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ESSAYS IN POVERTY AND CHILD NUTRITIONAL STATUS IN UGANDA

Coordinatore: Ch.mo Prof. Luigi Campiglio

Tesi di Dottorato di Wasswa Francis

Matricola: 3610950

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To my wife, Ssemuli Eva, and kids, Joel, Jemimah, Joab, and Joan

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Summary

This thesis consists of three essays. In these essays, I try to address two of the most challenging development issues in Uganda, poverty and child malnutrition. The foci of the three essays are interrelated but are examined separately. The title of the first essay is **"Poverty reduction and Income Distribution Impacts of Exogenous Policy Shocks in Uganda: A Social Accounting Matrix Perspective."** Most studies in Uganda that examine impacts of exogenous shocks focus on the consumption side and ignore the production side of the economy. Consumption side analysis is not able to capture, for example, the poverty and distributional effects of external shocks such as a reduction in migrant remittances which form a considerable share of household incomes in Uganda. This essay therefore set out to deepen our understanding of the impact-transmission mechanisms of exogenous policy shocks on poverty and income distribution in Uganda. The research question answered is therefore, how and which sectors and economic agents would be most affected by exogenous policy shocks that target growth, income distribution and poverty reduction? This is answered from a micro-macroeconomic perspective using a general equilibrium model: the Social Accounting Matrix (SAM) multiplier model. The model is based on a highly disaggregated 2002 Uganda SAM, which articulates the generation of income by activities of production and the distribution and redistribution of income between economic agents.

In order to meet the objectives of this study, we systematically carry out the analysis in three steps. First, we identify changes in absolute income of economic agents due to the multiplier process of general equilibrium model by computing the accounting multiplier matrix. From this matrix, we then compute the backward and forward linkages in order to identify key sectors of growth with significant linkages to the rest of the economy so as to enhance the ability of policy makers to affect the outcomes of policy changes or external shocks. Second, we identifying a list of non-exhaustive economic challenges the country could possibly face; (i) a 50 percent

increase in Agricultural Exports; (ii) a 5 percent decline in Migrant Remittances; and (iii) a 40 percent decline in Import Tariff Revenue and use a multiplier decomposition approach to simulate the impact on different socio-economic agents of these challenges. A detailed decomposition of some selected elements of the multiplier matrix aimed at disentangling the direct and indirect impacts of different exogenous shocks is performed as well. Third, unlike many traditional SAM-based multiplier studies which analyze the way aggregate income produced in the economy is distributed among different economic agents, our study goes a step further to examine changes in relative income of economic agents due to the multiplier process. Put it different, we examine what changes the possible exogenous shocks would cause to the relative position of a given socio-economic category. Fourth, we examine the poverty alleviation effects that would emanate from the stimulation of different productive sectors of the economy.

Our findings indicate that key sectors for growth are Real estate, Agriculture, Trade and Food processing industries. A viable policy advice would be to exploit, for example, the linkages between Agriculture, Industry and Services sectors, by improving the productivity of the Agriculture sector where the majority of the population are employed. This will require increasing the budget share of the agricultural sector and improving the status of infrastructure (roads, education, health). Regarding poverty and income distribution effects, we find that in general, poverty remains a rural phenomenon, and that there are marked gender and regional disparities in income distribution and redistribution. In particular, we find that on average, rural households in all regions of Uganda benefit relatively less from all production activities, and that they benefit relatively less from an equivalent income increase for all household income classes.

The title of the second essay is **"Measurement of Multidimensional Child Poverty in Uganda."** Virtually all poverty analysis that has been done on Uganda is based on a uni-dimensionional measure of well-being, i.e. household income or consumption expenditure per adult equivalent. Not only is the analysis uni-dimensional, but it also lumps child poverty and adult poverty together. In this essay, an attempt is made to move this research forward by using the recent nationally representative Uganda Demographic and Health Survey (UDHS) for the year 2006 and applying the Dual Cutoff and Counting Approach developed by Alkire and Foster (2007, 2011) to the measurement of multidimensional poverty among children under the age of five years in Uganda. We use, as measures of child well-being two main dimensions;

the composite wealth indicator (CWI) and nutritional status (child anthropometric measures). A child is considered poor if he/she comes from a household whose CWI is below a certain wealth poverty line or if his/her nutritional status is below a certain threshold. Due to lack of income/expenditure measures in the DHS data, we use factor analysis to construct an asset index which reflects socio-economic status of households in which a child lives. This asset index is then used as a proxy for the composite wealth indicator. The nutrition status dimension is composed of children's standardized heights and weights. The standardized heights and weights are affine positive transformations of children's height-for-age, weight-for-age, and weight-for-height z-scores based on the new 2006 World Health Organization (WHO) children growth standards.

The main results show high deprivation rates in each of the two dimensions. For instance, 40.3 percent of children in both rural and urban areas live in households that are deprived in the asset index while 38.8 percent of children are stunted; 6.6 percent are wasted; and 16.1 percent are underweight. The incidence of deprivation varies considerably between rural and urban areas as well as between regions. While only 8.5 percent of children in urban areas are deprived in the asset index, the proportion is five times higher in rural areas (43.9 percent). Similarly, 25.4 percent and 11 percent of children in urban areas are stunted and underweight respectively, compared to 40.3 percent and 16.7 percent in rural areas. Children in the the Northern (54.5 percent) and Eastern (45.7 percent) regions are the most deprived in the asset index. However, children from the Western region are the most stunted (43.9 percent), followed by those in North (41.1 percent) and East (40.0 percent).

The multidimensional poverty results indicate that when poverty is evaluated at one dimension, 48 percent of children are multidimensionally poor, and on average they are deprived in 2.32 dimensions. When this relative depth of deprivation in poverty measurement is taken into account, 27.8 percent of children are multidimensionally poor. When poverty is evaluated at all dimensions, only 1.2 percent of children are considered multidimensionally poor. Our results show that the percentage of multidimensional poor children gets much smaller when poverty is evaluated at more than two dimensions. Results also indicate evidence of a big rural/urban divide suggesting that child poverty is a rural phenomenon (51.4 percent of children in rural areas compared to 17.8 percent in urban areas) being classified as multidimensionally poor when poverty is evaluated at one dimension.

The title of the third essay is **"The Relationship Between Maternal Autonomy and Child Stunting in Uganda."** Child stunting prevalence rates in Uganda are very high (38 percent), especially in rural areas (40 percent) and stunting is apparent even among children less than 6 months of age (17 percent). Child stunting, an outcome of chronic undernutrition, contributes to poor quality of life, morbidity and mortality. Recent literature on child health suggest that the low status of women is thought to be one of the primary determinants of undernutrition across the lifespan. Low female status can result in compromised health outcomes for women, which in turn are related to lower infant birth weight and may affect the quality of infant care and nutrition.

Maternal autonomy (defined in this essay as a woman's ability to make decisions on her own, to control her own body, and to determine how resources will be used, without needing to consult with or ask permission from another person) is likely an important factor influencing child care and ultimately infant and child health outcomes. To examine the relationship between maternal autonomy and child stunting in Uganda, we analyzed data from the 2006 Uganda Demographic and Health Survey (UDHS). We used cross-sectional demographic, health and anthropometric information for married or cohabiting mothers and their children ($n = 2108$) from UDHS 2006. In the UDHS 2006, only currently married or cohabiting women were asked about their participation in decision-making in the household. The main explanatory variables of maternal autonomy are presented by four direct measures of women's autonomy, namely, freedom of movement to visit families or relatives, decision-making power on making large household and daily purchases, and women's attitude toward verbal and physical abuse (i.e. domestic violence captured via women's attitudes towards wife beating). These are combined with children characteristics (e.g., age and sex); maternal characteristics (e.g., mother height, education level, and employment status); and women's relative status indicators (e.g., age and education differences between husband and wife) in logistic regression models to test the associations between indicators of women autonomy and the risk of having a stunted child. The relative importance of women's autonomy indicators versus demographic, socioeconomic and women's relative status indicators is an important empirical issue that we address in our regression analysis to ascertain which variables increase the risk of having a stunted child.

The results of this study supports the hypothesis that low maternal autonomy- represented by a single decision making indicator, namely 'Final say in own health care' - is associated with

child stunting, after controlling for child's age and sex, household socio-economic status, and mother's education. While this result is impressive, our findings indicate that there is lack of influence from other women's autonomy indicators regardless of whether socio-economic factors are controlled for or not. These results show that most socio-economic indicators, particularly, maternal education and household wealth have strong influence on child health. Nonetheless, these findings suggest that both women's autonomy and socio-economic indicators should be analyzed simultaneously in order to derive a complete understanding of the determinants of child nutritional status and that policy interventions should target improving female education and household economic status, and educating the population about the importance of gender equality in a society.

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Essay 1: Poverty reduction and Income Distribution Impacts of Exogenous Policy Shocks in Uganda: A Social Accounting Matrix Perspective

1.1 Background and Rationale of the Study

1.1.1 Research Question and Aims of the study

Over the last two decades, the Uganda government has implemented policies geared towards eradicating poverty among its people. However, restoring sustainable growth in the incomes of the poor, reducing income inequality, building strong social and economic infrastructure, enhancing human development, increasing agriculture productivity and using public resources more efficiently are still some of the key challenges outlined in the National Development Plan (NDP)[1] (GoU, 2010). The question this essay asks is what are the economy wide growth and welfare implications of such policies in light of the challenges the Ugandan economy faces? Put in a different way, how and which sectors and economic agents would be most affected by exogenous policy shocks that target growth, income distribution and poverty alleviation?

Answering the above question is of paramount importance from a development policy per-

[1] In April 2010, the NDP replaced the Poverty Eradication and Action Plan (PEAP), which was a national framework for addressing poverty actions in Uganda since 1997.

spective. In fact, our results could constitute policy prescriptions for the government of Uganda on areas it needs to target in the design of policies aimed at creating prosperity for all. If, for example, our results suggested that increasing Agricultural exports had a significant impact on incomes of rural households and unskilled labor relative to their urban counterparts, then a sensible policy recommendation would be to sensitize farmers on new farming methods, provide inputs, and invest in feeder roads to link farmers to markets.

In light of the above question, the main goal of this essay is to identify key sectors of growth with significant linkages to the rest of the Ugandan economy so as to enlighten policy makers on how to affect outcomes of exogenous shocks. The specific objective are: (1) Derivation of "backward and forward" linkages to identify sectors with larger prospective linkages to the rest of the economy; (2) Examine the direct and indirect effects of exogenous income injections on mean income of different economic agents; (3) Determine changes in absolute and relative income of economic agents in light of exogenous shocks; and (4) Determine changes in poverty reduction that would result from stimulation of alternative production activities.

1.1.2 Motivation

The motivation of this study comes from the fact that despite the structural reforms of the 1990's and impressive growth and poverty reduction recorded since then, these achievements have not been sustainable partly because of the inadequate knowledge among Ugandan policy makers with regard to which sectors have strong linkages with the rest of the economy.

In the last two decades, Uganda has achieved a marked reduction in poverty and emerged as one of the fastest-growing economies in Sub-Saharan Africa. Annual gross domestic product (GDP) growth averaged about 7.0 percent between 1986 and 2008 – double the average for Sub-Saharan Africa as a whole (UBOS, 2009). Initial economic growth was driven by post-war recovery and reconstruction, and since the early 1990s by comprehensive macro-economic and structural reforms (Collier and Reinikka, 2001). Strong economic growth has led to a reduction in income poverty. The share of the population that live below the poverty line declined from 56.4 percent in 1992/93 to 31 percent in 2005/06 (Ssewanyana and Younger, 2007) and to 24.5 percent in 2009/10 (UBOS, 2011), implying that Uganda has met and gone beyond the 28 percent Millennium Development Goals (MDG-1) poverty target of cutting of halving, between 1990 and 2015, the proportion of people whose income is less than $1 a day. However, from

the multidimensional poverty standpoint, Uganda's 2011 Human Development Index (HDI)[2] of 0.446 (translating into a rank of 161 out of 187 countries and territories) is below the average of 0.456 for countries in the low human development group and below the average of 0.463 for countries in Sub-Saharan Africa (UNDP, 2011). Moreover, under the current economic trends, the absolute number of poor people is projected to increase because of Uganda's rapid population growth to 9.2 million in 2015, an increase of 0.8 million from 2005 (PMA, 2009). For Uganda, therefore, meeting MDG-1 is not sufficient to effectively reduce poverty.[3]

While poverty (particularly income poverty) has reduced, inequality has continued to rise; the Gini coefficient (a measure of income inequality) increased from 0.365 to 0.426 between 1992 and 2009, and there are wide regional and gender disparities in poverty levels[4], all of which continue to undermine the positive impact of growth on poverty reduction (Kappel et al., 2005; Ssewanyana, 2009). As noted above, Uganda's HDI for 2011 is 0.446. However, when inequality in all three dimensions of the HDI is taken into account by 'discounting' each dimension's average value according to its level of inequality, the HDI falls to 0.296, a loss of 33.6 per cent due to inequality in the distribution of the dimension indices. In addition, there is widespread gender inequality as indicated by Uganda's Gender Inequality Index (GII) value of 0.577, ranking it 116 out of 146 countries in the 2011 index (UNDP, 2011)

Similarly, the country has continued to face other challenges that have made it hard to achieve the much needed economic growth and socio-economic transformation. Most notably, the country has not achieved significant productivity growth in agriculture and has thus not experienced sufficient release of excess labor from the sector. For instance, while growth in GDP has been accompanied by changes in its broad sectoral composition (e.g. the contribution of agriculture declined from 23.1 percent in 2001/02 to 15.1 percent in 2008/09, while that of industry and services increased from 22 and 48.3 percent to 24.4 and 51.1 percent respectively),

[2]The HDI is a summary measure for assessing long-term progress in three basic dimensions of human development: a long and healthy life (measured by life expectancy), access to knowledge (measured by: i) mean years of adult education, which is the average number of years of education received in a life-time by people aged 25 years and older; and ii) expected years of schooling for children of school-entrance age, which is the total number of years of schooling a child of school-entrance age can expect to receive if prevailing patterns of age-specific enrollment rates stay the same throughout the child's life) and a decent standard of living (measured by Gross National Income (GNI) per capita expressed in constant 2005 PPP$) (UNDP, 2010).

[3]Effective poverty reduction is that which reduces both the proportion and absolute numbers of poor people

[4]The poor in rural areas represents 27.2% of the population but only 9.1% in urban areas. On average, poverty incidence in Northern region (46.2%) remains higher than the national average (24.5%) compared to 10.7% and 21.8% in Central and Western regions respectively. In absolute numbers, the current poverty incidence of 24.5 percent corresponds to nearly 7.5 million persons of which the majority are in rural areas (about 7.1 million) (UBOS, 2011, p.75)

there has not been a commensurate change in the distribution pattern of labor force. The share of labor force employed in manufacturing and services sectors decreased from 6.8 and 26.8 percent to 4.2 and 20.7 percent respectively despite the rise in GDP shares of these sectors. However, the share of labor force engaged in the agriculture sector increased from 66.4 percent in 2002/03 to 75.1 percent in 2005/06 while the share of agriculture to GDP declined over the same period (GoU, 2010). This may be attributed to a variety of factors including: a mismatch between skills acquired and the requirements of employers; the development of low skilled industries and services; the high rate of growth in the labor force and inability to absorb it in the growing sectors. These trends clearly contribute to low production and productivity in the agriculture sector which undermines the potential growth of the economy and contributes to other issues such as food insecurity. Other challenges include among others: low value added exports which are dominated by primary exports, slower than desirable growth of the agricultural sector relative to the industrial sector, new emerging sectors which are not doing enough to absorb the rapidly increasing labor force, slow accumulation of core production infrastructure such as energy and transport, and a narrow/limited domestic resource base.[5]

The above bottlenecks pose challenges for economic transformation. Uganda's development strategies for dealing with some of these challenges in the medium term have mainly focused on encouraging growth in export-led industries. While it is true that economic growth is a necessary condition for poverty reduction, it is not a sufficient prerequisite to reduce poverty and improve the distribution of income (see, for instance, Tanzi, 1998; Deininger and Squire, 1996; Shari, 2000). For economic growth to have an effective impact on poverty and income distribution, it is important that it occurs in sectors that are better targeted to have most impact on the poor. Therefore, an analysis that identifies key sectors of growth with significant linkages with the rest of the economy and examines the distributional and poverty reduction effects associated with growth in these sectors is critical and could greatly offer insights to policy makers and enable them to choose a wide range of policies that would alter the undesirable economic features mentioned above and hence, propel the Ugandan economy to a pro-poor growth[6] path.

[5]Uganda's current tax revenues of about 13 percent of GDP are low by regional standards (e.g., Sub-Saharan Africa average is about 20 percent and about 18 and 24 percent in Tanzania and Kenya) and insufficient to permit the public infrastructure investment needed to boost growth.

[6]Broadly, pro-poor growth can be defined as one that enables the poor to actively participate in and significantly benefit from economic activity Kakwani and Pernia (2000).

Many studies have investigated poverty and distributional effects of the growth process in Uganda (see, for instance, Appleton et al., 1999; Appleton and Ssewanyana, 2004; Ssewanyana et al., 2004; Okidi et al., 2007; Ssewanyana and Younger, 2007; Ssewanyana and Bategeka, 2007; Ssewanyana, 2009). While these studies are rich from a descriptive point of view, they are limited to micro-analytical framework which focuses on consumption and neglect the production structure of the economy and therefore, they can tell us very little about the transmission mechanisms and propagation channels through which demand-driven policy intervention and other exogenous shocks may affect economic activities and economic agents such as households.

This study examines the linkage between growth, poverty and income distribution from a micro-macroeconomic perspective by identifying the impact-transmission mechanisms of exogenous shocks using an economy-wide model: the social accounting matrix (SAM) multiplier decomposition model. Several assumptions, including a fixed price assumption, need to be made in order to use the SAM as a model. It is worth noting that our economy-wide methodology is appropriate to analyze the type of question this paper seeks to address. In fact, such a methodology can be used to explore the impact of exogenous changes in such variables as exports, certain categories of government expenditures, and investment on the whole interdependent socio-economic system, e.g. the resulting structure of production, factorial and household income distributions (Thorbecke, 2000). Moreover, the SAM framework has been highlighted in the World Bank's "toolkit" as a useful way of evaluating the poverty impacts of alternative policies (see Round, 2003b). In addition, the decomposition utilized here is an important additional analysis to compliment results from traditional SAM models, which only provide the aggregate impact of a shock. In fact, the decomposition is important because of its ability to separate the aggregate impact of a shock into three individual effects namely, transfer effects, spillover (open-loop) effects and closed-loop effects (explained in subsequent sections), making it easy to trace all the propagation channels of a shock.

The rest of the study is organized as follows. The next section presents a brief literature review on SAM-based multiplier models focusing mainly on some of their various applications in the developing world, notably, those assessing the impact of exogenous shocks on income distribution and poverty reduction. Section 1.3 describes the general equilibrium data system (the Uganda SAM) used in the analysis. Silent characteristics of the Ugandan economy will

also be discussed in light of the SAM. Section 1.4 describes the SAM multiplier decomposition model and the context of poverty reduction and relative income determination. Section 1.5 analyzes the results. The essay ends with a conclusion section.

1.2 Literature Review

The origins of the SAM is believed to be found in the by pioneering work of Sir Richard Stone in 1960s which was based on the United Kingdom and other industrialized countries. His ideas were further developed by Pyatt and Thorbecke (1976) who formalized the SAM and showed how it could be used as a conceptual and modular framework for policy and planning purposes and by Pyatt and Round (1977) who analyzed the relationship between the production structure and income distribution using SAMs for Iran, Sri Lanka and Swaziland.

SAM-based multiplier studies mainly in developing countries have since followed. Pyatt and Round (1979) applied fixed price multipliers and multiplier decomposition on the SAM for Sri Lanka economy and found that the income multiplier was lower for estate households (the poorest household) with high incidences of poverty, than for urban or rural household, except when the injection were in the tea or rubber sectors (e.g. an increase in export of tea or rubber). This meant that the indirect effects could not be relied on to alleviate poverty for the poorest sector and that they needed to be targeted directly. A second observation was that the input-output multipliers were lower than the between –account multipliers. This suggested that more emphasis needed to be placed on tracing the income generated to production factors and the transmission of this income to household, rather than estimating inter-industry linkages, as the latter are weak.

Recent works include Alderman (1990) who use a Mexico SAM to explore the inter-sectoral impacts of alternative adjustment strategies, Dorosh (1994) who develops a semi-input-output (SIO) model based on a 1987 Lesotho SAM to analyze how the changes in economic policies and external shocks have affected poor households in Lesotho. One experiment similar to the one performed in Dorosh (1994) was also conducted in this study although the magnitude differs (e.g., migrant remittances is reduced by 17.2 percent in Dorosh (1994) vs. 5 percent in our study). It is worth mentioning that since SAM-multiplier models do not assume supply constraints while SIO models do, one should expect the multipliers obtained from SIO models to

be lower in magnitude than those generated from SAM-multiplier models. Nonetheless, despite adding realism to SAM models, SIO models still do not account for price effects and substitution effects between factors of production. To capture these effects one needs to use flexible-price models such as the computable general equilibrium (CGE) model. However, CGE models can be complex and require a great deal of time and modeling skills.

Thorbecke and Jung (1996) develop a decomposition method of the fixed-price multiplier matrix to analyze poverty alleviation. As an application to their proposed method, they study the impact of sectoral growth on poverty alleviation in Indonesia and conclude that agriculture and service sectoral growth could contribute more to overall poverty reduction than industrial growth. Khan (1999) attempts to explore the links between sectoral growth and poverty alleviation along the same lines as Thorbecke and Jung (1996), but applied to South Africa. He finds that growth in agriculture, services and some manufacturing sectors have larger alleviation effects for the black African population.

Using the Ghanaian SAM, Powell and Round (2000) investigates the effects of additional export income of cocoa on the economy. The study established that unskilled male workers and mixed income were the largest beneficiaries of additional export income stemming from an increase in global demand for cocoa. Besides returns to labor, certain urban and rural households also benefited almost the same but the impact was much less compared to a similar injection in mining and construction sectors. However, the study found evidence of weak closed-loop effects (see the discussion in subsequent sections) in the Ghanaian economy, demonstrating limited interdependency or income interrelationships among endogenous accounts.

Other lines of research at the International Food Policy Research Institute (IFPRI) include Arndt et al. (2000) who adopt the SAM multiplier approach to argue the relative importance of sectors of activity in Mozambique, Bautista et al. (2001) who use SAM and CGE frameworks to analyze alternative industrial development paths for Indonesia and Dorosh et al. (2003) who use SIO and CGE models to measure economic linkages emanating from investment-led growth in eight different African countries (Cameroon, Gambia, Lesotho, Madagascar, Niger, Nigeria, Tanzania, Zaire) with widely varying economic structures, finding that regardless of the methodology used, indirect effects prove to be large and investments in agriculture generate the largest impact on the poor. Although Bautista et al. (2001) recognized the limitations (e.g. SAM models are linear and ignore supply constraints) of the SAM multiplier analysis,

they conducted simulations under the two frameworks and got the same result-that agricultural demand-led industrialization yields higher increases in GDP compared to two other industrial-led development paths (food processing-based and light manufacturing-based). These results should not suggest that limitations of the SAM approach are not severe, rather they indicate that, depending on the type of experiment or the economy under study, results from the two approaches (SAM and CGE) can be similar.

More recently, Pyatt and Round (2006) extend the fixed-price multiplier analysis set out in Pyatt and Round (1979). They show that each element of the multiplier matrix can be disaggregated in order to reveal detailed information on paths and linkages of exogenous shocks. As an application to their proposed method, they explore changes in poverty that results from stimulation of different productive sectors using the 1980 Indonesian SAM finding that largest poverty alleviation effects come from sectoral growth in building & construction, mining and other crops sectors respectively.

There is also a growing number of SAM-based multiplier studies that analyze the impact of exogenous demand shocks on income distribution and poverty of both women and men. Using a SAM for Senegal, Fofana et al. (2009) assess how growth in various sectors affects the income of women and men in Senegal. They find that agriculture and financial services would increase the income share of women, and among the export-oriented sectors, tourism is the sector that increase this share the most. Wanjala and Were (2009) analyzes the gendered employment outcomes of various investment options using the 2003 Kenya SAM. Their results reveal that Kenya's agriculture sector accounts for the highest increase in employment compensation (mainly benefiting skilled labor and disproportionately benefiting men), while its manufacturing sector accounts for the largest share of job creation. They also find women stand to benefit more from employment creation mainly from informal jobs that offer low wages.

Civardi et al. (2010) extended the Pyatt and Round (2006) approach and show that the impact of exogenous shock can be divided into four different effects: direct-direct effects (D-D); direct-indirect effect (D-I); indirect-direct effects (I-D) and indirect-indirect effects (I-I).[1] Using the 2000 Vietnamese SAM, the authors show that the highest direct effects on the income of household groups are related to exogenous injections into the agricultural sector, while the highest indirect effects result from investing in other agriculture-related sectors such as food

[1] See section 1.4.2 and the cited paper for details.

processing. They conclude that policies focusing on the agricultural sector and on rural households will thus have greatest effect on reducing the level of income inequality. Decomposition of two sub-matrices of the accounting multiplier matrix, one of which is similar to one performed in Civardi et al. (2010) were also conducted in this study.

Pieters (2010) examines how the sectoral structure of growth contributes to household income inequality in India. What is novel in the cited paper is that the author carefully accounts for inequality among workers by taking the Indian SAM for the year 2002-03 and dis-aggregating its wage account in order to improve the link between households and sectors and by incorporating the skill premium and skill intensity of each sector. Using this extended SAM, Pieters finds that only agricultural growth reduces inequality, while growth in sectors such as community, social and personal services; heavy manufacturing and other services increases it. The main reason given for this result is that growth in these sectors increases inequality because they pay relatively high wages (the sector premium), they are skill-intensive, and pay a high skill premium.

The literature reviewed so far attest traditionally how the structure of the economy underlying the matrix of multipliers affects the way aggregate income produced in the economy is distributed among different households and the corresponding poverty alleviation effects that could emanate from changes in these income levels. However, the number of the existing literature on the SAM-based relative income study is far less than that of the application of the SAM multiplier as highlighted above. In fact, we could hardly find any study using a SAM framework to analyze the processes of income distribution and redistribution in developing countries despite the presence of high income inequality, which is closely related to the redistributive structure of developing economies.

For developed countries, however, research on the relative income determination model of the activity and household in the endogenous account started since the end of last century. Cohen and Tuyl (1991) presented an indicator based on the linear model of multipliers applied to the Dutch economy. Roland-Holst and Sancho (1992) discussed an analytical context to study the income generation process and its distributional effects and presented an application to the US economy. Cohen (1989) made use of Relative Distributive Measure to assess the impact of income redistribution in Netherlands. In fact, the relative income determination model put forward by Roland-Holst and Sancho (1992) has an even wider application. Llop and Manresa

(2004), De Miguel-Velez and Perez-Mayo (2006) and Noh (2010) all use their models to study income distribution among the different industries under the exogenous shocks in different economic systems. Some of these studies also undertake a decomposition of the redistribution matrix proposed by Roland-Holst and Sancho (1992) and also investigate the role of government in the distribution mechanism by endogenizing the government account in the model of multipliers.[2]

From the above review, it seems that the empirical evidence on the impact of exogenous shocks on poverty alleviation and income distribution is mixed. In addition, literature on relative income determination in developing countries is undoubtedly missing. To the best of our knowledge, our study is a first attempt at using the SAM multiplier framework to analyze the effects of exogenous shocks on poverty alleviation and the process of income distribution and redistribution in Uganda. Moreover, our analysis is based on a recent and first ever official Uganda SAM for the year 2002. In addition, we apply for the first time the recent SAM multiplier modeling techniques developed by Pyatt and Round (2006) and enunciated by Civardi et al. (2010) to an African country dataset to examine path and linkages of exogenous shocks. These new techniques have only been applied by their pioneers to developing countries in Asia, namely, Indonesia and Vietnam.

1.3 The Social Accounting Matrix for Uganda

1.3.1 Introduction and Basic Structure of the SAM

What is a SAM? A widely accepted definition of a Social Accounting Matrix (a concept originally due to Sir Richard Stone) is the following: "...a comprehensive, flexible and disaggregated framework that elaborates and articulates the generation of income by activities of production and the distribution and redistribution of income between social and institutional groups" (Round, 2003a, p.162). While *comprehensive* assures the full representation of transactions within the economy in a given period (usually one year), *disaggregation* allows one to explore the various interdependencies working within the socio-economic system and likely to affect its performance as well as the outcomes of policy. A peculiar feature of the SAM as an accounting system is the representation of flows as single entries in a square matrix. Each account is rep-

[2]For details, the reader is referred to the cited papers

resented by a row and column. Each cell shows the payment from the account of its column to the account of its row – the incomes of an account appear along its row, its expenditures along its column. Moreover, the underlying principle of double-entry accounting which requires that, for each account in the SAM, total revenue (row total) equals total expenditure (column total) is a powerful tool to detect lacks and errors. The SAM incorporates explicitly important relationships among variables such as the mapping of the factorial income distribution from the production structure and the mapping of the household income distribution from the factorial income distribution (Thorbecke, 2000).

The SAM used in this study modifies the structure/presentation (not the numbers) of the original, recent and first ever official SAM, the 2002 Uganda SAM[1], which is based on coherent sets of Uganda national accounts and Uganda national household surveys produced by Uganda Bureau of Statistics (UBOS) and the Supply and Use Table (SUT) for the year 2002, the first of its kind. In addition, the 2002 Uganda SAM contains detailed information on the production side, covering 74 activities (25 agricultural, 27 industrial, and 22 services) and 61 commodities (23 agriculture, 19 industry, and 19 services) as set out in Alarcon et al. (2006). There are also eighteen factors of production (1 mixed income, 1 operating surplus and 16 labor categories), thirty-three private institutions (32 household types classified by Uganda's four regions of Central, Eastern, Northern and Western and further by income quintiles, and 1 corporations account). In addition, the SAM contains a recurrent government and non-government account capturing government/NGOs expenditures, 4 tax accounts (direct, indirect commodity taxes, import duties and subsidies), 1 rest-of-the world recurrent account and a consolidated capital account reflecting both private and public-sector savings-investment balance.

For the sake of clarity and greater conformity to the national accounts published by the UBOS and in order to obtain some generalizable poverty and income distribution results, an aggregation of sub-accounts was performed resulting into a simplified micro SAM used in this study (called Uganda micro SAM or UgaSAM hereafter) and its macro version (called Uganda macro SAM or MacSAM hereafter).

After adjustments are made, UgaSAM has fifteen (15) activity sub-accounts and fifteen (15) commodity sub-accounts (details for the aggregation scheme used here are provided in Table

[1] An earlier and non-official Uganda SAM for the year 1999 was constructed **?** at the International Food Policy Research Institute (IFPRI).

A.1.1 of the Appendix A.1). These accounts include, Agriculture, Mining, Food processing, Other Manufacturing, Utilities, Construction, Trade, Tourism, Transport and Communications, Financial services, Real Estate, Government services, Education services, Health services, and Other private and Community services. In addition, it has twelve (12) factor payments labor sub-accounts, one (1) factor payments-capital account, one (1) factor payments-mixed income account, eight (8) households sub-accounts (details for aggregation scheme used here are provided in Table A.1.2 of the Appendix A.1), one (1) firms/enterprise account, one (1) core government account (1), four (4) tax accounts sub-accounts, one (1) capital or savings-investment account (1) and one (1) rest-of-the world (RoW) account.

It is worth noting that distinction is made between production activities (the entities that carry out production) and commodities. Commodities represent both activity outputs[2], which are either sold domestically or to the rest-of-the world (exports), and imports. Despite the fact that the UgaSAM was aggregated such that the number of activities equals exactly the number of commodities, the separation activity-commodity was maintained here and the Make matrix is not diagonal.[3] In the present SAM as well as in the original one, receipts are valued at producer's prices in the activity accounts and at market prices (including indirect commodity taxes) in the commodity accounts. Payments are made in the commodity accounts to domestic activities, domestic indirect commodity taxes and imports taxes accounts, and the rest-of-the world. Such a treatment of commodity gives the flexibility to model imports and domestic production as imperfect substitutes (the Armington assumption) or as perfect substitutes

The household sub-account in the UgaSAM is classified according to regions (central, east, north and west) and by residence (rural or urban) but not by income quintiles as in the original SAM. This was done in order to match the classification of households in the 2002/03 national household survey data which we later use to examine the impact of exogenous shocks on poverty and income distribution. This classification was also motivated by the fact that poverty and income inequality in Uganda are closely linked to household location. For instance, over 80 percent of the population live in rural areas which also contributed 91 percent to national headcount poverty between 2002/03 and 2005/06 (Ssewanyana and Younger, 2007). Moreover,

[2]The inclusion of commodity accounts in a SAM can be best seen as representing a region's or nation's product markets(Thorbecke, 2000).

[3]The Make matrix has industries (or activities) in the rows and products (or commodities) in the columns; the entries show how much of each product was made in each industry.

location is "a crucial criterion largely on the grounds that policy often has a locational element" (Thorbecke, 2000).

In the original SAM, the factors of production account was broken down into wage labor income (i.e. compensation of employees) and Other primary factor income. For the former, a further classification based on the level of eduction (not completed primary, completed primary Seven, above primary to completed secondary (inclusive), Graduate from tertiary education, i.e. above completed secondary) reflecting respectively the skill (unskilled, semi-skilled, skilled, high skilled) and by rural/urban and gender was used leading to a total of 16 labor categories. For the latter, which basically refers to factor income from "own-account" labor, from capital, and from land, a further breakdown into Mixed income and Operating Surplus was used. This classification aimed at capturing the most important characteristics on the factors participating in the production process. In our simplified SAM, we only aggregated the first two labor categories, i.e. added together the unskilled and semi-skilled labor incomes to form the Unskilled labor type while the rest of factors of production sub-accounts remained as in the original SAM.

1.3.2 Macroeconomic Characteristics

A coherent 2002 macroeconomic profile of the Ugandan economy can be derived from the MacSAM, and it emerges that Uganda is a poor country. Using an average exchange rate of UGX 1730/US$ and an estimated population of 26 million, per capita income amounted to only 254US$ in 2002 market prices.

With regard to the external balance, imports add up to some 25 percent of GDP, while exports are only 12 percent. This sizable foreign trade deficit is financed by an inflow of foreign capital, mainly in the form of aid. External capital inflows to the government and NGO account in the SAM can be directly attributed to foreign donors. The MacSAM also documents that in 2002, Uganda's fiscal balance (i.e. government savings) as a share of GDP was 4.5 percent. However, this figure excludes the cost of public investment.

The UgaSAM does not distinguish between private and public investment as it contains one consolidated capital account for all institutions.[4] Total investment amounts to 21 percent of GDP at market prices while total domestic savings from households, corporations and recurrent

[4]Institutions in SAM terminology usually include economic agents such as households, firms, government and rest-of-the world.

government amount to 12 percent of GDP, equivalent to 59 percent of total investment. This means that more than two-fifth of total investment is financed through external sources reflecting a dramatic aid dependence of Uganda's government. Maintaining a high and efficient level of investment and lowering aid dependency is a challenging task, given the need to increase the absolute levels of consumption of the Ugandan population.

In relative terms, private consumption of marketed commodities makes up 76 percent while public consumption (i.e. government and NGO consumption) amounts to 15 percent. While increase in consumption in absolute terms is important given widespread poverty, its sustainability is questionable given Uganda's high dependency on foreign sources. Therefore, for Uganda to maintain spending that is consistent with its policy priorities when aid is reduced or phased out, it must increase its domestic resources.

UgaSAM indicates that Aid and other non-factor income flows from abroad registered in the government budget amount to 42 percent. Other important sources of revenue are consumption taxes and import tariffs, accounting for 32 and 15 percent respectively, while income taxes yield 11 percent. The composition of revenue clearly reflects both a high aid dependence of the Uganda government and a limited domestic resource base. Trade taxes have so far been one of the few administratively feasible ways of mobilizing revenue from domestic sources but, their dependency will continue to reduce in line with trade reform efforts and formation of free trade areas and customs unions, and agreements with other regional blocs like the European Union. This means that strengthening the domestic revenue base is required to cover the losses from trade taxes. This is particularly the case where the East African Customs Union comprising of five countries[5] has now been implemented. Similarly, as countries compete more aggressively to attract foreign investment, there are forced to reduce corporate income tax rates to remain competitive. This implies that the tax base needs to be broadened to minimize impact on tax revenue. This is particularly so with the generous tax incentives often provided to attract foreign investors.

1.3.3 Sectoral Characteristics

The disaggregated nature of the UgaSAM makes it possible to extend the descriptive macroeconomic analysis based on MacSAM to a sectoral level. In what follows focus is, first on

[5]EAC countries include: Uganda, Kenya, Tanzania, Rwanda and Burundi

production activities, and second, on the supply and demand for commodities. The activities columns of UgaSAM indicate that value added (i.e. the earnings received by factors of production, such as employee compensation and gross operating surplus) at factor cost amounts to 54 percent of total production costs in Uganda. Table 1.3.1 shows that the share of value added is particularly high in the services sector (53 percent) followed by agriculture sector (27 percent). Within the services sector, it is wholesale & retail trade that contributes the most (about 14.3 percent) followed by real estate (9.5 percent), education (8.2 percent) and public administration (5.6 percent). In both the services and agricultural sectors, the use of intermediate inputs is relatively low, accounting for about 14 and 4 percent of total production costs respectively, an indication of the rudimentary nature of technology used in these labor-intensive sectors.

By contrast, the industry sector made the least contribution to total value-added in 2002. In fact, with the exception of the building & construction sub-sector, none of the major industry sub-sectors account for more than 4 percent of total value-added, with the industry total value-added equal to 20 percent of GDP at factor cost.

Table 1.3.1: Share of GDP Generated by Sectors

	Factors			Sector-value added at Factor cost
	Total labor	Mixed Income	Operating Surplus	
Agriculture	**18.2**	**45.1**	**1.5**	**26.8**
Industry	**13.0**	**11.1**	**50.1**	**20.1**
Mining & Quarrying	0.2	0.6	0.1	0.3
Food Processing	3.5	1.4	6.2	3.1
Other Manufacturing Activities	3.2	1.3	2.8	1.1
Electricity & Water (Utility)	2.0	0.0	15.0	3.9
Building & Construction	4.0	10.4	26.1	11.6
Services	**68.8**	**43.8**	**48.3**	**53.2**
Wholesale & Retail Trade	11.4	14.5	18.5	14.3
Hotels & Restaurants	2.2	4.6	9.8	4.9
Transport & communications	3.4	0.6	15.6	4.7
Financial services	9.4	0.9	-6.4	2.2
Real Estate/housing	0.1	21.1	0.2	9.5
Public Administration	15.0	0.0	2.7	5.6
Education	20.7	0.1	5.4	8.2
Health	3.5	0.6	2.0	1.9
Others priv. & comm. services	3.1	1.5	0.7	1.9
Total Value-added at Factor Cost	**100.0**	**100.0**	**100.0**	**100.0**

Source: Author's calculations based on UgaSAM

Total commodity supply in the columns of UgaSAM indicate that the agriculture share of total marketed supply is very low, as shown in Table 1.3.2. Industry sector play a significant role in formal sector sales, and it is also the sector in which imports make up an overwhelming share of supply. Thus, industry is the sector in which government has at present relatively easy access to revenue in the form of consumption taxes and import tariffs.

Table 1.3.2: Composition of Sectoral Supply (Billions of Uganda shillings)

	Agriculture	Industry	Services	All sectors
Domestic production	3293.7	6484.4	8932.6	18710.6
+Consumption taxes	66.9	270.1	126.6	463.6
+Import tariffs	1.1	384.3	0.0	385.5
+Imports	95.0	2241.7	613.4	2950.1
=Sectoral Supply	3456.7	9380.5	9672.6	22509.7
Share of Sectoral supply	15.4%	41.7%	43.0%	100.0%

Source: Author's calculations based on UgaSAM

The demand side of the Ugandan economy, in the commodity rows of UgaSAM (Table 1.3.3), is dominated by private consumption, but private and public investment also make up a considerable share of final demand (about 16 percent). Table 1.3.3 shows that the export share of the agricultural sector is the smallest but, since this is the sector that imports less, it is therefore the main foreign exchange earner for the economy. By contrast, the industrial sector that has the largest export share also has the largest share of imports, with imports far higher than exports. Thus, this sector runs a large trade deficit. The services sector also runs a trade deficit but is much smaller in magnitude compared to that of the industrial sector.

Table 1.3.3: Composition of Sectoral demand (Billions of Uganda shillings)

	Agriculture	Industry	Services	All sectors
Intermediate consumption	1311.4	3139.2	3324.1	7774.7
+Private consumption	1806.2	3299.3	3886.2	8991.7
+Government consumption	0.0	0.0	1808.8	1808.8
+Private & public investment	45.8	2297.5	76.9	2420.2
+Exports	293.2	644.5	576.6	1514.3
=Sectoral demand	3456.7	9380.5	9672.6	22509.7
Share of total demand	15.4%	41.7%	43.0%	100.0%

Source: Author's calculations based on UgaSAM

1.3.4 Household Incomes and Expenditures

Data on the sources of households income and expenditures is shown in Table 1.3.4. Results show that urban households receive a larger share of income from payments to labor compared to their rural counterparts. Further more, as expected, when the central region households are excluded, rural households get larger shares of income from payments of mixed income. This outcome is a characteristic of the way mixed income factor payments were constructed in the original SAM. Using data from the labor force survey module of UNHS 2002/03, mixed income was separated into mixed income from agricultural activities and from non-agricultural activities. Total mixed income from agricultural activities were then allocated to household classes using their shares of agricultural land holdings as weighting factors while total mixed income from non-agricultural activities were allocated to household classes using their shares of enterprise assets as weighting factors.

Household transfers occur largely among rural households and non for central and western urban households. Government transfers account for a small share of total income. Urban households in Uganda's poorest regions of Northern and Eastern receive the largest share of remittances from abroad, respectively, 12.5 percent and 12.8 percent. Rural households spend almost all of their resources on final consumption, while except for the central urban households, both rural and urban households almost pay the same in taxes. Thus, taxes may not be progressive, since on average rural households are poorer than urban ones and yet the share of expenditures for urban households reduces with the level of income, as does the share of expenditure for savings.[6] In fact, western rural households pay more than their urban counterparts in taxes.

Table 1.3.4: Households' sources of Income and Expenditures

	Source of income						Expenditure category					
Type of Household	labor	Mixed Income	Household transfers	Government	corporations	Remittances	Final Consumption	Household transfers	Enterprise transfers	Taxes	Savings	Transfers to RoW
Central rural	21.5	35.0	24.7	0.5	12.3	6.1	96.1		0.1	0.8	3.0	
Eastern rural	18.6	39.9	17.5	0.7	13.5	9.8	97.5		0.0	0.7	1.7	
Northern rural	37.5	19.6	21.0	0.6	12.9	8.4	98.3		0.0	1.0	0.7	
Western rural	28.5	46.2	5.8	0.3	15.2	3.9	94.7	2.1	0.1	1.3	1.7	
Central urban	33.0	46.3		0.8	16.3	3.6	55.6	22.3	0.2	2.3	8.2	11.4
Eastern urban	34.2	23.9	14.4	0.7	14.0	12.8	62.8	16.0	0.2	0.9	6.1	14.1
Northern urban	47.4	13.2	12.4	0.4	14.2	12.5	53.4	30.3	0.1	1.4	5.5	9.4
Western urban	35.8	46.0		0.2	16.1	1.8	48.2	34.1	0.4	0.6	4.8	11.8

Source and Notes: Author's calculations based on UgaSAM. All empty cells equal to zero.

