from each other although they

reflect the same human asset. Such an independence of three components revealed the complexity in nature of human asset. Human resource for agricultural activities inclines to abundance and availability of labour force of rural households devoted to their most important economic activity. Health status of household labour is able to indicate some range of labour quality, or somehow possibility to create high labour productivity. Meanwhile the diversification of job is considered a manner to improve rural household income in the context of limited land resource. Non-farm activities and working for others are two most common additional income sources for rural household. However, it seems that larger farm scale that the household uses, lesser labour works for others is. It is possible that working for others is often done by poor household and/or household who has very small-farm scale. Similarly, number of non-farm labour has negative relation to number of labour working for others. When household labour attains better qualification to operate by self-employment activities as household business, and productive activities or services, number of the one working for others to get wage or salary reduces. It's obviously that labour qualification is the latent aspect of the component "job diversification ability".

The natural asset is uniquely represented by the component "land resource". Therefore, again statistical result confirms that land is the most important economic asset of rural households.

Table 9. Livelihood assets' components of rural household and relevant quantitative indicators

Livelihood asset	Components	Relevant indicators
(1) Human asset	(1) Human resource for agriculture	total number of household labours household size labour working on farm
	(3) Health status	average day of treatment of a household member number of sickness day number of household's sick person
	(5) Job diversification ability	number of household member working non-farm number of household member working for others
(2) Natural asset	(4) Land resource	total agricultural cultivated area
(3) Physical asset	(2) Housing condition	house value housing area
(4) Financial asset	(6) Additional income	remittance received within year

The physical asset is represented by the component "housing condition" with two typical quantitative variables which are housing area and value of house. In fact, most of physical assets' values of the household are often not fully revealed by interviewees because their sensitiveness. In this case, obviously, housing condition closely reflects the richness of household and can be used as the most appropriate indicators of household physical asset.

With the absence of various quantitative indicators representing value of valuable properties of household as saved gold, jewellery, hard currencies, and other things it is very difficult to find a good indicator for household financial asset. Unexpectedly, value of credit loan is not statistically suitable for financial asset. Therefore, only one variable, the remittance received within year is able to present the component "additional income".

The social asset cannot be analyzed due to unavailability of the dataset.

The livelihood assets' components and their relevant indicators are presented in Table 9. These components of rural household livelihood assets can be considered as multi-dimensional aspects of rural household poverty in Vietnam.

4.3.2 Application of Multiple Correspondence Analysis (MCA) to detect qualitative indicators of multi-dimensional poverty

In order to deal with categorical variables Multiple Correspondence Analysis is applied. Twenty categorical variables selected from the VHLSS 2008 dataset for this statistical procedure. Of which, fifteen variables indicating rural household's ownership of common productive and consumption physical properties are in nominal scale. The five remainders are in ordinal scale showing measured order of observed categories. Human asset can be represented by the highest diploma of household member while physical asset is explained in term of housing quality (type of house), water source and its quality (consumption water source and consumption water dummy), type of toilet and electric source (Table 10).

All variables are numerically coded for calculation. Normalization method by Variable Principal is selected to optimize the association between variables. This method is useful to identify the correlation between the categorical variables.

Four dimensions are selected since they are able to explain for hundred percent of total variance. Reliability of variable composition in dimensions' structure is confirmed by high values of Cronbach's Alpha coefficients (Annex 5). Results of discrimination measures are presented in Table 11.

The combination of discrimination measures of categorical variables (Table 11) and their visualized correlations to dimensions (Figure 2) allows to identifying variable groups in four dimensions.

It is likely that the dimension 1 explains for owning status of luxury consumption goods for rural household. Computer, refrigerator and air conditioner are consumption goods which are rarely used in rural regions, except the rich households. In addition, computer might have relation to high-educated households. Although water pump falls into the same dimension but it is likely that no direct relation between this item and the three others. Therefore, the dimension 1 can be representative for luxury consumption goods of rural households.

Table 10. Categorical variables of livelihood assets extracted from VHLSS 08 dataset

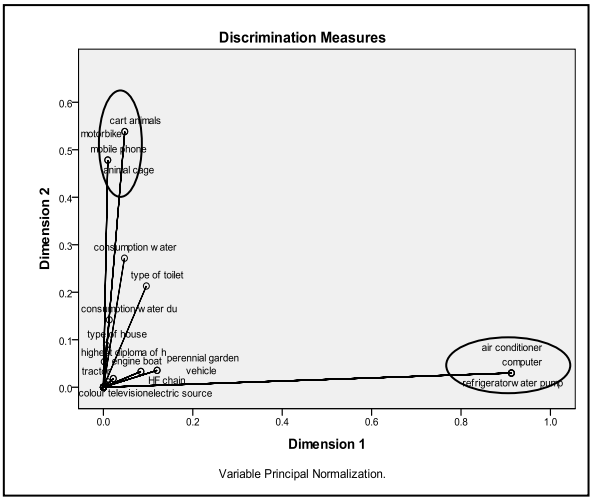
highest diploma of household	Primary, secondary, high school, college, bachelor, master, others
type of house	Villa, very good constructed, good constructed, fair constructed, poor constructed
consumption water source	River, rain, spring, dug water well, drilled water well, tap water
consumption water dummy	Not tap water; tap water
type of toilet	Septic tank toilet, sulabh flush toilet, 2-compartment latrine, on water surface, others, no toilet
electric source	Wired, engine, oil lamp, others
perennial garden, cart animals, animal cage, tractor, engine boat, water pump, vehicle, motorbike, mobile phone, colour television, HF chain, computer, refrigerator, air conditioner	No, Yes

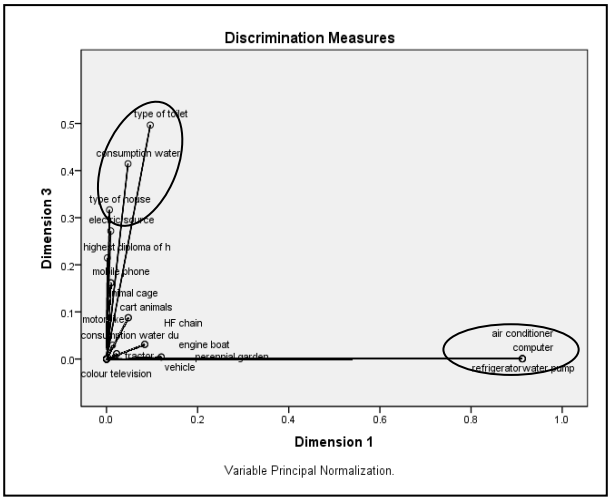
Note: extracted from VHLSS 2008 dataset

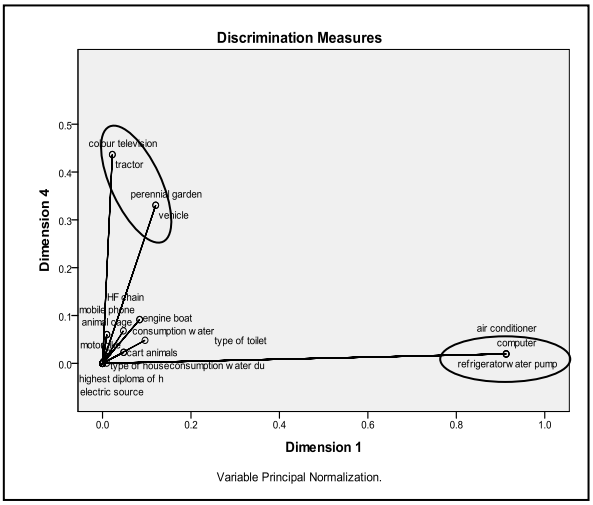
Table 11. Discrimination Measures

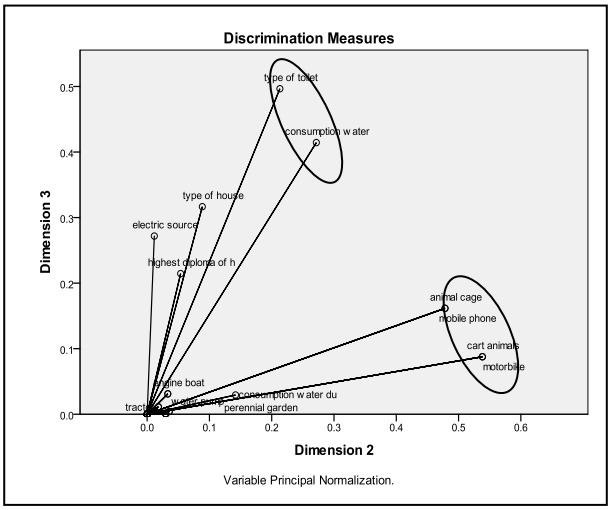
	Dimension				
	1	2	3	4	Mean
highest diploma of household	0.002	0.054	0.215	0.004	0.068
perennial garden	0.120	0.036	0.004	0.331	0.123
cart animals	0.048	0.538	0.088	0.023	0.174
animal cage	0.010	0.478	0.162	0.060	0.177
tractor	0.022	0.018	0.011	0.436	0.122
engine boat	0.084	0.033	0.031	0.092	0.060
water pump	0.913	0.030	0.001	0.020	0.241
vehicle	0.120	0.036	0.004	0.331	0.123
motorbike	0.048	0.538	0.088	0.023	0.174
mobile phone	0.010	0.478	0.162	0.060	0.177
colour television	0.022	0.018	0.011	0.436	0.122
HF chain	0.084	0.033	0.031	0.092	0.060
computer	0.913	0.030	0.001	0.020	0.241
refrigerator	0.913	0.030	0.001	0.020	0.241
air conditioner	0.913	0.030	0.001	0.020	0.241
type of house	0.007	0.089	0.317	0.015	0.107
consumption water	0.047	0.272	0.414	0.068	0.200
consumption water dummy	0.013	0.142	0.029	0.021	0.051
type of toilet	0.096	0.213	0.497	0.048	0.214
electric source	0.009	0.012	0.272	0.000	0.073
Active Total	4.393	3.107	2.337	2.118	2.989

