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# Diversification of livelihood activities in Ghana's households: effects of HIV, stress and selected socioeconomic factors

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**Diversification of livelihood activities in Ghana's households: effects of HIV, stress and selected socioeconomic factors**

by

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# INTRODUCTION

In the early 1900s, Russian agricultural economists became puzzled with one critical question. How could peasant households who together controlled less than 50% of the agricultural land, and were often characterized as exhibiting irrational economic behavior, become the primary agricultural producer in pre-World War I Russia? This question was partially answered by one of their colleagues, Alexandr Tschajanow, who learned that peasant households represent a special type of productive unit. Within this unit, household members could refrain from adopting seemingly beneficial technologies, engage in production of low value crops that require extensive labor, or divert labor resources from agricultural production by sending household members away for seasonal jobs and, as a result, often sacrifice quick monetary profits in favor of achieving long term sustainability of their livelihood systems. In the 1980s, in a theory of the subjective equilibrium of the farm household, Nakajima described this type of behavior as utility maximization (Nakajima, 1986).

Researchers cite these seminal works as important contributions to the foundation for contemporary diversification research (Von Braun and Pandya-Lorch, 1991). Livelihood diversification has become mainstreamed in international development. In low income countries in Asia, Latin America, and Africa, across socioeconomic groups, people purposefully attempt to diversify their productive activities, sources of income, and households' resources to secure their wellbeing and/or to respond to a crisis (Barrett et al., 2001b; Ellis, 2000, 1998; Von Braun and Pandya-Lorch, 1991; Hart, 1994).

For instance, better off rural households may diversify their farming practices and their non-agricultural employment to balance risks of possible market failure where the economy lacks adequate insurance mechanisms (Von Braun and Pandya-Lorch, 1991; Ellis, 1998). They also

may diversify sources of off-farm employment to increase household income when the economy is improving (Woldenhannaa and Oskamb, 2001). Poor farmers who can not rely solely on agriculture commonly use off-farm income diversification as a form of self-insurance (Barrett et al., 2001a). In some geographic areas, off-farm diversification as a supplement to farming is practiced by 70%-90% of all farmers (Rider Smith et al., 2001).

Researchers and representatives of development communities are intrigued by the potential of livelihood diversification for poverty reduction. The negative experience with structural adjustment programs prompted development practitioners to look for alternative development paradigms. Based on principles of privatization and deregulation of economic activities, these programs commonly failed to achieve sustainable growth and poverty reduction in low income countries. The World Bank noted that 40% of the sample of 28 developing countries experienced a decline in per capita income between 1981 and 1997. Approximately one-quarter of the sampled countries experienced a decline in life expectancy and increase of the share of population living in absolute poverty (Hanna et al., 1999). Since the early 1990s, development agencies have explored people centered 'bottom-up' approaches, including sustainable rural livelihoods. Guided by this new paradigm, extensive research has revealed that households with more diverse activities tend to exhibit lower vulnerability to food insecurity, greater resilience and adaptability to environmental and economic shocks, possess a greater repertoire of resources to use in their strategies to escape poverty, and achieve greater overall sustainability (Ellis and Allison, 2004).

Recently, an interest in people's livelihoods began to emerge in the context of the HIV/AIDS pandemic. The reciprocal links between poverty and HIV/AIDS are well established. The rates of HIV/AIDS are higher in low income countries. Poor people are more likely to contract the virus and, when infected, have fewer resources to deal with the consequences. It is known, for instance, that inadequate nutrition - a common companion of poverty - is one of the contributing factors to declining health in people who are HIV positive and who, as a result, experience faster progression of AIDS. Therefore, achieving sustainability of peoples' livelihoods is not only seen as a promising poverty reduction strategy, but also as yet another line of defense

against the global HIV/AIDS pandemic.

In light of the above interest, practitioners and researchers are in continuous quest for achieving the greater effectiveness of policies and programs aimed at livelihoods of HIV/AIDS affected populations. There are challenges exist, however. On the one hand, extensive body of knowledge is built in the literature about the relationships between symptomatic AIDS and peoples livelihoods. But at this stage the options for livelihood interventions are greatly constrained. For instance, at this stage peoples' abilities to engage in productive behavior have been significantly reduced due to declining health, and household resources often have been exhausted by growing healthcare needs. Interventions may prove to be the most effective at the stage of asymptomatic HIV when the above mentioned constrains are not present yet. But little is known about the effects of HIV on household livelihoods prior to AIDS symptoms developing. This is the other side of the problem. The common sense suggests that people with asymptomatic HIV may already show some individual and household level changes that need to be accommodated in program interventions. However, reliable information on HIV status is rarely available to researchers and/or study populations at the time of the study; therefore, existing research on the consequences of asymptomatic HIV and household livelihoods is rudimentary and provides little clues on the appropriate adjustments in programs' interventions.

The purpose of this research project is to contribute to the body of empirical knowledge about relationships between asymptomatic HIV and household livelihoods. This dissertation examines the effects of selected individual and household level factors on the diversification of livelihood activities in households with HIV positive and HIV negative women who recently gave birth to a child in the Eastern Region of Ghana. The data that is analyzed in this dissertation was collected through the Research to Improve Infant Nutrition and Growth (RIING) project. The uniqueness of the RIING project is that household livelihood data was systematically collected along with clinically confirmed HIV status of respondents.

Epidemiological studies show that women of childbearing age in Ghana experience a high incidence of HIV infections and are more likely than men to contract HIV and develop AIDS (Addo-

Yobo and Lovel, 1992; Ankrah et al., 1994; Cronin et al., 1991). In the case of nursing mothers, food insecurity due to increased vulnerability of household livelihoods may not only worsen their health status, but can also alter their infant feeding practices which can, in turn, increase an infant's risk of HIV infection (Coovadia et al., 2007). The focus on households with new mothers in Ghana is important in the context of international efforts to control the HIV/AIDS epidemic in Africa. Comparative analysis of diversification in households with HIV positive and negative mothers may provide valuable insights regarding factors that uniquely impact diversification in households affected by HIV/AIDS. This study seeks to answer three questions:

1. How does HIV status affect diversification of household livelihoods?
2. How do individual and households factors affect diversity of livelihoods in households in which a mother has known HIV/AIDS status?
3. What is the nature of relationships among individual and households factors that affect diversity of livelihood activities of households in which a mother has known HIV status?

Since one of the assumptions in this dissertation is that HIV effects not only people who are infected with the virus, but also their household members the term 'HIV affected' is used to signify the effects that spread beyond HIV positive people. The term 'HIV infected' is reserved for individuals and effects manifested at the individual level.

The dissertation is organized as follows: the remaining part of this introductory section provides the background information on the study area and the sample of the study. This remaining part of the introductory section also introduces the conceptual model for the research data analysis and details of measures construction. Research paper 1 focuses on the comparative analysis of levels of diversification for households with HIV positive and negative mothers. Relationships between stress and livelihood diversification are of special interest in this study. The role of human cognition is an undertheorized element of contemporary diversification research; therefore, research paper 2 constitutes in-depth analysis of relationships between stress and diversification of livelihood activities in my sample of households. Re-

search paper 3 inquiries into the nature of mediating-moderating relationships between stress, household resources and diversify of livelihood activities in my sample households. Finally, the conclusion summarizes the results and identifies the implications of this study.

The benefits of this study are expected at two levels - in terms of theory of livelihood diversification and for policy and practice in poverty reduction programs, with an emphasis on assisting HIV/AIDS affected populations. For theory, this study can enhance understanding of the role of cognitive factors such as stress in livelihood diversification and better articulate a currently under-theorized dimension in the diversification literature. This study can inform practitioners and policy makers when they design poverty reduction strategies and interventions in which development of livelihood assets is complemented by interventions specifically designed to address human cognition. For instance, efforts to reduce psychological stress may become viable complements or alternatives to costly full scale SL interventions in cases where stress plays the major role in livelihood behavior. Similarly, the combination of these two approaches can potentially result in positive synergies and increase the effectiveness of poverty reduction programs.

## Background information on Ghana and study area

### Geography and environment

**Ghana.** The southern coast of the Republic of Ghana is located 465 miles north of the equator on the Gulf of Guinea in the West Africa. Neighbored by Togo on the east, Cote d'Ivoire on the west and Burkina Faso on the north, Ghana occupies 92,100 square miles, comparable in size to the UK and the state of Oregon. Geographically, Ghana can be sub-divided into five areas with diverse terrain that includes plains, rolling hills, rivers and mountains. Approximately half of the country lies at the altitudes below 660 feet above the sea level. The coastline in the south consists of sandy shore, lagoons and low plains covered with scrub and intersected by several rivers. The southcentral and southwestern part of the country including the Greater Accra Region is made up of uplands and hills covered by forests. Along the southeastern boarder with Togo lies the Akwapim-Togo mountain range with its highest point as

Mount Afadjato. The Volta Basin region in the central east of the country features the world's largest man made, Lake Volta. The northern third of Ghana is made up of high plains with savanna and open woodland cover.

Ghana has tropical climate with three distinct climate zones and two rainy seasons in the southern and central parts of the country and one rainy season in the northern savannah areas. In the southern coastal zone the temperature fluctuates around mid and upper 80s F. The temperature tends to get warmer to the north of the country, reaching a high of upper 90s F.

**The Eastern Region.** The Eastern Region is located in the southeastern part of Ghana occupying approximately 8.1% of the country's territory. The region is Ghana's sixth largest administrative unit. The Eastern Region is rich with water resources. In general, three ecological zones of the Eastern Region - the semi-deciduous rainforest, forest savannah transition and guinea savannah - define the area's landscape which is represented by a set of highlands, woody valleys and waterfalls covered by the forest and savannah vegetation. The location in the wet semi-equatorial zone brings two rain seasons and temperatures that vary in range between upper 70s F in August and upper 80s F in March.

### Political organization and governance

**Ghana.** Republic of Ghana declared its formal independence from Great Britain on March 6, 1957 (Central Intelligence Agency (CIA), 2009). Ghana is a constitutional democracy that has three branches of governance with the President ashead of the state and head of government, aunicameral Parliament, and a Supreme Court . Administratively the territory of the country is divided into 10 regions (Ashanti, Brong-Ahafo, Central, Eastern, Greater Accra, Northern, Upper East, Upper West, Volta and Western) headed by a regional secretary. Regions are further subdivided into 169 districts with District Assemblies serving the highest political and administrative authority (GhanaDistricts.com, 2006).


*Source: CIA (2007). http://hdl.loc.gov/loc.gmd/g8851f.ct002219. Digital ID: g8851f ct002219.*

Figure 1 Ghana administrative divisions

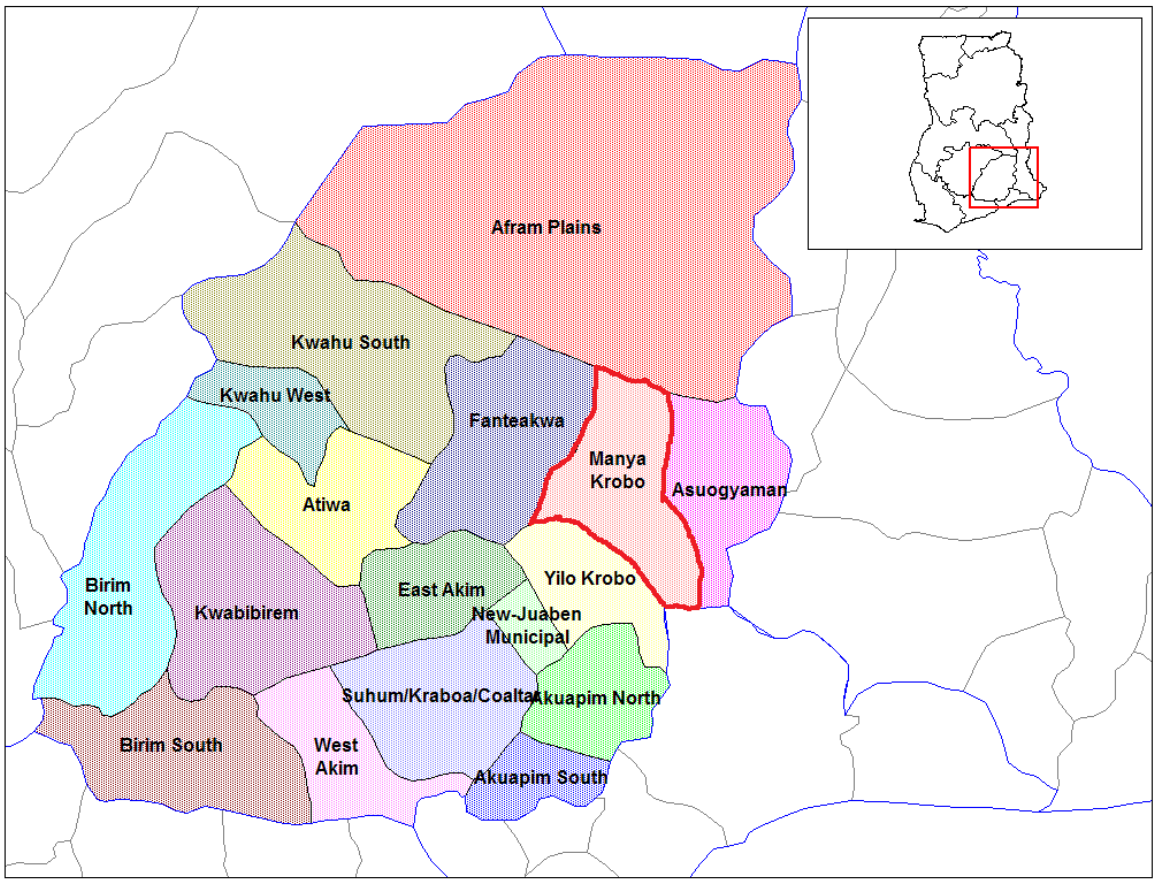


Figure 2 The Eastern Region administrative divisions and the study area (Manya Krobo District)

**The Eastern Region.** After four new districts were created in recent years, the Eastern Region is currently sub-divided into 21 administrative districts. The governing structure of the district consists of two units - the Regional Coordinating Council and the District Assembly, which preside in the regional capital of Koforidua. The Regional Coordinating Council is represented by the Regional Minister, members of the Regional House of Chiefs, the District Chief Executives of the region and the Presiding members of the district assemblies in the region. The Council is responsible for the governance of the region at the local level. The District Assembly represents the central government and supervises other administrative authorities in the region. The head of the Assembly - the District Chief Executive (DCE) - is appointed by the president and is responsible for the functioning of the Assembly. The Assembly has Urban, Zonal and Town/Area Councils, which are linked to Unit Committees at the grassroots level that assist councils with various activities, predominantly revenue mobilization, sanitation, and communal labor.

## Economy

**Ghana.** Ghana's economy demonstrates signs of moderate and stable growth in the last decade (Government of Ghana National Development Planning Commission, 2007). Between 2000 and 2008, Ghana experienced an average annual of 5.4% in Real GDP growth, ranked 13th in Africa and 4th in West Africa. In 2008, Ghana's annual Gross National Product (GDP) estimated on the basis of purchasing-power-parity (PPP) exchange rate and per capita GDP was estimated at US $29,965$ and US $1,251$, respectively, putting this country in seventh place in West Africa and 31st place in all Africa in per capita GDP (African Development Bank (AfDB) and OECD, 2009b).

In 2007, two sectors of economy - agricultural and service - accounted for about three-fourths of national GDP (approximately 36% and 38%, respectively) (African Development Bank (AfDB) and OECD, 2009a). Agriculture continues to be the major sector for employment, providing jobs for 55% of Ghana's labor force. Agricultural products also continue to be major exports and a key source of foreign exchange. For instance, cocoa, which is the main

cash crop, currently provides about 30% of all export revenues and timber industry is the fourth largest export industry in Ghana (Salm and Falola, 2002a).

Tourism now ranks third in foreign exchange earnings, replacing timber industry. Currently, Ghana ranks third in Africa for the numbers of arriving visitors. Since 2005, the tourism sector has generated more that one-hundred and eighty-three thousand new jobs (Government of Ghana National Development Planning Commission, 2007). The remaining 26% of the national GDP is coming from the mining and manufacturing industries, where gold, bauxites, manganese and diamonds represent the second largest export of Ghana (Salm and Falola, 2002a; African Development Bank (AfDB) and OECD, 2009a). Despite Ghana's economy being on the rise, critics argue that country's economy is still characterized by neocolonial economic structures that are heavily dependent on production and export of raw materials, despite a significant share of GDP from the industrial sector. Neoliberal reforms implemented since the 1980s have not significantly improved life for most Ghanaians (Salm and Falola, 2002a). In 2006, 39% of the rural and 11% of the urban population lived below the poverty line (African Development Bank (AfDB) and OECD, 2009a).

**The Eastern Region.** Currently the main economic activities in the Eastern Region are agriculture (55%), wholesale and retail trade (14%) and manufacturing (9%). Agricultural producers in the region commercially grow cocoa, pineapple, pawpaw, cola nut and oil palm. Recently several exotic crops including black and sweet pepper, ginger, cashew nuts, Irish potatoes, rubber and mangoes have gained greater importance in the region as export commodities. In addition, the Eastern Region produces considerable quantities of maize, cassava, and citrus (GSS, 2005).

The Eastern Region has a sizable industrial sector which includes mining/quarrying, manufacturing and electricity/water (GSS, 2008). The Eastern Region is rich with a wide variety of minerals including gold, diamonds, bauxite-tantalite, limestone, kaolin and clay. In the past the main commercially mined minerals were gold and diamonds; extraction of diamonds has considerably declined during the last two decades (GhanaDistricts.com, 2006).

In the region's economy, 55% of the economically active population is involved in agricul-

ture and related work. Others work in sales (14%) or production/transport/equipment work (14%). The professional/technical work employs another 7% of the workforce and services account for 5%. In 2003, 21% of typical household income, income from wages, 42% from household agriculture, and 285 came from self employment (GSS, 2008). While some discrepancies exist among sources regarding the current employment rates in the Eastern Region, 90% of the economically active people are working (Agyeman-Duah et al., 2006; GSS, 2005; Central Intelligence Agency (CIA), 2009). Consistent with other regions, the proportion of men employed is slightly higher than for women.

The Eastern Region is one of the two regions (including the Central Region) that experienced the largest decline in the incidence of poverty between 1998/9 and 2005/6. In 2005/6, 15% lived in poverty (down from 44% in 1998/9) and 7%lived in absolute poverty (from 31% in 1998/9). These figures are substantially lower than the national average at 29% and 18%, respectively, for 2005/6.The decline in poverty is attributed to aggressive poverty reduction interventions that increased exports of pineapples and cocoa from the Eastern region (Government of Ghana National Development Planning Commission, 2007).

**Population**

**Ghana.** In 2008, Ghana's had an was estimated 23.3 million people, of which 38% were children under age 15 years (African Development Bank (AfDB) and OECD, 2009a). About 70% live in the southern and central parts of the country (Salm and Falola, 2002a). In 2009, 50% live in urban areas (Central Intelligence Agency (CIA), 2009). Also some authors suggest that links between urban and rural areas grow stronger every year through trade of rural produce at the urban markets, through increasing dependence on remittances from urban to rural areas and through diffusion of urban culture into rural areas (Salm and Falola, 2002a).

Ghana's population can be characterized by high ethnic and cultural diversity. There are some 100 different ethnic divisions with distinct cultural and linguistic characteristics (Salm and Falola, 2002a). Akan is the largest ethnic group in Ghana (45%) (Central Intelligence Agency (CIA), 2009). Other major ethnicities include Mole-Dagbani, Gonja, Ewe, Ga-Dangbe

and Guan (Salm and Falola, 2002a).

According to 2000 census, 69% of Ghana's population are Christians, 15% are Muslims, 9% practice traditional religions and the remaining 7% are either practice other religions or are non-practitioners (Central Intelligence Agency (CIA), 2009). The central and southern areas of the country are predominantly populated by Akan, Ewe, Guan and several other major groups. These areas and ethnic groups have a long history of contact with Europeans, with widespread practice of Christianity, higher levels of education and adoption of Western values. Unlike groups residing in the southern parts of the country, Mole-Dagbani and Gonja, the most populous ethnic groups in the North, are predominantly Muslim and maintain a traditional Islamic way of living (Salm and Falola, 2002a).

Religious affiliations among Ghanaians are relevant in the context of their marital practices. In general, although polygamy and monogamy are both legally recognized forms of family unions, over 70% of families in Ghana are monogamous. Muslim men are allowed to have up to four wives. Customary law puts no restrictions on the number of wives. In Ghana's culture, men provide bridewealth to the family of a prospective bride and support the family after the marriage. Therefore, even in polygamous families, men rarely have more than two wives (Salm and Falola, 2002b).

In 2005-2006, an average household in Ghana had 4.0 persons living under the same roof and sharing household-keeping responsibilities (GSS, 2008). It is important to keep in mind, however, that households' composition reflects a great deal of regional, ethnic, cultural and religious variability. In southern and central regions and particularly in urban areas, households have a nuclear family structure. Unlike in North America and Europe, households in Ghana almost always include dependent relatives in addition to children.

Households consisting of extended families are still dominant in Ghana. Such domestic units may include several generations who live in the same dwelling and share responsibilities. The customary forms of co-habitation reflect the lineage traditions in Ghana.

One typical form of cohabitation in both the patrilineal and the matrilineal systems is an arrangement where husbands and wives live separately. Thus, among the Akan who are

the only ethnic group in Ghana to have a matrilineal lineage system, wives live in female compounds that include mothers, married and unmarried daughters, and children. Husbands live in their mothers' or maternal uncles' houses and have obligations to their own children and the children of their sisters. Such form of residence is called natolocal. Among the patrilineal Ga group where husbands and wives live separately, husbands stay in their fathers' houses, living with brothers and with their own and their brothers' sons ages 13 and older. Wives stay in their mothers' houses, where they reside with own children under age 13.They live with their sisters and their sisters' younger children.

Another typical form of co-habitation among groups with patrilineal decent is the joint residence of husbands and wives. Some variations of this form of co-habitation exist among ethnic groups and may effect the composition and structure of a typical household. Among people who live in the northern part of Ghana, households commonly include brothers, wives, and children. The elder brother is the head of the household. Each brother is responsible for his own family and all brothers are responsible for the wellbeing of the entire household. The typical household of the Ewe is composed of a husband, his wives, his children and several dependent relatives. Although less common among the Akan, some husbands, wives, and children live together. In such households, children may either leave their parents and move in with their maternal uncles after reaching adolescence (in case of adolescent males) or after marriage (for females), or may stay with parents bringing their own families in the house.

Polygamous families exhibit yet another form of co-residence. Thus, all wives rarely live under the same roof. More often, the senior wife lives with her husband, while other wives live in the separate residences (Salm and Falola, 2002b).

In the last decade, an average of 5% of national GDP was devoted to education, a level exceeded by only one other country in West Africa (Cape Verde at 5.7% GDP). With its estimated 65% adult literacy rate , Ghana has the third highest adult literacy rate among 12 other West African countries in 2005-2008 (African Development Bank (AfDB) and OECD, 2009a).

**Eastern Region.** The Eastern Region is the third most populous (2.1 million, 50.8% female)in Ghana and accounts for approximately 11% of the total population, according to the 2000 Census.. The region is characterized by a slightly higher than average dependency ratio (90.7 dependents for every 100 working age people vs. country average of 87.1). In 2000, approximately two out of five people in the region were children under 15 years. Elders over 65 years represent less than 6% of the region's population.

In general, the patterns of urbanization and urban-rural composition of the population in the Eastern Region reflect the country's patterns. Some 35% of the population was living in urban areas. The exceptions are Greater Accra (87%) and Ashanti (51%) Regions; at the other extreme are the predominantly rural Upper West (18%)and Upper East (16%) regions. The majority of urban dwellers in the Eastern Region resided in small size (under 10,000 inhabitants) or medium size (10,000 to 19,900 inhabitants) urban centers. Only 7 out of 56 such centers (including regional capital Koforidua) had a population exceeding 20,000. Regional officials report that almost half of all urban areas showed signs of demographic stagnation or decline in recent years (GhanaDistricts.com, 2006).

The Akan ethnic group comprises more than half of the total population. Three other ethnicities, namely the Ga-Dangme (19%), the Ewes (16%) and the Guans (7%), account for the largest part of the remaining residents. This ethnic composition, however, varies among districts. For instance, Ga-Dangme is the largest ethnic group in the Manya Krobo and Yilo Krobo districts making up some 70% of their population. Christianity is a dominant religion in the Eastern region (83%), followed by Islam (5%) and traditional religion (1%). The remaining 11% of region's population reported no religious affiliations in the 2005-2006 national survey (GSS, 2008).

Ghana Statistical Service defines household on the basis of co-habitation in the same dwelling and sharing house-keeping arrangements. According to 2005-2006 household survey, the average household size in the Eastern Region was 3.7 persons. This is below country's average (4.0) and is the second lowest in Ghana (GSS, 2008). However, household composition may vary depending on religious, ethnic or cultural traditions.

The most common type of dwelling in the Eastern Region was the compound (43% of all dwellings. Two other common types of residential arrangements are separate and semi-detached houses. Members of households in the region typically live in a dwelling with mud or cement walls, cement/concrete floors and roofs covered by coagulated metal sheets. They use kerosene lamps for lightning (64%), wood (69%) or charcoal (22) for cooking and pit latrines in their houses (38%) or public toilets (30%).They are more likely to use a safe source of drinking water (71.1%) and have safe sanitation (60%) (GSS, 2005).

Data from the Ghana 2003 Core Welfare Indicators Survey is used as a baseline statistics for current adult literacy rate in the Eastern Region; literacy among adults of 15 years and over in the region is slightly higher (56.6%) than the national average (53.7%). According to this survey, 71.3% of all males and 66.8% of urban adults were literate. Only 44.1% females and only 50.5% of rural residents (GSS, 2005) were literate. The distribution of literate population in the region was not uniform. Manya Krobo and Yilo Krobo are the two districts with the lowest level of female illiteracy.

**Health**

**Ghana** In 2006, Ghana spent 6.2% of its national GDP on health care programs. This is the second largest proportion in West Africa and is $13^{th}$ among all African countries (African Development Bank (AfDB) and OECD, 2009a). In 2004, the National Health Insurance Scheme was launched by the government to provide affordable health care. By 2006, 38% of Ghana's population was covered (Government of Ghana National Development Planning Commission, 2007).

International health organizations routinely use a wide range of health indicators including life expectancy, infant mortality rate, antenatal care and others to evaluate health status. In 2008, Ghana ranked seventh in West Africa and twenty-second among all African countries in terms of life expectancy (56.6 years) (African Development Bank (AfDB) and OECD, 2009a). In the last two decades, health related programs have helped to improve some of the country's health indicators. For instance, mortality rates for infants and children under age five were

estimated 50 and 80 per 1000, respectively, in 2008 - a substantial drop from 77 (infants) and 155 (children under 5 years) in 1988 (Ghana Statistical Service & Ghana Health Service (GSS & GHS), 2009). The 2008, the Ghana Demographic and Health Survey indicated that 1% of children under 24 months received no vaccination while approximately 79% were fully vaccinated. This survey also suggests that there was an improvement in maternity care, between 1988 and 2008, leading to increases in (by 10%), medically assisted births (by 17%) and tetanus toxoid injections (by 18%). One-quarter of all children under 5 years old may be experiencing malnutrition. Thus 37.8 % of Ghanaian children were stunted (had a low height-for-age ratio) according to World Health Organization (WHO) criteria and almost 80% had some type of anemia due to malnutrition, malaria and parasitic diseases (Ghana Statistical Service & Ghana Health Service (GSS & GHS), 2009). Anemia remains an issue of public concern since anemia prevalence of 40% or more is considered a major public health problem by the WHO (World Health Organization (WHO), 2001).

Acquired immune deficiency syndrome (AIDS) is recognized as one of the most serious public health challenges facing the world. African countries often have limited resources and simultaneously experience a high incidence of HIV/AIDS. Ghana holds 4th place among West African countries and is 25th among all African countries in HIV/AIDS prevalence. In 2007, 1.9% of adults were diagnosed with HIV/AIDS (Central Intelligence Agency (CIA), 2009; African Development Bank (AfDB) and OECD, 2009a). The distribution of HIV/AIDS cases in Ghana is highly uneven. A majority of HIV/AIDS cases are registered in the southern and central parts of the country. While polygamy is considered the major contributing factor in spreading the virus in Africa, areas with high levels of formal polygamy in Ghana are the least affected . In contrast, the Eastern region that has the lowest percentage of polygamous families in Ghana (18%) yet the highest prevalence of HIV/AIDS (Oppong, 1998).

**The Eastern Region.** In 2006, 37% of persons living in the region were covered by the NHIS (Government of Ghana National Development Planning Commission, 2007). Residents in the region not covered by or registered in the health care programs in 2005 reported two main reason: high premium cost and 'other' reasons, including waiting for one's guardian to register

them (GSS, 2008; Ghana Statistical Service & Ghana Health Service (GSS & GHS), 2009). Slightly less than half (49%) of rural households lived within 30 minutes walking distance from a health facility in 2003, compared to 81% in urban areas (GSS, 2005).

According to the Ghana Demographic and Health Report 2008, 96% of women in the Eastern Region who gave birth during the preceding five years received professional antenatal care. A majority had a birth assisted by a health professional (61%). Almost two out of three (59%) had a delivery in a health facility. These numbers are comparable to the national averages for these health indicators (95%, 59% & 57%, respectively). The rate of immunization against neonatal tetanus is one of the most widely used indicators of population health. In the Eastern Region, approximately 73% of women received tetanus toxoid injections during their pregnancy, slightly higher than the national average (71 %) (Ghana Statistical Service & Ghana Health Service (GSS & GHS), 2009).

Another important indicator of health status is the proportion of children vaccinated. The World Health Organization recommends vaccinating children against tuberculosis, diphtheria, pertussis, tetanus, polio and measles during the first year of their life. The 2008, a survey shows that the percent of fully vaccinated children in Eastern Region (76%) by 23 months is slightly lower than the national average (79%).

Malnutrition in children under 5 years of age is typical in Ghana. In the Eastern Region, children in this age group are more likely to be short (50.2% stunted). Such children are assumed to be more likely to receive an inadequate diet over an extended period of time and are more likely to experience negative effects from chronic diseases (Ghana Statistical Service & Ghana Health Service (GSS & GHS), 2009).

The prevalence of HIV/AIDS in the Eastern Region is among the most pressing public health problems. Currently, the Eastern Region has the highest percent of people (4.7%) living with HIV/AIDS in Ghana (UNAIDS/WHO, 2006). Such a high incidence of HIV/AIDS drew researchers to this region to understand factors contributing to the spread of the virus and to develop strategies to mitigate the negative effects of HIV/AIDS. Some studies show that the population in this region may be more likely to engage in risky behaviors and less

aware about common trajectories for virus spreads. According to the Ghana Demographic and Health Survey, the Eastern Region has the highest proportion of women who have had more than two sexual partners (3.4%) and who have engaged in risky sexual behavior (31.1%) in the preceding 12 months. The percentage of women having two or more partners is more than twice the national 1.5%. The proportion men who had more than two partners is comparable to the average national figure (16.8% and 16.7%, respectively), but considerably lower than in the Ashanti (21.5%) or the Greater Accra (21.1%) Regions. The proportion of men practicing high risk sex is slightly higher in the Eastern Region than on average in Ghana (43.8% and 37.9%). Fewer people in the Eastern Region, as opposed to other regions (86%), are aware of mother to child transmission of HIV (79%) (GSS, 2008; Ghana Statistical Service & Ghana Health Service (GSS & GHS), 2009).

## Research data

**The RIING project.** The data for the study of diversification in Ghana were collected through the Research to Improve Infant Nutrition and Growth project (RIING). Funded by the US National Institutes of Health (NIH/NICHD HD 43260) this project is being implemented in Ghana under the leadership of Iowa State University serving as a lead institution together with the University of Ghana operating in the capacity of the local lead institution. The RIING project has combined the efforts of an international multidisciplinary group of researchers from the Iowa State University (USA), the University of Ghana (Ghana), the University of Connecticut (USA),the McGill University (Canada) and experts from the Ghana Health Services (Nutrition & Reproductive and Child Health units), Manya-Krobo District Director's Office of Health Services, Atua Hospital, and St. Martins de Porres Hospital, Agormenya to create an environment in which infant and child nutrition in Ghana can be facilitated. To achieve its goal the RIING project employed strategies that combined research and development efforts. The development component of the RIING project was focused on providing both US-based and in-country training that enhances the research capabilities of Ghanaian academic/research institutions and improves local support infrastructure for future training and research in the

area of maternal and children's nutrition and health. The objective of the research component of the RIING project was to expand research initiatives in Ghana to study feeding infants and young children and to provide advice to improve infant and child nutritional status and health. The long term objective was to reduce morbidity and mortality and improve growth among children living in poverty by identifying factors that alter households' ability to provide optimal feeding and care-giving for infants and develope feeding and care-giving strategies that support children's health and growth and are feasible for all families to carry out. Data collection for the RIING project was conducted in the Eastern Region of Ghana between 2004 and 2008 as part of the research component of the RIING project. A cohort of pregnant women was recruited through the two hospitals in the Manya-Krobo district. The choice of the Manya-Krobo district was not accidental. This district is one of the areas in the country with high prevalence of HIV infections, yet it is accessible to researchers. In addition, the region has relatively good health infrastructure with three major hospitals (two sponsored by government, one by the Catholic Church), which facilitated the recruitment of subjects for the research. The cohort of pregnant women was selected on the basis of six criteria: 1) she was pregnant at the time of enrollment; 2) she requested voluntary testing and counseling (VCT) for HIV; 3) she agreed to have HIV results released to the project for selection purposes; 4) she was willing to participate for the entire 12-month study; 5) she had a definitive laboratory result identifying the mother as HIV- infected or HIV-uninfected; and 6) she was free of AIDS or other physical conditions that would limit ability to care for child.

The hospital staff members enrolled the subjects as participants for research.These people were responsible for the sample selection process. First, they informed of the study women who request VCT. Second, they obtained written consent from the prospective subjects allowing the release of their HIV results and the extraction of information from their clinical records. Third, they enrolled approximately 4 HIV-infected and 4 HIV-uninfected women per month for the study on the basis of the following procedures: (a) the first HIV-infected women who agreed to participate were enrolled and (b) since there were many more HIV-uninfected than infected women, the hospital staff member randomly selected the order in which to invite

healthy women to participate in the study. Usually healthy women tested on the same day as HIV-infected mothers were enrolled in the study. Post-natal follow-up continued among those women who met the following criteria: 1) had live birth, 2) had no birth defects that would hinder breastfeeding or normal growth; and 3) continued acceptance of home visits to observe care-giving behaviors.

The RIING sample represents residents of the peri-urban areas of the Manya Krobo District. A total sample of 667 respondents with known and unknown HIV status was enrolled in research through the above process including 264 HIV positive and 205 HIV negative women. An additional randomly selected group of women with unknown HIV status (n= 196) was included in the sample for control purposes. The drop-out rate for the total sample over the course of the study was 39%.

After the enrollment, the hospital and field staff followed subjects for 12 months, collecting the research data at enrollment during pregnancy, late prenatal stage, immediately after birth, and twice weekly after birth. The types of data collected included demographic characteristics, housing and living environment, food production, livestock rearing, social capital, remittances, borrowing, significant economic changes, stress, health perceptions, maternal pre-natal and post-natal depression, hygiene practices, onset of lactation, breastfeeding, intake of foods and liquids other than breast milk, feeding practices, maternal time allocation, anthropometry, food security and hunger, morbidity, knowledge of AIDS, the lived experience of stigma, and community services. The administration of research instruments, however, varied depending on the type of data collected. For instance, while demographics and housing instruments ware administered only once, the data on productive behavior of household members, their social, economic and human resources, and psychological stress were collected at enrollment, birth, three, six, nine and twelve months.

**The study of livelihood diversification.** This study is primarily concerned with livelihood diversification in the sample population; therefore, only the RIING data relating to the economically productive behavior of household members, social, economic and human resources, and psychological stress in 184 households with HIV positive women and 180 house-

Table 1 Comparison of selected socioeconomic and demographic characteristics: Ghana, Eastern Region and sample statistics

| | Ghana[a] | Eastern Region | Sample |
|---|---|---|---|
| **Household composition (%)** | | | |
| Mean Household Size | 4.1 | 3.9 | 5 |
| 1-2 | 32 | 33.1 | 11.9 |
| 3-4 | 28.5 | 29.8 | 37.9 |
| 5-6 | 23.3 | 23 | 33.7 |
| 7+ | 16.3 | 14.1 | 16.5 |
| **Gender (%)** | | | |
| Male | 48.7 | 47.8 | 42.7 |
| Female | 51.3 | 52.2 | 57.3 |
| **Age groups (%)** | | | |
| 0-14 years | 38.7 | 39.6 | 44.5 |
| 15-64 years | 56.8 | 54.9 | 53.1 |
| 65+ years | 4.5 | 5.5 | 2.4 |
| **Age dependency ratio (per 1 adult of productive ages)** | 0.8 | 0.8 | 0.9 |
| **6 years & older ever attended school (%)** | | | |
| Total | 71.6 | 79.5 | 82.9 |
| Male | 78.6 | 87.4 | 91.5 |
| Female | 65 | 72.3 | 77.2 |
| **Housing tenure (%)** | | | |
| Owns | 41.1 | 40.4 | 20.6 |
| Rent | 24.3 | 23.9 | 36.9 |
| Use without pay | 34.6 | 35.7 | 42.5 |
| **No regular job or work (unemployed and underemployed) (%)** | | | |
| Total | 5.4 | 3.7 | 8.3 |
| Male | 5.1 | 3.2 | 5.9 |
| Female | 5.6 | 4.1 | 10.3 |
| **Living conditions (%)** | | | |
| Access to improved water source | 74.1 | 71.2 | 96.3 |
| Access to electricity | 55 | 60.3 | 80 |
| Safe sanitation | 50.6 | 42.1 | 92 |
| Non wood fuel for cooking | 11.4 | 5.9 | 11.5 |

[a]Sources GSS (2005, 2008)

holds with HIV negative women is analyzed and discussed in this manuscript. Table 1 compares some demographic and livelihood characteristics of the study sample with population characteristics at the national and regional level.

This table suggests that the sample of peri-urban residents of Manya-Krobo District shares common characteristics with the national and regional populations. The sample slightly under-represents small sized households, males, adults over 65 years, and owners of the dwellings. The sample also slightly over-represents medium sized households, females, people who rent their dwelling or live there without pay. The sample population also appears to have better living conditions in comparison to a member of the average household in the Eastern Region. The above can be partially attributed to the sampling procedures and the fact that the sample was drawn from the peri-urban population and is likely to under-represent rural areas.

Since collection of the research data in the RIING project was conducted on a continuous basis, a substantial number of households were observed on alternate bases. For example, in some cases interviewers collected data four and a half months after the birth of a child, classified it as an observation at 3 months, and subsequently skipped the six-month observation of that household. Such variability in the timing of observations for a substantial number of households presents known methodological difficulties regarding completeness of the panel data. To correct for this problem, we combined six original waves of data (e.g., time of enrolment, birth and 3, 6, 9 & 12 months after birth) into three waves - enrollment/birth, 3/6 months, and 9/12 months. Our analysis of the actual dates of data collection in the resulting data set indicated that intervals of approximately 5 to 7 months characterized a majority of households surveyed, thus validating our approach for creating 3 waves of data. We applied two general rules to the organization of our research data: (1) only cases with complete data were analyzed in this study (cases with missing data were excluded from the analysis); and (2) all available complete cases were included in the analysis at the cross-sectional level, and only households with complete cases observed at all three waves of data were analyzed in our analysis of change. This explains variation in sample size for cross sectional and longitudinal analyses.

**Profiles of the households in the study sample.** The most recent statistics on regional incidence of poverty suggest that currently approximately 15 % of households in the Eastern Region of Ghana live below poverty line (GSS, 2008). Below are presented brief profiles of typical households with HIV positive and HIV negative women that were analyzed in this study. Households' were classified into four wealth categories based on scores of wealth owned by households. The wealth scores were estimated following Filmer and Pritchett (2001) method. The scores of weighted durable goods in households' possession were first estimated and then the categories of poor (the first 15%), lower middle ($16^{th}$ to $50^{th}$ percentile), upper middle ($51^{st}$ to $90^{th}$ percentile) and rich (top 10%) households were created.

