Households' Incomes and Poverty Dynamics in Rural Kenya: A Panel Data Analysis

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Contents

List of tables

List of figures

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Abstract

Most of the earlier studies on poverty in Kenya have been static, focusing on poverty incidence, gap and severity at a point in time. Whereas such studies provide valuable information on poverty characteristics and distribution, they do not necessarily provide a good indicator of welfare stability over time. This study is an addition to the few existing poverty dynamics studies in Kenya. It attempts to analyse rural households' income and poverty incidence over time. The analysis uses balanced panel data of 1,299 households in rural Kenya. The results reveal considerable regional welfare disparities and dynamics over time in rural Kenya. The geographical locations where the households are situated matter. The welfare dynamics are associated with demographic factors such as households' dependency burdens, gender and the education attainment of the household heads. Households with high dependency ratios and those under single-female headship are more likely to transition into poverty. The finding underscores the increasing importance of post-secondary education in the welfare of rural households. The success of any education policy in reducing poverty hinges on participants excelling beyond secondary schools and acquiring skills that are in demand on the job market. The results also highlight the increasing importance of the land resource in the rural areas. However, with shrinking land sizes due to increased population pressure, access to more land is not an option. The panacea is sustainable agricultural intensification and diversification to off-farm incomes. Perhaps the most disturbing finding is the effect of rainfall shocks on household welfare. While the amount of rainfall somehow increases household income, rainfall variability significantly reduces incomes, therefore, predisposing households to poverty. This is perhaps an indicator of the harmful effects of global warming and increased weather variability on agricultural-based households in sub-Saharan Africa. Finally, the study shows the importance of improved access to infrastructure and markets on rural household welfare. Consequently, the capability of the devolved development programmes to pull the consistently poor out of poverty is put on spotlight.

Key words: *Poverty, income dynamics, poverty dynamics, panel data, Kenya*
JEL classification: *C23, D31, D63, I30, I32*

1. Introduction

Over the past two decades, the goal of economic policy in Kenya has been mobilization and efficient utilization of national resources to achieve high economic growth and reduced poverty levels. Thus, various policy documents have been developed. The most famous was the Poverty Reduction Strategy Paper (PRSP) (Republic of Kenya, 2001). The PRSP was a product of broad-based and in-depth consultations among key stakeholders, in particular the poor. It outlined the priorities and measures necessary for poverty reduction. The PRSP was congruent to the long-term vision outlined in the National Poverty Eradication Plan (NPEP) and the United Nations' endorsed Millennium Development Goals (MDGs). The PRSP was central to the development of the Medium Term Expenditure Framework (MTEF) budgeting system that started in 2000/01. The MTEF budget aimed at improving the quality of expenditure by shifting resources towards pro-poor activities and programmes.

In 2003 the government came up with a broad nationwide development framework, the Economic Recovery Strategy for Wealth and Employment Creation (ERS) (Republic of Kenya, 2003). The ERS initiated some pro-poor programmes such as free primary education; the constituency development fund (CDF); and the local authorities transfer fund (LATF). The funds under CDF and LATF go directly to local levels, providing the people at the grassroots the opportunity to make expenditure decisions that maximize their welfare (Kimenyi, 2005). In 2008, the government launched Kenya Vision 2030, a long-term development plan (Republic of Kenya, 2008). This policy document proposes a variety of pro-poor investments, especially in the health and education sectors.

Despite all these poverty reduction efforts, poverty levels remain pervasive in the country. According to the Kenya National Bureau of Statistics (KNBS) 2006 Kenya Integrated Household Budget Survey (KIHBS) report, the national absolute poverty incidence was estimated at 45.9% while the absolute rural poverty stood at 49.1% (Republic of Kenya, 2007). According to this report, there are pockets of very high poverty that exceed the national average in some regions with North Eastern and Central provinces having the highest and lowest poverty incidence respectively. The high poverty incidence has created a continued desire for empirical studies and generation of new knowledge to inform poverty reduction strategies. Several problems have been attributed to the failure of poverty reduction efforts. Key among these is the lack of implementation of the formulated poverty reduction plans (Kristjanson et al, 2010).

While the aggregate national poverty indicators may be high, poverty is a dynamic phenomenon: the poor are not poor all the time (Yaqub, 2000). They experience many movements in and out of poverty. If researchers and policy makers knew more about

welfare pathways along which households move into and out of poverty and why they do so and the reasons why some households remain consistently trapped in poverty, this could go a long way in informing poverty reduction strategies and programmes. Consequently, this study is motivated by the need to understand the factors enabling households to move out of poverty and those that predispose households into poverty. The study uses household panel survey data collected in 2000, 2004 and 2007 to identify four types of rural households: (1) those that consistently remained poor through the panel period; (2) those that were poor in two spells; (3) those that were poor in one spell; and (4) those that consistently remained non-poor throughout the seven-year panel period. Specifically, the study examined the factors associated with these four welfare groups.

2. Review of selected literature on poverty dynamics

Most of the earlier studies of poverty in Kenya have basically been static in nature: focusing on poverty indices and construction of poverty profiles a point in time (e.g. Bigsten, 1981; Hazlewood, 1981; House and Killick, 1981; Foster et al, 1984; Mwabu et al, 2000; Manda et al, 2001; Geda et al, 2001; and Oyugi et al, 2000) while others have examined regional, institutional and spatial determinants of poverty in Kenya (Kabubo-Mariara et al, 2005; Okwi et al, 2006). Whereas such studies provide very valuable information on poverty characteristics and distribution, they do not necessarily provide a good indication of household welfare dynamics over time and the determinants of such dynamics. Many movements occur in and out of poverty and within poverty itself, with some households remaining consistently trapped in poverty. Inter-temporal household income mobility—who is getting ahead, who is falling behind, who is standing still, and why—is a subject that is less examined, partly due to the lack of reliable panel data sets (Woolard and Klasen, 2004). The injection of the time element in data opens many analytical possibilities. It makes it possible to study household welfare pathways along which households move into and out of poverty and why they do so (Haddad and Ahmed, 2003). It also makes it possible to examine how certain initial conditions and other factors that change over time affect household welfare pathways.

While the literature on poverty analysis is vast and rich, we only reviewed studies that are relevant to this study. The aim was to examine the methods used and how the results are relevant to the Kenya context. Common approaches to the subject of income and poverty dynamics have been the use of transition matrices, and binary and multinomial limited dependent models (Okidi and McKay, 2003; Woolard and Klasen, 2004; Badiani et al, 2007; Bokosi, 2007; Quisumbing, 2007). These studies found that poverty is not only location-specific but it also depends on various initial household characteristics. Generally, the results indicate that education of the household head; per capita acreage cultivated; changes in household size; and household assets are significantly related to the probability of being poor. However, transition matrices analysis and multinomial models have limitations. While transition matrices describe the condition of being poor, rather than considering how or why the condition exists, multinomial models impose the property of "independence of irrelevant alternatives" (McFadden, 1973). This means that relative probabilities for any two alternatives depend only on the attributes of those alternatives.

Focusing specifically on Kenyan literature, past research has shown that factors that influence poverty and income dynamics are universally comparable to those of other developing countries (Place et al, 2003; Krishna et al, 2004; Kristjanson et al,

2004; Burke et al, 2007; Muyanga et al, 2007; Suri et al, 2008; Muyanga et al, 2013). The scantiness of panel data is the main attribution to the lack of poverty and income dynamic studies in Kenya. .

This study is, therefore, an addition to the few existing poverty dynamics studies in the region. It is different from earlier works on poverty dynamics in Africa, and particularly in Kenya, in several ways. First, most of these studies are based on only two or three waves of short panel data covering fairly short periods of analysis (Place et al, 2003; Kristjanson et al, 2004; Krishna et al, 2004; Burke et al, 2007). Because many households tend to experience temporary movements into and out of poverty, a permanent movement across the poverty line is indistinguishable from temporary movements when only short panels are available. Thus, short panels are unable to detect longer-term asset accumulation processes that occur over a decade or longer. This study covers a 10-year period, which makes it possible to detect long-term trends and distinguish them from transitory movements. Second, some of the past studies are limited in scope and analysis. Most of them focus only on some regions and use relatively small sample sizes. To circumvent data deficiencies, some of them adopt unusual approaches and methodologies. Existence of such studies notwithstanding, continued analysis will be important in the light of the rapidly changing economic and market scenarios for assessment and policy reorientation at the inception of every policy regime. In this study, we attempt to overcome these limitations by using a rich data set that is representative of the rural population in Kenya at agro-ecological zones level.

