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Analyzing Chronic Poverty in Rural Cambodia: Evidence from Panel Data

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Abstract

This paper uses four years of panel data on 793 households collected during 2001–2011 to measure chronic poverty in rural Cambodia and to identify its key determinants. A household wealth index—a proxy for long-term welfare—constructed by polychoric principal component analysis is used as welfare indicator. Both ordered logistic and multinomial logistic regression models are adopted to identify the causes of chronic and transient poverty by focusing particularly on five explanatory variables: agricultural land and livestock, demography, human capital, social capital, and natural resources. To ensure the robustness of the results, two poverty lines are applied: 40th percentile and 60th percentile of the wealth index. The findings indicate that households experiencing chronic poverty account for only 4–10 percent of the total sample, while transient poverty affects 40–52 percent. Among the total poor households, transient poverty is 84–90 percent. The ordered logistic regression model reveals that the composition of household size, the education of the household head, social capital (i.e., connection with three or more people in the community), agricultural land, and livestock are likely to be the most important factors that help the chronically poor to move into better off groups. Common property resources seem to have an opposite effect. Multinomial logistic regression model results reconfirm that household composition, particularly the number of children aged 7–14 years and females aged 15–64 years, the education of the household head, agricultural land, and livestock play an important role in reducing the likelihood of chronic poverty. It appears that education, agricultural land, and livestock would also help to reduce transient poverty. Social capital is likely to be strongly correlated with both transient poverty and being never poor.

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1. Introduction

Poverty analysis in Cambodia is based primarily on cross-sectional household survey data that provide estimates of the aggregate and static poverty rates. Poverty reduction strategies and policies drawn from these studies are likely to address poverty in the long rather than the short term. Estimates of poverty over time provide a richer picture. As discussed widely in the literature (Haddad and Ahmed 2003; Jalan and Ravallion 2000; Kedir and McKay 2003), poverty over the long term is called "chronic poverty" and poverty resulting from income shocks that is likely to be temporary is called "transient poverty." This reflects the vulnerability of the nonpoor.

Between 2007 and 2010, it is possible that the poverty rate in Cambodia increased by 1–4 percent (World Bank 2009; 2010a). Tong *et al.* (2009) also found that poverty rate in Cambodia increased between 2008 and 2009, partly because of a World Bank-predicted economic contraction of 2 percent in 2009 (World Bank 2010b). The global financial and economic crisis posed a great challenge to achieving the 2015 Millennium Development Goals (MDGs), particularly the goal of eradicating extreme poverty and hunger. In 2007, the poverty rate was 30.1 percent and, taking into account the rate of poverty decline of 1 percent per year and the increase in poverty owing to the economic crisis, the achievement of this MDG is in doubt. This implies that current poverty reduction policies are failing to protect vulnerable households from falling into poverty and to address chronic poverty efficiently. It is widely noted in the literature that different policies have different implications for transient and chronic poverty (Jalan and Ravallion 2000). Improving the capacity of the poor to earn income, for example through schooling or by increasing opportunities in the economy, is perceived to be more appropriate for reducing chronic poverty in the long run. In the short term, chronic poverty can be alleviated through social transfers. The chronically poor would also need more opportunities, protection, and support. While transient poverty can be alleviated by mechanisms that help families smooth their consumption over time—such as formal or informal insurance, or loan or income stabilization programs—these policies also have implications for chronic poverty.

In other developing countries, the study of poverty dynamics has recently increased (Jalan and Ravallion 2000; Baulch and Hoddinott 2000; Kedir and Mckay 2003; Haddad and Ahmed 2003). However, a rigorous analysis of poverty dynamics in Cambodia has never been undertaken, mainly due to a lack of panel data. This study aims to address this limitation by using seven rounds of unique panel data on 793 households interviewed in 2001, 2004/05, 2008, and 2011 in nine rural villages (two rounds in each specified year except 2011). The main objectives of this study are: (i) to deepen the understanding of poverty dynamics,

particularly the nature of chronic poverty and the processes that underpin persistent poverty; (ii) to increase the attention that researchers and policymakers give to chronic poverty and its reduction; and (iii) to contribute to the knowledge about policies and methodologies to assist the chronically poor. The results can also help policymakers to launch evidence-based and effective poverty reduction strategies. This paper is organised as follows: Section 2 reviews a selection of previous studies. Section 3 describes the characteristics of the data. Section 4 explains how to construct the wealth index and measure poverty. Section 5 provides descriptive analysis and econometric results. Section 6 presents a conclusion and discussion on policy implications.

2. Literature Review

Over the past decade, poverty studies in Cambodia have been increasing. The best known is the Cambodia Poverty Profile, which provides poverty estimates using the nationally representative cross-sectional Cambodia Socio-Economic Surveys (CSES) in 1993–1994, 1997, 1999, 2003–2004, and 2007. The latest report shows that the poverty headcount rate fell from 47 percent to 30 percent between 1993–1994 and 2007 (World Bank 2009). However, it fails to show what happened to individual households over time—the dynamics of poverty: why some households move out of poverty, why some fall into it, and why some remain there.

The *Moving Out of Poverty* study by Fitzgerald and So (2007) used two-period panel data and employed mixed methods (qualitative and quantitative). It categorized households into very poor, moderately poor (between 20% above and below the poverty line), and well-off. It found that 52 percent of households did not change their status between 2001 and 2004. About 14 percent of the very poor in 2001 managed to move to moderately poor or well-off. Approximately 7 percent of the moderately poor became very poor, while 12 percent became well-off. Some 15 percent of the well-off fell to moderately poor or very poor. The study's descriptive analysis might have ignored other useful economic information concerning simultaneous effects on the key determinants of the defined poverty measure. Therefore, the analysis led to inconclusive results.