Dwellers of a typical poor household in the study usually live in rooms or occupy whole houses, they either own their dwelling or use it without monthly payment. A majority of these dwelling have a safe source of water and a sanitary toilet and use wood and charcoal as major sources of energy for cooking. The main durable goods in possession of such households are radios, some kitchenware, sewing machines and some basic furniture including beds, tables and chairs. In general, the above characteristics are common for both households with HIV positive and HIV negative women. Yet some specific differences between these groups exist with respect to housing characteristics or available amenities. For instance, households with HIV positive women are little less likely than households with HIV negative women to live in houses (31% vs. 43%). On the other hand, they are less likely to pay for their dwellings (17% vs. 29%). Moreover households of HIV positive group are more likely to be connected to the electricity (64% vs. 42%) and use electricity as a source of light (62% vs. 36%).

The housing conditions are comparable across other wealth categories and across HIV groups. Thus, in low middle, upper middle, and rich wealth categories, dwellers of households tend more often to live in rooms or houses with safe water and sanitary toilets. They are more likely to pay for their dwelling (37% to 48%) than dwellers in poor households. There is substantially higher proportion of households in these wealth categories that are connected to electricity. These proportions range between 70% in the lower middle wealth group to 100% in the rich group. A slightly higher percentage of households in these wealth categories use non-

wood energy sources for cooking. Probably the greatest distinctive characteristic of households in different wealth categories is the repertoire of owned durable goods. In addition to those assets in possession of households in the poor category, households in the low middle category are more likely to own a pressing iron, sewing machine, fan, fridge, telephone or kerosene lamp. Few of these households also own bikes and cars. Not only do households in low middle group possess a greater variety of assets, but a greater percentage of households own them and these assets appear to be of greater value. This pattern is consistent across all wealth groups. Thus, households in the upper middle group tend to own a greater variety home electronics than households in the low middle group. These electronics include videocassette recorders (VCR), compact-disc (CD) players, digital video disc (DVD) players or blenders. While only half of households in the low middle group own a fan, it's 90% among households in upper middle group.

The members of households in the poor category are less likely to receive nine years of basic or 12 years of secondary education. They are also less likely to receive further education (e.g., vocational/technical, professional diploma or university), or be currently enrolled in school. Members of households with HIV positive mothers are more likely than members in households with HIV negative mothers to receive no formal education at all (28% vs. 21%). They are only half as likely to complete secondary education (14% vs. 26%). Overall, only one in four members in households with HIV positive women completed basic or secondary education, while in households with HIV positive mothers one out of three members accomplished this level of educational attainment. Less than half of HIV positive women in the category of poor households were married at the time of the study (44%). This is substantially lower percentage than the percentage of married HIV-negative mothers (71%) in the same wealth category. In addition, households with HIV negative mothers have higher household dependency ratios when compared to their counterparts in the same wealth category. Thus for each working person in these households, there is more than one person (1.1) in the dependent ages. In households with HIV negative women, there is less than one person (0.8) in the dependent ages for each working person.

The percentage of members in both HIV groups in the lower middle, the upper middle and the rich wealth categories of households who received basic education (25% to 30%) is comparable to the percentage of household members with the same level of education among households with HIV-negative women in poor households. The percentage of members who received secondary education, however, tends to increase with an increase in household wealth. For instance, while in the low middle group secondary education was completed by 16% of members in households with HIV positive women and 19% of members in households with HIV negative women, the percentage of members who achieved the same educational level are 24% and 33%, respectively in the HIV groups among the rich. Interestingly the percentage of married mothers is higher (70% vs. 91%) and the dependency ratio is lower (1.1 vs. 0.6) when comparing household wealth groups. As a general rule (with the exception of the rich group, where 91% of HIV positive women are married vs. 81% among HIV negative mothers), the percentage of married HIV positive mothers is 10% lower than for HIV negative mothers. The number of dependents is lower in households with HIV positive mothers than in households with HIV negative mothers, and ranges from 0.9 (in the low middle category) to 0.6 (in the rich category) in the former group, compared to 1.0 (in the low middle category) to 0.8 (in the rich category) in the latter group.

Almost two out of three members in the poor category of households have a regular job, with the majority of members being self employed primarily in petty trading or sales (approximately 45%). The second and third most common areas of employment for members in poor households are services (25%) and farming (17%). A majority of members in poor households work 5 to 7 days a week, with half of them using their own equipment. The only difference between households with HIV-positive and HIV-negative women is the fact that the members of the former group are more commonly self employed (84% vs. 75%).

There is a comparable proportion of employed household members in the low middle, the upper middle and the rich wealth categories of households. Similar to members of households in the poor category, they are more likely to be self employed. However, in these wealth categories there is a 10% difference in the number self employed in each respective HIV group

when compared to the category of poor. Thus, in these categories, self employed are 75% percent of household members in the HIV positive group and 63% in the HIV negative group. Similar to households in the poor category, the major economic activities of household members in these wealth categories are petty trading and sales. Petty trading and sales employ one in three members of households in the lower middle wealth category, and two in five members of households in rich households. There is, however, a visible difference in the percentage of household members who are employed as professionals (5% to 36%) or in the service sector (25% to 35%) and fewer of those who are employed in farming (13% to 3%) when poor and rich households are compared. As a rule, a higher percentage of members in households with HIV positive mothers are engaged in petty trading and sales, and a lower percentage are employed as professionals, when compared to members in households with HIV negative mothers.

Approximately one in four households in the poor category is engaged in livestock rearing and one in six in crop production. Among the poor, chicken and goats are raised by 18% and 7% of all households, respectively. Rarely do these households rear sheep (2%), pigs (1%) or other (usually snails) livestock (2%). Livestock are usually kept for consumption and rarely sold, with the exception of chickens. There are some group specific differences. For instance, more households with HIV positive women rear goats (10% vs. 4%) and other livestock (5% vs. 0%). The households that are engaged in crop production primarily harvested maize and cassava. Unlike livestock, a substantial portion of these crops are sold. For instance, three out of five households with HIV positive women and half of the households with HIV negative women grow maize. The former HIV group sold 40% percent of the harvested crop and the latter HIV group sold almost 70% of their crop. There are some group specific differences in the pattern of crop production observed between HIV households in this wealth category . Thus, households with HIV negative women are only half as likely to engage in crop production when compared to households with HIV-positive women (11% vs. 22%).

In general, more households in the lower middle, upper middle, and rich groups of households rear livestock, their livestock portfolios are more diverse, and they tend to sell some of it (approximately one in five livestock rearing households in these categories sell it). Ap-

proximately one in three of all households in these wealth categories rear chicken, one in five rears goats, and one in twenty rears sheep. Few households also rear pigs, cattle and other livestock. There are several differences in livestock rearing that are associated with households' wealth status and specific HIV groups. Thus, for instance, there are fewer households with HIV-positive mothers in the lower middle wealth category that rear livestock (36% vs. 41%). This pattern reverses in the upper middle wealth category where more households with HIV-positive mothers rear livestock (40% vs. 30% respectively) and particularly in the rich wealth category, where the proportion of households in the HIV-positive group rearing livestock is almost twice the proportion of households in the HIV negative group (60% vs. 35%). As a rule, it appears that more households with HIV positive women in each wealth category rear a greater diversity of livestock, but more households with HIV negative women sell their livestock. The exception to this rule is cattle rearing. There are as many households with HIV positive women as with HIV negative women who grow cattle in the upper middle category (1%) and less in the category of rich households (2% vs. 6%, respectively).

With respect to the crop production activities, it appears that a comparable proportion of households in each wealth category and each HIV group (20% to 25% of all households) are engaged in crop growing. Households in the lower middle and the upper middle groups tend to grow a greater variety of crops. In addition to maize and cassava that are commonly produced by households in the poor wealth category, households in these groups may grow cocoyam, yam, plantain, beans, okra and others. Between 5% to 25% of all crop producing households grow these additional crops. Typically larger a proportion of households with HIV positive women in these wealth categories produced and sold their crops. The percent difference between HIV groups ranges between 5% to 20% for specific crops. There is one characteristic, however, that is distinctive to the category of rich households. Households in the rich category tend to reduce the diversity of produced crops and limit their crops production to growing maize, none of which was sold during the period of the study.

## Conceptual model of household's livelihood diversification

While policies and infrastructure also influence households' livelihood diversification, development studies often focus on household level decision-making for understanding diversification (Ellis, 1998), which is viewed as a purposeful strategy (Tschajanow, 1989; Nakajima, 1986). Livelihood diversification exists among households at all socioeconomic levels. This phenomenon is common in both low income and wealthy countries. It occurs when economies are on the rise and when households have to face the difficult times due to economic downturns. Evidence from research shows that rural families are engaged in constructing "a diverse portfolio of activities and social support capabilities in order to survive and to improve their standards of living" (Ellis, 1998, p. 1). At a popular level, livelihood diversification is reflected in the widely used idiom 'Don't put all your eggs into one basket,' warning against the risk of loosing everything by investing all resources in only one activity. Increasing the resilience of households from various shocks and crises and taking advantage of emerging opportunities are the stimuli underlying households' diversification behavior.

Research in low income countries has described several specific livelihood diversification scenarios typical of a wide variety of households operating under different economic conditions. Thus, diversification of income earning sources through commercial farming and non-agricultural employment is a common strategy among better off households that want to spread risks of possible market failure in economies lacking insurance mechanisms (Von Braun and Pandya-Lorch, 1991; Ellis, 1998). When economies demonstrate signs of growth, the same category of households may diversify their off farm self-employment "to reap the attractive return" and thus increase their income (Woldenhannaa and Oskamb, 2001, p. 364). In resource poor areas with low cropping potential and among poor rural households, diversification of income through off farm activities is used as a self-insurance mechanism (Barrett et al., 2001a; Anderson and Deshingkar, 2004; Zoomers and Kleinpenning, 1996; Rider Smith et al., 2001). Following these strategies households often improve their quality of life and enter the 'upward spiral' out of poverty (Carter, 1997). Although researchers are well aware of cases in which diversification of income through disposal of household productive resources lead to increased

vulnerability of households' livelihood systems (Bryceson, 1999), their interest to livelihood diversification is supported by the potential role of this strategy in enhancing and in reducing poverty in low income countries.

The literature suggests that three types of household level factors may affect livelihood diversification: household resources, the level of psychological stress, and HIV status of household members.

**Household resources.** The role of household resources is articulated in the sustainable livelihoods (SL) literature which emerged during the 1980s (Ellis and Biggs, 2001). At the conceptual level, SL views wellbeing and poverty as consequences of existing means to gain livelihoods (Chambers and Conway, 1992; Toner and Franks, 2006). The SL perspective assumes that people possess a broad repertoire of tools, skills and assets. This versatile combination is used to earn a living and mitigate negative effects of various other vulnerability contexts (economic trends, shocks, disasters, etc.). The current livelihood diversification literature implicitly suggests that the nature and level of diversification is a function of the resources available to households (e.g., social, natural, financial, human, economic, political, and physical capitals).

For instance, research identifies three basic patterns of associations between economic variables and diversification behavior - linear negative, linear positive and inverted U-shaped. Reardon et al. (2000) came to the conclusion that substantial entry barriers for the poor exist in Africa; therefore, these countries typically demonstrate linear positive relationship between diversification and the socio-economic status of households. Similar linear decreasing diversity of livelihoods as poverty increased was also found by researchers in other studies in Africa supporting Reardon et al. (2000) the hypothesis of entry barriers hindering the poor (Woldenhannaa and Oskamb, 2001; Block and Webb, 2001; Barrett et al., 2001b). A linear positive relationship was also observed between social capital and diversification in non-farm income-generating activities in Tanzania and Uganda (Lanjouw et al., 2001; Rider Smith et al., 2001). The literature reports less consistent patterns of association between human capital and diversification, however. Some studies found positive relationship between education and diversification (Barrett

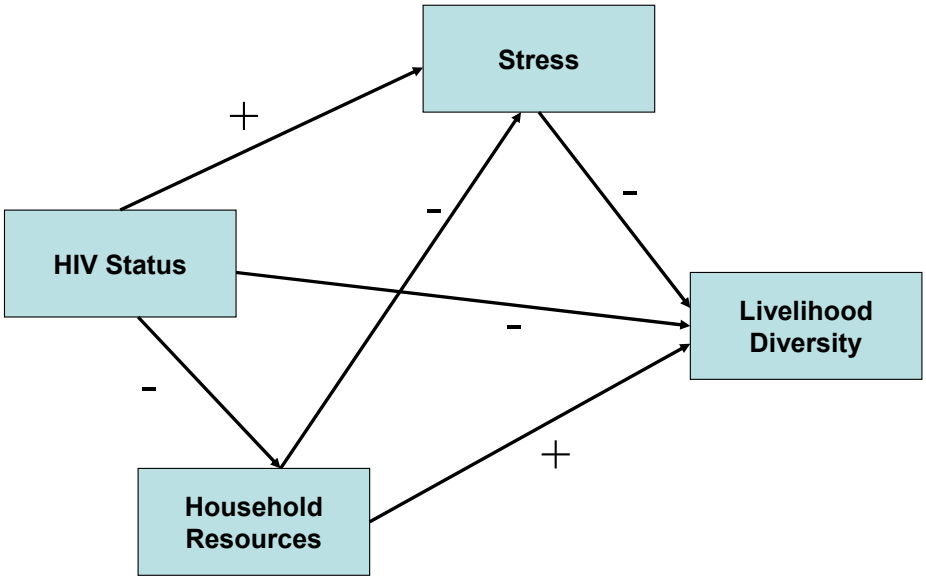


Figure 3 Diversity of livelihood activities in households with HIV positive members: conceptual model

et al., 2001b; Lanjouw et al., 2001; Canagarajah et al., 2001; Abdulai and CroleRees, 2001), while in others this relationship was insignificant (Block and Webb, 2001; Canagarajah et al., 2001).

**Psychological stress.** Research also suggests that the process of coping with psychological stress is commonly associated with altered productive behaviors. That is, excessive stress tends to reduce human performance by impairing decision making (Combs and Taylor, 1952; Easterbrook, 1959; Janis and Mann, 1977), increasing the time to complete tasks (Idzikowski and Baddeley, 1983), and degrading human capability for problem solving (Yamamoto, 1984).

Not only is stress capable of altering human productive behavior, but its effects can be more

pronounced in people affected by HIV/AIDS due to the increased stress levels in this group. For instance, the psychological effects of learning that one is HIV positive can be equivalent to the experience of the death of a spouse or imprisonment (Kartikeyan et al., 2007). Moreover, people living with HIV often suffer from various disorders, including depression, anger, anxiety and other psychological symptoms (Kelly et al., 1993). It is, therefore, expected that relationship between stress and household livelihood diversification is negative and pronounced in HIV affected populations. Thus, psychological stress can be increased by HIV/AIDS.

On the other hand, psychological stress can potentially be moderated by available household resources. Empirical research suggests that - consistent with psychological appraisal theories - (Lazarus et al., 1985; Monroe and Kelley, 1995; Lazarus and Folkman, 1984; Depue et al., 1979) negative relationships exist between available economic, social and human resources and appraised stress and depressive symptoms (see for example, Nielsen et al. (2008); Wright et al. (2007); Brannen et al. (2009); Lin (2009)).

**Effects of HIV/AIDS.** In addition to indirect effects, HIV/AIDS can also affect livelihood diversification directly. For instance, empirical evidence suggests that the direct effect of HIV on diversification of livelihood activities is the loss of labor due to the deteriorating health status and the shrinkage of available jobs options due to stigma. Stigma often extends beyond people infected with the virus to family, friends, social and health workers (Brimlow et al., 2003; Herek., 1990). Thus, contraction of the virus by a single member of the household can negatively affect household livelihood diversification. This study hypothesizes that HIV is an important factor that negatively affects diversity of livelihood activities.

The conceptual model with hypothesized relationships among household level resources, stress and livelihood diversification is presented in Figure 3. This model suggests that livelihood diversity is positively associated with household socioeconomic status, social and human capital. Further, livelihood diversity is negatively associated with psychological stress. Household resources can reduce the levels of stress neutralizing its potentially negative effect on livelihood diversity. Stress, on the other hand, can diminish the positive effects of household resources on livelihood diversity. Therefore, stress and household resources in the model are

negatively associated. Finally, the literature provides empirical evidence that HIV/AIDS positive people may experience higher levels of stress and that prevalence of HIV/AIDS is higher among the poor (Cohen, 1998)

**Defining diversification.** The literature offers two general conceptualizations of livelihood diversification - one broad and the other narrow (Niehof, 2004). The broad conceptualization incorporates household assets, income earning activities and outcomes of such activities (e.g. income, agricultural produce, etc.) (Barrett et al., 2001b; Ellis, 2000). The narrow conceptualization focuses on one component of household livelihood portfolios. Many researchers often consider the structure of income generating activities as a primary indicator of household livelihood diversification. Each conceptualization has advantages and limitations. The broad understanding is more comprehensive, encompassing all aspects of household productive behavior (e.g., resources, activities and outcomes). This comprehensiveness, on the other hand, limits its applicability in situations when one needs to explain cause-effect relationships that lead to either wellbeing or poverty.

Another important consideration is that people's diversification can either reduce households' vulnerability to poverty (Block and Webb, 2001) or increase it (Canagarajah et al., 2001). Sequential asset disposal leads to livelihood deterioration, in contrast to processes that increase the complexity of livelihoods portfolios Ellis and Freeman (2004). The literature traditionally identifies the latter as contributing to increased wellbeing and constituting a pathway out of poverty. Therefore, livelihood diversification is best understood as behavior associated with increasing complexity of household livelihood portfolios and increased resilience to poverty.

In this study, livelihoods diversification is defined narrowly as the proportion of non-farm activities in households' income generating (e.g., livelihood) portfolios.

**Focus on household level analysis.** This study examines livelihoods diversification at the household level, as do most studies (Niehof and Price, 2001; Niehof, 2004; de Sherbinin et al., 2008; Economic Commission for Europe, (ECE UN), 2007), though it is recognized that gender or power based intra-household inequalities are inadequately addressed. Households

Table 2 Modified Cohen's four item scale of perceived stress

| |
|---|
| Effective coping with important changes in life |
| Confidence about own ability to handle personal problems |
| Inability to control the important things in life |
| Inability to overcome difficulties |

Note: Frequency of experiencing the above feelings in the last month: 1="Never"; 2="Only once or twice"; 3="At least once a week"; 4= "More than once a week"; 5="Almost daily".

represent the basic production and consumption unit in rural societies, and are an agent of economic change (Kilmartin, 1990; Economic Commission for Europe, (ECE UN), 2007).Within households, livelihood resources are strategically allocated and livelihood behavior is strategically organized. From a methodological point of view, a household model has high predictive capabilities, particularly for explaining interactions among household decisions and broader economic trends (Ellis, 2000).

## Operationalizations & Measures

**Stress.** Contemporary stress research in psychology tends to view stress as a stimulus that prompts a human to choose specific coping responses. For instance, catastrophic events or daily burden may play a role of stimuli that would require emotional and behavioral adaptation. However, the response associated with these stimuli depends on a cognitive appraisal process that evaluates both the stressful event and available resources to cope with such an event. As such, psychologists often define stress in terms of a lack of balance between demands imposed by the surrounding environment and resources available to address such demands (Lazarus et al., 1985; Monroe and Kelley, 1995; Lazarus and Folkman, 1984; Depue et al., 1979) and measure the stress in terms of such an imbalance.

The levels of psychological stress in this study are assessed using a modified version of Cohen's 4-item scale of perceived stress (Table 2). The stress is measured among women with known HIV status [HIV- positive (HIV-P) and HIV - negative (HIV-N)]. Respondents reported

their perceived capability to cope with significant changes, problems and challenges on a five point scale.

**Human capital.** Human capital is commonly understood as knowledge and skills that are relevant to humans' economic activities (Schultz, 1961; Becker, 1962). Researchers often use education and the age of the head of household as proxies for household level human capital (see for example Barrett et al. (2001b); Block and Webb (2001); Jagger and Pender (2003); Quisumbing et al. (2008)). Following this tradition, human capital was operationally defined as the level of educational attainment of the head of the household and measure human capital in terms of the number of years of completed education.

**Socio-economic status.** To create the measure of household socio-economic status, the Filmer and Pritchett (2001) principal component analysis (PCA) based method was adopted. The PCA based method was developed as a simple technique to estimate households' wealth proxy index when income and/or expenditure data are not available. Traditionally, many studies collect information on a broad range of households' assets which can inform a researcher regarding the household's wealth status. Gathering this type of information, on the one hand, is a standard practice. On the other hand, using this information as an aggregate proxy of households' wealth often presents a challenge.

One of the most straightforward and simple proxies of household wealth is aggregation of household assets by counting the number of different items, treated in a dichotomous manner. The total score of all available assets is used as a proxy of household wealth. Despite the apparent simplicity of this method, it has a fundamental limitation. In this technique, all the assets are weighted equally and present a known problem. For instance, household that can only afford to own a bike would be weighed equally with the household that owns a car but does not have a bicycle. One can easily argue that a household needs to have greater wealth to possess a car. Another technique is estimation of the current value of the assets in possession. In this technique, the current value of an asset serves as the weight. Although benefits of a wealth index created on the basis of current value of assets are apparent, this approach has its

own limitations. Reliable data on the value of assets and their depreciation are rarely available. Therefore, valid value based wealth indexes can rarely be constructed in practice.

An alternative approach to creating an index of household assets is using asset variables as dummies in linear multivariate regression. Such an approach according to Filmer and Pritchett (2001) performs well when one needs to study the relationships between non-wealth variables while controlling for wealth factors. However, it does not help to estimate the direct and indirect wealth effects on other variables. The principal component analysis (PCA) overcomes these limitations:

> *"Principal components is a technique for extracting from a set of variables those few orthogonal linear combinations of the variables that capture the common information most successfully. Intuitively the first principal component of a set of variables is the linear index of all the variables that captures the largest amount of information that is common to all of the variables." (Filmer and Pritchett, 2001, p. 116)*

The fundamental assumption of the PCA based method is that households' long term wealth explains the variability of available assets (Filmer and Pritchett, 2001). Putting this assumption into plain language may, in most general terms, mean that acquisition of household durable assets depends on the level of household wealth and that households have in their possession only assets they can afford to buy and maintain. Such a view of households' durable assets assumes some form of internal hierarchy of these assets. The households with low levels of wealth would possess fewer, highly essential assets and/or assets that are likely to be of lower economic value. An increase in household wealth is likely to be associated with more, higher value durable good assets.

Mathematically, the relationship between the $i^{th}$ measured variable $A_i$ ($E[A_i] = 0$) and the $j^{th}$ principal component $C_j$ can be expressed by the formula:

$$A_i = \sigma_{ii}\gamma_{ij}C_j \tag{1}$$

where $\sigma_{ii}$ is a standard deviation of the variable $A_i$ and the $\gamma_{ij}$ is the principal component loading of variable $i$ in component $j$. When variance-covariance matrix is used in PCA analysis the correlation between the variable $A_i$ and component $C_j$ is estimated as follow:

$$\rho_{ij} = \gamma_{ij} \sqrt[2]{\lambda_j^2/\sigma_{ii}^2} \tag{2}$$

where $\lambda_j^2$ is the variance of the $j^{th}$ principal component and $\sigma_{ii}^2$ is the variance of the $i^{th}$ variable $A_i$. When the PCA method is used in households' proxy wealth index construction, it is typically assumed that the first principal component captures variability in the ownership of assets due to the level of household wealth. Closer examination of the above formula reveals the magnitude of correlations between the first principal component representing long-term household wealth and individual assets depends on two parameters $\gamma_{ij}$ and $\sigma_{ii}^2$. Since the $\sqrt[2]{\lambda_j^2}$ will remain constant for all assets contributing to the principal component, the magnitude of correlations between individual durable assets and the first principal component will depend on the following ratio:

$$\gamma_{ij}/\sqrt[2]{\sigma_{ii}^2}$$

or

$$\gamma_{ij}/\sigma_{ii}$$

where $\sigma_{ii}$ is standard deviation of the $i^{th}$ asset variable Filmer and Pritchett (2001) used this property to estimate their socioeconomic status (SES) wealth index. I followed these authors in constructing my SES index. First, all variables with quantities of different household durable items (e.g. kitchen equipment, electronics, automotive, etc.) were converted into a set of dichotomized variables where '1' represented any quantity of a specified item and '0' the absence of that item. Second, means and standard deviations were estimated for the distribution of each item among all households. Third, the first principal component was extracted from the set of dichotomized and normalized variables so that a specific PCA value

($\gamma_{AiC1}$) corresponded to a specific item ($A_i$). Fourth, the weight for each item was estimated by dividing the item's PCA value by its standard deviation ($\gamma_{AiC1}/\sigma_{AiAi}$) (Appendix B.2. Fifth, since the all the asset variables are in the dichotomized form, the resulting weights have straightforward interpretation. Thus, the move from '0' (having no asset) to '1' (having an asset in the position) means that household wealth is increased by the value equal to the $\gamma_{AiC1}/\sigma_{AiAi}$ (where $i$ is the $i^{th}$ asset in the list containing 31 assets). Therefore, the value 1 in each dichotomous variable was replaced with the corresponding weight and summed all variables to obtain the total socio-economic status (SES) score for a specified household as a wealth proxy index.

$$SES = (\gamma_{A1C1}/\sigma_{A1A1})A_1 + (\gamma_{A2C1}/\sigma_{A2A2})A_2 + \cdots + (\gamma_{A31C1}/\sigma_{A31A31})A_{31} \tag{3}$$

Or

$$SES = \sum_{1}^{31}(\gamma_{AiC1}/\sigma_{AiAi})A_i \tag{4}$$

where $SES$ is the composite proxy index of household wealth; $\gamma_{AiC1}/\sigma_{AiAi}$ is weighting score of the $i^{th}$ durable asset ($A$); $Ai =$ the $i^{th}$ durable asset measured as dichotomous variable ($A_i = 0$ or 1) and $Ai \; \epsilon \; N\{1, 2, \ldots, 31\}$.

Traditionally the PCA based index is used either as continuous variable or used to define cut off points for the broad classification of socio-economic groups (Vyas and Kumaranayake, 2006). In this study, the SES index was use as a continuous variable. The strengths and limitations of the PCA method are discussed elsewhere (see, for example, Kolenikov and Angeles (2009)). For instance, one of the limitations of the method is that weights in the index are not grounded theoretically (Filmer and Pritchett, 2001). Yet, despite its limitations, the PCA base method of households' wealth proxy index construction has demonstrated acceptable validity and reliability and currently is widely used by the World Bank, USAID and other international development organizations (Rutstein and Johnson, 2004; Rutstein, 2008).

**Diversification of livelihood activities index:** Ellis and Freeman (2004) view of diversification adopted in this study helped operationalize the measure of household diversification. These authors suggest that diversification associated with increased sustainability of better off households has two important characteristics. First, better off households exhibit an increasing proportion of non-farm activities in their livelihood portfolios. Second, these households simultaneously show evidence of increasing livelihood complexity. Following this lead, a weighted composite diversification index was created for on-farm and off-farm activities.

During the first step of index construction, four separate complexity scores were created for the four livelihood activities of the population, including livestock production, agricultural production, work for wages and receiving remittances. The complexity score representing work for wages was calculated by estimating the proportion of economically active household members over 15 year who are employed or self-employed and earn income.

$$J_i = \frac{N_j}{N_t} \tag{5}$$

where:

$J_i$ - household's employment index; $N_j$ - number of employed household members over 15 years old and $N_t$ - the total number of household members over 15 years old.

To create complexity scores for three other activities namely livestock production, agricultural production and receiving remittances, the PCA based approach that was earlier used for SES index construction was adopted. Each of these three general categories of household livelihoods is represented in by the list of specific activities (Appendix B.1). For instance, livestock production may involve raising chickens, goats, pigs, sheep, cattle or another type of livestock. Agricultural production may consist of growing up to 14 types of different crops and households may receive up to 3 remittances in a given time period. Extending the original approach of the PCA method, when it is used for constructing wealth index, it was assumed that variation associated with specific farm activities and the number of received remittances is explained by the decision of households to increase the complexity of their livelihood strategies. Consequently, complexity scores for remittances, livestock and agricultural production

were estimated as follows:

$$R_k = \sum_{1}^{3} (\gamma_{RiCR}/\sigma_{RiRi}) R_i; \tag{6}$$

$$L_k = \sum_{1}^{6} (\gamma_{LiCL}/\sigma_{LiLi}) L_i; \tag{7}$$

$$F_k = \sum_{1}^{14} (\gamma_{FiCF}/\sigma_{FiFi}) F_i; \tag{8}$$

were:

$R_k$, $L_k$ and $F_k$ are complexity scores for receiving remittances, livestock rearing and crops production by the $k^{th}$ household;

$R$ is receiving remittances, $L$ is livestock rearing and $F$ is crops production that are represented by dichotomous variables measured on the scale from '0' ($No$) to '1' ($Yes$);

$i$ is the $i^{th}$ remittance ($R$), livestock ($L$) or crop ($F$) and $R_i \, \epsilon N\{1, \ldots, 3\}$, $L_i \, \epsilon N\{1, \ldots, 6\}$ and $F_i \, \epsilon N\{1, \ldots, 14\}$;

$\sigma_{RiRi}$, $\sigma_{LiLi}$ and $\sigma_{FiFi}$ are standard deviations of the $i^{th}$ remittance ($R$), livestock ($L$) or crop ($F$) and

$\gamma_{RiCR}$, $\gamma_{LiCL}$ and $\gamma_{FiCF}$ are first principal components for the $i^{th}$ remittance, livestock or crops. The PCA based weights and summary statistics used in the construction of the above indices are summarized in Appendix B.1.

At the second step in diversification measure construction, the proportion of non-farm activities in households' livelihood portfolios was calculated. The complexity scores of the four above indexes were summed to create the total diversification score and estimated the proportion of non-farm activities (e.g., diversification index) by dividing the sum of complexity scores for jobs and remittances by the total diversification score. To create the livelihood diversification index, the following formulas were used:

$$DV_i = \frac{R_i + J_i}{R_i + J_i + L_i + F_i} \tag{9}$$

where:

$DV_i$ - household's diversification score (e.g. the proportion of non farm activities).

**Social capital:** The fundamental concept of social capital is that 'social networks have value' that "can affect the productivity of individuals and groups" (Putnam, 2000, p. 18). Although many different definitions exist, a majority of authors define social capital in terms of networks, norms and trust that increases actors' effectiveness in achieving common objectives (Schuller, 2001; Schuller et al., 2000). In the literature several indicators of social capital are commonly discussed, which include the density of social networks, the quality of relationships, and reciprocity (Adler and Kwon, 2002). In this study, social capital is operationalized in terms of the quality of social relationships and reciprocity within inner circles (spouse, friend, relatives and neighbors) and outer circles (co-workers, government officials, etc.).

The quality of relationships with the individuals and institutions from one's inner and outer circles were evaluated with 14 (Appendix B.3) questions inquiring about a broad spectrum of personal, health, child rearing, economic, and other obstacles experienced by a respondent. The score '1' was assigned to individuals or institutions if they help address the specified problem and '0' if not. The index of social capital was created using the PCA method. For instance, spouses, friends, neighbors or co-workers can help a respondent to address major personal problems, problems obtaining food, problems obtaining clothing, etc. Extending the original proposition of the PCA method, it was assumed that variation associated with specific questions is explained by the quality of relationships and reciprocity in households' social capital. The measure of the social capital was constructed as follow:

First, separate PCA based indices were created for quality and reciprocity for six relationships - spouses, relatives in the house, relatives outside the house, neighbors, friends and others (including co-workers, bank, government officials, etc.). Second, scores of these indexes were summed into the global index of social capital which represents the total score on the quality of relationships and reciprocity of available social network. The formulas are presented below:

$$S_k = \sum_{1}^{14} (\gamma_{SiCS}/\sigma_{SiSi}) S_i; \tag{10}$$

$$RI_k = \sum_{1}^{14} (\gamma_{RIiCRI}/\sigma_{RIiRIi}) RI_i; \tag{11}$$

$$RO_k = \sum_{1}^{14} (\gamma_{ROiCRO}/\sigma_{ROiROi}) RO_i; \tag{12}$$

$$N_k = \sum_{1}^{14} (\gamma_{NiCN}/\sigma_{NiNi}) N_i; \tag{13}$$

$$FR_k = \sum_{1}^{14} (\gamma_{FRiCFR}/\sigma_{FRiFRi}) FR_i; \tag{14}$$

$$O_k = \sum_{1}^{14} (\gamma_{OiCO}/\sigma_{OiOi}) O_i; \tag{15}$$

were:

$S_k$, $RI_k$, $RO_k$, $N_k$, $FR_k$ and $O_k$ are complexity scores for the quality of relationships with a spouse ($S$), relatives in the house ($RI$), relatives outside the house ($RO$), neighbors ($N$), friends ($FR$) and others ($O$) in the $k^{th}$ household;

$i$ is the $i^{th}$ item on the standard 14 item scale ($i\ \epsilon N\{1, \ldots, 14\}$) with dichotomous response options ('0'= $No$, '1' = $Yes$) that is used to evaluate quality of relationships with a spouse ($S$), relatives in the house ($RI$), relatives outside the house ($RO$), neighbors ($N$), friends ($FR$) and others ($O$);

$\sigma_{SiSi}$, $\sigma_{RIiRIi}$, $\sigma_{ROiROi}$, $\sigma_{NiNi}$, $\sigma_{FRiFRi}$ and $\sigma_{OiOi}$ are standard deviations of the $i^{th}$ item in the standard 14 item scale specific a spouse ($S$), relatives in the house ($RI$), relatives outside the house ($RO$), neighbors ($N$), friends ($FR$) and others ($O$) and

$\gamma_{SiCS}$, $\gamma_{RIiCRI}$, $\gamma_{ROiCRO}$, $\gamma_{NiCN}$, $\gamma_{FRiCFR}$ and $\gamma_{OiCO}$ are first principal components for the $i^{th}$ item in the standard 14 item scale specific to a spouse ($S$), relatives in the house ($RI$),

relatives outside the house ($RO$), neighbors ($N$), friends ($FR$) and others ($O$). The PCA based weights and summary statistics used in the construction of the above indices are summarized in Appendix B.1.

$$SC = S_k + RI_k + RO_k + N_k + FR_k + O_k \tag{16}$$

where $SC$ is a global score on the household's social capital. Individual weights that were used in index are summarized in the Appendix B.3.

# DIVERSITY OF LIVELIHOOD ACTIVITIES IN HOUSEHOLDS WITH HIV-POSITIVE AND HIV-NEGATIVE MOTHERS IN EASTERN GHANA

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## Abstract

Research suggests that feedback relationships exist between HIV/AIDS and households' livelihoods. HIV/AIDS affected people often loose their ability to contribute to household livelihoods as their health status deteriorates. In addition due to HIV/AIDS relating stigma and social isolation peoples' options to diversify their livelihood activities may shrink and result in the greater risk of poverty which can further aggravate the HIV/AIDS epidemic. This study hypothesizes that households with HIV positive members begin experiencing negative effects of HIV on their livelihoods systems before the symptoms of AIDS become manifest. Thus, it is hypothesized that households with HIV-positive members would have significantly lower scores on the diversification of livelihood activities when compared to households with HIV negative mothers. This hypotheses is supported in the panel of households with HIV-positive and negative mothers in Eastern Ghana. The results of the ANOVA test and SEM growth curve analysis (GC) suggest that HIV-positive group has significantly lower diversification scores and, unlike the group with HIV-negative mothers, experienced steady decrease in the measure of diversification over the 12 months period. This study argues that timely and adequate

interventions are needed for the households with HIV-positive women in Eastern Ghana to address the above problem. Without opportunities to generate adequate livelihoods they are likely to exhaust their household resources, which may in tern undermine their food security and reduce their capability to resist HIV infection.

## Introduction

During the past two decades, the theme of livelihood diversification has emerged as an important element in research on sustainability. Numerous studies in low income countries have shown that households with more diverse activities exhibit lower vulnerability to food insecurity, greater resilience and adaptability to environmental and economic shocks, possess a greater repertoire of resources to use in their strategies to escape poverty and achieve greater overall sustainability (Ellis and Allison, 2004). Recognizing the potentially important role of diversification for poverty reduction, researchers have investigated its nature and identified the factors facilitating or constraining it. Access to resources, credit, nature of policies and the state markets and infrastructure were identified among the most common contributing factors Ellis (1999).

Recently links between households' livelihoods and HIV/AIDS became a special question of interest to researchers. Literature suggests that feedback relationships exist between HIV/AIDS and households' livelihoods. For instance, there is an evidence that contraction of HIV/AIDS can decrease diversity of livelihood activities. On the one hand, HIV/AIDS affected people need special care, continuous treatment and increased energy intake which require allocation of additional household resources. On the other hand, these people can lose their ability to contribute to household livelihoods as their health status deteriorates due to HIV/AIDS (Haddad and Gillespie, 2001). All these factors can deplete households' resources and reduce peoples' options for contributing to households' livelihoods. In addition, HIV/AIDS related stigma can be extended to all household members and can lead to social isolation and decrease in income earning opportunities (Murphy, 2008; Anarfi, 1995).

Although links between manifest HIV/AIDS and increased vulnerability of households'

livelihoods is recognized, there is little empirical evidence regarding the nature of such linkages prior to when AIDS symptoms became manifest. Traditionally researchers see AIDS relating vulnerability of households' livelihoods resulting from the loss of labor and from stigma. This may be only part of the story. One can easily argue that households dealing with HIV/AIDS have to start coping with this problem the moment they become aware of it. Contraction of HIV by even a single member of the household may require adjusting livelihoods behavior and diversification strategies. For example, households may change their intra-household redistribution of resources or engage in re-structuring the portfolio of livelihood activities (Topouzis, 1998). The above argument fits well with a tradition of seeing household livelihoods as a function of utility maximization strategies (Tschajanow, 1989; Nakajima, 1986). For development practitioners, this may mean that livelihoods interventions need to be modified to meet the needs of early intra households' adjustments to HIV.

This paper seeks to address the paucity of livelihoods research on HIV positive people without overt symptoms of AIDS and understand how HIV status of new mothers in Ghana affects the diversity of household livelihood activities. The focus on households with new mothers in Ghana is important in the context of international efforts to control the HIV/AIDS epidemic in Africa. Ghana is experiencing a high incidence of HIV infections among women of childbearing age. These women are more likely than men to contract HIV and develop AIDS (Addo-Yobo and Lovel, 1992; Ankrah et al., 1994; Cronin et al., 1991). In the case of nursing mothers, increased food insecurity due to increased vulnerability of household livelihoods may not only worsen their health status, but can also alter their infant feeding practices. That action can, in turn, increase an infant's risk of HIV infection if, for example, mothers have to use combination of breast feeding and solid foods as coping strategy to food insecurity (Coovadia et al., 2007).

This paper raises three specific questions regarding the diversification of livelihood activities of these households: (1) does HIV status affect the diversity of households' livelihood activities? (2) Does diversity of livelihood activities change over time? (3) Do patterns of change differ for households with mothers affected by HIV? This paper hypothesizes that households with HIV positive mothers would have less diversified livelihood activities. It is expected that

diversification will decrease over time in households with HIV positive mothers. It is also expected that in households with HIV negative mothers the spectrum of change in diversification can potentially range from negative to positive, yet, if decrease at diversification is observed it would occur at significantly lower rate than in households with HIV positive women.

## Putting the study of diversification into context

Although the diversification discourse became a norm in livelihoods literature, operationalization of this concept in empirical studies still poses challenges for researchers. Not only is the concept complex and the literature still lacks common definitions and relevant terminology (Barrett et al., 2001b), but extensive empirical evidence suggest that people diversify their livelihoods differently, for different reasons, and with different consequences for the sustainability of their livelihoods systems. Therefore, researchers seeking to investigate diversification in relation to sustainability or vulnerability of livelihood systems, have to carefully operationalize the concept.

Von Braun and Pandya-Lorch (1991) track the origins of contemporary diversification research back to the studies by Tschajanow and Nakajima. In analysis of survey data from 11,500 peasant households in Russia collected between 1874 and 1917 Tschajanow (1989) suggested that a peasant household constitutes a non-economic productive unit in which livelihood strategies are aimed at maximizing subjective utility rather than monetary profit. According to the author, this partially explained why peasant households commonly refused to adopt new agricultural technologies, produced low value crops that require extensive labor and distracted labor resources from agricultural production by sending household members away for seasonal jobs. Building on this study, Nakajima in the 1980s developed a theory of the subjective equilibrium of the farm household in which he integrated household production, consumption and labor decisions in a utility maximization framework (Nakajima, 1986).

**Diversification as utility function**

Seeing diversification as a utility function assumes that households use diversification as a purposeful strategy. Why do households diversify their livelihoods? What do they diversify? With what consequences? These are the questions commonly raised in the literature. The empirical research identified two main reasons underlying diversification. Studies tend to distinct among household diversification as coping strategy in times of crisis and diversification as a strategy to spread risks and/or to increase wealth and securing or improving households' socio-economic status (Zoomers and Kleinpenning, 1996).