3. Data source and variables

The analysis uses a balanced panel data from Tegemeo Institute drawn from 1,299 rural households. The data were collected by Tegemeo Institute (Egerton University) and Michigan State University (MSU) under the TAMPA project funded by the United States Agency for International Development (USAID). Administratively, the households span 24 districts, 39 divisions and 120 villages. The sampling was done within a framework of incorporating the ecological diversities that are inherent in the country to ensure that the emerging sample was representative. Agro-ecological zoning brought together areas with similar ecological characteristics, thus livelihoods (Appendix 1).

The arid region, which mainly comprises districts in northern eastern region of the country, was covered in the first wave (1997) only. This was due to logistical and insecurity problems given that the communities living in this area are nomadic pastoralists moving from one place to another in search of pasture and water, and that poor infrastructure and cattle rustling characterize the region. Hence, it was not feasible to re-interview them in the subsequent waves of the panel. A quick survey of about 80 panel households was carried out in August 2008. The purpose of this survey was to corroborate the panel data and assist in the interpretation of the current study findings. The survey included a sub-sample of households that started poor and ended up non-poor; those that started non-poor and ended up poor; and those that either remained consistently poor or non-poor.

Even though the panel consists of four waves (1997, 2000, 2004 and 2007), only data from three waves (2000, 2004 and 2007) were found useful in this study. Whereas the original sample comprised 1,500 households, only 1,299 households consistently remained in the sample in 2000, 2004 and 2007. The attrition arose mainly as a result of dropping the northeastern region. The average attrition rate between any two consecutive rounds was about 5%. Jin and Jayne (2011) estimated re-interview models to assess the degree to which attrition could be a problem in this panel data. While their results are not presented here due to space limitation, the authors found that the observed attrition is largely random. Accordingly, this study did not worry about selection biases caused by attrition, although efficiency was somehow lost because of the reduced sample size.

4. Conceptual framework

Understanding poverty involves not only how it is measured, but more importantly the underlying determinants and dynamics in order to design policies that can contribute to poverty reduction. In this study, we examined the factors that influence household welfare pathways over the seven-year panel period. Following Woolard and Klasen (2004), the model used is derived from the standard household utility maximization model with adult equivalent household income as a money metric measure of utility. Even though most of the previous studies on poverty have used consumption data based on its appropriateness in measurement of household welfare (ill-fare) as per the economic theory, data on consumption were unavailable[1]. The underlying assumption in this model is that household income is a function of household assets (both physical and human) and the economic environment in which these assets can be utilized to generate income (Woolard and Klasen, 2004).

Household income is derived as the sum of both farm and off-farm incomes. Since most of the rural households derive most of their income from agriculture, the panel data survey instrument has a comprehensive crop and livestock module capturing all crops planted and livestock kept, production inputs costs and of the outputs. Off-farm income included proceeds from employment, business, remittances and pension accruing to retired household members. The summary statistics of the other variables in the analysis are presented in Appendix 2. The Consumer Price Index published by the Kenya National Bureau of Statistics (KNBS) was used to deflate nominal aggregate household incomes to real income to cater for price inflationary effects, especially for the 2004 and 2007 household incomes to bring them to the same level as the 2000 incomes. Next, the real household real income was adjusted for the number of equivalent adults and gender of household members available in the household using the World Health Organization (WHO) adult equivalent scales[2]. These scales are derived from detailed studies of the nutritional requirements of males and females of different ages in developing countries. At time t, our measure of income for household i, denoted by y_{it} is:

$$y_{it} = \mathcal{H}\frac{\sum_{h=1}^{H_i} Z_{hit} + \sum_{k=1}^{K} w_{kit}}{\sum_{k=1}^{K} q_{kit}}, \forall\ i = 1,2,...,N\ ;\ t = 1,2,...,T \qquad (1)$$

where Z_{hit} is the income accruing at the household level from H_i different sources (for example, crop income) and w_{jit} is the income of each household member (for non-earning members income is zero) summed over the household size K_i, all divided by the sum of equivalent adults q_{jit} in the household.

To determine whether a household was poor in any of the three survey waves, we used the food poverty line. The food poverty line is the cost of consuming the 2,250 kilocalories per day per adult recommended by the Food and Agriculture Organization of the United Nations (FAO) and WHO. In Kenya, the poverty line estimate was computed by extrapolating from the Kenya National Bureau of Statistics (KNBS) rural poverty lines for 1997 and 2006, which were Ksh1,239/month and Ksh1,562/month respectively. The resulting poverty line for 2007 was Ksh1,598/month (Ksh19,176/year). Based on household poverty status in 2000, 2004 and 2007, the household welfare trajectories were identified (Figure 1). We then used econometric techniques to determine factors associated with these trajectories.

Estimation strategy and empirical model

To evaluate the determinants of per adult equivalent household incomes over the panel period, we used panel data estimation techniques. Having data over time for the same cross section units is useful because it allows us to control for the unobserved cross-section heterogeneity. These include unobserved time constant effects such as ability, motivation and other household level factors that do not change over time. For example, household head's level of education is likely to be correlated with the unobserved ability or talent. Following Wooldridge (2010), the unobserved population panel data model for a randomly drawn cross section observation *i* is specified as follows:

$$y_{it} = x_{it}\beta + c_i + u_{it},\ t = 1,2,..,T,\ i = 1,2,..,N \tag{2}$$

where, the dependant variable y_{it} is the real per adult equivalent income, x_{it} is a vector of both household level and community-level variables, β a vector of the parameters to be estimated, c_i is the unobserved effects while u_{it} is the random disturbance. We assume x_{it} allows for a full set of the time period intercepts, and that u_{it} is uncorrelated with the elements of x_{it} and has a zero mean.

How we estimate Equation 2 depends on the assumption we impose on c_i. There are two major panel data models, fixed and random effects models. The fixed effects model allows arbitrary dependence between c_i and the explanatory variables. One of the key advantages of panel data is that it allows the fixed effect factor to be removed from Equation 2 through fixed effect estimation. The main drawback of the fixed effects model is that it is not possible to estimate the impact of time-constant variables. If there are sufficient grounds to assume that the unobserved heterogeneity is uncorrelated with any of the explanatory variables in all time periods, then estimator of Equation 2 using fixed effect estimation is not efficient. Instead, an alternative method, a random effects model, is used. Equation 2 is rewritten as follows:

$$y_{it} = x_{it}\beta + v_{it} + u_{it},\ t = 1,2,..,\ T\ ,\ i = 1,2,..,\ N \tag{3}$$

where $v_{it} = c_i + u_{it}$ is a composite error. Even if we are willing to assume that u_{it} is serially uncorrelated, v_{it} is likely to be serially correlated because of the presence of c_i component in each period. Generalized least squares (GLS) is used to handle the problem of serial correlation in v_{it}. If we assume the random effects assumption hold, then the pooled ordinary least square (OLS) estimator is also available. However, the standard errors and hypotheses testing must be made fully robust to arbitrary serial correlation and heteroscedasticity.

Even though the random effects specification allows the inclusion of time-constant variables, the assumption that the fixed effect factor is uncorrelated with the explanatory variables is often not plausible. Besides, the random effects model imposes a particular variance covariance structure. To overcome these shortcomings of both fixed and random effects estimators, Mundlak (1978) and Chamberlain (1984) propose a framework known as the correlated random effects (CRE) or the Mundlak-Chamberlain device. This approach allows modeling in the following way:

$$c_{\mathrm{i}} = \overline{x}_i\psi + \omega_i,\ \omega_i \mid x_i \sim N(0,\ \sigma_\omega^{\ 2}),\ i = 1,2,..,\ N \tag{4}$$

where $\overline{x}_i$ represents the time-averaged x_{it} over the various panel periods. The CRE estimator, however, requires the model to have a standard normal distribution, and strict exogeneity conditional on c_{i}. While the parameter estimates β are interpreted as the short-run effects the estimates ψ are interpreted as the long-run effects of the explanatory variables on the dependent variable. The main benefits of the CRE estimator are that: (1) it controls for unobserved time-constant heterogeneity as with fixed effects; and (2) by including time-average terms we can measure the effects of time-constant independent variables.