[6]Data in the original SAM shows that for all regions, final expenditure and tax payments reduce for household types in the third and fourth quintile distribution while their savings increase.

1.4 The SAM-Based Multiplier Model

1.4.1 The Linear SAM Model

The linear SAM model shows the released effects generated in the economic activity of the various agents with a perspective of the circular flow of income. The relations captured by this model incorporate interdependences within the productive sphere, final demand decisions, and income distribution operations.

SAM models calculate extended multipliers that quantify the global effects in terms of increase in income, produced by exogenous income instruments. By analyzing the multipliers, it is possible to determine which agents have the greatest (smallest) effects on economic activity. In fact, the SAM model is similar to the input-output model, but with one clear difference: the SAM multipliers incorporate in the process of income creation not only production relations, but also relations of income distribution and final demand.

The SAM model rests on two limiting basic sets of assumptions. First, the existence of excess capacity and unused resources; under this demand-driven Keynesian framework, prices are obviously assumed constant since any increase in demand can be satisfied by a corresponding increase in supply (Thorbecke, 2000). Second, functional relationships represented by the SAM columns are linear. That is, the activities in SAM models assume Leontief production functions and there is no substitution between imports and domestic production in the commodity columns (Arndt et al., 2000). Therefore, the comparative static nature of the SAM multiplier analysis, as such, precludes capturing and estimating dynamic effects.

The starting point in the SAM model is to divide accounts into two types: endogenous and exogenous. In general, endogenous accounts are those for which changes in the level of expenditure directly follow any change in income, while exogenous accounts are those for which we assume that the expenditures are set independently of income (Saudolet and de Janvary, 2003). Here, we adopt the usual assumption of endogeneity made in SAM models that follows the Pyatt and Round (1985) criteria, which consider sectors of production, factors (labor, land and capital), and private consumers as endogenous components. On the other hand, the government, the saving-investment account and the foreign sector are considered exogenous components. This assumption, therefore, captures the complete relationships of the circular flow of income and shows the connections between productive income, factorial and personal distribution of

income, and consumption patterns. Table 1.4.1 contains the accounting identities (summarized in a compact form using matrix notation) inherent to a SAM in which the accounts have been divided into the above two types.

Table 1.4.1: Structure of the SAM

		Expenditures				
		Endogenous Accounts			Exogenous Accounts	Total
		Production	Factors	Households & Firms	Others	
Income	Production (activities & commodities) Factors Households & Firms	T			X	y_n
	Others	L			F	z
	Total	y'			z'	

T is the $(n \times n)$ matrix of endogenous transactions, where n is the number of endogenous accounts;
X is the $(n \times m)$ matrix of exogenous injections (demand for goods and services and other receipts of endogenous institutions from government, capital and RoW accounts), where m is the number of exogenous accounts;
L is the $(m \times n)$ matrix of leakages including outlays of endogenous towards exogenous accounts;
F is the $(m \times m)$ matrix of transactions among exogenous accounts that collectively represent the flow of funds of the considered economy;
y_n is $(n \times 1)$ vector of total income of all endogenous accounts;
z is the $(m \times 1)$ vector of total income of all exogenous accounts

To solve the model the matrix T has to be used to derive the technical coefficient matrix A_n (column shares), by dividing each element of T by the relevant element of vector y_n. Each element of matrix A_n is given by the following expression:

$$a_{ij} = \frac{t_{ij}}{y_j} \qquad i, j = 1, 2....n.$$

In matrix notation

$$A_n = \hat{y}' T \tag{1.4.1}$$

where $\hat{y}'$ denotes the diagonal matrix with the inverses of the elements of vector y_n on its main diagonal.

From equation (1.4.1) it follows that the accounting identities for endogenous accounts can now be represented in terms of matrix A_n and vectors y_n and x, the latter including the row sums of elements of matrix X, (i.e. $x = X\iota$ where ι is a column vector of ones of the proper dimension):

$$y_n = A_n y_n + x \tag{1.4.2}$$

Solving for y_n in equation (1.4.2) yields

$$y_n = (I - A_n)^{-1} x = M_a x \tag{1.4.3}$$

where x is an $(n \times 1)$ column vector of injections and I is an identity matrix of proper dimension.

In expression (1.4.3), M_a is the matrix of "accounting multiplier" (Pyatt and Round, 1979). This matrix shows the overall effect (direct and indirect) on the endogenous accounts caused by unitary income change of the exogenous accounts provided M_a exists.[1] A generic element m_{ij} of the matrix M_a reflects the increment that will accrue in the income of endogenous account i if endogenous account j receives an additional monetary unit of income from the exogenous accounts.

1.4.2 Decomposition of the multipliers

1.4.2.1 Decomposing the Accounting Multipliers Matrix

As noted before, the traditional endogeneity assumption of Pyatt and Round (1979) considers production activities, factors of production and private institutions to be endogenous components. So, matrix A_n of technical coefficients has the following structure:[2]

$$A_n = \begin{bmatrix} A_{11} & 0 & A_{13} \\ A_{21} & 0 & 0 \\ 0 & A_{32} & A_{33} \end{bmatrix}$$

where A_{11} contains the input-output coefficients, A_{13} contains the coefficients of the household sectoral consumption, A_{21} contains the factors of production coefficients, and A_{32} contains the coefficients of factors income of consumers. The SAM model therefore completes the circular flow by capturing not only the intermediate demand relations, but also the relations between factor income distribution and private consumption.

To provide a deeper insight into the analysis of SAM multipliers, Pyatt and Round (1979) divided matrix M_a into different circuits of interdependence. Specifically, if we define a diagonal matrix A_0 whose elements are the diagonal elements of matrix A_n and assume that $(I - A_0)^{-1}$

[1] Most transactions in the SAM are positive and the expenditure shares are all smaller than unity. Hence $M_a \geq 1$ (i.e., it has elements which are at least large as those in the identity matrix). This is justified if A is assumed to be semi-positive (Pyatt and Round, 1979)

[2] The commodity and activity accounts are seen as a single production account, however, they will be analyzed separately.

exists (i.e., $det(I-A_0) \neq 0$), equation (1.4.2) can be written as:

$$\begin{aligned} y_n &= A_n y_n + x = (A_n - A_0) y_n + A_0 y_n + x \\ &= (I-A_0)^{-1}(A_n - A_0) y_n + (I-A_0)^{-1} x \\ &= A^* y_n + (I-A_0)^{-1} x \end{aligned} \tag{1.4.4}$$

where $A_0 = \begin{bmatrix} A_{11} & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & A_{33} \end{bmatrix}$, $(A_n - A_0) = \begin{bmatrix} 0 & 0 & A_{13} \\ A_{21} & 0 & 0 \\ 0 & A_{32} & 0 \end{bmatrix}$ and $A^* = (I-A_0)^{-1}(A_n - A_0) =$

$$\begin{bmatrix} 0 & 0 & A^*_{13} \\ A^*_{21} & 0 & 0 \\ 0 & A^*_{32} & 0 \end{bmatrix}, \begin{cases} A^*_{21} = A_{21} \\ A^*_{13} = (I-A_{11})^{-1} A_{13} \\ A^*_{32} = (I-A_{33})^{-1} A_{32} \end{cases}$$

Multiplying both sides of equation (1.4.4) by A^* and substituting for $A^* y_n$ on the right hand side yields:

$$y_n = (A^*)^2 y_n + (I + A^*)(I-A_0)^{-1} x \tag{1.4.5}$$

where $(A^*)^2 = \begin{bmatrix} 0 & A^*_{13}A^*_{32} & 0 \\ 0 & 0 & A^*_{21}A^*_{13} \\ A^*_{32}A^*_{21} & 0 & 0 \end{bmatrix}$.

Similarly, multiplying both sides of equation (1.4.4) by $(A^*)^2$ and substituting for $(A^*)^2 y_n$ in equation (1.4.5) yields:

$$\begin{aligned} y_n &= (A^*)^3 y_n + \left[I + A^* + (A^*)^2\right](I-A_0)^{-1} x \\ &= \left[I - (A^*)^3\right]^{-1} \left[I + A^* + (A^*)^2\right](I-A_0)^{-1} x \end{aligned} \tag{1.4.6}$$

where $(A^*)^3 = \begin{bmatrix} A^*_{13}A^*_{32}A^*_{21} & 0 & 0 \\ 0 & A^*_{21}A^*_{13}A^*_{32} & 0 \\ 0 & 0 & A^*_{32}A^*_{21}A^*_{13} \end{bmatrix}$.

More generally,

$$y_n = \left[I - (A^*)^k\right]^{-1} \left[\sum_{j=0}^{k-1} (A^*)^j\right] (I - A_0)^{-1} x \tag{1.4.7}$$

In our model, $k = 3$ because we have three endogenous accounts (i.e., production, factors and institutions). Hence, equation (1.4.6) completes the three steps of decomposition. In fact, equation (1.4.6) reflects the sequence of substitution that corresponds to one complete cycle in the circular flow of income within the economy (Pyatt and Round, 1979).

If we denote $M_1 = (I - A_0)^{-1}, M_2 = \left[I + A^* + (A^*)^2\right]$, and $M_3 = \left[I - (A^*)^3\right]^{-1}$, then equation (1.4.6) can be written as

$$y_n = M_3 M_2 M_1 x \tag{1.4.8}$$

where

$$M_a = M_3 M_2 M_1 \tag{1.4.9}$$

In the expression above, matrix M_a of total SAM multipliers has been defined by three multiplicative components that convey different economic meanings.[3] After the corresponding matrix algebra has been applied, it can be seen that the first block M_1 has the following elements

$$M_1 = (I - A_0)^{-1} = \begin{bmatrix} (I - A_{11})^{-1} & 0 & 0 \\ 0 & I & 0 \\ 0 & 0 & (I - A_{33})^{-1} \end{bmatrix}$$

This matrix is called the intra-group or the matrix of transfer multiplier effects. It capturing the effects resulting from direct transfers within the endogenous accounts. Specifically, the perspectives of income transmission reflected in M_1 responds to the effects of inter-sectoral linkages and the effects of transactions between consumers.

Additionally, matrices M_2 and M_3 are as follows:

$$M_2 = \begin{bmatrix} I & A^*_{13}A^*_{32} & A^*_{13} \\ A^*_{21} & I & A^*_{21}A^*_{13} \\ A^*_{32}A^*_{21} & A^*_{32} & I \end{bmatrix}$$

[3]Note that the decomposition in equation (1.4.9) is not unique. In consequence, the interpretation of the decomposed multipliers depends basically on the division of the matrix of expenditure share coefficients, that is, the structure of matrix A_0. However, Pyatt and Round (1979) argue that the ordering adopted in (1.4.9) is perhaps to be preferred since it corresponds to the progression from transfer effects to open-loop to closed-loop models.

$$M_3 = \begin{bmatrix} \left[I - A^*_{13}A^*_{32}A^*_{21}\right]^{-1} & 0 & 0 \\ 0 & \left[I - A^*_{21}A^*_{13}A^*_{32}\right]^{-1} & 0 \\ 0 & 0 & \left[I - A^*_{32}A^*_{21}A^*_{13}\right]^{-1} \end{bmatrix}$$

The matrix M_2 is called the extra-group or the matrix of open-loop multipliers explaining "... why and how the stimulation of one part of the system has repercussions for all others" and M_3 is the matrix of inter-group or closed-loop multipliers explaining "... the consequences of change in x traveling around the entire system to reinforce the initial injection" (Pyatt and Round, 2006, p.239).

The decomposition of SAM multipliers identifies the channels through which income effects can be produced and transmitted throughout the economy. Logically, this kind of information is very useful for establishing the origin of income shocks on economic agents and institutions, and it provides deeper insights into the circular flow of income.

However, the multiplicative decomposition shown above does not enable the results to be interpreted immediately. In order to better interpret the results, we perform an additive decomposition of the multiplier matrix. This decomposition, proposed by Stone (1985),[4] allows us to use an additive formula calculated by a simple transformation of the previous multiplicative division to reveal the net contribution made by each individual effect:

$$M_a = M_3M_2M_1 = I + (M_1 - I) + (M_2 - I)M_1 + (M_3 - I)M_2M_1 \quad (1.4.10)$$

$$M_a = M_3M_2M_1 = (\mathbf{I} + \mathbf{T} + \mathbf{O} + \mathbf{C}) \quad (1.4.11)$$

where I is the initial impulse or identity multiplier (unit increase); $\mathbf{T} = (M_1 - I)$ is the net contribution of transfer multiplier effects; $\mathbf{O} = (M_2 - I)M_1$ is the net contribution of open-loop or cross-multiplier effects; $\mathbf{C} = (M_3 - I)M_2M_1$ is the net contribution of circular or closed-loop multiplier effects.[5] The above additive specification indicates that the degree of linkage in the system can be observed from the degree of departure of each matrix M_1, M_2, and M_3 from the identity matrix.

It should be pointed out that, in addition to these multiplier decomposition processes, some

[4]The first version of the paper was presented at the World Bank Conference on Social Accounting Methods in Development Planning held at the University of Cambridge, UK from 16-21 April 1978.

[5]Stone (1981) derived the equivalence shown in equation (1.4.11)

authors have proposed alternative analyses. For example, Defourny and Thorbecke (1984) proposed the so-called structural path analysis. This method observes the paths along which the multipliers travel. While this method has the advantage of obtaining the entire network through which the influence is transmitted, from the origin account to a destination account, it is extremely computational demanding. Recently, a decomposition approach proposed by Pyatt and Round (2006) and enunciated by Civardi et al. (2010) shows that each element m_{ij} of the matrix M_a can be decomposed to reveal all the direct and indirect effects, thus providing the same information on the path and linkages of a shock as in Defourny and Thorbecke (1984). Unlike the latter, the new approach which is presented next is easy to use and requires less computations.

1.4.2.2 Decomposing the elements of Accounting Multipliers Matrix

Following Pyatt and Round (2006) it is possible to disaggregate the accounting multiplier M_a and to calculate the value for each element m_{ij}. This step allows to better analyze the direct and indirect effects of any exogenous injection on the level of income of different endogenous accounts. Using equation (1.4.9), m_{ij} can be expressed as:

$$m_{ij} = d_i^{'} M_a d_j = d_i^{'} M_3 M_2 M_1 d_j = \iota^{'} (\hat{r} A \hat{s}) \iota \tag{1.4.12}$$

where (d_k, $k = i, j$) is a vector the k^{th} element of which is one and all other elements of d_k are zero (Pyatt and Round, 2006). ι is a vector of ones and the matrix A, and the vectors $r^{'}$ and s are defined as:

$$r^{'} = d_i^{'} M_3 \qquad A = M_2 \qquad \text{and } s = M_1 d_j \tag{1.4.13}$$

Equation (1.4.12) indicates that each element m_{ij} must be equal to the sum of all elements of an $\hat{r}A\hat{s}$- type transformation of the matrix M_2 where $\hat{r}$ is a diagonal matrix formed from the i^{th} row of the M_3 and $\hat{s}$ is a diagonal matrix formed from the j^{th} column of the M_1. Therefore, a complete accounting multiplier that captures the direct effects, across effects and indirect effects, arising from account j to account i ($i \neq j$) can be constructed for any i and j from the three elements namely: the i^{th} row of the matrix M_3; the entire matrix M_2 and the j^{th} column of matrix M_1. "The last of these shows how the consequences of a particular injection will be amplified as a result of transfer effects within the category of accounts in which the initial stimulus arises. The second explains how these initial effects will spread across to accounts

belonging to other categories. And the leading term $\hat{r}$ quantifies the consequences for account i of the circulation around the entire system of the *stimuli* generated via the first two mechanisms" (Pyatt and Round, 2006, p.240).

All three mechanisms are important for diagnostic reasons since they allow us to account for m_{ij} in microscopic detail. To shed more light on this point, assume that i is a particular household group ($i\varepsilon I$) and j is alternatively a particular sector of activity ($j\varepsilon P$) or ($j\varepsilon F$) for the case of factors of production. As before, if one has three blocks of endogenous accounts (i.e. activities, factors, households), then M_1 and M_3 are block diagonal matrices, and thus it follows from equation (1.4.12) that the element m_{ij} of M_a will now be an element of sub-matrices M_{IP}, M, M_{II} of M_a.

Using equation (1.4.12) and for each $j\varepsilon(P,F,I)$, the element m_{ij} can be written as:

$$m_{ij} = d_i^{'} M_{3(II)} M_{2(IP)} M_{1(PP)} d_j \tag{1.4.14}$$

$$m_{ij} = d_i^{'} M_{3(II)} M_{2(IF)} M_{1(FF)} \tag{1.4.15}$$

$$m_{ij} = d_i^{'} M_{3(II)} M_{2(II)} M_{1(II)} \tag{1.4.16}$$

where $M_{1(FF)}$ and $M_{2(II)}$ are identity matrices. Equations (1.4.14) to (1.4.16) can now be written in the form $\iota^{'}(\hat{r}A\hat{s})\iota$:

$$r^{'} = d_i^{'} M_{3(II)} \qquad A = M_{2(IP)} \qquad \text{and } s = M_{1(PP)} d_j \tag{1.4.17}$$

$$r^{'} = d_i^{'} M_{3(II)} \qquad A = M_{2(IF)} \qquad \text{and } s = M_{1(FF)} d_j = I \tag{1.4.18}$$

$$r^{'} = d_i^{'} M_{3(II)} \qquad A = M_{2(II)} = I \qquad \text{and } s = M_{1(II)} d_j \tag{1.4.19}$$

Equations (1.4.17 - 1.4.19) clearly show that the element m_{ij} is equal the sum of all of the $\hat{r}A\hat{s}$ -type transformation, where the vectors $r^{'}$ is formed from the row of the block matrices $M_{3(II)}$, ($A = M_{2(IP)}$ or $M_{2(IF)}$ or $M_{2(II)}$) and s is formed from the column of $M_{1(PP)}, M_{1(FF)}$ or $M_{1(II)}$. This decomposition shows in a clear manner the consequences of an exogenous injection in the j^{th} Activity, Factor or households account on the i^{th} household group. In particular, $M_{2(IP)}$ or $M_{2(IF)}$ are the matrices of the across- effects and they explain how the original injection into the Activities/Factors accounts has repercussions on the households account. These matrices have been bordered by the two vectors $r^{'}$ and s. The multiplier matrix M_{II} "... can be considered

a structural measure of inequality in income distribution to households. It captures, in fact, the transfer effects (related to M_1) and the closed-loop effects (related to matrix M_3) that only involve private institutions" (Civardi et al., 2010, p.116).

Civardi et al. (2010) extend the Pyatt and Round (2006) approach and show that the total impact of exogenous injections captured by the $\hat{r}A\hat{s}$ -type transformation of the multiplier m_{ij} can be divided into four effects: direct-direct; direct-indirect; indirect-direct and indirect-indirect. For example, if one considered the intersection of the institutions and production accounts, these effects can then defined as follows:[6]

(1) *Direct-Direct (D-D) effect* is the direct effect, at the end of the circular process, of an exogenous income injection in the production sector j on institution i without considering any other effect on other production sectors or on other institutions. It equals the i^{th} element of the j^{th} column vector of the matrix $\hat{r}_i A\hat{s}_j$, corresponding to the production sector where the injection first occurs and the private institution that is directly affected:

$$D-D \text{ effect} = d_i^{'}\left[(\hat{r}M_{2(IP)}\hat{s})d_j\right] \tag{1.4.20}$$

(2) *Direct-Indirect (D-I) effect* is the effect that an exogenous increase in demand for the products of production sector j has on the income of all other institutions and from those to the i^{th} ones. It is obtained as the difference between column total of the matrix $\hat{r}_i A\hat{s}_j$ (which captures the total effect of the j^{th} production sector on the total income of private institutions), and the direct-direct effect:

$$D-I \text{ effect} = (\iota_I - d_i)^{'}\left[(\hat{r}M_{2(IP)}\hat{s})d_j\right] \tag{1.4.21}$$

where ι_I is a unit vector with dimension $(I,1)$

(3) *Indirect-Direct (I-D) effect* is the effect from all other productive sector, different from the one affected by the exogenous injection, on the i^{th} institution. It captures the effect that an increase in demand for products of sector j has on all the other sectors and from those to the i^{th} institution. It is obtained as the difference between the row total of the $\hat{r}_i A\hat{s}_j$ for the i^{th} institution (which captures the total effect from the j^{th} production sector on the ith element of

[6]Definitions are taken directly from Civardi et al. (2010) with their permission.

the institution) and the direct-direct effect:

$$I-D \text{ effect} = \left[d_i^{'}(\hat{r}M_{2(IP)}\hat{s})\right](\iota_P - d_j) \tag{1.4.22}$$

where ι_P is a unit vector with dimension $(P,1)$.

(4) *Indirect-Indirect effect* is the effect from all other production sectors, different from the one affected by the exogenous injection, on the i^{th} institution. It captures the effect that an increase in the demand for the products of the sector j has on other sectors and from those to other institution. It is calculated as the difference between the total effect from the j^{th} sector on the i^{th} institution (given, itself, by the total sum of the matrix $\hat{r_i}A\hat{s_j}$ and equal to the multiplier m_{cij}) and previously identified effects (*D-D, D-I, I-D*).

$$I-I \text{ effect} = (\iota_I^{'} - d_i^{'})\left[d_i^{'}(\hat{r}M_{2(IP)}\hat{s})\right](\iota_P - d_j) \tag{1.4.23}$$

Furthermore, by combining these four different effects, it is possible to calculate: the total effects on the *ith* institution from sector j (equals the sum of the direct-direct and indirect-direct effects); the total direct effects from the j^{th} sector on all institutions (equals the sum of direct-direct and direct-indirect effects); the total indirect effects from the j^{th} sector on all the other $i^{'} \neq i$ institutions (equals the sum of direct-indirect and indirect-indirect effects) and, finally, the total indirect effects from all the other $j^{'} \neq j$ sectors on all the other $i^{'} \neq i$ institutions (equals the sum of indirect-direct and indirect-indirect effects).

It worth mentioning that the derivation of the above effects relies strictly on the structure of the matrix M_{ij} considered. For instance, when an initial injection occurs in the factors of production account, they would be no direct transfer effects among factors, i.e., $M_{1(FF)}$ is an identity matrix. This of course has significant consequences on the decomposition of the single element multiplier m_{ij} related to the effect of an exogenous injection into the j^{th} factor on the i^{th} household group, because in the $\hat{r}A\hat{s}$ transformation, the *indirect-direct* and the *indirect-indirect* effects would be zero.

1.4.3 Multiplier effects and Redistribution of incomes

The SAM multiplier analysis has traditionally focused on determining changes in absolute income levels. It is also important, however, to determine what changes the possible exogenous shocks would cause to the *relative* position of a given socio-economic category or economic agent. The accounting multipliers matrix M_a can be used as the basis to define other measures that capture these relative effects. A good example as already mentioned in the section 1.2 is found in the redistributive multipliers set forth by Roland-Holst and Sancho (1992). Following these authors, a normalized measure $\hat{s}_n$ of income shares for the endogenous accounts is considered:

$$\hat{s}_n = \frac{y_n}{\iota' y_n} \tag{1.4.24}$$

where $\hat{s}_n$ is the vector of incomes distributed among households groups and ι is the unit vector.

The change in $\hat{s}_n$ induced by an exogenous injection can be obtained by substituting the expression for y_n from equation (1.4.3) into equation (1.4.24). With matrix differentiation, one obtains:

$$\begin{aligned} d\hat{s}_n &= (\iota' M_a x)^{-1}[I - (\iota' M_a x)^{-1}(M_a x)\iota']M_a dx \\ &= \frac{1}{\iota' y_n}\left[I - \frac{y_n}{\iota' y_n}\iota'\right]M_a dx = R dx \end{aligned} \tag{1.4.25}$$

The matrix R here denotes redistribution matrix (Roland-Holst and Sancho, 1992) and determines the ultimate distribution of relative incomes resulting from different exogenous shocks. More specifically, it measures the effect of a unit change in an exogenous account (dx) on a change in the relative income ($d\hat{s}_n$) of an endogenous account. To interpret the redistributive effects more closely, it can be shown that the expression for a generic element of matrix R is the following:

$$r_{ij} = \frac{\iota' m_{.j}}{\iota' y}\left[\frac{m_{ij}}{\iota' m_{.j}} - \hat{s}_{ni}\right] \tag{1.4.26}$$

where as before m_{ij} denotes a generic element of matrix M_a. The sign of the elements of matrix R is affected by the elements in square bracket on the right hand side of equation (1.4.26). The relative position of institution i in income distribution (measured in terms of income share $\hat{s}_{ni}$) is improved when the share of total multiplier effect of an exogenous inflow towards group j (first

element in bracket) is greater than the the initial share in income distribution and vice-versa (Noh, 2010).

From equation (1.4.25), the matrix of absolute (non normalized) values of redistributive effects is given by

$$R^* = \iota' y_n R = \left[I - \hat{s}_n \iota' \right] M_a \tag{1.4.27}$$

Equation (1.4.27) yields the value of the redistribution induced by an additional unit of exogenous inflow while total income is held constant at its initial level. R^* is a sign-preserving transformation of R and the elements of each column sum to zero, as in the case of the original matrix, since only redistributive effects are accounted for. The sum of the positive elements of each column shows the overall extent of income redistribution, while the sign of each element indicates the direction of the change.

1.4.4 Multiplier effects and Poverty alleviation

In a recently published paper, Pyatt and Round (2006)[7] propose an extension of the Pyatt and Round (1979) fixed-price multiplier decomposition approach. The new approach is suitable for examining changes in poverty due to an exogenous shock. Following these authors, a measure of poverty Q which is assumed to be additively decomposable across groups of households can be expressed as follows:

$$Q = \sum_i Q_i \tag{1.4.28}$$

where i denotes a generic household group.

Defining n_i as the number of people in household group i and P_i as the proportion of people who are poor (i.e. incidence of poverty) in the same group, we can write:

$$Q_i = n_i P_i \tag{1.4.29}$$

so that the change in the poverty measure for each group is given by

$$dQ_i = n_i dP_i + P_i dn_i \tag{1.4.30}$$

[7]The reader is referred to the cited paper for more details.

Equation (1.4.30) shows that in effect, the change in the number of poor people in household group i depends both on the population of the household group and the proportion of those who are poor. With respect to the latter of these it is implicit that dP_i will depend both on changes in average income for households in group i and also on changes in prices, if only to the extent that such changes will shift the poverty line (i.e. income below which one is considered poor) and hence change the proportion of those in category i who are poor. As changes in prices cannot be addressed in a fixed-price analysis,we can only estimate the sensitivity of adopted poverty measure to changes in household group mean-incomes. Moreover, the impact of income change on poverty needs to be clarified. Kakwani (1993) showed that a change in poverty measure can be decomposed into two parts: the change in mean-per-capita income and the change in income distribution. For simplicity, if we assume that the dispersion of income within each household group i is unaffected by the change in per capita income, then we can write

$$dP_i = \frac{\partial P_i}{\partial \lambda_i} d\lambda_i \text{ and } \frac{d\lambda_i}{\lambda_i} = \frac{d\left(\frac{y_i}{n_i}\right)}{\frac{y_i}{n_i}} \tag{1.4.31}$$

where λ_i is the per capita income among households in group i and y_i is their total income. Pyatt and Round (2006) show that the change in the number of poor in a generic socio-economic group is given by

$$\frac{dQ_i}{Q_i} = \left[(1+|\varepsilon_i|)\frac{dn_i}{n_i} - \frac{|\varepsilon_i|}{y_i}\mathbf{d}_i' M_I d\mathbf{x}\right] \tag{1.4.32}$$

where ε_i is the partial elasticity of P_i with respect to λ_i (which is usually referred to as poverty elasticity for households in group i); d_i is a vector with the $i-th$ element equal to 1 with all the other elements equal to 0; M_I is the sub-matrix $(m \times n)$ of income multipliers for household groups with m= number of household groups and n =number of row/columns of multiplier matrix and x is the vector of exogenous shocks.

The expression in (1.4.32) implies that the number of poor in a socio-economic group decreases only if the increase in the average income stimulated by the growth of the economy (second term of the right hand side of the equation) is able to counterbalance the negative effect of population growth.

1.5 Empirical Application to Ugandan Economy

1.5.1 Output, Demand, Valued-Added and Income Multipliers

The accounting multiplier matrix was computed by assuming unitary income/expenditure elasticities. This is clearly a hard to imagine assumption in the real world especially with regard to household consumption patterns. We would have remedied this problem as is done in some literature by using the matrix of marginal propensities[1] instead of average propensities to compute the matrix of fixed-price multipliers. Unfortunately, the paucity of data on expenditure (income) elasticities in Uganda prevented us from correcting this problem.

Since the present multiplier framework has four endogenous accounts, for each account in the SAM we can calculate four multiplier measures: the production activity or *output multipliers*; commodity/domestic supply or *demand multipliers*; factorial income or *value added/GDP multipliers*; and the institutional *income multipliers* (see Arndt et al., 2000, p.297) which show the total effect on gross output, commodity output, GDP and institutional incomes (respectively) of a unit-income increase in a given endogenous account of the SAM. These multipliers are obtained by adding elements in the multiplier matrix along the column for each endogenous account.

Before presenting the analysis of these multipliers, it should be remembered that the entire multiplier framework is built on the SAM with sets of endogenous accounts and exogenous accounts as shown in Table A.2.1 of the Appendix A.2. We can see that all exogenous incomes for factors of production are zero, however some are zero by default or by design or even by definition. In this regard, it is not uncommon that production factors receive income remittances from abroad which can be identified from the external sector accounts as factor income payments. When the original Uganda SAM was constructed, these payments were found to be insignificant and hence they were netted out with payments abroad. Secondly, the exogenous incomes for production activities also appear as zero, here again sectors may receive production subsidies from the government. Again, data sources did not allow separating subsidies from taxes, thus direct taxes were netted out of subsides and these were then booked as outlays of production activities in the Taxes on production and imports other than VAT account (for details, see Alar-

[1] Since expenditure (income) elasticity is equal to the ratio of the marginal expenditure propensity to the average expenditure propensity for any given good *i*, it follows that the marginal expenditure propensity can be readily obtained from the product of the income elasticity and the average expenditure propensities.

con et al., 2006). This means that its the commodities and private institutions accounts that receive exogenous injections and thus, the multipliers related to these accounts are the focus in this subsection.

1.5.1.1 Output and Demand Multipliers

The commodity multipliers extracted from the overall accounting multiplier matrix (Table A.3.1 of the Appendix A.3) are presented in Table 1.5.1. They capture both the Leontief (input-output) production linkages and the consumption expenditure linkages as a result of changes in production activities through their effects on incomes of endogenous institutions (Bautista et al., 2001). If a policy maker was interested in studying the impact on the Ugandan economy of a 1 million Uganda shillings (1 mln hereafter) exogenous increase in the final demand for agricultural products (say in form of increased exports), he/she would read the relevant multipliers along the corresponding column of the commodities block of the accounting multiplier matrix.

Table 1.5.1 show that a 1 mln increase in the final demand for agricultural products would lead to an increase of 1.680 mln in Agriculture's production, 0.382 mln in trade and 0.193 mln and 0.187 mln in Other manufacturing and Real estate respectively and so on. Surprisingly, the Food processing sector which is expected to be more linked to the Agriculture sector experiences an increase in production of only 0.310 mln. If instead the 1 mln injection occurred for processed Food processed products, it would generate an increase of 1.049 mln in its own production, 0.349 mln in trade, while that of the Agriculture sector which supplies most of the intermediate inputs to Food processing sector would increase by 0.865 mln. This means that an injection in the Agriculture sector has less indirect influence on other sectors compared to the same injection in the Food processing sector (issue of direct/indirect effects will be discussed in detail later in this section). The strong effect arising from injections in either Agriculture or Food processing sectors have to do with the fact Agriculture and Food processing sectors are the two most important sector for the Ugandan economy. For example, Agriculture sector accounts for 19.4 percent of the total output (production) and 25.4 percent of the total GDP. On the commodity supply side, agriculture commodity alone represents 15.4 percent of total commodity supply, 16.9 percent of the total intermediate demand, 20.1 percent of the total private consumption demand, and 19.4 percent of total exports, while 18.1 percent and 29.6 percent of the processed food products are used for private consumption and exports respectively (see

Table 1.5.1: Aggregate Multipliers for a 1 unit increase in final demand of commodities (Absolute values)

	Commodities																
	Agric	Min	Fproc	Omnf	Util	Cons	Trade	Tour.	Trsp.	Fin.	Real Est	Gov	Educ	Health	Others	Total	Average
Agriculture	1.680	0.311	0.865	0.128	0.384	0.402	0.469	0.546	0.268	0.316	0.607	0.460	0.515	0.445	0.397	7.793	0.520
Mining	0.005	0.590	0.004	0.003	0.003	0.014	0.004	0.004	0.002	0.003	0.005	0.004	0.004	0.004	0.004	0.652	0.043
Food processing	0.310	0.160	1.049	0.072	0.201	0.213	0.255	0.284	0.145	0.172	0.318	0.249	0.264	0.236	0.214	4.142	0.276
Other Manufacturing	0.193	0.157	0.185	0.446	0.140	0.242	0.179	0.165	0.130	0.153	0.195	0.184	0.199	0.207	0.192	2.967	0.198
Public utilities	0.083	0.053	0.067	0.018	1.025	0.059	0.081	0.073	0.046	0.054	0.092	0.083	0.085	0.095	0.104	2.019	0.135
Construction	0.053	0.031	0.043	0.012	0.036	1.040	0.053	0.050	0.034	0.044	0.129	0.075	0.056	0.058	0.056	1.768	0.118
Trade	0.382	0.210	0.349	0.099	0.248	0.287	1.319	0.352	0.268	0.275	0.407	0.328	0.371	0.500	0.373	5.766	0.384
Tourism	0.063	0.034	0.049	0.011	0.045	0.046	0.056	0.972	0.036	0.062	0.078	0.060	0.071	0.058	0.063	1.703	0.114
Transport & comm.	0.138	0.076	0.118	0.033	0.094	0.116	0.172	0.128	0.699	0.121	0.141	0.178	0.128	0.141	0.134	2.416	0.161
Financial services	0.130	0.095	0.166	0.058	0.097	0.129	0.197	0.145	0.191	1.413	0.152	0.205	0.148	0.156	0.336	3.618	0.241
Real estate/housing	0.187	0.117	0.144	0.037	0.130	0.132	0.206	0.188	0.111	0.145	1.102	0.192	0.202	0.199	0.179	3.270	0.218
Government services	0.011	0.007	0.009	0.003	0.007	0.008	0.019	0.011	0.011	0.011	0.017	1.014	0.011	0.013	0.074	1.226	0.082
Education	0.125	0.068	0.088	0.024	0.087	0.087	0.107	0.152	0.062	0.078	0.146	0.216	1.126	0.151	0.100	2.619	0.175
Health	0.038	0.018	0.029	0.014	0.022	0.026	0.027	0.029	0.017	0.027	0.034	0.029	0.030	0.582	0.025	0.947	0.063
Others	0.062	0.033	0.045	0.011	0.041	0.043	0.052	0.054	0.034	0.042	0.067	0.053	0.056	0.307	0.756	1.657	0.110
Total activity (Industries)	**3.459**	**1.960**	**3.209**	**0.968**	**2.560**	**2.844**	**3.196**	**3.154**	**2.055**	**2.916**	**3.491**	**3.329**	**3.265**	**3.151**	**3.006**	**42.564**	**2.838**
Total commodity	**4.020**	**2.662**	**3.819**	**1.784**	**2.961**	**3.396**	**3.698**	**3.633**	**2.693**	**3.593**	**4.013**	**3.861**	**3.805**	**3.694**	**3.583**	**51.216**	**3.414**
Low skilled, rural male	0.219	0.096	0.126	0.023	0.058	0.071	0.088	0.082	0.047	0.056	0.091	0.088	0.094	0.078	0.074	1.291	0.086
Low skilled, rural female	0.034	0.013	0.019	0.003	0.009	0.009	0.012	0.013	0.007	0.009	0.014	0.027	0.015	0.013	0.016	0.212	0.014
Low skilled, urban male	0.032	0.037	0.030	0.013	0.020	0.030	0.047	0.024	0.022	0.018	0.027	0.036	0.025	0.037	0.050	0.448	0.030
Low skilled, urban female	0.013	0.008	0.022	0.003	0.007	0.008	0.014	0.012	0.017	0.008	0.012	0.011	0.013	0.015	0.020	0.184	0.012
Skilled, rural male	0.029	0.010	0.024	0.006	0.024	0.022	0.022	0.017	0.020	0.013	0.020	0.047	0.034	0.027	0.017	0.331	0.022
Skilled, rural female	0.016	0.010	0.018	0.006	0.011	0.014	0.022	0.016	0.019	0.129	0.018	0.025	0.024	0.025	0.033	0.385	0.026
Skilled, urban male	0.046	0.023	0.048	0.016	0.048	0.040	0.085	0.052	0.041	0.061	0.044	0.086	0.045	0.054	0.065	0.753	0.050
Skilled, urban female	0.008	0.005	0.007	0.002	0.056	0.006	0.012	0.011	0.005	0.007	0.009	0.011	0.011	0.013	0.013	0.175	0.012
High skilled, rural male	0.053	0.027	0.038	0.017	0.053	0.061	0.045	0.054	0.026	0.036	0.057	0.128	0.307	0.125	0.070	1.096	0.073
High skilled, rural female	0.017	0.008	0.014	0.003	0.009	0.010	0.017	0.015	0.007	0.009	0.016	0.022	0.081	0.031	0.013	0.271	0.018
High skilled, urban male	0.064	0.040	0.064	0.024	0.065	0.060	0.104	0.067	0.085	0.249	0.073	0.331	0.137	0.128	0.169	1.660	0.111
High skilled, urban female	0.038	0.022	0.035	0.010	0.032	0.029	0.059	0.117	0.032	0.085	0.043	0.098	0.129	0.093	0.061	0.884	0.059
Mixed Income	1.290	0.685	0.793	0.133	0.446	0.710	0.883	0.933	0.383	0.490	1.545	0.592	0.644	0.711	0.671	10.910	0.727
Capital	0.250	0.149	0.249	0.068	0.794	0.457	0.392	0.515	0.356	-0.003	0.280	0.297	0.322	0.333	0.240	4.698	0.313
Total labor	**0.569**	**0.299**	**0.443**	**0.125**	**0.392**	**0.360**	**0.526**	**0.481**	**0.328**	**0.680**	**0.423**	**0.911**	**0.914**	**0.639**	**0.602**	**7.691**	**0.513**
Total all Factors	**2.109**	**1.133**	**1.485**	**0.327**	**1.632**	**1.527**	**1.802**	**1.928**	**1.067**	**1.166**	**2.247**	**1.799**	**1.879**	**1.683**	**1.513**	**23.299**	**1.553**
Central rural	0.470	0.246	0.316	0.066	0.300	0.310	0.361	0.385	0.205	0.250	0.488	0.343	0.388	0.339	0.301	4.053	0.312
Central urban	0.668	0.377	0.489	0.111	0.516	0.488	0.636	0.664	0.362	0.463	0.773	0.669	0.560	0.572	0.557	6.861	0.528
Eastern rural	0.330	0.172	0.220	0.045	0.208	0.216	0.251	0.269	0.140	0.148	0.347	0.229	0.268	0.233	0.203	2.778	0.214
Eastern urban	0.073	0.042	0.057	0.014	0.065	0.058	0.078	0.079	0.046	0.063	0.083	0.092	0.071	0.072	0.071	0.850	0.065
Northern rural	0.146	0.074	0.100	0.023	0.105	0.101	0.112	0.119	0.069	0.087	0.136	0.136	0.172	0.123	0.103	1.388	0.107
Northern urban	0.034	0.021	0.029	0.008	0.035	0.030	0.041	0.039	0.027	0.041	0.038	0.060	0.039	0.039	0.042	0.467	0.036
Western rural	0.399	0.204	0.261	0.053	0.235	0.252	0.287	0.308	0.158	0.171	0.402	0.260	0.347	0.276	0.231	3.242	0.249
Western urban	0.126	0.072	0.093	0.022	0.095	0.092	0.121	0.120	0.070	0.092	0.145	0.134	0.104	0.108	0.109	1.305	0.100
Corporations	0.273	0.163	0.271	0.074	0.860	0.496	0.426	0.558	0.386	0.002	0.305	0.323	0.350	0.362	0.262	4.672	0.359
Total Households	**2.247**	**1.209**	**1.566**	**0.341**	**1.560**	**1.547**	**1.888**	**1.984**	**1.077**	**1.315**	**2.411**	**1.923**	**1.949**	**1.762**	**1.619**	**20.944**	**1.611**
Total all Institutions	**2.520**	**1.372**	**1.837**	**0.415**	**2.420**	**2.043**	**2.314**	**2.542**	**1.464**	**1.313**	**2.716**	**2.246**	**2.299**	**2.125**	**1.881**	**25.615**	**1.970**

Source: Author's calculations based on UgaSAM

Table 1.3.3).

Similarly, reading across the row of total activity (i.e. total *output multipliers*) and total commodity (total *demand multipliers*), an injection of 1 mln in demand for Agricultural products increases total domestic production and supply in the economy by 3.459 mln and 4.020 mln respectively, while the effects would be 3.209 mln and 3.819 mln respectively if the increase in demand occurred for Food processed products. It is clear that demand multipliers exceed output multipliers indicating that some of the demand has to be met via imports. The Other manufacturing sector has the lowest output multiplier effect (0.968) compared to the demand multiplier effect (1.784) an indication that this is the most import dependent sector. This is not surprising given that 67.7 percent of the manufacturing sector products are imported compared to exports of only 10.5 percent. Trade statistics computed from UgaSAM indicate that the Manufacturing sector faced most import competition: Import Penetration Ratio (IPR) (i.e.

the share of imports in the value of total demand) was 49.2 percent compared to the Export Intensity Ratio (EIR) (i.e. share of exports in the value of gross output) of only 10.6 percent. By contrast, even though Uganda imports agricultural goods, these account for only a small part of total agricultural demand (IPR of 2.8 percent compared to EIR of 8.1 percent).