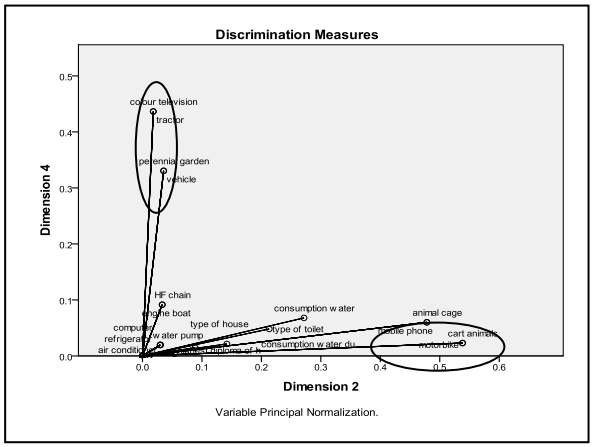
Note: calculated from VHLSS 2008 dataset











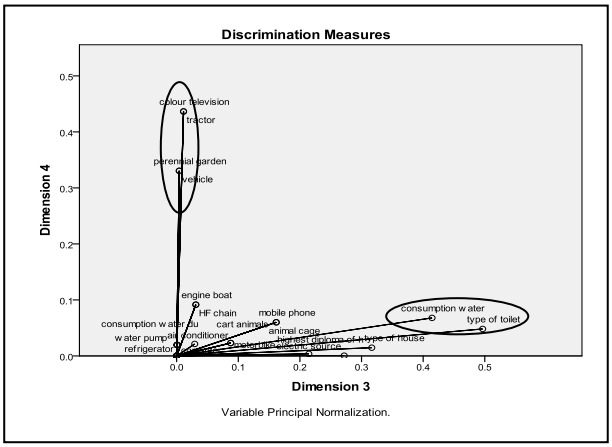


Figure 2. Distribution of categorical indicators by dimensions extracted from MCA results

The dimension 2 seems reflects both productive and consumption physical assets. Cart animal and animal cage are for the former, and motorbike and mobile phone are for the latter. Similar distribution of categorical variables also occurs to the dimension 4. While tractor, perennial garden represent for productive physical asset, vehicle and colour television are consumption asset.

The dimension 3 includes almost variables indicating housing condition, clean water accessibility and hygiene condition. Type of house, electric source, water source, and type of toilet are really reliable relevant indicators.

From MCA results, it is possible to extract the categorical indicators representative for multi-dimensional poverty as showed in Table 12. The variables tractor, perennial garden, vehicle and colour television can be dropped out because they are not common owned by rural households in compared to other variables as motorbike, mobile phone, cart animal and animal cage.

Table 12. Physical asset of rural household and relevant categorical indicators

Livelihood asset	Dimension	Relevant indicators
(3) Physical asset	(1) Luxury consumption goods	Computer
		Refrigerator
		Air conditioner
	(2) Ordinary consumption goods	Motorbike
		Mobile phone
	(2) Productive goods	Cart animal
		Animal cage
	(3) Housing condition	Type of toilet
		Water source
		Type of house
		Electric source

4.3.3 Selection of indicators of multi-dimensional poverty with livelihood assets approach

The combination of PCA and MCA results allows identifying 23 indicators for livelihood assets of rural household (Table 13). They can be classified in quantitative indicator group (12 variables) and categorical indicator group (11 variables). There are total 10 dimensions of four livelihood assets. Of which, human asset includes three independent dimensions (human resource for agriculture, health status and job diversification ability). Physical asset composes of five independent dimensions (housing condition, housing facilities, productive goods, ordinary consumption goods and luxury consumption goods). Natural asset can be represented by one dimension (land resource). Similarly is financial asset (additional income). Data for social asset is not available from the VHLSS 2008 dataset.

Because the number of extracted variables is still numerous it should be reduced depending on data availability and on choice of the most appropriate variables. The analysis results give possibility to select different sets of variables depending on availability of data collection. For example, variable "number of household member working on farm" can be dropped out of dimension 1 because of its low loading value in compared to the others (Table 8). Similarly, variable "number of household's sick person can be eliminated from the dimension 2. Concerning physical asset, luxury consumption goods can also be dropped because their presence is rare for rural household. Productive goods as cart animal and animal cage are considered not common and they also depend on agro-ecological conditions, farming habits and specialization of agricultural activities of rural household. These variables should be considerably selected because they are not representative for all cases.

Basing on these above rationale, there are likely 16 appropriate variables that can be used as livelihood assets' indicators of rural household for further analysis. Certainly, variables in the same dimension can be alternatively used. Even so, variables with highest factor loading value or discrimination measure to its component or dimension should be chosen for household livelihood assets.

Table 13. Potential indicators of multi-dimensional poverty under livelihood assets approach

Livelihood asset	Dimension	Relevant indicators
(1) Human asset	(1) Human resource for agriculture	Total number of household labours
		Household size
		Number of household member working on farm*
	(2) Health status	Average day of treatment of a household member
		Number of sickness day
		Number of household's sick person*
	(3) Job diversification ability	Number of household member working non-farm
		Number of household member working for others
(2) Natural asset	(4) Land resource	Total agricultural cultivated area
(3) Physical asset	(5) Housing condition	House value; Housing area; Type of house
	(6) Housing facilities	Type of toilet; Water source; Electric source
	(7) Productive goods	Cart animal*; Animal cage*
	(8) Ordinary consumption goods	Motorbike; Mobile phone
	(9) Luxury consumption goods	Computer*; Refrigerator*; Air conditioner*
(4) Financial asset	(10) Additional income	Remittance received within year

Note: * the variables which can be dropped out of calculation for multi-dimensional poverty

4.3.4 Section remarks

Application of PCA and MCA is efficient in detecting appropriate socio-economic indicators of livelihood assets of rural household. Statistical convergences of continuous and categorical variables in components and dimensions are relevant and meet real study context. At least 10 poverty dimensions related to four livelihood assets are found.

They are representative for different aspects of household welfare and can be used for multi-dimensional poverty measurement.

4.4 Classification of rural household by multi-dimensional poverty

4.4.1 Multi-dimensional poverty measurement

In this section, application possibility of selected variables for measuring multi-dimensional poverty will be explored by using Cluster Analysis. The method Two Step Cluster Analysis (TSC analysis) is chosen because it provides the following unique features: 1) automatic selection of the best number of clusters, in addition to measures for choosing between cluster models; and 2) ability to create cluster models simultaneously based on categorical and continuous variables. Additionally, this procedure can analyze large data file. TSC analysis assumes variables to be independent; continuous variables are assumed to be normally distributed, while categorical variables are assumed to be multinomial. All continuous variables will be standardized in calculation. Number of cluster is specified fixed at 5. Schwarz's Bayesian Information Criterion (BIC) is applied. Distance measure method used is Log-likelihood.

In order to explore application of variables of multi-dimensional poverty selected from PCA and MCA, and to satisfy assumption of independence of variables for clustering, only one variable representative for each dimension of livelihood asset will be used in clustering calculation. The variables which have the highest correlation values to its dimension will be selected. Therefore, there will be six continuous variables chosen including total number of household labour, average day of treatment of a household member, number of household member working non-farm, total agricultural cultivated area, household value and remittance received within year. In addition, expenditure per capita is also used in calculation to compare to monetary-based poverty classification. Two categorical variables selected are type of toilet and motorbike. The clustering is carried out by two options of with and without these two categorical variables to explore their role in clustering.

The first glance at TSC analysis results shows that housing facilities (type of toilet) and ordinary consumption goods (motorbike) are likely to have the most important role in multi-dimensional poverty measurement. The other dimensions as housing condition, human resource for agriculture, job diversification ability and health status play critical roles but their importance level is reduced when housing facilities and ordinary consumption goods are added. Natural asset and financial asset have lower influences on clustering. Surprisingly, expenditure per capita has very weak impact in clustering for both cases (Figure 3).

The results suggest some important findings which provide new insight on poverty measurement of rural household in Vietnam context.

The first finding is that there must be remarkable difference between poverty classification by monetary-based and multi-dimensional approaches. It is likely that expenditure per capita, a conventional typical variable of monetary-based poverty, has lowest influence on multi-dimensional poverty classification. It means income or expenditure is just able to explain an individual aspect of poverty. Rural household ability to achieve good housing condition, and better health; abundance of human resource for agricultural activities and employment diversification are main factors contributing household welfare. Therefore, if multi-dimensional approach is applied, poverty structure can be deeply changed.