Since the primary motivation for panel data applications is to solve the omitted variables problem associated with the existence of unobserved individual or household effects, it makes sense first to test for the presence of the unobserved effects. Wooldridge (2010) proposes a simple AR(1) serial correlation test. Since it is assumed that the variance of v_{it} in Equation 3 is $\sigma_v^2 = \sigma_u^2 + \sigma_c^2$, then the null hypothesis of the absence of unobserved effects is, $H_o : \sigma_c^2 = 0$. To implement the test, we first estimate model (3) using the random effects estimator and using the regression residuals, $\hat{v}_{it}$, run the auxiliary regression:

$$y_{it} = x_{it}\beta + \rho\hat{v}_{i,t\text{-}1} + \varepsilon_{it},\ t = 2,..,\ T\ ,\ i = 1,2,..,\ N \tag{5}$$

where ε_{it} the error term. A standard t test, robust to arbitrary heteroscedasticity, on coefficient ρ is sufficient and valid under the null $H_o : \rho = 0$. If the null holds then by implication $H_o : \sigma_c^2 = 0$ also holds. If the null is not rejected, the pooled OLS is efficient and the pooled OLS statistics are asymptotically valid. If the null is rejected, then we

appeal to the Mundlak-Chamberlain CRE estimator, Equation 4. The simple AR(1) serial correlation test was implemented and we obtained a $\hat{\rho} = 0.34$ and $t_{\hat{\rho}} = 4.31$, consequently the null, $H_o : \sigma_c^2 = 0$ is rejected. This implies that use of pooled OLS or OLS survey-by-survey and random effects models are inappropriate. Consequently, we estimate Equation 2 using the CRE estimator.

The dependent variable y_{it} is the household income per adult equivalent (in Ksh). The choice of the explanatory variables is informed by past studies and conditioned on data availability. The following variables are used as covariates in the econometric models: (1) demographic variables such as household dependency burden, household head's age (years), gender, marital status and education attainment; (2) household per capita landholding size in acres; (3) distances to the nearest input markets, services and infrastructure; (4) rainfall amount and variability; (5) dummies capturing the agro-ecological zone; and (6) year dummies to capture other aggregate time effects that are not controlled for by the other variables.

To examine the factors behind sustained poverty escapes we use a sequential logit model from the three-wave panel data (Baulch and Hoang Dat, 2011). This model imposes structure on poverty dynamics. In this case, the model consists of seven logit models which are estimated in the order in which households would make poverty transitions (Figure 1). While the dependent variable in is the households welfare trajectory as indicated in Figure 1, the vector of explanatory variables (x) remains as explained in the foregoing paragraph, but this time measured at baseline.

5. Results and discussions

Poverty transitions and profiles

As a prelude to the econometric analysis results, we present some descriptive analysis results. The mobility of household incomes between quintiles using a transition matrix is presented in Tables 1 to 3. The rows show household income distribution in quintiles in initial period, t_1. The columns show household income distribution the last period, t_2. The results reveal considerable rural households' income dynamics. For example, out of the 259 households classified as the 20% poorest in 2000, only 40% remained in that category in 2004 (Table 1). Other households experienced increase in incomes with some nine households being categorized among the 20% wealthiest households in 2004. Similarly, out of the 260 households classified under the 20% wealthiest households in 2000, only 51% remained under this category in 2004. Other households experienced considerable decline in incomes with about 5% of them ending up among the 20% poorest group in 2004.

Similar dynamics are observed when we consider household welfare transitions between 2004 and 2007 (Table 2). For example, out of the households in the lowest (poorest) income quintile in 2004, only 46% of them remained in that category in 2007. Likewise, out of the households in the highest (wealthiest) income quintile in 2004, only 57% of them remained under that category in 2007. The rest experienced decline in incomes with nine households emerging among the 20% poorest in 2007.

Tables 3 to 5 present poverty incidence (headcount), gaps and severity over panel period[3]. Generally, the results indicate that poverty levels have declined considerably over the panel period. In 2000 about 75% of the households lived below the absolute poverty line (Table 3). This percentage reduced to 57% in 2004, and 47% in 2007. Although the 2000 poverty index might seem to be on the higher side, considering that this is the year when the country's economic growth hit negative 0.3%, the results are not surprising. Next, we break down the results first by the agro-ecological zones and second by the administrative provinces where the households are located. The Western lowlands maintained the highest poverty rates in all the panel surveys while the Central highlands region had the lowest. In terms of the relative contribution to national poverty, the Coastal agro-ecological zone made the highest contribution in all the panel survey years. Similar poverty trends are observed when we look at the results by the old provinces (we use the old provincial classification to make our results comparable to earlier studies). Nyanza Province, which largely constitutes the Western lowlands agro-ecological zone, had the highest headcount poverty while Central Province, a subset of the Central highlands agro-ecological region,

had the lowest poverty rates. In terms of relative contribution to national poverty, Coast Province contributed the largest percentage while Rift Valley contributed the least.

The national poverty gap and severity indexes mimic the poverty head count ratios (Tables 4 and 5). The national poverty gap index declined from 0.44 in 2000 to 0.29 in 2004, and 0.19 in 2007 (Table 4). The poverty gap is loosely interpreted as the amount of money required to get those below the poverty line out of poverty. The Western and Coastal lowlands agro-ecological zones had the highest poverty gaps in all the panel surveys. Central agro-ecological zone had the lowest poverty gaps. Similar patterns appear when we break down the results by province. The results further show that the squared poverty gap (severity) index also declined significantly from 0.31 in 2000 to 0.18 in 2004, and 0.11 in 2007 (Table 5). Poverty remains more severe in the same regions with the highest headcount and poverty gaps such as the western and the coastal lowlands. It is important to mention that even though poverty gaps and severity have remained high in some regions, the incidence considerably decreased between 2000 and 2007.

As a robustness check of the poverty incidence results, we present Foster-Green-Thorbecke (FGT) (Foster et al, 1984) curves[4] in Figures 1 to 3. The FGT curves are useful distributive tools that show how the level of poverty varies with different poverty lines and also indicate poverty dominance between distributions. The results confirm our immediate findings. The 2000 survey distribution headcount poverty (Figure 1), poverty gap (Figure 2) and poverty severity (Figure 3) dominate both the 2004 and 2007 distributions across the entire range of poverty lines. The 2004 distribution dominates the 2007 distribution too. This is a confirmation that poverty levels generally declined in rural Kenya over the panel period.

Poverty dominance curves at the agro-ecological level (figures not presented here but available from the authors upon request) show that the Western lowlands dominate other regions while the central highlands agro-ecological zone clearly maintains low poverty levels across the entire range of poverty lines. No clear dominance is exhibited when we look at the distribution curves of other regions. This means that whether a region is considered poor or non-poor compared to the others depends to a large extent on the choice of the poverty line. As we move from 2000 to 2007, the curves become flatter implying poverty incidence generally declined over the panel period. Similarly, comparable trends emerge when we consider poverty gaps and severity dominance curves across regions (figures not presented here but available from authors upon request).

Generally, the poverty dominance curves at the agro-ecological and provincial administrative levels over the panel period reveal some interesting dynamics. First, no clear poverty dominance is exhibited across the regions in 2000. Then, the curves become relatively flat over the panel period, implying reduced poverty incidence across the regions. The Central highlands manage to steer away from high poverty incidence, while two "clubs" of poverty, high and low, are clearly established. The members of the low poverty club are generally the households that are located in the high potential agro-ecological zones, areas characterized by stable livelihoods. Membership to the high poverty club comprises households located in the lowlands, areas characterized by agriculturally unproductive land, rainfall unreliability and thus prone to natural catastrophes such as drought and famine. While one would have expected the Western highlands to remain in low poverty club, it did not. This could be attributed to the

extremely high population densities characteristic of this region and the attendant diminishing land sizes as well as probable back-wash effect as a result of its close proximity to the high poverty Western lowlands.

Next we present results from poverty spells analyses. Households are classified into four groups based on possible welfare (ill-fare) status over the panel period. The classification is as follows: households that remained consistently above the absolute poverty line in the entire three panel surveys; households that had one spell below the poverty line; households that experienced two spells; and households that remained consistently below the absolute poverty line. Households that consistently stayed non-poor and those that remained consistently poor represent 36% and about 19% of the sample respectively (Table 6). About 21% of the households had two spells below the absolute poverty line while 24% had only one spell. From the agro-ecological perspective, patterns similar to those that obtained in the poverty incidence analysis emerge (Table 6). About 73% of the households located in the Central highlands agro-ecological zone stayed consistently non-poor. The high potential maize zone followed with the highest consistently non-poor households (42%). At the end of the spectrum, Western lowlands (37%), Western highlands (32%) and the Coastal lowlands (30%) agro-ecological zones had the highest percentage of households within each region that stayed consistently poor over the panel period. From the provincial administrative perspective, similar poverty patterns emerge. Central (66%) and Eastern (55%) provinces had the highest number of households within each region that stayed consistently non-poor. However, 35% and 33% of households in Nyanza and Coast provinces respectively were consistently poor within each province in the period under consideration.