1.5.1.2 Factor Income/Value Added GDP Multipliers

The GDP or valued added multipliers capture the induced effects on GDP at factor cost. Results in Table 1.5.1 show that Real Estate sector has the largest GDP multiplier. This is followed by Agriculture, Tourism Education and Government sectors. A 1 mln increase in final demand for the real estate sector, after all general equilibrium effects have taken place, will generate additional factor returns of 2.247 mln. If the same injection went into the agriculture sector, the effect on GDP is 2.109 mln. Regardless of which commodity account receives the injection, the production factor that benefits most is mixed income. The share of the mixed income multiplier in total GDP multiplier is highest for Real estate (69 percent) followed by Agriculture (61 percent), Mining & quarrying (60 percent) and Food processing (53 percent). In general, when capital is excluded, the mixed income and low skilled labor are the key inputs in most sectors, but more particularly in Agriculture. This result, should not be surprising since mixed income accounts for bigger share in total value added for each of these sectors, the highest being in Real estate sector (99.4 percent) followed by Agriculture (75.8 percent), Mining and quarrying (72 percent) and Food processing (19 percent) respectively.[2]

There is a clear evidence of gender disparities with regard to paid labor earnings. For all labor categories, the multiplier effects are systematically higher for male workers compared to their female counterparts regardless of the area of residence and skill levels. This means that the 1 mln exogenous increase in demand for products of all sectors will increase more than proportionately the incomes of the male workers compared to females workers. For low skilled rural labor the biggest multiplier (0.219 for rural male) and (0.034 for female) is when an injection is received by Agriculture sector, which is consistent with the fact that Agriculture is the biggest employer of unskilled workers. In contrast, for low skilled urban workers, the biggest multipliers arise when an injection is received by either Other private and community

[2]Note that mixed income is comprised of agricultural income based on household shares of land holdings and non-agricultural income based on shares of enterprise ownership. It is not surprising the sectors that use alot of land, exert larger factorial income impact on mixed income.

services, Trade, Health, Mining or Government sectors. This result is consistent with the fact alot of low skilled workers in urban centers of Uganda are self-employed; operating mainly very small scale enterprises or what is called “own account workers” in the Uganda labor Surveys. In the period 2002-2003, 54 percent of all employed persons were “own account workers”, with proportion of women who were Own account workers being higher in the urban areas than in the rural areas. Overall, men dominated as Own account workers UBOS (2003, p.20). The corresponding highest multipliers and their source for the high skilled labor categories is as follows: High skilled rural male (Education: 0.307), high skilled rural female (Education: 0.081), high skilled urban male (Government: 0.331) and high skilled urban female (Education: 0.129).

Perhaps the question to ask here is whether the observed differences between male and female labor categories is due to wage differentials or simply due to the possibility that production sectors employ more male workers than female or whether female are less economically active than male. Data from the UNHS 2002/03 labor survey shows that the majority of Uganda’s population is usually active[3] (88 percent) with females exhibiting slightly higher percentages than males (88 percent compared 86 percent). Urban dwellers are more likely to be "usually active employed" than their rural counterparts (95 percent compared to 88 percent). Looking at actual numbers of “usually active” persons for selected sectors (Table 1.5.2), it is clear that, more female than male in both rural and urban areas are employed in agriculture, Trade, Tourism and Health sectors. However, the government sector (mainly public administration) employs more male than female and so is the education sector but only in rural areas. These numbers clearly point to wage differentials as the root cause of gender inequality.

Table 1.5.2: Number of employed Persons Aged 10 Years and Above, by Industry, Residence and Sex

	Rural			Urban			National		
Sector	Male	Female	Total	Male	Female	Total	Male	Female	Total
Agriculture	2,574	3,628	6,200	77	127	205	2,652	3,755	6,397
Trade	421	342	646	198	196	394	618	422	1,037
Tourism	41	72	136	10	73	83	49	165	213
Government	38	21	40	37	7	45	75	97	83
Education	139	106	200	23	32	55	159	39	259
Health	26	30	56	10	15	26	35	58	74
Number (’000)	3,757	4,497	7,972	652	617	1,271	4,412	4,835	9,238

Source: Author’s calculations using data in UBOS (2003): in Table 3.3

[3]Persons engaged in economic activities during the 12 months prior to the survey

1.5.1.3 Institutional Income Multipliers

This Subsubsection presents a detailed analysis of three sets of multipliers related to households' incomes. The aim is to determine gross income effects for different household groups and other private institutions when an exogenous injection is received by production account, factors of production account or the institutions account itself.

First, the submatrix of multiplier contribution between commodities and households (Table 1.5.1 above), suggests that a change in final demand for Real estate by 100 million would increase total household income by 272 million. It is important to note that the transaction values reported in the SAM for real estate sector are mainly imputed rents for different dwellings. So an exogenous increase in demand may raise rents for homes or allow people to acquire better homes and hence increase household incomes. Results further show that in addition to agriculture sector, strong knock-on effects also emanate from the services sector.In particular, tourism, education, government services, and trade among others show high income effects on households. These results confirm the importance of services sector in Uganda's economy. The industrial sector[4] depicts less contribution compared to agriculture and the services sector. Under industrial sector, highest knock-on effects come from Food processing followed by Construction. Other manufacturing activity is not only the least integrated sector, but one with least knock-on effects on households and private institutions incomes. As noted before, other manufacturing sector uses alot of imported inputs into production which are leaks out of the economic system.

Regardless of the source of injection, most of the households multiplier effects occurs for central urban household group, which show the highest row total of 6.861. This means that most of the income growth goes to a small fraction of the population since only 8 percent of the population lives in the central region. If we go ahead considering the effects on different types of households, whether we look at the average values or single elements of the sub-matrix, two issues can be raised. First, with the exception of the central rural, the rural households are the beneficiaries of most of the income linkages. It is interesting to note that rural households benefit more than their urban counterparts in both agricultural and non-agricultural activities. For example, for Central, Eastern and Western rural households, highest multiplier effects would

[4]Mining & quarrying, Food processing, Other manufacturing , Electricity & Water supply and Construction sectors are classified under the Industrial sector in Uganda's National Accounts

emanate from injections in Real estate (0.488, 0.347 and 0.402 respectively) followed by Agriculture (0.470, 0.330 and 0.399 respectively) while Northern rural households would benefit more from injections into Education (0.172) and Agriculture (0.146). The systematically higher effect on incomes of rural households may be related to the fact that in this group there is the highest population share of Ugandan households.[5] Similar conclusions are drawn in Tarp and Roalnd-Holst (2002) and Pansini (2008) for the case of Vietnam. The opposite effects for the case of central rural households may be attributed to high intra-household transfers between the central urban and central rural households. Out of the 24.67 percent of the total income received from all households, central urban households transfers equal to 69.93 percent. Second, there is a regional imbalance that emerges if we compare the level of multipliers for households in the Central and Western regions with those of Eastern and Northern regions. The multipliers for the latter category are systematically lower than for the formers. This should not be surprising given that the latter regions are the poorest regions in the country.[6]

Second, we consider the submatrix of multiplier contributions between factors of production and private institutions. As noted before, factors may receive remittances from abroad. Results in Table 1.5.3 show that on average, a 1 mln exogenous injection received by the factor of production accounts would generate an income increase of 2.472 mln in the households income and an increase of 2.815 mln on total income of households and corporations. Different labor market features emerge from the analysis of the derived multipliers in this matrix. First, as in the previous matrix, on average, nearly 30 percent of increase in household incomes due to a 1 mln injection in all factors of production would accrue to central urban households. Second, with the exception of the central rural group, all other rural households receive the highest income benefit compared to urban ones. Third, there is a regional bias especially among the urban households represented by the fact that on average, the central urban and western urban households have higher expenditure effects (0.782 and 0.148 respectively) than their Eastern urban and Northern urban counterparts (0.100 and 0.057 respectively).

[5]In 2002, 86 percent of Uganda's population lived in rural areas. This marginally reduced to 83 percent in 2005.

[6]In 2002/03, the incidence of poverty for the eight household categories was: Central rural (27.6%), Central urban (7.8%), Eastern rural (48.3%), Eastern urban (17.9%), Northern rural (65.0%), Northern urban (38.9%), Western rural (34.3%), Western urban (18.6%) (author's calculations from UNHS 2002/03 data).

Table 1.5.3: Income multipliers for increase in income of factors of production (Absolute values)

	Low skilled rural male	Low skilled rural female	Low skilled urban male	Low skilled urban female	Skilled rural male	Skilled rural female	Skilled urban male	Skilled urban female	High skilled rural male	High skilled rural female	High skilled urban male	High skilled urban female	Mixed Income	Operating Surplus	Total	Average
Central rural	0.629	0.627	0.348	0.359	0.683	0.765	0.352	0.366	0.590	0.446	0.347	0.361	0.525	0.359	6.757	0.483
Central urban	0.508	0.507	1.039	1.101	0.501	0.510	1.067	1.161	0.497	0.497	1.026	1.136	0.826	0.567	10.943	0.782
Eastern rural	0.422	0.460	0.232	0.229	0.394	0.355	0.232	0.226	0.387	0.475	0.231	0.225	0.374	0.255	4.497	0.321
Eastern urban	0.059	0.059	0.147	0.123	0.058	0.059	0.178	0.132	0.058	0.058	0.152	0.157	0.087	0.071	1.398	0.100
Northern rural	0.242	0.397	0.122	0.121	0.279	0.285	0.119	0.109	0.355	0.146	0.130	0.109	0.143	0.122	2.678	0.191
Northern urban	0.033	0.030	0.099	0.095	0.030	0.030	0.096	0.059	0.029	0.029	0.125	0.068	0.039	0.037	0.799	0.057
Western rural	0.620	0.423	0.220	0.220	0.533	0.517	0.216	0.214	0.540	0.811	0.220	0.210	0.434	0.290	5.468	0.391
Western urban	0.096	0.096	0.246	0.225	0.095	0.096	0.195	0.182	0.094	0.094	0.232	0.161	0.155	0.106	2.072	0.148
Total Households	**2.607**	**2.598**	**2.453**	**2.473**	**2.574**	**2.618**	**2.455**	**2.448**	**2.550**	**2.557**	**2.464**	**2.428**	**2.582**	**1.807**	**34.612**	**2.472**
Corporations	0.300	0.299	0.243	0.245	0.296	0.302	0.244	0.243	0.293	0.293	0.244	0.241	0.279	1.275	4.796	0.343
Total	**2.907**	**2.898**	**2.696**	**2.717**	**2.870**	**2.920**	**2.698**	**2.691**	**2.842**	**2.850**	**2.708**	**2.670**	**2.861**	**3.082**	**39.409**	**2.815**

Source: Own calculations based on UgaSAM

Reading column wise, a number of effects can be observed. First, there is evidence of gender bias among few household groups. A 1 mln injection into low skilled rural female labor would increase incomes of western rural households by 0.423 mln compared to 0.620 mln if the the same injection went into low skilled rural male labor. The reverse occurs when the same injection is via high skilled labor category with increases in income of 0.540 mln for high skilled rural male compared to 0.811 mln for high skilled rural female category (read the intersection of the row of Western rural with respective columns). Looking at the Northern rural households, we can see that a 1 mln injection into low skilled rural female workers increases household income by 0.397 compared to 0.242 if the same injection was via low skilled male workers. On the other hand, the same exogenous injection in high skilled rural male workers increases incomes by 0.355 mln compared to only 0.146 for female. For central rural households, gender bias is only observed among high skilled labor with increases in income of 0.590 for male compared to 0.446 for female workers. For the remaining household groups, there is no evidence of gender nor location bias in the way each factor of production affects household incomes. A perusal of the results in Table 1.5.3 reveals an interesting pattern. With the exception of Central region households, a 1 mln injection in any of the labor category benefits rural households more than the urban households regardless of the skill level and location of the factor. The low skilled and skilled labor types contribute more to income growth of central urban households compared to their rural counterparts.[7] Overall, urban households in Eastern and Northern regions are the least beneficiaries of any exogenous injection via factors of production. This may be because the two are the poorest regions in the country. It is interesting to note that central urban house-

[7]The 2002 labor survey data on earnings by main occupation showed that only one third of the urban dwellers earn less than 40,000 shillings (about US$ 20) per month as compared to 45 percent for their rural counterparts

holds benefit the same from an injection into the incomes of either low skilled or high skilled labor category.Monthly Earnings of Currently Employed Persons Aged 10 Years and Above, During the Last 7 days, by Residence (%)

As expected, rural households benefit more than their urban counterparts from injections via mixed income. This is because the source of mixed income in rural areas is mainly land holdings while in urban areas is enterprise ownership and income from other informal activities. The high income growth for central urban households (0.826) compared to central rural households (0.525) emanating from injections into mixed income is a clear indication that most informal activities are concentrated in the central region. This is not surprising give that it is the most urbanized region. On the other hand, capital has the highest income impact on central urban household group (0.567 mln) and lowest impact on Northern urban households (0.037 mln).

Third, and to conclude this Subsubsection, we shall consider the submatrix of multiplier contributions between private institutions themselves. Exogenous injections into the institutions account may be in form of transfers from the government, remittances from abroad or through commuting labor abroad or returns on overseas investments. These multipliers show the effects on each private institution after increasing by the same amount the incomes of all private institutions. The last two columns of Table 1.5.4 shows that central urban household group has the highest row total and average of 5.266 and 0.585 respectively, thus, they show the highest level of impact due to an exogenous injection. It also shows marked income distribution biases towards the urban households in the Northern, Eastern, and western regions. On average, the transfer benefits accruing to these household groups constitute only (6.0, 4.9 and 6.9 percent respectively) of the total average benefit (2.902 mln) to all households compared to 20.2 percent that goes to Central urban households. This finding is consistent with previous studies in Uganda (e.g. Ssewanyana and Younger, 2007; Ssewanyana et al., 2004) based on National Household surveys which show that, for example, between 1997/98 and 2002/03, income inequality among urban households increased by 37 percent compared to only 16 percent among the rural households. Therefore, from the policy standpoint, our finding suggests that any policy intervention focusing on reducing inequality among urban households will thus benefit the overall personal income distribution and create greater equity. Overall, rural households benefit more on average (combined share of 48.6 percent) from income transfers than their urban counterparts except for Central rural.

Looking at other columns of Table 1.5.4, one observes that all diagonal elements are greater than one indicating that an injection of 1 mln into incomes of any of the household groups (say in form of family allowances) results into an increase greater than one due to feedback effects. The highest diagonal element corresponds to central urban households. A 1 mln injection into this household account would lead to an increase of 1.397 mln in the account itself while, as a result of trickle down effect, the increase in incomes of other households would range between 0.029 mln for Northern Rural to 0.406 mln for Central Rural. The fact that Central urban households gets a direct injection means that they get the million plus 0.397 mln as a result of feedback's. The third last row of Table 1.5.4 shows that when corporations are excluded, highest bilateral income linkages would come from injections going into Western rural (2.970). On the other hand, over 50 percent of benefits originating from an injection into corporations goes to central households. This is not surprising because most corporations are located in the central region, specifically, in the capital city (Kampala) and the surrounding metropolitan areas like Entebbe, Wakiso and Mukono. Overall, last row of Table 1.5.4 clearly show a bias towards rural households in terms of significant knock-on effects, indicating that any policy intervention targeted at rural households would generate higher income effects for all institutions.

Table 1.5.4: Income multipliers for increase in households' and corporations incomes (Absolute value)

	Central rural	Central urban	Eastern rural	Eastern urban	Northern rural	Northern urban	Western rural	Western urban	Corporations	Total	Average
Central rural	1.327	0.406	0.328	0.249	0.333	0.267	0.331	0.264	0.359	3.865	0.429
Central urban	0.514	1.397	0.515	0.396	0.519	0.423	0.516	0.418	0.567	5.266	0.585
Eastern rural	0.228	0.210	1.229	0.333	0.233	0.186	0.231	0.316	0.255	3.222	0.358
Eastern urban	0.060	0.058	0.060	1.047	0.060	0.050	0.060	0.092	0.071	1.558	0.173
Northern rural	0.105	0.098	0.106	0.082	1.106	0.386	0.107	0.147	0.122	2.258	0.251
Northern urban	0.030	0.029	0.031	0.024	0.030	1.030	0.030	0.044	0.037	1.287	0.143
Western rural	0.270	0.205	0.271	0.205	0.276	0.220	1.296	0.319	0.290	3.352	0.372
Western urban	0.097	0.075	0.097	0.075	0.098	0.080	0.097	1.079	0.106	1.804	0.200
Total Households	2.632	2.479	2.637	2.411	2.656	2.642	2.669	2.679	1.807	22.611	2.512
Corporations	0.307	0.247	0.308	0.250	0.301	0.258	0.302	0.258	1.275	3.504	0.389
Total Institutions	2.939	2.726	2.945	2.661	2.957	2.900	2.970	2.937	3.082	26.116	2.902

Source: Own calculations based on UgaSAM.

1.5.2 Linkages and Key Sector Analysis

In this subsection, we use the backward and forward linkages generated from the overall accounting matrix as the main identification criteria for key sectors of the Ugandan economy. Then, to check how consistent the rankings are, we use the sectoral growth impact criteria.

Note that any exogenous injection(s) into the system will increase the income of the corre-

sponding account at first and it will trigger off effects on the income of all other endogenous accounts, thus, creating both direct and indirect effects. Indirect effects are the sum of production linkages and consumption linkages. Consumption linkages reflect increased incomes generating consumption demand for other sector's products. On the other hand, production linkages are comprised of forward and backward linkages (Breisinger et al., 2009). For example, an increase in exports for Uganda's agricultural products will be satisfied partially by domestic production and partially by an increase in imports. While the latter will not produce any further effects on the economy (i.e. leakages), the former will generate a second round of effects via the inter-industry interdependencies, leading to an increase in production also in the other domestic production activities. Moreover, the general increase in output will in turn generate an increase in the income earned by factors of production and, consequently, in the income accruing to institutions supplying factors themselves. A further round of effects will also be generated by the increase induced by institution's expenditure, leading to a further round of impacts on demand for commodities.

The column total and row sum of the accounting matrix M_a can be called total backward linkages (BL) and total forward linkages (FL) (see, e.g., Sonis et al., 2000). While the interpretation of these measures is straight forward with in the Input-Output model, it is not in SAM models simply because the linkages are a composite of effects for several types of accounts. For example, domestic commodities are produced by domestic activities and factors of production transfer the bulk of their income to the institutions and principally to households. Thus, in lumping all linkage effects, as is the case with total linkages, one incurs double counting. To remedy this problem, various normalizations of total backward and forward linkages have been proposed and used in empirical studies; the commonly used is that proposed by Hirschman-Rasmussen (1957) which involves dividing total linkages by the average value of the total multiplier matrix M_a.

The normalized forward linkages of sector i quantifies the change in income in sector i, relative to the average change in the economy, caused by a unitary injection in the final demand of all sectors. A value greater than one indicates that a unit change in all sectors' final demand would create an above average increase in income of sector i. Similarly, backward linkages of sector j quantifies the change in economy wide income relative to the average change in the economy, caused by a unitary injection in the final demand of sector j and a value greater than

one indicates a unit change in final demand in sector j will create an above average increase in income in the economy. A *key* sector can then be defined as one with both backward and forward linkages greater than one. Similarly, a weak sector is one in which both backward and forward linkages less than one. A sector with *backward (forward)* linkages greater than 1, and *forward (backward)* linkages less than 1, is called *backward (forward) oriented (Sonis et al., 2000).* Following this criteria, the total backward and forward linkages from across all production activities are calculated and divided by average value of all elements of the accounting multiplier matrix. These results are summarized in Table 1.5.5 below.[8]

Table 1.5.5: Total Backward and Forward Linkages for Production Activities

Activity	Total Backward Linkages: BL	Total Forward Linkages: FL	Normalized $\overline{BL}$	Normalized $\overline{FL}$
Agriculture	11.67	30.71	1.17	3.09
Mining	10.12	1.84	1.02	0.18
Food processing	10.77	16.42	1.08	1.65
Other Manufacturing	6.11	11.16	0.61	1.12
Public utilities	8.96	6.19	0.90	0.62
Construction	8.87	4.89	0.89	0.49
Trade	10.01	20.39	1.01	2.05
Tourism	10.54	5.13	1.06	0.52
Transport & comm.	8.81	8.49	0.89	0.85
Financial services	9.65	10.58	0.97	1.06
Real estate/housing	11.69	11.39	1.18	1.14
Government services	10.38	2.66	1.04	0.27
Education	10.57	8.53	1.06	0.86
Health	9.91	3.13	1.00	0.31
Others	9.55	4.86	0.96	0.49

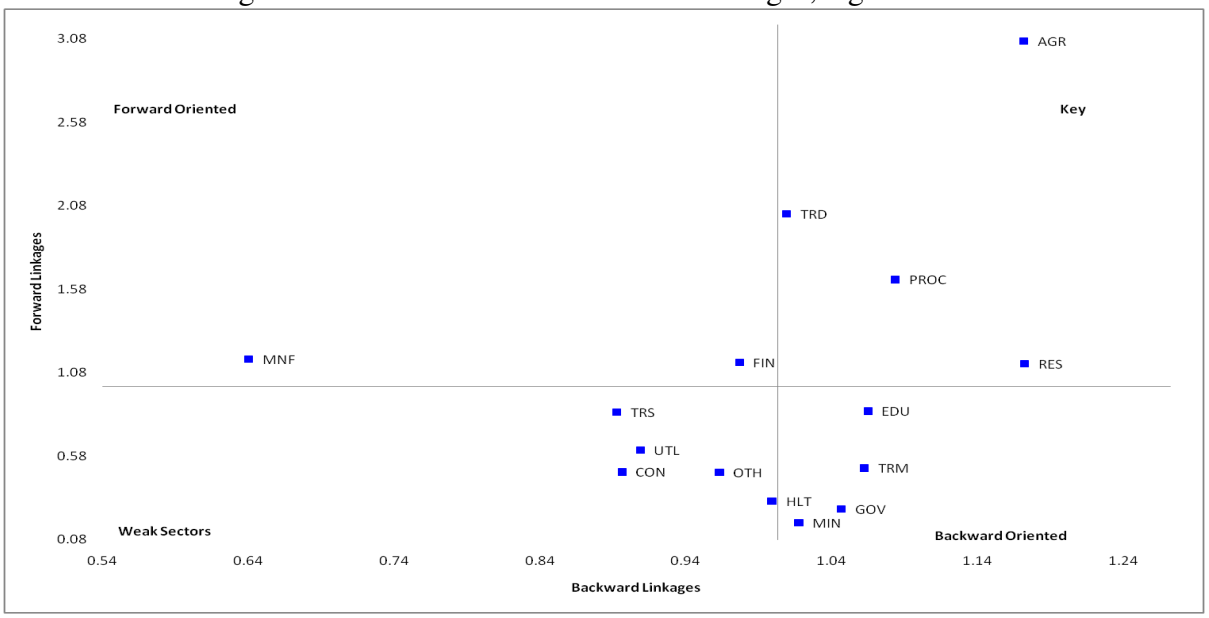
Source: Authors calculations based on UgaSAM

A scatter plot (Figure 1.5.1) of the numbers in the last two columns of Table 1.5.5 representing the relationship between forward and backward linkages for all production activities suggests that Agriculture, Trade, Food processing and Real estate services were Uganda's key sectors in 2002. Similarly, Transport and communication, Construction, Utilities (Water & Electricity) and Other private and community services sectors were weakly linked with the rest of the economy. Education, Health, Government services, Tourism and Mining were the backward oriented sectors while Manufacturing and Financial services were the forward oriented

[8]Note that the Hirschman -Rasmussen indices do not take into account the relative importance of each sector in terms of GDP, final demand, or total production. It is common to use total production shares to compute weighted linkages indices (see, e.g Cuello et al., 1992; Parra and Wodon, 2008). In our case, the ranking of key sectors did not change when weighted backward (forward) linkages were used and so we chose not to report these results.

sectors. This ranking shows that Uganda is still an agricultural country although the services sector is taking an increasing role. For instance, according to UNDP (2007), agriculture and the Service sectors contributed a combined 80 percent to GDP in 2007 and the agriculture sector contributed over 70 percent of export earnings, all domestic food requirements, and nearly all raw materials used in the industrial sector during this period. Therefore, if Uganda is to achieve its poverty alleviation and economic growth targets by 2015, policy interventions should focus on Agriculture transformation by increasing its budget share and increasing its productivity.

Figure 1.5.1: Backward and Forward Linkages, Uganda 2002

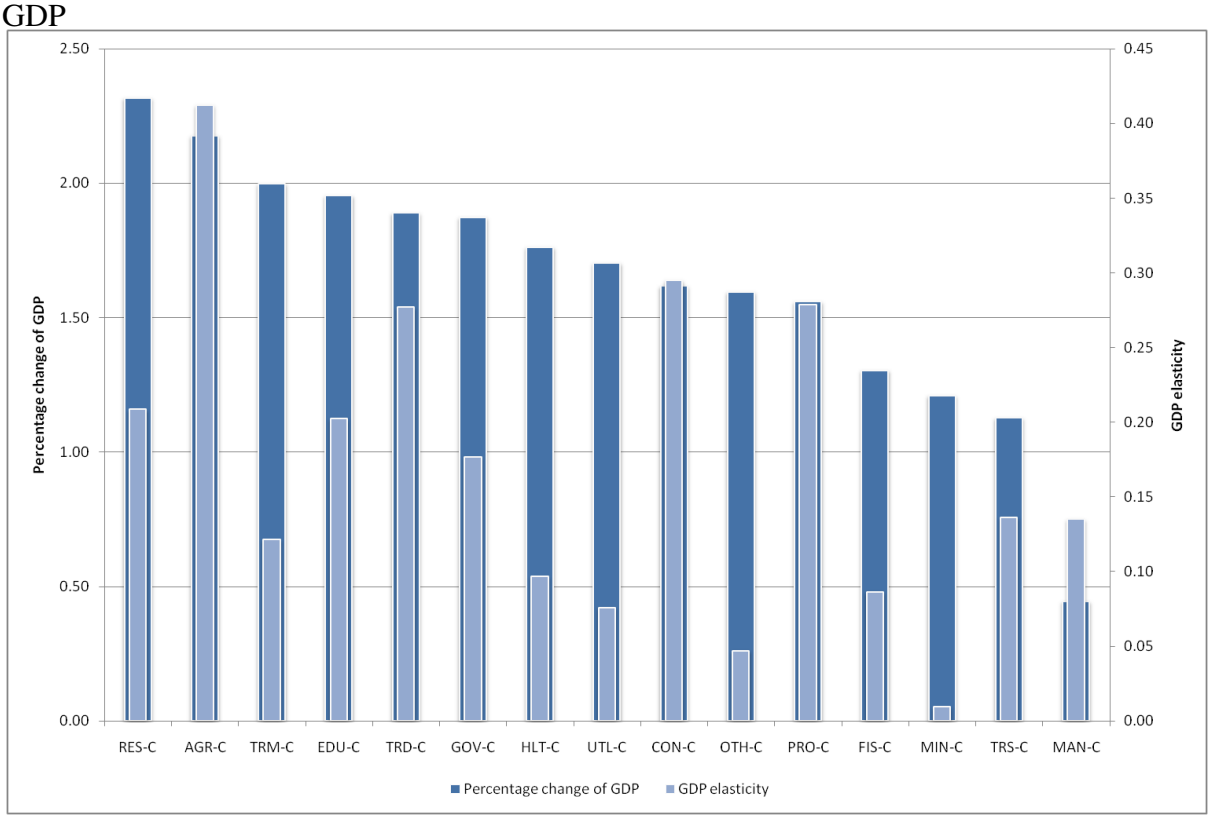


Sectors: AGR-Agriculture, MIN-Mining, PROC-Food processing, MNF-Other Manufacturing, UTL-Public utilities, CON-Construction, TRD-Trade, TRM-Tourism,TRS-Transport & communications, FIN-Financial services, RES-Real Estate/housing,GOV-Government services, EDU-Education services, HLT-Health services, OTH-Other Private & Community services

Lastly in this subsection, we check our results for the rankings of key sectors using another criteria. This criteria identifies key sectors by comparing the productive sectors in terms of their impacts on growth in the event of an exogenous shock to productive sectors. This can be done in two ways: we can shock all sectors, one at a time, by the same exact amount, and compare the impact on aggregate GDP (or production); or we can compute the GDP elasticity for each sector, i.e., the percentage change in aggregate GDP caused by a 1 percent change in the sector's production (supply).[9]

[9]"If GDP_j and Y_j denote sector j's GDP and total supply respectively while the variables without sub index denote aggregate figures, then sector j's impact on aggregate GDP can easily be computed as: $\triangle GDP_j = \sum_i \frac{GDP_j}{Y_j} m_{ij}(Shock/GDP)$ where the Shock is expressed as a percentage of aggregate GDP and is held constant across sectors j. The endogenous percentage change in commodity j's supply is given by $\triangle Y_j = m_{jj} Shock/Y_j$. GDP elasticity of commodity j's total supply can be expressed as: $\varepsilon_{GDP,,j} = \triangle GDP_j / \triangle Y_j$" (Parra and Wodon, 2008)

Figure 1.5.2: Sectoral growth impact and GDP elasticity due to a shock of 1% of aggregate GDP



Commodities: AGR-Agriculture, MIN-Mining, PROC-Food processing, MNF-Other Manufacturing, UTL-Public utilities, CON-Construction, TRD-Trade, TRM-Tourism,TRS-Transport & communications, FIN-Financial services, RES-Real Estate/housing,GOV-Government services, EDU-Education services, HLT-Health services, OTH-Other Private & Community services

Figure 1.5.2 shows the ranking of sectors in terms of their importance with regard to sectoral growth impact on one hand and GDP elasticity on the other when there is a shock of 1 percent of aggregate GDP. Results show that in 2002, the sector with the highest impact on aggregate GDP was Real estate with 2.32 percent increase in aggregate GDP, followed by Agriculture (2.18 percent), Tourism (2.00 percent) and Education (1.95 percent). The sectors with lowest impacts are Other manufacturing (0.44 percent), and Transport and communications (1.13 percent). The sector with highest GDP elasticity is Agriculture with an elasticity of 0.41, meaning that a 1 percent change in agriculture total supply causes a change in aggregate GDP of 0.41 percent. Construction is the sector with the second highest elasticity (0.29), followed by food processing and trade sectors each with elasticity of 0.28. The sector with the lowest elasticity, mining (0.01) is also the third lowest sector on the side of aggregate percentage change. From a policy standpoint, if one is interested in growth in GDP, the sectors with high percentage changes are the potential candidates. The ranking of sectors in this case is pretty much consistent with that under the backward and forward linkage criteria thus, giving us reasonable confidence in the

identified key sectors.

1.5.3 A Multipliers Decomposition Applied to Uganda

This subsection first presents results for the decomposition of the multiplier matrix for Ugandan economy using the additive transformation proposed by Stone (1985) under three hypothetical experiments. For each simulation, the first column of the table presents the transfer (within-account) effects, second column is the spillover (open-loop) intra-account effects, and the third column presents all the indirect or circular (closed-loop) effects. The last column of the results table shows the overall effect which is simply the sum of the three separate effects. It is worth mentioning as a general rule that transfer effects would be zero in cases where the origin and the destination sectors belong to different accounts. Also, a relatively large transfer effect (and correspondingly, a small closed-loop effect) points to a highly integrated sector which has weak forward links to the rest of the economy (i.e. a backward oriented sector). Moreover, open-loop effects would be zero if origin and destination sectors belonged to the same account block.[10] A large open-loop effect between two accounts suggests a high degree of dependence of the destination account upon the origin account, but the link does not have to be symmetrical (Roland-Holst and Sancho, 1995). Second, selected results for the decomposition of elements of multiplier matrix related to household incomes, i.e. sub-matrices activities-households and factors-households are also presented.

1.5.3.1 Experiment 1: Economy-wide Effects of Export-led sectoral growth in Agriculture sector (a 50 percent increase in agriculture exports: UGX 146.6 billion)

The effects of an injection of UGX 146.6 billion in Agriculture exports are shown in Table 1.5.6. This injection leads to an increase in total production of 2.69 percent of which 0.96 percent (about 35.7 percent of the overall change) generated by transfer effects alone. The remaining 1.73 percent (about 64.3 percent of the overall change) corresponds to closed loop effects. Total supply increases by 1.96 percent of which 0.22 percent (11.2 percent of the total effect) is accounted for by transfer effects and 1.74 (about 88.8 percent of the overall change) by feedback/closed loop effects. It should be noted that relative to other sectors, a shock in

[10]For example, if an exogenous shock is received by the agriculture sector, then open-loop effects would be zero for the entire production account block (i.e., activities and commodities)

Agriculture leads to a higher transfer effect within the sector itself (4.48 percent), highlighting the interdependency. Similarly, large closed loop effects and small transfer effects point to the fact that Agriculture has strong forward linkages with rest of the economy. Open loop effects for the production account are zero because the source and destination of the injection are in the same account bloc (i.e. production account).

The sectoral impact of the shock to Agricultural exports shows that Agriculture is the most important sector with an overall increase in production of 6.83 percent, of which 4.48 percent (65.6 percent of the overall change) is due to inter-industry flows. Other sectors that would benefit from this policy experiment include Food Processing (2.21 percent); Electricity and Water (2.48 percent); Trade Service (2.41 percent); Transport (2.22 percent) and Manufacturing (1.97 percent). With regard to the factor incomes block, all transfer effects are zero since origin (production) and destination (factors) are in different account blocks.

Table 1.5.6: Selected Results of the effects of a 50 percent increase in Agriculture exports (UGX 146.6 billion)

	Transfer Effects (%)	Open-loop Effects (%)	Closed-loop Effects (%)	Overall (%)
Agriculture	4.48	0.00	2.34	6.83
Food Processing	0.11	0.00	2.10	2.21
Other Manufacturing	0.23	0.00	1.65	1.97
Public Utilities	0.10	0.00	2.37	2.48
Trade	0.22	0.00	2.18	2.41
Transport & communications	0.23	0.00	1.99	2.22
Real estate and Housing	0.10	0.00	2.49	2.59
Other Private and Community Serv.	0.13	0.00	2.08	2.21
Total production	0.96	0.00	1.73	2.69
Total supply	0.22	0.01	1.74	1.96
Low skilled rural male	0.00	3.38	2.14	5.52
Low skilled rural female	0.00	3.07	1.89	4.96
Low skilled urban male	0.00	0.69	1.75	2.44
Low skilled urban female	0.00	0.42	2.04	2.46
Skilled rural male	0.00	1.03	1.48	2.52
Skilled rural female	0.00	0.36	1.68	2.04
Skilled urban male	0.00	0.41	1.67	2.08
Skilled urban female	0.00	0.12	1.99	2.11
High skilled rural male	0.00	0.15	1.25	1.40
High skilled rural female	0.00	0.46	1.54	2.00
High skilled urban male	0.00	0.11	1.17	1.28
High skilled urban female	0.00	0.09	1.40	1.50
Mixed Income	0.00	2.06	2.08	4.14
Capital	0.00	0.18	1.54	1.72
Central rural	0.00	1.36	1.67	3.03
Central urban	0.00	1.06	1.67	2.73
Eastern rural	0.00	1.33	1.62	2.95
Eastern urban	0.00	0.75	1.42	2.17
Northern rural	0.00	1.12	1.51	2.62
Northern urban	0.00	0.55	1.34	1.89
Western rural	0.00	1.52	1.76	3.28
Western urban	0.00	1.07	1.69	2.76

Source and Notes: Author's calculations based on UgaSAM. For exposition purposes only eight most affected sectors are reported in the activities bloc

Overall, the Table shows that low skilled workers in rural areas will benefit more than high skilled labor. This is consistent with the fact that Agriculture is the major employer of workers

in rural areas and most rural households earn their livelihood from this sector (UNDP, 2007). Incomes of Rural Male low skilled workers increased by 5.52 percent, slightly above their female counterparts (4.96 percent) as a result of the shock to Agriculture. This could be attributed to the fact that most households in Uganda are male-headed and therefore control household earnings. Surprisingly, there is no significant difference between the aggregate effects on income of Low Skilled labor in urban areas by gender. The total income of Low Skilled Urban labor regardless of gender increases by about 2.4 percent as a result of the injection in Agriculture. Apart from the Low Skilled labor in rural areas, the closed loop effects for the remaining categories are larger than the open loop effects, signifying that Agriculture has strong forward and backward linkages with the rest of the economy and feed back effects are the most important for all sectors. Thus a shock to Agriculture exports generates significant income changes to Low Skilled labor in both rural and urban areas, and to Capital. However, incomes of High Skilled labor in urban areas are least affected by the same shock.

The impact on household income is differentiated and seems persistently higher for rural households than their urban counterparts. Households in the Western regions are affected more by a shock to Agriculture exports relative to other household groups. The aggregate effect on incomes of Western rural (3.28 percent) and Western Urban (2.76 percent) households are slightly above their Central counterparts (at 3.03 and 2.73 percent).

1.5.3.2 Experiment 2: Economy-wide effects of a 5% decline in Migrant remittances

Money sent home by Ugandans living in the diaspora (i.e. migrant remittances[11]) is expected to reach US$981m (about UGX 2.3 trillion) by the end of 2011, statistics from Bank of Uganda show.[12] This shows an increase from $773m (UGX 1.8 trillion) in 2010 and $732 million in 2008, making it the largest source of foreign exchange revenue in the country.[13] It is hoped that increased inflows of remittances would help to bridge the savings-investment gap, reduce pressure in the foreign exchange market and contribute to economic growth. In addition, remittances plays a significant role in reducing poverty and enhancing human development through

[11]Migrant remittances are defined as the sum of workers' remittances, compensation of employees, and migrants' transfers(WorldBank, 2010, xvi)

[12]The true size, including unrecorded flows through formal and informal channels, is believed to be significantly larger

[13]In 2010, remittances surpassed traditional foreign currency earners like tourism, which amounted to $400m (UGX 900b), coffee at $269m (UGX 605b) and fish at $144m (UGX 323b).

health and education. In 2010, for example, education (20.2 percent), health (24.8 percent) and food (12.4 percent) were the biggest uses of remittance monies in Uganda(WorldBank, 2010).

There is no doubt remittances play a very important role and thus, a shock that reduces migrant remittances is likely to affect household consumption and savings decisions and also have an impact on output, growth and factorial and household income distribution. For instance, the decline in Uganda's economic growth from 7 percent in 2008/09 to 6 percent in 2009/10 was partly due to falling inflows particularly migrant remittances which were 5 percent lower than the 2008 level of $732m.

Table 1.5.7 shows the SAM multiplier decomposition of the economy-wide effects of a 5 percent decline in foreign remittances. Under this simulation, total production decreases by 0.46 percent of which 0.20 percent (about 43.48 percent) is due to transfer effects and -0.27 percent (about 58.69 percent) correspond to closed loop effects. Similarly, total domestic supply decreases by 0.47 percent as a result of the shock. The transfer effects are zero because the shock originated from household account, which is different from labor and production accounts. Sector wise, the Table shows that the production of Transport & communications, Other Service,Trade Service, Food Processing, Financial services, Agriculture, and Electricity and Water, and Real estate and housing would decline by 0.53 percent to 0.65 percent with a 5 percent reduction in migrant remittances. Feed back effects are more important for production activities, factors and households. This can be summarized as follows: A decrease in household incomes as result of fall in foreign remittances leads to a decline in total domestic activity production, leading to fall in their payment to factors. In addition, since Agriculture is the key employer of low skilled labor, a decline in the sector's production leads to a fall in payments particularly to low skilled labor in rural areas which in turn affects household incomes. In fact, the decline in household income is between 0.38 percent and 0.49 percent, with the rural household affected most by the shock. Open loop effects are zero for households since origin and destination sectors belong to the same account block.

Table 1.5.7: Selected Results of the effects of a 5 percent decline in Migrant Remittances (UGX 33.45 billion)

	Transfer Effects (%)	Open-loop Effects (%)	Closed-loop Effects (%)	Overall (%)
Agriculture	0.00	-0.28	-0.35	-0.63
Food Processing	0.00	-0.26	-0.32	-0.58
Public Utilities	0.00	-0.28	-0.36	-0.64
Trade	0.00	-0.26	-0.33	-0.59
Transport & communications	0.00	-0.22	-0.31	-0.53
Financial Services	0.00	-0.16	-0.29	-0.45
Real estate and Housing	0.00	-0.26	-0.38	-0.65
Other Private and Community Serv.	0.00	-0.23	-0.32	-0.55
Total production	**0.00**	**-0.20**	**-0.27**	**-0.46**
Total supply	**0.00**	**-0.20**	**-0.26**	**-0.47**
Low skilled rural male	0.00	-0.25	-0.32	-0.57
Low skilled rural female	0.00	-0.23	-0.28	-0.51
Low skilled urban male	0.00	-0.20	-0.27	-0.47
Low skilled urban female	0.00	-0.24	-0.31	-0.55
Skilled rural male	0.00	-0.17	-0.22	-0.40
Skilled rural female	0.00	-0.16	-0.28	-0.44
Skilled urban male	0.00	-0.19	-0.26	-0.45
Skilled urban female	0.00	-0.23	-0.30	-0.53
High skilled rural male	0.00	-0.14	-0.19	-0.33
High skilled rural female	0.00	-0.17	-0.24	-0.41
High skilled urban male	0.00	-0.12	-0.18	-0.31
High skilled urban female	0.00	-0.16	-0.22	-0.37
Mixed Income	0.00	-0.24	-0.31	-0.55
Capital	0.00	-0.18	-0.23	-0.41
Central rural	-0.04	0.00	-0.45	-0.49
Central urban	0.00	0.00	-0.44	-0.44
Eastern rural	-0.05	0.00	-0.43	-0.48
Eastern urban	-0.02	0.00	-0.38	-0.40
Northern rural	-0.08	0.00	-0.40	-0.48
Northern urban	-0.02	0.00	-0.36	-0.38
Western rural	-0.01	0.00	-0.47	-0.48
Western urban	0.00	0.00	-0.45	-0.45

Source and Notes: Author's calculations based on UgaSAM. For exposition purposes only eight most affected sector are reported in the activities bloc

1.5.3.3 Experiment 3: Economy-wide Impact of UGX 154.19 billion decline in Import Tariff Revenue

At first, the nature of the SAM multiplier model (demand-based model) would not seem to allow the modeler to perform a trade liberalization simulation, which is a supply-side experiment. However, such a policy experiment could be converted into a demand-based experiment under some assumptions. For the present case, since trade liberalization (reduction in tariff rates) could affect governments customs revenue, one could make the inference that investigating the effects of trade liberalization is similar to looking at the impact of a decline in government's import tax revenues. Moreover, it is crucial in conducting SAM multiplier experiments to identify the exogenous account(s) in which the injection originates. So, since our structure of the Uganda SAM only suggests that import taxes go from the corresponding tax account (Import duties; VAT on imports account) to the core or recurrent government account (an exogenous account), it is impossible to conduct such an experiment using the same matrix (A_n -matrix)

of average expenditure propensities used in previous experiments. Hence, the core government account was endogenized and a new technical coefficient matrix A_g and the corresponding accounting multiplier matrix M_g were computed.

The results of this trade liberalization experiment are presented in Table 1.5.8. It is worth noting that the importance of the present illustration comes from the fact that import taxes represented 26 percent of government revenue (excluding donor funds) or 3.3 percent of GDP at market prices (in year 2002). Therefore a shock that reduces international revenues is likely to have adverse effects on the Ugandan economy. For example, due to the 2008 global financial crisis, import duties reduced dramatically causing a revenue shortfall of about UGX 151 billion against government revenue targets for the financial year 2008/09 (MoFPED, 2009).