Tong (2011), for the first time in Cambodia, attempted to analyze the key determinants of chronic and transient poverty using an econometric approach from three-period panel data on 827 households.[1] Welfare was measured by both real consumption per capita and a wealth index (which was estimated by principal component analysis). Households that had wealth

1 Tong (2011) used the same panel data set in Fitzgerald and So (2007) for the period 2001–2004.

index below the 39th percentile of the wealth index (cut-off line) in all three years were defined as chronic poor, and the transient poor were defined as those with wealth index below the cut-off line for at least one period.[2] The study found that the transient poor accounted for more than 75 percent of the total poor households.

That study also found that determinants of chronic poverty differ from those of transient poverty. Household size, particularly the number of males aged 15–64 years, household head characteristics (such as education and occupation), agricultural land, and livestock are important factors in chronic poverty but are not significant determinants of transient poverty. Only non-land assets are negatively associated with chronic and transient poverty. The study noted further that the asset approach provided a more reasonable result than a consumption approach on the key determinants of chronic and transient poverty.

There is a significant literature on poverty dynamics in other developing countries. Kedir and Mckay (2003) examined chronic poverty in urban Ethiopia using panel data on 1,500 households collected during 1994–1997. Defining the chronically poor as households with real total expenditure per adult per month below the poverty line in all three years and the transient poor as those below the poverty line in one or two of the years, they found more transiently poor than chronically poor households. Using multinomial logit regression, they argued that chronic poverty was positively associated with household composition, unemployment, lack of asset ownership, casual employment, lack of education, ethnicity, the age of household head, and a female as household head.

Haddad and Ahmed (2003) applied quintile regression to two-period panel data on 347 households in Egypt to identify the causes of chronic and transient poverty. They categorized households that had real consumption per capita below the poverty line in both periods as chronic poor, and households below the poverty line in one of the two years as transient poor. They used quintile regression to determine the causes of chronic and transient poverty and found that household size, number of members aged less than 15 years, age of household head, livestock assets, agricultural land, education of household members, and employment status affect chronic poverty. Only members aged over 60 years and ownership of agricultural land increased the likelihood of transient poverty.

Jalan and Ravallion (2000) used data on 5,854 households in south-west rural People's Republic of China over 1985–1990 to test whether the determination of transient poverty is similar to that of chronic poverty. They defined chronic poverty as having time-mean consumption below the poverty line. Households experienced transient poverty if they had

2 With the same concept, households that had real consumption per capita below the poverty line in all three years were defined as chronic poor, and the transient poor were defined as those with real consumption per capita below the poverty line for at least one period.

been poor at least once in the available data and had time-mean consumption above the poverty line. Using quintile regression, they found that age of household head, physical wealth, and ownership of cultivated land are the most important variables for transient poverty. Demographic characteristics such as household size, ages of the children, education, household members' employment status, physical wealth, and ownership of cultivated land seemed to be more important factors for determining chronic poverty.

Although the determinants of chronic and transient poverty differ slightly among countries, it is commonly noted that health and education services, asset redistribution, and infrastructure development are likely to reduce chronic poverty. Unemployment and health insurance, income stabilization programs, micro-credit, and temporary social safety nets are important when poverty is transient. To alleviate poverty, there is also a need to know the location of the two types of poverty.

3. Data and Method

This study uses Cambodia Development Research Institute's (CDRI) seven-round panel data collected in 2001, 2004/05, 2008, and 2011. CDRI first collected significant information on the three villages in 1996–1997 for a food security study. The results were published in Murshid (1998). However, the data were poorly recorded and are unlikely to be of much use for other studies. To examine the challenges of rural livelihood, in 2001, six additional villages were included in the sample. The nine villages were selected to represent livelihoods and coping strategies in four agro-climatic regions. The researchers chose the villages by initially consulting with provincial and district agricultural and planning officials and briefing them on the study's requirements. The officials then helped to identify the communes and villages that might meet the selection criteria. After selecting two or three villages in each region that met the criteria, the research team made personal visits to these villages.

Table 1: Characteristics of Survey Villages

Village	District	Province	Basic Selection Criteria
Tonle Sap plains			
Andoung Trach	Sangkae	Battambang	Substantial amount of wet season rice grown in flooded Tonle Sap, high emigration
Krasang	Thma Koul	Battambang	Substantial amount of wet season rice grown in flooded Tonle Sap, high

			resettlement of returnees from border camps
Khsach Chi Ros	Kompong Svay	Kompong Thom	Floating rice plus substantial fishing in flooded Tonle Sap
Mekong plains			
Prek Kmeng	Lvea Aem	Kandal	Dry season rice and substantial fishing
Ba Baong	Peam Ro	Prey Veng	Substantial dry season rice
Plateau			
Kanhchor	Chhloung	Kratie	Dry season rice and substantial forest dependence
Dang Kdar	Santuk	Kompong Thom	Low-yield wet season rice and substantial forest dependence
Trapeang Prei	Odongk	Kompong Speu	Low-yield wet season rice and dependence on hiring out labor
Coastal			
Kompong Tnaot	Kampot	Kampot	Low-yield wet season rice, coastal fishing and salt mining

Source: Chan and Acharya (2002)

The villages were finally chosen based on a field assessment of which would best fit the criteria (Chan and Acharya 2002). CDRI revisited the same households in those nine villages for the Moving Out of Poverty study in 2004/05, the Poverty Dynamics Study in 2008, and the Global Financial Crisis and Vulnerability project in 2011.

Tables 1 and 2 present the key characteristics of each village and village sample size in 2001. Approximately 21 percent of the original 1,005 households in the 2001 sample dropped out of the panel. The most common reason for attrition was migration. The estimated probit model showed that attrition was a more common occurrence for households in Krasang, Andoung Trach, Khsach Chi Ros, Dang Kdar, and Trapeang Prei; for households whose heads had less education; for households with fewer children aged 7–14 years; fewer livestock; and less agricultural land (Appendix 1).