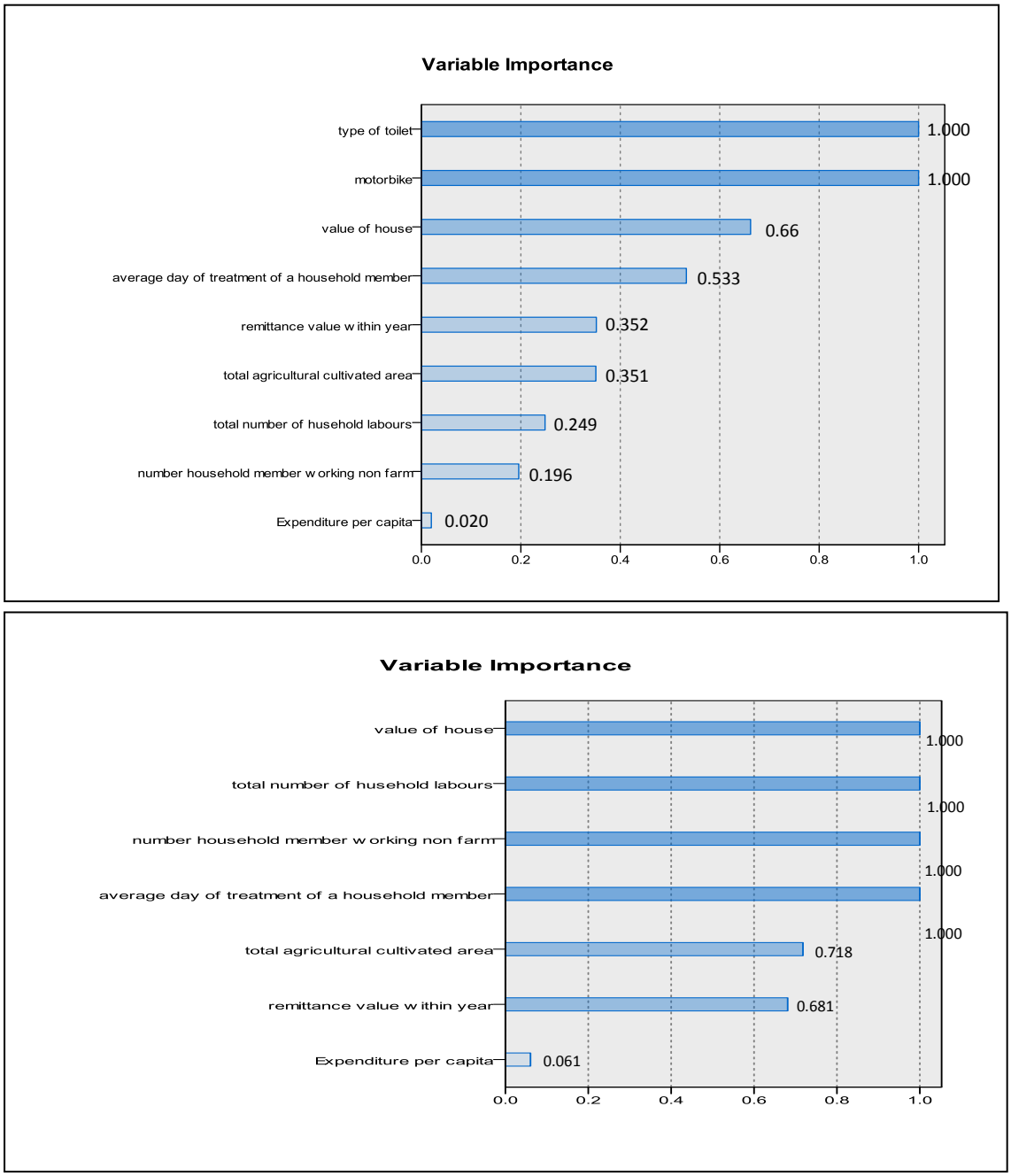


Figure 3. Importance of multi-dimensional poverty indicators for rural household poverty classification with and without presence of categorical variables

The second finding is that livelihood assets dimensions have different contribution levels to multi-dimensional poverty. Dimensions of physical asset and human asset contribute remarkable to multi-dimensional poverty classification while natural asset and financial asset just have modest role. The finding reveals that in the context of low income, land scarcity and limited financial availability rural household can base on human resource to overcome difficulty, especially making use of labour skill to diversify income source by joining to self-employment non-farm activities or working for other to earn living.

The third finding is that physical asset's dimensions are very critical in showing poorness or richness of rural household in terms of living conditions that the household benefits. More comfortable housing condition, better quality and quantity of owned home applicants as toilet, motorbike, better hygiene water source for consumption, easy accessibility to electricity are basic indicators of acceptable living standards in rural regions.

The fourth finding is that agricultural land is no longer precise indicator of poorness or richness for rural households. The statistical results can make people awareness on role of land resource changed. Due to stagnancy in labour demand of construction and services sectors in recent years, labour force stuck in rural regions. As the consequences, land scarcity has become seriously constraint of income improvement and limit ability of income improvement by agricultural activities.

Fifthly, remittance is also an important additional income source for rural household. This is advantage for rural households who have relatives migrating to and working in other cities or abroad.

The sixth finding is about weights of livelihood dimensions in multi-dimensional poverty measurement. Statistical results show that variable importance varies by each indicator. It suggests that weights of different poverty dimensions are important in measurement of multi-dimensional poverty and values of variable importance might be used as the weights.

In general it is clear that the findings related to indicators of multi-dimensional poverty are mostly similar as Asselin (2009), Ki, Faye and Faye (2009, cited in Asselin, 2009), Asselin and Vu (2009) and Crooks (1995) except the absence of education's indicators.

4.4.2 Comparison of rural household classification by monetary-based and multi-dimensional poverty

This section describes the distribution of surveyed observations by quintiles of expenditure per capita and by clusters obtained from TSC analysis option with presence of two categorical variables and seven continuous variables. Distribution of observations remarkably changes by new clusters in compared to that by quintiles. All cases are redistributed into five clusters withdrawn from TSC analysis with different percentages. Clearly, the involvement of additional eight variables strongly influences to distribution

of surveyed rural households. The distribution of multi-dimensional poverty totally differs from the monetary-based point of view (Table 14). This means rural households in a specific quintile of expenditure per capita can be fallen into different situations of poorness or richness which indicate overall accessibility to household welfare dimensions. In the other words being rich in terms of money does not mean rich in other welfare aspects. Vice versa, even a poor household can be rich in the other things. Therefore it's not easy to say a cluster is "poor" or "rich". In the other words, a rural household can fully access to one or some socio-economic dimensions but can inadequately own the other welfare dimensions. As the consequence, any explanation for the feature and naming of each cluster must be carefully taken.

For example, households of the lowest quintile of expenditure per capita are redistributed into all five clusters. There are 457 observations belonging to cluster 5 which have the highest mean values of expenditure per capita and house value. However these households have the lowest level of agricultural land area. In terms of human resource these households are the second weakest in holding labour force but are the ones keeping most non-farm labour force (Table 15).

Similarly, 12.8% of "monetary rich" households are redistributed to cluster 1 that has both lowest expenditure and house value but most abundant in terms of agricultural land area and total labour force.

If expenditure per capita is also used as main livelihood indicator of poverty, 5 clusters can be ordered as showed in Table 15. It is likely that values of important livelihood indicators among five clusters have the same tendency which explains differences in livelihood assets' dimensions among five clusters. It is easy to see better within-group convergence on variables as expenditure per capita, house value, average schooling year, household labour and non-farm labour. As the result, it is easier to identify main features of each household group. Below is brief description for two typical clusters.

Households belonging to the cluster 1 have the common following features:

1) Consumption capacity of households is low. Expenditure per capita is at lowest level.
2) Housing condition remains poor in general. House value is at lowest level.
3) Household economy depends on agriculture. Agriculture is main economic activity with high use level of natural resource and human resource. Land asset plays important role and requires contribution of a lot on-farm labour.
4) Households have low ability in job diversification and less accessibility to non-farm activities;
5) Household members attained relative low education level; and
6) Accessibility to health care service is still constraint.

Table 14. Distribution of surveyed observations by quintiles of expenditure per capita and by clusters

Cluster	Poor		Near poor		Middle		Better off		Rich		Total	
	obs	%	obs	%	obs	%	obs	%	obs	%	obs	%
1	217	15.9	473	36.4	370	27.1	253	18.5	175	12.8	1,488	21.8
2	154	11.3	46	3.4	74	5.4	101	7.4	155	11.3	530	7.8
3	318	23.3	403	29.5	494	36.1	428	31.3	359	26.2	2,002	29.3
4	220	16.1	361	26.4	280	20.5	279	20.4	225	16.4	1,365	20.0
5	457	33.5	83	6.1	148	10.8	306	22.4	454	33.2	1,448	21.2
N	1,366	99.9	1,366	99.0	1,366	99.9	1,367	100	1,368	99.9	6,833	99.9
Missing		1		1		1		0		1		4
Total		1367		1367		1367		1367		1369		6837

Note: calculated from VHLSS 2008 dataset

Table 15. Comparison of uni-dimensional and multi-dimensional poverty classification on some main quantitative indicators

	Average day of treatment		Household labour		Non-farm labour		Agricultural cultivated area		House value		Expenditure per capita		Average schooling year	
	day	CV %	person	CV%	person	CV%	m^2	CV%	1,000 VND	CV%	VND	CV%	Year	CV%
Poor	1.43 b	207.9	3.11a	54.0	0.56 c	154.4	8,924 bc	235.6	232,957 c	150.0	9,510a	49.7	7.02 d	40.02
Near poor	0.97a	228.3	3.85 d	54.2	0.31a	231.2	9,550 c	219.1	81,675a	408.8	2,492,671 b	32.0	4.53a	57.72
Middle	1.15a	182.6	3.58 c	50.8	0.43 b	179.5	7,599ab	266.5	102,477a	125.6	4,090,821 c	8.3	5.71 b	43.13
Better off	1.35 b	180.4	3.42 b	50.8	0.54 c	159.0	6,926a	213.5	138,202 b	138.7	5,538,964 d	9.0	6.45 c	38.77
Rich	1.47 b	188.5	3.22a	50.6	0.64 d	146.2	7,334a	184.1	217,439 c	168.7	7,810,030 e	12.7	7.27 e	35.02
Cluster 1	0.68a	159.5	4.19 d	44.2	0.34a	203.2	11,102 c	116.8	83,154a	113.1	3,662,872a	63.3	6.19 b	44.61
Cluster 4	1.76 c	127.2	3.34 c	54.7	0.40 bc	186.9	6,855 b	131.5	81,814a	122.0	3,928,645 b	63.0	4.74a	51.98
Cluster 3	0.92 b	148.6	3.26 bc	52.3	0.43 bc	175.2	5,380a	145.1	102,890a	108.7	4,095,293 bc	60.8	6.34 b	43.17
Cluster 2	3.82 d	176.9	2.98a	58.2	0.61 c	144.7	22,870 d	238.7	195,485 b	103.9	4,138,866 bc	78.1	6.62 c	4.136
Cluster 5	0.99 b	135.0	3.15 b	54.4	0.80 d	132.4	4,375a	180.6	352,916 c	157.8	4,182,072 c	79.8	7.21 d	35.29

Note: calculated from VHLSS 2008 dataset. The figures in the same column with the same character are statistically insignificant different at alpha level of 0.05. Statistical results for mean equality base on Duncan test (see Annexes 6-21).