For instance, in economies lacking insurance mechanisms, better off households engage in commercial farming and tend to increase their non-agricultural employment to balance risks of possible market failure (Von Braun and Pandya-Lorch, 1991; Ellis, 1998). In northern Ethiopia wealthy farmers diversify off farm self-employment 'to reap the attractive return" and thus increase their income (Woldenhannaa and Oskamb, 2001, p. 364). In areas with low cropping potential in Kenya where poor farmers can not rely solely on agriculture, they use off farm income diversification as a form of self-insurance (Barrett et al., 2001a). This echoes findings from India (Anderson and Deshingkar, 2004), Paraguay (Zoomers and Kleinpenning, 1996) and eastern and central Uganda where off farm diversification as a supplement to farming is practiced by 70%-90% of all farmers (Rider Smith et al., 2001).

The apparent duality in the conditions under which people make diversification decisions was revealed through empirical research and described in terms of motivational dichotomies. People diversified their livelihoods out of necessity an often involuntary coping response to crises or they intentionally chose diversification (Barrett et al., 2001b; Ellis, 2000) as a deliberate strategy to spread risks (Von Braun and Pandya-Lorch, 1991; Ellis, 1998) or increase wealth (Hart, 1994). The availability of choice - in contrast to respond to a crisis out of necessity - influences decisions about what should be diversified and how to do so.

For instance, rich households were more likely to diversify with non-farm business activities, while economically disadvantaged groups engaged in casual on-farm wage labor (Ellis and Freeman, 2004). Empirical studies reported cases in which diversification of livelihoods was

associated with either improved quality of livelihoods (Carter, 1997) or increased vulnerability of households due to deterioration of their livelihoods (Bryceson, 1999).

**Choosing the 'right' diversification**

The fact that livelihood diversification can both reduce (Block and Webb, 2001) or increase (Canagarajah et al., 2001) households' vulnerability raises the question about the 'right' type of diversification. What are the essential features of the diversification associated with increased sustainability and poverty reduction? To answer this question, Ellis and Freeman (2004) suggest looking at the diversification strategies of richer households. According to Ellis and Freeman (2004), the 'right' diversification possesses several important characteristics. First, security of livelihoods of better off households is achieved through a combination of farm and non-farm components, with a simultaneous increase in farm productivity and decrease of the importance of farm component in the overall livelihood system. Second, the livelihood behavior of better off households is best characterized by "virtuous spirals of accumulation typically involving diverse livestock ownership, engagement in non-farm self-employment, and diversity of on-farm and non-farm income sources" (Ellis and Freeman, 2004, p. 1). Third, the pathway out of poverty is commonly associated with incremental increase in complexity of livelihoods and livelihood activities. This process is described in the literature as a sequence of trading of household assets with assets of higher value (e.g. chickens for goats, to cattle, etc.) (Ellis and Mdoe, 2003) and contrasted with a process of livelihood deterioration due to sequential asset disposal (Corbett, 1988; Devereux, 1993).

**Scope of understanding**

There are two general understandings of livelihood diversification in the literature - the broad and the narrow (Niehof, 2004). Researchers who interpret diversification broadly tend to include in their operational definitions of diversification household assets, income earning activities and outcome of such activities (Barrett et al., 2001b; Ellis, 2000). One limitation of this approach is the difficulty of translating associations between elements into structure of

causal relationships, thereby reducing options for program interventions.

Another apparent limitation is that livelihood assets, activities, and outcomes may experience different temporal trends. For instance, durable goods and means of production may reflect long-term accumulation of goods, while income commonly reflects seasonal and annual trends (Filmer and Pritchett, 2001; Rutstein and Johnson, 2004). In this context, livelihood activities and outcomes may have higher rates of fluctuation caused by short term economic shocks and household responses to these shocks, while household assets demonstrate greater stability over time. Similarly, using livelihood outcomes as a proxy for diversification may present some difficulties. For instance, households may resort to selling productive assets to generate additional income (Corbett, 1988; Devereux, 1993; Bryceson, 1999). The short term outcome of this action is increased households' income, which in comparison to others can put such households in the category of better offs. But in the longer term perspective the above strategy may undermine the sustainability of household livelihoods.

This study adopts the narrow view on diversification. It focuses on livelihood activities as a proxy for livelihood diversification. Although such an understanding does not directly take into consideration the 'big picture' of household livelihoods, it seems well suited for capturing 'virtuous spirals' and agency in household livelihoods behavior.

**Focus on households**

Despite the fact that the household as the unit of analysis is criticized for its inability to reflect gender or power based intra-household inequalities, households remain the predominant focus of livelihoods research (Niehof and Price, 2001; Niehof, 2004; de Sherbinin et al., 2008; Economic Commission for Europe, (ECE UN), 2007). Households represent the simplest and yet most complex form of social organization that operates as a basic production and consumption unit and as an agent of economic change (Kilmartin, 1990; Economic Commission for Europe, (ECE UN), 2007). It is within household that livelihood resources are strategically allocated and livelihood behavior is strategically organized. From a methodological point of view, a household model has high predictive capabilities, "especially concerning the interac-

tions between household decisions and trends in the larger economy" (Ellis, 2000, p. 292). Therefore, following many researchers and practitioners the author of this paper believes that households constitute the 'locus of livelihoods generation' (Niehof, 2004) and focus on households in this study of diversification in households with HIV- positive and negative women in Eastern Ghana.

## Methodology

### Data

The data for this study were collected in the Eastern Region of Ghana between 2004 and 2008 through the Research to Improve Infant Nutrition and Growth (RIING) project (NIH/NICHD HD 43260). Pregnant women attending antenatal clinics in the Yilo and Manya Krobo districts were recruited into the study after voluntary counseling and HIV testing. These women were followed for 12 months after delivery where household livelihoods, socio-economic, demographic and other data relating to productive behavior, hygienic practices and cognitive state of household members were collected during regular home visits. This analysis includes households with HIV positive (HIV-P) and HIV negative (HIV-N) women studied at enrollment/birth (HIV-P n=184, HIV-N n=180), at 3/6 months (HIV-P n=129, HIV-N n=160) and at 9/12 months (HIV-P n=104, HIV-N n=157). For convenience the above waves of data are indicated in tables and figures as observations at 0, 6 and 12 months respectively.

### Measures

**Units of analysis.** The diversity of livelihood activities is evaluated at household level. There are many different definitions of the concept household, but operationalization of this concept still poses difficulties for the researcher (Messer, 1983). No single known definition fits all circumstances (Rogers, 1990). Traditional definitions of households in terms of joint production, consumption or co-residence (Bender, 1967) create known ambiguities (Messer, 1983; Rogers, 1990). Households defined according these functions often were comprised of different sets of individuals within different socio-cultural contexts (Heywood, 1990). For instance, units

of production may consist of people other than the unit of food consumption and may not meet the criteria of co-residence as is often the case with household labor migrants (Rogers, 1990). Therefore no single set of criteria can be developed for defining the concept household and researchers need "to explicate the precise meaning of the social unit they are calling households in the elucidation of particular problems" (Arnould and Netting, 1982, p.572). This study defines household on the basis of three criteria: (1) co-residence, (2) family ties (for children under 16 years old temporarily living away), and (3) members of the household who were not present in the homes at the time of interview but lived at least 15 days there in the preceding year were included in the definition of the household.

**Diversification of livelihood activities index.** The primary focus of this paper is evaluating the diversification in households with HIV positive and negative mothers. Ellis and Freeman (2004) suggest that diversification that is associated with increased sustainability of households can be characterized by the increased proportion of non-farm activities in households' livelihood portfolios. This paper adopted this view on diversification and created weighted composite diversification index for on-farm and off-farm activities including livestock production, agricultural production, work for wages and receiving remittances. The details of this index construction are discussed in the *'Operationalizations & Measures'* section of the introductory part of the dissertation.

The diversification composite indexes were compared between households with HIV positive and negative mothers using analysis of variance (ANOVA). The composite indexes were compared at enrolment/birth, 3/6 and 9/12 months. To test hypotheses regarding change, structural equation modeling (SEM) using AMOS Graphic/SPSS 17.0 was employed. This approach is traditionally viewed as extends to the general linear model (GML) and allows for greater flexibility of statistical assumptions, has the capability to model relationships between measurement errors, direct and mediated effects, and provides alternative measures of construct validity and reliability (Marsh and Hocevar, 1985; Bollen, 1989a; Kaplan, 2000). In addition, SEM is capable of modeling unobserved constructs with multiple measures and is routinely used for between-group comparisons, one of the foci in this research project. To

explore changes over time in the extent of diversification in two groups, this paper utilized SEM growth curve (GC) and multigroup analysis approaches.

**Interpreting SEM estimates.** The interpretation of the estimates in the fitted model (e.g., squared multiple correlations, factor loadings/paths and $\chi^2$) is relatively straightforward. In the estimate model, the squared multiple correlations and factor loadings (e.g. paths from unobserved factor to its indicators) between explanatory and dependent variables are interpreted as slopes and $R^2$ in multiple regression analysis. They show how successful independent variables are in predicting the dependent variables and the strength of the hypothesized relationships between the independent and dependent variables. The model's factor loadings (also called path coefficients) show how a predictor (independent) variable affects a dependent variable, or in statistical language, how much change occurs in the dependent variable when an independent variable changes by one unit (given that all other variables stay constant).

The $\chi^2$ in the estimated model is a test of model significance. In SEM, a significant $\chi^2$ usually means that model has a poor fit and that an alternative model would better represent the data. Since the value of a $\chi^2$ tends to increase and become significant with the increase of a sample size, researchers developed a set of additional fit indices. In addition to $\chi^2$ statistic researchers often report The Bentler-Bonett normed fit index (NFI), Bollen's relative fit index ( RFI), Bollen's incremental fit index (IFI), the Bentler-Bonett non-normed fit index (NNFI) and the Root Mean Square Error of Approximation (RMSEA). The common rule of thumb that NFI, RFI, IFI and NNFI $>.95$ and RMSEA $<.05$ indicate good fit of the model.

## Results

### Non-farm activities in HIV positive and negative households

To compare the diversification of livelihood activities between HIV-P and HIV-N groups ANOVA test was performed. The test of significance of diversification indexes in these groups suggest at enrolment/birth the proportion of non-farm livelihood activities in households' portfolios is comparable in two groups. The mean value of diversification index is .40 in households

Table 3 Comparative analysis of diversification indexes in HIV-P and HIV-N groups (full sample)

| | HIV Positive | | | HIV Negative | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Mean** | **Std. Deviation** | *N* | **Mean** | **Std. Deviation** | *N* | *F* | *p.* |
| DV index (0 mo.)[a] | 0.40 | 0.22 | *184* | 0.44 | 0.24 | *180* | 2.66 | 0.104 |
| DV index (6 mo.)[b] | 0.40 | 0.24 | *129* | 0.45 | 0.23 | *160* | 3.81 | 0.052 |
| DV index (12 mo.)[c] | 0.36 | 0.21 | *104* | 0.43 | 0.22 | *157* | 7.01 | 0.009 |

[a]Observation at enrolment/birth
[b]Observation at 3/6 months
[c]Observation at 9/12 months

with HIV-P women and .44 in households with HIP-N women (p = .104). The difference, however, starts to manifest in later observations. HIV-P group demonstrates significantly lower levels of diversification at 3/6 and 9/12 months. The mean value of diversification in HIV-P groups is .40 at six and .36 at 12 months while in HIV-N group these values are .45 and .43 respectively (p = .052 and p = .009) (Table 3).

This study was interested in evaluating changes in livelihood diversification experienced by households with HIV-P and HIV-N women over the 12 month period. Since analysis of change is performed on subjects who completed the study households for which information was not available at 3/6 and/or 9/12 months were excluded from the data set. Then second ANOVA analysis was performed on this sub sample of households for which observations at all three time points were available (HIV-P n= 101, HIV-N n = 150). The results obtained in sub sample were similar to the earlier results for ANOVA test in the full sample. The mean proportions of non-farm livelihood activities in HIV-P group were .41, .39 and .36 at enrolment/birth, three/six and nine/twelve months and for HIV-N group these values were .45, .45 and .44 respectively. The test of significance shown that no significant difference between groups exist at birth (p = .237), the difference between HIV-P and HIV-N groups is marginally

Table 4 Comparative analysis of diversification indexes in HIV-P and HIV-N groups (sub sample)

| | HIV Positive | | | HIV Negative | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Mean** | **Std. Deviation** | *N* | **Mean** | **Std. Deviation** | *N* | *F* | *p.* |
| DV index (0 mo.)[a] | 0.41 | 0.22 | *101* | 0.45 | 0.24 | *150* | 1.40 | 0.237 |
| DV index (6 mo.)[b] | 0.39 | 0.24 | *101* | 0.45 | 0.23 | *150* | 3.26 | 0.072 |
| DV index (12 mo.)[c] | 0.36 | 0.21 | *101* | 0.44 | 0.22 | *150* | 7.00 | 0.009 |

[a]Observation at enrolment/birth
[b]Observation at 3/6 months
[c]Observation at 9/12 months

significant at 3/6 months (p = .072) and groups are significantly different at 9/12 months (p = .009) (Table 4).

To validate the results in the sub sample key demographic and socio-economic characteristics were compared in households included and excluded (HIV-P n = 83; HIV-N n= 30) in the sub sample, which is used in the subsequent stage of the analysis - the analysis of change. No significant difference between excluded and included groups were observed in regard to their initial levels of diversification (HIV-P mean = .39 and HIV-N mean = .41, p = .28), socio-economic status, age and education of index mothers, elementary or secondary education of other household members as well as number of household members of the same generation or generation preceding index mother. Groups, however, varied in regard to some demographic characteristics. For instance, excluded group of households with HIV-P women tend to have less household members of younger generation, less children under 14 years old and less adults with completed primary education. The excluded group with HIV-N women tend to have less children under 14 years old.

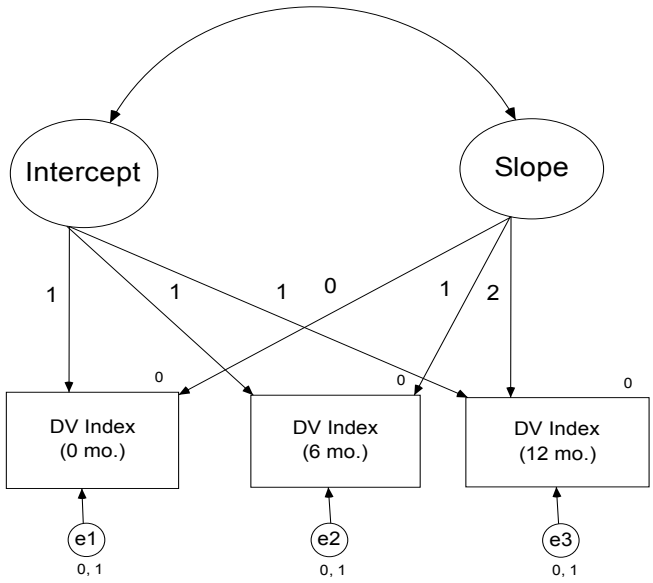


Figure 4 Analysis of change in the diversity of livelihood activities: conceptual model

**Evaluating change**

The question of special interest to me in this study is the dynamics of change in the proportion of non-farm activities in households' livelihood portfolios. To answer this question growth curve approach was employed and implemented in structural equation modeling environment. Based on the results of ANOVA analysis it was hypothesized that change in two groups follow linear trend. The model of linear growth is represented in Figure 4. Latent intercept and slope are represented by ovals. Rectangles represent observed indexes of diversification at enrolment/birth, 3/6 and 9/12 months. Pointed arrows represent factor loadings from latent intercept and slope to observed diversification indexes. Factor loadings in SEM have the same interpretation as slopes in regression analysis. It was also assumed that households' diversification is measured with errors, which are represented in the figure by $e1, e2$ & $e3$. To specify the growth model all factor loadings from latent slope and from measurement errors to diversification indexes were constrained equal 1 and mean values of diversification indexes and measurement errors were set equal 0. Finally, to model linear trend of change factor loadings

Table 5 Changes in measures of diversification in HIV-P and HIV-N groups: GCM fit statistics

| | $\chi^2$ | $d.f.$ | **Bollen-Stine** $p.$ | $\Delta\chi^2/d.f.$[a] | **NFI** | **RFI** | **CFI** | **RMSEA** |
|---|---|---|---|---|---|---|---|---|
| **Model** | | | | | | | | |
| Fully constrained[b] | 14.05 | 7 | 0.05 | - | 0.81 | 0.83 | 0.89 | 0.06 |
| Partially constrained 1 [c] | 10.89 | 6 | 0.06 | 3.16 | 0.85 | 0.82 | 0.91 | 0.07 |
| **Partially constrained 2** [d] | **4.20** | **5** | **0.47** | **6.69** | **0.94** | **0.93** | **1.00** | **0.00** |
| Partially constrained 3 [e] | 4.10 | 4 | 0.34 | 0.10 | 0.94 | 0.92 | 1.00 | 0.01 |
| Partially constrained 4 [f] | 3.50 | 4 | 0.46 | 0.70 | 0.95 | 0.93 | 1.00 | 0.00 |
| Partially constrained 5 [g] | 2.65 | 4 | 0.57 | 1.55 | 0.97 | 0.95 | 1.00 | 0.00 |

[a] $\Delta\chi^2$ represents improvement per one degree of freedom. Model 2 is a base model for models 3, 4 and 5
[b] Means, variances and correlations between latent intercepts and slopes are set equal
[c] Variances of latent slopes are freely estimated
[d] Best fitting model. Variances and means of latent slopes are freely estimated
[e] Variances & means of latent slopes and covariance between latent intercepts & slopes are freely estimated
[f] Variances & means of latent slopes and variances of latent intercepts are freely estimated
[g] Variances & means of latent slopes and intercepts are freely estimated

from latent slope to diversification index at 0 months (enrolment/birth) were specified equal 0, to diversification index at 6 (3/6) months equal 1 and to diversification index at 12 (9/12) months equal 2.

We estimated the initial values of diversification (latent intercept) and the rate of linear change (latent slope) in HIV-P and HIV-N groups using growth in multiple populations analysis approach. The data correlation matrix is presented in Appendix A.1. Following standard procedure equality constraints were imposed on means and variances of and co-variances between latent intercepts and slopes across groups and estimated the base model. Then these constrains were released one by one and re-estimated the model using model fit statistics as a criteria for excepting or rejecting the model (Duncan et al., 2006). Since distribution of the data in HIV-N group demonstrated significant multivariate non-normality (multivariate kurtosis = - 2.269, p. $< .05$) bootstrap method was used during fitting process and for estimating parameters of the best fitting model. The summary of the model fitting process is presented in Tables 5 and 6.

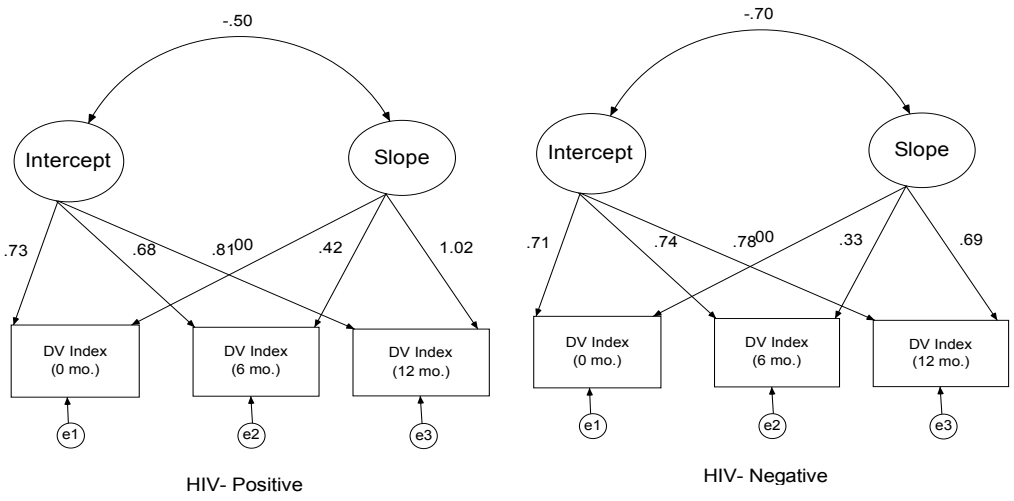


Figure 5 Analysis of change in the diversity of livelihood activities: estimated models

The results in the Table 5 suggest that partially constrained model 2 with equality constraints retained on variances and means of latent intercepts and on co-variances between latent intercepts and slopes has the best fit. It shows both a good fit to the research data ($\chi^2$= 4.2, d.f. = 5, Bollen-Stine p. = .47 and modification indexes ranging from .93 to 1.00 for NFI, RFI and CFI and .00 for RMSEA) and significant improvement in fit over the fully constrained base model ($\Delta\chi^2 = 9.85$, $d.f.$=2). Best fitting model with estimated standardized parameters for HIV-P and HIV-N groups is presented in Figure 5. The remaining models in the Table 5, although show overall good fit to the data (insignificant $\chi^2$), do not demonstrate significant improvement in fit over the above model and do not meet selection criteria for the best fitting model.

Further examination of the parameters of the best fitting model suggest that all the parameters estimated in the model are significant (except for $e3$ variance in HIV-P groups and latent slope variance in HIV-N group) and in the hypothesized direction. For instance, the latent slope in the HIV-P group shows negative trend in the proportion of non-farm activities in household livelihood portfolios (−.033, p. = .012), while in the HIV-N group no change is observed (.001, $p. = ns$).

Table 6 Changes in measures of diversification in HIV-P and HIV-N groups: GCM parameters estimates

| | HIV Positive | | HIV Negative | |
|---|---|---|---|---|
| | **Estimate** | **Standard Estimate** | **Estimate** | **Standard Estimate** |
| **Regression Weights** | | | | |
| DV 0 mo. ← Slope[a] | 0.00 | 0.00 | 0 | 0.71 |
| DV 6 mo. ← Slope | 1.00 | 0.42 | 1 | 0.78 |
| DV 12 mo.← Slope | 2.00 | 1.02 | 2 | 0.00 |
| DV 0 mo. ← Intercept | 1.00 | 0.73 | 1 | 0.33 |
| DV 6 mo. ← Intercept | 1.00 | 0.68 | 1 | 0.74 |
| DV 12 mo.← Intercept | 1.00 | 0.82 | 1 | 0.69 |
| **Means** | | | | |
| Intercept | 0.43***[b] | n/a | 0.43*** | n/a |
| Slope | -0.03 ** | n/a | 0.00 | n/a |
| **Covariances** | | | | |
| Intercept | -0.01 ** | n/a | -0.01 ** | n/a |
| **Correlations** | | | | |
| Intercept | -0.50 | n/a | -0.70 | n/a |
| **Variances** | | | | |
| Intercept | 0.03*** | n/a | 0.03 ** | n/a |
| Slope | 0.01 ** | n/a | 0.01 ns | n/a |
| $e2$ | 0.04*** | n/a | 0.04 ** | n/a |
| $e3$ | 0.01 ns | n/a | 0.03 ** | n/a |
| $e1$ | 0.02 ** | n/a | 0.03 ** | n/a |

[a] DV - Diversification index (e.g. proportion of non-farm activities in households' livelihood portfolios)
[b] * - p. $< 0.1$; ** - p. $< 0.05$; *** - p. $< 0.01$

## Discussion and conclusion

Consensus exists among researchers that diversification of livelihood activities can significantly influence long term sustainability of households. Although much research discusses positive implications of diversification, some authors note that in certain cases diversification can be achieved at the expense of the future wellbeing. This may happen when, for instance, households that need to generate quick cash have to sell their productive resources such as tools, equipment, land, etc. In the mid or long term perspective such behavior can undermine their capacity to generate livelihoods, increase vulnerability to social and economic shocks and can set off downward spiral to poverty. To distinct two types of diversification outcomes

researchers sometimes use terms 'good diversification' and 'bad diversification.'

The study of peri-urban households with HIV-P and HIV-N women who recently gave birth in Eastern Ghana was conducted under the assumption that 'good diversification' of income generating activities in portfolios of households' livelihoods can contribute to their wellbeing. Ellis and Freeman (2004) suggested that 'good diversification' is associated with gradual increase in the proportion of non-farm income generating activities in households' portfolios with simultaneous increase in productivity of farm based activities. This strategy can both increase sustainability of households' livelihoods and serve an indicator of 'upward spiral' out of poverty.

In the sample of households with women who recently gave birth in the peri-urban areas of Manya Krobo District, four specific situations were examined in which households could diversify their livelihood activities. Residents of these households could engage in livestock rearing, agricultural production, receive in-kind and monetary remittances, and seek wage employment. During the course of the study, changes in the proportion of wage employment and remittances in the overall portfolio of the above livelihood activities were examined. The underlying assumption is that an increase in the proportion of wage employment and remittances may improve sustainability of households' livelihood systems, while a decline may threaten their wellbeing. Since overarching theme of the multi-year collaborative research project RING is studying the effects of HIV epidemic on new mothers and their households, the primary concern in this study was evaluating the diversification of livelihood activities in households with HIV-P women in comparison to households with HIV-N women.

Contemporary theory and empirical evidence offer competing hypothesis in regard to how diversity of livelihoods in households with HIV-P mothers would measure against households with HIV-N women. It is plausible to assume that if state of physical health plays primary roles in the choice of households' livelihood behavior, then households with HIV-P mothers who do not have manifest symptoms of AIDS should not differ significantly from the households with HIV-N mothers. This is the first guiding hypothesis in this study. Consistently with this hypothesis it was found no statistically significant difference in the proportion of non-

farm activities in households' livelihood portfolios between HIV-P and HIV-N groups at time of birth of the child. At the beginning of this study some 40% (41% in the sub-sample) of activities in the portfolios' of livelihoods of households with HIV-P women consisted of wage jobs and remittances. Some 44% (45% in the sub-sample) of the similar activities was present in the portfolios of households where HIV-N women were present at the time of birth of a child. Consistent results were obtained using two methods ANOVA and LGC SEM.

It is also plausible to assume that HIV represents significant 'stress' factor to households. HIV may require households to modify their livelihood behavior or incur heavy toll on household resources. Similarly being HIV positive may restrict income generating options due to declining health or shrinking job opportunities in communities where HIV people are stigmatized. My second guiding hypothesis aimed at evaluating the rate of change in the measure of diversification in two groups. It was expected to see increasing difference between groups as the study progressed. My ANOVA findings were consistent with hypotheses. The first evidence of increasing differences was observed at 3/6 months after the birth of a child. Although mean values of diversification index has shown change within 1-2% in full and sub-sample, the significance test suggest that the marginal difference between groups exists ($p.<.052$ in full sample, $p.<.072$ in sub-sample). Even greater difference was observed at 9/12 months. For full and sub-samples the difference was significant at $p. <.01$ level. The closer examination of the pattern of change with SEM growth curve model supported the initial hypothesis regarding the change in the values of diversification index in HIV-P and HIV-N groups. While the proportion of non-farm activities in portfolios of livelihoods in HIV-N group remained unchanged, HIV-P group demonstrated its significant linear decline. The total mean decline in the proportion of non-farm activities in the livelihood portfolios of HIV-P households was 15% between beginning of the study (.43) and its end (.37).

Our findings show that households with HIV-P women experience significant negative change in the measure of livelihoods diversification. Statistical reports and independent research suggest that in the last two decades some 50-60 percent of a typical Ghanaian household's income was derived from employment, non-farm based enterprises and remittances (GSS,

2008). In the Eastern Region, approximately nine out of ten economically active residents are engaged in some form of economic activity to generate cash (GSS, 2005). The Eastern Region is the third largest recipient of remittances in Ghana (Mazzucato et al., 2008). With the decreasing share of wage employment and remittances in their household livelihood activity portfolios, HIV positive women may become increasingly dependent on farming as a primary and in some cases the only source of household livelihoods. This can result not only in an overall decline in the absolute level of household income, but also may increase households' vulnerability to various economic or environmental shocks.

It is well known that farming depends on many factors and involves many risks. For instance, harsh weather conditions, lack of agricultural inputs or pest control chemicals, or an increase in fuel costs may substantially reduce the amount harvested. During the RIING study, 17 percent of households in the study that engaged in farming activities reported crop failure and approximately one out of five reported deaths of one or more goats, sheep, pigs or cattle. In Ghana's recent history, there have been major negative impacts on the export oriented agricultural sector due to declining prices for cocoa. This economic downturn drained country's foreign exchange reserves and put out of business many small and medium size cocoa producers (Salm and Falola, 2002a). This helps contextualize the present study and suggests potentially negative long term effect on the wellbeing of households with HIV negative women due to the decreasing proportion of wage jobs and remittances in their livelihood portfolios. Considering the fact that increasing proportion of non-farm activities represent the case of 'good diversification' Ellis and Freeman (2004) - diversification that associated with increased sustainability of households' livelihoods and the 'upward spiral' out of poverty, decline in the values of this indicator may suggest that HIV-P households are not only at the disadvantaged position, but also may face serious problems in the long run. These households may be well on the downward path to poverty. This may be even more so for the low income category of households in the HIV-P group. My analysis suggests that those households with smaller proportion of non-farm activities tend to experience decline at higher rate than households with higher proportion of non-farm activities. Although this pattern is comparable in both HIV-P

and HIV-N groups (covariance = -.009, p. <.05), being HIV-P and poor puts households in the category of the most disadvantaged.

Our findings may suggest that without timely and adequate interventions households with HIV-P women in Eastern Ghana may be facing serious challenges in the mid-term and long-term future. Without opportunities to generate adequate livelihoods they are likely to exhaust their household resources, which may in tern undermine their food security and reduce their capability to resist HIV infection. Substantial research exists that links the breast feeding and contraction of HIV by new born babies. Inadequate feeding practices during the lactation period may contribute to the higher rates of HIV infections among new borne children. Yet evidence suggests that poor may have little options. Therefore negative effects of HIV on households with new borne babies can be even more profound. In the context of the larger issue of HIV epidemic this finding suggests that without early strategies that help households affected by HIV to secure their livelihoods the battle against HIV/AIDS may be difficult task.

Two general pathways for interventions may be worth exploring in light of the findings in this study. The first involves searching for new non-farm based income generating livelihood activities that households with HIV positive members can utilize. Another involves finding innovative forms of farming practices and new business enterprises based on these practices. For instance, in southwestern Uganda, communities neighboring Bwindi Impenetrable National Park substantially reduced their dependence on the park's resource -once the major source of their livelihoods - and increased sustainability of their livelihoods after introduction of improved livestock management practices, new crops, new crafts and new enterprises. Thus, the production of wild honey, Irish potatoes, oyster mushrooms and crafts target the growing local and national markets demand for this produce (Marquardt et al., 1993; FAO, 2005). Ghana has successfully implemented a crop diversification strategy that contributed to poverty reduction. Currently, the Eastern Region is ranked first among Ghana's regions in terms of substantially reducing the incidence of poverty through successful implementation of public-private sector partnerships (Government of Ghana National Development Planning Commission, 2007). International and domestic experiences should be closely examined to to

address the vulnerabilities of livelihood systems in households affected by HIV/AIDS epidemic.

**Limitations**

Although empirical evidence was obtained supporting initial hypotheses in regard to the diversification of non-farm activities in livelihood portfolios of households with HIV-P and HIV-N women, some comments are in order.

First, the sample was obtained based on self selection process in three hospitals in Eastern Ghana. The natural question that arises is how well this sample represents the entire population of these hospitals and how well the hospital population in Eastern Ghana represents all households with new mothers in the country? As is often happens in longitudinal studies there were few subjects who did not complete the study. Based on the analysis of diversification index, socio-economic and demographic characteristics of households included in the analysis of change and households excluded from this analysis due to the failure to complete the study participants appears not to be a significant contributing factor of bias. No information is available, thought, to evaluate the extent of self-selection bias.

Second, the results regarding the rate of change in HIV-P and HIV-N groups are estimated with linear growth curve model obtained in SEM environment. The conclusion is reached based on the evidence that hypothesized model adequately describes research data. Yet, this model may be only one of many other models that may have equally good description of the data.

Finally, one fundamental assumption in this study is that HIV is a factor in the households' livelihoods. My conclusions regarding the extent of the effects are only as good as initial assumptions that HIV affects only group of households with HIV-P women. In this study one can positively conclude that households with HIV-P women and HIV-N women are different and that the sustainability of livelihoods of the households with HIV-P women may be at greater risk. One can be less certain, however, about the specific role of HIV or the magnitudes of its effects. No data on the HIV status of other household members is available. It is possible that some other members of households with HIV-P mothers are also HIV positive. If so HIV may

have cumulative effects in these households. On the other hand, it also could not be excluded the possibility that some members in households with HIV-N mothers are HIV positive.

**Future research**

The implications of the above limitation can be broad in the context of the general question about the impact of HIV epidemic on the sustainability of households' livelihoods, their long-term wellbeing and the poverty in general. Not knowing the HIV status for all household members may mean that results in this paper could both underestimate or over-estimate the effects of HIV in this analysis. For instance, if HIV is a significant contributing factor to the deterioration of households' livelihoods and there were HIV positive members in households that are identified as HIV-N group in this study than the true rate of decline in the proportion of non-farm activities may be even greater than estimated.

It is also possible to hypothesize that some other factors than contraction of HIV contribute to the degradation of livelihoods in HIV-P group. Let's look at the hypothetical situation that HIV-N households also include HIV positive members who simply are not aware of their status. Under this condition households exist who are aware about HIV status of their member or members and households which are not aware about HIV status of its members. As such results of this study can be interpreted as if knowing the status makes a difference to the livelihood diversification. In other words it could be concluded that knowing the HIV status by households can alter the choice of livelihoods behavior. In the context of the general findings of this study some questions for the future research arise: to what extent the effects observed in this study groups can be explained by HIV status of women in the house and to which extent these effects are a function of other individual or socio-economic factors?

# GHANA: DOES PERCEIVED STRESS PREDICT DIVERSITY OF LIVELIHOOD ACTIVITIES IN HOUSEHOLDS WITH HIV POSITIVE AND HIV NEGATIVE MOTHERS?

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## Abstract

The process of coping with psychological stress is commonly associated with altered behaviors, including reduced work motivation, job satisfaction and deteriorated performance. This makes stress a potentially significant factor that can affect households' diversification behavior. The guiding hypothesis in this paper is that increased levels of psychological stress contribute to decreased diversity of household livelihood activities. This paper further hypothesizes that negative effects of stress are more pronounced in households with HIV-positive mothers. The structural equation modeling multigroup and growth curve analysis of the panel of 362 households with HIV positive and negative mothers in Eastern Ghana studied over the 12 month period does not provide definitive evidence in support of the research hypotheses. Only at the beginning of the study did stress negatively affect the diversity of livelihood activities in households with HIV positive mothers. No associations between change in stress and diversity of livelihood activities were observed in the study. The study, however, suggests that HIV positive women experience significantly higher levels of psychological stress, which, if it persists, may negatively affect their health status and productive behavior.

## Introduction

Numerous studies in low income countries have shown that households with more diverse activities exhibit lower vulnerability to food insecurity, greater resilience and adaptability to environmental and economic shocks, and possess a greater repertoire of resources to use in their strategies to escape poverty (Ellis, 1998, 2000). As such, livelihood diversification can be particularly appealing goal in programs that seek to reduce the negative effects of the HIV pandemic. Indeed, the literature provides sufficient evidence that poverty and the HIV/AIDS pandemic are intertwined. For instance, with over-two thirds of all HIV positive people living in poor countries, researchers suggest strong spatial links between the pandemic and poverty. Moreover, poor are more likely to engage in risky behaviors and have fewer resources to deal with infection (Cohen, 1998). Therefore, understanding the factors that contribute to or impair the diversification of livelihood activities and ultimately influence the wellbeing of households affected by HIV/AIDS is an important research objective.

The overarching question that is raised in this paper is: how does psychological stress affect diversification of livelihood activities in households with HIV positive members? There is long tradition of multidisciplinary research to study the effects of psychological stress on work performance and job satisfaction. This research suggests that the process of coping with psychological stress is commonly associated with altered behaviors. Since stress can impair work behavior, this factor ultimately can also contribute to the deterioration of household livelihoods and decrease their diversity. This makes stress a potentially important explanatory factor in research on household livelihood diversification behavior of populations affected by HIV.

### Putting livelihoods diversification into context

The literature tracks the origins of contemporary diversification research back to the studies by Tschajanow and Nakajima, who realized that a purposeful strategy underlies households' livelihood diversification (Tschajanow, 1989; Nakajima, 1986). People diversify their livelihoods differently, for different reasons, and with different consequences for the sustainability

of their livelihoods systems (Zoomers and Kleinpenning, 1996; Von Braun and Pandya-Lorch, 1991; Ellis, 1998; Woldenhannaa and Oskamb, 2001; Barrett et al., 2001a; Anderson and Deshingkar, 2004; Rider Smith et al., 2001). To distinct between 'progressive' diversification - one that reduces households' vulnerability (Block and Webb, 2001) - and 'reactive' diversification - one that increases their vulnerability (Canagarajah et al., 2001) - researchers looked at the diversification behaviors of better off households and identified several typical features of 'right diversification.' First, security of livelihoods of better off households is achieved through decreased relative importance of the farm component in an overall livelihood system. Second, the livelihood behavior of better off households is best characterized by virtuous spirals of accumulation with diverse livestock ownership, non-farm self-employment, and diversification of on-farm and non-farm income sources. Third, the pathway out of poverty is commonly associated with incremental increases in complexity of livelihood activities (Ellis and Freeman, 2004). Researchers describe this process as a sequence trading of household assets for assets of higher value (e.g., chickens for goats, to cattle, etc.) (Ellis and Mdoe, 2003). They contrast this with a process of livelihood deterioration due to sequential asset disposal (Corbett, 1988; Devereux, 1993).

**Defining stress**

Defining stress in empirical studies is not a trivial task. Regardless of wide use of the term by various disciplines, little agreement exists among them on how to operationalize the concept. The fundamental characteristic of stress is that it involves responses at psychological, physiological and behavioral levels. Therefore, some tend to define stress as emotion while others as a state of arousal that is essential to initiate response to external stimuli (Dougall and Baum, 2003). Contemporary stress research in psychology tends to view stress in terms of stimulus that prompts a human to choose specific coping responses. For instance, catastrophic events or daily burden may play a role of stimuli that would require emotional and behavioral adaptation. However the associated arousal would not constitute the stimulus. The extent of arousal depends on a cognitive appraisal process that evaluates both the stressful event

and available resources to cope with such an event. As such, psychologists often define stress in terms of lack of balance between demands imposed by the surrounding environment and resources available to address such demands (Lazarus et al., 1985; Monroe and Kelley, 1995; Lazarus and Folkman, 1984; Depue et al., 1979).

**Stress and human performance: can stress affect diversification of livelihood activities?**

Significant research efforts have been made to understand human performance under stress. Three types of theories describing possible relationships have been developed. Some suggest and support with empirical evidence that any level of stress linearly and negatively affects human performance (Jamal, 1985; Vroom, 1964). Other argue the opposite, and suggest that stress is an essential performance booster (Meglino, 1977; Arsenault and Dolan, 1983; Hatton et al., 1995). The theories that received the greatest attention and empirical support, however, describe relationships between stress and performance as complex inverted U-shaped functions (Scott Jr., 1966; Srivastava and Krishna, 1991; Selye, 1975; McGrath, 1976). According to this theory, stress increases performance until it reaches a certain threshold which depends on cognitive complexity of a task. Excessive stress, nevertheless, reduces performance. Among common performance reducing consequences of elevated levels of stress are impaired decision making (Combs and Taylor, 1952; Easterbrook, 1959; Janis and Mann, 1977), increased time to complete the task (Idzikowski and Baddeley, 1983), and degraded capability for problem solving (Yamamoto, 1984). For instance, some examples of impaired decision making may include the failure to consider the broader spectrum of alternatives and making oversimplified decisions without considering long-term consequences (Friedman and Mann, 1993; Staw et al., 1981). In addition, extended psychological stress had been found to be highly correlated with burn out at a job (Maslach et al., 2001).

### Stress in HIV affected populations

Research suggests that reciprocal relationships may exist between stress and contraction of HIV. Psychological stress has been positively associated with deteriorating health status in numerous studies. For instance, in asymptomatic HIV patients, increased stress was associated with decrease in killer lymphocytes, thus weakening the immune response to the virus (Evans et al., 1995). In turn, contraction of HIV can itself significantly influence psychological well-being. Some studies suggest that the psychological effects of discovering one's positive HIV status can be equivalent to the effects resulting from the experience of death of a spouse or an imprisonment (Kartikeyan et al., 2007). Psychological distress can be caused directly by the virus by affecting humans' physical capability to function (Horwath, 2003) or indirectly by influencing social surroundings (Brimlow et al., 2003).