Table 2: Sample Size

	Number of Households in 2001	Sample Size in 2001	Final Sample in 2011	Dropped out	% Attrition
Tonle Sap					
Andoung Trach	196	85	57	28	32.9
Krasang	228	120	83	37	30.8
Khsach Chi Ros	305	120	84	36	30.0
Mekong plain					
Prek Kmeng	339	120	105	15	12.5
Ba Baong	536	127	108	19	14.9
Plateau					
Kanhchor	278	120	104	16	13.3
Dang Kdar	306	125	97	28	22.4
Trapeang Prei	68	68	47	21	30.8
Coastal					
Kompong Tnaot	348	120	108	12	10.0
All villages	2,604	1,005	793	212	21.1

Source: CDRI rural households survey

The information collected in each round included household demographics, housing conditions, land ownership and transactions, credit markets, food and nonfood consumption, non-land assets, livestock ownership, household income, agricultural production, production expenditure, and wages and self-employment.

Tong (2011) notes that determining the change of the survey data for 2001, 2004/05, and 2008 has proven problematic. Inconsistencies have been introduced over time, and these are hard to remedy at this stage. The meaning of some questions has changed, whereas others have been combined or split to meet the purpose of the study in each round. Interviewer training and allocation could also impact on the measurement of household income and expenditure. In addition, the comparison of monetary indicators is only as valid as the deflator used. In this regard, CDRI has collected the prices of 106 food and nonfood items to construct a village consumer price index (CPI) since 2004/05. However, lack of data on commodity prices in 2001 requires assumptions regarding village inflation rates between 2001 and 2004/05. Fitzgerald and So (2007) simply assumed that the inflation rate across all villages between 2001 and 2004/05 was around 18 percent—which is unlikely to be true for villages located in different regions. Tong (2011) also assumed that the inflation rate was

approximately 17 percent. The quality of commodity price data is also poor. Therefore, real income and consumption data derived from the estimated village CPI have serious drawbacks.

Asking people about their durable assets, access to utilities, and household characteristics often provides more accurate information than do income and expenditure because these items have been accumulated over time and often have less likelihood of measurement errors.[3] In this paper, transient and chronic poverty were measured based on the combination of durable assets, access to utilities, and household characteristics as welfare indicators. Asset or wealth index were constructed to incorporate a number of such proxies into a single variable. The most popular method is to assign weights to observed variables and sum them up. In the early 20th century, Pearson (1901) and Hotelling (1933) developed principal component analysis (PCA) for the similar purpose of aggregating information (cited in Kolenikov and Angeles 2004).

One of the most influential poverty analyses using PCA to construct a wealth index was that by Filmer and Pritchett (1998). They suggested aggregating several binary asset ownership variables into a single dimension. As noted by Kolenikov and Angeles (2004), PCA is suitable only for continuous data because it was developed for samples from multivariate normal distribution and most of the theoretical results were derived under the normality assumption. However, an alternative approach to the analysis of discrete data, polychoric PCA, was well developed by Pearson and Pearson (1922) and Olsson (1979). Polychoric PCA uses maximum likelihood, similar to an ordered probit regression, to estimate the correlation between the unobserved normally distributed continuous variables from their discrete version, and has a number of advantages over PCA.

Polychoric PCA coefficients are more accurate than those estimated with PCA because the ordering of the categories is taken into account. For example, the quality of house construction or different educational level of the household head might be recorded on a 1-4 or 1-5 scale. Binary data, i.e., variables that can take one of only two values, such as gender or ownership of a car, can be viewed as a special case of ordinal data. Kolenikov and Angeles (2004) demonstrate that Filmer and Prichett's (1998) simple procedure of splitting ordinal data into binary variables introduces a large amount of distortion into the correlation matrix because the variables are automatically, perfectly, negatively correlated with each other. In addition, the ordinal information is lost because PCA treats every variable the same. Polychoric PCA solves these problems by assigning each value of a discrete variable and ensuring that the coefficients of an ordinal variable follow the order of its values. It will be used for this study.

[3] However, nonmonetary data may fail to describe short-term shocks to households.

Yaqub (2000) notes that there are two approaches to measuring chronic and transient poverty from panel data: "spell" and "component." In the spell approach (Baulch and McCulloch 1998; Gaiha and Deolalikar 1993), the chronically poor are identified by the number or length of poverty spells they experience—so that all poor households are classified as either chronic or transient. The component approach defines transient poverty as the contribution of consumption variability over time to the expected consumption poverty, with what remains being the measure of chronic poverty (Jalan and Ravallion 1998). Building on Baulch and McCulloch (1998) and Gaiha and Deolalikar (1993), we propose a five-tier system for this study:

- Always poor: Wealth index in each period below the poverty line
- One period poor: Wealth index falls below the poverty line in one of the years
- Two periods poor: Wealth index falls below the poverty line in two of the years
- Three periods poor: Wealth index falls below the poverty line in three of the years
- Never poor: Wealth index in all periods above the poverty line

These categories can be further aggregated into the chronically poor (always poor), the transiently poor (one, two, and three periods poor) and the nonpoor. We will use this approach to identify chronic and transient poverty.

We use a quantitative approach (multinomial logistic regression model and ordered logistic regression model) to identify the factors explaining total, transient, and chronic household poverty with a special focus on five factors: wealth, demography, human capital, social capital, and natural resources. The negative relationship between household wealth and poverty has been discussed widely in the literature (World Bank 1996; Jalan and Ravallion 1998). In particular, wealthier households are less likely to experience chronic poverty since they are capable of smoothing consumption over time even in the absence of large amounts of credit. In addition, they are in a better position to maintain their consumption against their assets, especially after shocks (Chronic Poverty Research Centre 2004).