Table 1.5.8: Selected Results of the effects of a 40 percent tariff cut (UGX 154.2 billion decline in Import tax revenues)

	Transfer Effects (%)	Open-loop Effects (%)	Closed-loop Effects (%)	Overall
Public Utilities	0.00	-0.52	-1.53	-2.05
Transport & comm.	0.00	-0.70	-1.32	-2.02
Financial services	0.00	-1.00	-1.40	-2.41
Real estate &housing serv.	0.00	-0.53	-1.65	-2.18
Government Services	0.00	-5.57	-0.09	-5.67
Education Services	0.00	-2.98	-0.93	-3.91
Health Services	0.00	-3.12	-0.78	-3.90
Other Private and Community Serv.	0.00	-1.55	-1.36	-2.91
Total production	**0.00**	**-0.88**	**-1.15**	**-2.03**
Total Supply	**0.00**	**-0.82**	**-1.13**	**-1.95**
Low skilled rural male	0.00	-0.42	-1.37	-1.79
Low skilled rural female	0.00	-1.21	-1.21	-2.43
Low skilled urban male	0.00	-0.85	-1.12	-1.98
Low skilled urban female	0.00	-0.55	-1.34	-1.90
Skilled rural male	0.00	-1.70	-0.96	-2.66
Skilled rural female	0.00	-1.25	-1.17	-2.42
Skilled urban male	0.00	-1.32	-1.09	-2.41
Skilled urban female	0.00	-1.09	-1.29	-2.38
High skilled rural male	0.00	-2.71	-0.82	-3.53
High skilled rural female	0.00	-2.47	-1.01	-3.48
High skilled urban male	0.00	-2.83	-0.79	-3.62
High skilled urban female	0.00	-2.21	-0.93	-3.14
Mixed Income	0.00	-0.30	-1.36	-1.66
Capital	0.00	-0.73	-1.07	-1.80
Central rural	-0.08	0.00	-1.81	-1.90
Central urban	-0.09	0.00	-2.00	-2.09
Eastern rural	-0.09	0.00	-1.71	-1.80
Eastern urban	-0.09	0.00	-1.92	-2.01
Northern rural	-0.08	0.00	-2.01	-2.10
Northern urban	-0.07	0.00	-2.15	-2.21
Western rural	-0.06	0.00	-1.87	-1.93
Western urban	-0.05	0.00	-2.08	-2.14
Core Government	0.00	0.00	0.00	0.00

Source and Notes: Author's calculations based on UgaSAM. For exposition purposes only eight most affected sector are reported in the activities bloc

Our results indicate that under this experiment, total domestic production would decline by 2.03 percent with open-loop effects amounting to 0.88 percent decline and 1.15 percent decline due to closed-loop or feedback effects. There is no transfer effects for activities since the origin

of the shock (core recurrent government account) and destination sectors (production activities) are in different blocs.

Across all sectors, the Table 1.5.8 shows that Government services are significantly affected (5.67 percent decline in their SAM value) with open-loop effects accounting for 98. 23 percent of the overall change (5.57 percent). The domestic production of Public Utilities,Transport & communications, Financial services, Real estate & housing services, Education Services, Health Services and Other Private and Community Services would decline by 2 percent to nearly 4 percent with open-loop effects dominating for Education, Health and Other private and community services while closed-loop effects dominate for the other sectors.

On the factors of production side, high skilled urban male category would be most affected with 3.62 percent overall decline followed by high skilled rural male. This result is not surprising since from Government to labor factors of production, these two factors are the ones with a higher multiplier effect (see the intersection of row of high skilled rural and urban male and column of government sector in Table 1.5.1). Overall, the entire high skilled labor category is the most affected since the government sector in Uganda is the biggest employer of high skilled labor. Low skilled and skilled labor types would potentially decrease by 1.79 to 2.66 percent. Open-loop effects of trade liberalization on high skilled and skilled labor incomes are substantial; on average they represent 74.25 percent and 54.25 percent respectively. Meanwhile closed-loop effects are more important for the low skilled labor categories; on average representing 62.42 percent of their overall decline. Capital (operating surplus for corporations) and Mixed income are the least two affected factors of production. This result is not surprising since mixed income sub-account in the SAM is capturing mostly incomes from land and enterprise holdings mainly in the informal economy.

For all household groups, there are transfer effects but there are no open-loop effects. While the former shows the interactions between the origin sector or account (Core Government) and government transfers accruing to different households, the latter is explained by the fact that the origin of the shock (Core Government) and household categories belong to the same institutions block. Results show that households in the Northern region are the most affected. This result is not surprising given that the government has been spending alot of money in this region through the Northern Uganda Recovery program aimed at helping and resettling people initially displaced by war. Moreover, a large number of people in this region still live in In-

ternally Displaced Camps (IDPs) which heavily depend on both donor and government funds. What also emerges from Table 1.5.8 is that on average, urban households would be more affected compared to their rural counterparts. Closed-loop effects dominate transfer effects as they account for 94.24 percent of the overall change. The dominance of closed-loop effects over transfer effects is indicative of a low degree of dependence of the household account (destination account) upon the Core Government (origin sector). This is was expected since in the 2002 Uganda SAM, government transfers to households accounts for only 1.73 percent of the total household income. Alternatively, household incomes might be depending on sectors such as Government services which belong to the production activities block. Lastly, the effects of a reduction in import tax revenues accruing to Uganda are almost negligible on recurrent government itself as one should expect since in our SAM the core government is linked to the rest of the economy mainly through its activities with the Government services sector. For example, the core government expenditure on government services amounts to 37.3 percent of its total expenditure.

1.5.4 Multiplier decomposition into direct and indirect effects of some selected elements of the accounting multiplier matrix

For exposition purposes, Table 1.5.9 shows the $\hat{r}A\hat{s}$ matrix where $r^{'}$ is the row of $M_{3(II)}$ corresponding to the central rural household group, A is equal to $M_{2(IP)}$ and s is the jth column of $M_{1(PP)}$ corresponding to the agriculture production sector. Since $M_{2(IP)}$ is a 9 x 15 matrix, each element of the multiplier matrix is disaggregated into 135 components. We can notice that the sum of all elements in Table 1.5.9 (bottom right corner) corresponds exactly to an increase in the incomes obtained by central rural households as a result of an exogenous injection of one monetary unit into the Agriculture sector (i.e. intersection of row of central rural and column of agriculture sector in Table A.3.1 of Appendix A.3). Most of the elements of in Table 1.5.9 are zero, indicating that they are not sufficiently large enough to contribute to total multiplier effect.

Table 1.5.9: Decomposition of the multiplier contribution between Central rural households and Agriculture sector

	Agric	Min	Foodproc	Manfc	Util	Cons	Trade	Tourism	Trspt	Financ	Realest	Gov	Educ	Health	Others	Total
Central rural	0.281	0.000	0.000	0.000	0.001	0.000	0.005	0.000	0.002	0.001	0.002	0.000	0.000	0.001	0.000	0.295
Central urban	0.045	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.048
Eastern rural	0.049	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.052
Eastern urban	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005
Northern rural	0.021	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.022
Northern urban	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002
Western rural	0.061	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.063
Western urban	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008
Corporations	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	0.470	0.000	0.001	0.001	0.001	0.000	0.010	0.000	0.003	0.002	0.004	0.000	0.000	0.002	0.001	**0.495**

Source: Own calculations based on UgaSAM

Table 1.5.10 shows some selected results from the $\hat{r}A\hat{s}$ type decomposition, showing the four effects derived from exogenous income injections. It contains the level and share of the four effects for selected household groups and production activities. These results have been derived with respect to Central rural, Eastern rural, Western rural, Central urban and Western Urban households.[14] The production activities selected are those identified as key sectors plus one sector (Tourism) from those sector that backward oriented. for each i and j accounts.

Looking at the effects of an injection into the agriculture sector on the Central rural households, the level of total multiplier effect is 0.495 indicating that an exogenous increase of 1 mln in the demand for agricultural products, after income circulates in the entire economic system, will increase the incomes of Central rural households by 0.495 mln. This total effect can be divided into direct and indirect effects and as expected, the highest is the direct-direct effects (56.8 percent). This effect reduces to 53.3 percent and 56.6 percent respectively when we examine Eastern and Western rural households. The shares of direct-direct effects from agriculture activity are similar for all rural households despite Eastern and Western rural households having lower total multiplier effect (0.348 and 0.420 respectively). It is interesting to notice that the main income activation effect even from other institutions is the direct one from agriculture (38.2 percent for Central rural, 38.8 percent for Western rural and 41.9 percent for Eastern rural) households. This means that any exogenous injection into the production of agriculture products has an income effect that is spread among all institutions and not only on the household considered by the selected multiplier. Thus, any development policy benefiting the agricultural sector production in Uganda would have a widespread impact on the institution's income, and particularly on that of households.

When the exogenous injection into agriculture is transmitted to the Central urban house-

[14]Other tables for decompositions for other households are not presented in this study but are available upon request

holds and Western urban households we find that, different from rural households, the total multiplier effect is much higher (0.703) for Central urban households and much smaller for Western households. Moreover, in this case, the highest effects are those related to the capacity that agriculture production has to stimulate the incomes of other institutions (share of Direct-Indirect effects equal to 47.6 percent and 56.3 percent respectively). This means that when a policy is targeted at urban households, the benefits are spread all over other institutions, and particularly on other households. Clearly, results in Table 1.5.10 show that an injection into the agricultural sector regardless of where it is transmitted would generate minimal indirect effects. Both the indirect/direct effects from other activities and indirect/indirect effects from other institutions and activities are very small. This means that stimulating the agriculture sector has stronger direct-direct effects and direct-indirect effects from other institutions particularly for rural households, but less capacity to activate other sectors as indicated. Similar conclusions are drawn in Civardi et al. (2010).

Next, we investigate the effects from the industry sector, particularly, the manufacturing sector. Among the manufacturing sector, food processing has strong linkages with the agriculture sector and therefore, apriori, one may expect strong similar direct effects on households as was the case with agriculture. Decomposition results for the food processing sector (see column FoodProc) show that direct effects are actually lower than indirect effects. The shares for indirect-direct effects for the Central, East and West rural households are 45.8 percent, 442.1, and 44.1 respectively. The corresponding indirect-indirect effects are 32.4 percent, 36.1 percent and 34.7 percent respectively. Clearly, these results show that stimulating food processing sector activates other sectors, from those the effects are transmitted to other institutions, which in turn stimulate the incomes of rural households. As was the case for the agriculture sector, for food processing, the multiplier is is higher for the Central urban households and smallest for Western urban households. The existence of stronger indirect effects compared to direct ones has been found in Indonesian case for food processing by Pyatt and Round (2006) and recently, in the case of Vietnam, Civardi et al. (2010) arrive at a similar conclusion. The authors find that for rural households both male and female multipliers from an injection into the food processing activity are systematically higher than those of self-employed urban households, both male and female. Although in our case, households are not classified by gender and type of employment as in these studies, we still find that overall, food processing benefits rural households

more than their urban counterparts. Therefore, from a policy standpoint, our results suggest that stimulating the industrial sector, particularly the manufacturing activities of food processing can have significant effect on the income of the poorest households. These results therefore support Uganda's core development strategy of agriculture-led growth accompanied by growth in food processing industries.

In addition to agriculture and food processing activities, we have also decomposed the effects of injections into Real estate, Trade and Tourism sectors on the same household groups above. Stimulating production activities related to Real estate sector generates higher effects on both rural and urban households' incomes than any other of the considered sector. What emerges is the predominance of direct-direct effects and direct-indirect effects from other institutions on total multiplier. Interestingly, Real estate sector activates similar indirect-indirect effects as the agriculture sector. However, Trade and Tourism sectors activate relatively larger indirect-indirect effects (between 8 and 12 percent) compared those activated by agriculture and Real estate sectors (below 5 percent). These results again confirm the importance of the services sector in Uganda's economy. From a policy standpoint, these results could have double implication: on one hand, interventions in services sector such as trade, for, example, does activate important channels between households that allow transmission of total effects more than that of agriculture. On the other hand, policy targeted to a specific group of households especially through the services sector must take into account these indirect effects.

Table 1.5.10: Decomposition into direct/indirect effects for some selected elements of Institutions and Activities Multiplier block

		Origin of a unit exogenous injection and percentage of total effect									
Targeted Household		Agric	%	FoodProc	%	Trade	%	Real estate	%	Tourism	%
Central rural	Direct/Direct effect	0.281	56.8	0.042	12.0	0.160	44.2	0.281	55.7	0.184	46.4
	Indirect/Direct effects from other activities	0.014	2.7	0.160	45.8	0.042	11.5	0.014	2.9	0.039	10.0
	Direct/Indirect effects from other institutions	0.189	38.2	0.034	9.8	0.129	35.6	0.198	39.3	0.144	36.3
	Indirect/Indirect effects from other activities and from other institutions	0.011	2.2	0.113	32.4	0.032	8.7	0.011	2.1	0.029	7.3
	Total effect	0.495	100.0	0.349	100.0	0.362	100.0	0.504	100.0	0.396	100.0
Eastern rural	Direct/Direct effect	0.185	53.3	0.026	10.9	0.104	41.5	0.191	53.1	0.121	43.5
	Indirect/Direct effects from other activities	0.008	2.4	0.102	42.1	0.025	9.8	0.009	2.6	0.025	9.0
	Direct/Indirect effects from other institutions	0.146	41.9	0.026	10.8	0.098	38.9	0.151	42.0	0.110	39.5
	Indirect/Indirect effects from other activities and from other institutions	0.008	2.4	0.087	36.1	0.025	9.8	0.008	2.3	0.022	8.0
	Total effect	0.348	100.0	0.242	100.0	0.251	100.0	0.359	100.0	0.277	100.0
Western rural	Direct/Direct effect	0.238	56.6	0.030	10.6	0.116	40.5	0.222	53.3	0.131	41.5
	Indirect/Direct effects from other activities	0.010	2.3	0.126	44.1	0.028	9.8	0.011	2.6	0.030	9.5
	Direct/Indirect effects from other institutions	0.163	38.8	0.030	10.6	0.114	39.8	0.174	41.8	0.129	40.9
	Indirect/Indirect effects from other activities and from other institutions	0.010	2.3	0.099	34.7	0.028	9.9	0.009	2.3	0.025	8.1
	Total effect	0.420	100.0	0.286	100.0	0.287	100.0	0.416	100.0	0.315	100.0
Central urban	Direct/Direct effect	0.326	46.4	0.082	14.9	0.317	49.7	0.428	53.8	0.359	52.2
	Indirect/Direct effects from other activities	0.026	3.7	0.224	40.9	0.075	11.8	0.022	2.8	0.062	9.0
	Direct/Indirect effects from other institutions	0.335	47.6	0.052	9.5	0.196	30.7	0.327	41.2	0.219	31.9
	Indirect/Indirect effects from other activities and from other institutions	0.017	2.4	0.191	34.7	0.049	7.8	0.018	2.2	0.047	6.8
	Total effect	0.703	100.0	0.549	100.0	0.636	100.0	0.795	100.0	0.688	100.0
Western urban	Direct/Direct effect	0.050	37.5	0.013	12.5	0.049	40.6	0.065	43.4	0.050	39.8
	Indirect/Direct effects from other activities	0.004	3.1	0.035	33.4	0.012	9.9	0.003	2.3	0.010	7.8
	Direct/Indirect effects from other institutions	0.075	56.3	0.013	12.1	0.048	39.6	0.077	51.5	0.054	43.5
	Indirect/Indirect effects from other activities and from other institutions	0.004	3.0	0.044	41.9	0.012	9.8	0.004	2.7	0.011	8.9
	Total effect	0.132	100.0	0.104	100.0	0.121	100.0	0.149	100.0	0.124	100.0

Source: Own calculations based on UgaSAM

We also looked at the decompositions of elements of the accounting multiplier M_{IF} that maps increases in factorial income into households income. This analysis is motivated by the belief that for increases in sectoral output to increase incomes they must, in the first instance, generate an effective demand for factor services, specifically, demand for unskilled labor because this the only asset the poor households in both rural and urban areas have. Therefore, labor markets are crucial for understanding how a demand-driven intervention in the economic system translates into new factorial distribution and redistribution of income. For instance, it is rational to suppose that demand for rural labor would increase with an increase in agricultural exports and at the same time that demand for urban workers employed in value added industries such as food processing that have strong backward linkages with agriculture to increase.

As in the case of production sectors, we calculate $\hat{r}A\hat{s}$ - type transform in which $r^{'}$ is the i^{th} row of $M_{3(II)}$, A is equal to $M_{2(IF)}$ and s is the column j of $M_{1(FF)} = I$. This means that in the case of any injection into factor accounts, there are no indirect effects, and thus, the total multiplier can only be divided into direct-direct effects from factor j to household i and from

factor j to other households and from those households to household group i (direct-indirect effect).

Table 1.5.11 contains results for the level and shares of the four effects for the case of an exogenous injection into rural labor factors of production and these results have been derived with respect all rural households. Starting with the low skilled rural male category, the level of total multiplier is highest for central rural households (0.629) followed by that of western rural households (0.446). The corresponding direct-direct effects are 64.3 percent for central rural and 72 percent for western rural respectively. Notice that although the level total multiplier for the Eastern and Northern rural households are lower (0.422 and 0.242 respectively), the share of direct-direct effect is almost same as that of their central rural counterparts (57.1 percent and 62.9 percent respectively). Comparing these results with those when an injection goes into low skilled rural female labor category, the picture remains almost the same for central rural households but changes for the other three household groups. The level total multiplier for western rural households now reduces to 0.423, while that of Eastern and Northern rural households increases to 0.288 and 0.397, thus confirming the existence of gender bias in these three households groups. Thus policies aimed at raising incomes of low skilled rural female workers would increase the incomes of the two poorest households in the country (Eastern rural and Northern rural) compared to the same policies targeted at their male counterparts.

An exogenous injection transmitted through the skilled labor type would again be more beneficial to central and western rural households with the level of total multiplier of 0.684 and 0.533 respectively and the corresponding direct-direct effects accounting for 70.5 percent 63.8 percent respectively. Notice however that with the exception of central rural households and Northern rural households, the other two household groups would benefit less from injections into skilled labor type compared to low skilled type. Comparing with the results when an exogenous injection is transmitted through the skilled female labor type, the multipliers are almost the same except for the central rural households, thus indicating a gender bias only within the central rural household group.

Looking at the High skilled rural male labor type, again the level of total multiplier is higher for central and western rural household but it is smaller than what they receive if an injection goes low skilled. For central rural households, the multiplier effect is also smaller than when an injection goes into skilled labor type. From high skilled rural male to central and western

rural households, direct-direct effect (0.362 and 0.352 respectively) represent 61.3 percent and 65.6 percent respectively of the of the total effect (0.590 and 0.540 respectively). Comparing with results for high skilled female type, there is a marked gender bias that emerges. For high skilled female labor, the multipliers for Western rural and Eastern rural households are much higher (0.811 and 0.475 respectively) and direct-direct effects represents 85.7 percent and 65.6 percent respectively. On the other hand, the multiplier effects are much lower for Central and Northern rural households (0.446 and 0.146 respectively). Moreover, in this case the direct-indirect effects from other institutions predominate: they represent 61.7 percent and 66.7 percent respectively of the total multiplier for the respective household group. What is also emerging from these results is that income changes occur for the majority households (Central, Eastern, Northern) from the effect of an exogenous injection into the female factor with low education (low skilled and skilled).

Table 1.5.11: Decomposition in direct/indirect effects on Institutions of an exogenous injection into Rural labor factors of production

		Low skilled rural male		Skilled rural male		High skilled rural male		Low skilled rural female		Skilled rural female		High skilled rural female	
			%		%		%		%		%		%
Central rural	Direct/Direct effect	0.404	64.3	0.482	70.5	0.362	61.3	0.402	64.2	0.583	76.2	0.171	38.3
	Direct/Indirect effects from other institutions	0.224	35.7	0.202	29.5	0.228	38.7	0.225	35.8	0.182	23.8	0.275	61.7
	Total effect	0.628	100.0	0.684	100.0	0.590	100.0	0.627	100.0	0.765	100.0	0.446	100.0
Eastern rural	Direct/Direct effect	0.241	57.1	0.210	53.2	0.203	52.6	0.288	62.5	0.157	44.2	0.312	65.6
	Direct/Indirect effects from other institutions	0.181	42.9	0.184	46.8	0.184	47.4	0.172	37.5	0.198	55.8	0.163	34.4
	Total effect	0.422	100.0	0.394	100.0	0.387	100.0	0.460	100.0	0.355	100.0	0.475	100.0
Northern rural	Direct/Direct effect	0.152	62.9	0.195	69.9	0.280	78.8	0.324	81.6	0.199	69.9	0.049	33.3
	Direct/Indirect effects from other institutions	0.090	37.1	0.084	30.1	0.075	21.2	0.073	18.4	0.086	30.1	0.098	66.7
	Total effect	0.242	100.0	0.279	100.0	0.355	100.0	0.397	100.0	0.285	100.0	0.146	100.0
Western rural	Direct/Direct effect	0.446	72.0	0.340	63.8	0.352	65.2	0.197	46.6	0.315	60.8	0.695	85.7
	Direct/Indirect effects from other institutions	0.174	28.0	0.193	36.2	0.188	34.8	0.226	53.4	0.203	39.2	0.116	14.3
	Total effect	0.620	100.0	0.533	100.0	0.540	100.0	0.423	100.0	0.517	100.0	0.811	100.0

Source: Own calculations based on UgaSAM

Lastly in this application, we analyze the impact on urban household incomes of an exogenous injection into urban labor factors of production- low skilled, skilled and high skilled. These results are presented in Table 1.5.12. What emerges is that the central urban households is almost the only beneficiary of an exogenous unit income injection in any of the labor factors of production. The level total multiplier in each case exceeds 1 with direct-direct effects of over 80 percent regardless of the source of increased demand for factor services. In addition, there is no evidence of gender bias in terms of of the sources of factorial income within the central urban household group. Lack of evidence of gender bias is also observed within the Western and Northern urban household groups but only in the case of low skilled and skilled labor types.

From high skill male to Western urban and Northern urban households, total multipliers (0.232 and 0.125 respectively) are higher than (0.161 and 0.068 respectively) for the case when an injection goes from high skilled female. The corresponding direct-direct effects are also higher: 71.2 and 82.3 percent respectively compared to 56.9 percent and 66.6 percent respectively in the case of high skilled female. Overall, an exogenous injection into any of the female labor types would increases incomes of Central and Eastern urban households more than when the same injection is targeted at male labor category. The reverse is true for the Western and Northern urban households.

Table 1.5.12: Decomposition into direct/indirect effects on Institutions of an exogenous injection into Urban labor factors of production

		Low skilled urban male		Skilled urban male		High skilled urban male		Low skilled urban female		Skilled urban female		High skilled urban female	
			%		%		%		%		%		%
Central urban	Direct/Direct effect	0.831	80.0	0.865	81.1	0.812	79.1	0.907	82.4	0.987	85.1	0.960	84.5
	Direct/Indirect effects from other institutions	0.208	20.0	0.202	18.9	0.214	20.9	0.194	17.6	0.173	14.9	0.177	15.5
	Total effect	1.039	100.0	1.067	100.0	1.026	100.0	1.101	100.0	1.161	100.0	1.136	100.0
Eastern urban	Direct/Direct effect	0.104	71.1	0.136	76.7	0.110	72.2	0.079	64.5	0.089	67.6	0.116	73.5
	Direct/Indirect effects from other institutions	0.042	28.9	0.041	23.3	0.042	27.8	0.044	35.5	0.043	32.4	0.042	26.5
	Total effect	0.147	100.0	0.178	100.0	0.152	100.0	0.123	100.0	0.132	100.0	0.157	100.0
Northern urban	Direct/Direct effect	0.077	77.4	0.074	76.6	0.102	82.3	0.072	76.1	0.036	61.2	0.045	66.6
	Direct/Indirect effects from other institutions	0.022	22.6	0.023	23.4	0.022	17.7	0.023	23.9	0.023	38.8	0.023	33.4
	Total effect	0.099	100.0	0.096	100.0	0.125	100.0	0.095	100.0	0.059	100.0	0.068	100.0
Western urban	Direct/Direct effect	0.181	73.3	0.127	64.9	0.165	71.2	0.158	70.0	0.113	62.2	0.092	56.9
	Direct/Indirect effects from other institutions	0.066	26.7	0.068	35.1	0.067	28.8	0.067	30.0	0.069	37.8	0.069	43.1
	Total effect	0.246	100.0	0.195	100.0	0.232	100.0	0.225	100.0	0.182	100.0	0.161	100.0

Source: Own calculations based on UgaSAM

1.5.5 Redistributed income sub-matrices for activity-households and households-households

A more detailed analysis was made of two sets of multipliers related to households' incomes: *activity sectors-households* and *households-households*.[15] The activities-households' multipliers are those that reflect how exogenous injections into the activity sectors affect household incomes. On the other hand, households-households multipliers are those that reflect how those incomes are affected when households receive exogenous inflow income transfers. The aim is to determine in relative terms for which household groups increments in final exogenous demand or in income transfers are beneficial, and for which they are detrimental. For easy interpretation of results, the analysis is done using the income redistribution matrix R^*.

[15] "Elements of the matrix R are in a one-to-one correspondence with those of the original M_a, and the normalization of incomes can be chosen for the subgroup of endogenous institution under study" (Roland-Holst, 1990, p.129)

Starting from the activities-households submatrix of M_a, we calculated its corresponding redistributed income matrix (Table 1.5.13). The last row indicates the redistribution of household income over each sector of activity when there is an increase its corresponding demand of 1 mln. For example, if there is an exogenous increase in the demand for agricultural products, 0.094 mln of household income would be redistributed: 0.029 mln corresponding to the first households group, 0.011 mln to the third and 0.054 mln to the seventh, while the rest of the household's incomes would undergo a relative worsening.

Table 1.5.13: Redistributed income between production sectors and households

	Agric	Min	Foodproc	Manfc	Util	Cons	Trade	Tourism	Trspt	Financ	Realest	Gov	Educ	Health	Others	Average.
Central rural	0.029	0.013	0.006	-0.003	-0.007	0.005	-0.011	-0.006	-0.010	-0.011	0.015	-0.036	0.004	-0.003	-0.020	-0.002
Central urban	-0.033	0.001	0.008	0.012	0.032	0.006	0.048	0.052	0.036	0.065	0.021	0.071	-0.050	0.003	0.056	0.022
Eastern rural	0.011	0.001	-0.006	-0.010	-0.015	-0.004	-0.017	-0.013	-0.019	-0.048	0.006	-0.045	-0.009	-0.015	-0.026	-0.014
Eastern urban	-0.024	-0.016	-0.010	-0.001	-0.001	-0.008	-0.003	-0.005	0.001	0.009	-0.022	0.010	-0.013	-0.006	0.001	-0.006
Northern rural	-0.014	-0.019	-0.012	-0.002	-0.006	-0.008	-0.021	-0.024	-0.009	-0.007	-0.037	0.000	0.036	0.009	-0.013	-0.009
Northern urban	-0.018	-0.012	-0.007	0.001	-0.001	-0.006	-0.002	-0.008	0.003	0.013	-0.020	0.016	-0.006	-0.004	0.004	-0.003
Western rural	0.054	0.029	0.017	-0.002	-0.007	0.013	-0.005	-0.002	-0.012	-0.040	0.032	-0.039	0.048	0.016	-0.018	0.006
Western urban	-0.004	0.004	0.004	0.005	0.005	0.003	0.012	0.006	0.010	0.020	0.005	0.023	-0.010	0.000	0.016	0.007
Total effect	**0.094**	**0.046**	**0.034**	**0.015**	**0.030**	**0.027**	**0.060**	**0.057**	**0.050**	**0.098**	**0.078**	**0.120**	**0.088**	**0.016**	**0.076**	**0.034**

Source: Author's calculations based on UgaSAM

One observes that a higher redistribution of household incomes occurs when an injection goes into the services sector, especially government and financial services. Agriculture which is a key sector in Uganda also has strong redistribution effects. However, the industrial sector has the lowest redistribution effects.

It is more interesting to consider the values in the last column. This column represents the mean redistributive effects of a unitary increment in demand. One observes that pattern of relative improvements or worsening showed by the mean effect remains, almost independently of which production sector receives the exogenous injection. These results clearly depict the increasing regional disparities in Uganda. In particular, the results show a worsening in the relative position of all households (both rural and urban) in Eastern and Northern regions. The only household groups that benefit in relative terms are those from rich regions of Western and Central Uganda. Note that the gain in relative terms for central urban household group is nearly 2 times that of all western region household groups, an indication of unequal distribution of income between the rich households in these regions.

Second, and to conclude our analysis of redistributive income, we shall consider the households-households multipliers and its corresponding redistributed income matrix (see Table 1.5.14).

The aim is to determine how the relative incomes of households are affected by transfers received by the households themselves.

In contrast to Table 1.5.13 and with the exception of Northern rural household group, one observes a clear predominance of negative signs. The exogenous income transfers only improve the relative position of the household group that received them, so that there are no mutually beneficial linkages (symmetric pairs of positives). The Northern rural household group is the only group that experiences an improvement in the relative position when an exogenous injection is received by their urban household group counterparts. This improvement occurs because the multiplier contribution between Northern rural and Northern urban households (i.e. 0.385 from Table A.3.1) exceeds the income share for the Northern rural households (i.e. $\hat{s}_{ni} = 0.071$).

Accordingly, except for the elements along the main diagonal, for each household group the elements in its corresponding row are very similar, that is, irrespective of the household group that receives the exogenous injection, changes in its relative position are almost the same. Although this is true, one specific trend emerges; all rural household groups experience a lesser relative worsening position when an exogenous injection is received by an urban household group.

It is important to note that the results given in the last column (average redistributive effects) are in the opposite sense to those presented in Table 1.5.13. What these results show is that a transfer increase reduces the difference between the low and high incomes. The lowest income households in the Eastern and Northern regions are almost the only ones that benefit in their relative positions. Surprising, the high income Western urban households still benefits while their rural counterparts do not. This is an indication that of a widening gap in income distribution in this region and also with other regions.

Table 1.5.14: Redistributed income between households

	Central rural	Central urban	Eastern rural	Eastern urban	Northern rural	Northern urban	Western rural	Western urban	Average
Central rural	0.807	-0.084	-0.193	-0.227	-0.192	-0.254	-0.196	-0.265	-0.075
Central urban	-0.307	0.624	-0.308	-0.356	-0.310	-0.401	-0.317	-0.417	-0.224
Eastern rural	-0.147	-0.143	0.853	-0.010	-0.146	-0.190	-0.150	-0.065	0.000
Eastern urban	-0.051	-0.047	-0.051	0.945	-0.052	-0.062	-0.053	-0.022	0.076
Northern rural	-0.078	-0.076	-0.078	-0.087	0.921	0.201	-0.079	-0.041	0.085
Northern urban	-0.029	-0.027	-0.029	-0.031	-0.029	0.970	-0.030	-0.016	0.097
Western rural	-0.139	-0.180	-0.139	-0.169	-0.137	-0.190	0.881	-0.097	-0.021
Western urban	-0.055	-0.068	-0.055	-0.065	-0.056	-0.073	-0.057	0.924	0.062
Total effect	0.807	0.624	0.853	0.945	0.921	1.171	0.881	0.924	0.321

Source: Author's calculations based on UgaSAM

1.5.6 Poverty alleviation impacts of exogenous shocks

The poverty alleviation effects that would emanate from stimulation of alternative production sectors were computed using the Pyatt and Round (2006) approach. Figures in Table 1.5.15 have been used to carry out the analysis calculating the second term of the right hand side of equation (1.4.32), i.e. the effect of economic changes on poverty independently from population growth.

Table 1.5.15: Relevant statistics for household groups

HouseholdD groups	Income from the SAM (UGX Billion)	Income share (%)	Population (in thousands)	Income per capita (thousands of UGX)	Population shares (%)	Headcount ratio (%)	Poverty share (%)	Poverty elasticity
Central rural	2258.54	19.70	5455.16	414.02	21.6	27.60	15.35	1.94
Central urban	3569.26	31.14	2029.12	1759.02	8.0	7.80	1.61	1.75
Eastern rural	1631.09	14.23	6395.54	255.04	25.3	48.30	31.50	1.96
Eastern urban	488.89	4.27	539.09	906.89	2.1	17.90	0.98	1.96
Northern rural	811.47	7.08	4240.02	191.38	16.8	65.00	28.11	1.93
Northern urban	264.66	2.31	365.57	723.95	1.4	38.90	1.40	1.75
Western rural	1775.14	15.49	5704.60	311.18	22.6	34.30	19.95	1.99
Western urban	663.27	5.79	543.60	1220.14	2.2	18.60	1.03	1.87
Total	11462.31	100.00	25272.71	453.55				

Source: Columns 6-8: Ssewanyana and Younger (2007)Table 6.10; Column (9): Okidi et al. (2005) Table 4; other columns author's calculations

Table 1.5.16 displays the results for an exemplificative simulation of an exogenous 1 percent increase in the final demand for all products. Its columns (3-10) set out the estimates for percentage change in poverty for each household group that would result from a 1 percent increase in final demand for the products of each production sectors. The last column (All Households) shows the aggregate, economy-wide effects on poverty of a 1 percent change in the final demand for the products of each sector. It is worth noting that using the poverty incidence as social/welfare evaluation criterion has some limitations. Most notably, the headcount index does not satisfy the principle of transfers.[16] However, for a country like Uganda with an ultimate aim of reducing the headcount ratio to 17 percent by 2015 (a more ambitious target compared to the Millennium Development Goals (MDGs) target of 28 percent), knowing the impact of changes in final demand on the headcount ratio is still critical and such analysis can provide important information to policy makers and guide them in designing and implementing poverty reduction strategies.

[16] A wide range of other social evaluation criteria not open to this objection exist.

Table 1.5.16: Percentage change in numbers of poor people arising from a one percent change in exogenous sectoral demand

	Initial Exogenous Sectoral demand (UGX Billions) Xp	Central rural	Central urban	Eastern rural	Eastern urban	Northern rural	Northern urban	Western rural	Western urban	All Households
Agriculture	339.04	-0.14	-0.12	-0.14	-0.10	-0.12	-0.08	-0.16	-0.13	-0.14
Mining & Quarrying	10.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Food Processing	571.93	-0.17	-0.15	-0.17	-0.15	-0.15	-0.13	-0.18	-0.17	-0.17
Other Manufacturing	638.47	-0.08	-0.08	-0.08	-0.09	-0.08	-0.08	-0.09	-0.09	-0.08
Public Utilities	27.14	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Construction	1693.94	-0.45	-0.41	-0.44	-0.39	-0.41	-0.33	-0.48	-0.44	-0.44
Trade	185.85	-0.06	-0.06	-0.06	-0.06	-0.05	-0.05	-0.06	-0.06	-0.06
Tourism	326.49	-0.11	-0.11	-0.11	-0.11	-0.09	-0.09	-0.12	-0.11	-0.11
Transport & comm	115.65	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Financial &Bus. Serv	23.59	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Real estate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Government	974.75	-0.29	-0.32	-0.27	-0.37	-0.32	-0.39	-0.29	-0.37	-0.30
Education	495.33	-0.17	-0.14	-0.16	-0.15	-0.21	-0.13	-0.20	-0.15	-0.18
Health	324.41	-0.10	-0.09	-0.09	-0.09	-0.10	-0.08	-0.11	-0.09	-0.10
Others	16.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00
Total	5,743.32	-1.63	-1.53	-1.58	-1.55	-1.59	-1.41	-1.73	-1.68	-1.62

Source: Author's calculations based on UgaSAM

The following example illustrates how results in the Table 1.5.16 should be read. The results of the last column suggest that 1 percent increase in final demand yields a 1.62 percent decrease in the share of poor on total population for Uganda. The effect is differentiated among different households and seems to be slightly higher for rural households. The detail suggest that for most household groups the largest percentage reductions in poverty would be achieved by a 1 percent increase in exogenous demand for construction. Other high poverty alleviation effects would also come from injections into services sector (e.g. government and education services), food processing, and agriculture. Among the industrial sector, food processing, which has closer inter-production activity linkages with agriculture, or is more labor intensive (especially for low skilled labor), and construction (which is also labor intensive) made relatively large contributions to poverty reduction (0.17 and 0.44 respectively). On the other hand, Other manufacturing sector display relatively low total poverty reduction effects of 0.08. Some of the reasons for the low value in comparison to food processing and construction sectors appears to be low inter-industry production linkages (only 0.968) and high import demand effect. Our finding on sectors with highest poverty reduction effects is consistent with findings in other developing countries such as those of Thorbecke and Jung (1996) andPyatt and Round (2006) for Indonesia and Khan (1999) for South Africa. It worth mentioning that stronger poverty alleviation effects originate from the services sector compared to agriculture. A Similar conclusion was drawn in Saari et al. (2008) for the case of Malaysia where they find that stronger poverty alleviation effects originated from the services sector.

Reading across the row of the table corresponding to agriculture sector, one observes that the level of final demand for agricultural products as recorded in the Uganda SAM for year

2002 was 339.04 billion. A 1 percent exogenous increase in final demand for this sector sector is expected to be larger relative to say a 1 percent exogenous increase in final demand for products of the Financial and business services or Trade sectors. An exogenous injection into the agriculture sector alone would have a higher poverty alleviation effect on Western rural (0.16 percent), Central rural (0.14 percent) and Eastern rural (0.14 percent) households. Similar significant effects for the same household groups would also emanate from food processing and construction. It is interesting to note that all household groups would experience the same poverty alleviating effect from trade sector. A similar pattern is also observed for the case of tourism, public utilities, other manufacturing and transport and communications sectors. An injection into government sector would benefit Northern urban households most while Western rural households would benefit more than any other household from injections in education and health sectors. Our results also confirm one of the dilemmas among policy makers in Uganda, that is, the rapidly growing new sectors (mainly services sector) seem not to be contributing much to poverty alleviation. As can be seen in Table 1.5.16, none of the seven (7) activities under the services sector (i.e. trade, public utilities, transport & communication, financial & business services, real estate, health, and other private & community services), reduces the number of poor people by more than 0.1 percent. Only education and government services seem to have the potential to reduce poverty among different households. However, bearing in mind that the government and education sectors employ a very small fraction of the labor force, the overall impact on the number of poor people alleviated from poverty may actually be small.

There is also a clear pattern with regard to exogenous changes in final demand for products of the education and government sectors. Poverty among all rural household groups is more sensitive to the exogenous increase in demand for education services than government services and the reverse is true for all urban households. This may largely be driven by the effects of the Universal Primary Education (UPE) program introduced in January 1997, following a political commitment by President Museveni that the Government would meet the cost of primary education of four children per family. This commitment was soon extended to allow all children of school going age. However, under UPE parents/guardians still have to incur out of pocket expenses for books, uniforms, and feeding of their children at school. This program benefits mostly rural households since most children in urban areas go private schools. On the other hand, the sensitivity of urban poverty to increase in final demand for government services

should be surprising since government services here largely refer to public administration which employs the high skilled labor in urban areas.

1.6 Concluding remarks

This essay has analyzed poverty reduction and the process of income distribution among the agents in a developing country, through the use of a 2002 SAM for the Ugandan economy. In order to clarify the complex process of income distribution, we performed a multiplier decomposition. In addition, we have identified key sectors in the Uganda economy, changes in absolute and relative incomes of economic agents and changes in the number of the poor due to a multiplier process.

Our results indicate that Agriculture, Food processing, Real estate and Trade are the key sectors in Uganda's economy. We have also disentangled the direct and indirect effects of the total impact of an exogenous injection into the economic activities and factors of production hence deriving significant policy oriented results. First, when simulating the impact of exogenous shocks via the agricultural sector, the dominating effects are the direct-direct effects. This means that despite its importance, the agricultural sector has less capacity to activate important linkages with other sectors. However, we find that significant indirect effects also occur from agricultural policies that enhance the incomes of urban households. This means that when an agricultural policy is targeted at urban households, the benefits are spread all over other institutions, and particularly on other households. Second, there are other sectors like food processing sector that activate important indirect effects from other activities and other institutions, which can be relevant in the process of transmission of the impacts of exogenous shocks in the economy and thus should not be neglected.

Our results also show a clear evidence of gender inequality in terms of factorial income distribution with male workers regardless of the skill level and location being the main beneficiaries of expansion in production. In addition, there is regional inequality among households with the Eastern and Northern households being the least affected of exogenous shocks of any origin. Overall, the analysis of aggregate multipliers suggest that rural households would benefit most compared to their urban counterparts. This finding is especially important for poverty reduction purposes since most people in need are those that live in rural areas. Thus, a policy

intervention targeted at rural households would generate higher income effects for rural households and all other institutions at large. However, the analysis of relative income shows that rural households in all regions of Uganda benefit relatively less from all production activities, and that they benefit relatively less from an equivalent income increase for all household income classes. The details of poverty analysis suggest that for most household groups the largest percentage reductions in poverty would emanate from growth in construction sector followed by government services, education services, food processing, and agriculture sectors.

It should be noted that the SAM-based linkage and multiplier analysis presents a static model which is based on restrictive and unrealistic assumptions of economic behavior, while the real potential poverty and income distribution impacts of exogenous shocks may be of a more dynamic nature. Although our findings can be justified for a small and dependent Ugandan economy, they must be interpreted with caution. Our analysis could be improved by using a CGE model which incorporates flexible prices and substitutability among factors.

Chapter 2

Essay 2: Measurement of Multidimensional Child Poverty in Uganda

2.1 Introduction

2.1.1 Motivation and objectives of the study

It is acknowledged in policy that the welfare of children is intricately linked to the welfare of adults and the communities they live in. Most children live with adults and experience their way of living including poverty. As a result, there is always a tendency of lumping child poverty with adult poverty.[1] There is a need to differentiate between adult poverty and child poverty by explicitly measuring child poverty. Few studies on children's well-being in developing countries exist at present, despite increased availability of quality data on children and their families. Aside from basic health and education indicators, most "knowledge" about children actually is derived from statistics that depict the situation of the child's family or main caregiver. However, this can be problematic when trying to estimate poverty levels because household-based measures typically assume an equal sharing of resources among members — an assumption that

[1]The State of the World's Children 2005 proposes the following working definition of children in poverty: *Children living in poverty experience deprivation of the material, spiritual and emotional resources needed to survive, develop and thrive, leaving them unable to enjoy their rights, achieve their full potential or participate as full and equal members of society* (UNICEF, 2004, P.18). For a collection of different institutional definitions of child poverty, see Tsegaye et al. (2008).

may not hold true for many families, rich and poor alike.

Most poverty measures are based on the money-metric approach which uses one dimensional yardstick — household income or expenditure per capita or per adult equivalent to judge a person's well-being (Younger, 2003). In many cases, the World Bank consumption - based poverty line of a dollar per day[2] is used to judge who is poor. Using such a consumption-based poverty line is inappropriate for estimating child poverty since so little is known about the income or consumption needs of children and how these may vary by age, gender and location. Young children, for instance, have low food requirements but numerous other basic needs that require expenditure. Particularly in developing countries, whether a child lives in poverty does not only depend on family income but also on access to public goods and services such as a safe water supply, roads, health care, and education. In addition, income based poverty line ignores the fact that, for example, children in a household living on 3 dollars-a-day (i.e. an income non-poor household) may be unable to have access to education, safe and clean water, quality health care, and may be living in a conflict-ridden environment. Moreover, poverty viewed from income perspective has a strong tendency of leaving children out of the plans and strategies to address poverty because they, in a majority of cases, do not earn an income (UCRNN, 2008, vii). White et al. (2005) argue that "high dependency on the direct environment for the distribution of basic needs puts children at a higher risk of poverty and makes their situation less transparent".