To conclude this section, we compare poverty estimates from our study with those from previous studies carried out during the same period. Even though our sample size is smaller than that of the KNBS 2006 KIHBS (Appendix 3), the poverty incidence estimates are generally comparable. The KIHBS rural poverty estimate for 2006 was 49% while the estimate from this study for 2007 put it at 47%. Further, both our study and the KIHBS results indicate that Central Province had the least absolute poverty with KIHBS putting it at about 30% while this study estimated it at about 10%. According to the KIHBS results, Coast Province registered the highest absolute poverty level (70%). According to this study, Nyanza Province had the highest absolute poverty (60%) followed by the Coast Province. Similarly, the findings from this study are also congruent with some other past studies that found rural poverty in Nyanza more severe than in all other parts in the country (Society for International Development, 2004).

Finally, these results reveal that rural household incomes do not remain stable across space and over time. There are significant regional poverty incidence differences and considerable household income dynamics over time in rural Kenya. These dynamics are the important policy insights observable from panel data analysis that studies based on single cross-sectional data will never reveal.

Econometric analysis results

In this section, econometric analysis results are presented and discussed. The results from the CRE estimation are presented in Table 7. The dependant variable is the log

of real per adult equivalent income in '000 Kenya shillings. Both the CRE short-run and long-run elasticities, as explained in the methods section, are presented. The results indicate that several variables conform to the theoretical expectations. Among the most important demographic correlates of household incomes are the dependency ratio, gender and education attainment of the household head. Household incomes are a decreasing function of the household dependency burden in the long run. A switch in the dependency ratio from 0 to 1 decreases the household mean income by about 21% in the long run. The results also indicate that a move from monogamous family to single female headship decreases household mean income by about 10% in the short run and about 13% in the long run. However, the short-run single female headship coefficient is only significant at 10% level. Single female headship is a result of widowhood, divorce, abandonment, and single parenthood. Consequently, such households are more disadvantaged in terms of human resource availability compared to the male-headed counterparts.

As far as household head's education is concerned, the most notable observation is the importance of post-secondary education in household incomes. A switch from households headed by a person without formal education to that of a person with post-secondary education increases household income by about 28% in the long run. The results also show that an increase in per capita landholding by one acre increases household incomes by about 7% in the short run and about 11% in the long run. Perhaps this finding underscores the increasing importance of land in the rural areas. With the increasing population densities and the high prices of productivity enhancing agricultural inputs, return on additional land is going to remain high and perhaps on the upward trend in the foreseeable future.

Next we turn to the effect of proximity to markets, social services and infrastructural facilities on household income. The results indicate that proximity to electricity supply increases household incomes both in the short run and in the long run. This finding may be attributed to two possible effects: first, access to usable electric power is important in stimulating rural economic growth. It opens up new income opportunities, especially in agricultural primary products value addition. Secondly, the variable could be capturing the effect of other income earning opportunities that come along with the electricity supply. Other important services, though significant at only 10%, are proximity to motorable roads and water source. While proximity to motorable roads eases access to both input and output markets by reducing transportation costs, shortened distances to water sources release the labour tied up in water searching activities for other economic uses. Even though the other distance variables coefficients are not statistically significant, a Wald test for joint significance of all the distance variables shows that all the variables are jointly significant at 1%.

As expected, the results show that household incomes in rural Kenya are also driven by rainfall and rainfall shocks. A decrease in rainfall by 10mm in the previous main season before the survey reduces incomes by about 2% in the short run and by about 12% in the long run. Perhaps the most important and less discussed factor is the rainfall variability. We included a variable capturing the percentage of 20-day periods during the previous main season when the rainfall was less than 40mm. A switch in this percentage from 0 to 100 reduced household income by about 33% in the short run and by over 100% in the long-run. This is an indicator of perhaps the effects of global warming and

increased weather variability on agricultural-based rural household livelihoods in sub-Saharan Africa.

Household income levels are also found to be associated with the agro-ecological and administrative region where the households are located. The estimations were done first with agro-ecological zones dummies of where the households are located and second with provincial administrative region dummies. In the first round, the Central highlands region is used as the base category. The results indicate that households in the other regions, and especially the lowlands, are associated with relatively lower incomes but to varying degrees. Even though the results on provincial dummies are not reported due to lack of space, the results generally show that households in Central Province have relatively higher incomes than households in other provinces. These results generally confirm the findings from the descriptive analysis that household incomes vary across Kenya with the central region having the highest household incomes and the lowlands having the lowest. Wald tests for joint significance of all the agro-ecological zones and provinces show that all the variables are jointly significant at 1% in their respective models.

The survey year dummies emerged statistically significant showing there was a general improvement in household incomes over the panel period, which coincided with a period of an increase in the general economic growth. One can only speculate about the causes of a generalized improvement in incomes over this period, but clues can be obtained by considering other trends and development initiatives at work during this period that might have broadly influenced household incomes.

We next turn to the sequential logit regression results on correlates of household poverty trajectories (Table 9). Odds ratios and the corresponding p-values are presented in Table 9. When the odds ratio is greater than one, it means that the variable increases the probability of a household escaping poverty in that transition period. Conversely, when the odds ratio is less than one, the variable decreases the probability of a household escaping poverty in that transition period. The factors associated with living out of poverty vary according to the transition as presented under panels 1 to 7.

The results indicate that high dependency ratio, female headship, long distances to agricultural input markets (fertilizer) and electricity, and rainfall shocks increased the probability of a household being poor in the initial period (panel 1). Conversely, higher education attainment by household head, more land endowment and rainfall received decreased the probability of households being poor in the initial period.

Households headed by persons with high education attainment, those with relatively large land endowment, and those that received comparably more rainfall in 2004 were more likely to stay out of poverty in 2004 after having been non-poor in 2000 (panel 2). Additionally, households in close proximity to infrastructural facilities (agricultural input markets and electricity supply), and those that experienced less rainfall variability in 2004 were more likely to remain non-poor in 2004 after having been non-poor in 2000. Households with low dependency burden, those headed by persons with higher education attainment, those that received less rainfall variability in 2004, and those that had relatively large landholdings had a higher probability of staying out of poverty in 2004 having been poor in 2000 (panel 3).

Households headed by single females and those located far away from infrastructural facilities were more likely to be poor in 2007 having been non-poor in 2000 and 2004

(panel 4). The results also show that households headed by single males and persons with low education attainment, and those located relatively far away from infrastructural facilities were more likely to be poor in 2007 having been non-poor in 2000 and 2004 (panel 5). Households with high dependency ratio, headed by persons with no post-secondary education (using no education as the base), relatively small landholding, located far away from infrastructural facilities, and those that received relatively low rainfall had a higher probability of being poor in 2007 if they were poor in 2000 and 2004 (panel 6). Lastly, the results show that high dependency ratio, long distances to infrastructural facilities, and low rainfall received in 2007 increased the chances of households falling into poverty after having been poor in 2000 and non-poor in 2004 (panel 7).

6. Conclusion and implications for rural development strategies

This study sought to analyse household welfare dynamics in rural Kenya. Both descriptive statistics and econometric methods were used to achieve the study objectives. The results reveal that rural household incomes do not remain stable across space and over time. There are significant regional household welfare differences and welfare dynamics over time in rural Kenya. The econometrics results indicate that high dependency ratio, gender and education attainment of the household head influence household incomes and determine transitions in and out of poverty. The other very important determinants of household welfare transitions are proximity to infrastructural facilities, household landholding sizes, and the quantities of rainfall received and rainfall shocks. While access to motorable roads improves access to both inputs and outputs markets and cut down transportation costs, reduced distances to electricity supply usually trigger new income generating opportunities to the rural communities. The results also highlight the increasing importance of the land resource in the rural areas. Return on additional land is likely to remain high. However, with the shrinking landholding sizes due to increased population pressure, access to more land is not a feasible option. Sustainable agricultural intensification and transitions to off-farm income-earning opportunities are crucial options as land becomes a bidding constraint to rural development. Perhaps the most interesting finding is the effect of quantity of rainfall received and its variability on household incomes and poverty. As mentioned earlier, this is probably an indicator of the negative effects of global warming and increased weather variability to the agricultural-based rural households in sub-Saharan Africa. A proposal for further research would include analysing the differential impacts of current devolved development programmes and the renewed macroeconomic growth on poor households in the rural agricultural based households in Kenya.