Other things being equal, increased household size, i.e., dependency ratio is likely to place extra burdens on a household's assets and resources and would generally be expected to be positively related to chronic poverty (McCulloch and Baulch 2000; Jalan and Ravallion 1998). Hence, household wealth and demographic factors, i.e., characteristics of household size can be expected to be important determinants of chronic poverty. But demographic factors may hide complexity in some cases. For example, in peasant agriculture, large household size may be a benefit, enabling the family to overcome labor shortages at critical

periods. The positive relationship between education and income is also well established. Therefore, investment in education is seen as a central poverty reduction strategy in many countries. However, it is not clear whether education is a significant determinant of transient poverty. Jalan and Ravallion (1998), for example, report that educational levels of household members do not have a statistically significant association with transient poverty in the People's Republic of China. Unlike wealth, a household's human capital is one of the potential determinants of poverty that can be influenced significantly by government intervention.

Politics and the availability and accessibility of natural resources have also been identified as causes of poverty in the literature (Hulme *et al.* 2001). Bad governance can lead to bad policies, which create a discouraging environment for saving, investment, risk-taking and employment creation and it is often associated with political instability, repression, and violent conflict (Hulme and Shepherd 2003). The poor depend heavily on common property resources for both productive inputs and consumption goods. Cavendish (1999) reveals that environmental resources are higher than cash income (non-environmental income) in rural Zimbabwe; in terms of budget share, these account for 35 percent of total income—just less than that of the largest item, i.e., subsistence consumption. However, we are not aware of any published studies that focus on a specific set of these factors and examine the ways they interact to explain the incidence and nature of chronic poverty in Cambodia.

4. Construction of the Wealth Index and Measuring Poverty

The wealth index is estimated from the selected variables of the panel data. Since the questionnaire was revised in each round, only variables collected in all rounds and capturing the same meaning are included. Table 3 presents these variables with the categories for each variable and their weights. These variables can be divided into ownership of durable assets, access to utilities, and housing structure.

The estimated weight rises with the possession of durable assets and increasing access to utilities and quality of housing. For example, the weight of having no radio is negative while that of having a radio is positive. The household index score is a welfare measurement. However, the index is not adjusted for household size[4] because polychoric PCA (or PCA) techniques used to calculate the asset indices do not have units and would therefore be unsuitable for interpreting variables on a per capita basis.

4 Larger households tend to have more people working and generate more income than smaller households. This implies that larger households may have an advantage in accumulating assets so that they look wealthier, but those assets have to be shared among a greater number of people (Moser and Felton 2009).

To look into the dynamics of living standards, it is crucial to have an absolute poverty line. Tong (2011) used the poverty rate estimated by consumption data with the national survey (CSES 2003/04) as the benchmark for poverty. However, poverty analysis is very sensitive to changes in the poverty line. Hence, we choose two poverty lines for this study: the 40th percentile, which is in line with the national rural poverty rate in 2003/04, and a higher line set at the 60th percentile because some regions have a higher poverty rate than the national level and wealth index does not discriminate well at very low level.

Table 3: Variables and Weights Obtained from Polychoric PCA

Variable	**Categories**	
Radio	Does not own a radio	-0.094
	Owns a radio	0.198
TV	Does not own a TV	-0.245
	Owns a TV	0.235
Bicycle	Does not own a bicycle	-0.332
	Owns a bicycle	0.178
Motorcycle	Does not own a motorcycle	-0.199
	Owns a motorcycle	0.446
Animal cart	Does not own an animal cart	-0.078
	Owns an animal cart	0.224
Sewing machine	Does not own a sewing machine	-0.051
	Owns a sewing machine	0.558
Boat	Does not own a boat	0.022
	Owns a boat	-0.023
Plough/harrow	Does not own a plough/harrow	-0.082
	Owns a plough/harrow	0.140
Water pump	Does not own a water pump	-0.098
	Owns a water pump	0.364
Rice mill	Does not own a rice mill	-0.035
	Owns a rice mill	0.727
House	Thatch house	-0.400
	Wooden house (tin roof)	-0.030
	Wooden house (tiled roof)	0.343
	Concrete	0.955
Drinking water	Other	-0.026
	River/pond/steam	-0.004
	Protected dug well	0.010
	Piped in dwelling/tubed-piped well	0.019
Toilet	Does not own a toilet	-0.094
	Owns a toilet	0.547
Cooking fuel	Firewood collected	-0.037