Vice versa, common features of the households of this cluster 5 are as followed:

1) Household has high consumption capacity. Expenditure per capita is at highest level.
2) Household benefits comfortable housing condition. House value is at highest level.
3) Economic activity does not mainly base on agricultural activity. Land use is at lowest level.
4) Household obtains high level in job diversification and high accessibility to non-farm activities.
5) Household obtained highest education level.

Nevertheless it is not easy to define that households are "poor" if belonging to the cluster 1 or "rich" if belonging to the cluster 5. The above analyses are just proved that awareness on poverty will be deeply changed if multi-dimensional poverty is used. It also provides a new manner to understand poverty, socio-economic structure and main activity of rural household.

Even so it's worth to know if household classification by multi-dimensional poverty is more efficient than monetary-based measurement. In principle observations in the same cluster should converge surrounding a mean value of each variable. More convergence means increasing in in-group homogeneity and so reducing in-group dispersion. TSC allows to confirming that classification by multi-dimensional poverty is more efficient than monetary-based measurement. In almost variables, coefficients of variation reduce remarkably as TSC applied except the variable expenditure per capita because it is the key variable of monetary-based classification (Table 15).

4.4.3 Section remarks

Multi-dimensional poverty measurement is a complicated issue in both academic and practical aspects. This study tried to compare rural household classification by monetary-based and multi-dimensional approaches. Results lead to deep change in household distribution. Multi-dimensional poverty classification is more statistically efficient when homogeneity with group is improved by each indicator. Nevertheless it would be very complicated to show exactly poorness or richness of a specific group or household individual. In addition, socio-economic conditions vary significantly by region and agro-ecological condition, and specialization of rural households in their economic activities. Therefore, multi-dimensional poverty should be applied for further poverty analysis in rural area, especially in Vietnam context where heterogeneity is common found.

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The study tries to explore interrelations between livelihood assets and poverty in rural Vietnam. Sustainable livelihood approach in linking with multi-dimensional poverty is applied in this study. Different multivariate analysis methods as Principle Component Analysis, Multiple Correspondence Analysis and Cluster Analysis are applied on VHLSS 2008 dataset provided by General Statistics Office of Vietnam. The study results allow to going to some conclusions as the followings.

Firstly, several socio-economic indicators can be used to describe multi-dimensional poverty in linking with livelihood assets of rural household in Vietnam. Multi-dimensional poverty can be explained by at least ten dimensions representative for four livelihood assets. Of which, three independent dimensions which are human resource for agriculture, health status and job diversification ability indicate human asset. Physical asset composes of five independent dimensions which are housing condition, housing facilities, productive goods, ordinary consumption goods and luxury consumption goods. Natural asset can be represented by land resource and financial asset is explained by dimension of additional income. In the other words, multi-dimensional poverty of rural households in Vietnam can be explained by 10 different socio-economic aspects.

Secondly, 23 indicators of 10 dimensions extracted from VHLSS 2008 dataset can be used to describe multi-dimensional poverty of rural household. The number of indicators is statistically reduced by choosing the most representative ones for the dimension they indicate. Of which, indicators as total number of household labour, average day of treatment of a household member, number of household member working non-farm, total agricultural cultivated area, household value and remittance received within year, expenditure per capita and type of toilet and motorbike are statistically proved to be most relevant indicators of multi-dimensional poverty.

Thirdly, the found indicators have close interrelations to monetary-based poverty. Therefore they can provide better understanding on socio-economic situation of rural household in multi-dimensional poverty approach.

Fourthly, application of multi-dimensional poverty measurement strongly affect to features of rural households in compared to monetary poverty. Multi-dimensional poverty classification is more statistically efficient when homogeneity with group is improved by each indicator. Nevertheless, it is not easy at all to define exact poorness or richness of a specific group or household individual. Because socio-economic conditions vary significantly subject to region, agro-ecological condition, production habitude, and specialization of rural households in their economic activities, multi-dimensional poverty should be applied for each specific rural region. By such way, homogeneity of rural household is better ensured.

The study also faces some limitation. Social asset of rural household was not taken into account in analysis. Moreover, only expenditure per capita was used to indicate monetary-based poverty while income per capita would be more relevant. Last but not least, multi-dimensional poverty classification was carried out for all eight socio-economic regions of Vietnam as the whole. As the consequences, differences in regional features would strongly affect to measurement. It means multi-dimensional poverty should be measured separately by socio-economic region than the whole rural. These limitations should be overcome in further analyses.

5.2 Recommendation

Multi-dimensional poverty measurement is a critical academic and practical issue to provide insightful and comprehensive understanding about poverty, especially in rural regions where majority of poor households locate in absolute term. The study approach using PCA, MCA and TSC techniques is feasible and applicable to find relevant socio-economic indicators of dimensional poverty. The statistical-proved relevant indicators can be used to build a multi-dimensional poverty index such as Composite Indicator of Poverty (CIP) and/or Multi-dimensional Poverty Index (MPI) instead of basing on experience only or simple statistical procedures.

The study results also revealed importance of using weights for indicators. Three main groups of weights can be withdrawn from Principle Component Analysis, Multiple Correspondence Analysis and Two Step Cluster Analysis. It's necessary to identify appropriate manner to apply these above weights for multi-dimensional poverty measurement.

Further studies should focus in updated dataset such as VHLSS 2010. In addition, both income-based and expenditure poverty ought to be applied to compare with multi-dimensional poverty. In particular, the multi-dimensional poverty has to be separately measured by socio-economic region, and more indicators of social asset must be taken into account.

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ANNEXES

Annex 1. Pearson's correlation coefficients among quantitative livelihood indicators

	household size	Expenditure per capita	number of household 's sick person	average schooling year of a household member	average day of treatment of a household member	number household member working for others	number household member working on farm
household size	1	-.041**	.284**	-.068**	-.173**	.293**	.505**
		.001	.000	.000	.000	.000	.000
	6837	6837	6837	6837	6837	6837	6837
expenditure per capita	-.041**	1	.034**	.114**	.018	-.004	-.043**
	.001		.004	.000	.136	.766	.000
	6837	6837	6837	6837	6837	6837	6837
number of household's sick person	.284**	.034**	1	-.015	.063**	.121**	.154**
	.000	.004		.215	.000	.000	.000
	6837	6837	6837	6837	6837	6837	6837
average schooling year of a household member	-.068**	.114**	-.015	1	-.128**	.058**	-.018
	.000	.000	.215		.000	.000	.131
	6837	6837	6837	6837	6837	6837	6837
average day of treatment of a household member	-.173**	.018	.063**	-.128**	1	-.034**	-.137**
	.000	.136	.000	.000		.004	.000
	6837	6837	6837	6837	6837	6837	6837
number household member working for others	.293**	-.004	.121**	.058**	-.034**	1	.069**
	.000	.766	.000	.000	.004		.000
	6837	6837	6837	6837	6837	6837	6837
number household member working on farm	.505**	-.043**	.154**	-.018	-.137**	.069**	1
	.000	.000	.000	.131	.000	.000	
	6837	6837	6837	6837	6837	6837	6837
number household member working non farm	.134**	.058**	.058**	.101**	-.009	-.175**	-.105**
	.000	.000	.000	.000	.441	.000	.000
	6837	6837	6837	6837	6837	6837	6837
total number of household labours	.609**	-.007	.212**	.066**	-.126**	.551**	.737**
	.000	.547	.000	.000	.000	.000	.000
	6837	6837	6837	6837	6837	6837	6837
total agricultural cultivated area	.213**	-.041**	.069**	-.038**	-.036**	-.069**	.281**
	.000	.001	.000	.001	.003	.000	.000
	6837	6837	6837	6837	6837	6837	6837
area of housing	.181**	.003	.071**	.189**	-.041**	-.035**	.038**
	.000	.798	.000	.000	.001	.003	.002
	6833	6833	6833	6833	6833	6833	6833
value of house	.049**	-.004	.017	.169**	-.021	.021	-.161**
	.000	.734	.162	.000	.089	.087	.000
	6833	6833	6833	6833	6833	6833	6833
costs for using housing services	.017	.020	.005	.049**	-.017	-.021	-.037**
	.151	.094	.707	.000	.170	.088	.002
	6837	6837	6837	6837	6837	6837	6837
value of credit loan at borrowing time	.059**	-.028*	.030*	.057**	.021	-.045**	.000
	.000	.023	.014	.000	.079	.000	.991
	6837	6837	6837	6837	6837	6837	6837
remittance value within year	-.054**	.006	-.002	.051**	-.002	-.053**	-.028*
	.000	.614	.853	.000	.898	.000	.019
	6837	6837	6837	6837	6837	6837	6837

Note: calculated from VHLSS 2008 dataset

Annex 1. Pearson's correlation coefficients among quantitative livelihood indicators (Cont.)