Table 1: Transition matrix for real income quintiles (2000–2004)

		Income quintiles in 2004					
		1 (Lowest)	**2**	**3**	**4**	**5 (Highest)**	**Total**
Income quintiles	1 (Lowest)	104 (40%)	76 (29%)	44 (17%)	26 (10%)	9 (4%)	259 (100%)
in 2000	2	78 (30%)	77 (30%)	54 (21%)	32 (12%)	19 (7%)	260 (100%)
	3	38 (15%)	52 (20%)	70 (27%)	64 (25%)	36 (14%)	260 (100%)
	4	25 (10%)	37 (14%)	57 (22%)	77 (30%)	64 (25%)	260 (100%)
	5 (Highest)	14 (5%)	18 (7%)	35 (14%)	61 (24%)	132 (51%)	260 (100%)
	Total	259 (20%)	260 (20%)	260 (20%)	260 (20%)	260 (20%)	1299 (100%)

Source: Tegemeo Institute Rural Household Surveys.

Table 2: Transition matrix for real income quintiles (2004–2007)

		Income quintiles in 2007					
		1 (Lowest)	**2**	**3**	**4**	**5 (Highest)**	**Total**
Income quintiles	1(Lowest)	120 (46%)	66 (26%)	46 (18%)	24 (9%)	3 (1%)	259 (100%)
in 2004	2	74 (29%)	78 (30%)	57 (22%)	38 (15%)	13 (5%)	260 (100%)
	3	37 (14%)	62 (24%)	73 (28%)	65 (25%)	23 (9%)	260 (100%)
	4	19 (7%)	40 (15%)	56 (22%)	73 (28%v	72 (28%)	260 (100%)
	5 (Highest)	9 (4%)	14 (5%)	28 (11%)	60 (23%)	149 (57%)	260 (100%)
	Total	259 (20%)	260 (20%)	260 (20%)	260 (20%)	260 (20%)	1299 (100%)

Source: Tegemeo Institute Rural Household Surveys.

Table 3: Rural household poverty headcount by zones and provinces

Zone	2000		2004		2007	
	$P_{\alpha=0}$	Relative contribution	$P_{\alpha=0}$	Relative contribution	$P_{\alpha=0}$	Relative contribution
By agro ecological zone	%	%	%	%	%	%
Coastal lowlands	82 (0.06)	31 (0.03)	74 (0.07)	41 (0.03)	50 (0.07)	32 (0.04)
Eastern lowlands	78 (0.06)	21 (0.03)	43 (0.07)	14 (0.03)	63 (0.07)	26 (0.04)
Western lowlands	94 (0.02)	12 (0.01)	75 (0.05)	12 (0.01)	60 (0.05)	11 (0.01)
Western transitional	69 (0.05)	11 (0.01)	49 (0.06)	10 (0.01)	53 (0.06)	14 (0.02)
High potential maize	72 (0.03)	12 (0.01)	50 (0.04)	11 (0.01)	34 (0.04)	09 (0.01)
Western highlands	86 (0.04)	05 (0.00)	70 (0.05)	05 (0.01)	53 (0.05)	05 (0.01)
Central highlands	43 (0.04)	07 (0.01)	27 (0.03)	06 (0.01)	08 (0.02)	02 (0.00)
Marginal rain shadow	78 (0.07)	01 (0.00)	42 (0.09)	01 (0.00)	28 (0.09)	01 (0.00)
By province						
Coast	84 (0.05)	35 (0.03)	74 (0.06)	45 (0.03)	53 (0.07)	38 (0.04)
Eastern	65 (0.06)	19 (0.03)	32 (0.06)	11 (0.02)	48 (0.07)	20 (0.04)
Nyanza	93 (0.02)	14 (0.01)	74 (0.04)	14 (0.01)	60 (0.04)	13 (0.01)
Western	73 (0.04)	17 (0.01)	54 (0.05)	16 (0.02)	51 (0.05)	19 (0.02)
Central	49 (0.04)	05 (0.01)	35 (0.04)	05 (0.01)	10 (0.03)	02 (0.00)
Rift Valley	72 (0.03)	11 (0.01)	47 (0.04)	09 (0.01)	32 (0.04)	08 (0.01)
Overall	75 (0.02)	100 (0.00)	57 (0.03)	100 (0.00)	47 (0.03)	100 (0.00)

Standard errors in parentheses.
Source: Tegemeo Institute Rural Household Surveys.

Table 4: Rural household poverty gaps by agro-ecological zones and provinces

Zone	2000		2004		2007	
	$P_{\alpha=1}$	Relative contribution	$P_{\alpha=1}$	Relative contribution	$P_{\alpha=1}$	Relative contribution
By agro ecological zone						
Coastal lowlands	0.50 (0.05)	0.32 (0.03)	0.41 (0.05)	0.45 (0.04)	0.22 (0.04)	0.34 (0.06)
Eastern lowlands	0.48 (0.05)	0.21 (0.03)	0.19 (0.04)	0.13 (0.03)	0.24 (0.05)	0.24 (0.05)
Western lowlands	0.69 (0.03)	0.14 (0.01)	0.41 (0.04)	0.13 (0.02)	0.26 (0.03)	0.12 (0.02)
Western transitional	0.34 (0.04)	0.09 (0.01)	0.23 (0.03)	0.09 (0.01)	0.20 (0.03)	0.13 (0.02)
High potential maize	0.39 (0.02)	0.11 (0.01)	0.25 (0.02)	0.10 (0.01)	0.15 (0.02)	0.10 (0.02)
Western highlands	0.50 (0.03)	0.05 (0.01)	0.38 (0.03)	0.06 (0.01)	0.23 (0.03)	0.05 (0.01)
Central highlands	0.17 (0.02)	0.05 (0.01)	0.10 (0.01)	0.04 (0.01)	0.02 (0.01)	0.01 (0.00)
Marginal rain shadow	0.45 (0.05)	0.01 (0.00)	0.14 (0.04)	0.00 (0.00)	0.08 (0.03)	0.00 (0.00)
By province						
Coast	0.53 (0.05)	0.37 (0.03)	0.41 (0.04)	0.48 (0.04)	0.23 (0.04)	0.40 (0.06)
Eastern	0.36 (0.05)	0.18 (0.03)	0.14 (0.03)	0.09 (0.02)	0.18 (0.04)	0.19 (0.05)
Nyanza	0.66 (0.02)	0.17 (0.01)	0.40 (0.03)	0.15 (0.02)	0.25 (0.02)	0.14 (0.02)
Western	0.37 (0.03)	0.15 (0.01)	0.27 (0.03)	0.15 (0.02)	0.21 (0.02)	0.19 (0.03)
Central	0.21 (0.02)	0.04 (0.01)	0.14 (0.02)	0.04 (0.01)	0.03 (0.01)	0.01 (0.00)
Rift Valley	0.39 (0.02)	0.10 (0.01)	0.22 (0.02)	0.08 (0.01)	0.13 (0.02)	0.08 (0.01)
Overall	0.44 (0.02)	1.00 (0.00)	0.29 (0.02)	1.00 (0.00)	0.19 (0.02)	1.00 (0.00)

Standard errors in parentheses.
Source: Tegemeo Institute Rural Household Surveys.