In Uganda, a large body of literature now exists on poverty affecting men and women. Much less information however exists, scattered in various institutions, on children and the various forms of poverty and social conditions that they face. Children in poverty are invisible and yet by the very nature of their situation, they are included among those classified as the poor in Uganda.[3] Children are subsumed within the poverty categories most often referred to such as households, communities, people – which means that there is a high tendency to focus on adult-related poverty while child poverty is ignored, partly because children have little power and influence within a group that contains adults (MFPED, 2005). Despite the fact that over the last decade, the need for child focused perspective in the development and poverty

[2]This threshold has recently been updated to a $1.25 per day (see (Ravallion et al., 2008)

[3]In Uganda, children in poverty have been defined as those that have *little or no access to resources, services, assets, emotional care, livelihood and human development opportunities, and social capital (family, community and societal support structures)* (see, for instance, White and Masset, 2002; NCC and MGLSD, 2004; MFPED, 2005).

reduction process has been widely recognized (see, for instance, Gordon et al., 2003c; Gordon et al., 2003b; Minujin et al., 2006), there is still lack of child focus in poverty reduction plans and strategies in Uganda. This is partly due to misconceptions about child poverty. According to MFPED (2005, p.5), there is a general misconception among senior policy makers and implementers and the general public that poverty conditions faced by adults are the same as those faced by their children and therefore the same interventions suffice to reduce child and adult poverty simultaneously.[4]However, the assumed "trickle down" effect may not occur due to lack of knowledge about the intra-household dynamics such as resource allocation with in a household in which children live. Another common misconception is that children are not independent economic agents and hence their perspective and views are not relevant(Witter, 2002, p.1).

The above limitation is particularly important for Uganda. Uganda's population is youthful and dependent, with the proportion of persons aged less than 15 years estimated at about 51 percent of the total population while that of persons aged 65 and above constituted only 3.1 percent, indicating a high age dependency ratio meaning that for every 100 persons in the working age group (15–64 years), there are 117 dependent persons. Given these numbers, policy makers and the general public need to recognize that children are part of economic fabric both in terms of child-headed households and the contribution working children make to the household economy. Unless child poverty is explicitly recognized, the above mentioned misconceptions will continue to exist.

Tsegaye et al. (2008) argues that "we must appreciate the fact that poverty affects children differently from adults and that the term child poverty is a powerful rhetorical term which serves as a good organizing concept for improving wider child well-being by focusing and emphasizing that children have rights and are more than only prospective adults". In brief, child well-being means a lot of things that go beyond the incomes of the households in which they live. "... it is about children being safe, well, healthy and happy, ...children's opportunities to grow and to learn, positive personal and social relationships, being and feeling secure and respected, being given a voice and being hard, and about full and harmonious development of each child's personality, skills and talents" (African Child Policy Forum, 2008, p.18). Therefore, child

[4]This thinking is not in line with CRC definition of childhood as "separate space" from adulthood. "Separate space" means that even when children face the same challenges as adults, they may require different solutions.

poverty is multidimensional and integrated and its measurement calls for a multidimensional approach.

Empirical evidence on child well-being in Uganda is largely concentrated on explaining trends and variations in infant and mortality rates (see, for instance, Vellaa et al., 2008; Ssewanyana and Younger, 2007; Ntozi and Nakanaabi, 1997) and determinants of children health status (see, for instance, Kikafunda et al., 2006; Bahiigwa, 2005; Lawson, 2004; Ssewanyana, 2003; Kikafunda et al., 1998). Empirical evidence on multidimensional child poverty remains scanty (e.g. Bugembe et al., 2005; MFPED, 2005; Witter, 2002). Moreover, these studies fail to take into account the breadth, depth and severity of multidimensional child poverty. In addition, they focus on all children below 18 years of age without paying much attention to age-specific groups especially the under-five age category and yet poverty at this early age has detrimental future consequences on long term well-being.

This study attempts to fill the above lacuna by focusing on the measurement of multidimensional child poverty in Uganda. We focus specifically on children for a number of reasons. First, in most countries children are a high-risk poverty group in the sense that they are more likely to live in monetary poor households. Second, the strong linkages between the current well-being of children and their future well-being as (working, tax paying and voting) adults are of particular importance to policy makers. The concern here is that childhood deprivation puts a brake on child development and thereby causes permanent damage to children's chances of success and well-being in adulthood. Third, since the status of deprivation is beyond the control of the child, this may provide an additional rationale for public intervention. We measure child poverty in two dimensions: children nutritional status measured by standardized height-for-age (*haz*), weight-for-height (*whz*), and weight-for-age (*waz*) z-score, and a household composite poverty indicator (measured by a household asset index to proxy household income).[5] There is no straightforward way for choosing how to choose dimensions of human well-being. Alkire (2008) identify five processes by which dimensions are regularly selected, and discuss in detail when and how each could contribute to the task of selecting dimensions of multidimensional poverty. The five processes are: (1) Use existing data; (2) Make assumptions – perhaps based on a theory; (3) Draw on an existing list that was generated by consensus; (4) Use an ongo-

[5]There are other important dimensions of children well-being such as psychosocial support, participation (inclusion), expression of opinion, empowerment, opportunity, basic rights. However, they are not easy to measure or quantify and data on these dimensions is not readily available.

ing deliberative participatory process; and (5) Propose dimensions based on empirical studies of people's values and/or behaviors. What is very clear, immediately, is that these processes overlap and are often used in tandem. In selecting our dimensions, we were guided by the eight Millennium Development Goals (MDGs).[6] The MDGs are in line with the Uganda National Development Plan (NDP), which covers the objectives, strategy and the policy framework for achieving economic development. In addition, quality data on children nutritional status and household assets is widely available from Demographic and Health Surveys (DHS). Moreover, after Sen's seminal work, the health dimension is now widely believed to be an important dimension of human well-being. According to Sen, good health is a basic capability (Sen, 1985; Sen, 1987). Human well-being is not just about a problem of low incomes to enable a person acquire at least the basic needs which are only instrumentally important, but also deprivations with respect to a variety of capabilities and functionings (Younger, 2003). Child anthropometric measures therefore should be treated as independent[7] and more direct measures of capability deprivation than income and expenditure and individual well-being in this form can be directly observed. To identify the deprived children, we define non-consumption based thresholds in each dimension below which a child is considered poor (we shall come back to this issue later).

The measurement of child poverty made here follows the dual cutoff and counting approach proposed by Alkire and Foster (2011a)[8]. One important advantage of the poverty counting approach is that it identifies which child is poor using two forms of cutoff: one *within* each dimension to determine whether a child is deprived in that dimension, and a second *across* dimensions that identifies the poor child by "counting" the dimensions in which a child is deprived. The aggregation step employs the Foster, Greer and Thorbecke (FGT) (Foster et al., 1984) measures, appropriately adjusted to account for multidimensionality (Alkire and Foster, 2007). As far as we know, ours is the first study in Uganda to measure multidimensional child poverty using the dual cutoff and counting approach. Regarding the measures of well-being, a paper particularly close to ours is that of Younger (2003) in that we use the same approach and household asset possessions in constructing the composite poverty indicator. However, our study differs

[6]The MDGs are: 1) Eradicating extreme poverty and hunger; 2) Achieving universal primary education (UPE); 3) Promoting gender equity and empowering women; 4) Reducing child mortality; 5) Improving maternal health; 6) Combating HIV/AIDS; 7) Ensuring environmental sustainability; and 8) Developing global partnerships for development.

[7]See e.g. Duclos et al. (2006a); Haddad et al. (2003).

[8]See Alkire and Foster (2007) for the first version of the paper

from his in a number of ways: First, we limit our analysis to children, whereas Younger treat children and adults together, without distinction. This is important since there is evidence that children form the largest group of the poor in Uganda. Secondly, Younger uses stochastic dominance approach (see, Sahn and Stifel, 2002; Duclos et al., 2006a) to analyze poverty changes in Uganda and its individual regions, whereas we use a dual cutoff and counting approach of Alkire and Foster (2007, 2011) to measure child poverty. This approach appropriately adjusts the traditional FGT poverty measures by taking into account the average number of deprivations a child suffers. Thirdly, Younger uses measures of well-being defined across household expenditure or household assets, children's health status measured by their standardized heights (their height-for-age z-score), and in some cases, mother's literacy. We exclusively use a household asset index and all the three standard anthropometric measures (mentioned before) to capture a wider range of deprivations. Lastly, we use the first survey in Uganda to cover the entire country-i.e., the nationally representative Uganda Demographic and Health Survey (UDHS) for the year 2006 while Younger uses the 1992/93 Integrated Household Survey, 1999/2000 National Household Survey, and three DHS (Demographic and Health Surveys) for 1988, 1995, and 2000, all of which did not cover the entire country to due to civil war and instability. Our results can thus be expected to differ from the earlier study. Second, our adjusted headcount measure (M_0) (explained later) is robust to different poverty lines. In particular, M_0 is implied by first order stochastic dominance, and implies second order stochastic dominance, in turn. Consequently, the M_0 partial ordering is more complete than the multidimensional headcount partial ordering, and is able to make more comparisons independently of the selection of cutoff k.

Against the backdrop of the above, the main objective of this study is to measure multidimensional child poverty in Uganda. The specific objectives include:

1. To construct a composite wealth index that provides an aggregate measure of overall well-being or "welfare".

2. To measure multidimensional child poverty among children under 5 years using the nutritional status indicators and the composite wealth indicator.

3. To compare multidimensional child poverty status across regions and between rural and urban areas.

4. Draw policies relevant for addressing and improving specific children nutritional status and overall well-being.

The insights gained from this study can enhance the existing knowledge and understanding of the extent of multidimensional child poverty in Uganda in several key aspects: First, the MDGs focus attention on deprivation in multiple dimensions. One of the targets under MDG1 is to halve the proportion of underweight among the under-five by 2015. It is therefore hoped that results from this study will help the Uganda Government and other African countries to decide on appropriate measures to improve children's welfare in order to meet the MDG targets. Secondly, it is hoped that the results will help policy makers in Uganda to evaluate whether the policy strategies that have been put in place to address child poverty are more relevant to the specific needs and challenges that are faced by different categories of vulnerable children. Thirdly, we hope the framework presented in this study will offer an opportunity to discuss theoretical, methodological and empirical insights with regard to measurement of child poverty in Uganda.

The essay is organized as follows: Section 2.2 presents a review of relevant research. It starts by giving an overview of different approaches to multidimensional poverty measurement. It then presents a review of different studies that have applied the aforementioned approaches to the measurement of multidimensional child poverty; Section 2.3 contains information on the dataset we used, the variables we constructed, and the method selected for computing multidimensional poverty indexes; Section 2.4 contains our main results; and Section presents some final remarks.

2.2 Review of Relevant Research

2.2.1 Approaches to Multidimensional Poverty

In recent years, a consensus has emerged among those studying and making policies related to individuals' well-being: poverty is best understood as a multidimensional phenomenon. However, views differ among analysts regarding the relevant dimensions and their relative importance. Welfarists stress the existence of market imperfections or incompleteness and the lack of perfect correlation between relevant dimensions of well-being (Atkinson, 2003;Bourguignon

and Chakravarty, 2003; Duclos and Araar, 2006), which makes the focus on a sole indicator such as income somewhat unsatisfactory. Non-welfarists point to the need to move away from the space of utilities to a different and usually wider space, where multiple dimensions are both instrumentally and intrinsically important. Among the non-welfarists, there are two main strands: the basic needs approach and the capability approach (Duclos and Araar, 2006). The first approach is inspired by a humanist vision which is beyond the economic sphere (Asselin and Dauphin, 2001). For the proponents of this approach, the poor are people deprived of a subset of goods and services specifically identified and seen as universally common to man, including nutrition, health, education, housing, etc. One of the major problems facing this approach is the determination of these basic needs because they are very often exogenous regardless to the perceptions of people. The second approach, championed by Sen (1985) argues that the relevant space of well-being should be the set of functionings (or outcomes) that the individual is able to achieve. This set is referred to as the capability set "reflecting the person's freedom to lead one type of life or another" Sen (1992, 40).[1]

Recognizing that well-being and deprivation is multidimensional, the challenge of using any one of these classic approaches is how to make comparisons between two distributions and assess, for instance, whether one distribution exhibits higher poverty levels than the other? To answer this question one needs to make decisions about the domains relevant to well-being, their respective indicators and threshold levels, and the aggregation function. Next, we present some literature that uses the aforementioned approaches to measure multidimensional child poverty.

2.2.2 Review of previous research measuring child poverty

The multi-dimensional nature of poverty includes quantifiable variables such as income, consumption and access to basic services, but it also includes capabilities variables that may not be easily measurable - such as the capability to participate in society without facing discrimination. Because of these complexities, most researchers and development agencies rely on the welfarist (monetary) approach to measure child poverty, which is a very crude, in many ways, a counter-productive approach to measuring child poverty (Minujin et al., 2006). However, there are other approaches to child poverty measurement such as human rights-based approach, and those mentioned in (2.2.1) above. These measurement approaches differ along their identifica-

[1] Duclos and Araar (2006) provide a thorough analysis of the differences between the three approaches.

tion mechanisms, methods of aggregation[2], data requirement (micro or macro data), and by the study's nature and objectives. The main differences are attributed to whether one is interested in monitoring child well-being for the purpose of evaluation of outcomes and effects of economic and social policies or the identification and measurement of impacts of different factors on the outcomes (Heshmati et al., 2008). In fact, there is no consensus as to which would be the best composite measure for international or national comparisons on child poverty(Roche, 2009). Instead, there is a range of different efforts that have been developed for different purposes. These have been broadly categorized as: child poverty index measures, child poverty count measures, and holistic child poverty approaches (Roelen and Gassmann, 2008).

2.2.2.1 Child poverty index measures

Child poverty index is an aggregate figure that enables one to compare the performance of various groups with respect to child poverty (Moore et al., 2007). These groups can comprise geographic locations (e.g. countries or states) or demographic groups (e.g. age groups or ethnic groups). According to Nardo et al. (2008), a range of methods is available for the construction of the index measures and inherent to this construction are the decisions on the normalization, weighting and aggregation techniques. Once the group index has been constructed, the groups can consequently be ranked according to their performance. The Human Development Index (HDI) is an example of a poverty index measure, comparing country performance on the basis of educational attainment, longevity and standard of living (UNDP, 2007). Examples of child poverty index measures include:

EU Child well-being Index

Bradshaw et al. (2007) introduced an index of child well-being in 25 European Union (EU) countries. The aim was to use the index in monitoring the well-being of children on the European level. The index is based on the rights-based approach and is a multi-dimensional understanding of child well-being. The performance of countries on 8 clusters with 23 domains and 51 indicators is studied. The clusters are children's material situations, housing, health, subjective well-being, education, relationships, civic participation and risk and safety. Heshmati

[2]According to Sen (1976) the construction of a poverty measure involves two interconnected exercises: first, the identification of the poor; second, the aggregation of the poor. In the multidimensional space, the aggregation exercise takes into account individual capabilities (Sen, 1985).

et al. (2008) analyze children's well-being in six dimensions containing 18 components based on 40 indicators. The six dimensions are similar to those in Bradshaw et al and they include: children's material well-being, health and safety, education, peer and family relationships, subjective well-being, and behavior and risk. The results indicate that countries differ in their performance with respect to different well-being components. Richardson et al. (2008) make a first attempt at producing a multidimensional index of well-being of children in the Central and Eastern Europe (CEE) and the Commonwealth of Independent States (CIS) countries. The study follows the methods employed in similar induces produced by the same authors for EU and OECD countries. Indicators are derived from existing survey and administrative sources. They are combined into components and the components are combined into seven domains of well-being. The results show considerable variation in the performance of different countries in different domains. Croatia, Bosnia Herzegovina, FYR Macedonia and Serbia are at the top of the index while Azerbaijan, Albania, Tajikistan and Moldova are at the bottom of the index. The findings suggest that the level of wealth in GDP per capita (i.e. the monetary indicator) explains only about a third of the variation of children's well-being in this region.

The US Child and Youth well-being Index (CWI)

This index was developed by Land et al. (2001) to answer the question how well children and youth are faring in America. It is designed to consider changes in child and youth well-being over time for specific demographic and geographical groups. The authors capture child well-being in seven different domains of life, based upon studies by Cummins (1996) and Cummins (1997). The 7 domains of well-being include: Material well-being; Health; Safety; Productive activity; Place in community; Intimacy; and Emotional well-being. This index has recently been used by Land (2007) to compare the well-being of children in the USA and four English speaking countries namely Australia, Canada, New Zealand and UK. The comparison was based on 19 international indicators of child and youth well-being. The study used the 7 domains of well-being in the original index. The results shows variations in countries performance in individual indicators and domains. A related index to CWI is the KIDS COUNT index developed by The Annie E. Casey Foundation's KIDS COUNT project using Land's model (O'Hare and Bramstedt, 2003). Moore et al. (2007) use recent micro-data, representative of U.S. children, from the National Survey of America's Families (NSAF) to create an index of child well-being and an

index of the condition of children. The authors compare conclusions that might be drawn from such an index with those based on six versions created with aggregated data compiled by Land et al. (2001), Johnson (2005), and O'Hare and Bramstedt (2003).

Child Development Index (CDI)

CDI is an example of child poverty index based on macro data. It was launched in 2008 by the international NGO Save the Children. The index has been computed for a total of 37 countries for ranking comparison. The CDI uses three child specific indicators namely, the mortality rate of children who are under five years of age, the percentage of school-age who are not enrolled in primary school, and the percentage of children under five year of age who are underweight, all of which are MDG indicators.

The South African Index of Multiple Deprivation for Children (SAIMDC)

SAIMDC is an example of an index computed directly from micro data (Barnes et al., 2007). With appropriate weighting, aggregated induces of fourteen (14) indicators of well-being are computed at the level of municipality directly from the Census micro-data. These initial 14 indicators are then aggregated into five domains of deprivation: income and material, employment, education, adequate care, and living environment. The aggregation by domain is carried out - in all cases except the dimension of education deprivation - by simply computing the proportion of children experiencing at least one of the deprivations in the original indicators (Bastos and Machado, 2009). A much earlier study by Haarmann (1999) contains many of the elements of the model of multiple deprivation used in the SAIMDC, but unlike SAIMDC, it only provides a measure of child poverty at national and provincial level.

2.2.2.2 Holistic child poverty measures

On the Holistic Child Poverty measures, Young Lives Approach is a good example. The Young Lives Project a UK Department of International Development (DFID)-funded international collaborative longitudinal study of childhood poverty in Ethiopia, India (Andhra and Pradesh States), Peru and Vietnam. The project started in 2001 and will run for 15 years. Between 2002 and 2015, some 2000 children in each country are being tracked and surveyed at 3-4 year intervals from when they are 1 until 14 years of age. In addition, 1000 older children in each

country are being followed from when they are aged 8 years. The definition of child poverty in this project is based on the basic needs derived from the core themes of the Convention on the Rights of the Child (CRC) and the livelihoods framework from the Department for International Development (DFID)[3]. Rather than formulating one definition of poverty, the project puts forward a holistic framework with six child-specific outcomes to provide indicators for the poverty status of children. The choice of these outcomes was made with the notion that child poverty is different from adult poverty and needs a redirected focus (Roelen and Gassmann, 2008). These six outcomes are nutritional status, physical morbidity, mental morbidity, life skills (literacy, numeracy, work skills etc.), developmental stage for age, and perceptions of well-being and life chances. The last of these outcomes emphasizes the importance of participatory methods in the poverty mapping process to learn more about children's own opinion and perceptions of poverty and their own situation. This derives directly from CRC and the recognition that children themselves act as social agents (Boyden, 2006).

In 2002 Save the Children UK carried out a study on child poverty in Uganda, as part of the on-going Uganda Participatory Poverty Assessment Programme. Instead of starting with a pre-conceived framework, the study uses the themes which emerge from the children's responses. The study starts by asking what children's perceptions are of poverty in Uganda, its causes and implications, and how these differ from the adults they interviewed. The responses fall into 6 broad areas: emotional, personal or spiritual factors, social and family factors, political factors, physical factors, financial and material factors and environmental factors. The results show that children have a broad and rich understanding of the nature and causes of poverty compared with adults, who appear to place more emphasis on personal and family factors. The adults in the study (mainly officials) have a fairly narrow, material understanding of poverty, and see child and household poverty as identical. Children also see poverty as inherited, but not uniformly and inevitably; they identify ways in which 'rich' children can be poor, in a wider sense. They have a positive view of their potential role in mitigating poverty and are enthusiastic to be involved. In addition, they have very negative views about how society sees them, as poor children, and describe vividly the 'shame' of poverty with some groups expressing strong negative emotions of despair. Children's definitions of poverty are remarkably similar, across different groups of children interviewed (Witter, 2002).

[3]Detailed information on this approach is available at `http://www.younglives.org.uk`

Witter (2004) takes the broader Save the Children UK study mentioned above and focus on the definitions provided by child participants and how these compare with existing poverty monitoring efforts with an aim of developing a more holistic framework for poverty monitoring, which responds more closely to children's concerns. Comparing the definitions of poverty drawn up by children in the study with existing information in Uganda, the author identifies the following main gaps: all indicators relating to personal, emotional and spiritual factors; child abuse cases, of various kinds; information on quality of parental care; participation indicators; access and quality of life indicators for the disabled; numbers for vulnerable groups including street children, child workers and child-headed households and understanding of intra-household distribution of goods and resources. The author argues that focused effort in the areas outlined, if integrated into national poverty monitoring and evaluation strategies, could contribute to policies to address child poverty in Uganda.

2.2.2.3 Child Poverty Count Measures

According to Roelen and Gassmann (2008), child poverty count measures are those that are based on individual level information. These measures "count" the number of poor children and provide a headcount of poverty or incidence rate. The count of poor children is performed by considering the number of children that find themselves below the poverty line (may be an absolute or relative poverty line). Incidence measures can also be extended to measure both the depth and severity of poverty. Information on the distance at which an individual child finds itself from the poverty line is aggregated to find how deep or how severe child poverty is. For the different poverty measures to be calculated, one needs micro-data (i.e. information on the poverty status of individual children) to be able to construct an overall poverty count, depth or severity indicators. Examples of child poverty count measures include: monetary poverty approach, Bristol multidimensional approach and Dual cutoff and counting approach.

Money-metric poverty approach

As noted before, this is the most dominant approach to the measurement of child poverty and is commonly known as a *uni-dimensional* approach. The identification step defines an income poverty line based on the amount of income that is necessary to purchase a basic basket of goods and services. It conceptualizes child poverty as children living in household where the resources

(i.e. household income) x_i fall below the minimum subsistence level or an equivalent poverty depth measure z. Low household income is considered to have strong link with the well-being of children and their opportunities for development (Noble et al., 2006). The reasoning behind the monetary poverty approach is that, in principle, a household above the monetary poverty line is thought to possess the potential purchasing power to acquire the bundle of attributes yielding a level of well-being sufficient to function (Thorbecke, 2008; Tsui, 2002).[4]

The use of money as an indicator has a number of advantages. First, money has an accepted normative interpretation (i.e. more is better). Second, it has public acceptance almost globally as an indicator of well-being (hence its inclusion in the first Millennium Development Goal, for example). Third, there is a large literature on its measurement, and hence some confidence among researchers and academics that results can be tested for robustness. Fourth, it is responsive to effective policy interventions (i.e. if a particular group in society is found to be income poor, a government can reduce their poverty simply by giving them money (Redmond, 2008). On the other hand, the monetary approach suffers a number of drawbacks especially in terms of child poverty measurement. To begin with, considering a child as poor if the household he/she lives in is below the monetary poverty line may not be sufficient. For instance, there can be poor children in rich households and rich children in poor households depending on the intra-household distribution of material and immaterial resources. Cockburn et al. (2009) addresses the issue of intra-household allocations using a recent innovative Bangladeshi survey that includes detailed information on the intra-household allocation of food, non-food and time, as well as information on bargaining power and other individual, household and community characteristics. Specifically, the authors attempt to shed more light on two important issues. First, the role played by intra-household allocations in mitigating or exacerbating child poverty. Second, the scale of the measurement errors resulting from not considering the intra-household allocation in the measurement of child poverty. Their findings show that, for example, 30 percent of children have calorie adequacy ratios (CAR)[5] inferior to 0.8 based on individual

[4]Given household income x_i and the poverty line z, individual poverty level is generally measured by the normalized gap defined as: $\begin{cases} g_i = \left[\frac{(x_i - z)}{z}\right] \text{ for } x_i < z \\ g_i = 0 \text{ for } x_i \geqslant z \end{cases}$. The individual information is most commonly aggregated in the second step using the aggregation function proposed by Foster, Greer and Thorbecke (1984) known as the FGT measures, defined as: $FGT_\alpha = \frac{1}{n}\sum_{i=1}^{n} g_i^\alpha$. The coefficient α is a measure of poverty aversion. Larger values of α give greater emphasis to the poorest poor. When $\alpha = 0$, the FGT is the headcount measure, where all poor individuals are counted equally. Other measures include the poverty gap ($\alpha = 1$) and poverty gap squared ($\alpha = 2$).

[5]CAR is obtained by dividing individual calorie consumption by individual calorie requirements (Cockburn et

data, whereas only 20 percent live in households that have an aggregate CAR ratio below 0.8. Therefore, the household-level approach underestimates child poverty by 10 percentage points if CAR=0.8 is set as the poverty line.

While a child's situation in the family is important (and if the family is not doing well, it is unlikely the child would be doing well), there is nonetheless a leap that needs to be made from a family's economic welfare to a child's economic welfare (Redmond, 2008). While the literature on how this leap might be made is vast (see, for instance, Saunders and Bradbury, 2006), it is still nonetheless contested and problematic. For instance, White and Masset (2002) argues that children are not independent economic agents. They are not able to generate income at least for many of them to sustain their own livelihoods hence making monetary indicators inadequate tools for capturing child poverty. Moreover, as Thorbecke (2008) puts it, money metric assumptions presupposes that a market exists for all attributes and that their prices reflect utility weights all households within a specific setting assign to these attributes. In reality, however, some non-monetary attributes cannot be purchased because their markets do not exist, for example, with some public goods. Even where markets exist, they may operate imperfectly. For example, in developing countries, many small farmers are sealed off from accessing formal rural credit markets due to inadequate collaterals. Appleton and Song (1999) on the other hand, argue that a uni-dimensional measure of well-being (e.g.income or consumption expenditure) is not highly correlated with other capabilities of interest such as child nutrition status indicators, hence making its use as the sole indicator of well-being in poverty analysis is very limited as it typically does not incorporate and reflect key dimensions of poverty related to the quality of life.

Recent studies using the monetary approach to child poverty measurement in developing countries include Barnes et al. (2009) who measure child poverty in South Africa using a money metric approach. The analysis of child poverty based on the income levels of the households in which children live using the Community Survey 2007. The author argues that it is still important to include money metric definitions and measurements in a multi-dimensional framework of child poverty despite the well know criticisms of money metric approach. Their results indicate that nationally, 66 percent of children are in poverty when the rate is measured using a poverty line of R444 per month in 2007 prices. The lower threshold (i.e. $2 a day poverty line

al., 2009)

equivalent to R245 per month in 2007 prices) gives a child poverty rate of 40 percent. Using $1 a day poverty line gives a child poverty rate of 16 per cent (pre 2008 revision to the PPPs). Using an upper threshold (R818 per month in 2007 prices) gives a rate of 81 per cent.

The Bristol Deprivation approach

Not long ago, a group of scholars at the University of Bristol and London School of Economics developed a child poverty measurement approach commonly referred to as "The Bristol Approach" (Gordon et al., 2003a). The approach has contributed significantly to child poverty measurement, in expanding the income based approach. This model was the first measurement of the headcount of child poverty in developing countries and is aligned with the human rights based approach and broad international consensus on what dimensions are essential for human development. Seven measures of severe deprivation considered in the study include food, water, sanitation facilities, health, shelter, education, and information. The headcount results indicate that 56 percent of children in low- and middle-income countries suffer from one or more forms of severe deprivation. South Asia and sub-Saharan Africa have severe deprivation rates of more than 80 percent. More poignantly, rural children in these two regions have severe deprivation rates of more than 90 percent. The results of the study were later published as part of the 2005 UNICEF's world report, '*The state of the Worlds Children 2005*' (UNICEF, 2004). While the measure in this approach improves upon income poverty, it does not account for the breadth, depth, or severity of dimensions of child poverty. The traditional income - FGT- measures in income poverty do account for these (see, Foster et al., 1984). Also, the headcount cannot be broken down by dimension to uncover the components of child poverty in different regions or age groups or by gender or by orphanhood status.

Delamonica and Minujin (2007) extend the Bristol approach by exploring how to estimate the depth and severity of child poverty. They argue that two countries can have the same proportion of children living in poverty, but the actual plight of children could be very different depending on how many deprivations, on average, children suffer. The authors approach is similar to dual cutoff and counting approach which we turn too shortly, though they propose to calculate the average deprivation only among those children who are identified as multidimensionally poor, and then incorporate it to an adjusted headcount ratio.

Notten (2008) takes the Republic of Congo as a case study to analyze multidimensional poverty. Notten attempts to answer the question of: What are the prevalent patterns of simultaneous deprivation in Congo and how do these patterns differ between men, women and children. The author defines poverty (or deprivation) as lack of access to the resources and services needed to satisfy basic needs. In some cases, Notten makes a distinction in the basic needs of adults and children. With regard to children, Notten follows the deprivation approach set in Gordon et al. (2003c) to measure multidimensional poverty with respect to monetary poverty and education dimensions among children in the age group 6 to 17 years. The study make use of the nationally representative Congolese household survey data set. Results show high incidence of deprivation in money (53.7 percent) and education (52.5 percent). One observation that stands out in the analysis is that 32 percent of the Congolese children are deprived simultaneously in the education and money dimensions compared to adult women (19 percent) and men (11 percent). In another related study, Notten (2009) analyze the consequences of using monetary poverty as a proxy for deprivation in the physical environment of children in the Republic of Congo by studying the degree of overlap between these dimensions. The author selects three components or dimensions of the physical environment: housing, water and sanitation, and integration finding that incidence rates of poverty and deprivation differ substantially in magnitude; that high risk poverty characteristics do not necessarily correspond to high risk deprivation characteristics; and that the relation between poverty and deprivation in the physical environment is positive but not very strong. The author concludes that monetary poverty indicators are a blunt tool for identifying vulnerable groups with regard to dimensions of the physical environment.

The Alkire and Foster (AF) dual cutoff and counting approach

According to Alkire and Foster (2009) the literature on the multidimensional poverty measures has two significant challenges. First, the measurement methods are largely dependent on the assumption that variables are cardinal, when, in fact, many dimensions of interest are ordinal or categorical.[6] Second, identification methodology and the aggregation index, uses headcounts. To overcome these deficiencies, Alkire and Foster propose a family of measures which combine information on both the number of deprivations and their level. The family is an extension of

[6]See, for example, Sen (1980, 1985)

the FGT class of measures and satisfies a set of desirable properties. In addition, the AF measures also allow for different dimension weighting schemes. The approach uses a dual cutoff, that is, *within dimension cutoff* is the poverty line that determines whether a person is deprived in that dimension, and *across-dimensional cutoff* is the number of dimensions (k) required to be considered poor. Using this approach, a person is described as poor if is deprived in k or more dimensions.[7] A key feature of one of the measures in the family is that it allows qualitative and quantitative information to be combined. For example, information (such as dwelling characteristics and access to services) and income or consumption data can be aggregated in a meaningful way. The method was illustrated using data from the USA and Indonesia. For the US they considered the following variables (all assumed ordinal): fifteen income groups measured in poverty line increments, self-reported health status, health insurance, and years of schooling. For Indonesia, five dimensions are considered: expenditure, health (body mass index), years of schooling, access to clean drinking water and access to sanitation facilities. The results indicated that the dual cutoff identification method and the adjusted headcount poverty measure are appropriate to use with capabilities and functionings that are ordinal. There is now a growing number of studies that employ this approach, with only a few using it to measure multidimensional child poverty.

Santos and Ura (2008) apply the AF approach to estimate multidimensional poverty in Bhutan using the 2007 Bhutan Living Standard Survey data. While they do not specifically measure multidimensional child poverty, most of the well-being dimensions used have a strong bearing on children well-being. For instance, of the five dimensions (i.e. income, education, room availability, access to electricity and access to drinking water),[8] the education dimension includes indicator that requires all children between age 6-16 years to be attending school for a household to be considered education non-deprived. For rural Bhutan, the authors also consider access to roads and land ownership. In contrast to the other applications that use equal weights, two alternative weighting systems are used. The results indicate that multidimensional poverty is mainly a rural phenomenon, although urban areas present non-depreciable levels of deprivation in room availability and education. Within rural areas, it is found that poverty in

[7]The term 'deprived' is used to indicate that a person's achievement in a given dimension falls below its cutoff. If a person meets the multidimensional identification criterion, then the person is considered to be 'poor', and the condition is called 'poverty' (Alkire and Foster, 2009, 2)

[8]For rural Bhutan, they also consider access to roads and land ownership.

education, electricity, room availability, income and access to roads, contribute similar shares to overall multidimensional poverty, while poverty in land ownership and water have relatively smaller contributions. The results in this study also indicate that the weighting system can make a difference in terms of identifying the forms of deprivation that make the highest contribution to multi-dimensional poverty.

In his study of multi-dimensional poverty in fourteen Sub-Saharan Africa countries, Batana (2008) uses the AF approach to identify who is poor and who is not poor based on four dimensions: assets, health, schooling and empowerment. Four main results include: Firstly, there are important cross-country differences in multi-dimensional poverty. Secondly, ranking of countries based on the AF multi-dimensional poverty measure differs from ranking based on standard welfare measures (Human development Index (HDI) and income poverty). Thirdly, decomposition of multi-dimensional poverty by location, indicates that multi-dimensional poverty is more prevalent in rural than urban areas. Finally, decomposition of poverty by dimensions indicates that lack of schooling is the key contributor to multi-dimensional poverty.

Roche (2009) measures multidimensional child poverty among children under five years in Bangladesh using the 2006 Bangladesh Multiple Indicator Cluster Survey. In particular, he examines how the AF methodology can compliment other measures of child poverty by particularly proposing a headcount ratio adjusted by the breadth of deprivation of the multidimensional poverty based on the traditional Foster et al. (1984) measures of poverty. Eight dimensions of well-being considered in the analysis are: access to drinking water, access to improved sanitation, security of tenure and eviction, measles immunization, overcrowded housing, salt iodization, vitamin A and support for learning. The results indicate that 57 percent of children are multidimensionally poor when poverty is measured in any two dimensions.

Battiston et al. (2009) use AF methodology to conduct an in-depth study of multidimensional poverty in Latin America countries of Argentina, Brazil, Chile, El Salvador, Mexico and Uruguay for the period 1992–2006. Six indicators of deprivation are considered: three cardinal variables (income, proportion of children age 7-15 years in the household not attending school and years of education of the household head) and three dichotomous variables (having running water in the household, having proper sanitation and living in a house with non-precarious materials). Similar to Santos and Ura (2008), the authors use two alternative weighting systems (equal weights for each indicator and weights derived from a participatory study on the voices

of the poor in Mexico, which asked the poor about their valuations of different dimensions). The AF results indicate suggest that increasing access to proper sanitation (either flush toilet or pit latrine) as well as improving education of the household head (intrinsically valuable and also instrumentally important as a mean to access a better income) should be priorities in all countries as these two dimensions are the highest contributors to overall multidimensional poverty, accounting for 20 to 30 per cent of overall poverty. Deprivation in children attending school was found to be among the lowest contributors in all countries, which results from the high enrollment rates observed in the region.

Biggeri and Trani (2010) examine child poverty in Afghanistan by focus concerns on the deprivation of Afghan children aged between 5 and 14 years. The authors define child poverty as the deprivation of basic capability and related achieved functionings. Fourteen (14) dimensions of deprivation are used to measure child poverty. The results indicate high percentages of children deprivations in the dimensions of: health (75.2 percent), Family assets (72.6 percent) and Food security (37.4 percent), Education (49.4 percent) among others. 76.7 percent of children (5-7 years) are deprived in education compared to 41.3 percent and 43.5 percent for the (8-11) and (12-14) year categories respectively.

Roelen et al. (2010) develop a country specific multidimensional and outcome-based child poverty approach by taking into account policy makers perspectives and current advances in child poverty measurement. The approach is applied to the 2006 Vietnam Multiple Indicator Cluster Survey to obtain an in-depth child poverty profile. The authors use multidimensional poverty line based on the dual cutoff identification method. The authors produce poverty rates according to when poverty is measured in one dimension or two dimensions. The results show that 37 percent of all children in Vietnam live in poverty, with the most pressing areas of deprivation being water, sanitation and leisure. Although the authors do not find evidence of gender bias, they find marked disparities between rural and urban areas, regions and different ethnic groups.

Using Demographic and Health Survey (DHS) data sets for the period 1993, 1998 and 2003 and employing the AF approach, Kabubo-Mariara et al. (2010) conducts multidimensional poverty comparisons for women and children in Kenya. This is the only study in Africa employing AF approach to measure multidimensional child poverty. The authors measure well-being in two dimensions: a composite wealth indicator (constructed using different household

assets) and health status captured by anthropometric indicators for children under 5 years and the body mass index for women. In addition, the authors test for multidimensional poverty dominance along the lines of Duclos et al. (2006a) and also investigate the determinants of multidimensional poverty using bi-variate probit models. Their AF results show that the highest contribution to multidimensional poverty is from assets relative to health, rural areas relative to urban areas and boys relative to girls. The stochastic dominance analysis results suggest slightly different orderings of poverty from the AF approach, especially for regions. Their econometric analysis results show that child, household, environmental and geographical characteristics are important determinants of multidimensional poverty.

2.3 Methodology

In the process of measuring multidimensional poverty, important decisions have to be taken about many aspects: the choice of data source, unit of analysis (person or household), dimensions to be considered and the indicators that reflect these dimensions, the indicators deprivation cut-offs, the weighting scheme attached the selected dimensions and indicators, the setting of poverty cut-off (to identify the poor), and way of aggregating the results in each dimension. In this section we present our decisions related to these aspects step-by-step: first, we present our data and unit of analysis (Subsection 2.3.1), discuss the main dimensions, variables and thresholds of our analysis (Subsection 2.3.2), and then discuss the methods used to compute multidimensional poverty measures (Subsection 2.3.4). These methods may imply different weighting schemes and aggregation criteria.

2.3.1 Data and unit of analysis

The unit of analysis in this study is a child. The study obtained approval from Macro International to use data from the recent and the first survey ever to cover the entire country – the Uganda Demographic and Health Survey (UDHS) for 2006. The 2006 UDHS is a nationally representative survey of 8,531 women aged 15–49 and 2,503 men aged 15–54 and the first ever survey in Uganda to cover the whole country UBOS and Macro International Inc. (2007). The sample was designed to allow separate estimates at national level and for rural and urban areas of the country. Three questionnaires were used, namely: a household questionnaire, women's

questionnaire, and men's questionnaire. Sampling was done in two stages; in the first stage 321 clusters were selected from among a list of clusters sampled in the 2005–2006 Uganda National Household Survey (UNHS). An additional 17 clusters were selected from the 2002 Census frame from Karamoja to accommodate special regions of Karamoja. Finally, 30 internally displaced camps (IDPs) were selected from a list of camps compiled by the United Nations Office for Coordination of Human Affairs. In the second stage, households in each cluster were selected based on a complete listing of households as per UNHS listing, however, in addition to the UNHS sampled households 20 households were randomly selected in each cluster.

The UDHS provides information on the demographic characteristics of the country. Of most most importance to this study is the women's questionnaire which collected information on fertility; family planning; infant, child, adult, and maternal mortality; maternal and child health; nutrition; and knowledge of HIV/AIDS and other sexually transmitted infections. In addition, the data set provides a household wealth index which is constructed by combining information on household assets, such as ownership of consumer items, type of dwelling, source of water, and availability of electricity into a single asset index. The sample is split into five equal groups (quintiles) from 1 (lowest, poorest) to 5 (highest, richest). Therefore, the data set provides an opportunity to measure multidimensional child poverty and to decompose it across all regions of Uganda including children in the IDP camps.

2.3.2 Dimensions, Indicators and Thresholds

2.3.2.1 Construction of a Composite Wealth Indicator

From a human development point of view, a poverty indicator must be significant and eventually measurable at the individual, household, or community level. Multidimensional poverty indicators allow for a broader explanation and measurement of poverty because they take into account factors not directly related to a family's income. Studies on multidimensional poverty first focus on constructing a composite measure of poverty/wealth. In order to achieve the first objective of the study and in the absence of income or expenditure measures in the DHS, we derive a composite wealth indicator (CWI) from the household's asset information available in the DHS.[1] This is an outcome of a factor analysis (FA) of various household characteristics

[1] A number of studies (see, for instance, Montgomery et al., 1999; Filmer and Pritchett, 2001; Sahn and Stifel, 2000, 2003) have shown that it is possible to construct a welfare variable from DHS whose statistical properties

(water source, toilet facilities, and construction materials) and durables (ownership of radio, television, refrigerator, bicycle, motorcycle and/or car) as well as education of the household head. We assume that there is a common factor, "welfare," behind the ownership of these assets, and allow the factor analysis to define that factor as a weighted sum of individual assets.[2]Thus, the CWI reflects the socio-economic status of a household in which a child lives and is one of the dimensions used to measure multidimensional child poverty.

Like any other index of wealth, there are some major challenges in constructing an asset index. Most prominent is the difficulty involved in the aggregation of the various types of assets into a single number that represents the sum total of the value of assets. Several aggregation methods have been employed in the literature including entropy and inertia approaches. The inertia approach is a parametric approach to the composite indicator and stems from static mechanisms and is mainly based on multidimensional analysis techniques(Asselin, 2009). The inertia approach uses the principal techniques of factor analysis including principal components analysis (PCA), generalized canonical analysis (GCA) and multiple correspondence analysis (MCA). The inertial approach is preferred to the entropy for two reasons. First, it is less arbitrary in the definition of the functional form for the composite indicator. Second, it enables an optimal choice among the relevant poverty dimensions. With this preferred approach, the task that remains is the choice between different inertia approaches given the structure of the data available and the assumptions formulated on the indicators under study (Asselin, 2009; Ki et al., 2005).

The aggregation challenge aside, one is also faced with a problem of defining a set of weights for each asset. Indeed, to construct an index of the household assets recorded in the DHS requires selecting a set of weights for each asset. Following Sahn and Stifel (2000, 2003), we construct an index of the following form:

$$A_i = \sum_k \tau_k a_{ik} \tag{2.3.1}$$

where A_i is the asset index for household i , a_{ik}'s are the individual assets, k, recorded in the survey and τ_k are the weights, which can be estimated using different approaches. Because neither the quantity nor the quality of all assets is collected, nor are prices available in the data,

are comparable to the standard household expenditure or income variable.