	number household member working non farm	total number of husehold labours	total agricultural cultivated area	area of housing	value of house	value of credit loan at borrowing time	remittance value within year
household size	.134**	.609**	.213**	.181**	.049**	.059**	-.054**
	.000	.000	.000	.000	.000	.000	.000
	6837	6837	6837	6833	6833	6837	6837
expenditure per capita	.058**	-.007	-.041**	.003	-.004	-.028*	.006
	.000	.547	.001	.798	.734	.023	.614
	6837	6837	6837	6833	6833	6837	6837
number of household's sick person	.058**	.212**	.069**	.071**	.017	.030*	-.002
	.000	.000	.000	.000	.162	.014	.853
	6837	6837	6837	6833	6833	6837	6837
average schooling year of a household member	.101**	.066**	-.038**	.189**	.169**	.057**	.051**
	.000	.000	.001	.000	.000	.000	.000
	6837	6837	6837	6833	6833	6837	6837
average day of treatment of a household member	-.009	-.126**	-.036**	-.041**	-.021	.021	-.002
	.441	.000	.003	.001	.089	.079	.898
	6837	6837	6837	6833	6833	6837	6837
number household member working for others	-.175**	.551**	-.069**	-.035**	.021	-.045**	-.053**
	.000	.000	.000	.003	.087	.000	.000
	6837	6837	6837	6833	6833	6837	6837
number household member working on farm	-.105**	.737**	.281**	.038**	-.161**	.000	-.028*
	.000	.000	.000	.002	.000	.991	.019
	6837	6837	6837	6833	6833	6837	6837
number household member working non farm	1	.282**	-.040**	.151**	.163**	.116**	-.006
		.000	.001	.000	.000	.000	.648
	6837	6837	6837	6833	6833	6837	6837
total number of household labours	.282**	1	.151**	.078**	-.032**	.028*	-.054**
	.000		.000	.000	.008	.022	.000
	6837	6837	6837	6833	6833	6837	6837
total agricultural cultivated area	-.040**	.151**	1	.132**	-.014	.102**	-.026*
	.001	.000		.000	.232	.000	.029
	6837	6837	6837	6833	6833	6837	6837
area of housing	.151**	.078**	.132**	1	.371**	.103**	.055**
	.000	.000	.000		.000	.000	.000
	6833	6833	6833	6833	6833	6833	6833
value of house	.163**	-.032**	-.014	.371**	1	.093**	.014
	.000	.008	.232	.000		.000	.244
	6833	6833	6833	6833	6833	6833	6833
costs for using housing services	.045**	-.019	.036**	.188**	.140**	.148**	.038**
	.000	.120	.003	.000	.000	.000	.002
	6837	6837	6837	6833	6833	6837	6837
value of credit loan at borrowing time	.116**	.028*	.102**	.103**	.093**	1	.040**
	.000	.022	.000	.000	.000		.001
	6837	6837	6837	6833	6833	6837	6837
remittance value within year	-.006	-.054**	-.026*	.055**	.014	.040**	1
	.648	.000	.029	.000	.244	.001	
	6837	6837	6837	6833	6833	6837	6837

Note: calculated from VHLSS 2008 dataset

Annex 2. Kendall's Tau-b correlation coefficients among categorical livelihood indicators

	Expenditure quintiles	highest diploma of household	perennial garden	cart animals	animal cage	tractor	engine boat
Expenditure quintiles	1.000	.071	.031	-.065	.047	.029	.030
	.	.000	.005	.000	.000	.008	.006
	6837	6228	6837	6837	6837	6837	6837
highest diploma of household	.071	1.000	.014	-.008	.110	.003	-.053
	.000	.	.246	.475	.000	.802	.000
	6228	6228	6228	6228	6228	6228	6228
perennial garden	.031	.014	1.000	-.011	.021	.089	.004
	.005	.246	.	.343	.090	.000	.745
	6837	6228	6837	6837	6837	6837	6837
cart animals	-.065	-.008	-.011	1.000	.317	-.001	-.076
	.000	.475	.343	.	.000	.957	.000
	6837	6228	6837	6837	6837	6837	6837
animal cage	.047	.110	.021	.317	1.000	.019	-.050
	.000	.000	.090	.000	.	.126	.000
	6837	6228	6837	6837	6837	6837	6837
tractor	.029	.003	.089	-.001	.019	1.000	.012
	.008	.802	.000	.957	.126	.	.322
	6837	6228	6837	6837	6837	6837	6837
engine boat	.030	-.053	.004	-.076	-.050	.012	1.000
	.006	.000	.745	.000	.000	.322	.
	6837	6228	6837	6837	6837	6837	6837
water pump	.051	-.014	.196	-.062	.000	.075	.149
	.000	.228	.000	.000	.984	.000	.000
	6837	6228	6837	6837	6837	6837	6837
vehicle	.031	.014	1.000	-.011	.021	.089	.004
	.005	.246	.	.343	.090	.000	.745
	6837	6228	6837	6837	6837	6837	6837
motorbike	-.065	-.008	-.011	1.000	.317	-.001	-.076
	.000	.475	.343	.	.000	.957	.000
	6837	6228	6837	6837	6837	6837	6837
mobile phone	.047	.110	.021	.317	1.000	.019	-.050
	.000	.000	.090	.000	.	.126	.000
	6837	6228	6837	6837	6837	6837	6837
colour television	.029	.003	.089	-.001	.019	1.000	.012
	.008	.802	.000	.957	.126	.	.322
	6837	6228	6837	6837	6837	6837	6837
HF chain	.030	-.053	.004	-.076	-.050	.012	1.000
	.006	.000	.745	.000	.000	.322	.
	6837	6228	6837	6837	6837	6837	6837
computer	.051	-.014	.196	-.062	.000	.075	.149
	.000	.228	.000	.000	.984	.000	.000
	6837	6228	6837	6837	6837	6837	6837
refrigerator	.051	-.014	.196	-.062	.000	.075	.149
	.000	.228	.000	.000	.984	.000	.000
	6837	6228	6837	6837	6837	6837	6837
air conditioner	.051	-.014	.196	-.062	.000	.075	.149
	.000	.228	.000	.000	.984	.000	.000
	6837	6228	6837	6837	6837	6837	6837
consumption water	.028	.065	-.033	-.055	.003	.001	.000
	.004	.000	.003	.000	.763	.903	.999
	6707	6111	6707	6707	6707	6707	6707
consumption water dummy	.009	.032	-.018	-.111	-.085	-.015	.052
	.407	.006	.146	.000	.000	.217	.000
	6837	6228	6837	6837	6837	6837	6837

	Expenditure quintiles	highest diploma of household	perennial garden	cart animals	animal cage	tractor	engine boat
type of toilet	.093	.238	.017	-.179	.036	.003	-.013
	.000	.000	.107	.000	.001	.754	.229
	6837	6228	6837	6837	6837	6837	6837
electric source	.077	.111	.023	-.147	.097	.014	-.003
	.000	.000	.054	.000	.000	.228	.779
	6837	6228	6837	6837	6837	6837	6837
have a credit	-.009	-.024	.005	.043	.034	.013	.030
	.396	.042	.660	.000	.005	.265	.014
	6837	6228	6837	6837	6837	6837	6837

Note: calculated from VHLSS 2008 dataset

Annex 2. Kendall's Tau-b correlation coefficients among categorical livelihood indicators (Cont.)

	water pump	vehicle	motorbike	mobile phone	colour television	HF chain	computer
Expenditure quintiles	.051	.031	-.065	.047	.029	.030	.051
	.000	.005	.000	.000	.008	.006	.000
	6837	6837	6837	6837	6837	6837	6837
highest diploma of household	-.014	.014	-.008	.110	.003	-.053	-.014
	.228	.246	.475	.000	.802	.000	.228
	6228	6228	6228	6228	6228	6228	6228
perennial garden	.196	1.000	-.011	.021	.089	.004	.196
	.000	.	.343	.090	.000	.745	.000
	6837	6837	6837	6837	6837	6837	6837
cart animals	-.062	-.011	1.000	.317	-.001	-.076	-.062
	.000	.343	.	.000	.957	.000	.000
	6837	6837	6837	6837	6837	6837	6837
animal cage	.000	.021	.317	1.000	.019	-.050	.000
	.984	.090	.000	.	.126	.000	.984
	6837	6837	6837	6837	6837	6837	6837
tractor	.075	.089	-.001	.019	1.000	.012	.075
	.000	.000	.957	.126	.	.322	.000
	6837	6837	6837	6837	6837	6837	6837
engine boat	.149	.004	-.076	-.050	.012	1.000	.149
	.000	.745	.000	.000	.322	.	.000
	6837	6837	6837	6837	6837	6837	6837
water pump	1.000	.196	-.062	.000	.075	.149	1.000
	.	.000	.000	.984	.000	.000	.
	6837	6837	6837	6837	6837	6837	6837
vehicle	.196	1.000	-.011	.021	.089	.004	.196
	.000	.	.343	.090	.000	.745	.000
	6837	6837	6837	6837	6837	6837	6837
motorbike	-.062	-.011	1.000	.317	-.001	-.076	-.062
	.000	.343	.	.000	.957	.000	.000
	6837	6837	6837	6837	6837	6837	6837
mobile phone	.000	.021	.317	1.000	.019	-.050	.000
	.984	.090	.000	.	.126	.000	.984
	6837	6837	6837	6837	6837	6837	6837
colour television	.075	.089	-.001	.019	1.000	.012	.075
	.000	.000	.957	.126	.	.322	.000
	6837	6837	6837	6837	6837	6837	6837
HF chain	.149	.004	-.076	-.050	.012	1.000	.149
	.000	.745	.000	.000	.322	.	.000
	6837	6837	6837	6837	6837	6837	6837

	water pump	vehicle	motorbike	mobile phone	colour television	HF chain	computer
computer	1.000	.196	-.062	.000	.075	.149	1.000
	.	.000	.000	.984	.000	.000	.
	6837	6837	6837	6837	6837	6837	6837
refrigerator	1.000	.196	-.062	.000	.075	.149	1.000
	.	.000	.000	.984	.000	.000	.
	6837	6837	6837	6837	6837	6837	6837
air conditioner	1.000	.196	-.062	.000	.075	.149	1.000
	.	.000	.000	.984	.000	.000	.
	6837	6837	6837	6837	6837	6837	6837
consumption water	.026	-.033	-.055	.003	.001	.000	.026
	.017	.003	.000	.763	.903	.999	.017
	6707	6707	6707	6707	6707	6707	6707
consumption water dummy	.039	-.018	-.111	-.085	-.015	.052	.039
	.001	.146	.000	.000	.217	.000	.001
	6837	6837	6837	6837	6837	6837	6837
type of toilet	.016	.017	-.179	.036	.003	-.013	.016
	.135	.107	.000	.001	.754	.229	.135
	6837	6837	6837	6837	6837	6837	6837
electric source	.022	.023	-.147	.097	.014	-.003	.022
	.069	.054	.000	.000	.228	.779	.069
	6837	6837	6837	6837	6837	6837	6837
have a credit	.038	.005	.043	.034	.013	.030	.038
	.002	.660	.000	.005	.265	.014	.002
	6837	6837	6837	6837	6837	6837	6837