Table 5: Rural household poverty severity (squared gaps) by agro-ecological zones and provinces

Zone	2000		2004		2007	
	$P_{\alpha=2}$	Relative contribution	$P_{\alpha=2}$	Relative contribution	$P_{\alpha=2}$	Relative contribution
By agro region						
Coastal lowlands	0.37 (0.05)	0.34 (0.04)	0.26 (0.04)	0.46 (0.04)	0.12 (0.04)	0.34 (0.08)
Eastern lowlands	0.33 (0.04)	0.21 (0.04)	0.11 (0.03)	0.11 (0.03)	0.14 (0.04)	0.25 (0.07)
Western lowlands	0.55 (0.03)	0.16 (0.02)	0.29 (0.03)	0.15 (0.02)	0.14 (0.02)	0.12 (0.02)
Western transitional	0.22 (0.03)	0.09 (0.01)	0.14 (0.02)	0.09 (0.01)	0.11 (0.02)	0.13 (0.03)
High potential maize	0.26 (0.02)	0.10 (0.01)	0.16 (0.02)	0.10 (0.01)	0.08 (0.01)	0.10 (0.02)
Western highlands	0.34 (0.03)	0.05 (0.01)	0.24 (0.02)	0.06 (0.01)	0.13 (0.02)	0.05 (0.01)
Central highlands	0.09 (0.01)	0.04 (0.01)	0.05 (0.01)	0.03 (0.01)	0.01 (0.00)	0.01 (0.00)
Marginal rain shadow	0.29 (0.05)	0.01 (0.00)	0.06 (0.02)	0.00 (0.00)	0.03 (0.02)	0.00 (0.00)
By province						
Coast	0.39 (0.04)	0.39 (0.04)	0.26 (0.03)	0.49 (0.04)	0.13 (0.03)	0.41 (0.08)
Eastern	0.24 (0.04)	0.16 (0.04)	0.07 (0.02)	0.08 (0.02)	0.10 (0.03)	0.19 (0.06)
Nyanza	0.52 (0.02)	0.18 (0.02)	0.28 (0.03)	0.17 (0.02)	0.13 (0.02)	0.13 (0.02)
Western	0.24 (0.02)	0.13 (0.02)	0.17 (0.02)	0.15 (0.02)	0.11 (0.02)	0.18 (0.03)
Central	0.12 (0.02)	0.03 (0.00)	0.07 (0.01)	0.03 (0.01)	0.01 (0.00)	0.01 (0.00)
Rift Valley	0.26 (0.02)	0.09 (0.01)	0.14 (0.02)	0.08 (0.01)	0.08 (0.02)	0.08 (0.02)
Overall	0.31 (0.02)	1.00 (0.00)	0.18 (0.01)	1.00 (0.00)	0.11 (0.01)	1.00 (0.00)

Standard errors in parentheses.
Source: Tegemeo Institute Rural Household Surveys.

Table 6: Poverty spells (2000–2007) by agro-ecological zones and provinces

	Consistently non-poor		Poor- one spell		Poor two spells		Consistently poor		Sample	
Agro-regional zones	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Coastal lowlands	9	13	17	24	23	33	21	30	70	100
Eastern lowlands	48	34	42	29	35	25	18	13	143	100
Western lowlands	12	8	35	24	47	32	54	37	148	100
Western transitional	33	22	50	34	40	27	25	17	148	100
High potential maize zone	143	42	84	25	53	16	60	18	340	100
Western highlands	24	19	31	24	32	25	41	32	128	100
Central highlands	174	73	33	14	23	10	9	4	239	100
Marginal rain shadow	14	38	14	38	5	14	4	11	37	100
Province										
Coast	9	11	18	23	26	33	26	33	79	100
Eastern	117	55	50	24	34	17	13	6	214	100
Nyanza	23	10	57	25	68	31	78	35	226	100
Western	64	26	70	28	60	24	56	22	250	100
Central	105	66	24	16	21	13	9	6	159	100
Rift Valley	139	43	87	27	49	15	50	15	325	100
Total	457	36	306	24	258	21	232	19	1299	100

Source: Tegemeo Institute Rural Household Surveys.

Table 7: Correlated random effects regression results of household incomes

	Short-run elasticities		Long-run elasticities	
Dependent variable: log income '000 Ksh	**Coef.**	**Robust SE**	**Coef.**	**Robust SE**
Dependency ratio	-0.035	0.06	-0.212***	0.07
Age of the household head (years)	0.020	0.09	-0.001	0.12
Gender and marital status of the head (monogamously married is the base)				
Single female	-0.101*	0.06	-0.132**	0.06
Single male	-0.016	0.04	-0.009	0.04
Polygamous married	0.010	0.03	-0.054	0.05
Level of education of the head (no formal education is the base)				
Primary	-0.001	0.03	0.012	0.03
Secondary	0.022	0.04	0.065	0.04
Post-secondary	0.033	0.04	0.278***	0.05
Per capita land holding (acres)	0.075***	0.02	0.109***	0.02
Distance to infrastructural facilities, services and markets (km)				
Nearest fertilizer seller	0.150	0.15	0.179	0.22
Nearest motorable road	-0.088	0.30	-1.361*	0.80
Nearest water source	-0.050	0.09	-0.371*	0.21
Nearest healthcare facility	0.224	0.19	-0.180	0.34
Nearest electricity	-0.531***	0.15	-0.846***	0.31

continued next page

Table 7 Continued

	Short-run elasticities		Long-run elasticities	
Dependent variable: log income '000 Ksh	**Coef.**	**Robust SE**	**Coef.**	**Robust SE**
Nearest public telephone	-0.046	0.14	-0.220	0.22
Rainfall received (10mm)	0.017***	0.01	0.115***	0.02
Rainfall shock	-0.327***	0.09	-1.411***	0.20
Region dummies (Central highlands is the base)				
Western highlands	0.061	0.04	--	--
High potential maize zone	0.013	0.03	--	--
Western transitional	0.012	0.04	--	--
Western lowlands	-0.082*	0.05	--	--
Eastern lowlands	-0.088***	0.03	--	--
Coastal lowlands	-0.094**	0.05	--	--
Marginal rain shadow	0.154***	0.04	--	--
Survey year dummies (year 2000 is the bases)				
y2004	0.111***	0.01	--	--
y2007	0.294***	0.01	--	--
Constant	3.451***	0.16	--	--
Observations	3897			
Households	1299			
R-squared				
Within	0.212			
Between	0.468			
Overall	0.345			

Note: *** p<0.01, ** p<0.05, * p<0.1

Table 8: Sequential logit regression of results of poverty trajectories

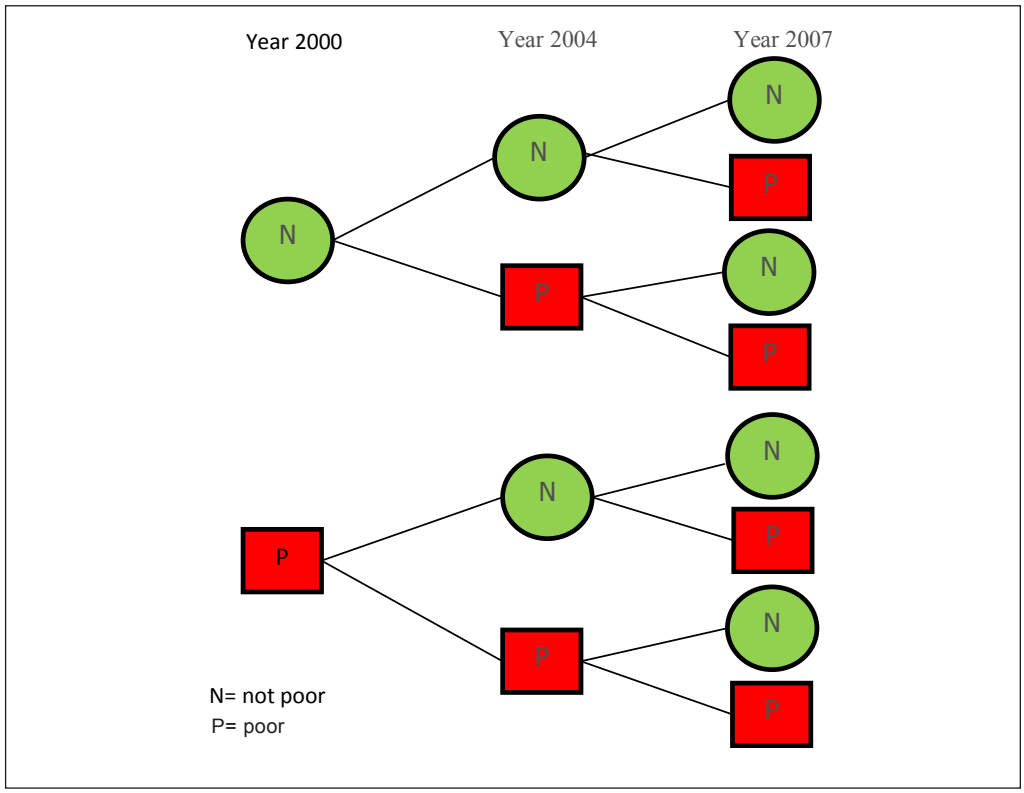
	2000		2004				2007							
	Household welfare trajectories													
	[1] N v. P		[2] NN vs. NP		[3] PN vs. PP		[4] NPN vs. NPP		[5] NNN vs. NNP		[6] PPN vs. PPP		[7] PNN vs. PNP	
	OR	P>z	OR	P>z	OR	P>z	OR	P>z	OR	P>z	OR	P>z	OR	P>z
Dependency ratio	0.99	0.01	0.99	0.13	0.98	0.00	0.99	0.19	0.99	0.29	0.99	0.09	0.98	0.03
Age of the household head	1.00	0.94	0.99	0.48	0.99	0.29	0.98	0.29	1.01	0.38	1.01	0.25	1.02	0.37
Gender and marital status of the head (monogamously married is the base)														
Single female	0.60	0.02	1.33	0.44	0.96	0.88	0.15	0.02	1.40	0.60	1.07	0.84	0.57	0.29
Single male	0.77	0.44	1.31	0.71	1.77	0.37	1.87	0.56	0.11	0.02	1.47	0.63	0.80	0.81
Polygamous married	1.31	0.45	1.13	0.79	0.40	0.12	0.92	0.91	0.92	0.92	0.77	0.64	0.42	0.26
Level of education of the head (no formal education is the base)														
Primary	1.40	0.05	1.46	0.17	0.96	0.86	0.68	0.39	1.18	0.69	1.56	0.14	1.17	0.72
Secondary & post-secondary	4.27	0.00	2.36	0.01	2.23	0.01	1.84	0.31	3.25	0.05	2.57	0.03	1.79	0.27
Per capita land holding (acres)	4.55	0.00	2.24	0.00	2.47	0.00	1.78	0.25	1.33	0.19	2.01	0.04	1.43	0.42
Distance to infrastructural facilities, services and markets (km)														
Nearest fertilizer seller	0.97	0.04	0.95	0.04	0.99	0.65	1.00	0.90	1.05	0.33	1.01	0.92	0.97	0.46
Nearest hybrid seed seller	1.01	0.47	1.05	0.12	1.00	0.86	1.00	0.93	1.01	0.80	0.98	0.63	0.98	0.60
Nearest motorable road	1.02	0.19	1.00	0.85	0.98	0.24	1.02	0.57	0.96	0.03	1.01	0.51	0.98	0.10
Nearest water source	1.01	0.62	0.99	0.59	0.99	0.53	0.96	0.27	1.09	0.14	1.02	0.51	1.00	0.89
Nearest healthcare facility	1.00	0.88	1.01	0.73	0.93	0.09	0.93	0.35	0.95	0.25	1.04	0.29	1.06	0.76
Nearest electricity	0.95	0.00	0.95	0.04	1.03	0.14	0.89	0.03	0.92	0.06	0.94	0.07	0.92	0.06