[2]This is similar to the principal component analysis of Filmer and Pritchett (2001).

the natural welfarist choice of prices as weights is not possible. Moreover, it may be hard to attach a unit price on indicators such as the education level of the household head. Rather than imposing arbitrary weights as in Montgomery et al. (1999), we let the data determine them directly. Filmer and Pritchett (2001) and Rutstein and Johnson (2004) use a similar method that employs PCA to construct an asset index. In this case, the weights for the indices are the standardized first principal component of the variance-covariance matrix of the observed household assets. We use factor analysis instead of PCA because the latter forces all of the components to accurately and completely explain the correlation structure between the assets. Factor analysis, on the other hand, accounts for the covariance of the assets in terms of a much smaller number of hypothetical common variates, or factors (Lawley and Maxwell, 1962). In addition, it allows for asset specific influences to explain the variances. In other words, all of the common factors are not forced to explain the entire covariance matrix. In our case, we assume that the one common factor that explains the variance in the ownership of the set of assets is a measure of economic status, or "welfare." [3]

Other researchers like Booysen et al. (2008), Tegoum and Hevi (2010) uses MCA while Njong and Ningaye (2008) use MCA and fuzzy set approaches to determine weights. Howe et al. (2008) compares PCA with other methods namely: PCA using dichotomized versions of categorical variables; equal weights; weights equal to the inverse of the proportion of households owning the item; and Multiple Correspondence Analysis (MCA) with an aim of identifying whether PCA offers an advantage over other methods. The author concludes that the choice of assets used is important and that despite PCA limitations, other approaches also have disadvantages. Kabubo-Mariara et al. (2010) uses four alternative approaches to construct the welfare index; the first three being MCA, FA and PCA. The fourth one is a two stage procedure. In the first stage, they use MCA to estimate individual scores for each dimension. In the second stage, using the continuous dimensional scores (estimated from at the first stage), they perform a PCA estimation to compute the individual composite wealth indicator of well-being. They argue that this procedure is appropriate because it captures the advantages of MCA in the first stage and avoids the disadvantages of PCA in the second stage since, here, PCA is ap-

[3]It is also important to note that because asset indices constructed from principal components and factor analysis generally are highly correlated, the choice of technique is mainly a matter of convenience. For instance, in their study of poverty comparisons over time and across countries in Africa, Sahn and Stifel (2000) find that the Spearman rank correlation between PCA and FA asset indexes is about 0.98 for each of their samples.

plied only to continuous variables. Along the lines of Ki et al. (2005), this two stage procedure avoids overestimation of the contribution of dimensions with higher variability and enables the derivation of uncorrelated linear combinations of indicators of well-being.

2.3.3 Nutritional Status Indicators and their standardization

As noted before, we use three of the most commonly used anthropometric indicators for infants and children— weight-for-height, height-for-age, and weight-for-age as measures of child nutritional status.[4]Each of these indicators provides different information about growth and body composition of a child. Height-for-age is an indicator of linear growth retardation and cumulative growth deficits. Children whose height-for-age z-score is below minus two standard deviations (-2 SD) are considered short for their age (stunted) and are chronically malnourished. Stunting reflects failure to receive adequate nutrition over a long period of time and is also affected by recurrent and chronic illness. Height-for-age represents the long-term effects of malnutrition in a population and is not sensitive to recent, short-term changes in dietary intake. Weight-for-height measures body mass in relation to body height or length and describes current nutritional status. Children whose z-scores are below minus two standard deviations (-2 SD) are considered thin (wasted) and are acutely malnourished. Wasting represents the failure to receive adequate nutrition in the period immediately preceding the survey and may be the result of inadequate food intake or a recent episode of illness causing loss of weight and the onset of malnutrition. Weight-for-age is a composite index of height-for-age and weight-for-height, which takes into account both acute and chronic malnutrition. It is commonly used for monitoring growth and assessing changes in the magnitude of malnutrition over time (O'Donnell et al., 2008).

For the anthropometric indicators to be used for poverty analysis, they must be standardized based on the reference population, usually the U.S. children population. There is a long-standing debate about the appropriateness of the U.S. reference standard for children in developing countries, in particular concerning the extent to which growth paths will depend on feeding practices. Reflecting these concerns, in 1993 the World Health Organization (WHO) undertook a comprehensive review of the uses and interpretation of anthropometric references,

[4]The three nutritional status indicators are related to MDG1, target 1c: *Reduce by half the proportion of people who suffer from hunger*. The two performance outcomes under this target are (i) Prevalence of underweight children under-five years of age, (ii) Proportion of population below minimum level of dietary energy consumption.

concluding that the National Center for Health Statistics (NCHS) and WHO growth reference did not adequately represent early childhood growth. As a result, a multicenter growth reference study was undertaken to develop new growth curves for assessing the growth and development of children, and in April 2006, the WHO issued new standards for children from birth to five years of age (WHO Multicentre Growth Reference Study Group, 2006).[5] Following these new standards, we constructed the standardized height and weight z-scores (*haz*, *waz*, *whz*) by considering how a child's height or weight compares to the median of the WHO reference sample of healthy children of the same age and gender. We calculated the standardized variables as follows:

$$Z = \frac{\left[\frac{Y}{M}\right]^{L} - 1}{S * L} \tag{2.3.2}$$

where Y is a child's height or weight, M is the median value for height or weight in the reference population, L is the Box- Cox transformation power (for detecting skewness)[6], and S is the generalized coefficient of variation. Equation (2.3.2) simplifies to a normal distribution when $L = 1$, in which case a child's height or weight can be calculated as $Y = M + SMZ$, where $\sigma_x = S * M$ is the standard deviation.

The z-scores computed from equation (2.3.2) can be both negative and positive. For a developing country like Uganda, the z-scores are mainly negative and this poses a difficulty in performing poverty analysis. To deal with the problem, we follow Pradhan et al. (2003) and Sahn and Younger (2010), and use standardized children height and weight instead of the z-scores. A child standardized height and weight is obtained by taking a child's z-score regardless of age and gender, and assigning that same child the height or weight corresponding to the same z-score in the 24-month-old girls distribution in the WHO reference population. In other words, the height/weight derived is that the child would have if he/she was a 24-month old girl. According to Fujii (2010), the standardized height and weight are an affine transformation of z-scores and preserve all the desirable properties of the original z-scores. Thus, the standardization allows us to compare children of different ages and genders while maintaining a positive value for each child. The poverty line that we assign for this variable is the standardized height

[5]For a detailed discussion of the rationale, implementation, and findings from this work, see De Onis et al. (2006) and Garza and De Onis (2004).

[6]The Box-Cox power transformation was proposed by two statisticians -George Box and David Cox in 1964. The Box-Cox power transformation is a family of data transformations designed to achieve normality. The Box-Cox power, L, is the exponent to which all data points must be raised to transform it into a normal shape. To get the appropriate L, the Box-Cox power transformation searches for $L = -5$ to $L = +5$ until the best value is found.

that is two standard deviations below the median of the distribution of the reference population of health children, a practice that is standard in the literature. The values of parameters for standardization and the poverty line were obtained from WHO Multicentre Growth Reference Study Group (2006).[7]

2.3.4 Poverty Measurement Method

In this Subsection, we discuss the method used in this essay to identify a poor person. This method is the so-called "dual cutoff" approach introduced by Alkire and Foster (2007, 2011). "Dual" because it involves two different forms of cutoffs: one pertaining to each single dimension (so that many cutoffs must be selected) and another relating to cross-cutting dimensions. The class of measures to address multidimensional poverty are based on the generalized Foster-Greer-Thorbecke (FGT) index. This new measure is sensitive to deprivation in each dimension and to the number of deprivations that each household or person experiences. The method is explained step-by-step below.

2.3.4.1 Alkire and Foster Dual Cutoff and Counting approach

The Alkire and Foster (2007, 2011) methodology measures poverty in the sense of Sen (1976) that first identifies who is poor, then aggregates to obtain overall measures of poverty that reflect the multiple deprivations. "It is perhaps best seen as a general framework for measuring multidimensional poverty in the sense that it gives the investigator flexibility in selecting dimensions, dimensional cutoffs (to determine when a person is deprived in a dimension), dimensional weights (to indicate the relative importance of the different deprivations), and a poverty cutoff (to determine when a person has enough deprivations to be considered to be poor)... this flexibility makes it particularly useful for measurement efforts at the country level where these decisions can fit the purpose of the measure and can embody normative judgments regarding what it means to be poor" (Alkire and Foster, 2011b, 1-2).

Assume a population of n persons and let $d \geq 2$ be the number of dimensions or capabilities. Let $x = [x_{ij}]$ denote $n \times d$ matrix of achievements, where the typical entry x_{ij} is the achievement of individual $i = 1,2.....n$ in dimension $j = 1,2,.....d$. Each row vector $x_{i.}$ lists child $i's$

[7]The report is available on `http://www.who.int/childgrowth/standards/technical_report/en/index.html`

achievements, while the column vector $x_{.j}$ gives the distribution of achievements in dimension j across the set of individuals. Assume that the number of dimensions, d is fixed and given. The size of the population n is allowed to vary to allow poverty comparisons populations of different sizes. The domain of matrices under consideration is given by $X = \{x \varepsilon R_{+}^{nd} : n \geqslant 1\}$(Alkire and Foster, 2009).

According to Sen (1976) a methodology M for measuring multidimensional poverty is made up of an identification method and an aggregate measure. As a first step, one is required to identify the poor. The most common approach is to first define a threshold level, z_j for each dimension j, below which a a child is considered to be deprived. The collection of these thresholds can be expressed in a vector of poverty lines $z = (z_1, ...z_d)$. In this way, whether an individual is deprived or not in each dimension is defined. However, unlike uni-dimensional measurement, a second decision needs to be made in the multidimensional context: among those who fall short in some dimension, who is to be considered multidimensionally poor?

2.3.4.2 Identification

Alkire and Foster (2009) represent the identification method using an identification function ρ written as:

$$\rho(x_i; z) = \begin{cases} 1 & \text{if individual i is poor} \\ 0 & \text{otherwise} \end{cases} \tag{2.3.3}$$

Assume all dimensions are equally weighted, an assumption that can be relaxed later. For any matrix x, one can define a matrix of deprivation $g^0 = [g_{ij}^0]$, where for all values of i and j:

$$g_{ij}^0 = \begin{cases} 1 & \text{if} \quad x_{ij} < z_j \\ 0 & \quad\quad x_{ij} \geqslant z_j \end{cases} \tag{2.3.4}$$

We can sum each row of g^0 to obtain a column vector c of deprivation counts containing the number of deprivations$c_i = |g_i^0|$[8]suffered by individual i. Notice that the matrix g^0 and vector c can be defined for any ordinal and cardinal variables from the matrix of achievements. In other words, g^o and c are identical for all monotonic transformations of x_{ij} and z_j (Alkire and Foster,

[8]Using Alkire and Foster (2009) notation, the sum of entries in any given vector or matrix v is denoted by $|v|$, while $\mu(v)$ is used to represent the mean of v (or $|v|$ divided by the number of entries in v).

2009, 5). If the variables in x are cardinal, then a matrix of normalized gaps $g^1 = [g^1_{ij}]$ can be defined, where the typical element $g^1_{ij} = g^0_{ij}\left(\frac{z_j - x_{ij}}{z_j}\right)$. Clearly, g^1 is an $n \times d$ matrix whose entries are non-negative between 0 and 1 inclusive, and each non-zero entry gives the extent of the deprivation experienced by individual i in dimension j. This matrix can be generalized to $g^\alpha = [g^\alpha_{ij}]$, with $\alpha > 0$, whose typical element g^α_{ij} is the normalized poverty gap raised to the α - power.

With a cutoff k mentioned earlier, we can compare the number of deprivations per individual. Since we have assumed that each selected dimension has the same weight, the cutoff $k = 1, ..., d$. The identification function relating to cutoff k is such that $\rho_k(x_i; z) = 1$ when $c_i \geqslant k$, and $\rho_k(x_i; z) = 0$ when $c_i < k$. This means a n individual is identified as multidimensionally poor if he/she is deprived in at least k dimensions. Alkire and Foster (2007) refers to ρ_k as the *dual cutoff* method because it uses *within* dimension cutoffs z_j to determine whether an individual is deprived or not in each dimension, and the *across dimensions* cutoffs k to determine who is to be considered multidimensional poor. The approach is also presented as a counting approach since it identifies the poor based on the number of dimensions in which they are deprived.

In a multidimensional context, the cutoff $k = 1$, corresponds to the *union identification* method in which an individual is considered poor if he/she is deprived in at least one dimension. The problem with this criteria is that it could overestimate poverty, especially when the number of dimensions is high enough with possible substitutability among some dimensions. The cutoff $k = d$, corresponds to the *intersection* criteria which consider an individual as poor only when he/she is deprived in all dimensions. This could on the other hand underestimate the poverty by not considering, for example a healthy illiterate person as poor when health and education are the two dimensions under consideration.[9] Alkire and Foster (2007, 2011) also define an *intermediate* cutoff method when $1 < k < d$. In the case of only two dimensions, the intermediate criterion will be a combination of two dimensions as proposed by Duclos et al. (2006b). Once the appropriate k has been determined, the next step is to get an appropriate poverty measure by aggregating all the deprivations.

"...Similar identification methods can be found in the literature, albeit with different motivations... For example, the *UNICEF Child Poverty Report 2003* identified any child who

[9] Atkinson (2003) first applied the terms 'union' and 'intersection' in the context of multidimensional poverty.

was deprived with respect to two or more dimensions as being in extreme poverty (Gordon et al., 2003b)...However, the dual cutoff method has desirable characteristics...First, 'poverty focused' in that an increase in an achievement level x_{ij} of a non-poor person leaves its value unchanged...Second, it is 'deprivation focused' in that an increase in any non-deprived achievement $x_{ij} \geqslant z_j$ leaves the value of the identification function unchanged; in other words, a person's poverty status is not affected by changes in the level of non-deprived achievements" (Alkire and Foster, 2009, 8)

2.3.4.3 Aggregation

The first step after an appropriate k has been determined is to obtain a censored matrix $g^0(k)$ from g^0 by replacing the i^{th} row with a vector of zeros whenever $\rho_k(x_i;z) = 0$. Also, the censored vector of deprivation $c(k)$ can be defined from c_i so that if $c_i \geqslant k$, then $c_i(k) = c_i$; and if $c_i < k$, then $c_i(k) = 0$. This is to say that in $c(k)$ the count of deprivations is always zero for those individuals that are not poor according to the identification function $\rho_k(x_i;z)$, while individuals that were identified as poor keep the original vector of deprivations experienced by a poor individual i. In a similar manner, when variables in matrix x are cardinal, matrix $g^\alpha(k)$ can be defined analogously for any $\alpha > 0$, with its typical elements $g^\alpha_{ij}(k) = g^\alpha_{ij}$ if i is such that $c_i \geqslant k$, while $g^\alpha_{ij}(k) = 0$ if i is such that $c_i < k$. Therefore, the aggregation step takes the identification function $\rho_k(x_i;z)$ as given and associates with the matrix x and the cutoff vector z an overall class $M(x;z)$ of multidimensional poverty measures.

The first multidimensional poverty measure that can be defined is the headcount ration $H = H(x;z)$, which is the percentage of the population that is poor and it can be written as:

$$H = \frac{q}{n} \tag{2.3.5}$$

where $q = q(x;z) = \sum_{i=1}^{n} \rho_k(x_i;z)$, is the total number of poor individuals identified according to the threshold vector z and the cutoff k. This measure is analogous to the traditional headcount ratio based on FGT measures proposed by Foster et al. (1984), and it has the advantage that it is easy to compute and understand, has direct interpretation, and can be calculated with ordinal data. Nevertheless, as is the case with income headcount ratio, the measure in equation (2.3.2)

has the disadvantage of being a crude, or partial, index of poverty.[10] While it provides information about the proportion of the population who are poor, it does not inform about the breadth, depth or severity of individuals in poverty. It also violates monotonicity and transfer axioms. Moreover, in the multidimensional context, it also violates dimensional monotonicity in a sense that if a poor person that was initially deprived in say two dimensions becomes deprived in an extra dimension, the measure does not change (Alkire and Foster, 2009).

To address the above concerns, Alkire and Foster (2009) propose the dimension adjusted FGT measures. Ideally, these measures are the traditional FGT measures adjusted by the average number of deprivations experienced by the poor. The average deprivations share across the poor can be computed from the censored vector of deprivation counts $c(k)$, where $c_i(k) = \rho_k(x_i;z)c_i$ for $i = 1,....,n$ as:

$$A = \frac{|c(k)|}{qd} = \frac{1}{qd}\sum_{i=1}^{n}\rho_k(x_i;z)c_i \tag{2.3.6}$$

The partial index in equation (2.3.6) conveys relevant information about multidimensional poverty, namely, the fraction of possible dimensions d in which the average poor person endures deprivation. Using equation (2.3.5) in (2.3.6) we obtain the adjusted headcount measure, which is the number of deprivations experienced by the poor, divided by the maximum number of deprivations that could be experienced by all people (nd) and is defined as:

$$M_0 = HA = \mu(g^0(k)) = \frac{1}{nd}\left[\sum_{i=1}^{n}c_i\rho_k(x_i;z)\right] \tag{2.3.7}$$

If the variables in x are cardinal, information on poverty depth and distribution can be obtained via the associated matrix of (normalized) gaps or shortfalls. Let G be the *average poverty gap* across all attributes/dimensions in which poor persons are deprived , given by $G = \frac{|g^1(k)|}{|g^0(k)|}$. The adjusted poverty gap is the product of the adjusted headcount ratio M_0 and the average poverty gap G, given by:

$$M_1 = HAG = \mu(g^1(k)) \tag{2.3.8}$$

Equation (2.3.8) says that adjusted poverty gap is the sum of normalized gaps of the poor, or $|g^1(k)|$ divided by the highest possible sum of normalized gaps, or nd. If the deprivation of

[10] A partial index provides information on only one aspect of poverty. See Foster and Amartya (1997)

a poor person deepens in any dimension, then the respective $g^1_{ij}(k)$ will rise and hence so will M_1Alkire and Foster (2009, 11). In general, for any value of $\alpha > 0$ the normalized gap raised to power α can be written as:

$$G^{\alpha}(k) = \frac{|g^{\alpha}(k)|}{|g^{\alpha-1}(k)|} = \sum_{j=1}^{d}\sum_{i=1}^{n} g^{\alpha}_{ij}\rho_k(x_i;z) \tag{2.3.9}$$

Then the adjusted FGT measure $M_{\alpha}(x;z) = HAG^{\alpha}$ can be defined as:

$$M_{\alpha} = \mu(g^{\alpha}(k)) = \frac{1}{nd}\sum_{j=1}^{d}\sum_{i=1}^{n} g^{\alpha}_{ij}\rho_k(x_i;z) \tag{2.3.10}$$

When $\alpha = 0$, M_{α} is the adjusted headcount ratio M_0 . When $\alpha = 1$, we get the adjusted poverty gap ($M_1 = HAG$). When $\alpha = 2$, the measure is the adjusted squared poverty gap:$M_2 = HAG^2 = HAS$ where $S = G^2$. This is a summary of the incidence of poverty, the average range and severity of deprivations of the poor. If a poor person becomes more deprived in a particular dimension, M_2 will increase more the larger the initial level of deprivation for this individual in this dimension. This measure obeys axioms of monotonicity and transfer, being sensitive to inequality of deprivations among the poor (Kabubo-Mariara et al., 2010, 16).

The measures of poverty in the $M_{\alpha}(x_i;z)$ family satisfy a a number of axioms including decompasability by subgroups of population and by dimensions.[11] Given a population subgroup I, its contribution to overall poverty is given by:

$$C_I = \left[\left(\frac{n_I}{n}\right) M^I_{\alpha}\right]\frac{1}{M_{\alpha}} \tag{2.3.11}$$

where (n_I/n) and M^I_{α} are the population share and the poverty measure of subgroup population I respectively, and M_{α} is the poverty measure of the overall population. Clearly, the decomposition could easily be generalized to any number of exclusive subgroups. In addition, it is also possible to break-down the contribution of each dimension j to the overall multidimensional poverty measure.

The $M_{\alpha}(x;z)$ family of multidimensional poverty measures presented so far assumes that all dimensions receive the same weight. However, it is possible to extend into a more general form, to allow different weighting systems. Decancq and Lugo (Forthcoming) argue that

[11] Alkire and Foster (2009) provide a detailed discussion on axioms, that is, joint restrictions on identification and aggregation methodologies.

weights play a crucial role in determining the trade-offs between the dimensions and that it is important to know how a well-being index reacts to parameters weights, in particular, and the achievements in different dimensions. Following Alkire and Foster (2009), let w be a dimensional d row vector, whose typical element w_j is the weight associated with dimension j. Define the $n \times d$ matrix $g^{\alpha} = [g_{ij}^{\alpha}]$ of weighted normalized gaps whose typical typical element is:$g_{ij}^{\alpha} = w_j \left[\frac{(z_j - x_{ij})}{z_j}\right]^{\alpha}$ when $x_{ij} < z_j$, and $g_{ij}^{\alpha} = 0$ otherwise. As illustrated before, a column vector of deprivation counts can be defined, whose i^{th} element $c_i = |g_i^0|$ represents the sum of weights for the dimensions in which person i is deprived. Each c_i varies between 1 and d, and so the associated dimensional cutoff for the identification step of the multidimensionally poor will be a real number k, such that $0 < k \leq d$. The dual cutoff identification method $\rho_k$associated with w is defined by $\rho_k(x_i;z) = 1$ whenever $c_i \geq k$ and $\rho_k(x_i;z) = 0$ otherwise. When equal weights are used, $k = min\{w_j\}$, the identification criterion corresponds to the union approach, whereas when $k = d$, the identification criterion corresponds to intersection approach; thus ρ_k includes both of these methods given any w. The special case of equal weighting is when ($w_j = 1$ for all $j = 1, ...d$) in which case the methodology works exactly the same as before, defining the censored matrices $c(k)$ and $g^{\alpha}(k)$, and the $M_{\alpha}(x;z)$ measures. The alternative specification $w_1 = d/2$ and $w_2 = ... = w_d = \frac{d}{2(d-1)}$ is an example of nested weighting structure, in which the overall weight is first split equally between dimension 1 and the remaining ($d-1$) dimensions, and then the weight accorded to the second group is allocated equally across the ($d-1$) dimensions. A cutoff of $k = d/2$, for example, would then identify as poor anyone who is either deprived in dimension 1 or in all of the remaining dimensions (Alkire and Foster, 2009, 14).

2.4 Estimation results

2.4.1 The Composite Wealth Indicator

The composite wealth indicator index was computed based on six categories of variables and 13 indicators. These and their corresponding scores (i.e. weights) are presented in Table 2.4.1. The first category relate to ownership of household assets. Ownership of these five assets may reflect different needs (for instance, radio and TV for communication, and entertainment, refrigerator for comfort, bicycle, motorcycle and car for transportation or recreation purposes), but are all

expected to have positive scores and therefore a welfare improving effect reflected by a positive contribution to CWI. The second category captures a household's stock of human capital or education attainment aspects. An educated household head, for example, may be employed in wage earning activities and thus is able to cater for his family adequately using the earned income, hence improving the household welfare. The third category captures the household's main source of drinking water. Poor households both in rural and urban areas are more likely to rely on unclean sources of water such as open surface water (wells, springs, dams, rivers and lakes and other sources), while richer households are likely to access piped water, either in their own residence or from a public tap. As expected, surface water has a negative score and thus a negative contribution to CWI. We also observe a negative score for no toilet indicator under sanitation category which includes toilet facilities (flush toilet or no toilet relative to pit or latrine facilities). Similarly, we observe a negative score for primitive flooring under the housing category (primitive flooring relative to high quality floor). Lastly, clean energy sources such as electricity are expected to have a positive impact on the CWI.

Table 2.4.1: Weights for the asset index

Asset	Weight
Radio	0.03353
Electricity	0.32408
Television	0.24918
Refrigerator	0.18374
Bicycle	-0.01284
Motorized transport	0.06975
Piped Water	0.11549
Surface water	-0.01895
Flush Toilet	0.07927
No Toilet	-0.02571
Primitive Flooring	-0.02571
Household Head's Years of Education	0.06525

Source: Authors own calculations from UDHS 2006

The computed CWI (asset index) contains both negative and positive values. Since our multidimensional poverty measures are defined over positive real numbers, we cannot measure child poverty using the unadjusted values of the asset index. To resolve this problem, we follow Sahn and Stifel (2003) and Booysen et al. (2008) and simply shift the distribution by an amount sufficient to transform all values to be positive-ie., we add just more than the negative value of the smallest number to each household's index value. This transformation gives the lowest value of the index as zero and it is possible that there will be very many zero values. This can be

problematic since the STATA software used in the analysis may drop the zero values. To resolve this problem, we add an additional small value of 0.01 to make the minimum value of the asset index non-zero. A positive finite transformation of this nature does not change the information contained in the index since the rank ordering of households is maintained and the variance of the asset index distribution is unaffected. However, the mean of the distribution is not preserved. The transformation essentially means that adjusted FGT measures other than headcount ratio only have meaning, but since the transformation leaves the distribution unchanged, the poverty measures still have meaning in a relative sense, thus enabling comparisons of resulting estimates of the asset index.

2.4.2 Correlation between Asset Index and Child health indicators

Empirical studies have shown that standard nutritional status indicators are not highly correlated with standard measures of household welfare such as consumption expenditures, incomes or asset index, and thus they can be treated as independent dimensions of well-being (see, for instance, Younger, 2003; Haddad et al., 2003; Duclos et al., 2006a). The correlation coefficient between child health indicators and the CWI are reported in Table 2.4.2. Our results are consistent with previous studies in Africa. For example, Duclos et al. (2006b) calculates the correlation coefficients between natural logarithm of household expenditure per adult equivalent and *haz* for Uganda, Ghana and Madagascar to be 0.10, 0.14, and 0.07 respectively. With the exception of the correlation coefficient between *whz* and *haz*, the rest of the coefficients are statistically significant at the 1 percent level. As expected, *haz* and *waz* are highly correlated (0.6721). Similarly, *whz* and *waz* are highly correlated (0.6396). In general, weight-for-height and height-for-age are not correlated, whereas there tends to be a positive correlation between weight-for-height and weight-for-age and between weight-for-age and height-for-age.

Table 2.4.2: Spearman rank correlation coefficient between dimensions

	Asset Index	*haz*	*whz*	*waz*
Asset Index	1.0000			
haz	0.1615	1.0000		
whz	0.0961	-0.0503	1.0000	
waz	0.1888	0.6721	0.6396	1.0000

Source: Authors own calculations

2.4.3 Incidence of deprivation and Identification

As noted before, we measure child poverty in two full dimensions: CWI (i.e. *asset index)* and nutritional status. Nutritional status is composed of three sub-indicators: standardized height-for-age, standardized weight-for-height and standardized weight-for-age. To identify children deprived in each of these dimensions, we set a poverty line or cutoff for each dimension, below which a child is considered poor. Apparently, there is no non-arbitrary level at which to set the poverty line when using an asset index. Sahn and Stifel (2003) for example, construct an asset index poverty line such that it is equivalent to $1/day. Booysen et al. (2008) instead use two relative poverty lines, one set at 40^{th} percentile which is in accordance with the World Bank recommendation for poverty analysis, and a second and higher poverty line is set at 60^{th} percentile to control for the fact that African countries have higher poverty than other world regions and their asset index does not discriminate well at lower levels. Younger (2003) in a study on Uganda, sets a poverty line such that the resulting national poverty headcount ratio is equal to that calculated by Appleton (2001) using the 1999/2000 Uganda National Household Survey. Following this literature, the cutoff for the asset index is based on a relative poverty line of 40^{th} percentile of the asset index distribution, which is equivalent to 0.2526.[1] For standardized nutritional status indicators, it is a standard practice to use the -2 z-score as the poverty line. The cutoff for standardized height for age is 79.3, the cutoff for standardized weight for height is 15.3 and the cutoff for standardized weight for age is 9.0.

The incidence of deprivation in each dimension for children in both rural and urban areas and different regions is reported in Table 2.4.3. The distribution of children is predominantly rural (89.7 percent compared to 10.3 percent in urban areas). This is consistent with the 2002 Uganda Census data which shows that 87.6 percent of Uganda's population lived in rural areas compared to 12.4 percent in urban areas. The results indicate that 40.3 percent of children in the whole sample live in households that are deprived in the asset index. Further more, 38.8 percent of children are stunted; 6.6 percent are wasted and 16.1 percent are underweight. The incidence of deprivation varies considerably between urban and rural areas as well between different regions. While the incidence of deprivation in asset index is only 8.5 percent in urban areas, the proportion is five times higher in rural areas (43.9 percent). Similarly, 25.4 percent

[1] We also used alternative relative poverty lines set at 0.2118 and 0.3086 for 25^{th} and 60^{th} percentiles respectively. The results (not reported) show that the estimated poverty measures are fairly consistent to the poverty line chosen.

and 11 percent of children in urban areas are stunted and underweight respectively, compared to 40.3 percent and 16.7 percent in rural areas. However, there is little difference in wasting between urban and rural areas.

Table 2.4.3: Incidence of deprivation by urban-rural areas (%)

	Area of Residence		Region					**Total**
Dimensions	Urban	Rural	Kampala	Central	Eastern	Northern	Western	
Asset Index	8.5	43.9	0.0	27.0	45.7	54.5	36.8	**40.3**
Stunted	25.4	40.3	25.8	31.3	40.0	41.1	43.9	**38.8**
Wasted	7.6	6.6	8.3	3.6	7.0	7.4	7.4	**6.6**
Underweight	11.0	16.7	11.4	10.1	17.2	20.4	15.3	**16.1**

Source: Authors own calculations from UDHS 2006

There are marked differences among regions with respect to deprivation in the asset index. Surprisingly, children in Kampala (capital city) are not deprived in the asset index.[2]Children in the Northern (54.5 percent) and Eastern (45.7 percent) regions are the most deprived. This finding is consistent with national poverty estimates in Uganda based on consumption expenditure per adult equivalent which show Eastern and Northern regions are the poorest regions in the country (see Ssewanyana and Okidi, 2007). As for deprivation in nutritional status indicators, stunting is highest in the Western region (43.9 percent)[3] and lowest in Kampala (25.8 percent). Wasting is higher in Kampala (8.3 percent), while other regions show little differences in wasting rate. Underweight ranges from 10.1 percent in Central to 20.4 percent in the North.[4]We also explore the mean child health status (standardized z-scores) by asset index quintile. The results suggest that child health status improves as we move to higher asset index quintiles. For instance, standardized height for age increases from 79.70 for the first quintile to 82.25 for the fifth quintile. Similarly, standardized weight for height and standardized weight for age in-

[2]The smallest value for the asset index in Kampala is 0.3347 compared to the poverty line of 0.2526. To check whether our result is consistent, we estimate the incidence of deprivation in the four dimensions using an already calculated wealth index in DHS 2006 data. The minimum value for the wealth index for Kampala is 3 and the 40th percentile for this wealth index is 2, which also gives the incidence of deprivation in the wealth index in Kampala as 0 percent. The DHS wealth index (see Rutstein, 2008) uses more indicators than we used in constructing the CWI.

[3]This finding consistent with previous studies (e.g Bahiigwa, 2005) which show that children in Western Uganda, a region generally considered less poor than either Eastern or Northern region, are significantly shorter than children in regions of the country. This result could possibly be due to genetics, ethnicity, and environmental factors.

[4]In UDHS 2006, regions were classified as: Central 1, Central 2, Kampala, East Central, East, North, West Nile, and Southwest. For regional decomposition in this study, we combined Central 1 and Central 2 to form the the Central region, East Central and East into Eastern region, North and West Nile into Northern Region, Southwest formed the Western region and Kampala. Although Kampala belongs to the Central region, it was left as a separate region because of being a capital city and the richest part of the country. Hence it allows us to compare it with the other less rich regions.

creases from 18.03 and 9.95 (respectively) for the first quintile to 18.75 and 10.92 (respectively) for the fifth quintile.

Another interesting exercise in the analysis of incidence of poverty consists of investigating the degree of overlap of poor children from different definitions of monetary poverty. The results presented in Table 2.4.4 below indicate lack of overlap in children falling into poverty (Laderchi et al., 2003; Booysen et al., 2008Booysen et al. 2007). To shed more light on this absence of overlap, consider children who are poor in terms of low height for age and also by a 40 percentile asset index poverty line. We can see from the table that only 17.7 percent (404 out of 2281 children) can be considered poor by both dimensions. 21.1 percent (481) are poor by the height for age, but are non-poor according to asset index poverty line. 38.6 percent (881) can be considered non-poor by height for age and 40^{th} percentile poverty line definition, while 24.2 percent (515) are height for age non-poor, but classified as poor by the 40 percentile status. A similar pattern of lack of overlap is also observed for the other two indicators of nutritional status and the alternative asset index poverty lines.

Table 2.4.4: Overlap in Child poverty by alternative indicators

		25^{th} percentile		40^{th} percentile		60^{th} percentile	
		Non-poor	Poor	Non-poor	Poor	Non-poor	Poor
Height for age	Non-poor	1,101	295	881	515	660	736
	Poor	623	262	481	404	321	564
Weight for height	Non-poor	1,616	513	1,272	857	910	1,219
	Poor	108	44	90	62	71	81
Weight for age	Non-poor	1,483	431	1,183	731	854	1,060
	Poor	241	126	179	188	127	240

Source: Authors own calculations from UDHS 2006

It is also useful to look at the incidence of deprivations by age and sex groups. For many purposes, anthropometric data should be presented according to age and sex groups. The main reason is that patterns of growth failure vary with age. WHO (1995) recommends that at least two age disaggregation be used namely; the under 24 months and the 24 months and over. Table 2.4.5 shows children's incidence of deprivation in each dimension by age and gender. There is little difference in the incidence of deprivation in the asset index among the age and sex groups. For child health indicators, it is clear that stunting increases with the age of the child through the first three years of life before declining in the fourth and fifth year. The increase is especially rapid during the first two years of life, as the proportion of stunted children increases

from 19.7 percent for the 0-11 age bracket to 42.1 percent for the 24-35 age bracket. Previous research on children nutritional status, for example, Kabubo-Mariara et al. (2008) attribute this to ceasing of breast feeding and weaning. Under normal circumstances, a child is introduced to a wider range of food nutrients after two years of life than at a more tender age, and this may explain the observed decline in stunting rates for children above two years. A further analysis of the data shows that boys are more likely to be stunted than girls (41.2 percent compared with 36.4 percent). This finding is consistent with other studies on nutritional status of children in Africa (e.g. Kabubo-Mariara et al., 2008; Ssewanyana, 2003; Bahiigwa, 2005). Wasting varies greatly by age and peaks among children in the 9-11 months bracket. Boys are slightly more likely than girls to experience wasting (8 percent compared with 6 percent). The percentage of children underweight more than triples from 9 percent among children under 6 months to 29 percent among the 9-11 months.

Table 2.4.5: Incidence of deprivations by Age and Sex in percentages

	Asset index	Stunted	Wasted	Underweight
Sex				
Male	41.6	41.2	7.8	17.3
Female	38.9	36.4	5.5	14.9
Age in Months				
0-11	40.9	19.7	12.4	15.8
12-23	36.5	42.1	12.1	20.6
24-35	42.5	48.2	3.7	16.3
36-59	40.9	43.0	1.6	13.4
Total	**40.3**	**38.8**	**6.7**	**16.1**

Source: Authors own calculations from UDHS 2006

Now, lets turn to the analysis of the exact number of deprivations a child suffers. Usually, it is not the same to suffer from only one deprivation than from multiple deprivations simultaneously. Table 2.4.6 presents the distribution of deprivation counts c, for the exact number of deprivations, independent of the specific area of deprivation.[5] The results show that 18.11 percent of the children suffer from exactly one deprivation and 9.73 percent from exactly two deprivations. Notice that the proportion of children in rural areas that are deprived in all the four dimensions is more than two times that of urban areas.

[5]Since we are using nested weights, one needs to be careful in interpreting the exact number of deprivations. For example, being deprived in exactly one dimension imply that a child is deprived in either the asset index or all the three nutritional status sub-indicators (i.e. each sub-indicator is weighted 0.667 for a total weight of 2). Therefore, independence is with respect to the sub-indicators of the nutritional status dimension. Being deprived in exactly two dimensions means a child is deprived in the asset index plus any one of the three sub-indicators of child health dimension (i.e. total weight of 2.667) and so on until a child is deprived in all the four dimensions.

Table 2.4.6: Distribution of deprivation counts, c

Exact number of Deprivations	Percentage of children deprived		
	Urban	Rural	Total
1	5.93	19.41	18.02
2	1.27	10.71	9.73
3	0.85	5.92	5.39
4	0.42	0.98	0.92

Source: Authors own calculations from UDHS 2006

2.4.4 Aggregate multidimensional poverty estimates

In order to use the approach described in section 2.3.4 to measure multidimensional child poverty, we require a child to be deprived in at least two dimensions ($d \geq 2$). In this section, we present different multidimensional child poverty measures according to different cutoffs k. Following Batana (2008), we use a nested weighting structure to assign weights to the asset index and the three sub-indicators of nutritional status. In the first stage, the CWI (asset index) and the nutrition status dimensions are each assigned an equal weight of 2. In the second stage, the weight for child health dimension is divided equally among the three sub-indicators, each getting a nested weight of 0.667. The sum of all weights must add up to the total number of indicators, in this case 4. Its important to note that the nested weighting framework used renders a different interpretation for each cutoff k- value compared to when equal weights are used. For example, assuming equal weights were used, $k = 1$ would imply that a child is multidimensionally poor if he/she is deprived in at least one of the four dimensions. With nested weights, a child would only be identified as multidimensional poor with $k = 1$ when he/she is deprived in at least a dimension or a combination of dimensions whose weights add to 1. For example, a child that is only too short for her age (i.e. stunted) is not considered multidimensionally poor with $k = 1$, and so is a child deprived in any of the other two nutritional status indicators, since their individual weights ($\frac{2}{3}$) is less than one. However, a child that is deprived only in the asset index is considered multidimensionally poor with $k = 1$, as well as any child that is stunted and wasted, stunted and underweight or wasted and underweight, because the weight of the asset index or the sum of weights for any two of nutritional status indicators exceeds one.

We can see from Table B.1 that the estimated poverty indices depend on the cutoff, k. Notably, poverty measures decrease as k increases. It can also be seen that the average number

of deprivations, $A(k)$ increases as k increases. $A(k)$ is computed by multiplying A in equation (2.3.6) by d - the number of dimensions. When $k = 0$, $A(k)$ becomes the average number of deprivations in the pooled population. Our estimate of $A(0)$ is 1.06, and as a result, the adjusted headcount ratio (M_0), and the corresponding adjusted poverty gap (M_1) and adjusted poverty gap squared (M_2) differ from the headcount ratio (H) by appropriately taking into account this relative depth of deprivation in poverty measurement. For instance, taking the headcount ratio (H), 48 percent of children are multidimensionally poor and on average, they are deprived in 2.32 dimensions (representing an average deprivation share of 57.9 percent) when $k = 1$ compared to 1.2 percent when $k = 4$. The values for M_0 however suggest that for the same cutoffs, 27.8 percent and 1.2 percent respectively of the children are poor. The corresponding adjusted poverty gap (M_1) and adjusted poverty gap squared (M_2) are quite small. Clearly, there is an inverse relationship between the poverty index and the cutoff and this is because an increase in k is equivalent to a reduction in the poverty line (Batana, 2008).

Table 2.4.7: Alkire and Foster (2007) MDP indices for Rural and Urban areas

Cutoff , k	Headcount ratio	Adjusted headcount, M0	Adjusted poverty gap, M1	Adjusted poverty gap squared, M2	Average deprivation share among the poor A	A(k)	Number of Children
0.7	0.644	0.305	0.066	0.031	0.473	1.894	1470
1.3	0.480	0.278	0.065	0.031	0.579	2.316	1094
2.0	0.418	0.257	0.064	0.031	0.615	2.460	954
2.7	0.198	0.147	0.034	0.017	0.743	2.971	452
3.3	0.078	0.067	0.016	0.008	0.858	3.434	179
4.0	0.012	0.012	0.003	0.001	1.000	4.000	27

Source: Authors own calculations from UDHS 2006

The multidimensional poverty incidence (H) estimates can be related to the one dimensional (asset index) poverty incidence, which is 40.2 percent. One should always present the estimates for different k- values. However, results in Table 6 above shows that, if one had to choose a value for k to define policy, $k = 2$ might be a reasonable intermediate cutoff which focus attention on a set of children narrow enough so as to ensure that they are indeed multidimensionally deprived, and broader enough so as to include children that, even if not deprived in a high number of dimensions, they still experience deprivation in several relevant ones.

It is also important to analyze whether there is overlap between the group of poor identified with the multidimensional approach and the group of poor identified with the uni-dimensional (usually the traditional monetary) approach. Laderchi et al. (2003) present empirical evidence

of significant lack of overlap in the identification by the monetary (uni-dimensional) and the capability approach for the case of India and Peru. Santos and Ura (2008) find similar evidence in the case of Bhutan. We also find similar evidence for the case of Uganda as the previous studies using any one of the four dimensions.

To illustrate this lack of overlap, consider the asset index dimension as the uni-dimensional measurement approach. Table 2.4.8 presents the percentage of children population that is asset index non-deprived but multidimensionally poor, and the percentage of the children population that is asset index deprived but multidimensionally non-poor, for different k values in the estimate of both rural and urban areas using the nested weighting structure. By definition, the percentage of the asset index non-poor that are multidimensionally poor decreases as k increases, being zero when $k = d$, since all the multidimensionally poor in that case are deprived in every considered dimension, including the asset index. As noted before, this is because an increase in k is equivalent to a decrease in the poverty line. For the same reason, the percentage of asset index poor that are multidimensionally non-poor increases as k increases. It goes from 0 when $k = 1$, since in that case all the income deprived are considered multidimensionally poor, to 39.2 percent, a value close to the aggregate asset index headcount ratio (40.2 percent) when $k = d$, given that in that case only the few asset index deprived that are also deprived in all the other dimensions are considered multidimensionally poor.

This suggests that, if one would want to reach the multidimensionally poor by using for example, the income poor as a "proxy" variable, there would be always some non-depreciable error: either a group that is only income poor but not multidimensionally poor would be included, which would be Type-I error, or a part of the multidimensionally poor would be excluded for not being income poor, which would be a Type-II error. If one considers a minimum possible k value to be relevant to identify the multidimensionally poor, using an income approach in that case minimizes the Type-II error but maximizes Type-I error. On the other hand, if one considers that $k = d$, is the relevant deprivation cutoff to identify the multidimensionally poor, using an income approach minimizes Type-I error but maximizes Type-II error. For k values in the middle of the extremes, there is some combination of each error type when an income approach is used (Santos and Ura, 2008).