For example, HIV positive people may experience apathy, problems with speech, memory and/or concentration - the conditions that are also known as minor cognitive-motor disorder (MCMD) (Goodkin et al., 1997). Also, stigma is one of the most widely known social consequences of HIV infection (Brimlow et al., 2003). Thus, in various countries in Africa, Middle East and Asia, where people maintain strong religious and cultural traditions, infection with HIV is often perceived as a consequence of immoral behavior and sometimes even as punishment for one's sins (Kaldjian et al., 1998; Ayranci, 2005; Zou et al., 2009). This stigma often extends beyond people infected with the virus to family, friends, social and health workers (Brimlow et al., 2003; Herek., 1990). As a result, people living with HIV often suffer from various disorders including depression, anger, anxiety and other psychological symptoms (Kelly et al., 1993).

### Research questions and hypotheses

Contemporary interdisciplinary research on stress suggests several hypotheses regarding possible relationships between psychological stress and diversification of household livelihood activities. This paper focuses on the study of relationships between stress in HIV-positive and HIV-negative women who recently gave birth to a child and the diversity of livelihood activities

in their households. First, it is hypothesized that contraction of HIV is a strong stress factor by itself; therefore, HIV positive mothers are likely to demonstrate significantly higher levels of stress when compared to HIV-negative mothers. As such, the difference can be observed in the form of significantly higher levels of stress among HIV positive women and in how stress is perceived by these women. Second, it is hypothesized that although stress may be both a positive and negative factor for livelihood diversification, contraction of HIV pushes the stress level beyond the acceptable threshold. The negative effects of HIV persist indefinitely and are likely to be aggravated with time due to associated negative health and socio-economic consequences. Moreover, the prior empirical studies report that stress in women may have spillover and contagion effects and, as a result, other household members may also experience elevated levels stress (Margolin et al., 1996; Grzywacz et al., 2002; Bolger et al., 1989). Therefore, it is expected that women's stress will be negatively associated with the diversity of livelihood activities in households. Although stress elevated beyond a certain threshold should negatively affect diversification of livelihood activities in all households, it is expected that these effects will be more pronounced in households with HIV-positive mothers. Therefore, it is expected to see significant relationships between women's stress and livelihood diversification in households with HIV negative members, while in households with HIV-negative mothers such effects are likely to of lower magnitude or non-significant.

## Methodology

### Data

The data for this study were collected in the Eastern Region of Ghana between 2004 and 2008 through the Research to Improve Infant Nutrition and Growth (RIING) project (NIH/NICHD HD 43260). Pregnant women attending antenatal clinics in the Yilo and Manya Krobo districts were recruited into the study after voluntary counseling and HIV testing. These women were followed for 12 months after delivery where household livelihoods, socio-economic, demographic and other data relating to productive behavior, hygienic practices and cognitive state of household members were collected during regular home visits. This study

includes analysis of data on perceived stress and livelihoods relating activities in households with HIV positive (HIV-P) and HIV negative (HIV-N) women studied at enrollment/birth (HIV-P n=183, HIV-N n=179), at 3/6 months (HIV-P $n = 129$, HIV-N $n = 159$) and at 9/12 months (HIV-P n=104, HIV-N n=157). For convenience in tables and figures these time periods are also referred to as 0, 6 and 12 months observations.

### Definitions and measures

**Units of analysis.** The diversity of livelihood activities is studied at the household level. The decision regarding the operational definition of households was based on several considerations. First, although many different definitions of the concept household exist, no single known definition fits all circumstances (Messer, 1983; Rogers, 1990). Traditional definitions of households in terms of joint production, consumption or co-residence (Bender, 1967) create known ambiguities (Messer, 1983; Rogers, 1990). Households defined according to these functions often are comprised of different sets of individuals within different socio-cultural contexts (Heywood, 1990). Thus, the unit of production may consist of people other than the unit of food consumption and may not meet the criteria of co-residence, as is often the case with household labor migrants (Rogers, 1990). Therefore, researchers need "to explicate the precise meaning of the social unit they are calling households in the elucidation of particular problems" in the context of a specific study (Arnould and Netting, 1982, p. 572). In this study the household is defined on the basis of three criteria: (1) co-residence, (2) family ties (for children under 16 years old temporarily living away), and (3) members of the household who were not present in the homes at the time of interview but lived there at least 15 days in the preceding year.

**Diversification of livelihood activities index.** To create a measure of household diversification, Ellis and Freeman (2004) view of diversification was adopted. They suggest that diversification that is associated with increased sustainability of households can be characterized by the increased proportion of non-farm activities in household livelihood portfolios. Following this lead, a weighted composite diversification index was created for on-farm and off-

farm activities. This index included four activities: livestock production, agricultural production, work for wages and receiving remittances. The measure of diversification (e.g., proportion of non-farm activities) was constructed through the following procedures:

First, the weighting method established by Filmer and Pritchett (Filmer and Pritchett, 2001) was extended to derive separate indexes for the following three livelihood activities: livestock rearing, agricultural production and receiving remittances. At the initial stage of the composite index construction three separate indexes for the above activities were created. In choosing the above weighting method Filmer and Prichett rationale for constructing socioeconomic status indexes was adopted. Following this rationale, it was assumed that engaging in activities that require more resources and skills would be less common in the population because of the financial and other access barriers; consequently, such activities would receive higher Principal Component Analysis weights. For instance, in the livestock production index, households that raise chickens would receive a lower weight score than households raising goats. Similarly, households that receive a second remittance in a given time period would receive a higher score than those that received only one. The PCA based weighting method has demonstrated acceptable validity and reliability, and is currently widely used by the World Bank, USAID and other international development organizations for construction of socioeconomic status (SES) indexes (Rutstein and Johnson, 2004; Rutstein, 2008).

Second, a household level work index was created by estimating the percent of working household members including new mothers among all adult members (over 15 years old) of the household.

Third, scores of the livestock rearing, agricultural production, remittances and work indexes were summed up to create the total diversification score and estimated the proportion of non-farm activities (e.g., diversification index) by dividing the sum of scores in work and remittances indexes by the total diversification score. The details of this index construction are discussed in the *'Operationalizations & Measures'* section of the introductory part of the dissertation.

**Stress.** Stress was assessed using a modified version of Cohen's 4-item scale of perceived stress (Table 1). Some researchers argue that measures that capture the underlining cognitive

process are better predictors of coping behavior than counts of stress stimuli (e.g., negative life events) (Cohen et al., 1983). The stress scale was administered to women with known HIV status [HIV- positive (HIV-P) and HIV - negative (HIV-N)]. Respondents reported their perceived capability to cope with significant changes, problems and challenges on a five point scale.

**Analysis**

We employed structural equation modeling (SEM) using AMOS Graphic/SPSS 17.0 to test hypotheses regarding perception and levels of stress and hypotheses regarding change of stress over time in HIV-P and HIV-N households. This approach is traditionally viewed as an extension of the general linear model (GML). SEM allows for greater flexibility of statistical assumptions, has the capability of modeling relationships between measurement errors, separate direct and mediated effects, and provides alternative measures of construct validity and reliability (Marsh and Hocevar, 1985; Bollen, 1989a; Kaplan, 2000). In addition, SEM is capable of modeling unobserved constructs with multiple measures and is routinely used for between-group comparisons, one of the foci in this research project. To explore changes over time in the extent of diversification in two groups, SEM growth curve (GC) and multigroup analysis approaches were utilized.

**Interpreting SEM estimates.** The interpretation of the estimates in the fitted model (e.g., squared multiple correlations, factor loadings/paths and $\chi^2$) is relatively straightforward. In the estimate model, the squared multiple correlations and factor loadings (e.g. paths from unobserved factor to its indicators) between explanatory and dependent variables are interpreted as slopes and $R^2$ in multiple regression analysis. They show how successful independent variables are in predicting the dependent variables and the strength of the hypothesized relationships between the independent and dependent variables. The model's factor loadings (also called path coefficients) show how a predictor (independent) variable affects a dependent variable, or in statistical language, how much change occurs in the dependent variable when an independent variable changes by one unit (given that all other variables stay constant).

Table 1 Perceived stress scale

| | |
|---|---|
| $X1$ | Effective coping with important changes in life |
| $X2$ | Confidence about own ability to handle personal problems |
| $X3$ | Inability to control the important things in life |
| $X4$ | Inability to overcome difficulties |

Note: Frequency of experiencing the above feelings in the last month: 1="Never"; 2="Only once or twice"; 3="At least once a week"; 4= "More than once a week"; 5="Almost daily".
Note: Reverse coding is used for items X3 & X4 in the analysis.

The $\chi^2$ in the estimated model is a test of model significance. In SEM, an insignificant $\chi^2$ usually means that model has a good fit and adequately represent the data. Since the value of a $\chi^2$ tends to increase and become significant with the increase of a sample size, researchers developed a set of additional fit indices. In addition to $\chi^2$ statistic researchers often report The Bentler-Bonett normed fit index (NFI), Bollen's relative fit index (RFI), Bollen's incremental fit index (IFI), the Bentler-Bonett non-normed fit index (NNFI) and the Root Mean Square Error of Approximation (RMSEA). The usual rule of thumb that NFI, RFI, IFI and NNFI $>.95$ and RMSEA $<.05$ indicate good fit of the model.

## Results

### Latent structure of the measure of perceived stress

The first step in the analysis of research data is evaluating the relationship between the proportion of non-farm activities in households' livelihood portfolios and perceived stress as a cross sectional phenomenon. In SEM, a graphical tradition exists to represent unobserved (e.g. latent factor) constructs as ovals and observed as rectangles. Following this tradition, the hypothetical model was specified, so that four observed measures of stress (e.g., $X1, X2, X3$ & $X4$ in Table 1) are loaded on the common factor Stress (Figure 1). It is assumed that $X1, X2, X3$ & $X4$ are measured with errors $e1, e2, e3$ and $e4$. The hypothesized relationships between stress and proportion of non-farm activities are represented by the arrow from the

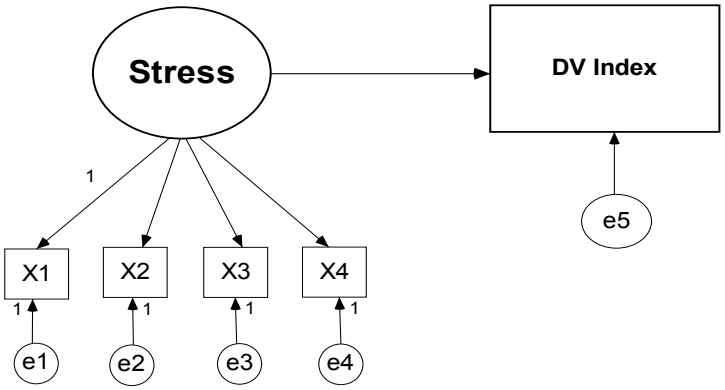
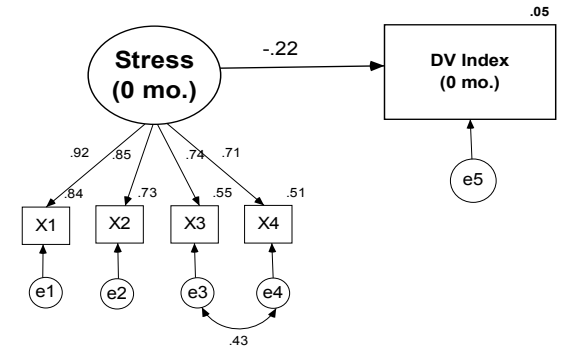


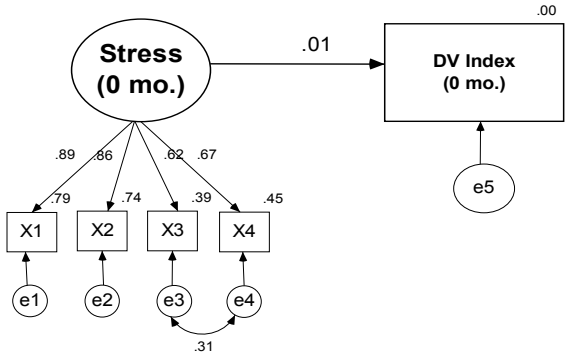

Figure 1 Effects of perceived stress on the diversity of livelihood activities: conceptual model

factor Stress to the measure of diversification which is also measured with an error ($e5$) (for detailed discussion on models specification see Bollen (1989b); Byrne (1998a); Arbuckle (2007)).

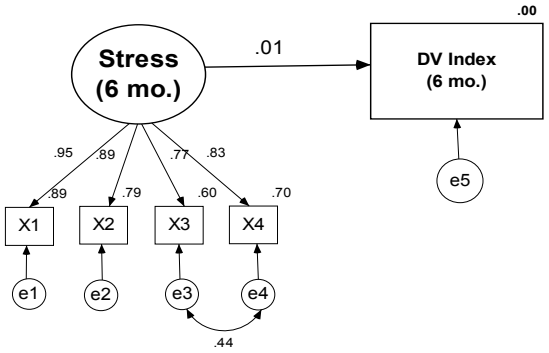
Figure 2 represents the unconstrained models with standardized solutions for HIV-P and HIV-N groups estimated simultaneously at birth, six and twelve months (Appendix A.4). The term unconstrained means that all parameters in models (e.g., factor loadings, intercepts and variances in groups) are freely estimated except for the loadings from Stress to $X1$ and all loadings from measurement errors to observed indicators. The latter are fixed to equal 1 for model identification purposes. The fit statistics for these models and parameters' estimates are represented in Tables 2 and 3. It is discovered that correlating measurement errors between $X3$ and $X4$ at enrolment/birth and 3/6 months improves models' fit statistics significantly. Since due to the methodological artifacts of the stress scale it had been expected that pairs of variables $X1-X2$ and $X3-X4$ may correlate, it appears justified to keep correlations between $X3$ and $X4$ in the models. Also the test of normality shows that research data do not meet the



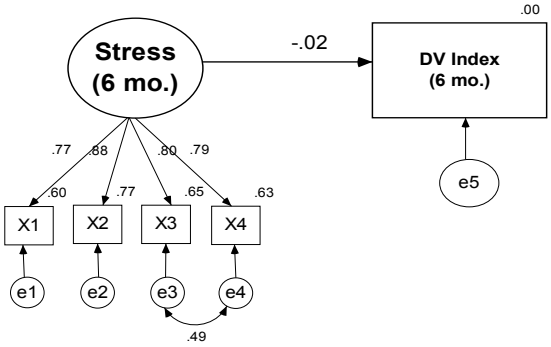

(a) HIV Positive (Chi=18.213, d.f.=8)



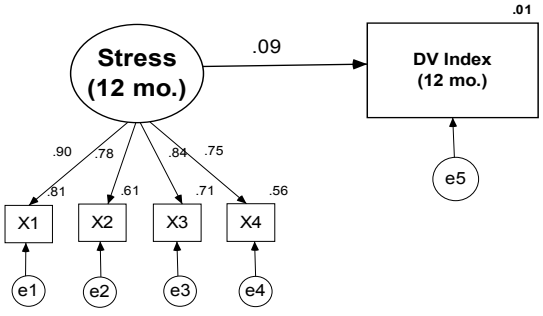

(b) HIV Negative (Chi=18.213, d.f.=8)



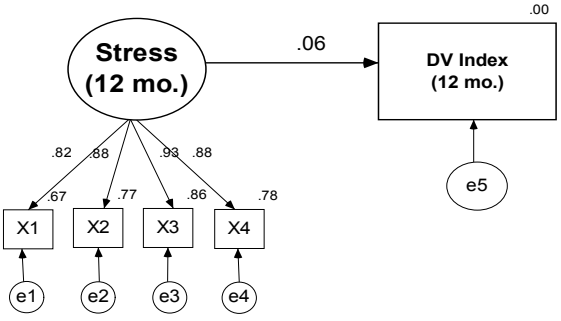

(c) HIV Positive (Chi=7.570, d.f.=8)




(d) HIV Negative (Chi=7.570, d.f.=8)




(e) HIV Positive (Chi=18.645, d.f.=10)




(f) HIV Negative (Chi=18.645, d.f.=10)

Figure 2 Effects of perceived stress on the diversity of livelihood activities: estimated models

criteria of multivariate normality (kurtosis > 11.9). To address the problem of non-normality bootstrap methods were used. To establish models' goodness of fit, $Bollen - Stine\ p.$ and percentile/bias-corrected confidence intervals methods were used for establishing significance of estimated parameters.

The insignificant $\chi^2$ statistics in all unconstrained models (chi < 18.645, d.f. = 8-10, $Bollen-Stine\ p. > .12$), relative fit indexes (NFI, RFI, IFI, TLI, CFI > .95 and RMSEA < .06) suggest that the hypothesized model is justified and describes reasonably well the research data (Figure 2). Further evaluation of estimated parameters in unconstrained modes also suggest that unstandardized loadings (regression weights) from the factor Stress on observed variables $X1, X2, X3$ and $X4$ are high and significant (Table 3). These unstandardized parameter estimates are in the range from .61 for the loading from Stress to $X3$ in HIV-N group at enrolment/birth to 1.11 for the loading from Stress to $X2$ in HIV-N group at 9/12 months. Also, the majority of squared multiple correlations for $X1, X2, X3$ and $X4$ in unconstrained models are in the range from .51 to .89, indicating that the factor Stress accounts for 51% to 89% of variability in the observed indicators of the factor stress. The two exceptions are squared multiple correlations for $X3$ and $X4$ in HIV-P group (.39 and .45, respectively) at enrolment/birth. The above statistics indicate that the measure of stress in this paper is a good measure with strong psychometric characteristics. In addition, in single factor models alternative measures of validity and reliability correspond exactly with estimated $R^2$ (Bollen, 1989c), thus, providing additional evidence that this measure of stress is reasonably valid and reliable.

**Stress and diversity of livelihood activities**

The special interest in this study is testing hypotheses regarding the effects of stress on the proportion of non-farm activities in livelihood portfolios of households with HIV-P and HIV-N women. The estimates indicate that at enrolment/birth a significant negative association existed between maternal stress and the measure of diversification (-.04, p. < .05) in the HIV-P group. Substantively, this means that higher levels of stress were associated with lower

Table 2 Stress & the proportion of non farm activities: SEM tests of parameters invariance across HIV-P and HIV-N groups

| | $\chi^2$ | $d.f.$ | *Bollen–Stine p.* | $\Delta\chi^2$ | $\Delta d.f.$ | $p.$ | **NFI** | **RFI** | **IFI** | **TLI** | **CFI** | **RMSEA** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Beginning of the study** | | | | | | | | | | | | |
| Unconstrained | 18.21 | 8 | 0.12 | - | - | - | 0.98 | 0.95 | 0.99 | 0.97 | 0.99 | 0.06 |
| Metric | 20.38 | 11 | 0.23 | 2.17 | 3 | ns[a] | 0.98 | 0.96 | 0.99 | 0.98 | 0.99 | 0.05 |
| Scalar | 20.85 | 14 | 0.35 | 0.47 | 3 | ns | 0.98 | 0.96 | 0.99 | 0.99 | 0.99 | 0.04 |
| Structural means | 23.21 | 15 | 0.30 | 2.36 | 1 | ns | 0.97 | 0.96 | 0.99 | 0.99 | 0.99 | 0.04 |
| Structural means & causal path | 26.77 | 16 | 0.21 | 3.56 | 1 | <.10 | 0.97 | 0.96 | 0.99 | 0.98 | 0.99 | 0.04 |
| Fully constrained | 29.00 | 17 | 0.18 | 2.23 | 1 | ns | 0.97 | 0.96 | 0.99 | 0.98 | 0.99 | 0.04 |
| ***Best fitting model***[b] | ***25.49*** | ***16*** | ***0.26*** | - | - | - | ***0.98*** | ***0.97*** | ***1.00*** | ***0.99*** | ***1.00*** | ***0.03*** |
| **6 months** | | | | | | | | | | | | |
| Unconstrained | 7.57 | 8 | 0.61 | - | - | - | 0.99 | 0.98 | 1.00 | 1.00 | 1.00 | 0.00 |
| Metric | 14.06 | 11 | 0.41 | 6.49 | 3 | <.10 | 0.98 | 0.97 | 1.00 | 0.99 | 1.00 | 0.03 |
| Scalar | 18.66 | 14 | 0.33 | 4.60 | 3 | ns | 0.98 | 0.97 | 0.99 | 0.99 | 0.99 | 0.03 |
| Structural means | 27.06 | 15 | 0.12 | 8.40 | 1 | <.01 | 0.97 | 0.96 | 0.99 | 0.98 | 0.99 | 0.05 |
| Structural means & causal path | 27.10 | 16 | 0.14 | 0.04 | 1 | ns | 0.97 | 0.96 | 0.99 | 0.98 | 0.99 | 0.05 |
| Fully constrained | 30.78 | 17 | 0.09 | 3.68 | 1 | <.10 | 0.96 | 0.96 | 0.98 | 0.98 | 0.98 | 0.05 |
| ***Best fitting model***[c] | ***18.70*** | ***15*** | ***0.38*** | - | - | - | ***0.98*** | ***0.97*** | ***1.00*** | ***0.99*** | ***1.00*** | ***0.03*** |
| **12 months** | | | | | | | | | | | | |
| Unconstrained | 18.65 | 10 | 0.34 | - | - | - | 0.98 | 0.95 | 0.99 | 0.98 | 0.99 | 0.06 |
| Metric | 30.65 | 13 | 0.17 | 12.00 | 3 | <.01 | 0.96 | 0.95 | 0.98 | 0.97 | 0.98 | 0.06 |
| Scalar | 31.76 | 16 | 0.22 | 1.11 | 3 | ns | 0.96 | 0.95 | 0.98 | 0.97 | 0.98 | 0.06 |
| Structural means | 37.64 | 17 | 0.13 | 5.88 | 1 | <.025 | 0.95 | 0.94 | 0.97 | 0.97 | 0.97 | 0.07 |
| Structural means & causal path | 37.71 | 18 | 0.15 | 0.07 | 1 | ns | 0.95 | 0.95 | 0.97 | 0.97 | 0.97 | 0.07 |
| Fully constrained | 45.22 | 19 | 0.08 | 7.51 | 1 | <.01 | 0.94 | 0.94 | 0.97 | 0.96 | 0.97 | 0.07 |
| ***Best fitting model***[d] | ***21.35*** | ***15*** | ***0.52*** | - | - | - | ***0.97*** | ***0.96*** | ***0.99*** | ***0.99*** | ***0.99*** | ***0.04*** |
| **Growth-curve** | | | | | | | | | | | | |
| Unconstrained | 258.10 | 188 | 0.39 | - | - | - | 0.89 | 0.88 | 0.97 | 0.96 | 0.97 | 0.04 |
| ***Best fitting***[e] | ***262.50*** | ***193*** | ***0.40*** | ***4.40*** | ***5*** | ***ns*** | ***0.89*** | ***0.88*** | ***0.97*** | ***0.96*** | ***0.97*** | ***0.04*** |

[a]ns - insignificant parameters (e. g. p. > 0.10)

[b]Path Stress → DV index is freely estimated, other parameters are set equal

[c]Means of Stress & DV index are freely estimated, other parameters are set equal

[d]Factor loadings from Stress to X2 & X4 and Means of Stress & DV index are freely estimated, other parameters are set equal

[e]Path between Stress Intercept & DV Slope, mean of DV Slope, covariance between Stress Slope & Intercept and variance of Stress Intercept are freely estimated

Table 3 Stress & the proportion of non farm activities: parameters estimates in the unconstrained SEM models

| | **0 months** | | **6 months** | | **12 months** | |
|---|---|---|---|---|---|---|
| | **HIV P** | **HIV N** | **HIV P** | **HIV N** | **HIV P** | **HIV N** |
| **Causal Paths**[a] | | | | | | |
| DV index[b] ← Stress | -0.04 (-0.22)[c] | 0.00 (0.01) ns[d] | 0.00 (0.01) ns | -0.01 (-0.02) ns | 0.00 (0.09) ns | 0.02 (0.06) ns |
| **Regression Weights**[e] | | | | | | |
| $X1 \leftarrow$ Stress | 1.00 (0.92) | 1.00 (0.89) | 1.00 (0.95) | 1.00 (0.77) | 1.00 (0.90) | 1.00 (0.82) |
| $X2 \leftarrow$ Stress | 0.94 (0.85) | 0.95 (0.86) | 0.89 (0.89) | 1.16 (0.88) | 0.78 (0.78) | 1.11 (0.88) |
| $X3 \leftarrow$ Stress | 0.73 (0.74) | 0.61 (0.62) | 0.77 (0.77) | 0.86 (0.81) | 0.92 (0.84) | 1.03 (0.93) |
| $X4 \leftarrow$ Stress | 0.75 (0.71) | 0.73 (0.67) | 0.83 (0.83) | 0.87 (0.80) | 0.68 (0.75) | 0.99 (0.89) |
| **Latent Means**[f] | | | | | | |
| Stress | 0.00[g] | -0.19 ns | 0.00 | -0.38 | 0.00 | -0.27[h] |
| $R^{2i}$ | | | | | | |
| DV index | 0.05 | 0.00 ns | 0.00 ns | 0.00 ns | 0.01 ns | 0.00 ns |
| $X1$ | 0.84 | 0.79 | 0.89 | 0.60 | 0.81 | 0.67 |
| $X2$ | 0.73 | 0.74 | 0.79 | 0.77 | 0.62 | 0.77 |
| $X3$ | 0.55 | 0.39 | 0.60 | 0.65 | 0.71 | 0.86 |
| $X4$ | 0.51 | 0.45 | 0.70 | 0.63 | 0.56 | 0.78 |

[a]Parameters significant at least at p. $<$ .10 level based on bias corrected and percentile bootstrap methods
[b]DV index - proportion of non-farm activities in household's livelihood portfolio
[c]Standardized solutions are given in parentheses
[d]ns - insignificant parameters (e. g. p. $>$ 0.10)
[e]All regression weights are significant at least at p. $<$ .05 level based on bias corrected and percentile bootstrap methods
[f]Significant at least at p. $<$ .10 level based on bias corrected and percentile bootstrap methods
[g]Latent mean stress level in HIV-P group is set equal 0 for scaling purposes
[h]Parameter estimate may have limited interpretation since model demonstrates only partial metric invariance for 9/12 months observations
[i]All $R^2$'s are significant at least at p. $<$ .05 level based on bias corrected and percentile bootstrap methods

levels of livelihood diversification measured as the proportion of non-farm activities. Stress in this group accounts for approximately 5% of variability in the measure of diversification. No statistically significant associations between stress and measures of diversification were found for other time periods in any of the groups. Results also show that the HIV-N group demonstrated significantly lower levels of stress in comparison to the HIV-P group at 3/6 (- .38, p. $< .05$) and 9/12 (- .27, p. $< .05$) months.

**Between groups comparisons**

Although the estimates allow to evaluate relationships between stress and measure of livelihood diversification in each of the two groups, one question of methodological and substantive importance remains unaddressed: do HIV-P and HIV-N groups perceive stress in a similar manner or is this measure of stress invariant across groups? Measure invariance is the extent to which the meaning of responses and the calibration of the measure regarding the latent construct is consistent across groups (Millsap and Kwok, 2004; Vandenberg and Lance, 2000; Ellis, 1989). Without such consistency, there would be no justified foundation for direct comparison of effects of latent factor stress on livelihood diversification in HIV-P and HIV-N households (Horn and McArdle, 1992).

In SEM, the test of group invariance is conducted as a set of steps when parameters constrained equal across groups. Insignificant change in the model's $\chi^2$ serves an evidence of invariance for specified parameters. Currently, it is accepted practice in research to establish full or partial configural, metric, scalar invariance and invariance of latent means to evaluate the degree of measure equivalence across groups (Byrne, 1998b, 2004; Cheung and Rensvold, 1999, 2001). In the initial analysis, models' configural invariance was established since all groups have the same factor structure. Following the accepted practice, groups then were tested for equivalence of factor loadings (metric invariance), equivalence of means of observed variables $X1, X2, X3$ and $X4$ (scalar invariance), and equivalence of means of latent factors Stress (structural means invariance). Additionally, groups were tested for equivalence of effects of stress on the measure of diversification (structural means and causal path invariance) and

Table 4 Stress & the proportion of non farm activities: parameters estimates in the best fitting SEM models

| | 0 months | | 6 months | | 12 months | |
|---|---|---|---|---|---|---|
| | **HIV P** | **HIV N** | **HIV P** | **HIV N** | **HIV P** | **HIV N** |
| **Causal Paths** | | | | | | |
| DV index[a] ← Stress | -0.03(-0.14)[b] | -0.03(-0.11) | 0.00(0.00) | 0.00(0.00) | 0.02(0.08) ns[c] | 0.02(0.01) ns |
| **Latent Means** | | | | | | |
| Stress | 0.00 | 0.00 | 0.00 | -0.38 | 0.00 | -0.22 |
| $R^2$ | | | | | | |
| DV index | 0.05 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 |

[a]DV index - proportion of non-farm activities in household's livelihood portfolios
[b]Standardized solutions are given in parentheses
[c]ns - insignificant parameters (e. g. p. $> 0.10$)
[b]Latent mean stress level in HIV-P group is set equal 0 for scaling purposes
[c]All parameters, unless specified otherwise, are significant at least at p. $< .05$ level based on bias corrected and percentile bootstrap methods
[d]Latent mean stress in HIV-N group at 12 months may have limited interpretation since model demonstrates only partial metric invariance

equivalence of means in the measure of diversification (full invariance, where in addition of equivalence of causal paths between stress and the measure of diversification, the means of the latter were set equal). These steps are summarized in the Table 2. Estimates of parameters in best fitting models at each time period are presented in the Table 4.

Models' fit statistics suggest that at time of enrolment/birth almost all the parameters in the HIV-P and HIV-N groups are statistically equivalent (invariant) since they produce insignificant increase in $\chi^2$ ($\Delta\chi^2$) when constrained equal across groups. For instance, when all factor loadings for $X1 - X4$ in this model are constrained equal across groups (metric invariance model), the $\chi^2$ statistics ($\Delta\chi^2$) increases insignificantly by 2.17 (d.f. $= 3$) providing evidence in support of metric invariance. Also, when the means of observed variables $X1 - X4$ and structural means of the factor Stress are constrained equal in two groups (scalar invariance model), the $\chi^2$ increases by 0.47 (d.f. $= 3$) and 2.36 (d.f. $= 1$) respectively. Only the causal path between stress and measures of diversification can be treated as non-equivalent at the marginal level in Structural means & causal path model ($\Delta\chi^2 = 3.56$, $d.f. = 1$, $p. < 0.10$). The model where all parameters constrained equal - except for the causal path between stress and measures of diversification - was accepted as the best fitting model at the time of enrolment/birth.

The same logic was applied for models evaluation at other time periods. Even though only marginally significant increase was observed in $\chi^2$ for metric invariance at 3/6 months ($\Delta\chi^2 = 6.49$, d.f. $= 3$) and significant for metric invariance at 9/12 months ($\Delta\chi^2 = 12.00$, d.f. $= 3$), groups at these time periods are still treated as partially metric invariant (Byrne et al., 1989; Cheung and Rensvold, 1999, 2001). The best fitting models at 6 and 12 months are scalar invariant with an additional equality constraint imposed on causal paths between Stress and measure of diversification. Causal paths between Stress and measures of diversification in the above best fitting models were re-established. The results are reported in Table 4.

Consistent with estimates in unrestricted models, best fitting models indicate that a negative association exists between stress and the measure of livelihood diversification (unstandardized parameter estimate, -.03, $p. < .05$) at the time of enrolment/birth data. However, in the best fitting model, this negative association is significant for both groups. Similar to

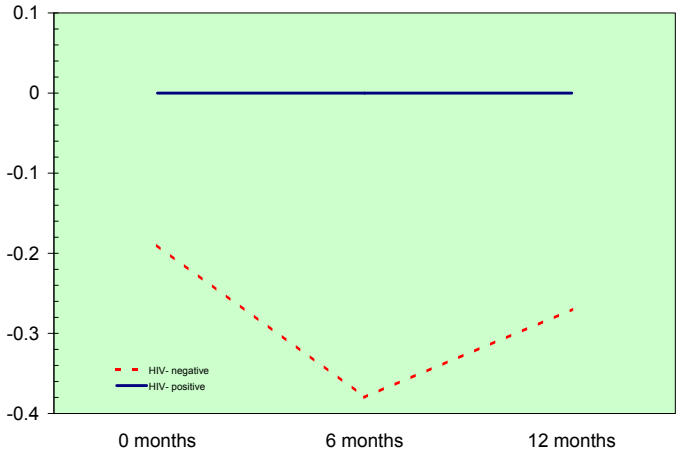



Figure 3 Plot of structural mean stress levels in HIV - positive and HIV - negative groups

unrestricted models, the best fitting models show that HIV-N women have significantly lower levels of stress in comparison to HIV-P women at 6 and 12 months observations (-.38 and -.22, p. $<$ .05, respectively). Previously it was established that households with HIV-P women have a significantly lower proportion of non-farm activities in household livelihood portfolios at 3/6 and 9/12 months (see *Diversity of livelihood activities in households with HIV-positive and HIV-negative mothers in Eastern Ghana* in this dissertation). The above analysis also suggests that HIV-P women experienced significantly higher levels of stress at the same time periods (Figure 3).

**Relationships between changes in stress and in household's diversity of livelihood activities**

The next step in the analysis is evaluating the relationships between changes in stress levels and changes in the measure of diversification across groups. The SEM random effects growth curve (GC) model is commonly used in longitudinal research to answer the question as to whether the trajectory of change in one variable is associated with the trajectory of change in another variable. This approach was used in the analysis.

For longitudinal analysis of the data households with incomplete data were excluded from further analysis. The GC analysis was performed on 101 households with HIV-P women

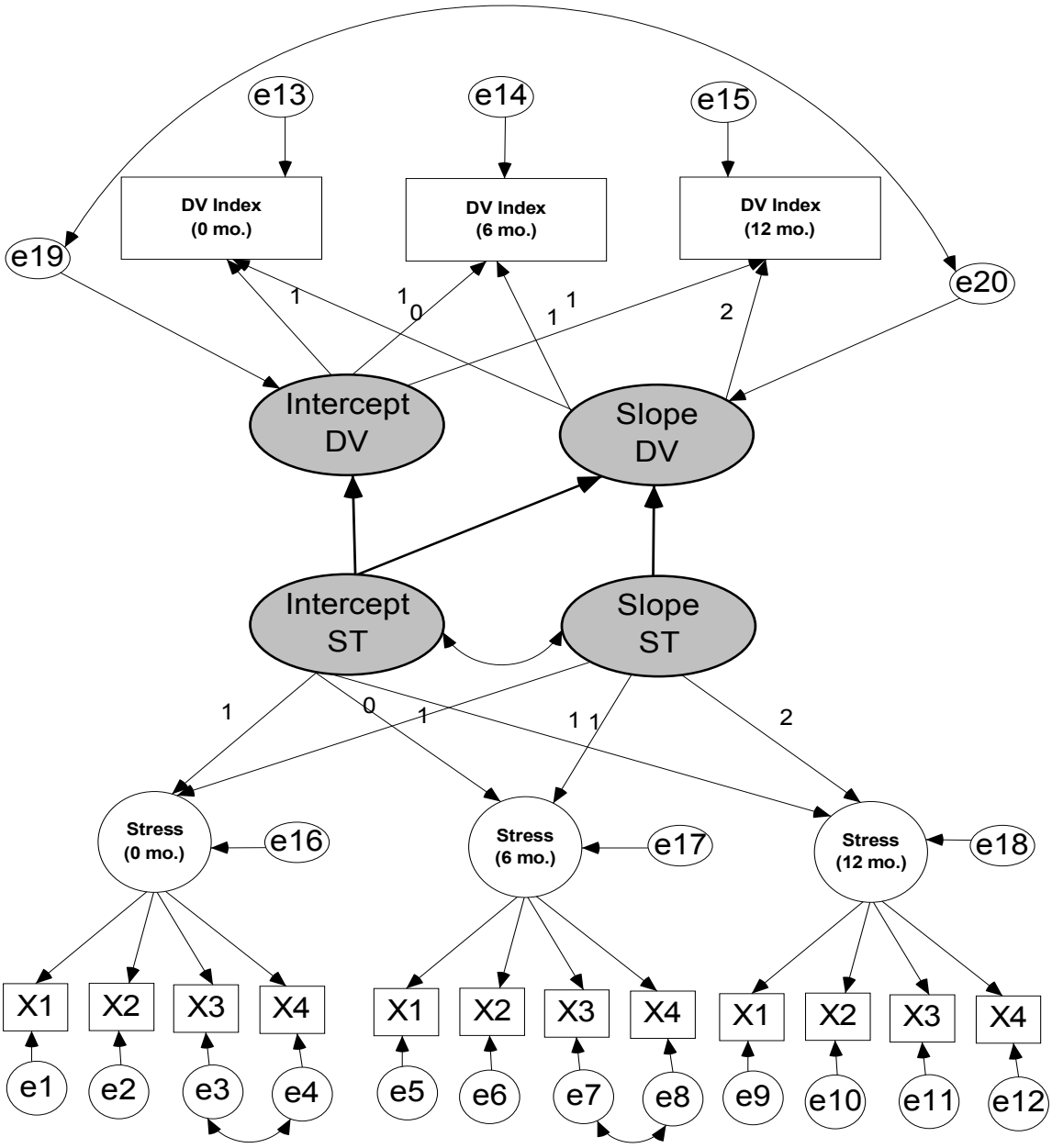



Figure 4 Effects of changes in stress on the changes in the diversification of livelihood activities: empirical model

and 150 households with HIV-N women (Appendix A.2, A.3). The ANOVA tests suggest that households not included in longitudinal analysis did not show a significant difference regarding levels of diversity of livelihood activities, socioeconomic status and demographic characteristics. The few exceptions included households with HIV-P women which tend to have fewer household members of younger generation, fewer children under 14 years old, and less adults with completed primary education than in the group included in longitudinal analysis. Also, households with HIV-N women excluded from longitudinal analysis tend to have fewer children under 14 years old.

The model of linear growth is presented in Figure 4. Specifications were applied from the best fitting models obtained during cross sectional analysis and combined all three waves of data in one model. This model was specified by creating four additional latent variables. These variables represent initial levels of stress and diversification (intercepts) and rates of change in stress and diversification (slopes). Following the accepted conventions, the growth model was specified by constraining all factor loadings from intercepts to respective measures of stress and diversification equal to 1 and from slopes to these measures equal to 0, 1 and 2 to reflect linear time change from enrolment/birth (0) to 3/6 months (1) to 9/12 months (2). Mean values of diversification indexes, stress and measurement errors were set equal to 0. Finally, causal paths from the stress intercept to the diversification intercept and from the stress slope to the diversification slope were specified to test hypotheses regarding associations between rates of change in stress and measures of diversification (Duncan et al., 2006).

We proceeded with the analysis of the data by first fitting the above model and allowing causal paths between intercepts and slopes to be freely estimated across groups (unconstrained models) and, then, refitting the model with equality constraints imposed on these causal paths as well as means and variances of intercepts and slopes across groups. Only equivalent parameters - the ones that did not increase significantly the models' $\chi^2$ - were retained in the best fitting models. The summary of models fit statistics and estimated parameters are in Tables 2 and 5.

The results suggest that the assumption of linear trends in both unconstrained and best

Table 5 Stress & the proportion of non farm activities: parameters estimates in the growth curve model

| | Unconstrained model | | Best Fitting Model | |
|---|---|---|---|---|
| | **HIV-P** | **HIV-N** | **HIV-P** | **HIV-N** |
| **Causal paths** | | | | |
| Intercept DV ← Intercept Stress | -0.01(-0.04) | 0.09(0.12) | [0.00(-0.02)][a] | [0.00( -0.01)] |
| Slope DV ← Intercept Stress | 0.02(0.15) | -0.01(-0.04) | [0.02(0.12)] | [0.02(0.12)] |
| Slope DV ← Slope Stress | 0.01(0.02) | 0.32(0.42) | [-0.01(-0.01)] | [-0.01(0.27)] |
| **Latent Means** | | | | |
| Intercept Stress | 0.00 | -0.17 | [0.00] | [0.00] |
| Slope Stress | 0.24 | 0.07 | 0.24 | 0.07 |
| Intercept DV | 0.41***[b] | 0.46** | [0.43***] | [0.43***] |
| Slope DV | -0.02 | -0.05 | -0.03 | -0.01 |
| **Covariances** | | | | |
| Slope Stress ↔ Intercept Stress | -0.16(-0.65) | 0.00(0.00) | -0.08(-0.80) | 0.00(0.00) |
| Slope DV ↔ Intercept DV | [-0.01(-0.51)] ns/*[c] | [-0.01(-0.74)] ns/* | [-0.01(-0.52)**] | [-0.01(-0.70)**] |
| **Variances** | | | | |
| Intercept Stress | 0.64** | 0.06* | 0.53* | 0.05 |
| Slope Stress | 0.10 | 0.01 | [0.02] | [0.02] |
| Slope DV | 0.01** | 0.01 | [0.01***] | [0.01] |
| Intercept DV | 0.02** | 0.03* | [0.03***] | [0.03***] |
| $R^2$ | | | | |
| Slope DV | 0.02 | 0.17 | 0.02 | 0.09 |
| Intercept DV | 0.00 | 0.02 | 0.00* | 0.00 |

[a] [] - parameters with equality constraints imposed across groups

[b] * - p. $< 0.1$; ** - p. $< 0.05$; *** - p. $< 0.01$ based on percentile and bias corrected bootstrap methods

[c] Parameter is significant at p. $< 0.1$ level according to one bootstrap method and insignificant according to another bootstrap method

fitting models demonstrate reasonably good fit to the data with $\chi^2$ values 258.1 and 262.5 and $Bollen - Stine$ *p.* over .38, respectively. Although NFI and RFI relative fit indexes are less than .90, the magnitude of other indexes exceeds .96 and RMSEA is .04 which provides additional evidence of reasonably good fit of models (Table 2).