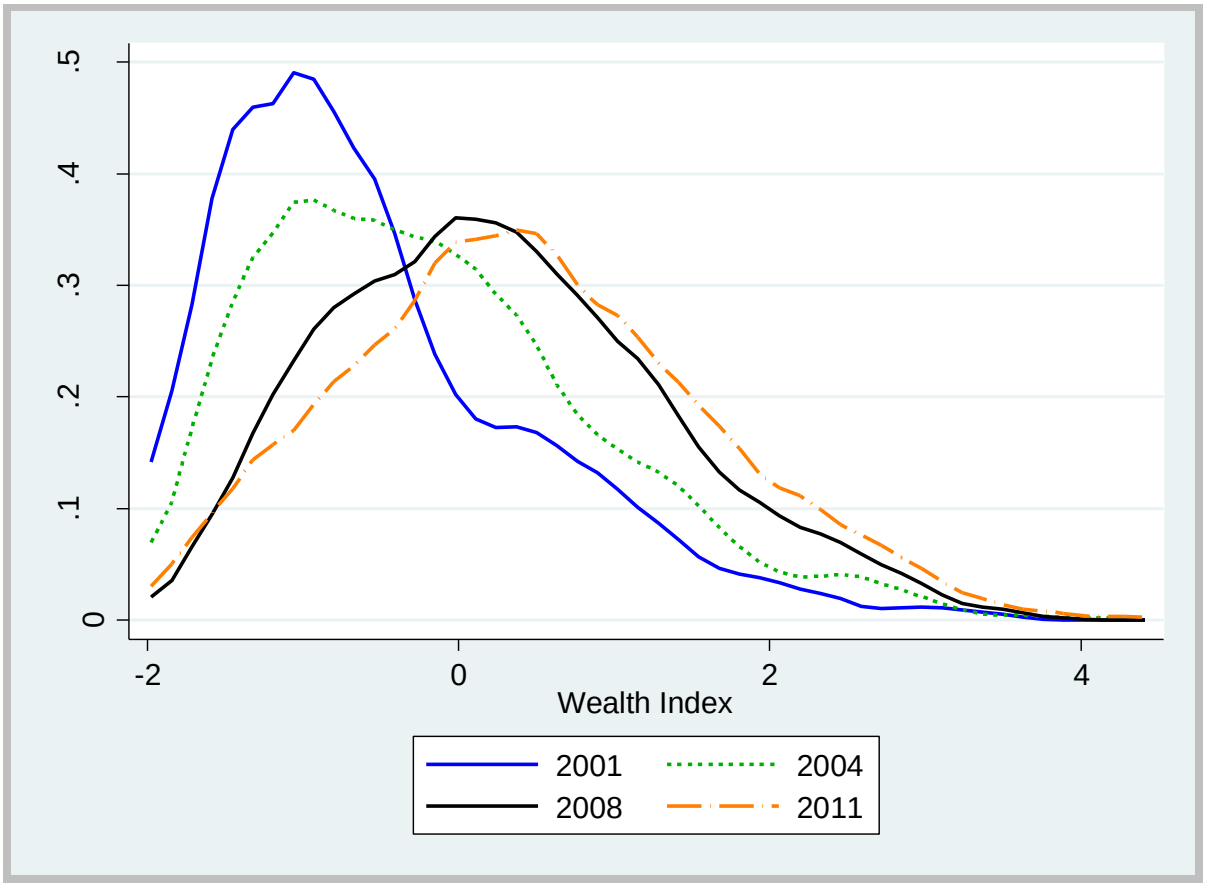
	Firewood bought	0.397
	Charcoal	0.541
	Gas	0.692

Note: Inverse probability weight is applied.
Source: CDRI rural household survey

5. Descriptive Analysis and Empirical Results

The national poverty rate, estimated by consumption, declined from 47 percent in 1993/94 to 30 percent in 2007—an average of about 1 percent per year (World Bank 2009). The kernel density distribution for a wealth index constructed by polychoric PCA for four rounds at the selected nine villages shows a similar trend. The distribution of the wealth index in 2001 and 2004 was highly skewed to the right (indicating a small number of nonpoor) but roughly normally distributed in 2008 and 2011 (Figure 1). The wealth index distribution has gradually shifted to the right—implying the improvement of welfare.

Figure 1: Wealth Index Density Estimates



Note: Inverse probability weight is applied.

Source: CDRI rural household survey

Using the 40th percentile of the asset index as the poverty line, we find that the proportion of poor households declined significantly over the following periods: from 36.7 percent in 2001 to 23 percent in 2004, to 9.8 percent in 2008, and 9.3 percent in 2011. Of the households, 56 percent were never poor and only 4 percent were poor in all rounds (Appendix 3). When a higher poverty line (60th percentile) was adopted, the proportion of poor

households declined at a slower pace except in 2011, when it dropped faster. Never poor households are reduced to 37.3 percent, while the always poor households increased to 10.2 percent. In either case, transient poverty accounts for more than 84 percent of the total poor households. This reconfirms the study by Tong (2011), which argues that tackling rural poverty in Cambodia requires a clear understanding of transient poverty.

Among the nine selected villages, Khsach Chi Ros has the largest proportion of always poor households, followed by Dang Kdar, regardless of poverty line. Transient poverty is extremely high in Khsach Chi Ros (55% of the sample), Prek Kmeng (51%), and Kompong Tnaot (42%) if the 40th percentile line is applied. The figures and ordering are different if the higher poverty line is adopted: Andoung Trach (65%), Khsach Chi Ros (61%), and Prek Kmeng (59%). However, it is obvious that different poverty statuses persist across Cambodia. This makes it essential to know the whereabouts or specific location of chronic and transient poverty at national level as it would affect the targeting of antipoverty policies.

Table 4: Household Demographics (at Initial Period) and Poverty Status

	Always Poor	**3 Periods Poor**	**2 Periods Poor**	**1 Period Poor**	**Never Poor**	**Total**
40th percentile poverty line						
Household (HH) size	4.66	5.10	6.00	6.04	6.39	6.13
Children 0–6 years old	1.06	0.85	1.08	0.99	0.90	0.95
Children 7–14 years old	0.91	1.52	1.73	1.53	1.56	1.54
Males 15–64 years old	1.13	1.09	1.31	1.49	1.86	1.64
Females 15–64 years old	1.43	1.53	1.69	1.79	1.77	1.74
Adults over 64 years old	0.13	0.12	0.19	0.23	0.31	0.26
HH head gender (1= male)	0.64	0.63	0.79	0.84	0.84	0.81
HH head age	41.63	43.42	42.13	43.90	44.22	43.74
HH head marital (1= married)	0.65	0.71	0.85	0.84	0.89	0.86
HH head education	2.20	3.04	3.34	3.81	4.23	3.88
HH head occupation (1= agriculture)	0.44	0.51	0.54	0.50	0.45	0.48
Social capital (1= 1–2 persons)	0.36	0.39	0.48	0.47	0.40	0.42
Social capital (1= 3–4 persons)	0.14	0.16	0.14	0.16	0.26	0.21
Social capital (1= more than 5 persons)	0.05	0.00	0.10	0.10	0.14	0.11
Agricultural land per capita (ha)	0.09	0.15	0.21	0.18	0.29	0.24
Non-land assets ('0000 riels)	3.51	3.99	4.85	5.32	20.21	13.48
Livestock per capita ('0000 riels)	4.47	12.51	13.28	15.86	23.86	19.40
Common property resources (1= access)	0.89	0.78	0.87	0.91	0.83	0.85
Health expenditure ('0000 riels)	22.64	43.13	33.55	32.44	32.21	32.47