Note: calculated from VHLSS 2008 dataset

Annex 2. Kendall's Tau-b correlation coefficients among categorical livelihood indicators (Cont.)

	refrigerator	air conditioner	consumption water	consumption water dummy	type of toilet	electric source	have a credit
Expenditure quintiles	.051	.051	.028	.009	.093	.077	-.009
	.000	.000	.004	.407	.000	.000	.396
	6837	6837	6707	6837	6837	6837	6837
highest diploma of household	-.014	-.014	.065	.032	.238	.111	-.024
	.228	.228	.000	.006	.000	.000	.042
	6228	6228	6111	6228	6228	6228	6228
perennial garden	.196	.196	-.033	-.018	.017	.023	.005
	.000	.000	.003	.146	.107	.054	.660
	6837	6837	6707	6837	6837	6837	6837
cart animals	-.062	-.062	-.055	-.111	-.179	-.147	.043
	.000	.000	.000	.000	.000	.000	.000
	6837	6837	6707	6837	6837	6837	6837
animal cage	.000	.000	.003	-.085	.036	.097	.034
	.984	.984	.763	.000	.001	.000	.005
	6837	6837	6707	6837	6837	6837	6837
tractor	.075	.075	.001	-.015	.003	.014	.013
	.000	.000	.903	.217	.754	.228	.265
	6837	6837	6707	6837	6837	6837	6837
engine boat	.149	.149	.000	.052	-.013	-.003	.030
	.000	.000	.999	.000	.229	.779	.014
	6837	6837	6707	6837	6837	6837	6837
water pump	1.000	1.000	.026	.039	.016	.022	.038
	.	.	.017	.001	.135	.069	.002
	6837	6837	6707	6837	6837	6837	6837

	refrigerator	air conditioner	consumption water	consumption water dummy	type of toilet	electric source	have a credit
vehicle	.196	.196	-.033	-.018	.017	.023	.005
	.000	.000	.003	.146	.107	.054	.660
	6837	6837	6707	6837	6837	6837	6837
motorbike	-.062	-.062	-.055	-.111	-.179	-.147	.043
	.000	.000	.000	.000	.000	.000	.000
	6837	6837	6707	6837	6837	6837	6837
mobile phone	.000	.000	.003	-.085	.036	.097	.034
	.984	.984	.763	.000	.001	.000	.005
	6837	6837	6707	6837	6837	6837	6837
colour television	.075	.075	.001	-.015	.003	.014	.013
	.000	.000	.903	.217	.754	.228	.265
	6837	6837	6707	6837	6837	6837	6837
HF chain	.149	.149	.000	.052	-.013	-.003	.030
	.000	.000	.999	.000	.229	.779	.014
	6837	6837	6707	6837	6837	6837	6837
computer	1.000	1.000	.026	.039	.016	.022	.038
	.	.	.017	.001	.135	.069	.002
	6837	6837	6707	6837	6837	6837	6837
refrigerator	1.000	1.000	.026	.039	.016	.022	.038
	.	.	.017	.001	.135	.069	.002
	6837	6837	6707	6837	6837	6837	6837
air conditioner	1.000	1.000	.026	.039	.016	.022	.038
	.	.	.017	.001	.135	.069	.002
	6837	6837	6707	6837	6837	6837	6837
consumption water	.026	.026	1.000	.493	.135	.113	-.004
	.017	.017	.	.000	.000	.000	.722
	6707	6707	6707	6707	6707	6707	6707
consumption water dummy	.039	.039	.493	1.000	.090	.058	-.007
	.001	.001	.000	.	.000	.000	.542
	6837	6837	6707	6837	6837	6837	6837
type of toilet	.016	.016	.135	.090	1.000	.199	-.068
	.135	.135	.000	.000	.	.000	.000
	6837	6837	6707	6837	6837	6837	6837
electric source	.022	.022	.113	.058	.199	1.000	-.006
	.069	.069	.000	.000	.000	.	.615
	6837	6837	6707	6837	6837	6837	6837
have a credit	.038	.038	-.004	-.007	-.068	-.006	1.000
	.002	.002	.722	.542	.000	.615	.
	6837	6837	6707	6837	6837	6837	6837

Note: calculated from VHLSS 2008 dataset

Annex 3. Spearman's correlation coefficients among categorical livelihood indicators

	Expenditure quintiles	highest diploma of household	perennial garden	cart animals	animal cage	tractor	engine boat
Expenditure quintiles	1.000	.082	.034	-.072	.052	.032	.033
	.	.000	.005	.000	.000	.008	.006
	6837	6228	6837	6837	6837	6837	6837
highest diploma of household	.082	1.000	.015	-.009	.118	.003	-.057
	.000	.	.246	.475	.000	.802	.000
	6228	6228	6228	6228	6228	6228	6228
perennial garden	.034	.015	1.000	-.011	.021	.089	.004
	.005	.246	.	.343	.090	.000	.745
	6837	6228	6837	6837	6837	6837	6837
cart animals	-.072	-.009	-.011	1.000	.317	-.001	-.076
	.000	.475	.343	.	.000	.957	.000
	6837	6228	6837	6837	6837	6837	6837
animal cage	.052	.118	.021	.317	1.000	.019	-.050
	.000	.000	.090	.000	.	.126	.000
	6837	6228	6837	6837	6837	6837	6837
tractor	.032	.003	.089	-.001	.019	1.000	.012
	.008	.802	.000	.957	.126	.	.322
	6837	6228	6837	6837	6837	6837	6837
engine boat	.033	-.057	.004	-.076	-.050	.012	1.000
	.006	.000	.745	.000	.000	.322	.
	6837	6228	6837	6837	6837	6837	6837
water pump	.057	-.015	.196	-.062	.000	.075	.149
	.000	.228	.000	.000	.984	.000	.000
	6837	6228	6837	6837	6837	6837	6837
vehicle	.034	.015	1.000	-.011	.021	.089	.004
	.005	.246	.	.343	.090	.000	.745
	6837	6228	6837	6837	6837	6837	6837
motorbike	-.072	-.009	-.011	1.000	.317	-.001	-.076
	.000	.475	.343	.	.000	.957	.000
	6837	6228	6837	6837	6837	6837	6837
mobile phone	.052	.118	.021	.317	1.000	.019	-.050
	.000	.000	.090	.000	.	.126	.000
	6837	6228	6837	6837	6837	6837	6837
colour television	.032	.003	.089	-.001	.019	1.000	.012
	.008	.802	.000	.957	.126	.	.322
	6837	6228	6837	6837	6837	6837	6837
HF chain	.033	-.057	.004	-.076	-.050	.012	1.000
	.006	.000	.745	.000	.000	.322	.
	6837	6228	6837	6837	6837	6837	6837
computer	.057	-.015	.196	-.062	.000	.075	.149
	.000	.228	.000	.000	.984	.000	.000
	6837	6228	6837	6837	6837	6837	6837
refrigerator	.057	-.015	.196	-.062	.000	.075	.149
	.000	.228	.000	.000	.984	.000	.000
	6837	6228	6837	6837	6837	6837	6837
air conditioner	.057	-.015	.196	-.062	.000	.075	.149
	.000	.228	.000	.000	.984	.000	.000
	6837	6228	6837	6837	6837	6837	6837
type of house	-.056	-.269	.020	.036	-.118	-.002	.033
	.000	.000	.104	.003	.000	.847	.007
	6833	6224	6833	6833	6833	6833	6833
consumption water	.035	.076	-.037	-.062	.004	.001	.000
	.004	.000	.003	.000	.763	.903	.999
	6707	6111	6707	6707	6707	6707	6707

	Expenditure quintiles	highest diploma of household	perennial garden	cart animals	animal cage	tractor	engine boat
consumption water dummy	.010	.035	-.018	-.111	-.085	-.015	.052
	.407	.006	.146	.000	.000	.217	.000
	6837	6228	6837	6837	6837	6837	6837
type of toilet	.110	.283	.020	-.201	.040	.004	-.015
	.000	.000	.107	.000	.001	.754	.229
	6837	6228	6837	6837	6837	6837	6837
electric source	.086	.120	.023	-.147	.098	.015	-.003
	.000	.000	.054	.000	.000	.228	.779
	6837	6228	6837	6837	6837	6837	6837
have a credit	-.010	-.026	.005	.043	.034	.013	.030
	.397	.043	.660	.000	.005	.265	.014
	6837	6228	6837	6837	6837	6837	6837

Note: calculated from VHLSS 2008 dataset

Annex 3. Spearman's correlation coefficients among categorical livelihood indicators (Cont.)