Table 2.4.8: Lack of overlap between Income (proxied by an Asset index) and Multidimensional Poverty, percentage of all children

	Cutoffs					
	$k = 0.7$	$k = 1.3$	$k = 2.0$	$k = 2.7$	$k = 3.3$	$k = 4$
Asset index Non-Poor but MD Poor	24.0	7.5	1.4	0.0	0.0	0.0
Asset index Poor but MD Non-Poor	0.0	0.0	0.0	20.6	32.5	39.2
Not stunted but MD Poor	25.5	23.6	22.7	2.0	1.1	0.0
Stunted but MD Non- Poor	0.0	14.6	19.7	21.1	32.1	37.6
Not wasted but MD Poor	57.7	42.7	37.6	17.1	5.6	0.0
Wasted but MD Non- Poor	0.0	1.6	4.1	3.9	4.4	5.5
Not underweight but MD Non- Poor	48.2	32.1	32.1	11.5	0.0	0.0
Underweight but MD Non- Poor	0.0	0.4	6.5	7.8	8.3	14.9

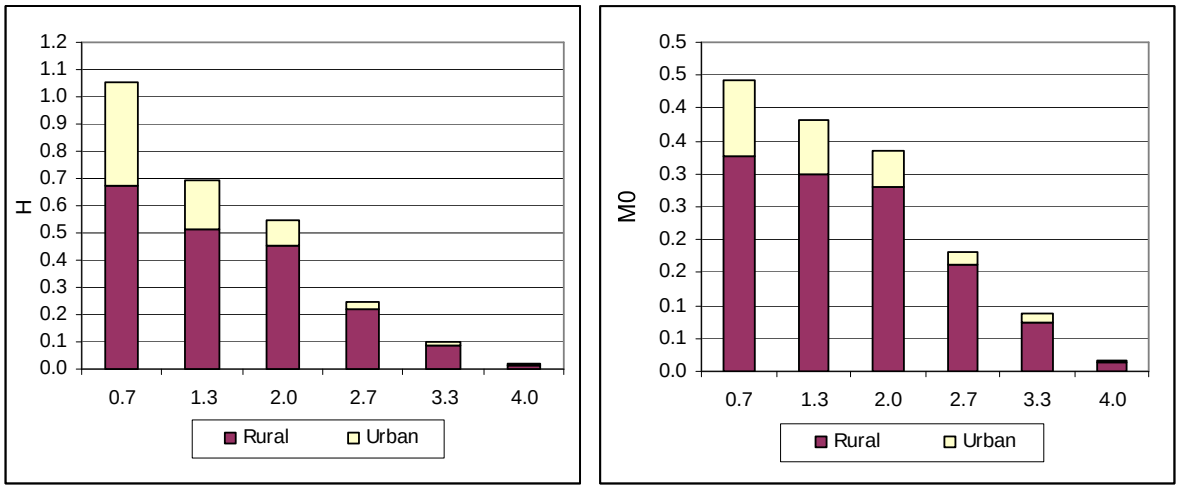
Source: Authors own calculations from UDHS 2006

Notes: MD-multidimensional

2.4.5 Decomposition by geographical location

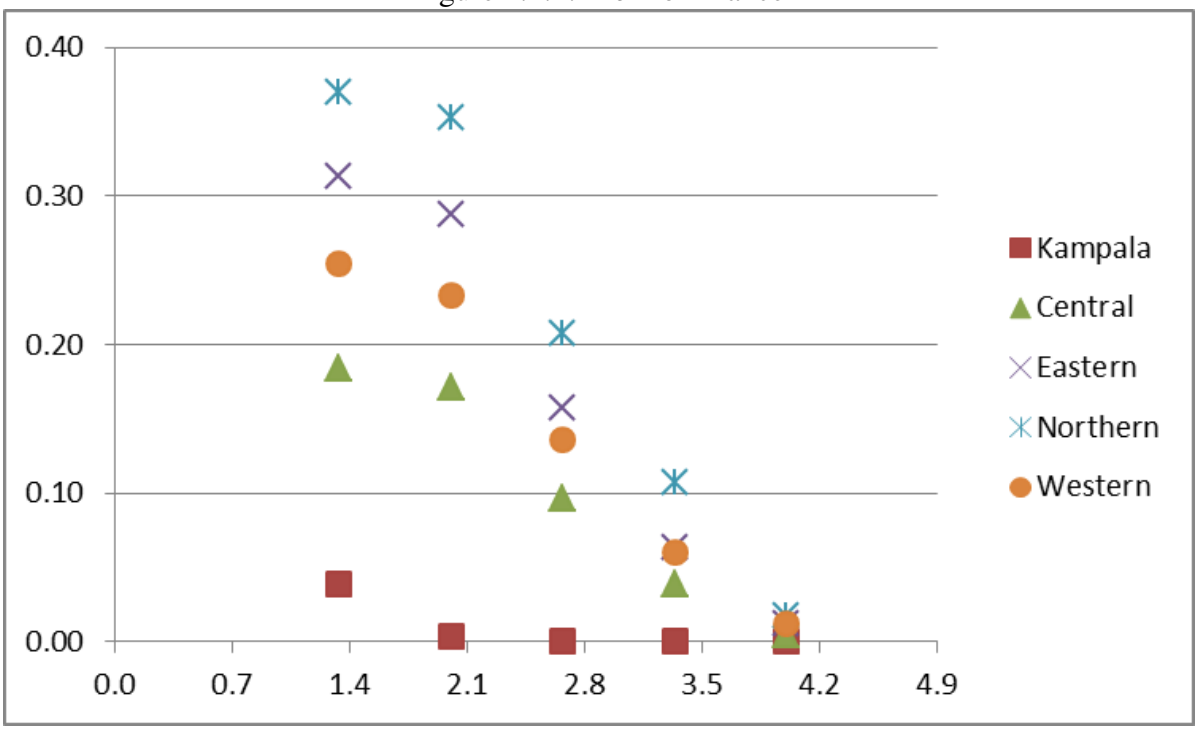
As explained before, a useful property satisfied by the $M_\alpha(x;z)$ family of multidimensional poverty measure is that they are decomposable by subgroups of population such as rural/urban or regions as shown by equation (2.3.11). Table B.1 shows the actual multidimensional child poverty measures while Figure 2.4.1 presents the rural and urban poverty estimates for H and M_0 contained in Table B.1. Clearly, child poverty is a rural phenomenon. The multidimensional poverty headcount ratio (H) is 51.4 percent in rural areas compared to 17.8 percent in urban areas when $k = 1$ is considered, and on average rural children are deprived in 2.33 dimensions compared to 1.86 dimensions in urban areas. The corresponding adjusted headcount ratio (M_0) is 30 percent in rural areas compared to 8 percent in urban areas. With $k = 2$, rural poverty incidence is almost ten times bigger than that in urban areas. In fact, with $k = 2$, urban areas have no significant contribution to overall H and M_0. However, the values for adjusted poverty gap and poverty gap squared are quite small for both rural and urban areas, but still higher in rural areas. The results are reinforced by looking at the relative urban and rural area contributions to overall multidimensional poverty indices. These results are presented in Table B.2. Clearly, for every single value of k, rural areas contribute over 95 percent to overall child poverty measures.

Figure 2.4.1: MDP Headcount Ratio and Adjusted Headcount Ratio for different cutoffs and by area of residence



Now let's turn to regional child poverty and the relative contribution of each region to the overall multidimensional child poverty. Results are presented in Tables B.3 and B.4. When $k = 1$, headcount ratio ranges from 11.36 percent in Kampala to 55.2 percent and 61.81 percent in Eastern and Northern regions respectively. Similarly, the adjusted headcount ratio (M_0) increases from 4 percent in Kampala to 37 percent in the Northern region. This finding is consistent with previous income poverty research findings in Uganda. For instance, recent income poverty estimates by (Ssewanyana and Okidi, 2007) show that 60.7 percent and 35.9 percent of the people in Northern and Eastern regions are poor compared to 16.4 percent and 20.5 percent in the Central and Western regions. Results further show that when a cutoff of $k = 2$ is considered, all children in Kampala are multidimensionally non-poor compared to 13.3 percent in Central, 22 percent in the East, 27.5 percent in the North and 18.3 percent in the West. Similarly, as Table B.4 shows, Kampala has no contribution to overall H and M_0, while the Central, Eastern, Northern, and Western regions contribute 12 percent, 28 percent, 39 percent and 20 percent respectively. As noted before, M_0 is implied by first order dominance, and implies second order dominance in turn, hence enabling comparisons among regions and area of residence independently of the deprivation cutoff k. Figure 2.4.2 illustrates stochastic dominance for M_0 for poverty comparisons among regions.

Figure 2.4.2: *Mo* Dominance



2.4.6 Decomposition by dimension

How does deprivation in each dimension contribute to the overall multidimensional poverty? To answer this question, we make use of the break down of the adjusted headcount ratio M_0. Tables B.5 and B.6 show the contribution of each dimension to the adjusted headcount ratio, and the corresponding adjusted poverty gap and gap squared for the full sample and also by area of residence. The Results show that socio-economic status of households as proxied by the the asset index has a very significant impact on child poverty, followed by the standardized height for age. For instance, when $k = 2$, deprivation in the asset index contributes 67.3 percent to the adjusted headcount ratio compared to 20.2 percent for height for age. When $k = 4$, the contribution by asset index (50.0 percent) is almost 4 times higher than that of height for age (16.7 percent). The other two nutrition status dimensions (weight for age and weight for height) have very little contribution to overall adjusted poverty measures. The results further suggest there is very little differences in contribution between the urban and rural areas to all adjusted poverty measures, despite big differences observed with one dimensional headcount analysis shown in Table 2.4.3. This is because M_0 takes into account the relative depth of deprivation of poverty measurement. Decompositions according to regions show very little differences in contributions and the results are similar to those reported in Tables B.5and B.6.

One may argue that the observed large contributions by an asset index to overall multidimensional child poverty measures compared to the nutrition status indicators could partly be a result of the nested weighting system that assigns a higher weight to the socio-economic status dimension. To test whether this may be the case, we drop one of the sub-dimensions of the nutritional status (in particular weight for age). This increases the weight of the remaining two sub-dimensions of child health from 0.667 to 0.75, but reduces the weight assigned to the asset index from 2 to 1.5. We recalculate the multidimensional poverty measures based on the three dimensions and the new weights. The results show that the asset index contribution to overall adjusted headcount ratio, M_0, is 77.7 percent for $k = 1$, 65.4 percent for $k = 2$, and 50.0 percent when $k = 3$, compared to 18.4 percent, 30.0 percent and 25.0 percent (respectively) for height for age, for the same k values. Clearly, the asset index contributions to overall adjusted poverty measure is almost the same regardless of the assigned weight.

2.5 Conclusions

This study has estimated multidimensional child poverty in Uganda by applying the recently developed methodology by Alkire and Foster (2007, 2009) to a nationally representative Uganda Demographic and Health Survey (UDHS) for the year 2006. The selection of dimensions was based on the Millennium Development Goals (MDGs) and on the Poverty Eradication Action Plan (PEAP), which covers the objectives, strategy and the policy framework for achieving economic development in Uganda. For both rural and urban areas, well-being is measured in two dimensions; asset index (to capture household economic status) and children nutritional status (measured by anthropometric indicators-i.e., height-for-age, weight-for-height and weight-for-age z-scores). In order to identify poor children in the asset index dimension, we use a relative poverty line set at the $40th$ percentile of the asset index distribution. The applied poverty line for the asset index, define a poor child as one whose households asset index lies below 0.2526 (the value for the $40th$ percentile). For nutritional status indicators, we use the WHO Multicentre Growth Reference Study Group (2006) thresholds where a cutoff of -2 standard deviations for height for age (*haz*), weight for height (*whz*) and weight for age (*waz*) are taken as measures of chronic malnutrition, wasting and underweight respectively. Instead of working with the z-scores, which, are mainly negative values, we use standardized heights and weights for children

as independent measures of well-being since they are not highly correlated with the asset index as indicated by the spearman rank correlation coefficient of less that 20 percent. The cutoffs for standardized heights for age is 79.3, the cutoff for weight for height is 15.3 and the cutoff for weight for age is 9.0.

The incidence of poverty results indicate that 40.3 percent of children in both rural and urban areas live in households that are deprived in the asset index. Further more, 38.8 percent of children are stunted; 6.6 percent are wasted and 16.1 percent are underweight. The incidence of deprivation varies considerably between rural and urban areas as well as between regions. While only 8.5 percent of children in urban areas are deprived in asset index, the proportion is five times higher in rural areas (43.9 percent). Similarly, 25.4 percent and 11 percent of children in urban areas are stunted and weight respectively, compared to 40.3 percent and 16.7 percent in rural areas. Children in the the Northern (54.5 percent) and Eastern (45.7 percent) regions are the most deprived in the asset index. However, children from the Western region are the most stunted (43.9 percent), followed by those in North (41.1 percent) and East (40.0 percent).

We also use the nested weighting structure to aggregate all the dimensions into overall multidimensional poverty measures. In the first stage, the asset index and the nutrition status dimensions are assigned an equal weight of 2. In the second stage, the weight for the health status dimension is divided equally among the three sub-dimensions, each getting a weight of 0.6667. The incidence, depth and severity of poverty at different dimensional cutoffs is then analyzed. In addition, we analyze the contribution of different dimensions/indicators of well-being, as well as residence and regions to overall multidimensional poverty. The results indicate that when poverty is evaluated at one dimension, 48 percent of the children population in both rural and urban areas are multidimensionally poor, and 19.8 percent are multidimensionally poor when poverty is evaluated in two dimensions. On average all children are deprived in 1.06 dimensions. When the headcount ratios are adjusted for the relative depth of deprivation (1.06), the adjusted headcount ratio (M_0) estimate is 27.8 percent and 14.7 percent respectively for the cutoff of $k = 1$ and $k = 2$ respectively. These results suggest that the poverty index depends on the number of dimensions and the that poverty measure decreases with the number of cutoffs. This is because an increase in k is equivalent to a decrease in the poverty line. The results further suggest that child poverty is a rural phenomenon, with 51.4 percent of children in rural areas compared to only 17.8 percent in urban areas considered multidimensionally poor when

poverty is measured in one dimension. The proportion reduces to 1.3 percent and 0.4 percent in rural and urban areas (respectively) when all the four dimensions are considered. In terms of dimensional contribution, the asset index has highest contribution to overall multidimensional poverty, ranging from 50.0 percent to 78.7 percent for different cutoffs. The contribution from nutrition status ranges from 21.3 percent to 50.0 percent. Height for age (*haz*) is the biggest contributor to health status.

Clearly, child poverty in Uganda is high and therefore Uganda's quest for attaining the NDP objectives and the MDG goals and targets may be suffocated if adequate attention is not paid to addressing the constraints that face children, especially those living in poverty. The insights from this study are important not only in that they change the focus from the traditional uni-dimensional perspectives of poverty, centered on income, and the general misconception among senior policy makers, implementers and the general public that poverty conditions faced by adults are the same as those faced by their children, to a broader multidimensional one, but they also point out the urgent need to address child deprivation in the specific dimensions for children in both rural and urban areas and in different regions of the country. In particular, the wide disparities in deprivation between the poorest regions of Northern, Eastern Uganda and the rest of the country needs special attention.

Chapter 3

Essay 3: The Relationship Between Maternal Autonomy and Child Stunting in Uganda.

3.1 Introduction and Motivation of the Study

Since the Cairo International Conference on Population and Development (UN, 1994), a growing body of literature is focusing on women's autonomy—the ability of women to control household and societal resources. Early research on this topic focused primarily on the effect that this variable had on fertility and the fertility transition. More recently, however, research has also begun to examine the role that women's autonomy might play in determining the health and well-being of women and their children. For instance, a recent United Nations Children's Fund (UNICEF) report states that 'Eliminating gender discrimination and empowering women will have a profound and positive impact on the survival and well-being of children (UNICEF, 2007). Direct and complex indirect pathways underlie the relationship between women's autonomy and health outcomes, especially child growth and survival (Engle et al., 1999; UNICEF, 2007). According to the extended UNICEF conceptual framework (Engle et al., 1999), underlying factors, such as feeding and care practices, maternal autonomy, household food security and community health services, affect dietary intake, morbidity and child nutritional status. The reason maternal autonomy can determine child stunting lies in the concept that mothers are the primary caregivers of their children in countries like Uganda and influence child nutrition di-

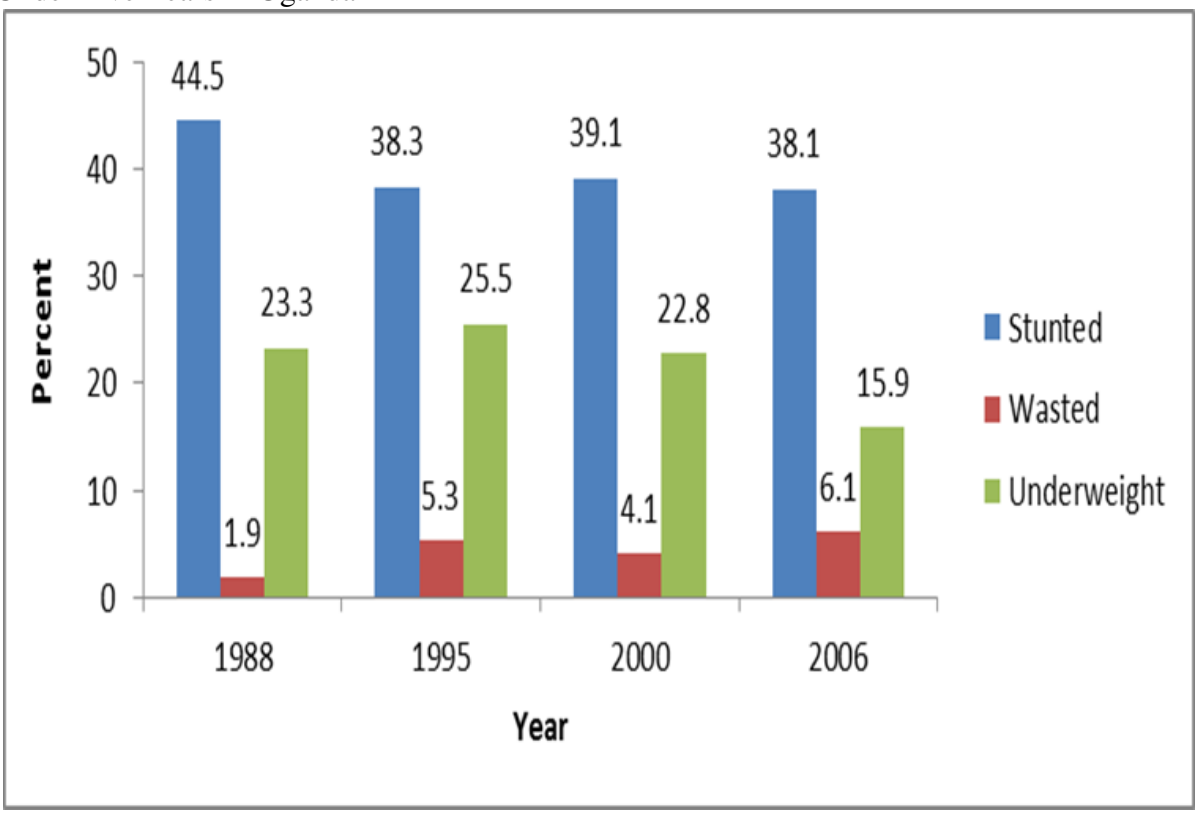
rectly through improved child care practices or indirectly through improvements in their own nutrition (Smith et al., 2003).

In light of the above, the overall objective of this study is to quantitatively examine the role of maternal autonomy in determining their children's nutritional health outcomes in Uganda, with a view of suggesting possible policy implications. To achieve this goal, we focus on long term growth of children and use stunting (low height-for-age) among children aged 0 to 59 as the outcome variable in the analysis. We attempt to provide answers to the following specific questions: does women's autonomy influence child malnutrition in Uganda? If so, what are the pathways by which women's autonomy may benefit child health in Uganda? What is the relative importance of women's autonomy versus socio-demographic characteristics in child nutritional status?

The study is motivated by the fact child under-nutrition remains a profound challenge in developing countries. For Uganda, in particular, there has been lack of improvement in children's nutritional status indicators for the last 15 years, while the country has registered impressive economic growth and significant reductions in income poverty over the same period. The recent 2006 Uganda Demographic and Health Surveys (UDHS) shows that children nutritional status indicators have performed dismally (Figure 3.1.1). In particular, the prevalence of stunting (low height-for-age), a measure that is generally used as a sign of chronic malnourishment reflecting a history of problematic dietary and/or health situations (den Broeck, 2007) among children younger than 5 years old declined from 45 percent in 1988 to 38 percent by 1995 and the rate has held steady for over 10 years. More rural children are stunted (40 percent) than their urban counterparts (26 percent) and there also substantial regional variations, with stunting being highest in the Southwest region (50 percent) and lowest in the capital city Kampala (22 percent) (UBOS and Macro International Inc., 2007). Moreover, efforts to reduce malnutrition and mortality rates continue to be challenged by the HIV/AIDS scourge that has led to increased number of orphaned children[1], who are at increased risk of morbidity, mortality, food insecurity, and malnutrition. Consequently, the co-existence of high malnutrition rates and impressive growth record has recently attracted the attention of policy makers (GoU, 2010) and renewed interest to understand the programmes and policies that may drive the reduction in malnutrition.

[1] In 2006, 4.5 percent of children under five were orphans (i.e., lost at least one parent).

Figure 3.1.1: Trends in the Prevalence of Stunting, Wasting, and Underweight among Children Under Five Years in Uganda



Source: UDHS Reports, 1988/89-2006

3.2 Past research on children's nutritional status in Uganda

Empirical evidence on child health, particularly, child nutritional status in Uganda is concentrated on the impact of women's socioeconomic status indicators such as maternal education and employment status. At the national level, Ahn and Shariff (1995) used the 1988 UDHS to examine the determinants of child height. They found that maternal schooling has a strong effect on child health only after the estimates are corrected for selectivity bias. In addition, the authors report that living in an urban area and female education are complements, whereas owning a radio and female education are substitutes in the production of child health. Bahiigwa (2005) analyzed trends and determinants of children's standardized heights in Uganda over the 1990s, finding that a broad package of basic health care services—vaccinations, professional prenatal care (including tetanus toxoid injections), professional birth assistance, and access to oral re-hydration therapy, modern contraceptives, malaria drugs, and antibiotics—has a large impact on children's heights. He also found that better educated mothers had taller children, but the only substantial impact was for children of mothers who had completed secondary school.

Ssewanyana (2003) used a cross-sectional survey collected at household level in Kampala district to analyze the major factors affecting food security and child nutrition status of urban poor households. Her findings show that while maternal education has a stronger impact on girls' long-term nutrition, paternal education has a stronger impact on that of boys. Kikafunda et al. (2006) examined nutritional status issues for HIV/AIDS orphaned children living in households headed by the elderly in Rakai district, south western Uganda. Results showed that malnutrition in Rakai District was a big problem resulting from a number of factors among them poverty, illiteracy, big family sizes, and the effects of the HIV/AIDS pandemic. Many families lacked enough of both material and psychological support to sufficiently care for their members. Overall, the study findings revealed that HIV/AIDS orphaned children living with their elderly relatives had poor nutritional status. The policy recommendation was that the extent of support to meet the needs of these children and their elderly caretakers needed to be increased in order to reduce malnutrition.

The recent 2006 UDHS report (UBOS and Macro International Inc., 2007) elaborates some of the factors, including, age of the mother at birth, birth order, type of place of residence, household wealth and mother's education level, that contribute to high child malnutrition and under-nutrition rates. The report underscores the importance of mother's education in reducing child malnutrition and under-nutrition showing that mothers who have attained at least secondary education have children with lower prevalence of stunting and underweight; children born to such women have nearly 20 percent less chance of being stunted or underweight. The report also provides descriptive statistics on women's empowerment measures such as decision-making in the household and gender norms in the society. However, no attempt was made in the report to link women's autonomy measures to children nutritional status. It should also be noted that the UDHS analysis is purely descriptive in nature and, therefore, does not provide a rigorous quantitative analysis.

In a recent study on food insecurity in Uganda, Ssewanyana and Kasirye (2010) used the 2005/06 Uganda National Household Survey (UNHS) and 2006 UDHS to link information on household incomes and caloric intakes to other indicators of nutrition status such as stunting, wasting, and underweight status, in order to examine how child nutritional status varies with food security status at household level. Such a link is important to understand why nutritional indicators have stagnated while income poverty has declined. They find that food insecurity at

household level is closely linked to child nutrition status. This finding suggest that antipoverty interventions and interventions to address food insecurity and child nutrition status have to be closely linked. It should be noted, however, that linking the two datasets reduces the sample of children dramatically. This is because, not all households interviewed in the UNHS were also selected for the UDHS survey.

From the above review, it is clear that in Uganda, the role of maternal autonomy in child nutritional status has gone largely unnoticed. To fill this research gap, we used evidence on direct measures of women's autonomy—from decision-making power in the household, to women's status in the society via freedom from verbal and physical abuse by their husbands/partners—to ascertain which specific measures of women's autonomy matter for child nutrition in Uganda. This is a significant contribution and extension of the literature on child health outcomes in Uganda. In fact, a literature review of past research in Uganda about the subject at hand yielded only two published papers: Smith et al. (2003) and Desai and Johnson (2005). The former examines the importance of women's status for child nutrition in 36 developing countries.[1] The latter explores the role of familial and social hierarchies, particularly, women's decision-making in child health in 12 developing countries.[2] However, our study differs from the above studies in two main aspects. First, our outcome measure of child nutritional status—prevalence of stunting among children 0-59 months of age, is different from children's height-for-age standardized score (*HAZ*) for children aged 13 and 36 months used in Desai and Johnson; and the weight-for-age standardized $z-$scores (*WAZ*) for children under three years used in Smith et al. Second, we used the most recent and a nationally representative dataset (UDHS 2006) instead of the 1995 and 2000 UDHS datasets used in Smith et al. and Desai and Johnson studies respectively. It is also important to note that in the previous UDHS's, information on decision-making domain of autonomy were collected from both married and unmarried women while, for the UDHS 2006, only currently married women were asked about decision-making.

This study comes at such a time when the Government of Uganda and other stakeholders are committed to achieving the highest possible child health outcomes in line with the Millennium Development Goals (MDGs). In fact, some studies (e.g. FAO, 2008) have warned that high prevalence of malnutrition, particularly, in sub-Saharan Africa is likely to restrict progress

[1]Data came from 4 countries in Asia, 23 in sub-Saharan Africa,Uganda inclusive, and 9 in Latin America/Caribbean region

[2]Benin, Malawi, Mali, Uganda, and Zimbabwe are from sub-Saharan Africa.

towards attainment of other MDGs since nutrition intake impacts on child and maternal mortality as well as school attendance. Moreover, high rates of malnutrition in childhood may lead to high levels of chronic illness and disability in adult life, affect mental capacity and impair school performance and working capacity in the adult period, and jeopardize future economic growth by reducing the intellectual and physical potential of the entire population (see, for example, UNICEF, 1998; Strauss and Thomas, 1998; Kabubo-Mariara et al., 2008). In addition, while its long term effects have not always been acknowledged, recently malnutrition is being recognized as a key to fighting poverty (World Bank, 2006).

Our study provides new insights on the pathways through which maternal autonomy affects child health in Uganda. These insights may be useful in informing policies and the country's efforts aimed at achieving poverty, health and gender equality-related MDGs. Moreover, the study adds to the stock of knowledge on women's autonomy and the production of child health in developing countries.

The remainder of the study is organized as follows. Section 3.3 starts by discussing the concept of women's autonomy as understood by different researchers. It then presents past research on the relationship between women's autonomy and children's health, emphasizing studies from sub-Saharan Africa. The data and description of outcome and explanatory variables used in the analysis are presented in Section 3.4. The the theoretical framework and the empirical strategy are discussed in section 3.5. The next section presents the empirical results and conclusions are drawn in Section 3.7.

3.3 Women's Autonomy and Children's Health: Definition and Past Research

3.3.1 Defining Women's Autonomy

To date, no consensus has been reached on a single definition of the concept of women's autonomy. Almost without exception, researchers use different definitions of autonomy, as well as different methods to measure this concept in their studies. For instance, while Caldwell (1986) defines autonomy as relating to the opportunities for women to receive an education and work outside the home, Miles-Doan and Bisharat (1990) define autonomy as a woman's position

within household power relations—in other words, her bargaining power. Alternatively, Mason (1986) defines autonomy as control over household and societal resources, while Jejeebhoy and Sathar (2001) suggest that autonomy consists of five interrelated components: autonomy conferred by knowledge or experiencing the world; decision-making authority; physical autonomy, including freedom of movement; emotional autonomy; and economic and social autonomy, which includes access to and control over resources. In addition to these and the many other definitions that exist, the idea of autonomy has been associated with or used interchangeably with related concepts including empowerment, power, locus of control, agency, and most especially status (Bloom et al., 2001).

Like autonomy, status has been defined in different ways. Status can mean prestige, as can be gained with increasing age or number of children (Balk, 1994), or it can be defined as access to resources based on the social or economic stand in the community (Mason, 1986). Often definitions of status include the concept of autonomy, defined as control over one's self or one's surroundings. For instance, Cain (1984) definition of status includes participation in domestic decision-making and freedom of movement. As Smith et al. (2003) points out, interchanging the terminology in this way—using the word status to describe autonomy, or autonomy to describe status—obscures important differences between the two concepts. To differentiate autonomy from status and the other terms often associated with women's decision-making abilities, Brunson et al. (2009) suggest that autonomy be defined as the ability to make decisions on one's own, to control one's own body, and to determine how resources will be used, without needing to consult with or ask permission from another person. They argue that defined this way, autonomy denotes control. In this study, we use the term autonomy as defined by Brunson et al. (2009) and it is represented by some selected direct measures of women's autonomy, namely freedom of movement to visit families or relatives, decision-making power on making large household and daily purchases, and women's attitude toward domestic violence, which is captured via women's attitudes towards wife beating by her husband/partner.

3.3.2 Past Research on the relationship between Women's Autonomy and Children's Health Outcomes

It is well-recognized that women's autonomy has a direct bearing on child health (Mason, 1986). Women with low autonomy tend to have weaker control over household resources, tighter time constraints, less access to information and health services, poorer mental health, and lower self-esteem. These factors are expected to be closely linked not only to women's own health status but also to their children's health. Though still limited, the empirical evidence on this relationship has been strong across regions and countries.Please note that some researchers use the concepts of women's autonomy, status, position or empowerment interchangeably.

Most of the early work on the relationship between women's autonomy and child nutrition concentrated in the Asian continent, particularly, in the South Asia region. This research was motivated by the so-called "Asian Enigma"- the existence of poor nutritional status of children despite economic growth and a reduction in poverty (see, for example, Ramalingaswami et al., 1996; Haddad et al., 1996; Smith et al., 2003). Ramalingaswami et al. (1996) argue convincingly that income inequality, the inappropriateness of international child growth standards for Asian countries, and South Asia's higher rates of vegetarianism are not responsible for its higher malnutrition.[1] In the face of this anomaly, Ramalingaswami, Jonsson, and Rohde write, "The exceptionally high rates of malnutrition in South Asia are rooted deep in the soil of inequality between men and women" (1996, 16). They argue that the reason for the Asian Enigma, the difference in malnutrition rates between South Asia and SSA, is the extremely low status of women relative to men in South Asia, compared with that in SSA. Such low status is thought to compromise women's own health, the subsequent birth weight of their children, and the quality of care their children receive.

The study by Smith et al. (2003) across 36 countries in Asia, sub-Saharan Africa and Latin America/Caribbean regions has unequivocally proved the strong connection existing between women's position and child health indicators. Their results confirm that women's status impacts child nutrition because women with higher status have better nutritional status themselves, are better cared for, and provide higher quality care to their children. However, they found that the strength of influence of women's status and the pathways through which it influences child

[1] Recently, the World Health Organization introduced new growth standards. For details, see WHO Multicentre Growth Reference Study Group (2006).

nutrition differed considerably across regions. In South Asia, increases in women's status had a strong influence on both the long- and short-term nutritional status of children, leading to reductions in both stunting and wasting. In sub-Saharan Africa too, women's status and the long- and short-term nutritional status of children were linked. Latin America and the Caribbean exhibited a different pattern from that of South Asia and Sub-Saharan Africa. Women's status had a positive effect only on children's short-term nutritional status and only in those households in which women's relative decision-making power was very low.

Desai and Johnson (2005) attempt to identify the pathways by which women's empowerment may benefit child health and survival in 12 countries.[2] More specifically, their paper examines the impact of women's ability to make independent decisions on children's health outcomes—particularly vaccination status, nutritional status, and child mortality. The study finds that children benefit from women's empowerment, but they benefit more when living in areas in which a large number of women are empowered. The gender context is consistently important for child health outcomes, and in most countries, is more important than individual empowerment. The authors also suggest that women's empowerment may be more critical to ensuring day-to-day care than for accessing emergency and other health care for the child. The relationship between women's empowerment and child health varies by region, suggesting that the relevance and role of women's empowerment may be somewhat dependent on the historical and cultural gender systems prevailing in that setting.

The Hindin paper, "Women's Autonomy, Women's Status and Nutrition in Zimbabwe, Zambia, and Malawi," examines the possible relationship between women's status and autonomy with their nutritional status. The relationship between food security and HIV is also briefly explored. The general conclusion is that women who have less autonomy are at a greater risk of having compromised nutritional status, which in turn can lead to a greater risk of food insecurity for themselves and their family due to loss of productive capacity. The policy implication is that empowering women in food constrained societies, particularly in countries greatly affected by HIV, is likely to benefit not only women and their families, but also helps to diminish food insecurity for everyone (Hindin, 2005).

In India, women's empowerment often varies by community, with tribes sometimes being the most progressive. Sethuraman et al. (2006) explore the relationship between women's em-

[2]Benin, Malawi, Mali, Uganda, and Zimbabwe are from sub-Saharan Africa.

powerment, maternal nutritional status, and the nutritional status of their children aged 6 to 24 months in rural and tribal communities of Karnataka in India. Using multivariate logistic regressions, the authors find that biological variables explained most of the variance in nutritional status, followed by health-care seeking and women's empowerment variables, while socioeconomic variables explained the least amount of variance. Women's empowerment variables were significantly associated with child nutrition and explained 5.6 percent of the variance in the sample. Maternal experience of psychological abuse and sexual coercion increased the risk of malnutrition in mothers and children. The authors conclude by arguing that in addition to investments needed reduce malnutrition, improving women's nutrition, promoting gender equality, empowering women, and ending violence against women could further reduce the prevalence of malnutrition in this segment of the Indian population.

Brunson et al. (2009) explores the effect of women's autonomy on children's health in the traditionally nomadic pastoralist Rendille population in northern Kenya. Using data collected from 435 women and 934 of their children, the authors tested the hypothesis that women with higher levels of autonomy would have children with better nutrition. Their results indicated that while women's autonomy had no effect on younger— ages 0–35 months—children's nutrition as measured by weight-for-height standardized Z-scores, greater levels of women's autonomy were significantly associated with improved nutrition among older—ages 3–10 years—children. These results suggest that women's autonomy is an important factor in relation to children's health in some circumstances.

Using the National Family Health Survey (NFHS)-2, Shroff et al. (2009) examines the relationship between maternal autonomy and child stunting among children under three years in Andhra Pradesh, India. Using logistic regressions and four main dimensions of women's autonomy—decision-making, permission to travel, attitude towards domestic violence and financial autonomy, they find that women with access to money and freedom to choose to go to the market were significantly less likely to have a stunted child, after controlling for household socio-economic status and mother's education. In this south Indian state, these two dimensions of female autonomy have an independent effect on child growth, suggesting the need for interventions that increase women's financial and physical autonomy.

Using DHS conducted in Eritrea and Ethiopia in 2002 and 2005 respectively, Woldemicael (2010) examines the role of women's decision-making and gender norms in reproductive

health in the two neighboring countries. The author investigates the effect of each of the four dimensions of women's decision-making autonomy—large household purchases, daily household purchases, visiting families/relatives, and wife beating justified on maternal and child health-care utilization. The author simultaneously consider the role of socio-economic (indirect) indicators of women's status. His findings show that most autonomy indicators are important predictors of maternal and child health-care utilization although the strength and statistical significance vary by health-care utilization outcome and country, and in some cases significance is lost when socio-economic indicators are held constant. While women's sole decision-making in visiting family or relatives had a strong positive effect on the use of antenatal care and child immunization, the same link could not hold for other dimensions of women's decision-making, when socio-economic factors were controlled; suggesting that some health-care seeking behaviors are more dependent on socio-economic factors like education and employment. While these results show that most socio-economic indicators have strong influence on both women's decision-making autonomy and on maternal and child health-care utilization, they underscore the importance of analyzing both women's autonomy and socio-economic indicators in order to have a complete understanding of the determinants of maternal and child health-care utilization in both countries.

Bhagowalia et al. (2010) examines the relationship between gender inequality and children nutrition using mobility, decision-making power, and attitudes towards verbal and physical abuse indices of women's empowerment in Bangladesh. The authors the prevalence of stunting, a measure of long tern growth, and the minimum diet diversity index, which illustrate differences in diets as the outcome variables for child health. In estimating the logit models, they control for socio-economic indicators such as age and sex of the child, maternal height and education. Their results indicate that a greater degree of women's empowerment is associated with better long term nutritional status of children. Attitudes towards domestic violence have a significant effect on chronic malnutrition and mobility, while participation in decision making and ability to purchase food are important predictors of dietary diversity index.

In summary, studies regarding the relationship between women's autonomy and child nutritional status have reported mixed results. The pathways through which women's autonomy influences child nutrition differs depending on child health outcomes used (short-term versus long-term), the way women's autonomy is defined, also how autonomy measures are con-

structed. In addition, some studies find that results differ considerably across regions (Smith et al., 2003; Desai and Johnson, 2005), suggesting that the relevance and role of women's autonomy, or status or empowerment may be somewhat dependent on the historical and cultural gender systems prevailing in a specific setting. Others reported lack of a significant relationship between women's autonomy and younger children but a stronger influence on the older children (Brunson et al., 2009). The common element inherent in all of the reviewed studies is that for one to have a complete understanding of determinants of children nutritional status, it is important to analyze both women's autonomy and socio, economic, and demographic indicators simultaneously.

3.4 Data and Description of variables

The data for this study were taken from the 2006 Uganda Demographic and Health survey (UDHS) already discussed in Essay 2. In the UDHS 2006, survey information was collected from 8531 women of reproductive ages (15-49 years). For these participants, there were 2372 children under the age of five ($0-59$ months) with complete anthropometric data. Our sample was limited to married and/or cohabiting women and their children. As mentioned earlier, the UDHS 2006, collected information on decision-making measures of autonomy from currently married and/or cohabiting women only. Because of this constraint, our sample consisted of observations on 2108 children.

Stunting was defined using a height-for-age $Z-$score ≤ 2 standard deviation (SD), based on the new World Health Organization reference (WHO Multicentre Growth Reference Study Group, 2006). Using this binary dependent variable, rather than the actual Z -scores (i.e., HAZ), facilitates interpretation of the results, as most measures of children's malnutrition are reported as the proportion of children who fall in this category.[1] Given the complexity of measuring some of the indicators of women's autonomy, we followed previous studies of reproductive health and health-seeking behaviors (Bloom et al., 2001; Shroff et al., 2009; Woldemicael and Tenkorang, 2010; Woldemicael, 2010) and selected five dimensions of maternal autonomy for which information was collected in the UDHS about their participation in household decision-making and their attitudes towards domestic violence—making choices on own health care,

[1] Refer to subsection 2.3.3 for a detailed elaboration on anthropometric indicators and how they are constructed.

large household purchases, daily household purchases, and visits to family or relatives, and their attitudes towards partner violence (as measured via their opinion toward wife beating). When women cannot make health care choices for themselves, they may be more vulnerable to illness and disease as well as to maternal complications. In addition, women's economic autonomy in the home is limited when men make most of the decisions regarding household purchases for both daily items and larger purchases. On the other hand, participation in decisions about visits to families, relatives or friends is expected to enhance women's ability to seek and gain knowledge which may influence their own health and children's health and well-being. When women cannot decide when to visit their own family, they are subject to social isolation and their personal autonomy is reduced.

In order to obtain information on the above measures of women's autonomy, the UDHS 2006 included the following question: "Who usually makes decisions about" (1) Health care for yourself?; (2) Making large household purchases?; (3) Making household purchases for daily household needs?; and (4) Visits to your family or relatives? For each of these questions, the women were given the following response options in the questionnaire: (1) respondent alone, (2) husband/partner, (3) respondent and husband/partner jointly, (4) someone else, and (6) other. It is important to note that in the actual UDHS 2006 data, responses for the above question are coded differently from the codes given in the questionnaire: (1) respondent alone, (2) respondent and husband/partner, (4) husband/partner alone, (5) someone else, and (6) others. Given the small number of cases in some of these response categories, we collapsed the five categories into three main categories, namely, (1) Respondent alone, (2) respondent and husband/partner, and (3) husband/partner or someone else or others (responses 4, 5, and 6).

We deviate from some researchers (e.g., Hindin, 2005; Brunson et al., 2009; Bhagowalia et al., 2010) who construct a dimension of autonomy as a simple summative index of a series of dichotomous items, thus, forcing all the dimensions to have equal weights. In creating a measure of total autonomy, Bhagowalia et al. (2010) summed five decision-making dimensions into a single decision-making index for autonomy. Brunson et al. (2009) used an 11 item Rendilles culture-specific questionnaire. Autonomy questions comprised of three questions that were centered on money, food procurement, and distribution; three questions that concerned the care, control, and sale of livestock; and five questions that centered on access to medical care and birth control for mothers and medical care and schooling for their children. and

weighted all questions equally and then averaged them into a single autonomy index. Hindin (2005) first constructed different sets of dichotomous variables for each of the decision-making domains—health care, household purchases, and visits to families, depending on whether the woman or her partner or the couple had final say over that decision. From the sets of dichotomous variables, indices were created to show the number of domains in which women or their partners had final say or whether the final decision was made jointly. However, Woldemicael and Tenkorang (2010) argues that since certain dimensions are not as strongly correlated to the other dimensions, analyzing the weakly associated dimensions as a part of an overall construct of autonomy may be inappropriate. Analyzing each dimension separately provides robust evidence for the impact of each individual dimension of autonomy. In light of this, we analyze the effects of each dimension of autonomy separately. In addition, since we focus only on married or cohabiting couples, decisions made by other women in the household such as mother-in-law were excluded.

In the DHS survey, women were also asked the following question about their attitude toward wife beating, a proxy for women's perception of their status in the society: "Sometimes a husband is annoyed or angered by things which his wife does. In your opinion, is a husband justified in beating his wife in the following situations": (1) If she goes out without telling him?; (2) If she neglects the children?; (3) If she argues with him?; (4) If she refuses sex with him?; and (5) If she burns food? These are general attitude questions, rather than questions that ask women about their own experience of domestic violence. The assumption with these questions is that women with high autonomy would not accept such obvious gender inequalities in power and would not agree with any justification for a husband beating his wife. For example, they would believe that a wife should have the right to decide when and whether she wants to have sex with her husband, or she argues with him. From these dichotomous variables (yes/no), we constructed a dichotomous variable that takes a value of "0" if the respondents feels wife beating is not justifiable for any of the above reasons and a value of 1 if the respondents feels wife beating is justifiable for any single or several reasons.