Parameters estimates (Table 5) indicate no statistically significant associations between changes in stress and changes in the measures of diversification. None of the causal paths between intercepts and slopes are statistically significant. For instance, although initial levels of stress in the HIV-P group is negatively associated with initial levels of diversification measures it is insignificant (unstandardized estimates of the path Intercept Stress → Intercept DV = -.01, p. = ns). Similarly, no statistically significant evidence of change was observed in the levels of stress or the levels of diversification. Mean values of slopes for the measure of diversification (Slope DV) range from -.01 to -.05 across models and for stress (Slope Stress) are in the range between .07 and .24, but remain insignificant. The estimates do not provide evidence that levels of stress vary across groups. When stress is set equal to 0 in HIV-P and HIV-N groups in the best fitting model, it does not produce significant change in goodness of fit statistics. Finally, squared multiple correlation statistics suggest that stress appear to explain little variability in intercepts and slopes in the measure of diversification (0 to 8.5%).

Some evidence suggests, however, that the HIV-P group demonstrates higher variability in initial levels of stress (intercepts). The variance of stress in the HIV-N group ranges between .05 and .06, while the variance in the HIV-P group ranges between .53 and .64. The substantive meaning of the above evidence points to greater heterogeneity of HIV-P women regarding their initial levels of stress. Also, negative correlations between initial values of the measure of diversification and its rate of change (slope) (-.01, p. $<$ .05) indicate that interaction exists between initial level of diversification and the rate of change at the individual level. Those households with higher a proportion of non-farm activities in both groups tend to decrease the proportion of non-farm activities in household livelihood portfolios at a slower rate.

## Discussion and conclusion

The overarching questions in this study are: is stress experienced by household members a good predictor of household livelihood diversification behavior and are effects of stress on household livelihood diversification stronger in households with asymptomatic HIV positive members than in households with HIV negative members? A substantial body of literature on stress has established links between elevated levels of stress and reduced health status, decreased work productivity, decline in job satisfaction and other negative effects. Any of the above effects have the potential to alter livelihood behavior which can ultimately result in increased household vulnerability to food insecurity, reduced wellbeing, and set off a downward spiral to poverty. While potentially harmful to any household's livelihoods, for households affected by HIV/AIDS, stress may have particularly adverse effects and lead to rapid deterioration of household resources. As a result of increasing growing health and nutritional needs of HIV/AIDS affected members, such households may soon be unable to cope with the consequences of HIV/AIDS.

In this study of peri-urban households with HIV-P and HIV-N mothers of infant children in Eastern Ghana, the focus was on the relationships between perceived stress by women who recently gave birth and the proportion of non-farm activities in households' livelihood portfolios at the time of enrolment or the child's birth and at 3/6 and 9/12 months after the birth. Proportion of non-farm activities was used as a measure of 'good diversification' - diversification that is commonly associated with increased resilience to economic and social shocks, increased sustainability and upward spiral out of poverty (Ellis and Freeman, 2004).

Households with HIV-P mothers experienced a decline in the proportion of non-farm activities, while households with HIV-N mothers retained their levels of diversification essentially unchanged (see *Diversity of livelihood activities in households with HIV-positive and HIV-negative mothers in Eastern Ghana* in this dissertation). In other words, the share of employment activities and remittances in the overall portfolio of livelihood activities was lower in households with HIV-P mothers and decreased over time. Such households demonstrated increasing dependence on farm based activities associated with livestock rearing and crop pro-

duction. Considering the fact that non-farm activities traditionally constitute a substantial share of livelihood portfolios in Ghana and that farming activities are associated with risks, an increasing share of the latter activities raises concerns in the context of contemporary diversification research.

For instance, some 50 to 60 percent of the income of a typical Ghana's household was derived from employment, non-farm based enterprises and remittances (GSS, 2008). The Eastern Region, where approximately nine out of ten economically active residents are engaged in some form of economic activity to generate cash (GSS, 2005), is the third largest recipient of remittances in the country (Mazzucato et al., 2008). At the same time, approximately one out of five respondents in the RIING research project, whose data is analyzed in this study, reported crop failure or livestock death. In prior livelihoods research, a positive association was found among households' wellbeing, increased share of non-farm livelihood activities, and increased complexity of livelihood activities. The opposite pattern observed in the households with HIV-P women in the Eastern Region of Ghana may point to their increasing vulnerability to poverty. Therefore, the objectives in this study have been to explore the nature of the association between perceived stress and the measure of livelihood diversification and to determine whether the levels of perceived stress may predict the extent of 'good diversification' (e.g., livelihood portfolios with an increasing share of non-farm activities) in household livelihoods.

This analysis has been guided by three hypotheses: (1) an appropriate measure of stress which is both reasonably valid and reliable in the study population has been used; (2) stress is negatively associated with the measure of diversification in HIV-P group; and (3) the trajectory of change in the levels of stress is negatively associated with the trajectories of change in the measure of diversification. In addition, it was hypothesized that the association is stronger in the HIV-P group. The above hypotheses were cross sectionally and longitudinally using structural equation modeling.

**Performance of stress measure in study population**

The question of tremendous methodological importance in any comparative study is how valid and reliable are the measures of phenomena of interest and how appropriate such measures are for comparison between groups. Multi-indicator measures of stress offer several methodological advantages when compared to investigator based ad hoc measures, single item measures or scales based on analysis of life events. For instance, they can offer a greater level of standardization, are often better suited for capturing change and sometimes can offer better reliability and validity (Monroe and Kelley, 1995). Nevertheless, the interpretation of results obtained with a multi-indicator measure of stress in a specific study depends on the performance of the measure in the study population. The results of the analysis using a modified version of Cohen's 4-item scale of perceived stress in the population of HIV-P and HIV-N mothers in Eastern Ghana suggest that the stress measure demonstrates good psychometric properties. The respondents were asked about their perceptions regarding their own ability to deal with four general problems. All four items in this scale appear to be adequately represented by the latent construct 'Stress' in both HIV-P and HIV-N groups. Also the measure demonstrates reasonable level of reliability and validity.

**Do HIV-P members perceive stress differently?**

It is often the case in studies that different subgroups within the same population perceive a certain phenomenon differently. For instance, teenagers, adults and seniors may offer different lists of criteria that define psychological construct 'love'. They also place different values on the same criterion, thus, suggesting that using the same measure of love in two sub-populations will produce non-equivalent results; the measure itself is non-invariant across groups. Analysis of measure invariance has important substantive and methodological implications. On the one hand, non-invariant measures indicate substantial qualitative differences within sub-populations. Qualitative comparisons between groups, however, are warranted. In the above example, a direct comparison between teenagers and seniors, based on the construct 'love,' may be problematic; to conclude that one or the other group experiences more or less

'love' would be unfounded. When the measure of a construct demonstrates invariance across groups, set of hypothesis regarding quantitative differences between these groups is possible.

The initial assumption in this study was that after learning of HIV positive status, the profound effect on household members would alter their perception of stress. The results suggest otherwise. Tests of measure invariance show that the modified version of Cohen's 4 item measure of perceived stress is invariant across groups. In other words, HIV-P women in the sample from Manya Krobo district of the Eastern Region of Ghana perceived and evaluated stress similarly to and HIV-N women during the first year after discovering their positive status. Some comments regarding invariance of the measure of stress in this study are appropriate. The analysis shows signs of increasing non-invariance in groups at 3/6 and 9/12 months. Although this measure of stress meets the invariance criteria, it is possible that if the study continued longer than 12 months one could observe additional evidence of non-invariance. Substantively, this evidence may reflect some cognitive processes of adjustment to stress in one or both groups. Over a longer period of time, this may lead to groups perceiving stress differently. This would require an appropriate interpretation of the results when comparison of levels of stress in the two groups is attempted.

Lack of empirical support for the initial assumption of measure non invariance, however, provided evidence that both HIV-P and HIV-N groups qualitatively perceive stress in a similar manner. This established methodological grounds for testing hypotheses regarding differences in levels of stress between these groups. This study produced evidence that HIV-P women experienced significantly higher levels of stress at 6 and 12 months, thus increasing their vulnerability to negative effects of HIV and, later, threatening the sustainability of household livelihoods. This indicates that interventions aimed at monitoring and reducing stress among HIV-P mothers in Eastern Ghana is an important component for any development initiative.

**Relationship between stress and diversification**

The second objective in this study was to understand how well stress in women who recently gave birth to a child can predict the proportion of non-farm activities in households' livelihood

portfolios. When assumed that psychological stress plays a significant and negative role in the choice of livelihood behavior, it is logical to conclude that negative relationships should exist between stress and livelihood diversification. The analysis, however, does not provide a definitive answer regarding the role of psychological stress of a specified household member for the diversification of household activities.

Consistent with the theory and hypotheses, a negative association between stress and the proportion of household non-farm activities was observed at the beginning of the study. Moreover, the analysis suggests that a negative relationship between stress and the measure of diversification is only present in households with HIV-P women. Thus, in these households, at the initial stage of the study the share of remittances and wage employment in portfolios of livelihood activities was smaller when HIV-P mothers experienced elevated levels of stress. This evidence may indicate that stress may indeed decrease the share of non-farm based livelihood activities and contribute to the vulnerability of households with HIV-N mothers. On the other hand, there was no significant association between stress and the measure of diversification found at 3/6 or 9/12 months in any of the groups. Also there was no evidence that change in stress had any statistically significant association with the change in the proportion of non-farm activities in household livelihood portfolios. In other words the initial levels of stress at the beginning of the study neither affected initial level of the households' diversification at the same time period, no affected the diversification behavior at later time periods during the course of this study. Likewise the changes in stress levels over the course of the study did not affect changes in diversification behavior during the same time periods. These results suggest that the role of stress in households' diversification of livelihood activities may be more complex than initially hypothesized.

There are several possible explanations for why it was not possible to establish definitive relationships between stress and the measure of diversification. It is plausible that stress does not have a direct effect on the diversification of household livelihood activities. In such a case, the positive association between stress and the measure of diversification at the beginning of the study could be explained by the artifacts in the research data. At this time, this paper

refrains from dismissing the possibility of links between stress and livelihood diversification. Some limitations in the study design may have affected the results. It is plausible that effects of stress become manifest only when stress levels reach a certain threshold. The literature on psychological stress provides evidence in support of this hypothesis (Scott Jr., 1966; Srivastava and Krishna, 1991; Selye, 1975; McGrath, 1976). If correct, than it can be inferred that contraction of HIV by itself does not increase stress levels to the extent it affects negatively human performance and livelihood behavior.

Another plausible explanation for the lack of definitive relationship between stress and the measure of livelihood diversification is the possibility of moderating effects of other variables. Extensive literature on sustainable livelihoods suggests that positive associations exist between household assets such as socioeconomic status or social capital and household livelihoods (Chambers and Conway, 1992; Hussein, 2002; Scoones, 2009). Similarly, the stress literature presents evidence that social and human capital and socioeconomic factors moderate psychological stress (Hamad et al., 2008; Nielsen et al., 2008; Wright et al., 2007; Brannen et al., 2009; Lin, 2009). Thus, changes in socioeconomic status or social support may have affected the relationships between stress and the measure of livelihood diversification.

Finally, the fundamental assumption tested in this study is that maternal stress has a significant effect on household diversification decisions. Some empirical evidence indicates that maternal stress may reflect the stress level of other household members and serve a proxy of household level stress due to spillover and contagion effects (Bolger et al., 1989; Grzywacz et al., 2002; Margolin et al., 1996). The suggests that maternal stress in this study does not have a substantial effect on households' diversification decision or it is not representative of the stress experienced by other members of households.

## Conclusions

Despite not finding a definitive link between stress and diversity of livelihood activities, elevated levels of stress in HIV-P group is still a concern. Persistent stress is likely to contribute to the deterioration of health status, which ultimately impairs physical capabilities to perform

work requires greater household resources to deal with deteriorating health conditions. This may strain often limited household resources, making these households more vulnerable to poverty. This is the main substantive conclusion of this research.

Another key finding has important methodological implications. This study suggests that the modified Cohen's 4-item scale of perceived stress is a valid and reliable instrument. In the initial period after discovering their health status, subjects seem to demonstrate no qualitative difference in their perception of stress. Finally, it is commonly accepted that the measure within a specific comparative study is often as good as its capability to capture differences between compared groups. The analysis suggests that the measure of stress was able to distinguish between HIV-P and HIV-N subjects regarding their levels of perceived stress.

In applied research, practitioners often face difficult methodological choices. They may need to use cost effective and efficient techniques; however, achieving efficiency may be realized at the expense of reliability and validity of study results. This analysis suggests that the modified Cohen's 4-item scale of perceived stress is a valid option in stress-related studies in populations affected by HIV/AIDS. This scale is efficient; it can be administered in a matter of minutes and possesses many essential psychometric properties such as reliability, validity and invariance across HIV-P and HIV-N groups.

**Limitations**

In addition to the limitations of the study design previously discussed, some comments are in order. One of the important questions researchers raises upon completion of their study is whether results could be generalized to a wider population? In other words, 'how representative is the sample?' In this study, the sample was obtained based on self-selection at three hospitals in Eastern Ghana. How well does this sample represent the entire population of women who obtain health services at these hospitals? How well does the hospital population in Eastern Ghana represents all households with new mothers in the country? No information is available to evaluate the extent of self-selection bias and/or the bias of the sample obtained in Eastern Ghana regarding the rest of the country. This may potentially limit the extent to which these

results could be generalized to the entire population of women who recently gave birth in Ghana.

Another consideration pertinent to generalizability of results is typical of longitudinal studies. There were some participants who did not complete the study. Based on the analysis of the diversification index and socio-economic and demographic characteristics of included and excluded groups, the drop out of study participants does not appear to be reflect any significant bias.

**Future research**

These results suggest three possible pathways for further research in the area of stress and diversification research. First, research that observes stress and livelihoods diversification behavior in HIV affected populations would benefit from studies that cover periods longer than 12 months. It is possible that such studies may have more opportunities to observe the relationships between stress and diversification behavior. Second, future studies may benefit from evaluating stress among all households members, thus increasing the precision of the household level analysis. Finally, the moderating factors may explain relationships between stress and household livelihood diversification.

# THE MEDIATING AND MODERATING EFFECTS OF PERCEIVED STRESS, SELECTED SOCIOECONOMIC AND DEMOGRAPHIC FACTORS ON LIVELIHOODS DIVERSIFICATION IN EASTERN GHANA

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## Abstract

Consensus exists among researchers that diversification of livelihood activities can contribute to poverty reduction in low income countries. Since poverty and the HIV/AIDS epidemic walk 'hand-and-hand,' interventions aimed at the diversification of livelihood activities in HIV/AIDS affected populations may prove to be a viable strategy for battling the epidemic. This paper hypothesizes that household resources and psychological stress may moderate diversity of livelihood activities in households affected by HIV. It is expected that household socioeconomic status, social capital and human capital are positively and stress negatively associated with the diversity of household livelihood activities. It is also expected that household resources moderate stress and that stress mediates their effects on diversification. Finally, it is hypothesized that observed effects are stronger in HIV affected households. The ANOVA and structural equation modeling analysis of 349 households observed at the initial stages of the study, 277 at approximately 6 months and 252 at 9 to 12 months after the initial stage of the study suggests that households with HIV positive members have significantly lower levels

of socioeconomic status and human capital. Human capital is a significant moderator of diversification and social capital and socioeconomic status are significant moderators of stress. Households with HIV positive and negative members appear not to be different regarding the magnitude of observed effects. Evidence regarding other hypothesized effects was inconclusive.

## Introduction

Diversification of livelihood activities presents an important goal in poverty reduction programs in populations affected by HIV. Empirical research suggest that households with more diverse income generating activities exhibit less vulnerability to food insecurity, greater resilience and adaptability to environmental and economic shocks, and possess a greater repertoire of resources to use in their strategies to escape poverty (Ellis, 1998, 2000). Indeed, coincidence of poverty and HIV/AIDS is well known among experts. For instance, over two-thirds of all HIV positive people live in poor countries, thus linking the epidemic with poverty spatially. Also poor people are more likely to engage in risky behavior leading to HIV infections; once infected with HIV, they have fewer resources available to deal with the consequences. This illustrates the reciprocity and feedback relationship between poverty and the severity of the HIV epidemic (Cohen, 1998). These reasons legitimate the study of livelihood diversification in the HIV/AIDS affected populations.

Substantial efforts in advancing livelihoods research have been made to understand how various socioeconomic factors influence household diversification behavior and the ensuing consequences. For instance, it has been found that in economies lacking insurance mechanisms, better-off households engage in commercial farming and tend to increase their non-agricultural employment to counteract the risks of market failure (Von Braun and Pandya-Lorch, 1991; Ellis, 1998). In northern Ethiopia, conversely, wealthy farmers diversify with off farm self-employment "to reap the attractive return" and increase their income (Woldenhannaa and Oskamb, 2001, p. 364). In areas with low cropping potential in Kenya, poor farmers use off farm income diversification as a form of self-insurance (Barrett et al., 2001a). This echoes findings from India (Anderson and Deshingkar, 2004), Paraguay (Zoomers and Kleinpenning, 1996)

and the eastern and central regions of Uganda where off farm diversification, as a supplement to farming, is practiced by 70%-90% of all farmers (Rider Smith et al., 2001).

Although the primary focus of livelihoods research is the relationship between socioeconomic factors and diversification, some authors are beginning to realize that human cognition may also be an important factor. Thus, in their study of post-famine Ethiopia, Block and Webb (2001) emphasized that household diversification decisions were often guided by cognitive perceptions of risk factors. Since relationships between human cognition and diversification behavior are yet to be fully understood, other disciplines provide insights regarding the nature of this relationship. The role of human cognition in productive behavior has been extensively studied in psychology, sociology, management, epidemiology, and other disciplines. This literature commonly identifies stress as a performance altering factor. Research routinely suggests that elevated stress can impair decision making (Combs and Taylor, 1952; Easterbrook, 1959; Janis and Mann, 1977), increase the time it takes to complete tasks (Idzikowski and Baddeley, 1983), diminish problem solving capabilities (Yamamoto, 1984), and lead to work 'burn out' (Maslach et al., 2001). Two examples often reported in literature and that have relevance to household diversification behavior are failures to consider a broader spectrum of alternatives and tendencies to make oversimplified decisions without considering long-term consequences (Friedman and Mann, 1993; Staw et al., 1981).

The purpose of this paper is to examine the relationships between stress, selected socioeconomic and demographic factors, and the diversity of household's livelihood activities. Three specific questions are of particular interest: (1) what are the effects of the above mentioned factors on household diversification behavior? (2) are there interactions among these factors? and (3) is there a difference in the magnitude of their effects for households with HIV-positive compared to HIV-negative members?

**Livelihoods diversification in context**

Evidence exists in the literature that people diversify their livelihoods differently, for different reasons, and with different consequences for the sustainability of their livelihood sys-

tems (Zoomers and Kleinpenning, 1996; Von Braun and Pandya-Lorch, 1991; Ellis, 1998; Woldenhannaa and Oskamb, 2001; Barrett et al., 2001a; Anderson and Deshingkar, 2004; Rider Smith et al., 2001). In general, studies have found that diversification can be 'progressive' and reduce household vulnerability (Block and Webb, 2001) or 'reactive' and increase vulnerability (Canagarajah et al., 2001). 'Progressive' diversification is often associated with three criteria: (a) decreased relative importance of the farming component in an overall livelihood system; (b) 'virtuous spirals of accumulation' with diverse livestock ownership, non-farm self-employment, and diversification of on-farm and non-farm income sources, and (c) incremental increase in complexity of livelihoods and livelihood activities (Ellis and Freeman, 2004). Ellis and Mdoe (2003) describe this process as a sequence of 'trading up' existing household assets for assets of higher value (e.g., chickens for goats, to cattle, etc.). They contrast this with the process of livelihood deterioration due to sequential asset disposal, described by Corbett (1988) and Devereux (1993).

### Households' livelihood diversification model

Two groups of theories - those that concern sustainable rural livelihoods and those that view stress as a result of cognitive appraisal process - may elucidate the nature of relationships between stress, socio-economic and demographic factors, and diversification.

**Household resources and diversification.** Sustainable livelihoods (SL) emerged as a theme in development during the 1980s (Ellis and Biggs, 2001). At the conceptual level, SL views wellbeing and poverty as the consequence of the aggregate of existing means to gain livelihoods (Chambers and Conway, 1992; Toner and Franks, 2006). The livelihood perspective assumes that people possess a broad repertoire of tools, skills and assets. This versatile combination is used to earn a living and mitigate negative effects of various other vulnerability contexts (economic trends, shocks, disasters, etc.). Most proponents of SL approaches share three basic ideas: "the asset limitations of the poor, the risks they confront, and the institutional environment that either facilitates or blocks them in their own endeavors to build pathways out of poverty" (Hussein, 2002, p. 11). Conceptual SL models of household liveli-

hoods traditionally see household assets (e.g., social, natural, financial, human, economic, political, physical capitals) as factors mediating the effects of vulnerability context and livelihood behavior. As such, these variables can be viewed as explanatory factors in the diversity of livelihood activities (Chambers and Conway, 1992; Hussein, 2002; Scoones, 2009).

Empirical diversification research has focused on the role of household economic, social, and human resources in household members' diversification behavior. For instance, research identifies three basic patterns of associations between economic variables and diversification behavior - linear negative, linear positive and inverted U-shaped - with the linear positive pattern common in African countries. Reardon et al. (2000) attribute this pattern to entry barriers for the poor. Consistent with Reardon et al., the high cost of entry was found to prevent diversification of livelihood activities of the poor in Ethiopia, Kenya, and Cote d'Ivoire (Woldenhannaa and Oskamb, 2001; Block and Webb, 2001; Barrett et al., 2001b). Similar relationship patterns are usually reported in associations between social capital and diversification behavior. For instance, social capital has a positive association with the involvement in non-farm income-generating activities in Tanzania and Uganda (Lanjouw et al., 2001; Rider Smith et al., 2001). Less consistent results, however, are reported for links between human capital and diversification. While education is positively associated with diversification in Kenya, Cote d'Ivoire, Uganda and Mali (Barrett et al., 2001b; Lanjouw et al., 2001; Canagarajah et al., 2001; Abdulai and CroleRees, 2001), it was an insignificant factor for non-farm income generating activities in Ghana and Ethiopia (Block and Webb, 2001; Canagarajah et al., 2001).

**Household resources and stress.** Psychological theories suggests that the relationships between household resources and livelihood diversification may be mediated by psychological stress. Stress is a complex phenomenon that can be manifest at three levels: psychological, physiological, and behavioral (Dougall and Baum, 2003).

This encompasses a broad range of theories and operational definitions of stress. The SL literature views sustainable livelihoods as a buffer to stress. This approach views stress as an exogenous disturbance to household livelihood systems, which is mediated by household assets. Thus, the negative effects of stressful events such as drought, economic crisis, injury,

or death are buffered by household economic, human, social, and other resources. Such an understanding, however, has limitations when one attempts to explain the links between negative events and coping behavior that is relevant to diversification. Mitchell (1984) suggests that despite extensive psychological research, results are inconsistent regarding the magnitude and direction of relationships between negative events and coping behavior when a buffer rationale is used.

Alternatively, the cognitive appraisal approach to stress depicts stress as an outcome of an internal process that evaluates both the severity of the stressful event and the adequacy of available resources to cope with such events. Within this view, stress is defined as a lack of balance between demands imposed by the surrounding environment and resources available to address such demands (Lazarus et al., 1985; Monroe and Kelley, 1995; Lazarus and Folkman, 1984; Depue et al., 1979).

Importantly, empirical research suggests that negative relationships exist among available economic, social and human resources and appraised stress and depressive symptoms (see for example, Nielsen et al. (2008); Wright et al. (2007); Brannen et al. (2009); Lin (2009)).

**Stress and Diversification.** There are three prominent groups of theories that explain the possible relationships between stress and performance. The first group suggests that any level of stress linearly and negatively affects human performance (Jamal, 1985; Vroom, 1964). The second group argues the opposite and suggests that stress is an essential performance booster (Meglino, 1977; Arsenault and Dolan, 1983; Hatton et al., 1995). The theories that received the greatest empirical support, however, describe relationships between stress and performance as complex inverted U-shaped function, or curvilinear (Yerkes and Dodson, 1908; Scott Jr., 1966; Srivastava and Krishna, 1991; Selye, 1975; McGrath, 1976). Stress, until it reaches a certain threshold, which depends on the cognitive complexity of a task, increases performance. Excessive stress, however, tends to reduce performance. According to the threshold theory, stress that exceeds a certain threshold is likely to negatively affect human performance and, as a result, household diversification behaviors.

Previous research suggests that there are reasons to believe that HIV populations experience

substantially higher levels of stress than those unaffected by HIV. For instance, some studies demonstrate that the psychological effects of discovering their positive HIV status can be equivalent to the effects of experiencing the death of a spouse or imprisonment (Kartikeyan et al., 2007). In addition, HIV positive people may experience increased levels of stress due to declining health status (Kelly et al., 1993) and/or stigma (Brimlow et al., 2003). In various countries in Africa, the Middle East and Asia, where people maintain strong religious and cultural traditions, HIV is often perceived as a consequence of immoral behavior and sometimes a punishment (Kaldjian et al., 1998; Ayranci, 2005; Zou et al., 2009). Preliminary evidence in Ghana suggests that households with HIV affected members demonstrate lower scores on non-farm activities in their livelihood portfolios (see *Diversity of livelihood activities in households with HIV-positive and HIV-negative mothers in Eastern Ghana* in this dissertation).

**Empirical model and hypotheses:**

This paper tests several hypotheses concerning the relationships among household HIV status, stress, socioeconomic, social and human capital, and the diversity of livelihood activities. In this analysis, the paper departs from the assumption that households with HIV-positive members differ in regard to their characteristics. From previous analysis it is known that households with HIV-positive members have significantly higher levels of perceived stress and lower diversification scores (see *Diversity of livelihood activities in households with HIV-positive and HIV-negative mothers in Eastern Ghana* and *Ghana: does perceived stress predict diversity of livelihood activities in households with HIV positive and HIV negative mothers?* in this dissertation). In this paper, it is hypothesized that HIV-positive households also have significantly lower scores on measures of socio-economic status, and social and human capital. Second, it is hypothesized that the relationships among stress, socioeconomic status, social and human capital, and diversity of household livelihood activities have a causal nature. It is assumed that perceived stress mediates the causal effects of socio-economic status and social and human capital on household diversification behavior. Further, it is hypothesized that the direction of causal effects between household resources and diversification is significant and positive; be-

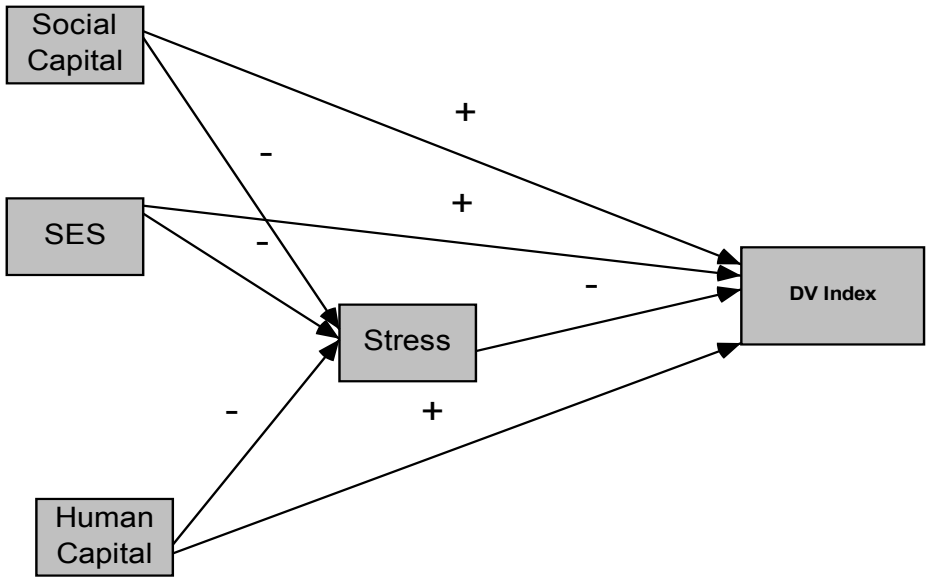



Figure 1 Path model of hypothesized effects of household resources & stress on the diversify of livelihood activities

tween resources, it is hypothesized that stress is significant and negative. Expressly, the causal effects between stress and diversification are negative and significant (Figure 1). Third, this paper hypothesizes that the magnitude of the relationships in households with HIV positive members is stronger than in households with HIV negative members.

## Methodology

### Data

The data for this study were collected in the Eastern Region of Ghana between 2004 and 2008 through the Research to Improve Infant Nutrition and Growth (RIING) project

(NIH/NICHD HD 43260). Pregnant women attending antenatal clinics in the Yilo and Manya Krobo districts were recruited into the study after voluntary counseling and HIV testing. These women were followed for 12 months after delivery where household livelihoods, socio-economic, demographic and other data relating to productive behavior, hygienic practices and cognitive state of household members were collected during regular home visits. This analysis includes data from households with HIV positive (HIV-P) and HIV negative (HIV-N) women studied at enrollment/birth (HIV-P n=176, HIV-N n=173), at 3/6 months (HIV-P n=122, HIV-N n=155) and at 9/12 months (HIV-P n=98, HIV-N n=154).

**Definitions and measures**

**Units of analysis.** The research data for this study is evaluated at the household level. Since no single known definition of household fits all circumstances (Rogers, 1990), and because researchers' need "to explicate the precise meaning of the social unit they are calling households in the elucidation of particular problems" (Arnould and Netting, 1982, p. 572), household is defined on the basis of three criteria: (1) co-residence, (2) family ties (for children under 16 years old temporarily living away), and (3) members of the household who were not present in the homes at the time of interview, but lived there at least 15 days in the preceding year.

**Human capital.** Human capital is commonly understood as knowledge and skills that are relevant to humans' economic activities (Schultz, 1961; Becker, 1962). Researchers often use education and the age of the head of household as proxies for household level human capital (see for example Barrett et al. (2001b); Block and Webb (2001); Jagger and Pender (2003); Quisumbing et al. (2008)). Following this tradition, human capital is operationally defined as the level of educational attainment of the head of the household.

**Socio-economic status.** To create the measure of household socio-economic status, the Filmer and Pritchett (2001) principal component analysis (PCA) based method was adopted. First, all variables with quantities of different household durable items (e.g. kitchen equipment, electronics, automotive, etc.) were converted into a set of dichotomized variables where '1' rep-

resented any quantity of a specified item and '0' the absence of that item. Second, means and standard deviations were estimated for the distribution of each item among all households. Third, the first principal component was extracted from the set of dichotomized variables so that a specific PCA value corresponded to a specific item. Forth, weight for each item was estimated by dividing the item's PCA value by its standard deviation (Appendix B.2. Fifth, value 1 in each dichotomous variable was replaced with corresponding weight and summed all variables to obtain the total socio-economic status (SES) score for a specified household. The overall rationale behind the above SES index is that more expensive, durable goods are more common for better-off households and are less frequently reported in the sample. The PCA-based weighting method assigns higher weight to such items. For example, a radio is reported in the possession of the vast majority of households in this study; therefore, the radio received low weight. On the other hand, only few households reported owing a car; therefore, a car was assigned high score. Although the PCA based method has its limitations - for instance Filmer and Pritchett (2001) point to the lack of theoretical foundation behind the PCA method - it demonstrates acceptable validity and reliability and is widely used by the World Bank, USAID and other international development organizations (Rutstein and Johnson, 2004; Rutstein, 2008).

**Diversification of livelihood activities index.** Following Ellis and Freeman (2004), diversification is defined as the proportion of non-farm activities in households' livelihood portfolios and created a weighted composite diversification index for four types of on-farm and off-farm activities including: livestock production, agricultural production, paid jobs, and receiving remittances. To construct the measure of diversification, first separate scores were created for each livelihood activity. Then individual scores were summed up into the total diversification score. Finally, the proportion of non-farming activities in household livelihood portfolios was calculated by dividing the score for non-farming activities (sum of scores for paid jobs and remittances) by the total diversification score.

Individual scores were calculated as follows: (a) the Filmer and Pritchett (2001) PCA based weighting method was extended to estimate three separate indexes for the livestock

rearing, agricultural production, and receiving remittances (Appendix B.1; and (b) a household level work index was created by estimating the percentage of working household members, including new mothers among all adult members (over 15 years old) of the households. By creating PCA indexes, several assumptions are made. First, it is assumed that activities requiring more resources and skills would not be common in the population because of financial and other access barriers; consequently, such activities received higher Principal Component Analysis weights. For instance, in the livestock production index, households that raise chickens would receive a lower weight score than households raising goats. Similarly, households that receive a second remittance in a given time period would have a higher score than those which received only one (Appendix B.1).The details of this index construction are discussed in the *'Operationalizations & Measures'* section of the introductory part of the dissertation.

**Social capital.** The fundamental concept of social capital is that 'social networks have value' that "can affect the productivity of individuals and groups" (Putnam, 2000, p. 18). Although many different definitions exist, a majority of authors define social capital in terms of networks, norms and trust that increases actors' effectiveness in achieving common objectives (Schuller, 2001; Schuller et al., 2000). In the literature several indicators of social capital are commonly discussed, which include the density of social networks, the quality of relationships, and reciprocity (Adler and Kwon, 2002). In this study, the Filmer and Pritchett (2001) PCA based weighting method was extended to estimate an index of social capital that would measure the quality of social relationships and reciprocity within inner circles (spouse, friend, relatives and neighbors) and outer circles (co-workers). First, the respondents answered a set of questions about various types of problems they encounter. These questions covered a broad spectrum of personal, health, child rearing, economic, and other obstacles. Then, respondents were asked to identify individuals and institutions from inner and outer circles who address these problems or suggest that respondents help them to address these problems. Finally, the relative weight of each member from inner and outer circles was estimated using Filmer and Pritchett PCA method and calculated households' social capital scores. Individual weights are summarized in the Appendix B.3.The details of this index construction are discussed in the

*'Operationalizations & Measures'* section of the introductory part of the dissertation.

**Stress.** Literature reports the presence of stress spillover and contagion effects among household members (Margolin et al., 1996; Grzywacz et al., 2002; Bolger et al., 1989). Therefore, it is assumed that selected members of different households could adequately represent household stress level. A modified version of Cohen's 4-item scale of perceived stress was administered to women with know HIV status [HIV- positive (HIV-P) and HIV - negative (HIV-N)]. These women reported their perceived capability to cope with significant changes and their problems and challenges on a five point scale. Cohen et al. (1983) suggest that measures of perceived stress show underlying cognitive processes and, as a result, are good predictors of coping behavior. Previously the validity and reliability of the utilized measures of stress was established in the above sample (see *Ghana: does perceived stress predict diversity of livelihood activities in households with HIV positive and HIV negative mothers?* in this dissertation).

## Analysis

We compared scores on socio-economic statuses, and the social and human capital between households with HIV-positive and -negative women using an analysis of variance (ANOVA) to test the hypothesis of unequal resources in two groups. The scores for the above variables were compared at enrolment/birth, 3/6 months, and 9/12 months. Then, to test hypotheses regarding the relationship among the measure of diversification, stress, socio-economic status, human and social capital, structural equation modeling (SEM) with a multigroup analysis approach was employed using AMOS Graphic/SPSS 17.0. This approach is traditionally viewed as an extension of the general linear model (GML). Marsh and Hocevar (1985); Bollen (1989b), and Kaplan (2000) emphasize that SEM allows for greater flexibility of statistical assumptions, It also has the capability to model relationships between measurement errors, separates direct and mediated effects, and provides alternative measures of construct validity and reliability. In addition, SEM is capable of modeling unobserved constructs with multiple measures and is routinely used for between-group comparisons, one of the foci.

**Interpreting SEM estimates.** The interpretation of the estimates in the fitted model (e.g., squared multiple correlations, factor loadings/paths and $\chi^2$) is relatively straightforward. In the estimate model, the squared multiple correlations and factor loadings (e.g. paths from unobserved factor to its indicators) between explanatory and dependent variables are interpreted as slopes and $R^2$ in multiple regression analysis. They show how successful independent variables are in predicting the dependent variables and the strength of the hypothesized relationships between the independent and dependent variables. The model's factor loadings (also called path coefficients) show how a predictor (independent) variable affects a dependent variable, or in statistical language, how much change occurs in the dependent variable when an independent variable changes by one unit (given that all other variables stay constant).

The $\chi^2$ in the estimated model is a test of model significance. In SEM, a significant $\chi^2$ usually means that model has a poor fit and that an alternative model would better represent the data. Since the value of a $\chi^2$ tends to increase and become significant with the increase of a sample size, researchers developed a set of additional fit indices. In addition to $\chi^2$ statistic researchers often report The Bentler-Bonett normed fit index (NFI), Bollen's relative fit index ( RFI), Bollen's incremental fit index (IFI), the Bentler-Bonett non-normed fit index (NNFI) and the Root Mean Square Error of Approximation (RMSEA). The usual rule of thumb that NFI, RFI, IFI and NNFI $>.95$ and RMSEA $<.05$ indicate good fit of the model.

## Results

### Comparison of socioeconomic characteristics of HIV-P and HIV-N groups

To test the hypotheses regarding resources available to households, ANOVA was conducted and the mean values of socio-economic statuses, and the social and human capital in HIV-P and HIV-N groups compared. The results of the test are summarized in Table 1. Consistent with the initial hypotheses, it was observed that the HIV-N group had significantly higher values of socio-economic status, which was measured as a weighted score of household durables and human capital expressed in terms of the level of educational attainment of the head of the households. For instance, heads of households in HIV-N group are significantly more likely to

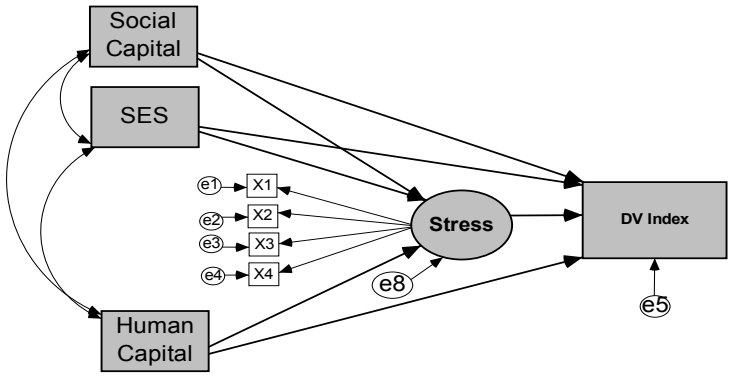
Table 1 Comparison of selected socioeconomic factors in HIV-P & HIV-N groups

| | HIV-Positive | | | HIV-Negative | | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean | Std. Deviation | N | Mean | Std. Deviation | N | *F* | *p.* |
| Social capital (0 mo.) | 32.91 | 18.35 | 133 | 39.26 | 18.79 | 158 | 8.42 | 0.00 |
| Social capital (6 mo.) | 36.64 | 19.79 | 120 | 40.07 | 18.04 | 155 | 2.24 | 0.14 |
| Social capital (9 mo.) | 36.25 | 20.13 | 98 | 38.74 | 19.45 | 152 | 0.95 | 0.33 |
| Socio-Economic Status | 8.59 | 5.93 | 176 | 11.85 | 5.67 | 173 | 27.36 | 0.00 |
| Human Capital | 2.71 | 1.31 | 176 | 3.17 | 1.32 | 173 | 11.06 | 0.00 |
| DV (0 mo.) | 0.40 | 0.23 | 176 | 0.43 | 0.24 | 173 | 2.02 | 0.16 |
| DV (6 mo.) | 0.40 | 0.24 | 122 | 0.45 | 0.24 | 155 | 2.87 | 0.09 |
| DV (12 mo.) | 0.36 | 0.21 | 98 | 0.43 | 0.22 | 154 | 6.56 | 0.01 |

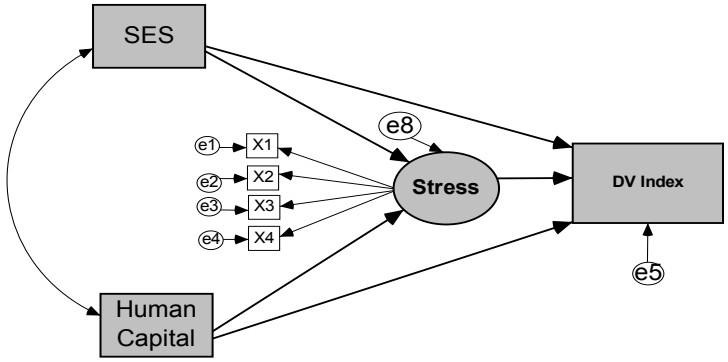
have completed basic education than heads of households in HIV-P group (mean score 3.17 vs. 2.71, F = 11.06, p. <.00) and have more expensive durable goods (mean score 11.85 vs. 8.59, F = 27.36, p. < .00). The ANOVA results provide less evidence in support of the assumption that study groups would also vary in terms of the social capital available to them. Thus, groups differ in social capital scores only at time 0, where the HIV-N group have a significantly higher scores than the HIV-P group (39.26 vs. 32.91, F = 8.42, p. < .00).