continued next page

Table 8 Continued

	2000		2004				2007							
	Household welfare trajectories													
	[I] N v. P		[2] NN vs. NP		[3] PN vs. PP		[4] NPN vs. NPP		[5] NNN vs. NNP		[6] PPN vs. PPP		[7] PNN vs. PNP	
	OR	P>z	OR	P>z	OR	P>z	OR	P>z	OR	P>z	OR	P>z	OR	P>z
Nearest public telephone	0.97	0.11	1.01	0.48	0.99	0.67	1.06	0.26	1.06	0.13	0.99	0.68	0.97	0.33
Rainfall received (10mm)	1.00	0.00	1.00	0.00	1.00	0.48	1.00	0.44	1.00	0.12	1.01	0.03	1.01	0.10
Rainfall shock	0.01	0.00	0.01	0.04	0.03	0.04	0.06	0.55	0.08	0.53	0.01	0.12	0.01	0.12
Agro ecological zones (central highlands is the base)														
Western highlands	0.80	0.62	0.37	0.20	0.75	0.64	1.78	0.72	0.20	0.27	0.37	0.23	0.53	0.56
High potential maize zone	0.81	0.44	0.81	0.63	1.05	0.91	0.76	0.81	0.39	0.28	0.38	0.12	0.54	0.42
Western transitional	1.51	0.36	0.34	0.16	1.26	0.71	2.09	0.64	0.09	0.09	0.58	0.55	0.45	0.46
Western lowlands	0.21	0.00	0.51	0.41	0.90	0.85	0.32	0.47	0.15	0.22	0.41	0.26	0.79	0.82
Eastern lowlands	0.27	0.00	0.28	0.01	0.96	0.93	0.12	0.02	0.13	0.02	0.61	0.42	0.11	0.03
Coastal lowlands	0.23	0.00	0.44	0.31	0.65	0.48	0.01	0.01	0.06	0.03	0.96	0.96	1.13	0.92
Constant	6.94	0.02	17.29	0.03	18.80	0.01	38.82	0.02	14.17	0.25	0.38	0.54	15.49	0.27
Households	1299													
R Squared	0.38													
Log pseudolikelihood	1907													
Wald chi2(26)	243													
Prob > chi2	0.00													

Figure 1: Possible poverty trajectories across three waves of panel data



Source: Scott et al. (2014).

Figure 2: Poverty headcount index by year (2000, 2004 and 2007)

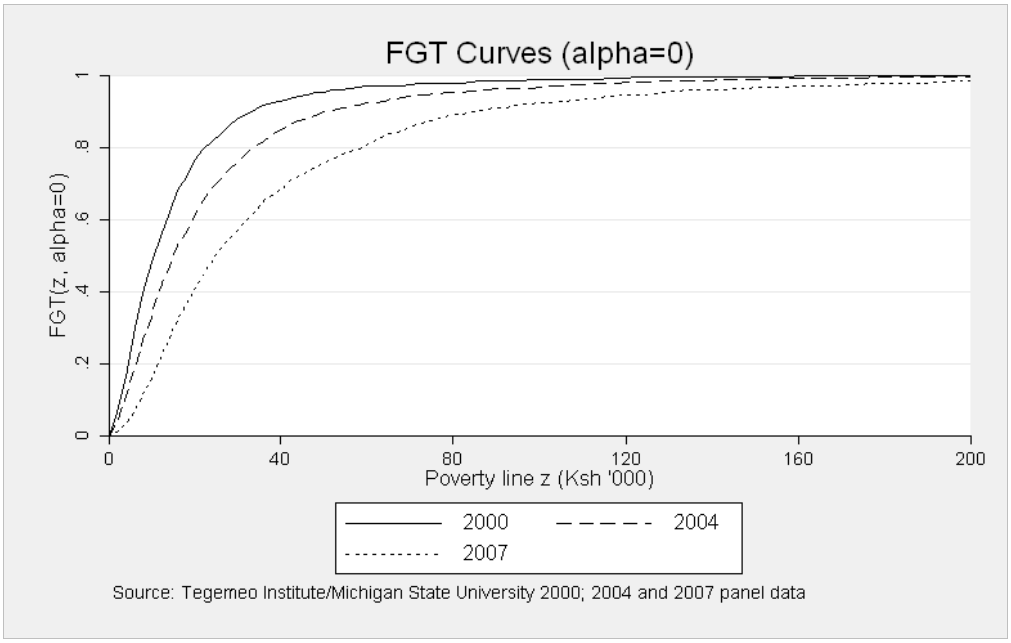


Figure 3: Poverty gaps by year (2000, 2004 and 2007)