60th percentile poverty line						
HH size	5.05	5.79	5.89	6.22	6.58	6.13
Children 0–6 years old	0.98	1.06	0.99	1.01	0.84	0.95
Children 7–14 years old	1.18	1.40	1.66	1.61	1.59	1.54
Males 15–64 years old	1.11	1.34	1.42	1.64	1.99	1.64
Females 15–64 years old	1.67	1.81	1.55	1.73	1.83	1.74
Adults over 64 years old	0.11	0.19	0.27	0.24	0.32	0.26
HH head gender (1= male)	0.63	0.79	0.83	0.86	0.84	0.81
HH head age	43.56	43.77	42.60	42.99	44.81	43.74
HH head marital (1= married)	0.67	0.83	0.85	0.87	0.91	0.86
HH head education	2.40	3.21	4.05	3.64	4.55	3.88
HH head occupation (1= agriculture)	0.44	0.54	0.55	0.52	0.41	0.48
Social capital (1= 1–2 persons)	0.46	0.42	0.51	0.39	0.39	0.42
Social capital (1= 3–4 persons)	0.16	0.13	0.16	0.22	0.27	0.21
Social capital (1= more than 5 persons)	0.02	0.05	0.11	0.13	0.15	0.11
Agricultural land per capita (ha)	0.12	0.18	0.21	0.21	0.32	0.24
Non-land assets ('0000 riels)	3.12	4.76	5.82	8.50	25.72	13.48
Livestock per capita ('0000 riels)	7.19	15.46	18.01	18.60	25.10	19.40
Common property resources (1= access)	0.84	0.95	0.86	0.88	0.81	0.85
Health expenditure ('0000 riels)	30.17	40.16	27.85	36.72	30.35	32.47

Note: Inverse probability weight is applied.
Source: Calculated from CDRI rural household survey

Table 4 describes household characteristics in the initial period (2001). Always poor households are often associated with smaller household size, more children 0–6 years old, and fewer adults 15–64 years old than never poor households. The head of always poor households is more likely to be younger, less educated, female, and single than that of never poor households. Always poor households have the least agricultural land, non-land assets, and livestock. They are less connected with their community than other households.

For "spell" and "component" poverty measurement, we use an ordered logistic regression model and multinomial logistic regression model to examine the factors affecting the likelihood of a household being in either of the poverty groups. The explanatory variables are human capital, land, physical assets, social capital, common property resource accessibility, and health shocks. The human capital variables are the number of children 0–6 years old; adults over 64 years old; adults 15–64 years old; and the age, education, gender, main economic activity, and marital status of the household head. Physical assets are both livestock and non-land assets. Social capital is defined as the number of people beyond close relatives who are willing and able to lend money (enough to cover consumption for the whole

family for one week) on short notice. Common property resource accessibility comprises access to forests, rivers, lakes, and sea. Health shock refers to an expenditure on health. We also include village dummies.

The dependent variable for ordered logistic regression takes the value 0, 1, 2, 3, and 4 for always poor, three periods poor, two periods poor, one period poor, and never poor. For multinomial logistic regression, the dependent variable takes the value of 0, 1, and 2 for chronically poor, transiently poor, and never poor. Tables 5 and 6 report the estimated coefficient (ordered logistic model), marginal effect (multinomial logistic model), and their statistical significance for all poverty measures.

The empirical analysis shows (Table 5) that an increased number of males and females 15–64 years old, adults over 64 years old, household head education, agricultural land, and livestock decrease the probability of being always poor. Households that are connected with three or more people in the community are more likely to be poor for only one period or to be never poor. However, we also find that the number of children 0–6 years old and household head characteristics such as main occupation in agriculture, marital status, and gender are unlikely to decrease or increase the probability of being always poor.

Table 5: Ordered Logistic Estimation of Determinants of Poverty

	40th Percentile Poverty Line	**60th Percentile Poverty Line**
Children 0–6 years old	-0.027	-0.074
Children 7–14 years old	0.096	0.180**
Males 15–64 years old	0.592***	0.637***
Females 15–64 years old	0.215**	0.248**
Adults over 64 years old	0.719***	0.733***
HH head gender (1= male)	0.110	-0.092
HH head age	-0.011	-0.018**
HH head marital (1= married)	0.306	0.555
HH head education	0.119***	0.131***
HH head occupation (1= agriculture)	-0.129	-0.291
Social capital (1= 1–2 persons)	0.102	0.021
Social capital (1= 3–4 persons)	0.903***	0.869***
Social capital (1= more than 5 persons)	0.792**	0.851***
Agricultural land per capita (ha)	0.129***	0.168***
Livestock per capita (log)	0.136***	0.126***
Common property resource (1=access)	-0.507*	-0.659**
Health expenditure (log)	-0.003	-0.010
vil_d2	0.040	-0.343
vil_d3	-0.959**	-1.076***
vil_d4	-2.472***	-2.288***

vil_d5	-1.059***	-1.181***
vil_d6	-0.977***	-0.965***
vil_d7	-1.730***	-1.416***
vil_d8	-0.631*	-0.438
vil_d9	-0.334	-0.492
Number of observations	793	793
LR chi²	268.92	258.31
Prob>chi²	0.000	0.000
Pseudo R-squared	0.1509	0.1425

HH = households

* Significant at 10 percent.

** Significant at 5 percent.

*** Significant at 1 percent.

Note: Inverse probability weight is applied.