**Testing significance of associations between measure of diversification and mediating and moderating factors**

The next step in the analysis of this research data was testing the hypotheses regarding the associations between moderating and mediating variables and measure of diversification. There are two methodological constraints in the research data that could potentially affect the results of this analysis. In the sample there were 58 households for which no social capital data were available due to specificities of data collection protocol. The ANOVA analysis suggest that households for which social capital data is available may differ from those for which such data is unavailable. For instance, although, the analysis indicates that no statistically significant differences exists between groups in regard to their socio-economic status, these groups do




(a) Original Model




(b) Modified Model

Figure 2 SEM models of hypothesized effects of household resources & stress on the diversify of livelihood activities

differ in regards to human capital (mean scores 2.59 vs. 2.99, F = 4.49, p. <.05).

Both that fact that some differences between above groups exist and that sample size decreases if above 58 households excluded from further analysis potentially can bias the parameter estimates in the hypothesized model. Therefore, it was decided to use multi-stage analysis procedures. First, the original hypothesized model was estimated with the sample that excluded 58 above mentioned households. Second, the original model was modified by excluding the social capital variable from the analysis and re-estimated using the complete sample (Figure 2). These models were estimated for the data collected at the enrolment/beginning of the study, at 3/6 months and 9/12 months (Appendixes A.5, A.6, A.7).

Another probable constraint of the data is a possibility of bias in estimates due to seasonal variations in household livelihood behaviors. Diversification literature suggests that seasonal jobs may constitute substantial part of household income generating strategies. For instance, household members may report having temporary farm work during planting and harvesting seasons and report having no work during off seasons. As a result, parameter estimates in models for data collected at the beginning of the study, at 6, and at 12 months may reflect seasonal bias. To address this constraint two additional models were estimated - original and modified - but with the data for stress, social capital and proportion of non-farm activities averaged over 12 months. The new data set included households for which at least two observations were made during the course of the study. The socio-economic status and human capital data remained unchanged, since it was collected only once over the course of this study (Appendixes A.9, A.10, A.11).

Overall, eight models were estimated. The main purpose of the multi-stage hypothesis testing process was to identify consistent patterns of associations between stress, socio-economic status, social and human capitals, and diversification of household activities in estimated models.

**Model fit statistics**

The initial estimate of the models showed that the data lacks multivariate normality. The value of multivariate kurtosis in the models is at least 10 and in some models exceeds 20. Since violation of normality assumptions in SEM may result in over-estimation or underestimation of the parameters the Bollen-Stine p. bootstrap method was used to estimate the significance of models' fit and the percentile and bias corrected percentile bootstrap methods to estimate the significance of model parameters.

The results of the models' fit statistics are summarized in Table 2. The insignificant $\chi^2$ values indicate that all eight models demonstrate good fit. For instance, the $\chi^2$ statistics for modified model, with mean values ($\chi^2 = 28.36$, d.f. $= 26$, Bollen-Stine p. $= .45$), suggest that there is a 45% probability that the model adequately describe the research data. Similarly

Table 2 Causal associations between diversification, stress, social, economic and demographic factors: fit statistics for unconstrained & constrained SEM models

| | $\chi^2$ | *d.f.* | **Bollen-Stine** *p.* | $\Delta\chi^2$ | $\Delta d.f.$ | *p.* | **NFI** | **RFI** | **IFI** | **TLI** | **CFI** | **RMSEA** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Original model** | | | | | | | | | | | | |
| Mean values[a] (U)[b] | 39.19 | 34 | 0.40 | - | - | - | 0.95 | 0.93 | 0.99 | 0.99 | 0.99 | 0.03 |
| Mean values (C)[c] | 43.20 | 41 | 0.51 | 4.01 | 7 | ns | - | - | - | - | - | - |
| 0 months (U) | 37.60 | 32 | 0.30 | - | - | - | 0.95 | 0.91 | 0.99 | 0.99 | 0.99 | 0.03 |
| 0 months (C) | 40.50 | 39 | 0.44 | 2.90 | 7 | ns | - | - | - | - | - | - |
| 6 months (U) | 40.47 | 32 | 0.29 | - | - | - | 0.95 | 0.92 | 0.99 | 0.98 | 0.99 | 0.03 |
| 6 months (C) | 46.50 | 39 | 0.32 | 6.03 | 7 | ns | - | - | - | - | - | - |
| 12 months (U) | 54.30 | 34 | 0.19 | - | - | - | 0.94 | 0.89 | 0.98 | 0.96 | 0.97 | 0.05 |
| 12 months (C) | 61.55 | 41 | 0.20 | 7.25 | 7 | ns | - | - | - | - | - | - |
| **Modified model** | | | | | | | | | | | | |
| Mean values (U) | 28.36 | 26 | 0.45 | - | - | - | 0.97 | 0.95 | 1.00 | 1.00 | 1.00 | 0.02 |
| Mean values (C) | 30.75 | 31 | 0.57 | 2.39 | 5 | ns | - | - | - | - | - | - |
| 0 months (U) | 39.12 | 26 | 0.16 | - | - | - | 0.96 | 0.93 | 0.99 | 0.98 | 0.99 | 0.04 |
| 0 months (C) | 44.88 | 31 | 0.16 | 5.76 | 5 | ns | - | - | - | - | - | - |
| 6 months (U) | 33.21 | 26 | 0.30 | - | - | - | 0.96 | 0.94 | 0.99 | 0.99 | 0.99 | 0.03 |
| 6 months (C) | 39.29 | 31 | 0.26 | 6.08 | 5 | ns | - | - | - | - | - | - |
| 12 months (U) | 39.39 | 28 | 0.38 | - | - | - | 0.95 | 0.93 | 0.99 | 0.98 | 0.99 | 0.04 |
| 12 months (C) | 40.98 | 33 | 0.47 | 1.59 | 5 | ns | - | - | - | - | - | - |

[a]Model with mean of three observations of households' social capital, stress and diversification
[b]Unconstrained model - all causal parameters are freely estimated in HIV-P and HIV-N groups
[c]Constrained model - all causal parameters are set equal in HIV-P and HIV-N groups

other fit indexes corrected for sample size and the number of parameters in the model show that the models are acceptable for testing the research hypotheses. Only one fit index for the original model for data collected at 12 months is below the common cut-off value .90 (RFI = .89) that distinguish good fitting models from poorly fitting models. All other fit statistics for all of the models exceed the above cut-off value with the majority of indexes exceeding the value .95 and with Root Mean Square Error of Approximation (RMSEA) less than .05.

**Parameters estimates**

**Relationships between socio-economic status, social and human capital.** The summary of estimated parameters in the models is presented in Tables 3 and 4. The models suggest that consistently with the theory and the hypotheses households' human capital (HC) and socio-economic status (SES) are positively associated. Moderate correlations were observed between the measures for the variables that are positive and significant in both groups in all models. For instance, in HIV-P group correlations between the above measures in estimated models vary between .30 (p.<.05) and .37 (p. $<$ .05). In HIV-N groups these correlations vary between .30 (p. $<$ .05) and .31 (p. $<$ .05) (Table 4). Contrary to expectations, however, little evidence was found suggesting significant correlations between socio-economic status and social capital and between human and social capital. Significant correlations were observed between the former only in HIV-P group in original model estimated for the data collected at the beginning of the study (r = .20, p. $<$ .05). Also, only two original models estimated for the data collected at 12 months and the data with mean values produced significant correlations between human and social capitals in HIV-N group (r = .17, p. $<$.1 and r = .20, p. $<$ .05 respectively).

**Stress, Socio-economic status, Human & Social Capital vs. Diversification.** Consistent with the hypotheses, the majority of estimated models suggest that positive associations exist between the educational attainment of the head of the household and the measure of diversification in at least one group (Table 3). For instance, the magnitude of unstandardized regression paths between the measures of human capital and diversification

Table 3 Causal associations between diversification, stress, social, economic and demographic factors: parameters estimates in SEM models

| | **Mean Values** | | **0 Months** | | **6 Months** | | **12 Months** | |
|---|---|---|---|---|---|---|---|---|
| | **HIV-P** | **HIV-N** | **HIV-P** | **HIV-N** | **HIV-P** | **HIV-N** | **HIV-P** | **HIV-N** |
| **Original Model** | | | | | | | | |
| ***N*** | ***91*** | ***147*** | ***133*** | ***158*** | ***120*** | ***155*** | ***91*** | ***149*** |
| DV[a] ← HC[b] | .03(.21)[c] */ns[d] | .02(.15) */ns | .02(.13) | .02(.09) | .04(.18) */ns | .01(.07) | .03(.17) | .03(.16) *[e] |
| DV ← SES[f] | -0.00(-0.09) | -.00(-.06) | -.00(-.06) | -.00(-.09) | -.01(-.24) ** | .00(.04) | .00(.00) | -.00(-.10) |
| DV ← Stress | .03(.11) | .02(.05) | -.03(-.14) | -.02(-.08) | -.01(-.03) | .01(.02) | .02(.09) | .01(.02) |
| DV ← SC[g] | .00(.17) | .00(.08) | .00(.05) | .00(.06) | .00(.03) | .00(.12) | .00(.26) ** | -.00(-.06) |
| Stress ← HC | .-07(-.11) | .03(.08) | -.12(-.14) | -.08(-.11) | .00(.00) | .05(.08) | -.01(-.02) | .07(.11) |
| Stress ← SES | -.03(-.21) * | -.02(-.23) ** | -.01(-.03) | -.02(-.13) | -.04(-.21) */ns | -.03(-.20) * | -.01(-.08) | -.01(-.10) |
| Stress ← SC | -.01(-.19) ** | -.01(-.15) */ns | -.01(-.19) ** | -.00(-.03) | -.01( -.14) */ns | -.03(-.20) * | -.00(-.05) | -.00(-.07) |
| **Modified Model** | | | | | | | | |
| ***N*** | ***121*** | ***155*** | ***176*** | ***173*** | ***122*** | ***155*** | ***98*** | ***154*** |
| DV ← HC | .03(.23) ** | .02(.14) ns | .03(.15) */ns | .01(.07) | .04(.21) * | .02(.09) | .03(.15) | .02(13) * |
| DV ← SES | -.01(-.16) | -.00(-.03) | -0.00(-0.09) | -.00(-.05) | -.01(-.26) ** | .00(.04) | -.00(-.02) | -.00(-.06) |
| DV ← Stress | .01(.06) | .02(.06) | -.04(-.22) ** | -.00(-.01) | -.01(-.04) | .00(.01) | 0.03(.11) | 0.01(.05) |
| Stress ← HC | -.05(-.08) | .01(.03) | -.16(-.17) ** | -.08(-.10) | -.03(-.03) | .04(.06) | -.03(-.04) | .05(.07) |
| Stress ← SES | -.02(-.18) */ns | -.02(-.18)** | -.04(-.19) * | -.01(-.08) | -.04(-.19) ** | -.03(-.19) ** | -.02(-.13) | -.01(-.06) |

[a]DV - Diversification index (e.g. proportion of non-farm activities in households' livelihood portfolios)
[b]Human capital - highest level of education of the head of the household
[c]Standardized solutions are given in parentheses
[d]ns - parameter is significant according to one bootstrap method and insignificant according to the other method
[e]* - significant at p.<.1, ** - significant at p.<.05, *** - significant at p. < .01
[f]Socio-economic status index
[g]Social capital index

Table 4 Causal associations between diversification, stress, social, economic and demographic factors: squared multiple correlations and correlations

| | **Mean Values** | | **0 Months** | | **6 Months** | | **12 Months** | |
|---|---|---|---|---|---|---|---|---|
| | HIV-P | HIV-N | HIV-P | HIV-N | HIV-P | HIV-N | HIV-P | HIV-N |
| **Original model** | | | | | | | | |
| **Correlations** | | | | | | | | |
| SES ↔ HC | .36 | .31 | .30 | .31 | .37 | .30 | .36 | .30 |
| SC ↔ SES | 0.06 ns | -0.01 ns | .20 | 0.10 ns | 0.02 ns | 0.00 ns | 0.08 ns | -0.02 ns |
| HC ↔ SC | 0.16 ns | .20 | 0.11 ns | -0.04 ns | 0.15 ns | 0.13 ns | 0.09 ns | .17 * |
| $R^2$ | | | | | | | | |
| Stress | .12 | .06 | .07 | .04 | .06 | .04 | .01 | .02 |
| DV | .08 | .03 | .05 | .02 | .06 | .02 | .11 | .03 |
| **Modified model** | | | | | | | | |
| **Correlations** | | | | | | | | |
| SES ↔ HC | .35 | .30 | .32 | .29 | .35 | .30 | .39 | .30 |
| $R^2$ | | | | | | | | |
| Stress | .06 | .03 | .08 | .02 | .04 | .03 | .02 | .01 |
| DV | .06 | .02 | .08 | .01 | .07 | .01 | .03 | .02 |

[a]All parameters, unless specified otherwise, are significant at at least p. $< .05$ based on percentile and bias corrected bootstrap method

varies between .02 (HIV-N group in modified model at 6 months) and .04 (in HIV-P group in modified model at 6 months). The only exception is found in the original model, at time 0, where no significant associations were observed between human capital and the diversification of livelihood activities. A typical characteristic of the majority of models, estimated at three time points, is that the relationship between human capital and the diversification of livelihood activities are more obvious in the HIV-P group. Except for original and modified models estimated at 12 months, where an insignificant path was observed between HC and proportion of non-farm activities (DV) in HIV-P, relationships between human capital and diversification was found insignificant in the HIV-N group. It is important to note that both groups have significant relationships between human capital and diversification in the original and modified models. Lastly, regarding the relationships between HC and the measure of diversity of household livelihood, certain activities related to significance levels of such relationships. For instance, the estimates suggest that most statistically significant paths between these variables

have at least a p.<.10 level, which is considered marginally significant by many researchers. Also, some parameters were found significant by one bootstrap method, but non-significant by the other bootstrap method; the estimate of the path between HC and proportion of non-farm activities for HIV-P and HIV-N group in the original model with mean values (unstandardized coefficients .03 and .02) significant at p <.1 according to percentile method and insignificant according to bias corrected method.

Contrary to the hypotheses little evidence was found supporting a positive relationship between stress, social capital, socio-economic status and household diversification. An estimate of only one of the original models, at 12 months, suggests that the path between social capital (SC) and proportion of non-farm activities (DV) is significant in the expected direction (unstandardized and standardized coefficients .003 and .26, p. $<$ .05) (Table 3). No other models showed significant relationships between social capital and the measure of diversification. Similarly, there was found little evidence of relationships between socio-economic status and proportion of non-farm activities. Only two models - the original and modified models estimated at six months - identified significant path between SES and the measure of diversification for HIV-P group (unstandardized coefficients -.01, p. $<$ .05). Moreover, the direction of these relations is opposite to what is hypothesized. Finally, only one modified model estimated for the data collected at the beginning of the study has shown significant relationship between stress and the diversity of livelihood activities for the HIV-P group (unstandardized coefficient -.04, p.$<$ .05). Contrary to the hypothesis and consistent with previous research (see *Ghana: does perceived stress predict diversity of livelihood activities in households with HIV positive and HIV negative mothers?* in this dissertation), the effects of stress on the diversification of household livelihood activities are inconclusive.

**Socio-economic status, Human & Social Capital vs. Stress.** The next set of hypotheses concerns moderating effects of socio-economic status, social and human capital on stress. It is hypothesized that the above variables would negatively associate with psychological stress. Consistent with this theory and the hypothesis, the evidence was found of significant and negative relationships between social capital, socio-economic status and stress. Five out

of estimated eight models suggest that an increase in socio-economic status causes the stress levels to decrease. The magnitude of moderation varies, with -.01 for the HIV-N group in the beginning of the study, and -.04 for the HIV-P group in the original model estimated for the data collected at 6 months. There were observed mixed results of the above effects in groups with different HIV status. For instance, only in modified model estimated at the beginning of the study the effects of socio-economic status on stress only manifested in the HIV-P group. In other models, these effects manifested in both groups. In one original model estimated for the data collected at 6 months, the path between SES and the measure of diversification was insignificant for bias corrected bootstrap method. This path was significant in other models either at p.< .1 or p. < .05.

As discussed earlier, only four out of the eight models evaluated the effects of social capital on stress. The estimates suggest that the hypothesized effects were evident in three of these models. The magnitude of these effects varies between -.01 (p. <.1/ns), in original model with mean values, and -.03 (p. < .1) in the HIV-N group in original model estimated for the data collected at 6 months. Only in one model estimated at 12 months did the above effect fail to manifest in either of the groups; only one model that estimated for the data collected at the beginning of the study showed insignificant effect of social capital on stress in HIV-N group.

Contrary to the original hypothesis, little evidence was found of significant relationships between human capital (HC) and stress. Only one modified model estimated for the data collected at the beginning of the study produced significant statistics for the path between HC and Stress in the HIV-P group (unstandardized coefficient -.16, p. <.05).

**Squared multiple correlations** The estimates suggest that explanatory variables in the models explain only a small percentage of variability in stress and the measure of household diversification (Table 4). The squared multiple correlation statistics show that stress, socio-economic status, and social and human capital explain from less than 1% of variance in the proportion of non-farm activities in the modified model estimated for the data collected at 6 months (HIV-N group), to 10.6% in the original model estimated for the data collected at 12 months (HIV-P group). Also socio-economic status and social and human capital explain

Table 5 Causal associations between diversification, stress, social, economic and demographic factors: equivalent causal paths in HIV-P and HIV-N groups

| | **Mean Values** | **0 Months** | **6 Months** | **12 Months** |
|---|---|---|---|---|
| **Original Model**[a] | | | | |
| DV[b] ← HC[c] | 0.02(0.18)[d] ** [e] | 0.02(0.11) | 0.02(0.11) */ns[f] | 0.03(0.16) ** |
| DV ← SC[g] | 0.00(0.12) | 0.00(0.06) | 0.00(0.08) | 0.00(0.08) |
| DV ← SES[h] | 0.00(-0.07) | 0.00(-0.08) | 0.00(-0.08) | 0.00(-0.05) |
| DV ← Stress | 0.02(0.09) | -0.02(-0.12) * | 0.00(0.00) | 0.01(0.06) |
| Stress ← HC | 0.01(0.02) | -0.10(-0.12) ** | 0.04(0.04) | 0.04(0.06) |
| Stress ← SC | -0.01(-0.13) ** | -0.01(-0.09) | -0.01(-0.10) * | 0.00(-0.06) |
| Stress ← SES | -0.02(-0.17) *** | -0.02(-0.08) | -0.03(-0.17) *** | -0.01(-0.08) |
| **Modified Model** | | | | |
| DV ← HC | 0.02(0.18) ** | 0.02(0.12) */ns | 0.03(0.13) * | 0.02(0.14) ** |
| DV ← SES | 0.00(-0.09) | 0.00(-0.07) | 0.00(-0.10) | 0.00(-0.04) |
| DV ← Stress | 0.02(0.07) | -0.03(-0.15) ** | 0.00(-0.02) | 0.02(0.08) |
| Stress ← HC | -0.01(-0.01) | -0.11(-0.12) * | 0.02(0.02) | 0.02(0.03) |
| Stress ← SES | -0.02(-0.15) ** | -0.03(-0.13) ** | -0.03(-0.17) *** | -0.01(-0.08) |

[a] All causal paths in HIV-P and HIV-N groups are set equivalent
[b] DV - Diversification index (e.g. proportion of non-farm activities in households' livelihood portfolios)
[c] Human capital - highest level of education of the head of the household
[d] Standardized solutions are presented in parentheses
[e] * - significant at p.<.1, ** - significant at p.< .05, *** - significant at p. <.01
[f] Parameter is significant according to one bootstrap method and insignificant according to the other method
[g] Social capital index
[h] Socio-economic status index

comparably low amounts of variance in the factor stress. The estimates of squared multiple correlations in the models for these variables are in the range between 1% (in HIV-N group in modified model at 12 months) to 11.7% (in HIV-P group in model with mean values).

The fundamental assumption in this study is that stress, socio-economic status, and social and human capital play important moderating effects on household diversification of livelihood activities. The squared multiple correlation statistics suggest that importance of these variables may be lower than initially hypothesized. Substantively, the small percentage of variance explained by these variables may mean that, in the sample of households, some other factors are more important moderators of stress and diversification behavior.

**Testing for differences in magnitude of associations in HIV-P and HIV-N groups**

Another question of importance is whether the magnitude of observed effects in the models vary across groups. To test the hypotheses regarding the non-equivalent magnitude of causal effects across groups the models were re-estimated with incremental paths between moderating, mediating and dependent variables set across groups. An insignificant increase in $\chi^2$ statistics indicated that the magnitude of effects in both groups is not statistically different or, in terms of SEM, causal paths are invariant. The fit statistics for the best fitting models with invariant paths is presented in Table 2. All estimated models demonstrate good fit to the data. For instance, in the original model with mean values the $\chi^2$ statistics is 43.2 with 41 degrees of freedom and Bollen-Stine p. = .51. The overall increase in $\chi^2$ square over unconstrained model is 3.9 with 7 degrees of freedom, which is insignificant. These results do not support the original hypothesis of non-equivalent magnitude of effects and suggest that all paths in all models are invariant across groups.

Table 5 summarizes parameters estimates for the above best fitting models. As a general rule the estimates demonstrate the following pattern: (a) if estimated parameters were significant in both groups prior to being constrained equal (Table 3), these parameters remain significant. For instance, the causal pathway between human capital and the measure of diversity in the original model with mean values was significant in both groups shown in Table 5 (HIV-P = .03(.21); HIV-N = .02(.15); p. <.1/ns). (b) Some causal paths that were significant only in one group in unconstrained model (Table 3 ) become significant in the constrained model in both groups (Table 5). Thus, the above path is significant in original unconstrained model in HIV-P group at 6 months and in HIV-N group at 12 months. In a constrained model, this path becomes significant for both groups at 6 and 12 months. (c) Some causal paths that were significant in one group in unconstrained model become insignificant in any of the groups in the constrained model. For instance, the causal path between household's socio-economic status and the measure of diversification was significant in the HIV-P group at 6 months in the unconstrained model (-.01(-.24) p. < .05) and became insignificant in both groups in the constrained model. (d) Some of the paths were significant in one group of unconstrained

models became insignificant in the group of constrained models and vice versa. For instance, none of the original unconstrained models produced significant causal paths between human capital and stress. These paths become significant in both groups in the constrained model at 0 months. At the same time, none of the original constrained models produced significant causal paths between socio-economic status and diversity of livelihood activities, while some of the unconstrained models suggest that a significantly negative relationship exists in the HIV-P group at 6 months.

## Discussion

Diversification as an indicator of sustainability of livelihood system has been widely discussed in the literature. The trajectory out of poverty is commonly associated with an increase in non-farm activities in households' livelihood portfolios (Ellis and Freeman, 2004). In the recent study it was found that Eastern Ghana households, with presence of HIV positive women who recently gave birth, demonstrated a significantly lower proportion of remittances and wage employment in the portfolios of livelihood activities that included non-farm activities and livestock rearing and crop production. Moreover, a significant negative trend in diversification of their livelihood activities was observed over the 12 months period (see *Diversity of livelihood activities in households with HIV-positive and HIV-negative mothers in Eastern Ghana* in this dissertation).

Non-farm activities traditionally constitute a substantial share of livelihood portfolios in Ghana. For instance, some 50 to 60 percent of the income of a typical Ghana's household was derived from employment, non-farm based enterprises and remittances (GSS, 2008). The Eastern Region where population for this study was recruited is the third largest recipient of remittances in the country (Mazzucato et al., 2008) and approximately nine out of ten economically active residents in this region are engaged in some form of economic activity to generate cash (GSS, 2005). Therefore, although agriculture production and livestock rearing are still key activities in Ghana, over-reliance on these activities as a single source of livelihoods may negatively affect households' long term wellbeing. Thus, livelihoods research shows that an

increasing share of non-farm activities and increasing complexity of livelihoods are associated with improved wellbeing (Ellis and Allison, 2004). In addition, over-reliance on farm activities may be associated with risks. For instance, approximately one out of five respondents in the RIING research project, whose data is analyzed in this study, reported crop failure or livestock death. In recent years, price fluctuations have negatively affected the agricultural sector in Ghana, disproportionately hurting smaller producers.

This inquiry into the potential influence of psychological stress on the share of non-farm activities also suggests that HIV positive women experience significantly higher levels of psychological stress, and that stress may be negatively associated with the proportion of remittances and employment in the livelihood portfolios of households with HIV-positive women (see *Ghana: does perceived stress predict diversity of livelihood activities in households with HIV positive and HIV negative mothers?* in this dissertation). The objective in this study was to investigate the relationships between socio-economic status, social and human capital, stress and diversification of households' livelihood activities. The question of particular interest has been whether households' socio-economic status and human and social capital interact with stress thus moderating its relationships with diversification behavior; it was also of interest to know whether stress mediates the effects of the mentioned factors on the proportion of non-farm activities in households' livelihood portfolios. Analysis of research data suggests several conclusions.

**Households' resources: is there difference between HIV-P and HIV-N groups?**

The point of departure in this study was the hypothesis that households with HIV positive women have fewer resources available to them. The literature suggests that poverty and low level of education may be associated with higher rates of infection with HIV. It also suggests that the stigma of HIV may result in ostracism and an ultimate shrinkage of social capital. Consistent with previous research, the analysis produced evidence in support of the hypothesis. Indeed HIV-P group in the study is characterized by significantly lower scores on socio-economic status and human capital. When compared to households with HIV-N

women, these households have significantly lower levels of household wealth expressed in terms of durable goods in possession (e.g., radios, TVs, refrigerators, etc.). The quantity and/or associated values of such durable goods tend to be lower in households with HIV-P women (mean score = 8.6 and standard dev. = 5.93, versus mean score = 11.9 and standard dev. = 5.67). Household heads in these households also tend to spend on average fewer years in school (mean = 2.7 and standard dev. = 1.31 versus mean = 3.2 and standard div. = 1.32 in the HIV-P group).

Results concerning the differences between these groups in regard to the available social capital are, however, inconclusive. Social capital in terms of the quality of the social relationships was measured by evaluating and weighting the extent of help provided by spouses, relatives, friends, neighbors and other people and institutions in addressing a broad range of problems. Only at the beginning of the study were significantly lower scores observed for support from relatives, neighbors, and friends in the HIV-P group. There are two possible explanations in the above observation. There is a possibility that the observed phenomenon is the opposite of stigmatization. While stigma is commonly manifested at community level, at household level discovering positive HIV status may initiate a higher level of support among one's close circle of relatives and friends which increased the score on the social capital index at 6 and 12 months. Another possible reason for the above phenomenon may have methodological explanations. As often happens in longitudinal research, some households did not complete the study. The data suggest that the drop in the sample size for HIV-P group is disproportionately larger than in HIV-N group. It is not possible to rule out the possibility that households with most adverse consequences of HIV dropped out the study and biased the estimates. It is possible that the failure to observe differences in the social capital at 6 and 12 months can result from these artifacts of the research data.

**Diversification and socio-economic status, human & social capitals**

The literature suggests that socio-economic status and human and social capitals may be positively associated with diversification behavior. this analysis demonstrates some consistency

with previous research, but the nature, direction and the strength of these effects may be group specific.

Thus, there is strong evidence in the data that years of completed education of the head of the household is an important predictor of the share of remittances and employment in portfolios of household livelihood activities. An increase in the proportion of these non-farm activities in households' livelihood portfolios was observed as the number of years of education for household heads increased. But it appears that education is a stronger predictor of the above relationships in households with the HIV-P members, while it remains inconclusive in the HIV-N group. For instance, six of eight estimated models show significant relationships between human capital and the measure of diversification in the HIV positive group, and only two models show such a relationship exists in the HIV negative group. A legitimate question for further research is whether the above associations are indeed a unique attribute of HIV-P group.

Contrary to the hypothesis, little evidence was found regarding relationships between social capital and diversification. Only one model produced marginally significant positive associations between scores associated with the quality of social capital and proportion of the non-farm activities in households' livelihood portfolios in HIV positive group. These results indicate that although social capital can expand the list of jobs options available to households' members, it is a less important factor in defining intra household livelihood behavior and household diversification strategies.

An interesting finding of this study is the possibility of negative relationships between socio-economic status and households' diversification behavior. Two out of the eight models produced evidence of significant negative associations between weighted indexes of household durable goods that proxy households' wealth (e.g., socioeconomic status) and the proportion of non-farm activities in the HIV positive group. The direction of this relationship is opposite to what was hypothesized. Although one cannot treat such results as conclusive in the context of this study, it must be noted that negative associations between household economic indicators and livelihood diversification were found in previous research. For instance, Reardon

et al. (2000) report a linear negative association between non-farm income and household total income and farm size in Latin America countries. Interestingly enough, the authors interpret such patterns of relationships as evidence of the trajectory that leads to decreased inequality between poor and better off households. They also suggest that the above pattern is not typical in Africa, where high transaction costs and entry barriers restrict income diversification options for the poor. If further research finds more empirical evidence of negative relationships between socio-economic status and diversification behavior in HIV-P groups, it may serve as an indicator of some adaptive strategy among Ghana's economically disadvantaged groups that can potentially benefit their livelihoods system. Also this may suggest that transaction costs for livelihood diversification activities in peri-urban areas of Ghana are not prohibitive for economically disadvantaged groups.

**Stress and households' resources**

Consistent with the hypotheses the results indicate that household socio-economic status (SES) and social capital (SC) moderate stress. Levels of stress in households tend to decline with increasing scores on durable goods in households' possession (e.g. SES) and the proxy index of the quality of relationships social capital. Seven out of eight models demonstrated that such effects are significant. Although two of these models suggest that the moderating effects of SES and social capital on stress were manifested only in the HIV positive group there is a reason to believe that such effects are non group specific.

We found little evidence of a relationship between human capital and stress. Previous research suggests that education may be negatively associated with stress, including jobs stress (Sharit and Salvendy, 1982), parental stress (Koeske and Koeske, 1990) and elderly depressive symptoms (Krause, 1995). The analysis, however, shows that only one model produced evidence of significant negative associations between the educational attainment of household heads and stress in the HIV positive group. The question of theoretical and practical importance in this context is whether human capital indeed is a non-significant contributor in stress reduction for the population or if the lack of observed relationships can be explained by the

study design. Some characteristics of research data may be interpreted in favor of the latter explanation. Thus, in this study households' stress was evaluated by observing the HIV-P and the HIV-N women, while human capital was represented by the education level of heads of households.

**Strength of associations**

The general rule in all of the estimated models is that if a specified causal path significant in both the HIV-P and HIV-N groups, the magnitude of such associations is larger in HIV-P group. Although the consequent test of the equivalency of magnitude of effects in two groups indicated that results should be interpreted conservatively and observed causal effects treated as equivalent across two groups, the possibility of greater magnitude of causal effects in the HIV positive group should not be ruled out. This substantively means that comparable changes in socio-economic status, social and human capitals may lead to either larger rate of increase or decrease in the levels of stress and diversification in HIV-P group. Previous research shows that the wellbeing of HIV affected populations often gradually deteriorates. Their economic resources are depleted and their social networks fall apart due to stigma. The results suggest that negative consequences of the mentioned would be more severe in the HIV-P populations, thus disproportionably increasing the vulnerability of this group. On the other hand, the results also suggest that the pay off of successful interventions may be greater in HIV affected group. This is encouraging news for researchers and field workers.

**Moderating and mediating roles of socioeconomic status, social capital, human capital and Stress**

In previous studies the author of this paper investigated the relationship in stress and diversity of the livelihood activities in Eastern Ghana households (see *Ghana: does perceived stress predict diversity of livelihood activities in households with HIV positive and HIV negative mothers?* in this dissertation). Since no significant associations were found it is hypothesized in this study that interactions may exist between stress and socio-economic status and social and

human capital, the effects of stress on diversification behavior is moderated by these variables. Contrary to the hypotheses, no evidence was found of moderating effects of socio-economic status and social and human capitals. Consistent with previous studies, little evidence is found of significant relationships between stress and the measure of diversification. There is empirical evidence in the literature that stress begins negatively affecting performance only when it reaches a certain threshold (Yerkes and Dodson, 1908; Scott Jr., 1966; Srivastava and Krishna, 1991; Selye, 1975; McGrath, 1976). The possibility exists that in the study sample stress did not reach a level sufficient to alter diversification behavior of household members. There is also no statistically significant evidence obtained that stresses mediates relationships between socio-economic and demographic variables and the proportion of non-farm activities in households' livelihood portfolios.

**Socioeconomic status and social and human capital as explanatory variables for stress and diversification of household livelihood activities**

Regardless of the general pattern of significant relationships that socioeconomic status and social and human capitals have with stress and the proportion of non-farm activities, the overall role of the former as explanatory factors of stress and diversification remains uncertain. The statistically significant predictor variables explain only a small amount of the variation in the measure of diversification (1-10%) and in psychological stress (1-11%). A legitimate question in this regard is whether these results are an artifact of the study design and associated methodological limitations, or the explanatory variables really provide little explanation power in relation to stress and diversification behavior in Ghana's households? Both explanations seem possible.

First, in this study perceived stress is measured in women who recently gave birth to children. This fact suggests that psychological stress in the study reflects stress that is specific to mothers with very young children. Such stress may be less reflective of the cognitive appraisal process that is a function of socioeconomic and demographic characteristics of respondents and imposes methodological limitations on the results. Quite naturally in such a case, the

explanatory variables would be expected to play a lesser role in explaining this type of stress.

Second, the fundamental assumption in the study is that household level resources play a major role in household diversification behavior. Alternatively, one may assume that other factors are as important or even more important for diversification. Thus, Von Braun and Pandya-Lorch (1991) and Ellis (1998) suggest that diversification behavior is reflective of the state of market institutions and infrastructure available to households and may be used to balance risks of possible market failure or to "to reap the attractive return" and thus increase their income (Woldenhannaa and Oskamb, 2001, p. 364). Other studies found that with increase in distance from town and markets, participation in non-farm livelihood activities decreased (Barrett et al., 2001b). It is plausible that external factors such as market institutions, the state of the economy and infrastructure may have an even more profound effect on households' diversification decisions in Eastern Ghana than households' resources available to them.

## Conclusion

The major findings of this study are two fold. On the one hand, the study has shown that households affected by HIV are in a disadvantaged position and may be facing higher risks of poverty. Compared with other households, they tend to have fewer resources, experience higher levels of stress, and tend to have lower scores on diversification of their livelihood activities. Although many of the relationships that were observed in this study are inconclusive, the empirical evidence indicates that both groups have at least comparable magnitudes of effects between factors of interest. In other words, it appears that effects of household wealth, years of schooling of household heads, quality of social relationships and maternal stress on the proportion of non-farm activities in households' livelihood portfolios are comparable in HIV-P and HIV-N groups. However, some evidence suggests the possibility that for some factors the magnitude of effects on diversification behavior may be under-estimated in households with HIV-P mothers. If the latter proved correct in other studies, this means that a comparable decrease in household resources would have greater negative effect on HIV positive populations.

This may mean, conversely, that increased household resources may have greater impacts on the wellbeing of HIV affected populations. This conclusion underscores the importance of programs targeting household livelihoods in programs designed to address problems associated with HIV/AIDS. Such programs should emphasize the development of economic, social and human capitals and stress management interventions.

For instance, since quality of social relationships may be an important stress reducing factor for HIV-positive people, public information and public education campaigns can be developed that target the inner circle and outer circle of social networks (e.g., relatives, friends, co-workers, etc.) of HIV-positive people. The interventions for those in the inner circle can identify assistance and support which can improve the quality of life of HIV-positive members of their families. Campaigns that attempt to change public attitudes towards HIV-positive people can target those in the outer circle of social networks. These interventions can be implemented through existing extension services, community groups, NGOs and the media.

This study suggests that the education is a strong predictor of household diversification behavior. Currently only two in five adults over 15 years of age in Ghana completed middle school and only three in twenty received secondary or higher education (GSS, 2008). Moreover, culturally education for women is viewed as being less important for females than for males (Salm and Falola, 2002b). As a result, females are less likely than males to obtain basic education (e.g. Middle School Leaving Certificate/ Basic Education Certificate Examination) (34% vs. 44%) and only half as likely to receive secondary or higher education diploma (GSS, 2008). Given the fact that education is not only positively associated with household diversification, but also found to be negatively associated with the incidence of HIV, the government of Ghana may want to vigorously pursue policies that encourage education in general and women's education in particular.

Finally, government and non-government development organizations can implement programs aimed at creating additional opportunities for the diversification of livelihood activities - both non-farm and farm based - for households affected by HIV/AIDS. Examples of such programs exist in other countries as well as in Ghana. For instance, in southwestern Uganda,

communities neighboring Bwindi Impenetrable National Park substantially reduced dependence on the park's resource -once the major source of their livelihoods - and increased sustainability of their livelihoods after introduction of improved livestock management practices, new crops, new crafts and new enterprises (Marquardt et al., 1993; FAO, 2005). Likewise, Ghana has successfully implemented a crop diversification strategy that contributed to the poverty reduction. Currently the Eastern Region, where the study took place, is ranked the first among other regions in Ghana which substantially reduced incidence of poverty as a result of successful implementation of public-private sector partnerships (Government of Ghana National Development Planning Commission, 2007).

# SUMMARY OF THE RESEARCH

There is a great deal of interest among development specialists and organizations around the world in understanding livelihoods systems. Neoliberal expectations that large scale modernization programs can address the problem of poverty and that benefits of such programs would 'trickle down' to the economically disadvantaged groups have proven to be overly optimistic. It's not surprising that the development community has turned its attention to peoples' livelihoods for insights on working alternatives. Throughout human history, people have demonstrated an incredible diversity of tools and livelihood strategies that they utilize in order to survive in situations of economic downturn, collapse of government, natural disasters and war. History suggests that people not only have used these tools to survive, but have often improved their wellbeing using household strategies. The latter has particular appeal for development practitioners who look at households as the appropriate level for poverty reduction interventions.

Recently, an interest in people's livelihoods began to emerge in the context of the HIV/AIDS pandemic. The reciprocal links between poverty and HIV/AIDS are well established. The rates of HIV/AIDS are higher in low income countries. Poor people are more likely to contract the virus and, when infected, have fewer resources to deal with the consequences. It is known, for instance, that inadequate nutrition - a common companion of poverty - is one of the contributing factors to declining health in people who are HIV positive and, as a result, experience faster progression of AIDS. Therefore, achieving sustainability of peoples' livelihoods is not only seen as a promising poverty reduction strategy, but also as yet another line of defense against the global HIV/AIDS pandemic.

Livelihoods literature has accumulated an extensive body of empirical evidence which indi-

cates that proper diversification of households' livelihood activities and resources can improve households' wellbeing. Programs and policies are introduced around the world aimed at increasing income generating and livelihood opportunities for economically disadvantaged groups affected by HIV/AIDS. An important question then arises: how one can increase the effectiveness of such policies and programs? Little is known about the effects of HIV on household livelihoods prior to AIDS symptoms developing. Yet this is the stage when interventions may prove to be the most effective: peoples' abilities to engage in productive behavior have not yet been significantly reduced due to declining health, and household resources have not yet been exhausted by growing healthcare needs. On the other hand, contraction of HIV may already have caused individual and household level changes that need to be accommodated in program interventions. Unfortunately, existing research on the consequences of asymptomatic HIV and household livelihoods is rudimentary, since reliable information on HIV status is rarely available to researchers and/or study populations at the time of the study.