	water pump	vehicle	motorbike	mobile phone	colour television	HF chain	computer
Expenditure quintiles	.057	.034	-.072	.052	.032	.033	.057
	.000	.005	.000	.000	.008	.006	.000
	6837	6837	6837	6837	6837	6837	6837
highest diploma of household	-.015	.015	-.009	.118	.003	-.057	-.015
	.228	.246	.475	.000	.802	.000	.228
	6228	6228	6228	6228	6228	6228	6228
perennial garden	.196	1.000	-.011	.021	.089	.004	.196
	.000	.	.343	.090	.000	.745	.000
	6837	6837	6837	6837	6837	6837	6837
cart animals	-.062	-.011	1.000	.317	-.001	-.076	-.062
	.000	.343	.	.000	.957	.000	.000
	6837	6837	6837	6837	6837	6837	6837
animal cage	.000	.021	.317	1.000	.019	-.050	.000
	.984	.090	.000	.	.126	.000	.984
	6837	6837	6837	6837	6837	6837	6837
tractor	.075	.089	-.001	.019	1.000	.012	.075
	.000	.000	.957	.126	.	.322	.000
	6837	6837	6837	6837	6837	6837	6837
engine boat	.149	.004	-.076	-.050	.012	1.000	.149
	.000	.745	.000	.000	.322	.	.000
	6837	6837	6837	6837	6837	6837	6837
water pump	1.000	.196	-.062	.000	.075	.149	1.000
	.	.000	.000	.984	.000	.000	.
	6837	6837	6837	6837	6837	6837	6837
vehicle	.196	1.000	-.011	.021	.089	.004	.196
	.000	.	.343	.090	.000	.745	.000
	6837	6837	6837	6837	6837	6837	6837
motorbike	-.062	-.011	1.000	.317	-.001	-.076	-.062
	.000	.343	.	.000	.957	.000	.000
	6837	6837	6837	6837	6837	6837	6837
mobile phone	.000	.021	.317	1.000	.019	-.050	.000
	.984	.090	.000	.	.126	.000	.984
	6837	6837	6837	6837	6837	6837	6837
colour television	.075	.089	-.001	.019	1.000	.012	.075
	.000	.000	.957	.126	.	.322	.000
	6837	6837	6837	6837	6837	6837	6837

	water pump	vehicle	motorbike	mobile phone	colour television	HF chain	computer
HF chain	.149	.004	-.076	-.050	.012	1.000	.149
	.000	.745	.000	.000	.322	.	.000
	6837	6837	6837	6837	6837	6837	6837
computer	1.000	.196	-.062	.000	.075	.149	1.000
	.	.000	.000	.984	.000	.000	.
	6837	6837	6837	6837	6837	6837	6837
refrigerator	1.000	.196	-.062	.000	.075	.149	1.000
	.	.000	.000	.984	.000	.000	.
	6837	6837	6837	6837	6837	6837	6837
air conditioner	1.000	.196	-.062	.000	.075	.149	1.000
	.	.000	.000	.984	.000	.000	.
	6837	6837	6837	6837	6837	6837	6837
type of house	.040	.020	.036	-.118	-.002	.033	.040
	.001	.104	.003	.000	.847	.007	.001
	6833	6833	6833	6833	6833	6833	6833
consumption water	.029	-.037	-.062	.004	.001	.000	.029
	.017	.003	.000	.763	.903	.999	.017
	6707	6707	6707	6707	6707	6707	6707
consumption water dummy	.039	-.018	-.111	-.085	-.015	.052	.039
	.001	.146	.000	.000	.217	.000	.001
	6837	6837	6837	6837	6837	6837	6837
type of toilet	.018	.020	-.201	.040	.004	-.015	.018
	.135	.107	.000	.001	.754	.229	.135
	6837	6837	6837	6837	6837	6837	6837
electric source	.022	.023	-.147	.098	.015	-.003	.022
	.069	.054	.000	.000	.228	.779	.069
	6837	6837	6837	6837	6837	6837	6837
have a credit	.038	.005	.043	.034	.013	.030	.038
	.002	.660	.000	.005	.265	.014	.002
	6837	6837	6837	6837	6837	6837	6837

Note: calculated from VHLSS 2008 dataset

Annex 3. Spearman's correlation coefficients among categorical livelihood indicators (Cont.)

	refrigerator	air conditioner	type of house	consumption water	consumption water dummy	type of toilet	electric source	have a credit
Expenditure quintiles	.057	.057	-.056	.035	.010	.110	.086	-.010
	.000	.000	.000	.004	.407	.000	.000	.397
	6837	6837	6833	6707	6837	6837	6837	6837
highest diploma of household	-.015	-.015	-.269	.076	.035	.283	.120	-.026
	.228	.228	.000	.000	.006	.000	.000	.043
	6228	6228	6224	6111	6228	6228	6228	6228
perennial garden	.196	.196	.020	-.037	-.018	.020	.023	.005
	.000	.000	.104	.003	.146	.107	.054	.660
	6837	6837	6833	6707	6837	6837	6837	6837
cart animals	-.062	-.062	.036	-.062	-.111	-.201	-.147	.043
	.000	.000	.003	.000	.000	.000	.000	.000
	6837	6837	6833	6707	6837	6837	6837	6837
animal cage	.000	.000	-.118	.004	-.085	.040	.098	.034
	.984	.984	.000	.763	.000	.001	.000	.005
	6837	6837	6833	6707	6837	6837	6837	6837
tractor	.075	.075	-.002	.001	-.015	.004	.015	.013
	.000	.000	.847	.903	.217	.754	.228	.265
	6837	6837	6833	6707	6837	6837	6837	6837

	refrigerator	air conditioner	type of house	consumption water	consumption water dummy	type of toilet	electric source	have a credit
engine boat	.149	.149	.033	.000	.052	-.015	-.003	.030
	.000	.000	.007	.999	.000	.229	.779	.014
	6837	6837	6833	6707	6837	6837	6837	6837
water pump	1.000	1.000	.040	.029	.039	.018	.022	.038
	.	.	.001	.017	.001	.135	.069	.002
	6837	6837	6833	6707	6837	6837	6837	6837
vehicle	.196	.196	.020	-.037	-.018	.020	.023	.005
	.000	.000	.104	.003	.146	.107	.054	.660
	6837	6837	6833	6707	6837	6837	6837	6837
motorbike	-.062	-.062	.036	-.062	-.111	-.201	-.147	.043
	.000	.000	.003	.000	.000	.000	.000	.000
	6837	6837	6833	6707	6837	6837	6837	6837
mobile phone	.000	.000	-.118	.004	-.085	.040	.098	.034
	.984	.984	.000	.763	.000	.001	.000	.005
	6837	6837	6833	6707	6837	6837	6837	6837
colour television	.075	.075	-.002	.001	-.015	.004	.015	.013
	.000	.000	.847	.903	.217	.754	.228	.265
	6837	6837	6833	6707	6837	6837	6837	6837
HF chain	.149	.149	.033	.000	.052	-.015	-.003	.030
	.000	.000	.007	.999	.000	.229	.779	.014
	6837	6837	6833	6707	6837	6837	6837	6837
computer	1.000	1.000	.040	.029	.039	.018	.022	.038
	.	.	.001	.017	.001	.135	.069	.002
	6837	6837	6833	6707	6837	6837	6837	6837
refrigerator	1.000	1.000	.040	.029	.039	.018	.022	.038
	.	.	.001	.017	.001	.135	.069	.002
	6837	6837	6833	6707	6837	6837	6837	6837
air conditioner	1.000	1.000	.040	.029	.039	.018	.022	.038
	.	.	.001	.017	.001	.135	.069	.002
	6837	6837	6833	6707	6837	6837	6837	6837
type of house	.040	.040	1.000	-.027	-.016	-.429	-.120	.063
	.001	.001	.	.025	.188	.000	.000	.000
	6833	6833	6833	6703	6833	6833	6833	6833
consumption water	.029	.029	-.027	1.000	.549	.166	.127	-.004
	.017	.017	.025	.	.000	.000	.000	.721
	6707	6707	6703	6707	6707	6707	6707	6707
consumption water dummy	.039	.039	-.016	.549	1.000	.101	.058	-.007
	.001	.001	.188	.000	.	.000	.000	.542
	6837	6837	6833	6707	6837	6837	6837	6837
type of toilet	.018	.018	-.429	.166	.101	1.000	.225	-.077
	.135	.135	.000	.000	.000	.	.000	.000
	6837	6837	6833	6707	6837	6837	6837	6837
electric source	.022	.022	-.120	.127	.058	.225	1.000	-.006
	.069	.069	.000	.000	.000	.000	.	.615
	6837	6837	6833	6707	6837	6837	6837	6837
have a credit	.038	.038	.063	-.004	-.007	-.077	-.006	1.000
	.002	.002	.000	.721	.542	.000	.615	.
	6837	6837	6833	6707	6837	6837	6837	6837

Note: calculated from VHLSS 2008 dataset

Annex 4. Principle Component Analysis

```
FACTOR
  /VARIABLES hhsize sick_person day_sickness pc_treatment_time pcschool number_wfo number_on_farm
number_non_farm number_hhlabors agricultural_land_area housing_area house_value credit_loan remittance
  /MISSING LISTWISE
  /ANALYSIS hhsize sick_person day_sickness pc_treatment_time pcschool number_wfo number_on_farm
number_non_farm number_hhlabors agricultural_land_area housing_area house_value credit_loan remittance
  /PRINT INITIAL CORRELATION SIG DET KMO EXTRACTION ROTATION
  /FORMAT BLANK(.4)
  /PLOT EIGEN
  /CRITERIA MINEIGEN(1) ITERATE(25)
  /EXTRACTION PC
  /CRITERIA ITERATE(25)
  /ROTATION VARIMAX
  /METHOD=CORRELATION.
```

Communalities

	Initial	Extraction
household size	1.000	.666
number of household's sick person	1.000	.363
number of sickness day	1.000	.469
average day of treatment of a household member	1.000	.553
average schooling year of a household member	1.000	.429
number household member working for others	1.000	.775
number household member working on farm	1.000	.755
number household member working non farm	1.000	.897
total number of husehold labours	1.000	.914
total agricultural cultivated area	1.000	.678
area of housing	1.000	.645
value of house	1.000	.660
value of credit loan at borrowing time	1.000	.279
remittance value within year	1.000	.855

Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.688	19.198	19.198	2.688	19.198	19.198	2.637	18.838	18.838
2	1.702	12.158	31.356	1.702	12.158	31.356	1.538	10.986	29.824
3	1.292	9.227	40.583	1.292	9.227	40.583	1.267	9.052	38.876
4	1.215	8.676	49.259	1.215	8.676	49.259	1.252	8.942	47.819
5	1.040	7.425	56.684	1.040	7.425	56.684	1.211	8.649	56.468
6	1.002	7.158	63.842	1.002	7.158	63.842	1.032	7.374	63.842
7	.927	6.618	70.460						
8	.893	6.381	76.841						
9	.827	5.905	82.747						
10	.791	5.652	88.398						
11	.653	4.665	93.063						
12	.569	4.066	97.129						
13	.402	2.871	100.000						
14	7.583E-16	5.416E-15	100.000						

Extraction Method: Principal Component Analysis.