Source: Calculated from CDRI rural household survey

Table 6 confirms that the number of children 7–14 years old and female adults 15–64 years old, household head education, agricultural land, and livestock tend to lower the likelihood of being always poor. Households connected with five or more people in the community are unlikely to be chronically poor. The table also reveals that the number of males 15–64 years old, adults over 64 years old, household head education, ownership of agricultural land, and social capital increase the probability of being never poor. In addition, households with access to common property resources have reduced probability of being never poor and increased likelihood of being transiently poor. It seems that the number of males who are 15–64 years old, household head education, social capital, and ownership of agricultural land and livestock contribute significantly to reducing transient poverty.

Although this study does not attempt to replicate the empirical results generated by Tong (2011), it provides some critical feedback on how the results have been improved by using polychoric PCA and inverse probability weights. Using the same econometric method, i.e., multinomial logistic regression, Tong (2011) found that education of the household head would increase the probability of being transiently poor—which was unlikely to be the case. This kind of unexpected result is not found in our analysis.

Table 6: Multinomial Logistic Estimation of Determinants of Poverty

	40% Percentile Poverty Line			**60% Percentile Poverty Line**		
	Chronic poor	Transient poor	Never poor	Chronic poor	Transient poor	Never poor
Children 0–6 years old	0.000	0.007	-0.008	0.005	0.010	-0.015
Children 7–14 years old	-0.014***	0.004	0.011	-0.018**	-0.003	0.021
Males 15–64 years old	-0.007	-0.105***	0.111***	-0.038***	-0.072***	0.111***

Females 15–64 years old	-0.015*	-0.015	0.031	-0.013	-0.043**	0.057***
Adults over 64 years old	-0.019	-0.112**	0.131***	-0.088***	-0.034	0.122***
HH head gender (1= male)	-0.001	0.028	-0.027	-0.036	0.117	-0.081
HH head age	0.000	0.002	-0.003	0.002	0.002	-0.003*
HH head marital (1= married)	-0.030*	-0.055	0.085	0.002	-0.130	0.127
HH head education	-0.005**	-0.013*	0.019***	-0.012***	-0.012*	0.024***
HH head occupation (1= agriculture)	0.003	0.014	-0.016	0.009	0.049	-0.058
Social capital (1=1–2 persons)	-0.012	0.000	0.011	0.004	-0.010	0.006
Social capital (1=3–4 persons)	-0.023	-0.143**	0.166***	-0.038	-0.114**	0.152***
Social capital (1=more than 5 persons)	-0.013	-0.124*	0.137**	-0.141**	0.005	0.136**
Agricultural land per capita (ha)	-0.005***	-0.015*	0.020**	-0.012***	-0.017*	0.030***
Livestock per capita (log)	-0.004***	-0.028***	0.033***	-0.011***	-0.011*	0.022***
Common property resource (1= access)	0.034*	0.115**	-0.149***	-0.004	0.164**	-0.159***
Health expenditure (log)	0.000	0.003	-0.003	-0.002	0.004	-0.002
vil_d2	0.010	0.025	-0.034	0.039	0.096	-0.135
vil_d3	0.056	0.184*	-0.240**	0.083	0.155	-0.238**
vil_d4	0.118***	0.358***	-0.477***	0.168***	0.272***	-0.440***
vil_d5	0.071*	0.133*	-0.205***	0.141***	0.036	-0.177**
vil_d6	0.066*	0.139*	-0.206***	0.120**	0.023	-0.143**
vil_d7	0.080**	0.245***	-0.325***	0.111**	0.121	-0.232***
vil_d8	0.022	0.115	-0.137***	0.046	0.028	-0.074
vil_d9	-0.355	0.351***	0.003	0.089	0.036	-0.125*
Number of observations	793			793		
LR chi^2	2484.11			248.43		
Prob>chi^2	0.0000			0.0000		
Pseudo R-squared	0.2188			0.2174		

* Significant at 10 percent.

** Significant at 5 percent.

*** Significant at 1 percent.

Note: Inverse probability weight is applied.

Source: Calculated from CDRI rural household survey

6. Conclusion

Our analysis of poverty dynamics in nine villages in rural Cambodia using a wealth index constructed by polychoric principal component analysis (PCA) has shown that households in the study villages, on average, experienced a significant improvement in the quality and quantity of their assets during 2001–2011. One may conclude that poverty, as measured by household assets, declined over the study period. The study highlights that transient poverty remains high compared to chronic poverty—registering approximately 84 percent of the total

poor households. This implies that unemployment and health insurance, income stabilization programs, micro-credit, and temporary social safety nets are the most important policies to pursue to address poverty reduction. We used multinomial logit and ordered logit regression to analyze the determinants of chronically poor, transiently poor, and never poor households, paying special attention to human capital, social capital, agricultural land, livestock, and common property resources. In general, the findings suggest that the education of the household head, agricultural land, livestock, and social capital play a critical role in reducing the likelihood of being always poor.

Appendix 1: Attrition Bias

In a longitudinal study, it is common for some participants to drop out temporarily or permanently. If the dropouts differ systematically from those who remain in the sample, the data set is no longer representative of the original sample. The result of the remaining sample may be seriously affected by attrition bias. However, if the attrition is not systematic—i.e., there are no unique characteristics among those who drop out—then there is no attrition bias, although the sample has decreased in size.

To verify differences between those who drop out and those who remain in the sample, a number of tests have been proposed, including attrition probits (Fitzgerald *et al.* 1998) and pooling tests (Becketti *et al.* 1988). Due to its simplicity, we follow the former approach.

Let variable $d_i = 1$ if y_{i2} is not observed in period 2 and $d_i = 0$ otherwise. Suppose that y_{i2} is not observed if the latent variable

$$d_i^* = \alpha X_{i1} + \beta Z_{i1} + \epsilon_i \geq 0 \qquad (1)$$

where X_{i1} is a vector of potential variables that may explain or predict the attrition, Z_{i1} is additional instrumental variables that affect only attrition and ϵ_i is an error term.