The uniqueness of the Research to Improve Infant Nutrition and Growth (RIING) project is that household livelihood data was systematically collected along with clinically confirmed HIV status of respondents. The data collected during this research project provides an excellent opportunity to contribute to the body of empirical knowledge about relationships between asymptomatic HIV and household livelihoods. This dissertation includes three papers that examine relationships between selected individual and household level factors and the diversification of household livelihood activities with HIV positive and HIV negative mothers.

**Overall results.** In this study of livelihood activities among peri-urban households with HIV-P and HIV-N women in Eastern Ghana, the operative assumption was that ''good diversification' can contribute to households' wellbeing. The 'good diversification' in this study means an increase in the proportion of non-farm income generating activities in household livelihood portfolios with a simultaneous increase in productivity of farm based activities. This strategy can both increase sustainability of households' livelihoods and serve an indicator of an 'upward spiral' out of poverty (Ellis and Freeman, 2004).

The overarching goal of this study was to understand which individual and household level

factors affect diversification of livelihood activities in households with HIV positive mothers. The primary focus has been understanding the nature of relationships between HIV status of household members, stress, household socioeconomic status, social and human capital, and the diversity of household livelihood activities. Thus, the questions to be answered were the following: do HIV status and stress affect the diversity of household livelihood activities? Do diversity of livelihood activities and stress change over time? Does change in psychological stress affect change in livelihood diversification? Do higher scores of socioeconomic status, social and human capital predict higher degrees of household livelihood diversification, and does stress mediate these affects? Do the magnitude and direction of effects and patterns of change vary across households with HIV positive and HIV negative mothers?

These hypotheses were tested using panel data for 364 households observed over a 12 month period with approximately 6 month intervals for the three time points in the analysis, using analysis of variance and structural equation modeling (SEM) multigroup and growth curve analysis. Several important conclusions were reached.

First, this study provides solid evidence that households with HIV positive mothers differ from households with HIV negative mothers in terms of available resources, levels of stress and diversification of livelihood activities. Analysis shows that these households have lower scores on durable assets (e.g., a proxy for socioeconomic status); their heads have fewer completed years of schooling (e.g., a proxy for human capital) and women who recently gave birth to a child in these households experience significantly higher levels of stress. These results are consistent with previous research that emphasizes the linkages between poverty and the HIV/AIDS epidemic. Although inconclusive, some additional evidence exists that households with HIV positive mothers may have lower levels of social capital. The analysis of variance test has shown that at the beginning of the study, significantly lower scores were observed on a weighted index of support from relatives, neighbors, and friends in the HIV-P group. No difference, however, was observed during the subsequent observations. Two possible explanations were proposed for these observed patterns. It is possible that discovering one's positive HIV status may initiate higher levels of support from a close circle of relatives and friends and

increase the score on the social capital index at 6 and 12 months. At the same time, the larger community may still stay unaware of one's infection since people with confirmed status had to be AIDS asymptomatic according to sample screening procedures. Thus, it is possible that the effects of stigma were not observed. Another plausible explanation for the above phenomenon is presence of methodological artifacts in the data due to the timing of data collection.

Probably the most impressive results regarding differences between households with HIV positive and HIV negative mothers was observed for diversification of livelihood activities. This study was motivated by the assumption that increased diversification of non-farm activities in household livelihood portfolios is associated with reduced vulnerability to economic shocks and establishes a virtuous cycle out of poverty. It is logical to argue further that the opposite process may increase the risk of poverty for such households. Findings suggest that households with HIV positive mothers not only demonstrate lower absolute values of diversification but, unlike their counterparts, also experience significant negative changes over time. Conversely the share of remittances and wage employment in the overall portfolio (which also included livestock rearing and crop production) was lower among such households and progressively decreased over the course of the study. Wage employment and remittances constitute a significant part of livelihoods in Ghana; as non-farm based activities, they are an important indicator of livelihood diversification and sustainability. Thus, households with HIV negative mothers that lack such income streams may face serious problems in the long run. These households may be moving on the downward path into poverty. This may be even more so for low income HIV-P households, since those households with an initially smaller proportion of non-farm activities experienced a more significant decline in their diversification. Being HIV-P and poor puts households in the category of the most disadvantaged.

Second, this study produced mixed results regarding hypothesized moderating and mediating relationships between psychological stress, socioeconomic status, social and human capital, and diversification of livelihood activities. Consistent with the hypotheses and previous research, human capital apparently is an important predictor of diversification in household livelihood activities. An increased proportion of non-farm activities in household livelihood

portfolios was observed according to increased level of education of the household head. Education is a stronger predictor of diversification in households with a HIV-P mother.

Contrary to expectations, little evidence exists regarding relationships between social capital and diversification and between stress and diversification. No significant role of stress in mediating relationships was observed between household resources and diversification. Yet based on analysis here, one can not rule out such a possibility. An interesting observation was made regarding the possibility of a negative relationship between socioeconomic status and household diversification. Although other researchers observed these associations, this pattern seems to be less common in Africa. Where entry barriers restrict income diversification options for the poor, positive relationships between socioeconomic status and diversification of livelihood actives indicate a problem of inequality of opportunities. In this case, if negative relationships between the above factors are confirmed, observations suggest that transaction costs associated with diversification of activities is less restrictive for economically disadvantaged groups in Ghana. It is, however, important to emphasize here that these results are inconclusive regarding the role of stress, social capital and socioeconomic status for diversification of livelihood activities, and further research is encouraged. Although as a general rule, significant relationships between the above factors were not observed for some tests at selected time periods produced significant results; therefore, one should be reluctant to rule out the possibility of relationships hypothesized in this study.

Although results concerning the relationships between stress and diversification of livelihood activities are inconclusive in this study, stress remains an important factor to consider for livelihoods of HIV affected households. Due to the established links between stress and deteriorating health status of HIV positive people, stress alone if it persists is capable of accelerating the development of AIDS symptoms and eventually contributing to the loss of labor that is essential for diversification of livelihoods. Therefore, it is important to identify and understand the role of stress moderating factors. In this study, evidence is obtained that - consistent with the hypotheses and previous research - household socioeconomic status (SES) and social capital (SC) moderate stress. Levels of stress in households are lower with higher

levels of SES and social capital. Human capital, on the other hand, was not associated with stress. Such effects may not be group specific.

The last finding of this study concerns the limited role of household resources and stress in explaining the diversification of livelihood activities. Similarly, household resources play a limited role in explaining psychological stress. The statistically significant predictor variables explain only a small amount of the variation in the measure of diversification (1-10%) and in psychological stress (1-11%). This lack of explanatory power may be partially attributed to artifacts of the data due to methodological issues. Also, it is very likely that other explanatory factors may play a significant role in moderating stress and the diversification of livelihood activities. For instance, Von Braun and Pandya-Lorch (1991) and Ellis (1998) suggest that diversification reflects the state of market institutions and infrastructure available to households. Some studies found that with an increase in distance from town and markets, participation in non-farm livelihood activities decreased (Barrett et al., 2001b). It is plausible that external factors such as market institutions, the state of the economy and infrastructure may have an even more profound effect on households' diversification decisions in Eastern Ghana than households' resources available to them.

**Programs and policy recommendations** In essence, these findings suggest that without timely and adequate interventions, households with HIV-P mothers in Eastern Ghana may be facing serious challenges in the intermediate and long-term future. Without opportunities to generate adequate livelihoods, they are likely to exhaust their household resources, which may in turn undermine their food security and reduce their capability to resist HIV infection. Inappropriate feeding practices during lactation may contribute to the higher rates of HIV infection among new born children. Yet evidence suggests that poor people may have few options. Therefore, negative effects of HIV on households with new born babies can be even more profound. In the context of the HIV epidemic, the findings suggest that without early strategies which help households affected by HIV to secure their livelihoods and manage stress, the battle against HIV/AIDS may be even more difficult task than assumed.

Possible courses of action may include programs that continue to encourage education

among Ghanaians. Higher level of education may create new economic opportunities. In addition to the need to increase the overall level of education attainment among people, it is particularly important to promote education among females. Traditional culture in Ghana still puts less value on their education. This is why many girls are kept out of school after the first few years. Fewer girls tend to complete basic education and only half as likely to complete high school or post-secondary education. Therefore, change of attitudes towards women's education could be one of the potential areas for policy and programs interventions.

Another promising area for policy and programming activities is creating new and innovative approaches - both farm and non-farm based - for livelihood diversification on the local level. There are many good examples in natural resource management which suggest that innovative opportunities can be successful even in areas with a high incidence of poverty and scarcity of natural resources. Successful examples can be also found in Ghana. Thus, effective implementation of private-public partnerships that created markets for small scale producers and stimulated production of new products has substantially reduced the incidence of poverty in Ghana.

The above strategies are not HIV status specific and can equally target HIV positive and HIV negative groups. The programs that may be particularly useful for HIV positive groups may focus on stress management and stress reduction initiatives.

**Limitations.** The research that is described in this dissertation has several limitations. First, one fundamental assumption of this study is that individual and household level factors explain peoples' livelihood portfolios. The study does not include analysis of relationships between policy and infrastructure and households livelihoods. These factors were found important in other studies. This study analyzes the data collected in one district of Ghana and one category of population - peri-urban. Therefore, the policy and infrastructure are naturally controlled by the study design. Caution should be used when comparing these results with those from similar studies in other areas since regional policy and infrastructural differences may be important contributing factors.

Another limitation of this study is associated with the measures. For instance, three of

the measures that were used in the analysis including stress, HIV status and human capital, were individual level measures, while the analysis is done on the household level. The practice of using individual level variables at household analysis is not unique to this study. However, one should keep in mind that some of the results may be biased due to this approach. Also, this operationalization of diversification is only one of many other available in the literature. It is important to remember that operationalizations are often study specific and need to be carefully considered.

Finally, one of the important limiting factors in this study is its sample. The sample was drawn in a single district through the process of self selection. Some evidence suggests that associations observed in this study are more typical of the southern and central parts of Ghana and less typical of the northern regions. Yet, without a truly random sample, even within southern and central regions, generalizations should be made carefully.

**Future research.** Since many of the relationships examined in this dissertation were inconclusive, further studies are required to receive definitive answers. These studies, however, should take into consideration the above limitations. Thus, future inquiries into the nature of relationships between household level factors, HIV and livelihoods need to be based on probability samples, address the measurement limitations and account for policy and infrastructural contexts. Another potential area for future research relates to the cognitive factor of a household based livelihood model. In this study, the author focused on stress. Yet stress is not the only household level factor that may negatively affect livelihood systems. Depression is another cognitive factor that may be negatively associated with household livelihoods. On the other hand, this model does not test the opposite proposition that cognition may have a positive impact on livelihood systems. For example, people's entrepreneurship may cause them to actively seek new opportunities. These are the factors that are yet to be addressed in future research.

# APPENDIX A. CORRELATION MATRICES

Table A.1 Correlations between measures of diversification at 0, 6 & 12 months

| | **HIV Positive** | | | **HIV Negative** | | |
|---|---|---|---|---|---|---|
| | 0 mo. | 6 mo. | 12 mo. | 0 mo. | 6 mo. | 12 mo. |
| DV index (0 mo.) | 1.00 | | | 1.00 | | |
| DV index (6 mo.) | 0.24 | 1.00 | | 0.42 | 1.00 | |
| DV index (12 mo.) | 0.20 | 0.46 | 1.00 | 0.21 | 0.27 | 1.00 |
| *N* | *101* | *101* | *101* | *150* | *150* | *150* |
| Mean | 0.41 | 0.39 | 0.36 | 0.45 | 0.45 | 0.44 |
| Std. Deviation | 0.22 | 0.24 | 0.21 | 0.24 | 0.23 | 0.22 |

Table A.2 The growth curve analysis of change: correlations between perceived stress & measures of diversification at 0, 6 & 12 months in HIV-P group

| | X1 | X2 | X3 | X4 | X1 | X2 | X3 | X4 | X1 | X2 | X3 | X4 | DV | DV | DV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 mo. | | | | 6 mo. | | | | 12 mo. | | | | (0 mo.) | (6 mo.) | (12 mo.) |
| X1[a] (0 mo.) | 1.00 | | | | | | | | | | | | | | |
| X2 (0 mo.) | 0.82 | 1.00 | | | | | | | | | | | | | |
| X3 (0 mo.) | 0.64 | 0.63 | 1.00 | | | | | | | | | | | | |
| X4 (0 mo.) | 0.60 | 0.59 | 0.74 | 1.00 | | | | | | | | | | | |
| X1 (6 mo.) | 0.34 | 0.32 | 0.26 | 0.24 | 1.00 | | | | | | | | | | |
| X2 (6 mo.) | 0.25 | 0.32 | 0.25 | 0.23 | 0.85 | 1.00 | | | | | | | | | |
| X3 (6 mo.) | 0.25 | 0.23 | 0.26 | 0.27 | 0.79 | 0.73 | 1.00 | | | | | | | | |
| X4 (6 mo.) | 0.29 | 0.25 | 0.22 | 0.26 | 0.85 | 0.77 | 0.79 | 1.00 | | | | | | | |
| X1 (12 mo.) | 0.21 | 0.22 | 0.15 | 0.13 | 0.28 | 0.31 | 0.16 | 0.25 | 1.00 | | | | | | |
| X2 (12 mo.) | 0.26 | 0.30 | 0.26 | 0.16 | 0.28 | 0.23 | 0.19 | 0.31 | 0.71 | 1.00 | | | | | |
| X3 (12 mo.) | 0.24 | 0.18 | 0.17 | 0.19 | 0.21 | 0.26 | 0.12 | 0.22 | 0.77 | 0.63 | 1.00 | | | | |
| X4 (12 mo.) | 0.25 | 0.29 | 0.23 | 0.15 | 0.14 | 0.25 | 0.11 | 0.13 | 0.65 | 0.66 | 0.63 | 1.00 | | | |
| DV[b] (0 mo.) | -0.11 | -0.04 | 0.06 | 0.05 | -0.09 | -0.03 | -0.18 | -0.01 | 0.05 | 0.07 | 0.02 | 0.10 | 1.00 | | |
| DV (6 mo.) | 0.08 | 0.20 | 0.16 | 0.13 | -0.06 | -0.03 | -0.06 | -0.03 | 0.16 | 0.12 | 0.11 | 0.10 | 0.25 | 1.00 | |
| DV (12 mo.) | 0.07 | 0.10 | 0.10 | 0.15 | -0.01 | -0.04 | 0.00 | -0.04 | 0.07 | 0.06 | 0.06 | 0.16 | 0.17 | 0.45 | 1.00 |
| ***N*** | ***101*** | ***101*** | ***101*** | ***101*** | ***101*** | ***101*** | ***101*** | ***101*** | ***101*** | ***101*** | ***101*** | ***101*** | ***101*** | ***101*** | ***101*** |
| Mean | 2.05 | 2.14 | 1.84 | 1.72 | 2.01 | 2.08 | 2.13 | 1.92 | 1.88 | 1.83 | 1.76 | 1.62 | 0.40 | 0.39 | 0.36 |
| Std. Deviation | 1.24 | 1.30 | 1.16 | 1.17 | 1.28 | 1.19 | 1.22 | 1.25 | 1.07 | 0.96 | 1.06 | 0.88 | 0.22 | 0.24 | 0.21 |

[a] $X1 - X4$ - items of perceived stress scale

[b] DV - diversification index (e.g. proportion of non farm activities in household's livelihood portfolios

Table A.3 The growth curve analysis of change: correlations between perceived stress & measures of diversification at 0, 6 & 12 months in HIV-N group

| | X1 | X2 | X3 | X4 | X1 | X2 | X3 | X4 | X1 | X2 | X3 | X4 | DV | DV | DV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 mo. | | | | 6 mo. | | | | 12 mo. | | | | (0 mo.) | (6 mo.) | (12 mo.) |
| X1[a] (0 mo.) | 1.00 | | | | | | | | | | | | | | |
| X2 (0 mo.) | 0.74 | 1.00 | | | | | | | | | | | | | |
| X3 (0 mo.) | 0.57 | 0.51 | 1.00 | | | | | | | | | | | | |
| X4(0 mo.) | 0.58 | 0.63 | 0.65 | 1.00 | | | | | | | | | | | |
| X1 (6 mo.) | 0.04 | 0.00 | 0.04 | 0.08 | 1.00 | | | | | | | | | | |
| X2 (6 mo.) | 0.10 | 0.05 | 0.04 | 0.12 | 0.67 | 1.00 | | | | | | | | | |
| X3 (6 mo.) | 0.00 | 0.09 | 0.00 | 0.06 | 0.60 | 0.69 | 1.00 | | | | | | | | |
| X4 (6 mo.) | 0.00 | 0.06 | 0.02 | 0.06 | 0.61 | 0.69 | 0.82 | 1.00 | | | | | | | |
| X1 (12 mo.) | 0.08 | 0.05 | -0.01 | -0.01 | 0.15 | 0.16 | 0.20 | 0.13 | 1.00 | | | | | | |
| X2 (12 mo.) | 0.15 | 0.12 | -0.05 | 0.01 | 0.05 | 0.05 | 0.19 | 0.10 | 0.78 | 1.00 | | | | | |
| X3 (12 mo.) | 0.10 | 0.05 | -0.05 | -0.05 | 0.01 | 0.05 | 0.09 | 0.01 | 0.74 | 0.81 | 1.00 | | | | |
| X4 (12 mo.) | 0.12 | 0.07 | -0.07 | -0.05 | 0.05 | 0.09 | 0.14 | 0.05 | 0.72 | 0.75 | 0.84 | 1.00 | | | |
| DV[b] (0 mo.) | -0.05 | -0.01 | -0.01 | 0.12 | 0.12 | 0.07 | 0.10 | 0.02 | -0.02 | -0.01 | -0.02 | -0.05 | 1.00 | | |
| DV (6 mo.) | 0.04 | -0.02 | -0.06 | -0.01 | 0.04 | -0.02 | 0.05 | -0.07 | 0.10 | 0.14 | 0.09 | 0.11 | 0.41 | 1.00 | |
| DV (12 mo.) | 0.05 | 0.02 | -0.03 | -0.01 | 0.19 | 0.09 | 0.00 | -0.03 | 0.00 | 0.07 | 0.02 | 0.09 | 0.20 | 0.30 | 1.00 |
| ***N*** | ***150*** | ***150*** | ***150*** | ***150*** | ***150*** | ***150*** | ***150*** | ***150*** | ***150*** | ***150*** | ***150*** | ***150*** | ***150*** | ***150*** | ***150*** |
| Mean | 1.91 | 1.97 | 1.78 | 1.75 | 1.75 | 1.79 | 1.61 | 1.52 | 1.58 | 1.61 | 1.47 | 1.43 | 0.44 | 0.45 | 0.43 |
| Std. Deviation | 1.15 | 1.13 | 1.02 | 1.18 | 1.03 | 1.05 | 0.83 | 0.88 | 0.89 | 0.93 | 0.82 | 0.82 | 0.24 | 0.23 | 0.22 |

[a] $X1 - X4$ - items of perceived stress scale

[b] DV - diversification index (e.g. proportion of non farm activities in household's livelihood portfolios

Table A.4 Cross sectional analysis: correlations between perceived stress & measures of diversification at 0, 6 & 12 months

| | HIV- Positive Group | | | | | HIV- Negative Group | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **0 months**[a] | | | | | | | | | | |
| | X1 | X2 | X3 | X4 | DV | X1 | X2 | X3 | X4 | DV |
| X1 | 1.00 | | | | | 1.00 | | | | |
| X2 | 0.78 | 1.00 | | | | 0.77 | 1.00 | | | |
| X3 | 0.68 | 0.64 | 1.00 | | | 0.58 | 0.50 | 1.00 | | |
| X4 | 0.66 | 0.61 | 0.73 | 1.00 | | 0.58 | 0.60 | 0.60 | 1.00 | |
| DV[b] | -0.23 | -0.20 | -0.04 | -0.09 | 1.00 | -0.02 | 0.01 | 0.02 | 0.12 | 1.00 |
| ***N*** | ***183*** | ***183*** | ***183*** | ***183*** | ***183*** | ***179*** | ***179*** | ***179*** | ***179*** | ***179*** |
| ***Mean*** | ***2.15*** | ***2.20*** | ***1.95*** | ***1.82*** | ***0.39*** | ***1.94*** | ***2.02*** | ***1.80*** | ***1.72*** | ***0.44*** |
| ***Std. Deviation*** | ***1.31*** | ***1.32*** | ***1.18*** | ***1.26*** | ***0.22*** | ***1.19*** | ***1.17*** | ***1.04*** | ***1.15*** | ***0.24*** |
| **6 months**[c] | | | | | | | | | | |
| | X1 | X2 | X3 | X4 | DV | X1 | X2 | X3 | X4 | DV |
| X1 | 1.00 | | | | | 1.00 | | | | |
| X2 | 0.84 | 1.00 | | | | 0.68 | 1.00 | | | |
| X3 | 0.73 | 0.68 | 1.00 | | | 0.62 | 0.71 | 1.00 | | |
| X4 | 0.79 | 0.74 | 0.80 | 1.00 | | 0.62 | 0.69 | 0.82 | 1.00 | |
| DV | 0.01 | 0.04 | -0.05 | -0.02 | 1.00 | 0.02 | -0.03 | 0.03 | -0.07 | 1.00 |
| ***N*** | ***129*** | ***129*** | ***129*** | ***129*** | ***129*** | ***159*** | ***159*** | ***159*** | ***159*** | ***159*** |
| ***Mean*** | ***2.06*** | ***2.12*** | ***2.05*** | ***1.89*** | ***0.39*** | ***1.75*** | ***1.77*** | ***1.60*** | ***1.50*** | ***0.45*** |
| ***Std. Deviation*** | ***1.29*** | ***1.22*** | ***1.21*** | ***1.21*** | ***0.24*** | ***1.02*** | ***1.05*** | ***0.84*** | ***0.87*** | ***0.24*** |
| **12 months**[d] | | | | | | | | | | |
| | X1 | X2 | X3 | X4 | DV | X1 | X2 | X3 | X4 | DV |
| X1 | 1.00 | | | | | 1.00 | | | | |
| X2 | 0.71 | 1.00 | | | | 0.77 | 1.00 | | | |
| X3 | 0.77 | 0.62 | 1.00 | | | 0.74 | 0.81 | 1.00 | | |
| X4 | 0.65 | 0.64 | 0.63 | 1.00 | | 0.71 | 0.75 | 0.84 | 1.00 | |
| DV | 0.07 | 0.05 | 0.06 | 0.16 | 1.00 | 0.02 | 0.07 | 0.03 | 0.08 | 1.00 |
| ***N*** | ***104*** | ***104*** | ***104*** | ***104*** | ***104*** | ***157*** | ***157*** | ***157*** | ***157*** | ***157*** |
| ***Mean*** | ***1.87*** | ***1.84*** | ***1.74*** | ***1.60*** | ***0.36*** | ***1.57*** | ***1.59*** | ***1.46*** | ***1.41*** | ***0.43*** |
| ***Std. Deviation*** | ***1.07*** | ***0.95*** | ***1.05*** | ***0.87*** | ***0.21*** | ***0.89*** | ***0.92*** | ***0.80*** | ***0.81*** | ***0.22*** |

[a]First observation at the beginning of the study
[b]DV - Diversification index (e.g. proportion of non-farm activities in households' livelihood portfolios
[c]Second observation
[d]Third observation

Table A.5 Analysis of causal associations between diversification, stress, social, economic and demographic factors: correlations matrices for original model at the beginning of the study (0 months)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **HIV- Positive** | | | | | | | | |
| X1 | 1.00 | | | | | | | |
| X2 | 0.82 | 1.00 | | | | | | |
| X3 | 0.69 | 0.68 | 1.00 | | | | | |
| X4 | 0.63 | 0.61 | 0.70 | 1.00 | | | | |
| SC | -0.17 | -0.21 | -0.20 | -0.17 | 1.00 | | | |
| SES | -0.07 | -0.10 | -0.12 | -0.15 | 0.20 | 1.00 | | |
| HC | -0.14 | -0.17 | -0.10 | -0.16 | 0.11 | 0.30 | 1.00 | |
| DV[a] | -0.21 | -0.13 | -0.01 | -0.01 | 0.08 | 0.01 | 0.14 | 1.00 |
| ***N*** | ***133*** | ***133*** | ***133*** | ***133*** | ***133*** | ***133*** | ***133*** | ***133*** |
| ***Mean*** | ***1.98*** | ***2.06*** | ***1.83*** | ***1.68*** | ***32.91*** | ***8.76*** | ***2.79*** | ***0.40*** |
| ***Std. Deviation*** | ***1.22*** | ***1.26*** | ***1.08*** | ***1.12*** | ***18.35*** | ***5.83*** | ***1.27*** | ***0.22*** |
| **HIV- Negative** | | | | | | | | |
| X1 | 1.00 | | | | | | | |
| X2 | 0.73 | 1.00 | | | | | | |
| X3 | 0.60 | 0.52 | 1.00 | | | | | |
| X4 | 0.54 | 0.58 | 0.68 | 1.00 | | | | |
| SC | -0.05 | 0.00 | -0.05 | -0.07 | 1.00 | | | |
| SES | -0.14 | -0.18 | 0.00 | -0.10 | 0.10 | 1.00 | | |
| HC | -0.16 | -0.12 | 0.01 | -0.12 | -0.04 | 0.31 | 1.00 | |
| DV | -0.10 | -0.06 | -0.03 | 0.07 | 0.05 | -0.04 | 0.07 | 1.00 |
| ***N*** | ***158*** | ***158*** | ***158*** | ***158*** | ***158*** | ***158*** | ***158*** | ***158*** |
| ***Mean*** | ***1.87*** | ***1.97*** | ***1.78*** | ***1.70*** | ***39.25*** | ***11.71*** | ***3.20*** | ***0.44*** |
| ***Std. Deviation*** | ***1.13*** | ***1.11*** | ***1.02*** | ***1.10*** | ***18.79*** | ***5.66*** | ***1.31*** | ***0.24*** |

[a]DV - Diversification index (e.g. proportion of non-farm activities in households' livelihood portfolios

Table A.6 Analysis of causal associations between diversification, stress, social, economic and demographic factors: correlations matrices for original model at 6 months

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **HIV- Positive** | | | | | | | | |
| X1 | 1.00 | | | | | | | |
| X2 | 0.83 | 1.00 | | | | | | |
| X3 | 0.72 | 0.64 | 1.00 | | | | | |
| X4 | 0.77 | 0.71 | 0.77 | 1.00 | | | | |
| SC[a] | -0.13 | -0.16 | -0.05 | -0.07 | 1.00 | | | |
| SES[b] | -0.16 | -0.19 | -0.22 | -0.23 | 0.02 | 1.00 | | |
| HC[c] | -0.09 | -0.04 | -0.07 | -0.14 | 0.15 | 0.37 | 1.00 | |
| DV[d] | 0.00 | 0.03 | -0.06 | -0.03 | 0.06 | -0.17 | 0.10 | 1.00 |
| ***N*** | ***120*** | ***120*** | ***120*** | ***120*** | ***120*** | ***120*** | ***120*** | ***120*** |
| ***Mean*** | ***2.05*** | ***2.10*** | ***2.02*** | ***1.85*** | ***36.64*** | ***8.77*** | ***2.78*** | ***0.39*** |
| ***Std. Deviation*** | ***1.27*** | ***1.18*** | ***1.17*** | ***1.18*** | ***19.79*** | ***5.81*** | ***1.24*** | ***0.24*** |
| **HIV- Negative** | | | | | | | | |
| X1 | 1.00 | | | | | | | |
| X2 | 0.68 | 1.00 | | | | | | |
| X3 | 0.65 | 0.72 | 1.00 | | | | | |
| X4 | 0.63 | 0.71 | 0.82 | 1.00 | | | | |
| SC | -0.10 | -0.11 | -0.01 | 0.00 | 1.00 | | | |
| SES | -0.13 | -0.18 | -0.14 | -0.11 | 0.00 | 1.00 | | |
| HC | 0.07 | -0.03 | 0.03 | -0.06 | 0.13 | 0.30 | 1.00 | |
| DV | 0.04 | -0.01 | 0.04 | -0.07 | 0.12 | 0.06 | 0.10 | 1.00 |
| ***N*** | ***155*** | ***155*** | ***155*** | ***155*** | ***155*** | ***155*** | ***155*** | ***155*** |
| ***Mean*** | ***1.74*** | ***1.76*** | ***1.61*** | ***1.51*** | ***40.07*** | ***11.73*** | ***3.19*** | ***0.45*** |
| ***Std. Deviation*** | ***1.00*** | ***1.04*** | ***0.85*** | ***0.88*** | ***18.05*** | ***5.68*** | ***1.29*** | ***0.24*** |

[a]Social capital index

[b]Socio-economic status index

[c]Human capital - highest level of education of the head of the household

[d]DV - Diversification index (e.g. proportion of non-farm activities in households' livelihood portfolios

Table A.7 Analysis of causal associations between diversification, stress, social, economic and demographic factors: correlations matrices for original model at 12 months

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **HIV- Positive** | | | | | | | | |
| X1 | 1.00 | | | | | | | |
| X2 | 0.73 | 1.00 | | | | | | |
| X3 | 0.84 | 0.65 | 1.00 | | | | | |
| X4 | 0.69 | 0.70 | 0.68 | 1.00 | | | | |
| SC[a] | -0.03 | -0.17 | 0.01 | -0.04 | 1.00 | | | |
| SES[b] | -0.09 | -0.06 | -0.10 | -0.03 | 0.08 | 1.00 | | |
| HC[c] | -0.05 | -0.04 | -0.06 | -0.01 | 0.09 | 0.36 | 1.00 | |
| DV[d] | 0.07 | 0.04 | 0.00 | 0.14 | 0.27 | 0.08 | 0.19 | 1.00 |
| ***N*** | ***91*** | ***91*** | ***91*** | ***91*** | ***91*** | ***91*** | ***91*** | ***91*** |
| ***Mean*** | ***1.82*** | ***1.82*** | ***1.67*** | ***1.62*** | ***36.18*** | ***8.52*** | ***2.85*** | ***0.36*** |
| ***Std. Deviation*** | ***1.08*** | ***0.95*** | ***0.96*** | ***0.90*** | ***20.09*** | ***5.26*** | ***1.26*** | ***0.21*** |
| **HIV- Negative** | | | | | | | | |
| X1 | 1.00 | | | | | | | |
| X2 | 0.75 | 1.00 | | | | | | |
| X3 | 0.75 | 0.81 | 1.00 | | | | | |
| X4 | 0.72 | 0.76 | 0.84 | 1.00 | | | | |
| SC | -0.07 | -0.04 | 0.01 | -0.13 | 1.00 | | | |
| SES | -0.05 | -0.03 | -0.05 | -0.09 | -0.02 | 1.00 | | |
| HC | -0.01 | 0.07 | 0.08 | 0.07 | 0.17 | 0.30 | 1.00 | |
| DV | 0.00 | 0.05 | 0.02 | 0.08 | -0.03 | -0.05 | 0.12 | 1.00 |
| ***N*** | ***149*** | ***149*** | ***149*** | ***149*** | ***149*** | ***149*** | ***149*** | ***149*** |
| ***Mean*** | ***1.57*** | ***1.59*** | ***1.46*** | ***1.41*** | ***39.09*** | ***11.73*** | ***3.23*** | ***0.43*** |
| ***Std. Deviation*** | ***0.88*** | ***0.92*** | ***0.82*** | ***0.81*** | ***19.40*** | ***5.70*** | ***1.27*** | ***0.22*** |

[a]Social capital index

[b]Socio-economic status index

[c]Human capital - highest level of education of the head of the household

[d]DV - Diversification index (e.g. proportion of non-farm activities in households' livelihood portfolios

Table A.8 Analysis of causal associations between diversification, stress, social, economic and demographic factors: correlations matrices for original model with data averaged over the 12 month period (mean values)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **HIV- Positive** | | | | | | | | |
| X1 | 1.00 | | | | | | | |
| X2 | 0.84 | 1.00 | | | | | | |
| X3 | 0.80 | 0.79 | 1.00 | | | | | |
| X4 | 0.78 | 0.82 | 0.82 | 1.00 | | | | |
| SC[a] | -0.19 | -0.24 | -0.20 | -0.15 | 1.00 | | | |
| SES[b] | -0.21 | -0.21 | -0.28 | -0.24 | 0.06 | 1.00 | | |
| HC[c] | -0.23 | -0.19 | -0.16 | -0.18 | 0.16 | 0.36 | 1.00 | |
| DV[d] | 0.02 | 0.06 | 0.03 | 0.09 | 0.17 | -0.04 | 0.18 | 1.00 |
| ***N*** | ***91*** | ***91*** | ***91*** | ***91*** | ***91*** | ***91*** | ***91*** | ***91*** |
| ***Mean*** | ***1.94*** | ***1.98*** | ***1.88*** | ***1.71*** | ***36.84*** | ***8.52*** | ***2.85*** | ***0.39*** |
| ***Std. Deviation*** | ***0.87*** | ***0.83*** | ***0.76*** | ***0.74*** | ***16.84*** | ***5.26*** | ***1.26*** | ***0.16*** |
| **HIV- Negative** | | | | | | | | |
| X1 | 1.00 | | | | | | | |
| X2 | 0.76 | 1.00 | | | | | | |
| X3 | 0.71 | 0.73 | 1.00 | | | | | |
| X4 | 0.69 | 0.75 | 0.77 | 1.00 | | | | |
| SC | -0.12 | -0.07 | -0.14 | -0.13 | 1.00 | | | |
| SES | -0.19 | -0.22 | -0.11 | -0.18 | -0.01 | 1.00 | | |
| HC | -0.04 | -0.05 | 0.08 | -0.07 | 0.20 | 0.31 | 1.00 | |
| DV | 0.09 | 0.05 | 0.02 | 0.03 | 0.10 | -0.02 | 0.15 | 1.00 |
| ***N*** | ***147*** | ***147*** | ***147*** | ***147*** | ***147*** | ***147*** | ***147*** | ***147*** |
| ***Mean*** | ***1.72*** | ***1.76*** | ***1.62*** | ***1.54*** | ***39.73*** | ***11.77*** | ***3.23*** | ***0.44*** |
| ***Std. Deviation*** | ***0.62*** | ***0.63*** | ***0.53*** | ***0.57*** | ***15.90*** | ***5.71*** | ***1.28*** | ***0.17*** |

[a]Social capital index

[b]Socio-economic status index

[c]Human capital - highest level of education of the head of the household

[d]DV - Diversification index (e.g. proportion of non-farm activities in households' livelihood portfolios

Table A.9 Analysis of causal associations between diversification, stress, social, economic and demographic factors: correlations matrices for modified model at the beginning of the study (0 months)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **HIV- Positive** | | | | | | | |
| X1 | 1.00 | | | | | | |
| X2 | 0.78 | 1.00 | | | | | |
| X3 | 0.69 | 0.67 | 1.00 | | | | |
| X4 | 0.65 | 0.60 | 0.73 | 1.00 | | | |
| SES[a] | -0.22 | -0.17 | -0.25 | -0.22 | 1.00 | | |
| HC[b] | -0.21 | -0.20 | -0.16 | -0.15 | 0.32 | 1.00 | |
| DV[c] | -0.24 | -0.22 | -0.05 | -0.10 | 0.01 | 0.17 | 1.00 |
| ***N*** | ***176*** | ***176*** | ***176*** | ***176*** | ***176*** | ***176*** | ***176*** |
| ***Mean*** | ***2.11*** | ***2.15*** | ***1.94*** | ***1.78*** | ***8.59*** | ***2.70*** | ***0.40*** |
| ***Std. Deviation*** | ***1.33*** | ***1.32*** | ***1.19*** | ***1.25*** | ***5.93*** | ***1.31*** | ***0.22*** |
| **HIV- Negative** | | | | | | | |
| X1 | 1.00 | | | | | | |
| X2 | 0.74 | 1.00 | | | | | |
| X3 | 0.64 | 0.54 | 1.00 | | | | |
| X4 | 0.54 | 0.56 | 0.66 | 1.00 | | | |
| SES | -0.09 | -0.14 | 0.04 | -0.07 | 1.00 | | |
| HC | -0.14 | -0.10 | 0.04 | -0.10 | 0.29 | 1.00 | |
| DV | -0.04 | -0.01 | 0.02 | 0.10 | -0.02 | 0.06 | 1.00 |
| ***N*** | ***173*** | ***173*** | ***173*** | ***173*** | ***173*** | ***173*** | ***173*** |
| ***Mean*** | ***1.90*** | ***1.98*** | ***1.80*** | ***1.68*** | ***11.84*** | ***3.17*** | ***0.43*** |
| ***Std. Deviation*** | ***1.14*** | ***1.13*** | ***1.04*** | ***1.08*** | ***5.68*** | ***1.32*** | ***0.24*** |

[a]Socio-economic status index

[b]Human capital - highest level of education of the head of the household

[c]DV - Diversification index (e.g. proportion of non-farm activities in households' livelihood portfolios

Table A.10 Analysis of causal associations between diversification, stress, social, economic and demographic factors: correlations matrices for modified model at 6 months

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **HIV- Positive** | | | | | | | |
| X1 | 1.00 | | | | | | |
| X2 | 0.84 | 1.00 | | | | | |
| X3 | 0.72 | 0.65 | 1.00 | | | | |
| X4 | 0.77 | 0.72 | 0.77 | 1.00 | | | |
| SES[a] | -0.16 | -0.18 | -0.22 | -0.23 | 1.00 | | |
| HC[b] | -0.10 | -0.05 | -0.07 | -0.15 | 0.35 | 1.00 | |
| DV[c] | -0.01 | 0.02 | -0.06 | -0.04 | -0.18 | 0.12 | 1.00 |
| ***N*** | ***122*** | ***122*** | ***122*** | ***122*** | ***122*** | ***122*** | ***122*** |
| ***Mean*** | ***2*** | ***2*** | ***2*** | ***2*** | ***9*** | ***3*** | ***0*** |
| ***Std. Deviation*** | ***1.26*** | ***1.17*** | ***1.17*** | ***1.17*** | ***5.80*** | ***1.24*** | ***0.24*** |
| **HIV- Negative** | | | | | | | |
| X1 | 1.00 | | | | | | |
| X2 | 0.68 | 1.00 | | | | | |
| X3 | 0.65 | 0.72 | 1.00 | | | | |
| X4 | 0.63 | 0.71 | 0.82 | 1.00 | | | |
| SES | -0.13 | -0.18 | -0.14 | -0.11 | 1.00 | | |
| HC | 0.07 | -0.03 | 0.03 | -0.06 | 0.30 | 1.00 | |
| DV | 0.04 | -0.01 | 0.04 | -0.07 | 0.06 | 0.10 | 1.00 |
| ***N*** | ***155*** | ***155*** | ***155*** | ***155*** | ***155*** | ***155*** | ***155*** |
| ***Mean*** | ***1.74*** | ***1.76*** | ***1.61*** | ***1.51*** | ***11.73*** | ***3.19*** | ***0.45*** |
| ***Std. Deviation*** | ***1.00*** | ***1.04*** | ***0.85*** | ***0.88*** | ***5.68*** | ***1.29*** | ***0.24*** |

[a]Socio-economic status index

[b]Human capital - highest level of education of the head of the household

[c]DV - Diversification index (e.g. proportion of non-farm activities in households' livelihood portfolios

Table A.11 Analysis of causal associations between diversification, stress, social, economic and demographic factors: correlations matrices for modified model at 12 months

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **HIV- Positive** | | | | | | | |
| X1 | 1.00 | | | | | | |
| X2 | 0.73 | 1.00 | | | | | |
| X3 | 0.82 | 0.65 | 1.00 | | | | |
| X4 | 0.69 | 0.66 | 0.65 | 1.00 | | | |
| SES[a] | -0.12 | -0.12 | -0.16 | -0.06 | 1.00 | | |
| HC[b] | -0.07 | -0.07 | -0.10 | -0.04 | 0.39 | 1.00 | |
| DV[c] | 0.09 | 0.06 | 0.03 | 0.16 | 0.02 | 0.14 | 1.00 |
| ***N*** | ***98*** | ***98*** | ***98*** | ***98*** | ***98*** | ***98*** | ***98*** |
| ***Mean*** | ***1.83*** | ***1.84*** | ***1.72*** | ***1.61*** | ***8.55*** | ***2.86*** | ***0.36*** |
| ***Std. Deviation*** | ***1.07*** | ***0.96*** | ***1.02*** | ***0.89*** | ***5.23*** | ***1.24*** | ***0.21*** |
| **HIV- Negative** | | | | | | | |
| X1 | 1.00 | | | | | | |
| X2 | 0.76 | 1.00 | | | | | |
| X3 | 0.74 | 0.81 | 1.00 | | | | |
| X4 | 0.71 | 0.76 | 0.84 | 1.00 | | | |
| SES | -0.02 | 0.00 | -0.04 | -0.08 | 1.00 | | |
| HC | -0.02 | 0.04 | 0.07 | 0.06 | 0.30 | 1.00 | |
| DV | 0.03 | 0.07 | 0.03 | 0.09 | -0.02 | 0.12 | 1.00 |
| ***N*** | ***154*** | ***154*** | ***154*** | ***154*** | ***154*** | ***154*** | ***154*** |
| ***Mean*** | ***1.57*** | ***1.60*** | ***1.46*** | ***1.41*** | ***11.67*** | ***3.19*** | ***0.43*** |
| ***Std. Deviation*** | ***0.89*** | ***0.93*** | ***0.81*** | ***0.81*** | ***5.70*** | ***1.29*** | ***0.22*** |