Annex 5. Multiple Correspondence Analysis

```
MULTIPLE CORRES VARIABLES=highest_diploma perennial_garden cart_animals animal_cage tractor
engine_boat water_pump vehicle motorbike mobile_phone colour_television HF_chain computer refrigerator
air_conditioner house_type consumption_water
consumption_water_nominal toilet electricity
  /ANALYSIS=highest_diploma(WEIGHT=1) perennial_garden(WEIGHT=1) cart_animals(WEIGHT=1)
animal_cage(WEIGHT=1) tractor(WEIGHT=1) engine_boat(WEIGHT=1) water_pump(WEIGHT=1)
vehicle(WEIGHT=1) motorbike(WEIGHT=1) mobile_phone(WEIGHT=1)
colour_television(WEIGHT=1) HF_chain(WEIGHT=1) computer(WEIGHT=1) refrigerator(WEIGHT=1)
air_conditioner(WEIGHT=1) house_type(WEIGHT=1) consumption_water(WEIGHT=1)
consumption_water_nominal(WEIGHT=1) toilet(WEIGHT=1) electricity(WEIGHT=1)
  /MISSING=highest_diploma(PASSIVE,MODEIMPU) perennial_garden(PASSIVE,MODEIMPU)
cart_animals(PASSIVE,MODEIMPU) animal_cage(PASSIVE,MODEIMPU) tractor(PASSIVE,MODEIMPU)
engine_boat(PASSIVE,MODEIMPU) water_pump(PASSIVE,MODEIMPU) vehicle(PASSIVE,MODEIMPU)
motorbike(PASSIVE,MODEIMPU) mobile_phone(PASSIVE,MODEIMPU) colour_television(PASSIVE,MODEIMPU)
HF_chain(PASSIVE,MODEIMPU) computer(PASSIVE,MODEIMPU) refrigerator(PASSIVE,MODEIMPU)
air_conditioner(PASSIVE,MODEIMPU) house_type(PASSIVE,MODEIMPU)
consumption_water(PASSIVE,MODEIMPU) consumption_water_nominal(PASSIVE,MODEIMPU)
toilet(PASSIVE,MODEIMPU) electricity(PASSIVE,MODEIMPU)
  /DIMENSION=4
  /NORMALIZATION=VPRINCIPAL
  /MAXITER=100
  /CRITITER=.00001
  /PRINT=CORR HISTORY DISCRIM
  /PLOT=CATEGORY(highest_diploma perennial_garden cart_animals animal_cage tractor engine_boat
water_pump vehicle motorbike mobile_phone colour_television HF_chain computer refrigerator air_conditioner
house_type consumption_water
consumption_water_nominal toilet electricity) (20) DISCRIM (20) NDIM(1,4).
```

MCA Model Summary

Dimension		Variance Accounted For		
	Cronbach's Alpha	Total (Eigenvalue)	Inertia	% of Variance
1	0.813	4.393	0.220	36.74
2	0.714	3.107	0.155	25.99
3	0.602	2.337	0.117	19.55
4	0.556	2.118	0.106	17.72
Total		11.955	0.598	
Mean	0.700	2.989	0.149	

Note: calculated from VHLSS 2008 dataset

Annex 6. Average day of treatment of a household member by expenditure quintile (day)

Duncan[a,b]

Expenditure quintiles		Subset for alpha = 0.05	
	N	1	2
near poor	1367	.97	
medium	1367	1.15	
better-off	1367		1.35
poor	1367		1.43
rich	1369		1.47
Sig.		.061	.238

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 1367.400.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Annex 7. Total number of household labours by expenditure quintile (person)

Duncan[a,b]

Expenditure quintiles		Subset for alpha = 0.05			
	N	1	2	3	4
poor	1367	3.11			
rich	1369	3.22			
better-off	1367		3.42		
medium	1367			3.58	
near poor	1367				3.85
Sig.		.114	1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 1367.400.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Annex 8. Number household member working non farm by expenditure quintile (person)

Duncan[a,b]

Expenditure quintiles		Subset for alpha = 0.05			
	N	1	2	3	4
near poor	1367	.31			
medium	1367		.43		
better-off	1367			.54	
poor	1367			.56	
rich	1369				.64
Sig.		1.000	1.000	.597	1.000

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 1367.400.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Annex 9. Total agricultural cultivated area by expenditure quintile (m²)

Duncan[a,b]

Expenditure quintiles		Subset for alpha = 0.05		
	N	1	2	3
better-off	1367	6926.92		
rich	1369	7334.02		
medium	1367	7599.71	7599.71	
poor	1367		8924.46	8924.46
near poor	1367			9549.96
Sig.		.371	.060	.374

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 1367.400.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Annex 10. Value of house by expenditure quintile (1,000 VND)

Duncan[a,b]

Expenditure quintiles		Subset for alpha = 0.05		
	N	1	2	3
near poor	1366	81675.05		
medium	1366	102477.01		
better-off	1367		138202.27	
rich	1368			217349.71
poor	1366			232956.95
Sig.		.061	1.000	.160

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 1366.600.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Annex 11. Average schooling year of a household member by expenditure quintile (year)

Duncan[a,b]

Expenditure quintiles		Subset for alpha = 0.05				
	N	1	2	3	4	5
near poor	1367	4.53				
medium	1367		5.71			
better-off	1367			6.45		
poor	1367				7.02	
rich	1369					7.27
Sig.		1.000	1.000	1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 1367.400.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Annex 12. Remittance value within year by expenditure quintile (1,000 VND)

Duncan[a,b]

Expenditure quintiles		Subset for alpha = 0.05	
	N	1	2
near poor	1367	608.34	
medium	1367	1023.41	
better-off	1367	1153.62	
poor	1367		1826.52
rich	1369		2001.67
Sig.		.121	.597

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 1367.400.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Annex 13. Expenditure per capita by expenditure quintile (1,000 VND)

Duncan[a,b]

Expenditure quintiles		Subset for alpha = 0.05				
	N	1	2	3	4	5
poor	1367	9510.5520				
near poor	1367		2492671			
medium	1367			4090821		
better-off	1367				5538964	
rich	1369					7810030
Sig.		1.000	1.000	1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 1367.400.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Annex 14. Average day of treatment of a household member by multivariate-based cluster (day)

Duncan[a,b]

TwoStep Cluster Number 2		Subset for alpha = 0.05			
	N	1	2	3	4
1	1488	.68			
3	2002		.92		
5	1448		.99		
4	1365			1.76	
2	530				3.82
Sig.		1.000	.454	1.000	1.000

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 1115.687.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Annex 15. Total number of household labours by multivariate-based cluster (person)

Duncan[a,b]

TwoStep Cluster Number 2		Subset for alpha = 0.05			
	N	1	2	3	4
2	530	2.98			
5	1448		3.15		
3	2002		3.26	3.26	
4	1365			3.34	
1	1488				4.19
Sig.		1.000	.133	.305	1.000

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 1115.687.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Annex 16. Number household member working non farm by multivariate-based cluster (person)

Duncan[a,b]

TwoStep Cluster Number 2		Subset for alpha = 0.05			
	N	1	2	3	4
1	1488	.34			
4	1365	.40	.40		
3	2002		.43		
2	530			.61	
5	1448				.80
Sig.		.124	.393	1.000	1.000

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 1115.687.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Annex 17. Total agricultural cultivated area by multivariate-based cluster (m^2)

Duncan[a,b]

TwoStep Cluster Number 2		Subset for alpha = 0.05			
	N	1	2	3	4
5	1448	4375.41			
3	2002	5379.99			
4	1365		6855.05		
1	1488			11102.35	
2	530				22870.25
Sig.		.181	1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 1115.687.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Annex 18. Value of house by multivariate-based cluster (1,000 VND)

Duncan[a,b]

TwoStep Cluster Number 2		Subset for alpha = 0.05		
	N	1	2	3
4	1365	81814.14		
1	1488	83154.52		
3	2002	102890.81		
2	530		195485.85	
5	1448			352916.23
Sig.		.089	1.000	1.000

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 1115.687.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Annex 19. Average schooling year of a household member by multivariate-based cluster (year)

Duncan[a,b]

TwoStep Cluster Number 2		Subset for alpha = 0.05			
	N	1	2	3	4
4	1365	4.74			
1	1488		6.19		
3	2002		6.34		
2	530			6.62	
5	1448				7.21
Sig.		1.000	.163	1.000	1.000

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 1115.687.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Annex 20. Remittance value within year by multivariate-based cluster (1,000 VND)

Duncan[a,b]

TwoStep Cluster Number 2		Subset for alpha = 0.05	
	N	1	2
5	1448	383.77	
3	2002	680.32	
1	1488	712.40	
4	1365	821.38	
2	530		9331.70
Sig.		.266	1.000

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 1115.687.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Annex 21. Expenditure per capita by multivariate-based cluster (1,000 VND)

Duncan[a,b]

TwoStep Cluster Number 2		Subset for alpha = 0.05		
	N	1	2	3
1	1488	3662872		
4	1365		3928645	
3	2002		4095293	4095293
2	530		4138866	4138866
5	1448			4182072
Sig.		1.000	.084	.481

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 1115.687.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.