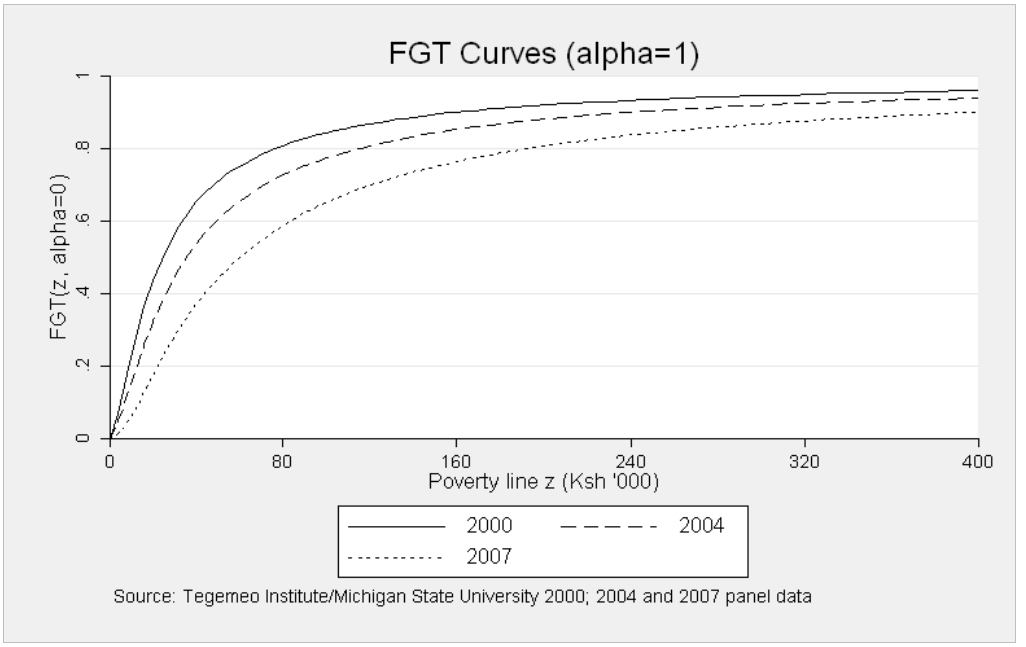
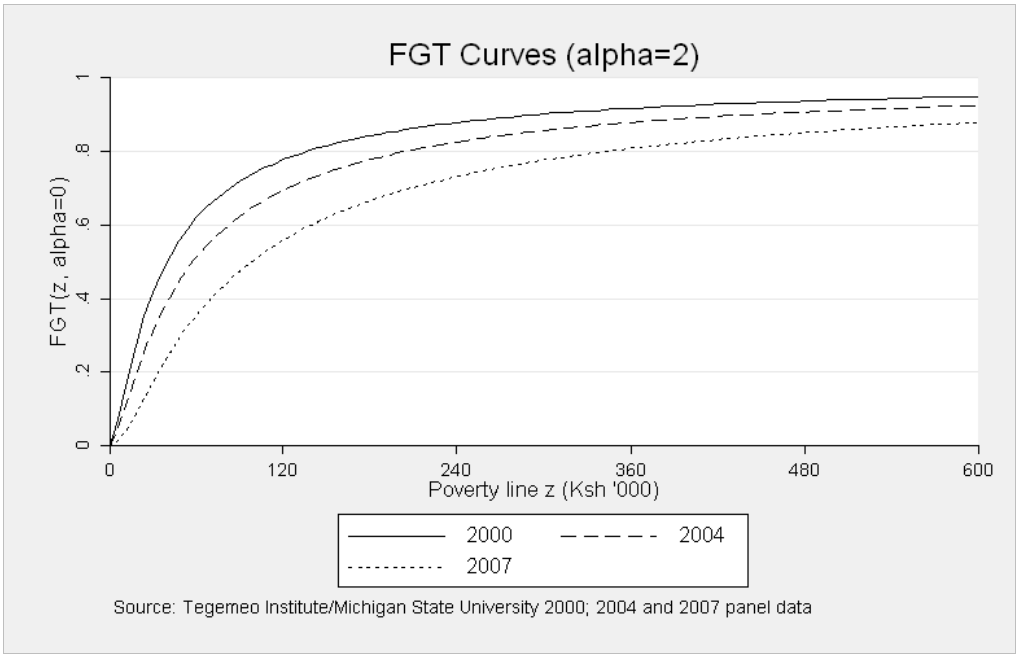


Figure 4: Poverty severity by year (2000, 2004 and 2007)



Notes

1. In some instances the use of both income and consumption has been undertaken and the findings have been not been significant (Badiani et al, 2007).

2. The well-being of individual household members will depend additionally on the number of people who have to share these assets and the incomes derived from them.

3. The Foster-Greer-Thorbecke (FGT) indices are used to measure poverty because of their additive decomposability property (Foster et al, 1984). The FGT indices are expressed as follows: $p(\alpha) = \frac{1}{N} \sum_{i=1}^{N} \left[\frac{(z - y_i)}{z} \right]^{\alpha} I(y_i) < z$ where z is the poverty line, y_i is the household adult equivalent income while α is a measure of 'poverty aversion' to inequality and variability (Foster et al, 1984). Thus, $p(\alpha = 0)$ is the head count (Table 3), $p(\alpha = 1)$ is the poverty gap (Table 4) index while $p(\alpha = 2)$ is the squared poverty gap or poverty severity index (Table 5). Alpha (α) is also an elasticity of poverty with respect to the poverty gap.

4. The curves were drawn using the Distributive Analysis STATA Package (DASP) routines developed by Araar and Duclos (2007).

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Appendixes

Appendix 1: Sample size

By agro-regional zones	Sample			Attrition (%)		
	2000	2004	2007	2000–2004	2004–2007	2000–2007
Coastal lowlands	79	78	75	1.27	3.85	5.06
Eastern lowlands	161	155	147	3.73	5.16	8.70
Western lowlands	177	163	153	7.91	6.13	13.56
Western transitional	166	156	149	6.02	4.49	10.24
High potential maize zone	399	375	353	6.02	5.87	11.53
Western highlands	151	142	139	5.96	2.11	7.95
Central highlands	259	246	240	5.02	2.44	7.34
Marginal rain shadow	54	45	43	16.67	4.44	20.37
By provinces						
Coast	90	88	84	2.22	4.55	6.67
Eastern	235	226	218	3.83	3.54	7.23
Nyanza	268	248	238	7.46	4.03	11.19
Western	291	273	257	6.19	5.86	11.68
Central	174	165	160	5.17	3.03	8.05
Rift Valley	388	360	342	7.22	5.00	11.86
Total	1,446	1,360	1,299	5.95	4.49	10.17

Appendix 2: Sample characteristics

	2000 survey		2004 survey		2007 survey	
VARIABLES	**Mean**	**Std. Err.**	**Mean**	**Std. Err.**	**Mean**	**Std. Err.**
Income per adult equivalent '000KSh	18.19	0.61	28.71	1.00	50.31	2.09
Dependency ratio	0.43	0.67	0.41	0.68	0.40	0.79
Age of household head (years)	53.57	0.38	56.36	0.37	58.65	0.37
Household head marital status and gender (proportion)						
Single female headed	0.12	0.01	0.16	0.01	0.19	0.01
Single male headed	0.02	0.00	0.03	0.00	0.05	0.01
Monogamously married	0.81	0.01	0.72	0.01	0.69	0.01
Polygamously married	0.04	0.01	0.10	0.01	0.07	0.01
Household head education attainment (proportions)						
No formal education	0.47	0.01	0.46	0.01	0.44	0.01
Primary education	0.33	0.01	0.33	0.01	0.35	0.01
Secondary education	0.15	0.01	0.13	0.01	0.14	0.01
Post-secondary education	0.06	0.01	0.07	0.01	0.07	0.01
Per capita land holding (acres)	4.44	0.15	4.30	0.12	4.02	0.13
Distances to nearest markets, services and infrastructure facilities (km)						
Fertilizer seller	5.72	0.22	4.10	0.21	3.34	0.13
Motorable road	1.28	0.06	1.06	0.04	0.53	0.02
Water source	5.31	0.25	6.86	0.27	3.96	0.17
Healthcare facility	3.40	0.10	2.79	0.08	3.05	0.09
Usable electricity	5.03	0.21	4.29	0.19	4.04	0.20
Public telephone	4.50	0.13	4.11	0.13	2.81	0.07
Rainfall in the previous one year (mm)	556.21	4.35	489.73	5.07	535.22	5.75
Rainfall shock	0.24	0.00	0.34	0.01	0.33	0.01
Agro-region zone (proportion)						
Central highlands	0.18	0.01				
Western highlands	0.11	0.01				
High potential maize zone	0.27	0.01				
Western transitional	0.11	0.01				
Western lowlands	0.12	0.01				
Eastern lowlands	0.11	0.01				
Coastal lowlands	0.06	0.01				
Marginal rain shadow	0.03	0.00				

Province (administrative)(proportion)		
Central	0.12	0.01
Coast	0.06	0.01
Eastern	0.17	0.01
Nyanza	0.18	0.01
Western	0.20	0.01
Rift Valley	0.26	0.01

Appendix 3: Rural absolute in Kenya by region, 2006

Province	**Headcount ($P_{\alpha=0}$) (adult Equivalent)**	**Poverty gap ($P_{\alpha=1}$)**	**Poverty severity ($P_{\alpha=2}$)**	**Contribution – head count (%)**
Central	30.4	9.5	4.5	9.0
Coast	69.7	26.6	13.2	10.1
Eastern	50.9	17.8	8.7	20.3
North Eastern	73.9	32.9	17.8	4.6
Nyanza	47.6	16.8	8.0	14.7
Rift Valley	49.0	17.5	9.4	26.7
Western	52.2	18.3	8.6	14.7
Total-Rural	**49.1**	**17.5**	**8.8**	**100**

Source: Republic of Kenya (2007).

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