[a]Socio-economic status index

[b]Human capital - highest level of education of the head of the household

[c]DV - Diversification index (e.g. proportion of non-farm activities in households' livelihood portfolios

Table A.12 Analysis of causal associations between diversification, stress, social, economic and demographic factors: correlations matrices for modified model with data averaged over 12 month period (mean values)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **HIV- Positive** | | | | | | | |
| X1 | 1.00 | | | | | | |
| X2 | 0.84 | 1.00 | | | | | |
| X3 | 0.77 | 0.72 | 1.00 | | | | |
| X4 | 0.75 | 0.74 | 0.83 | 1.00 | | | |
| SES[a] | -0.16 | -0.19 | -0.25 | -0.21 | 1.00 | | |
| HC[b] | -0.13 | -0.13 | -0.13 | -0.12 | 0.35 | 1.00 | |
| DV[c] | 0.03 | 0.07 | 0.04 | 0.12 | -0.09 | 0.16 | 1.00 |
| ***N*** | ***121*** | ***121*** | ***121*** | ***121*** | ***121*** | ***121*** | ***121*** |
| ***Mean*** | ***1.96*** | ***2.02*** | ***1.86*** | ***1.71*** | ***8.71*** | ***2.81*** | ***0.39*** |
| ***Std. Deviation*** | ***0.86*** | ***0.85*** | ***0.74*** | ***0.71*** | ***5.83*** | ***1.24*** | ***0.17*** |
| **HIV- Negative** | | | | | | | |
| X1 | 1.00 | | | | | | |
| X2 | 0.76 | 1.00 | | | | | |
| X3 | 0.71 | 0.73 | 1.00 | | | | |
| X4 | 0.67 | 0.72 | 0.76 | 1.00 | | | |
| SES | -0.14 | -0.19 | -0.08 | -0.16 | 1.00 | | |
| HC | -0.04 | -0.04 | 0.08 | -0.07 | 0.30 | 1.00 | |
| DV | 0.10 | 0.05 | 0.00 | 0.01 | 0.00 | 0.13 | 1.00 |
| ***N*** | ***155*** | ***155*** | ***155*** | ***155*** | ***155*** | ***155*** | ***155*** |
| ***Mean*** | ***1.73*** | ***1.77*** | ***1.63*** | ***1.54*** | ***11.73*** | ***3.19*** | ***0.44*** |
| ***Std. Deviation*** | ***0.62*** | ***0.64*** | ***0.52*** | ***0.56*** | ***5.68*** | ***1.29*** | ***0.18*** |

[a]Socio-economic status index

[b]Human capital - highest level of education of the head of the household

[c]DV - Diversification index (e.g. proportion of non-farm activities in households' livelihood portfolios

# APPENDIX B. PRINCIPAL COMPONENT ANALYSIS WEIGHTS

Table B.1 Diversification index: PCA based item specific weights

| | Mean | Std. Deviation | 1*st* PCA | PCA Weight (1*st* PCA/std. div.) |
|---|---|---|---|---|
| **Agricultural Produce** | | | | |
| Maize | 0.14 | 0.34 | 0.53 | 1.55 |
| Cassava | 0.07 | 0.25 | 0.62 | 2.46 |
| Cocoyam | 0.02 | 0.13 | 0.64 | 5.05 |
| Sweet potato | 0.00 | 0.06 | 0.50 | 8.19 |
| Yam | 0.02 | 0.13 | 0.67 | 5.17 |
| Plantain | 0.03 | 0.17 | 0.49 | 2.86 |
| Mango | 0.01 | 0.09 | 0.50 | 5.73 |
| Pineapple | 0.00 | 0.06 | 0.50 | 8.85 |
| Watermelons | 0.00 | 0.05 | 0.33 | 6.27 |
| Beans | 0.01 | 0.10 | 0.44 | 4.60 |
| Okra | 0.02 | 0.14 | 0.57 | 4.09 |
| Eggplant | 0.01 | 0.09 | 0.61 | 7.17 |
| Pepper | 0.02 | 0.15 | 0.68 | 4.61 |
| Tomato | 0.01 | 0.11 | 0.73 | 6.63 |
| **Livestock** | | | | |
| Chicken | 0.28 | 0.45 | 0.71 | 1.57 |
| Goat | 0.16 | 0.37 | 0.73 | 1.98 |
| Sheep | 0.04 | 0.19 | 0.57 | 3.10 |
| Pigs | 0.02 | 0.12 | 0.44 | 3.54 |
| Cattle | 0.01 | 0.10 | 0.16 | 1.64 |
| Other (snails) | 0.05 | 0.21 | 0.54 | 2.52 |
| **Number of Remittances**[a] | | | | |
| One | 0.48 | 0.50 | 0.76 | 1.52 |
| Two | 0.22 | 0.41 | 0.89 | 2.15 |
| Three | 0.08 | 0.28 | 0.77 | 2.79 |

[a]Number of remittances received by households in preceding time period

Table B.2 Socioeconomic status index: PCA weights for household's durable goods

| | Mean | Std. Deviation | 1*st* PCA | PCA Weight (1*st* PCA/std. div.) |
|---|---|---|---|---|
| **Durable goods** | | | | |
| Sewing machine | 0.44 | 0.50 | 0.20 | 0.41 |
| Table | 0.89 | 0.32 | 0.13 | 0.42 |
| Kente cloth/Wax | 0.74 | 0.44 | 0.19 | 0.42 |
| Kerosene stove/burner | 0.11 | 0.32 | 0.25 | 0.78 |
| Pyrex bowls/Glass utensils | 0.51 | 0.50 | 0.40 | 0.80 |
| Dresser | 0.27 | 0.45 | 0.39 | 0.88 |
| Aluminium utensils | 0.66 | 0.47 | 0.43 | 0.90 |
| Bicycle | 0.19 | 0.40 | 0.38 | 0.96 |
| Pick-up truck | 0.01 | 0.09 | 0.10 | 1.15 |
| Pressing iron | 0.63 | 0.48 | 0.57 | 1.18 |
| Coal pot | 0.23 | 0.42 | 0.49 | 1.18 |
| Radio | 0.76 | 0.43 | 0.51 | 1.19 |
| Freezer | 0.16 | 0.37 | 0.45 | 1.24 |
| Bed | 0.95 | 0.22 | 0.28 | 1.28 |
| Telephone/Mobile phone | 0.44 | 0.50 | 0.64 | 1.30 |
| VCR | 0.26 | 0.44 | 0.58 | 1.32 |
| Fan | 0.66 | 0.47 | 0.63 | 1.33 |
| Gas stove | 0.26 | 0.44 | 0.59 | 1.33 |
| Fridge | 0.36 | 0.48 | 0.66 | 1.37 |
| Car | 0.09 | 0.28 | 0.39 | 1.37 |
| Electric kettle | 0.05 | 0.22 | 0.30 | 1.38 |
| CD Player | 0.24 | 0.42 | 0.60 | 1.40 |
| TV | 0.54 | 0.50 | 0.71 | 1.43 |
| DVD Player | 0.23 | 0.42 | 0.61 | 1.46 |
| Motorcycle | 0.03 | 0.16 | 0.25 | 1.53 |
| Blender | 0.10 | 0.30 | 0.48 | 1.57 |
| Electricity stove | 0.05 | 0.21 | 0.36 | 1.71 |
| Car batteries | 0.05 | 0.21 | 0.37 | 1.74 |
| Air conditioner | 0.01 | 0.11 | 0.21 | 1.89 |
| Generator | 0.01 | 0.07 | 0.14 | 1.93 |
| Hot plate | 0.01 | 0.12 | 0.25 | 2.05 |

Table B.3 Social capital index: PCA weights for individual items

| | Mean | Std. Deviation | 1*st* PCA | PCA Weight (1*st* PCA/std. div.) |
|---|---|---|---|---|
| **Spouse** | | | | |
| Helps with major personal problems | 0.85 | 0.35 | 0.20 | 0.56 |
| Helps when there are problems obtaining food | 0.86 | 0.34 | 0.06 | 0.17 |
| Helps when there are problems obtaining clothing | 0.84 | 0.37 | 0.04 | 0.12 |
| Helps when there is general money problem | 0.87 | 0.33 | -0.03 | -0.08 |
| Helps completing the house chores | 0.51 | 0.50 | 0.46 | 0.92 |
| Helps caring for the young children | 0.79 | 0.41 | 0.31 | 0.76 |
| Give advice for preventing illness in an infant or a respondent | 0.78 | 0.42 | 0.48 | 1.15 |
| Looking after a family member when respondent is away | 0.70 | 0.46 | 0.48 | 1.04 |
| Telling a respondent that she did something well | 0.83 | 0.38 | 0.52 | 1.38 |
| Giving a respondent information to help her to understand a situation she is in | 0.77 | 0.42 | 0.59 | 1.41 |
| Provides a respondent with transportation | 0.84 | 0.37 | 0.12 | 0.32 |
| Loans or gives a respondent something she needs | 0.70 | 0.46 | 0.60 | 1.31 |
| Says things that make situation clearer and easier to understand | 0.79 | 0.41 | 0.54 | 1.32 |
| Let a respondent know that he/she will always be around if assistance is needed | 0.79 | 0.41 | 0.47 | 1.15 |

Table B.3 (Continued)

| | Mean | Std. Deviation | 1*st* PCA | PCA Weight (1*st* PCA/std. div.) |
|---|---|---|---|---|
| **Relatives in the house** | | | | |
| Helps with major personal problems | 0.55 | 0.50 | 0.21 | 0.42 |
| Helps when there are problems obtaining food | 0.52 | 0.50 | 0.24 | 0.49 |
| Helps when there are problems obtaining clothing | 0.36 | 0.48 | 0.46 | 0.96 |
| Helps when there is general money problem | 0.43 | 0.50 | 0.35 | 0.71 |
| Helps completing the house chores | 0.74 | 0.44 | 0.12 | 0.27 |
| Helps caring for the young children | 0.69 | 0.46 | 0.07 | 0.15 |
| Give advice for preventing illness in an infant or a respondent | 0.59 | 0.49 | 0.23 | 0.46 |
| Looking after a family member when respondent is away | 0.76 | 0.43 | -0.12 | -0.28 |
| Telling a respondent that she did something well | 0.75 | 0.44 | 0.27 | 0.63 |
| Giving a respondent information to help her to understand a situation she is in | 0.63 | 0.48 | 0.29 | 0.61 |
| Provides a respondent with transportation | 0.44 | 0.50 | 0.44 | 0.88 |
| Loans or gives a respondent something she needs | 0.54 | 0.50 | 0.33 | 0.66 |
| Says things that make situation clearer and easier to understand | 0.62 | 0.49 | 0.27 | 0.56 |
| Lett a respondent know that he/she will always be around if assistance is needed | 0.55 | 0.50 | 0.47 | 0.95 |

Table B.3 (Continued)

| | Mean | Std. Deviation | 1*st* PCA | PCA Weight (1*st* PCA/std. div.) |
|---|---|---|---|---|
| **Relatives outside the house** | | | | |
| Helps with major personal problems | 0.60 | 0.49 | 0.53 | 1.09 |
| Helps when there are problems obtaining food | 0.47 | 0.50 | 0.56 | 1.11 |
| Helps when there are problems obtaining clothing | 0.34 | 0.48 | 0.56 | 1.19 |
| Helps when there is general money problem | 0.46 | 0.50 | 0.55 | 1.11 |
| Helps completing the house chores | 0.24 | 0.43 | 0.66 | 1.55 |
| Helps caring for the young children | 0.42 | 0.49 | 0.63 | 1.28 |
| Give advice for preventing illness in an infant or a respondent | 0.55 | 0.50 | 0.65 | 1.31 |
| Looking after a family member when respondent is away | 0.41 | 0.49 | 0.57 | 1.16 |
| Telling a respondent that she did something well | 0.66 | 0.47 | 0.69 | 1.45 |
| Giving a respondent information to help her to understand a situation she is in | 0.59 | 0.49 | 0.67 | 1.35 |
| Provides a respondent with transportation | 0.40 | 0.49 | 0.63 | 1.29 |
| Loans or gives a respondent something she needs | 0.49 | 0.50 | 0.66 | 1.32 |
| Says things that make situation clearer and easier to understand | 0.60 | 0.49 | 0.63 | 1.28 |
| Lett a respondent know that he/she will always be around if assistance is needed | 0.54 | 0.50 | 0.68 | 1.36 |

Table B.3 (Continued)

| | Mean | Std. Deviation | 1*st* PCA | PCA Weight (1*st* PCA/std. div.) |
|---|---|---|---|---|
| **Friends** | | | | |
| Helps with major personal problems | 0.47 | 0.50 | 0.73 | 1.47 |
| Helps when there are problems obtaining food | 0.27 | 0.44 | 0.78 | 1.76 |
| Helps when there are problems obtaining clothing | 0.15 | 0.36 | 0.79 | 2.21 |
| Helps when there is general money problem | 0.26 | 0.44 | 0.78 | 1.78 |
| Helps completing the house chores | 0.22 | 0.42 | 0.78 | 1.88 |
| Helps caring for the young children | 0.30 | 0.46 | 0.80 | 1.74 |
| Give advice for preventing illness in an infant or a respondent | 0.45 | 0.50 | 0.77 | 1.54 |
| Looking after a family member when respondent is away | 0.30 | 0.46 | 0.72 | 1.58 |
| Telling a respondent that she did something well | 0.65 | 0.48 | 0.73 | 1.53 |
| Giving a respondent information to help her to understand a situation she is in | 0.57 | 0.50 | 0.72 | 1.45 |
| Provides a respondent with transportation | 0.27 | 0.45 | 0.78 | 1.74 |
| Loans or gives a respondent something she needs | 0.46 | 0.50 | 0.72 | 1.44 |
| Says things that make situation clearer and easier to understand | 0.57 | 0.50 | 0.73 | 1.47 |
| Lett a respondent know that he/she will always be around if assistance is needed | 0.40 | 0.49 | 0.79 | 1.62 |

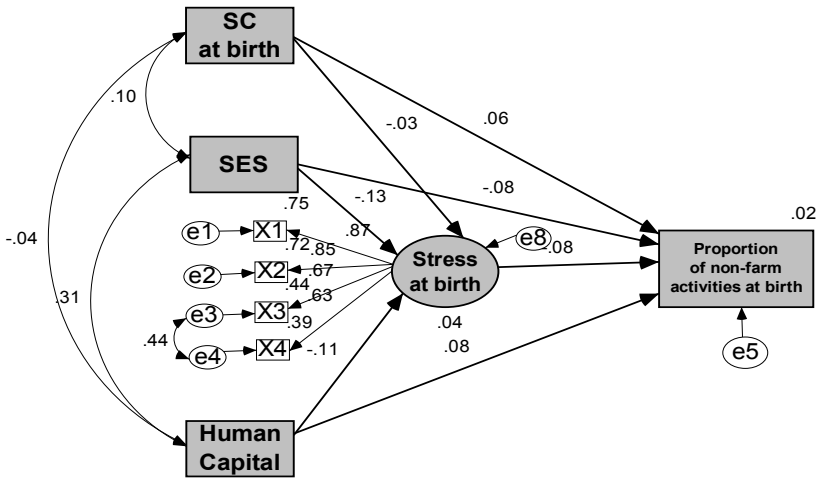
Table B.3 (Continued)

| | Mean | Std. Deviation | 1*st* PCA | PCA Weight (1*st* PCA/std. div.) |
|---|---|---|---|---|
| **Neighbors** | | | | |
| Helps with major personal problems | 0.25 | 0.43 | 0.78 | 1.82 |
| Helps when there are problems obtaining food | 0.14 | 0.35 | 0.80 | 2.28 |
| Helps when there are problems obtaining clothing | 0.07 | 0.25 | 0.78 | 3.12 |
| Helps when there is general money problem | 0.10 | 0.30 | 0.75 | 2.54 |
| Helps completing the house chores | 0.14 | 0.35 | 0.77 | 2.21 |
| Helps caring for the young children | 0.27 | 0.44 | 0.81 | 1.83 |
| Give advice for preventing illness in an infant or a respondent | 0.38 | 0.48 | 0.78 | 1.61 |
| Looking after a family member when respondent is away | 0.33 | 0.47 | 0.75 | 1.59 |
| Telling a respondent that she did something well | 0.59 | 0.49 | 0.78 | 1.58 |
| Giving a respondent information to help her to understand a situation she is in | 0.46 | 0.50 | 0.71 | 1.42 |
| Provides a respondent with transportation | 0.13 | 0.33 | 0.74 | 2.22 |
| Loans or gives a respondent something she needs | 0.33 | 0.47 | 0.74 | 1.57 |
| Says things that make situation clearer and easier to understand | 0.43 | 0.50 | 0.75 | 1.51 |
| Lett a respondent know that he/she will always be around if assistance is needed | 0.26 | 0.44 | 0.77 | 1.76 |

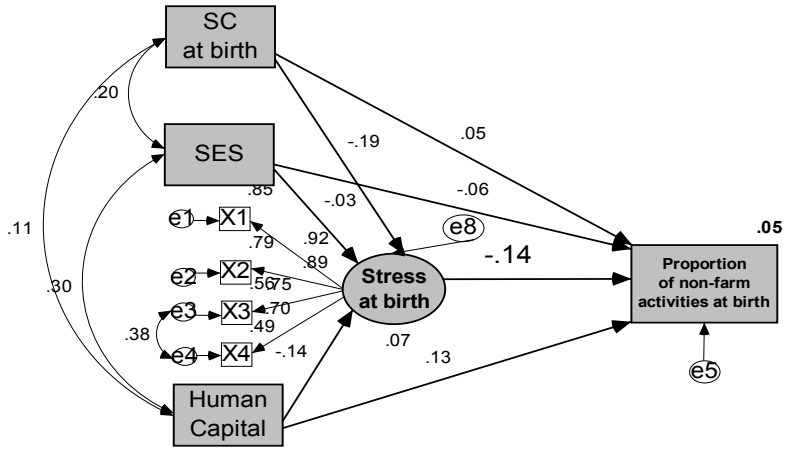
Table B.3 (Continued)

| | Mean | Std. Deviation | 1*st* PCA | PCA Weight (1*st* PCA/std. div.) |
|---|---|---|---|---|
| **Others (colleagues, bank, government officials, etc.)** | | | | |
| Helps with major personal problems | 0.04 | 0.19 | 0.41 | 2.17 |
| Helps when there are problems obtaining food | 0.02 | 0.13 | 0.41 | 3.20 |
| Helps when there are problems obtaining clothing | 0.01 | 0.10 | 0.35 | 3.45 |
| Helps when there is general money problem | 0.03 | 0.18 | 0.16 | 0.88 |
| Helps completing the house chores | 0.01 | 0.11 | 0.15 | 1.36 |
| Helps caring for the young children | 0.03 | 0.17 | 0.30 | 1.81 |
| Give advice for preventing illness in an infant or a respondent | 0.36 | 0.48 | 0.30 | 0.63 |

# APPENDIX C. TESTS OF DIRECT AND MEDIATED EFFECTS BETWEEN SELECTED INDIVIDUAL AND HOUSEHOLD LEVEL FACTORS AND PROPORTION OF NON FARM LIVELIHOOD ACTIVITIES: FITTED MODELS

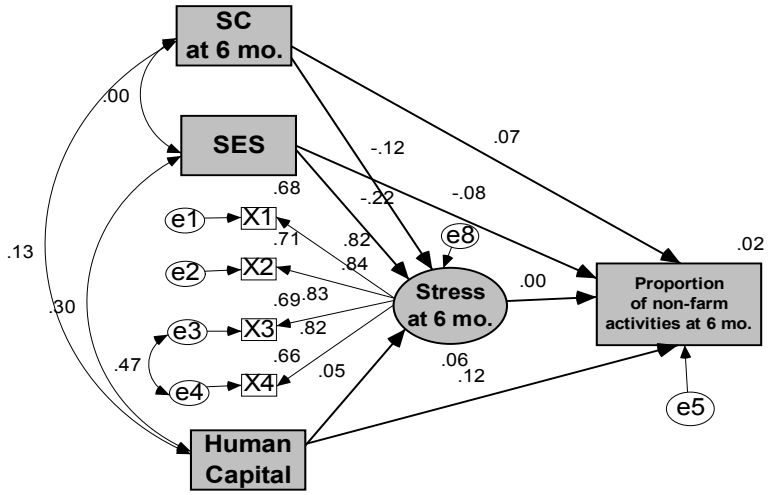



HIV Negative

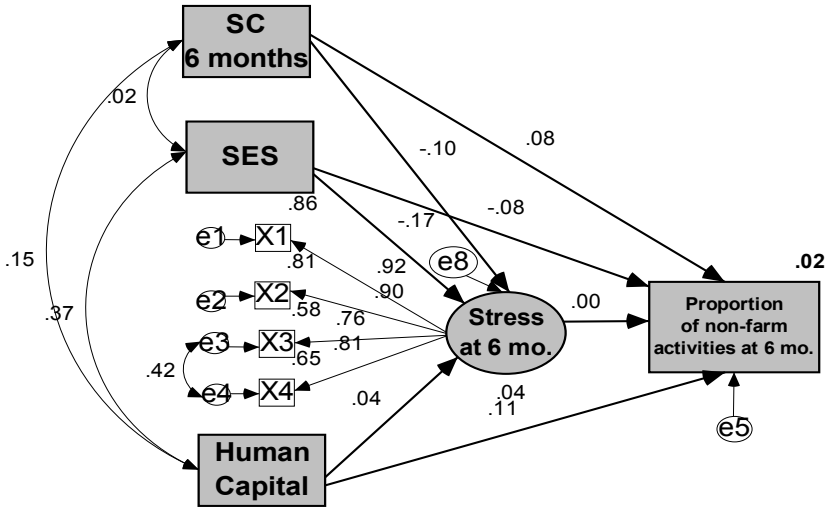



HIV Positive

Figure C.1 Analysis of causal associations between diversification, stress, social, economic and demographic factors: original model estimated for data collected at the beginning of the study

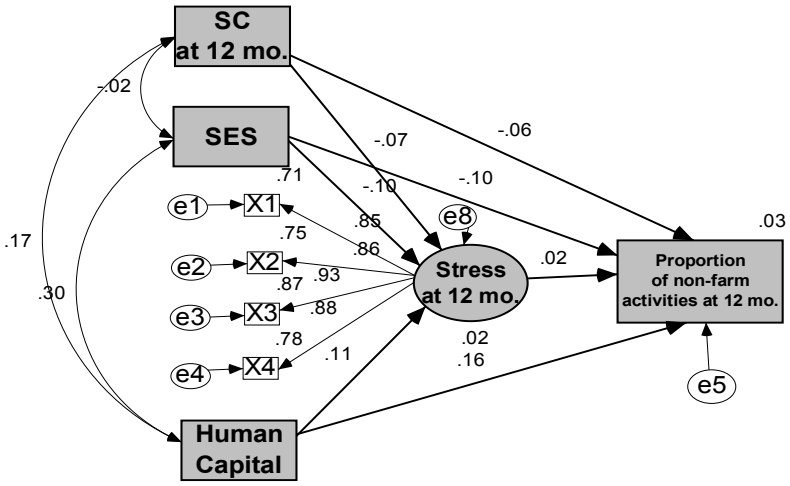



HIV Negative

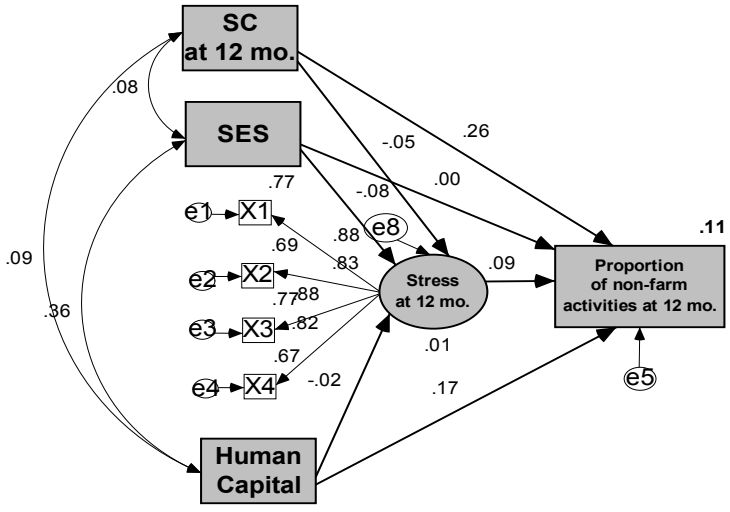



HIV Positive

Figure C.2 Analysis of causal associations between diversification, stress, social, economic and demographic factors: original model estimated for data collected at 6 months

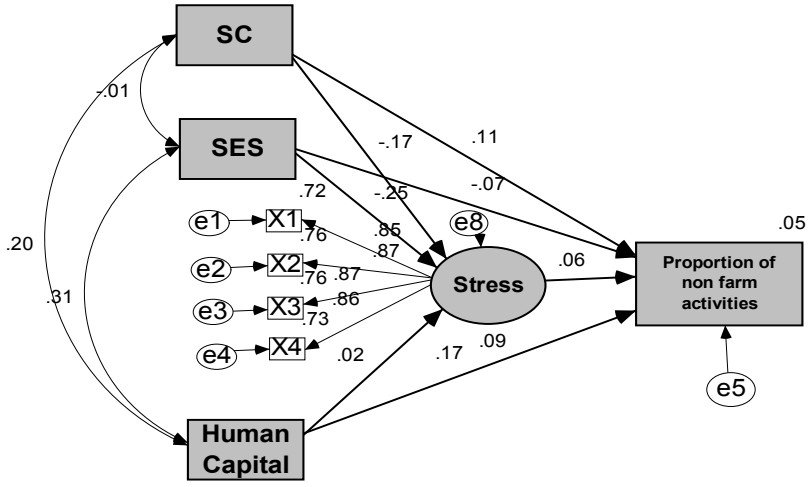



HIV Negative

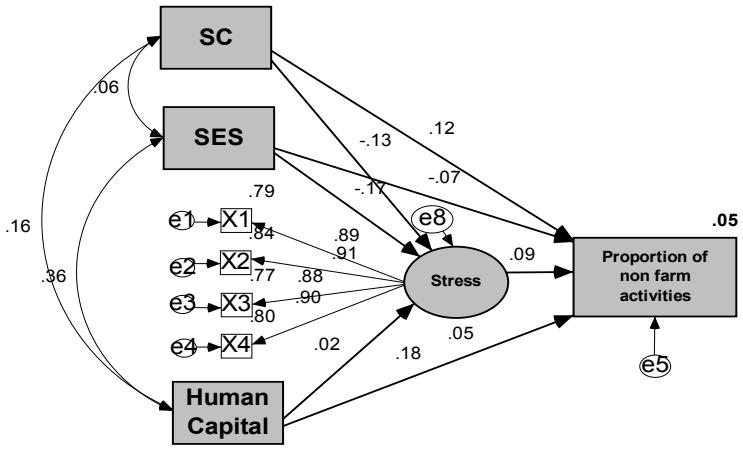



HIV Positive

Figure C.3 Analysis of causal associations between diversification, stress, social, economic and demographic factors: original model estimated for data collected at 12 months

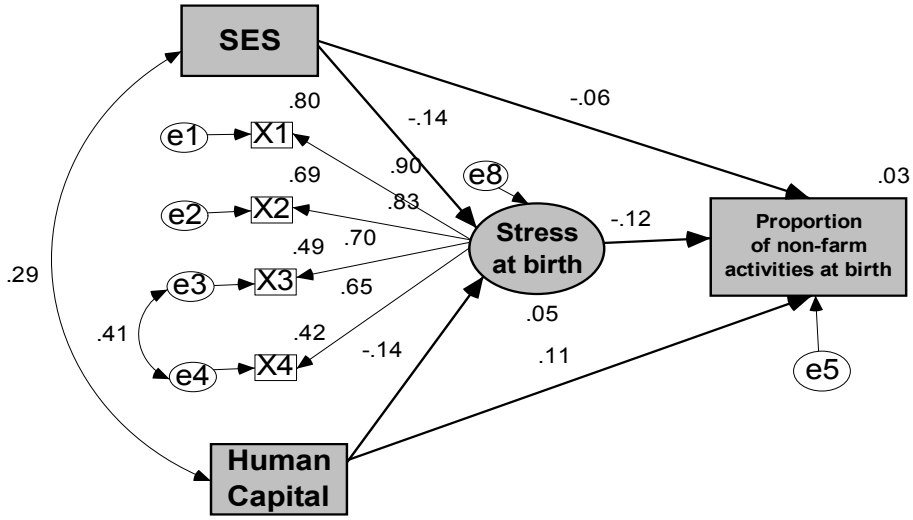



HIV Negative

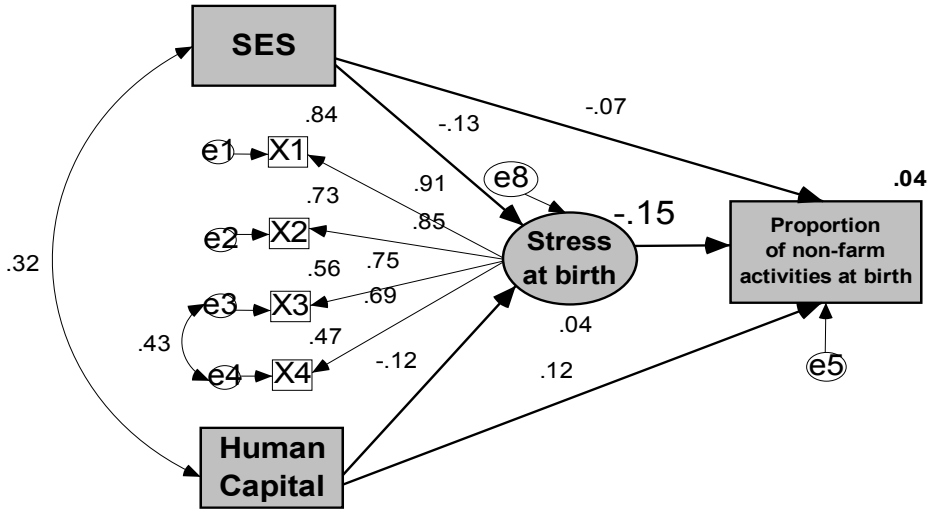



HIV Positive

Figure C.4 Analysis of causal associations between diversification, stress, social, economic and demographic factors: original model estimated for data averaged over 12 months period

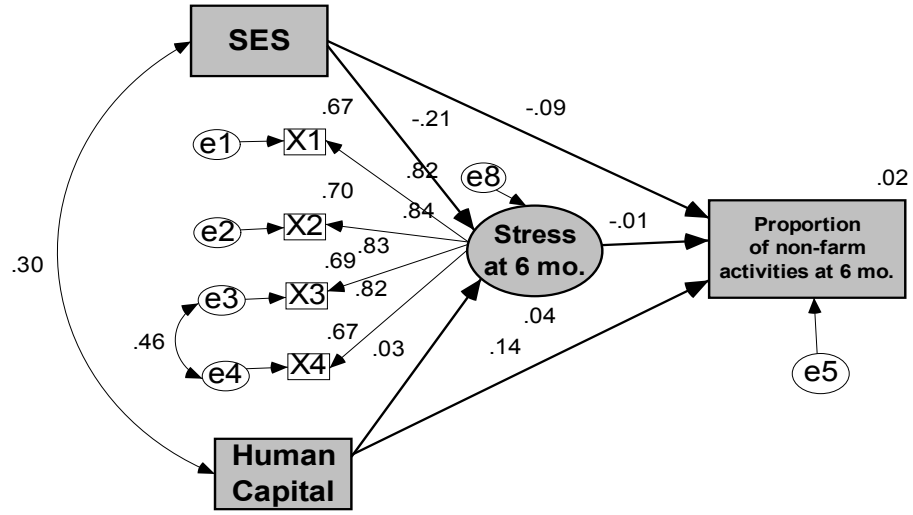



HIV Negative

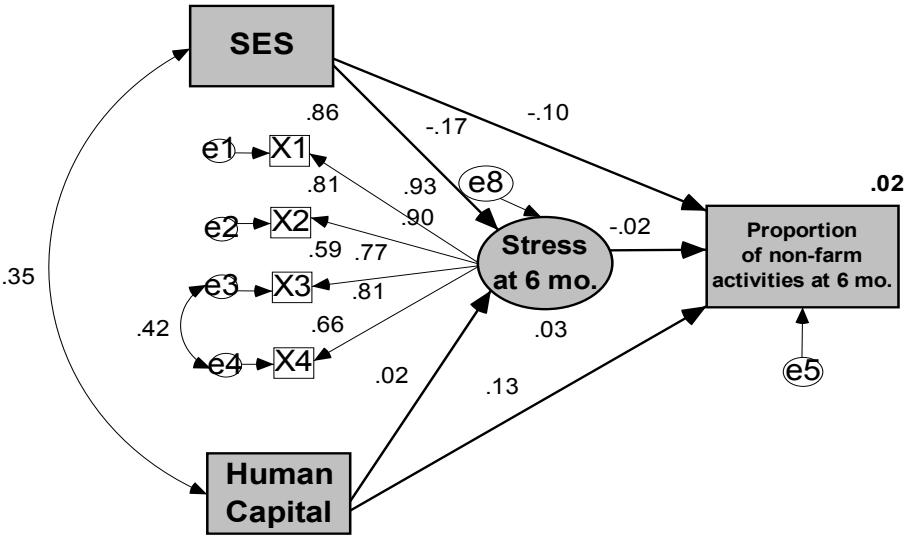



HIV Positive

Figure C.5 Analysis of causal associations between diversification, stress, social, economic and demographic factors: modified model estimated for data collected at the beginning of the study

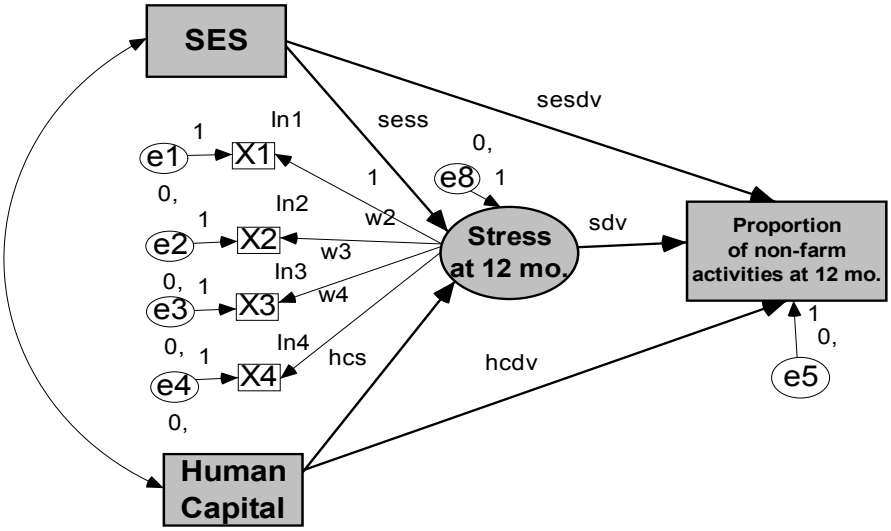



HIV Negative

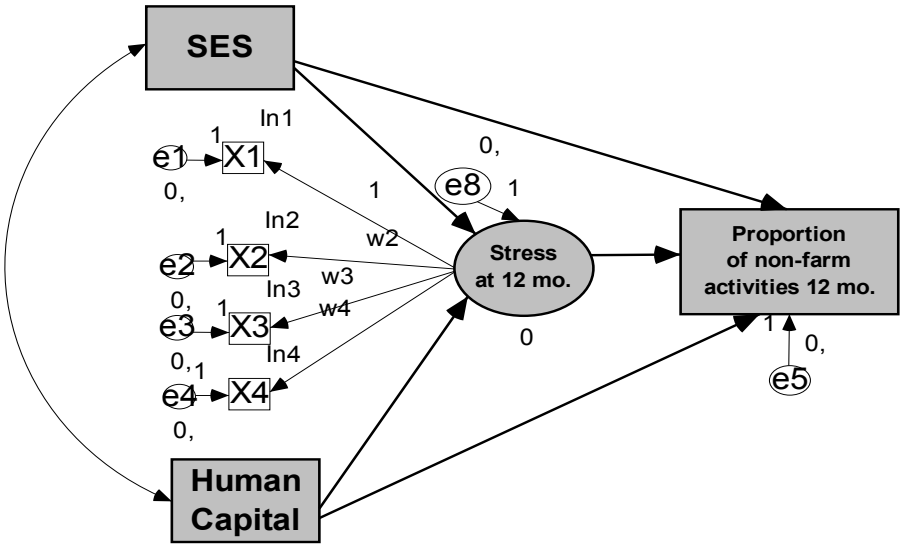



HIV Positive

Figure C.6 Analysis of causal associations between diversification, stress, social, economic and demographic factors: modified model estimated for data collected at 6 months

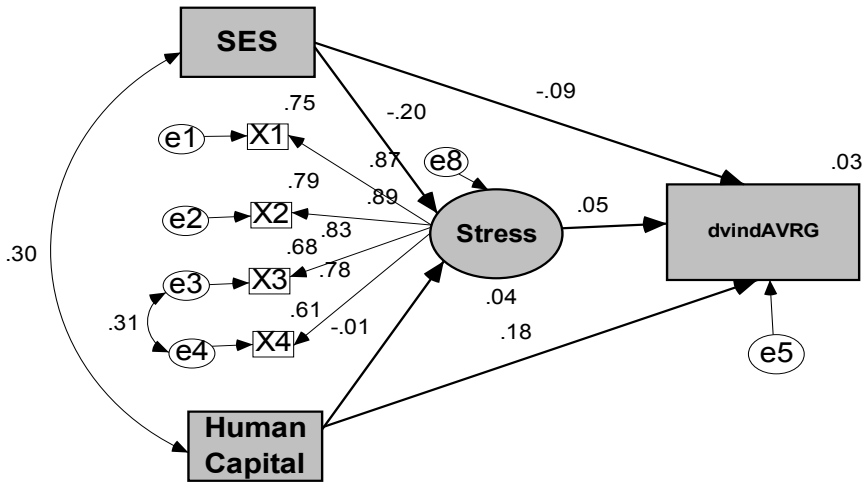



HIV Negative

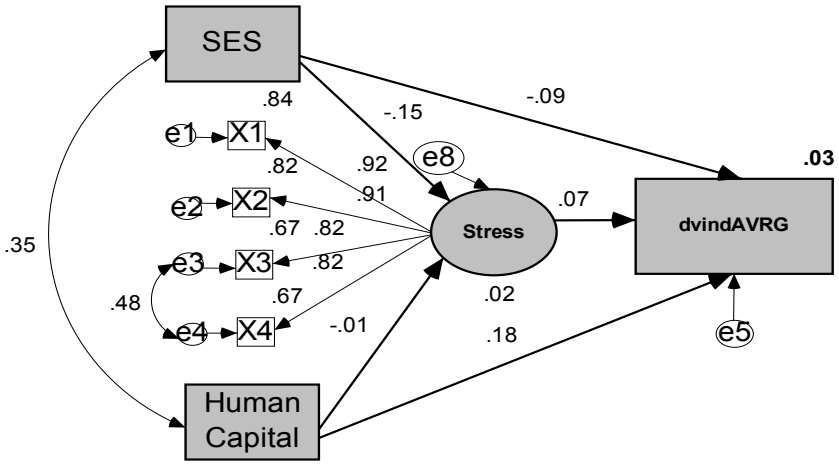



HIV Positive

Figure C.7 Analysis of causal associations between diversification, stress, social, economic and demographic factors: modified model estimated for data collected at 12 months




HIV Negative




HIV Positive

Figure C.8 Analysis of causal associations between diversification, stress, social, economic and demographic factors: modified model estimated for data averaged over 12 months period

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