Then the probability of attrition is a probit function given by

$$Prob(d_i = 1) = \emptyset(\alpha X_{i1}; \beta Z_{i1}) \qquad (2)$$

where $\emptyset(.)$ is the standard normal distribution function. A statistically significant coefficient for any of the variables indicates attrition bias. As shown in Table 7, four of the 22 variables in the attrition probit are statistically different from zero at 1 percent level, four variables at 5 percent level and one variable at 10 percent level. Those variables are agricultural land, livestock, the number of children 7–14 years old, the education of household head, and five village dummies.

Fitzgerald *et al.* (1988) and Wooldridge (2002) proposed a simple method known as inverse probability weights to correct for attrition bias. To estimate the inverse probability weights, equation (2) is re-specified as a probit model:

$$d_i = \alpha X_{i1} + \beta Z_{i1} + \epsilon_i \qquad (3)$$

Then a restricted version of the equation is re-estimated without additional instrumental variables Z_{i1}:

$$d_i = \alpha X_{i1} + \vartheta_i \qquad (4)$$

The ratio of the predicted values from equation (4) and equation (3) gives the inverse probability weights:

$$W_i = \frac{p^r}{p^u} \qquad (5)$$

This procedure gives more weight to households that have similar initial characteristics to households that subsequently drop out than to households with characteristics that are more likely to remain in the panel.

Table 7: Attrition Probit

	Coefficients	Standard Error	Z	P>z
Agricultural land (log)	-0.059***	0.014	-4.31	0.00
Non-land assets (log)	-0.019	0.013	-1.53	0.13
Livestock (log)	-0.023**	0.011	-2.19	0.03
Children 0-6 years old	0.052	0.047	1.10	0.27
Children 7-14 years old	-0.090**	0.041	-2.21	0.03
Males 15-64 years old	-0.072	0.057	-1.26	0.21
Females 15-64 years old	-0.070	0.059	-1.18	0.24
Adults over 64 years old	-0.073	0.124	-0.59	0.55
HH head gender (1= male)	0.318	0.218	1.46	0.14
HH head age	0.007	0.005	1.45	0.15
HH head marital (1= married)	-0.196	0.215	-0.91	0.36
HH head education	-0.0316*	0.019	-1.70	0.09
HH head occupation (1= agriculture)	-0.109	0.110	-0.99	0.32
village1	0.558***	0.210	2.66	0.01
village2	0.721***	0.223	3.24	0.00
village3	0.655***	0.224	2.92	0.00
village4	0.900**	0.205	4.40	0.00
village5	0.484**	0.208	2.33	0.02
village7	-0.060	0.231	-0.26	0.80
village8	-0.013	0.225	-0.06	0.95
village9	0.298	0.215	1.38	0.17
Constant	-0.325	0.320	-1.01	0.31

Number of observations	1005
Wald chi²(21)	108.81
Prob> chi²	0.0000
Pseudo R-squared	0.1215

* Significant at 10 percent.
** Significant at 5 percent.
*** Significant at 1 percent.
Note: Robust t-statistic is reported.
Source: CDRI rural household survey

Appendix 2: Poverty Rate, 2001–2011 (percentage of households)

Village	40 Percentile Poverty Line				60 Percentile Poverty Line			
	2001	2004	2008	2011	2001	2004	2008	2011
Krasang	28.0	11.2	1.5	3.1	43.1	20.4	13.5	13.1
Andoung Trach	34.1	15.1	9.4	4.7	63.1	33.9	24.8	19.0
Trapeang Prei	29.5	23.7	4.9	9.4	58.7	40.9	9.5	11.8
Khsach Chi Ros	57.7	45.9	19.3	20.5	74.7	62.8	27.6	33.4
Dang Kdar	38.6	23.6	14.6	16.0	59.6	52.9	31.8	22.5
Kompong Tnaot	37.4	22.9	11.1	10.1	62.0	35.5	27.6	22.9
Prek Kmeng	49.7	35.8	13.9	14.0	61.2	54.3	25.0	19.9
Kanhchor	34.2	17.9	7.3	5.4	52.4	32.3	18.4	12.0
Ba Baong	16.5	9.2	3.8	2.5	35.2	20.0	11.6	9.8
Total	36.7	23.0	9.8	9.3	55.6	38.6	21.9	17.7

Note: Inverse probability weight is applied.
Source: CDRI rural household survey

Appendix 3: Poverty Status, 2001–2011 (percentage of households)

	Always Poor	3 Periods Poor	2 Periods Poor	1 Period Poor	Never Poor
40th percentile poverty line					
Krasang	0.88	2.92	4.95	21.65	69.61
Andoung Trach	1.83	7.54	5.14	23.01	62.48
Trapeang Prei	3.58	3.40	8.71	25.57	58.74
Khsach Chi Ros	10.11	11.55	24.80	18.78	34.76
Dang Kdar	7.39	6.20	9.61	25.39	51.42
Kompong Tnaot	4.55	3.46	13.99	24.87	53.12
Prek Kmeng	6.60	7.72	20.42	23.01	42.25
Kanhchor	1.96	5.24	9.66	21.82	61.32
Ba Baong	0.00	2.00	4.99	15.96	77.05
Total	4.00	5.21	12.39	22.27	56.12
60th percentile poverty line					

Krasang	3.80	6.34	17.09	21.74	51.03
Andoung Trach	10.05	6.90	21.47	36.92	24.66
Trapeang Prei	9.51	2.33	22.34	31.22	34.60
Khsach Chi Ros	19.45	14.65	29.97	16.86	19.07
Dang Kdar	15.28	13.71	21.42	21.61	27.98
Kompong Tnaot	13.71	11.96	16.70	23.81	33.82
Prek Kmeng	11.18	14.00	28.11	17.37	29.34
Kanhchor	7.54	12.46	12.63	22.33	45.04
Ba Baong	4.62	4.70	7.34	29.33	54.00
Total	10.28	10.98	18.41	22.96	37.37

Note: Inverse probability weight is applied.

Source: CDRI rural household survey

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