Covariates considered in our models exploring the relationship between maternal autonomy and child stunting comprised (1) child characteristics (child sex and age); (2) socio-economic characteristics (place of residence, household-level socio-economic status proxied by the wealth index, and husband/partner lives in the household); (4) maternal characteristics (age, work sta-

tus, age at first marriage, education, and body mass index (BMI), which measures her nutritional status); and women's relative status indicators (age difference and education level difference). UDHS 2006 data include an index of household socio-economic status (wealth index), based on the household's ownership of selected assets (e.g., radio, television, telephone, refrigerator); household ownership of means of transport (bicycle, motorcycle, boat with or without a motor, or private car or truck); ownership of agricultural land; and ownership of farm animals such as local cattle, exotic/cross cattle, horses/donkeys/mules, goats, sheep, pigs, or chickens (UBOS and Macro International Inc., 2007, p.18). The wealth index places individual households on a continuous scale of relative wealth and it separates all interviewed households into five wealth quintiles (poorest, poorer, middle, richer and richest) to compare the influence of wealth on various population, health and nutrition indicators.[2] Relative difference between males and females (such as the difference in age or education and occupation levels), or more individual/absolute measures (such as the age at marriage, exposure to violence, access to assets) are found to be associated with improvements in child height and weight (Smith and Haddad, 2000; den Broeck, 2007; Bhagowalia et al., 2010).

3.5 Theoretical Framework and Empirical Strategy

3.5.1 Theoretical Framework

The main aim of this study is to examine the relationship between maternal autonomy indicators and child stunting, while controlling for the effects of other important determinants of nutritional status identified in the literature. To formalize this relationship, we follow the household production framework of Becker (1965). Households use human capital and other goods and services as inputs to produce a final good which is health (Rosenzweig and Schultz, 1983; Strauss and Thomas, 1995). This model is modified to include women's characteristics and their relative status to study the impact on child health.

$$U = U(c, l, N) \tag{3.5.1}$$

[2]For more information about the wealth index and its importance, please see the DHS Comparative Report at `http://www.measuredhs.com/publications/publication-cr6-comparative-reports.cfm`.

where U is the utility function, c is the consumption of food and non-food items purchased, and household production, l is the amount of leisure time andReal estate, Agriculture, Trade and Food processing industries N is the nutritional health status. Lastly but not least, I humbly thank my family. First, to my children who endured my absence from their lives for all these years. For some like Wasswa and Nakato who were born when I was not even there and are now in pre-primary. To my dear and loving wife, Ssemuli Eva Kalera, for all the support and tender loving care you have given me. Thank you for wearing my shoes and being both the wife and husband and taking of the children for all these years. There is nothing I can give you as a reward but only to pray to God to reward you the best way he knows how. I am also grateful for the love, support, and encouragement from my all other family members and friends throughout the pursuit of my PhD.s of each household member. We use prevalence of stunting as our measure of child health.

The nutritional status of a child is given by the production function:

$$N = N(c, I, k, m, h) \tag{3.5.2}$$

where c is the consumption, I is inputs into child health such as medical care, k is the child's observable characteristics including age, sex, birth order, and size at birth; m is a vector of maternal characteristics such as maternal education, mother's height, age at first marriage etc; h denotes household characteristics such as household wealth, education level of the household head, geographical location, and share of adult women.

The budget constraint for the household is

$$\sum_i p_i x_i = Y \tag{3.5.3}$$

where p_i is the price of the ith commodity, x_i is the complete set of commodities consumed including c and l, Y is the total money income.

Nutritional production functions like one specified in Equation (3.5.2) are rarely estimated. This is because inputs used in the nutritional production function are likely to be endogenously determined. Instead, the approach commonly adopted is to estimate a nutritional reduced form demand function (Silva, 2005). The underlying assumption of the model in equation (3.5.2) is

that good nutrition, as represented by the vector of nutritional status of children is desirable in its own right, and that households make consumption decisions on the basis of reasons other than nutrition (Pitt and Rosenzweig, 1995). Constrained optimization of the utility function subject to the budget constraint and the nutritional production function gives reduced form demand functions for the purchased goods and the nutritional status of children.

$$N = f(p, Y, k, m, h) \tag{3.5.4}$$

The reduced form model in equation (3.5.4) now enable us to capture the total impact of child, household and community characteristics rather than their impact conditional on a set of choice variables through a structural model.

3.5.2 Empirical strategy

3.5.2.1 The Logit Model

As noted before, the outcome variable is the prevalence of stunting such that for a random variable y,

$$y = \begin{cases} 1 & \text{if the child is stunted or underweight} \\ 0 & \text{otherwise.} \end{cases} \tag{3.5.5}$$

Since we do observe children who are stunted or underweight in a random sample of infant children, then y is a random variable that can take the values one and zero with probability p and $1-p$, respectively. The probability density function for the binary indicator variable y can be written as:

$$f(y) = p^y (1-p)^{1-y}, \qquad y = 0, 1 \tag{3.5.6}$$

The indicator variable y is said to follow a *Bernoulli*[1] distribution. It is fairly easy to verify by direct calculation that the expected value of y is $E(y) = p$, and its variance is $var(y) = p(1-p)$. Note that the mean and variance depend on the underlying probability p. Any factor that affects the probability will alter not just the mean but also the variance of the observations. This suggest that a linear model that allows the predictors to affect the mean but assumes that the variance is constant will not be adequate for the analysis of binary data.

[1] After Swiss mathematician Jacob Bernoulli, 1654–1705

We would like to have probabilities p depend on a vector of observed covariates x_i. The simplest idea would be to let p be a linear function of the covariates, say:

$$E(y) = p = x_i^{'}\beta, \tag{3.5.7}$$

where β is a vector of regression coefficients. Model 3.5.7 is sometimes called the *linear probability model*. This model is often estimated from individual data using ordinary least squares (OLS).

In the linear probability model, the estimated coefficients from the regression, which express the effect of unit variations on the independent variables on the probability of the dependent variable, has a value equal to one. The problem is that these effects are constant as x_i increases then p also increases (when β_i is positive, otherwise it continues to decrease) under a constant ratio. However, since $0 \leq p \leq 1$ it is impossible to have a constant rate of increase. The linear probability model also presents interscholastic errors and, therefore, the estimated coefficients are not sufficient and the hypothesis tests and confidence intervals may not be valid.

Aiming to overcome those problems, one can choose between the nonlinear *probit and logit* maximum likelihood models. In these models the slope is not constant and probabilities are restricted between zero and one. The probit model estimated is numerically complicated because the probit function is related to the standardization normal probability distribution, whereas, the *logit* function is related to the logistic distribution.

In this study, the logit model was chosen. A model construction that links the decision to a set of covariates is needed, at least in the spirit of regression. We seek to understand how a set of factors gathered in a vector x explains the prevalence of stunting, so that:

$$\begin{aligned} Prob(Y = 1|x) &= F(x^{'}\beta) \\ Prob(Y = 0|x) &= 1 - F(x^{'}\beta) \end{aligned} \tag{3.5.8}$$

The set of parameters, β, reflects the impact of the changes on x on the probability of the dependent variable, which takes a value equal to 1. The problem is devising a suitable model for the right hand of the equation. As mentioned above, as the linear probability model cannot

constrain $x'\beta$ to the (0,1) interval thus, there is a need to transform the probability to remove the range restrictions, and model the transformation as a linear function of the covariates. This can be done in two steps.

First, we can move from the probability p to the *odds ratio*

$$odds = \frac{p}{1-p}, \tag{3.5.9}$$

defined as the ratio of probability to its compliment, or the ratio of favorable to unfavorable cases. If the probability of an event occurring is a half, the odds are one-to-one or even. The odds in 3.5.9 can take any positive value and therefore have no ceiling restriction, so that for a given regressor vector x, one would expect:

$$\begin{aligned} lim_{x'\beta\to\infty} Prob(Y=1|x) &= 1 \\ lim_{x'\beta\to\infty} Prob(Y=0|x) &= 0 \end{aligned} \tag{3.5.10}$$

Second, we take logarithms, calculating the *logit* or log-odds as:

$$l = logit(p) = log\frac{p}{1-p} \tag{3.5.11}$$

which has the effect of removing the floor restriction. For instance, as the probability goes down to zero the odds approach zero and the logit approaches $-\infty$. At the other extreme, as the probability approaches one the odds approach $+\infty$ and so does the logit. Thus the logit maps probabilities from the range $(0,1)$ to the entire real line.

Solving for p in Equation 3.5.11 gives

$$p = logit^{-1}(l) = \frac{exp\{l\}}{1+exp\{l\}} = \frac{1}{1+exp\{-l\}} \tag{3.5.12}$$

Now, we can formally define a logistic regression model, by assuming that the *logit* of the probability p, rather than the probability itself, follows a linear model such that:

$$logit(p) = log\frac{Prob(Y=1|x)}{1-Prob(Y=1|x)} = x'\beta \tag{3.5.13}$$

where x is a vector of covariates and β is a vector of regression coefficients.

The regression coefficients β can be interpreted along the same lines as in linear models in Equation 3.5.7, bearing in mind that the left-hand-side is a logit not a mean. Thus β_j represents the change in the logit of the probability associated with a unit change in the $j-th$ predictor holding all other factors constant.

Exponentiating Equation 3.5.13 we can express the odds as:

$$\frac{p}{1-p} = exp\{x^{'}\beta\} \tag{3.5.14}$$

Solving for the probability p in the logit model in Equation 3.5.13 gives the more complicated and nonlinear model

$$Prob(Y=1|x) \quad = p = \quad \frac{exp\{x^{'}\beta\}}{1+exp\{x^{'}\beta\}} = \Lambda(x^{'}\beta) \tag{3.5.15}$$

$$Prob(Y=0|x) \quad = 1-p = \quad \frac{1}{1+exp\{x^{'}\beta\}} = 1-\Lambda(x^{'}\beta \tag{3.5.16}$$

where $\Lambda(.)$ is the cumulative distribution function of the logistic function. While the left-hand-side of equation (3.5.15) is the probability scale, the right-hand-side is a highly non-linear function of the predictors, and there is no simple way for expressing the effect on the probability of increasing a predictor by one unit while holding the other variables constant.

The logit model is estimated by the method of maximum likelihood, as with OLS $x^{'}\beta$ cannot be constrained to the 0-1 interval and the estimation could produce nonsense probabilities and negative variance. The joint probability or the likelihood function, with n independent observations can be written as:

$$L = \prod_{i=1}^{n} f_i(y_i) = \prod_{i=1}^{n} \Lambda(x_i^{'}\beta)^{y_i}(1-\Lambda(x_i\beta))^{y_i} \tag{3.5.17}$$

where $\prod$ is the product operator; one can write the joint probability density function as a product of individual density functions because y_i is drawn independently, and each y_i has the same (logistic) density function.

Taking natural logarithms of equation (3.5.17), we obtain what is called the log likelihood

function (LLF)

$$\text{InL} = \sum_{i=1}^{n} [y_i \ln \Lambda(x_i^{'}\beta) + (1-y_i)\ln(1-\Lambda(x_i^{'}\beta))] \tag{3.5.18}$$

And the first order conditions for a maximum are given by[2]:

$$\frac{\partial \ln L(\beta)}{\partial x_j} = \sum_{i=1}^{n} \left[\frac{y_i \nu(x_i^{'}\beta)}{\Lambda(x_i^{'}\beta)} + (1-y_i)\frac{-\nu(x_i^{'}\beta)}{1-\Lambda(x_i^{'}\beta)} \right] \beta_j \tag{3.5.19}$$

where ν is the density function of the logistic distribution.

From the above, the econometric model estimated is of the following form:

$$Y = \beta_0 + \beta_1 WA + \beta_2 RW + \beta_3 H + \beta_4 M + \beta_5 K + e \tag{3.5.20}$$

where Y is the dependent or outcome variable which is the prevalence of stunting, WA is a vector of direct indicators of women's autonomy (i.e., decision-making and attitudes towards domestic violence), RW is a vector of women's relative status indicators (i.e., age and educational differentials), H is a vector of household characteristics such as place of residence and the wealth index, M is a vector of maternal characteristics such as age, height, age at first marriage, and working status, and education level, K denotes child characteristics such as age and gender, and e is the error.

3.5.3 Statistical analyses

In our analyses, we adjusted all models for the survey design, sample weights, and clustering of errors by the survey cluster. Descriptive analysis of the different background characteristics of the sample was provided. Using Ordinary Least Squares (OLS) and the Variance Inflation Factors (VIF) test, there was a weaker evidence of multicollinearity among the covariates. With the exception of child's sex ($VIF = 10$) and place of residence ($VIF = 15$), all other covariates had $VIF < 10$. Descriptive statistics based on the associations between each of the autonomy variables and stunting were assessed using chi-square tests. All autonomy variables including those not significantly associated with stunting ($P >= 0.05$) were retained in the multivariate

[2]The proof that second order conditions for a maximum hold (i.e., the hessian matrix is negative definite) is provided in Greene (1997).

models. Bivariate logistic regression was used to estimate the association of each covariate with child stunting. The variables that were significantly associated with stunting (Table 3.6.3) were then included in the final multivariate logistic regression. The importance of interactions between covariates and main explanatory variables was assessed to be significant when $P < 0.05$.

3.6 Results

3.6.1 Background Characteristics

Table 3.6.1 presents descriptive statistics of the sample. Children's ages ranged from 0 to 59 months with boys constituting 51 percent and girls 49 percent. The mean *HAZ* score is -1.5 and 37 percent of the children are stunted, which indicates a high prevalence of child under-nutrition in Uganda. The mean *WAZ* is -0.9 and approximately 16 percent of the children are underweight. The prevalence of wasting is low at about 7 percent. Detailed child nutritional status statistics are presented in Table C.1.

Most residences are in rural areas (90 percent) and almost half (46 percent) of mothers reported to be living in a poor household, when the wealth index is used as a measure for welfare. Fourteen percent of mothers reported that their partner was not living with them. Whether or not the partner lives in the household can have an important relationship with both the availability of food resources and women's autonomy in decision-making, and how these factors influence children's health.

The majority (51 percent) of mothers were between 25 and 34 years of age, 87 percent were currently working, and nearly 60 percent reported being in a relationship (married or cohabiting) at less than 18 years of age. Given that in Uganda and many other countries the legal age of an adult is 18 years, the last result implies that on average, Ugandan mothers are children themselves. The Body Mass Index (measured as weight in kilograms divided by height in squared meters: kg/m^2) showed that a majority (76 percent) of mothers are nourished but, a considerable number (11 percent) are underweight, suggesting a high level of chronic energy deficiency among mothers. Mother's nutritional status may influence a child's nutritional status genetically, but may also be an indication of the mother's childhood nutrition status. In many

cases, It is usually the case that mothers that were malnourished in their childhood would have malnourished children. Twenty-five percent of women compared to only 10 percent of men did not have any formal education. In fact, only 15 percent of mothers' compared to 26 percent of their husbands'/partners' reported having achieved a secondary or higher education level. but may also be an indication of the mother's childhood nutrition status

In terms of women's relative status, only 2 percent of mothers' are older than their partners by more than four years, and the majority of husbands/partners (42 percent) are more than six years older than their wives (44 percent). This is consistent with the low age at first marriage noted above. While nearly 60 percent of the couples attain about the same level of education, 36 percent of mothers have more education than their partners.

Table 3.6.1: Baseline characteristics of mothers and children in Uganda

Characteristics	n	Mean (SD)
Anthropometric		
Height-for-age Z-score (HAZ), mean (SD)	2108	-1.5 (1.6)
Weight-for-height Z-score (WHZ), mean (SD)	2108	0.0 (1.3)
Weight-for-age Z-score (WAZ), mean (SD)	2108	-0.9 (1.2)
Stunting		
< -2 SD height-for-age Z-score	802	-3.0 (0.81)
$\geqslant$ 2 SD height-for-age Z-score	1306	-0.6 (1.2)
Characteristics	n	Percentage
Children		
Age, months (2108)		
0-11	512	21.6
12-23	524	22.1
24-35	475	20.0
36-47	441	18.6
48-59	416	17.6
Gender (2108)		
Boys	1074	51
Girls	1034	49
Socio-economic		
Place of residence (2108)		
Urban	211	10.2
Rural	1897	89.8
Wealth Index (2108)		
Poorest	499	24.7
Poorer	448	21.3
Middle	448	21.3
Richer	365	17.3
Richest	348	16.5
Husband/partner lives at home (2094)		
No	295	14.1
Yes	1799	85.9
Mothers'		
Age (2108)		
15-24	576	27.3
25-34	1074	51.0
35-49	458	21.7
Currently working (2103)		
No	271	12.9
Yes	1832	87.1
Age at first marriage (2108)		
$<$18	1260	59.8
18-23	755	35.8
24-29	73	3.5
$\geqslant$30	20	0.9
Education (2108)		
None	503	23.9
Primary	1328	60.0
Secondary	226	10.9
Higher	51	2.4
Body Mass Index (BMI) (2099)		
Underweight, BMI$<$ 18.5)	236	11.2
Normal, BMI 18.5 $-$ 24.9)	1590	75.8
Overweight/obese, BMI$\geqslant$ 25	273	13.0
Husband/partners'		
Education (2048)		
None	220	10.7
Primary	1302	63.6
Secondary	393	19.2
Higher	133	6.5
Women's Relative Status		
Age difference between partners (2083)		
Same age (woman<4 years older, partner<6 years older)	1171	56.2
Woman older by 4 years or more	44	2.1
Partner older by 6 years or more	868	41.7
Education difference between partners (2048)		
Same level	1205	58.8
Woman has more	681	33.3
Partner has more	162	7.9

Source: Authors calculations from UDHS 2006; SD, standard deviation

Table 3.6.2 shows the percent distribution of women by autonomy in decision-making and attitudes towards wife beating. With the exception of decision-making regarding household daily purchases, men are more likely to have the sole final say over women's health care (40 percent), large household purchases (49 percent) and visits to family or relatives (36 percent). This result is similar to what has been found in other studies. For instance, in her study on Malawi, Zimbabwe and Zambia, Hindin (2005), found that in Malawi, men were more likely to have the sole final say over large household purchases and women's own health care, but in Zambia, men were more likely to have the sole final say in all four domains, while in Zimbabwe, women were found to be more likely to have the sole final say than their partners over their own health care, household purchases. women's status in society is measured via women's attitudes towards wife beating.

In terms of women's attitudes towards wife beating, results show that 73 percent of women in Uganda believe that wife beating is justified in at least one of the five domains posed in the questionnaire. Common reasons for the justification were neglecting children (60 percent), going out without telling the husband/partner (56 percent), and refusing sex (44 percent). These results are not surprising since in many countries, both women and men believe that wife beating is acceptable, and it is not unusual for women to condone the violence more than men (see, for example, Population Reference Bureau, 2011). This attitude illustrates the need to work with both sexes to eliminate this harmful behavior. Not only does wife beating have serious consequences for the physical and mental health of women, but abused women are also less likely to have significant authority in their own homes. Moreover, when women are unable to refuse sex with their husbands for fear of violence, they are less able to protect themselves from unwanted pregnancy, sexually transmitted infections, and HIV/AIDS.

Table 3.6.2: Percent distribution of women in Uganda, by autonomy in decision-making and attitudes towards wife beating

Variables	*n*	Percentage
Autonomy in Decision-making (5354)		
Final say over health care		
Woman	1176	21.9
Joint	2076	38.8
Partner	2102	39.3
Final say over large purchases		
Woman	801	14.9
Joint	1921	35.9
Partner	2633	49.2
Final say over households daily purchases		
Woman	1850	34.6
Joint	1646	30.7
Partner	1858	34.7
Final say over visiting family or relatives		
Woman	1090	20.4
Joint	2326	43.4
Partner	1938	36.2
Women's attitudes towards wife beating		
Okay to beat wife if she goes out without permission		
No	2373	44.5
Yes	2957	55.5
Okay to beat wife if she neglects children		
No	2194	41.1
Yes	2143	58.9
Okay to beat wife if she argues with her spouse		
No	2991	56.5
Yes	2302	43.5
Okay to beat wife if she refuses to have sex		
No	3479	66.0
Yes	1794	34.0
Okay to beat wife if she burns food		
No	4021	75.7
Yes	1293	24.3
Wife beating justified under any circumstance		
No	1451	27.1
Yes	3911	72.9

Source: Author's own calculations from UDHS 2006

3.6.2 Factors associated with Prevalence of Stunting

In Table 3.6.3 and 3.6.4 the unadjusted associations of stunting are explored with cross-tabulations chi-square tests with appropriate degrees of freedom. Associations between stunting and the socio-demographic covariates are presented in Table 3.6.3. Factors that were significantly associated with stunting ($P < 0.05$) were child's age, with higher levels in the older age groups; place of residence; geographical region; wealth index; maternal education, where the number of stunted children was significantly higher among mothers who did not go to school and/or

completed primary compared with mothers who had completed secondary and/or higher level; maternal nutrition as measured by the body mass index, despite a relatively equal distribution of children stunted for both undernourished and nourished mothers; husband's education; and a child's sex, where stunting rates are nearly 5 percentage points higher among boys than in girls. Lower rates of stunting were observed in households with higher levels of socio-economic status (measured by wealth index) and/or living in households in urban settings. The disparity in stunting rates observed between boys and girls is consistent with findings from previous studies in Uganda and other African countries and has largely been attributed to genetic differences between male and female children (Bahiigwa, 2005; Kabubo-Mariara et al., 2008). Higher stunting rates are also observed in households were the husband has no education. These variables were also identified as confounders of the relationship between maternal autonomy and child stunting and were included in the final multivariate regression models.

Table 3.6.3: Bivariate associations of stunting with socio-demographic, women's and partners' variables

Variables	n	% Stunted	$P-$value
Children			
Age, months			0.000***
0-11	453	20.3	
12-23	470	41.7	
24-35	419	46.8	
36-47	395	42.3	
48-59	371	40.7	
Gender			
Boys	1,074	40.3	0.029**
Girls	1,034	35.7	
Wealth index			0.000***
Poorest		43.7	
Poorer		39.7	
Middle		42.4	
Richer		36.4	
Richest		23.9	
Husband/Partner living in household			0.092*
No	295	42.4	
Yes	1,799	37.2	
Mothers'			
Age			0.763
15-24	576	39.2	
25-34	1,074	37.8	
35-49	458	37.1	
Currently working			0.390
No	280	35.7	
Yes	1,823	38.4	
Age at first marriage			0.421
<18	1,226	38.8	
18-23	776	37.8	
24-29	87	29.9	
$\geqslant 30$	19	36.8	
Education			0.000***
None	503	43.5	
Primary	1,328	39.1	
Secondary	226	26.1	
Higher	51	9.8	
Body Mass Index (BMI)			0.003***
Underweight, BMI<18.5)	236	39.8	
Normal, BMI $18.5-24.9$)	1,590	39.4	
Overweight/obese, BMI$\geqslant 25$	273	28.6	
Husband/partners'			0.000***
Education			
None	220	48.2	
Primary	1,302	39.3	
Secondary	393	32.3	
Higher	133	27.8	
Women's relative status			
Age difference between partners			0.090*
Same age (woman<4 years older, partner<6 years older)	1,171	36.0	
Woman older by 4 years or more	44	43.2	
Partner older by 6 years or more	868	40.6	
Education difference between partners			0.61
Same level	1,205	38.6	
Woman has more	681	38.3	
Partner has more	162	34.6	

Source: Authors calculations from UDHS 2006; $***P<0.01; **P<0.05; *P<0.10$

Table 3.6.4 presents the unadjusted proportions of stunting by different dimensions of women's autonomy. Surprisingly, of all measures representing the *decision making domain of autonomy*, only 'final say over large purchases' was significantly associated with child stunting ($P = 0.009$), with an increased risk of a mother having a stunted child if she made sole decisions regarding large purchases. The lack of association between decision-making measures and child stunting has been observed in other studies, for example, in the Indian state of Andra Pradesh, Shroff et al. (2009), failed to establish the link, except for the permission to go to the market and financial decision variables. Maternal autonomy with respect to attitudes towards domestic violence was low and the difference in the percentage of children stunted between those women who approved and did not approve of wife beating under any given circumstance was not statistically significant. Although only one of the five measures of maternal autonomy was significantly associated with stunting, in the multivariate analysis, all of the five measures were included.

Table 3.6.4: Bivariate associations of stunting with autonomy variables

Autonomy Variables	n	% Stunted	$P-$value
Final say on own health care			0.715
Woman	415	36.6	
Joint	854	37.6	
Partner	833	38.9	
Final say over large purchases			0.009***
Woman	284	46.1	
Joint	745	36.9	
Partner	1,073	36.4	
Final say over household daily purchases			0.194
Woman	765	40.4	
Joint	593	35.9	
Partner	744	37.0	
Final say over visiting family or relatives			0.218
Woman	385	40.8	
Joint	899	38.6	
Partner	818	35.8	
Wife beating justifiable			0.885
No	532	37.8	
Yes	1,576	38.1	

Source: Authors calculations from UDHS 2006; $***P < 0.01; **P < 0.05; *P < 0.10$

3.6.3 Multivariate regression of Stunting

Table 3.6.5, presents the odds ratio from multivariate logistic regression analysis examining the association between maternal autonomy indicators and covariates found to be associated with stunting in the bivariate analysis. The results of this supports the hypothesis that low maternal

autonomy - represented by a single decision making indicator, namely 'Final say in own health care' - is associated with child stunting in Uganda. The hypothesis is not supported when other indicators of women's autonomy are used. In particular, women who have sole final decision on day-to-day and large purchases, and visiting families or relatives, have elevated odds of having a stunted child.

After adjusting for the potential cofounders (Model 2), women's sole final say on own health care retained its strong and negative association with stunting. The impact of women's final say on vising families or relatives was mediated from positive to negative association with stunting, but did not reach the required significance level.

Among the covariates, only child's age and sex, wealth index, and maternal education remained significantly associated with stunting in multivariate models. Relative to no education, children of women with secondary and/or higher education had lower odds of stunting. Also children of households that belong to the richest group had lower odds of stunting as compared to children from the poorest wealth quintiles. There are gender disparities; the odds of stunting in girls is nearly 20 percentage points lower than in boys. As in bivariate analysis, we also find that the risk of a child being stunted increases significantly with age. A similar result was derived in Brunson et al. (2009) for the case of the Rendille community in Kenya, where women's autonomy was not significantly associated with weight-for-height Z-scores of younger children (0-35 months). A strong association of maternal education and household wealth with stunting in maternal autonomy studies was also found in the case of Andra Pradesh, India (Shroff et al., 2009) and in Bangladesh (Bhagowalia et al., 2010).

Table 3.6.5: Odds ratios and 95% confidence intervals (CI) from multivariate logistic regression analysis of significant predictors of stunting in children under the age five in Uganda.

Variables	Model with autonomy only (Model 1)	(CI)	Full model (Model 2)	(CI)
Decision-making Autonomy				
Final say on own health care				
Ref. Respondent alone	1.0	-	1.0	-
Jointly	1.239	(0.922 - 1.665)	1.143	(0.830 - 1.574)
Partner/someone else	1.494**	(1.077 - 2.074)	1.381*	(0.973 - 1.959)
Final say on large household purchases				
Ref. Respondent alone	1.0	-	1.0	-
Jointly	0.672**	(0.469 - 0.963)	0.732	(0.498 - 1.076)
Partner/someone else	0.610***	(0.441 - 0.844)	0.752	(0.525 - 1.076)
Final say on daily household purchases				
Ref. Respondent alone	1.0	-	1.0	-
Jointly	0.866	(0.648 - 1.158)	0.839	(0.614 - 1.146)
Partner/someone else	0.950	(0.742 - 1.216)	0.893	(0.685 - 1.163)
Final say on visiting families or relatives				
Ref. Respondent alone	1.0	-	1.0	-
Jointly	0.996	(0.742 - 1.336)	1.029	(0.749 - 1.412)
Partner/someone else	0.807	(0.592 - 1.098)	0.805	(0.585 - 1.107)
Wife beating justifiable				
Ref. No	1.0	-	1.0	-
Yes	1.037	(0.832 - 1.292)	0.993	(0.788 - 1.253)
Children				
Age, months				
Ref. 0-11			1.0	-
12-23			2.721***	(1.996 - 3.711)
24-35			3.506***	(2.580 - 4.765)
36-47			2.855***	(2.127 - 3.831)
48-59			2.713***	(1.965 - 3.746)
Gender				
Ref. Boys			1.0	-
Girls			0.818**	(0.681 - 0.982)
Place of Residence				
Ref. Urban			1.0	-
Rural			1.158	(0.785 - 1.709)
Wealth Index				
Ref. Poorest			1.0	-
Poorer			0.897	(0.642 - 1.255)
Middle			1.131	(0.798 - 1.602)
Richer			0.906	(0.626 - 1.311)
Richest			0.647*	(0.408 - 1.024)
Womens'				
Education				
No education			1.0	-
Primary			0.907	(0.690 - 1.191)
Secondary			0.643*	(0.405 - 1.022)
Higher			0.242***	(0.0914 - 0.643)
Body Mass Index (BMI)				
Ref. Underweight, BMI$<$ 18.5			1.0	-
Normal, BMI 18.5 – 24.9			1.074	(0.778 - 1.482)
Overweight/obese, BMI$\geqslant$ 25			0.816	(0.513 - 1.298)
Husband/partners'				
Education				
Ref. None			1.0	-
Primary			0.840	(0.604 - 1.167)
Secondary			0.743	(0.481 - 1.148)
Higher			0.834	(0.451 - 1.543)
Number of Observations	2,102		2,036	

Source: Authors calculations from UDHS 2006; $***P < 0.01; **P < 0.05; *P < 0.10$

3.7 Discussions and Conclusions

This study examined the relationship between maternal autonomy and stunting in children under the age of five while controlling for important covariates such as child's age and sex, household wealth, and maternal education. Women's autonomy is a complex term that captures a multitude of constructs; controls of household resources and assets, decision making capabilities, position in the society and knowledge level among many others (see, Bloom et al., 2001; Smith et al., 2003; Brunson et al., 2009). We used direct evidence on decision making and attitudes towards intimate partner violence as indicators of women's autonomy. Data was drawn from the recent and nationally representative Uganda Demographic and Health Survey (UDHS) for year 2006.

Analyzing child characteristics, we find that stunting in Uganda is high (37 percent), especially in rural areas (40 percent), and among boys (40 percent). It is more pronounced in older age groups, especially in children between the age of 24 and 35 months. The analysis of women's autonomy variables indicates that most women in Uganda experience less autonomy. With the exception the indicator of autonomy concerning decision making about household daily purchases, men are more likely to have the sole final say over women's health care, large household purchases and visits to family or relative. A similar result has been reported in other African countries such Malawi, Zimbabwe and Zambia (Hindin, 2005). One possible explanation for the low women autonomy is that a large percentage of women are uneducated, which could explain their relative lack of involvement in decisions about their own health and large household purchases. Some studies have argued that education can raise women's self-confidence and status in the household, enabling women to take a more active and effective role in intra-household decision making and in obtaining health care assistance (Smith and Haddad, 2000; Alderman et al., 2003). Attitudes towards domestic violence tend to be rather forgiving, with majority of women accepting violence on ground or another. This result is not surprising since in many African countries, both women and men believe that wife beating is acceptable, and it is not unusual for women to condone the violence more than men (Population Reference Bureau, 2011). Not only does wife beating have serious consequences for the physical and mental health of women, but abused women are also less likely to have significant authority in their own homes. The high rates endorsement as observed in the analysis necessitate a need for national policies and programs aimed at sensitizing the general public about the far reaching

consequences of domestic violence.

Multivariate analysis shows that indicators representing attitudes towards domestic violence and three of the four indicators representing the decision-making domain of maternal autonomy, namely, final say on large purchases, final say on daily purchases, and final say on visiting families or relatives, were not statistically significantly associated with stunting. Previous studies found a strong association between the decision-making domain of autonomy and women's nutritional and reproductive health (Hindin, 2000; Mason and Smith, 2003; Woldemicael and Tenkorang, 2010). Although these studies found a positive relationship between decision-making autonomy and women's health, our study suggests that decision making as captured by the variables used to assess this dimension in the UDHS 2006 may not necessary extend to influence children's nutritional status. Moreover, one limitation of the decision questions listed in the UDHS 2006 is that the questions used might be more relevant to women's own health rather than the children's health. For instance, the survey asks about who makes the decision to access health care for the woman's own health, but does not ask specifically about decision making and health care for a child. A question related to the child's health might have revealed different results in its association with child stunting.

The overall picture that emerges from multivariate regression analyses is that greater women's autonomy, maternal education and household wealth are significantly associated with stunting and cofound maternal autonomy. Maternal education is commonly used as a proxy for autonomy since it education can also raise women's self-confidence and status in the household, thus, enabling women to take a more active and effective role in intra-household decision making and in obtaining health care assistance (Smith and Haddad, 2000; Alderman et al., 2003). However, proxy or indirect measures have been criticized for being highly imperfect and having grave policy implications when used to analyze the effects of autonomy (Balk, 1994). Some studies have shown that maternal autonomy has independent effects on child health when controlling for education (Basu and Stephenson, 2005), while others have found that maternal education may mediate and cofound the relationship between maternal autonomy and child health (Shroff et al., 2009). The nature of the impact of maternal education depends on the outcome of interest. In our study, maternal autonomy remained a significant predictor of stunting after controlling for mother's education, highlighting the independent effect of autonomy in this context. The fact that some of the measures of maternal autonomy remained statistically robust after control-

ling for education means that improving autonomy among Ugandan will have a stronger effect on improving child stunting above and beyond that provided by additional years of schooling.

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Appendix A

Appendix for Essay1:

A.1 Aggregation of Production, Factors and Households Accounts

This Appendix shows how some of the accounts of the original 2002 Uganda SAM were aggregated to obtain new accounts of the simplified SAM (i.e., UgaSAM) used in the analyses in Essay 1.

Table A.1.1: Aggregation of Activities and Commodities

UgaSAM	Label	Commodities (original SAM)	Label	Activities (original SAM)
Agriculture, forestry and fishing	AGR-C	Maize; Cassava; Potatoes; Cotton; Tobacco; Simsim Sunflower; Groundnuts; Beans; Millet and Sorghum; Rice, wheat, Other Cereals; Growing of other Horticulture Crops; Flowers And Seeds; Coffee; Tea Cocoa And Vanilla; Matoke; Passion Fruits; Farming Of Animals; Other Animal Products; Agriculture And Animal Husbandry Service Activities; Forestry, Logging And Related Service Activities; Fishing, Operation Of Fish Hatcheries And Fish Farms; Services (1-23)	AGR-A	Growing: Maize; Rice Upland; Wheat; Root Tubers, Cotton; Tobacco-Flue-Cured; Tobacco - Fire-Cured; Tobacco- Air-Cured; Simsim & sunflower; Groundnuts Sugar; Beans; Flowers & Horticultural crops; Coffee; Tea; Cocoa; Vanilla; Matoke; Passion Fruits & other tree crops. Farming of Cattle:Dairy Farming, Farming of Goats and Other Livestock, Poultry Farming, Forestry, Logging And Related Service Activities, Fishing, Operation Of Fish Hatcheries And Fish Farms (62-86)
Mining and Quarrying	MIN-C	Mining And Quarrying (24)	MIN-A	Mining And Quarrying (87)
Food, beverages and tobacco	PROC-C	Processed Food Products; Manufacture Of Alcoholic Products; Manufacture Of Soft Drinks and Production Of Mineral Waters (25-27)	PROC-A	Processing And Preserving Of Fish And Fish Products; Vegetable and animal oils & fats; Manufacture Of Dairy Products; Manufacture Of Sugar and Jaggery; Coffee and Tea Processing; Distilling and manufacture of malt; Manufacture Of Soft Drinks; Production Of Mineral Waters (88-94)

continued next page

Table A.1.1: Aggregation of Activities and Commodities (cont.)

UgaSAM	Label	Commodities (original SAM)	Label	Activities (original SAM)
Other Manufactures	MAN-C	Textile; Leather, Footwear; Saw-milling And Wood; Paper, Printing And Publishing; Petroleum Refining, Manufacture Of Products Of Coal; Chemical And Pharmaceuticals; Rubber And Plastics; Non Metallic Metal And Equipment; Manufacture And Repair Of Motor Vehicles And Ships; Other Manufacturing N..E.C (28-39)	MAN-A	Tobacco Products; starches; Cotton and associated activities; textiles; Wearing Apparel, Except Fur Apparel; apparel, leather and footwear; Wood & wood products; paper and paper products; Printing activities; petroleum and chemical products; rubber and plastic products; metal products; clay and ceramics products; cements and related products; electronics, etc.(95-109)
Electricity and Waters	UTL-C	Electricity Supply; Collection, Purification And Distribution Of Water (40-41)	UTL-A	Production, Collection And Distribution Of Electricity; Collection, Purification And Distribution Of Water (110-111)
Building and construction	CON-C	Building, Construction And Civil Engineering (42)	CON-A	Building; Civil Engineering (112-113)
Trade	TRD-C	Trade Services (43)	TRD-A	Motor repair and spare parts; Retails services; Wholesale services; Repair of personal households and other services (114-117)
Hotels and Restaurants	TRM-C	Hotels, Bars And Restaurants (44)	TRM-A	Hotels, Bars And Restaurants (118)
Transport and communication	TRS-C	Railway Transport; Passenger Road Transport ; Goods Road Transport; Water Transport; Air Transport; Other Transport Services; Telecommunications (45-51)	TRS-A	Railway Transport; Land passenger transport; Freight Transport By Road; Air transport; Warehousing and supporting transport activities; Post and courier; services Telecommunications (119-125)
Financial services	FIS-C	Banking And Insurance; Business Services (52, 55)	FIS-A	Financial services; Other Computer Related Activities; Other Business services (126, 128-129)
Real estate and housing	RES-C	Housing And Real Estate Services Lease Services (53-54)	RES-A	Real Estate Activities (127)
Government services	GOV-C	Public Administration And Defense (56)	GOV-A	Public Service Activities (130)
Education	EDU-C	Education services (57)	EDUC-A	Education services (131)
Health	HLT-C	Medical Services And Social Work (58)	HLT-A	Health services (132)
Other services	OTH-C	Social, Cultural And Recreational Services; Private Households With Employed Persons; Other Services (59-61)	OTH-A	Social services; Recreation & Entertainment; Other Activities (133-135)

Source and Note: Organized by author from the 2002 Uganda SAM. Production activities (labels ending with letter A) produce commodities (labels ending with letter C) and these short names are used in the UgaSAM. The numbers in parentheses indicate accounts' number (or row/column number) in the original 2002 Uganda SAM. Activity and Commodity accounts in our UgaSAM are classified according to the National accounts of Uganda (1*st* column above).

Table A.1.2: Aggregation of Factors of production and Households

UgaSAM	Label	Factors (original SAM)	UgaSAM	Label	Households (original SAM)
Low skilled-rural male	LSKD-RM	Unskilled, rural, male; Semi-skilled, rural, male (1,5)	Central rural	CR-HD	Central Rural Q1; Central Rural Q2; Central Rural Q3; Central Rural Q4 (1-4)
Low-skilled-rural female	LSKD-RF	Unskilled, rural, female; Semi-skilled, rural, female (2,6)	Central urban	CU-HD	Central Urban Q1; Central Urban Q2; Central Urban Q3; Central Urban Q4 (5-8)
Low-skilled-urban male	LSKD-UM	Unskilled, urban, male; Semi-skilled, urban, male (3,7)	Eastern rural	ER-HD	Eastern Rural Q1; Eastern Rural Q2; Eastern Rural Q3; Eastern Rural Q4 (9-12)
Low-skilled-urban female	LSK-UF	Unskilled, urban, female; Semi-skilled, urban, female (4, 8)	Eastern urban	EU-HD	Eastern Urban Q1; Eastern Urban Q2; Eastern Urban Q3; Eastern Urban Q4 (13-16)
Skilled-rural male	SKD-RM	Skilled, rural, male (9)	Northern rural	NR-HD	Northern Rural Q1 Northern Rural Q2 Northern Rural Q3 Northern Rural Q4 (17-20)
Skilled-rural female	SKD-RF	Skilled, rural, female (10)	Northern urban	NU-HD	Northern urban Q1 Northern urban Q2 Northern urban Q3 Northern urban Q4 (21-24)
Skilled-urban male	SKD-UM	Skilled, urban, male (11)	Western rural	WR-HD	Western Rural Q1; Western Rural Q2; Western Rural Q3; Western Rural Q4 (25-28)
Skilled-urban female	SKD-UF	Skilled, urban, male (12)	Western urban	WU-HD	Western Urban Q1 Western Urban Q2 Western Urban Q3 Western Urban Q4 (29-32)
High skilled-rural male	HSKD-RM	High-skilled, rural, male (13)			
High-skilled-rural female	HSKD-RF	High-skilled, rural, female (14)			
High-skilled-urban male	HSKD-UM	High-skilled, urban, male (15)			
High-skilled-urban female	HSKD-UF	High-skilled, urban, female (16)			
Mixed Income	MixedInc	Mixed income (17)			
Operating Surplus	OpSurplus	Operating surplus (18)			

Source and Notes: Organized by author from the 2002 Uganda SAM. Labels are those used in the UgaSAM and numbers in parentheses indicate accounts' number (or row/column number) in the original 2002 Uganda SAM. Households in our UgaSAM are classified according to the Uganda National Household Surveys ($4th$ column above)

A.2 Macro-SAM for Uganda

The appendix presents a consolidated balanced SAM for Uganda. It clearly incorporates all main transactions within a socioeconomic system. For instance, production activities produce different sectoral goods and services or commodities (e.g. agricultural products) by buying raw materials and intermediate goods and services (commodities) locally. In addition, these accounts pay taxes net of subsidies to the government, and the remainder is, by definition, value added that goes to the factors of production. Therefore, each account of the SAM registers transactions and other flows with income or resources in the rows and expenditures or uses in the columns. The sequence shows how the flow cascades from the generation, to the primary distribution, then to secondary income, its uses and connections with the capital and the rest of the world.

Table A.2.1: MacSAM for Uganda (Millions of UGX, 2002 Prices)

	Endogenous Accounts					Exogenous Accounts			
	Commodities	Production Activities	Factors of Production	Households	Corporations	Government	Consolidated Capital Account	Rest of the World current Account	
Commodities		Intermediate Consumption 7,774,738		Household Final Consumption Exp 8,991,685		Gov. Final Consumption Exp 1,808,821	Gross Capital Formation 2,420,211	Exports of Goods and Services fob 1,514,289	Total use at Producer's prices 22,509,744
Production Activities	Output at Basic prices 18,710,605								Gross Output at Basic prices 18,710,605
Primary Factors of production		Value-added, net at Basic prices 10,062,458						Compensation of Employees from RoW 0	Primary factor income generated 10,062,458
Households			Compensation of Employees & Mixed income. net 7,835,800	Inter-households Current transfers 1,219,686	Distributional Fac. & Non-Fac.Income 1,667,507	Distributional Fact. & Non-Fact. Income 70,364		Distributional Fact. & Non-Fact Income from RoW 668,954	Disposable Household Income 11,462,312
Corporations			Net Operating Surplus 2,143,282	Non-factor income transfers 14,030	Distributional Fact. & Non-Fact.Income 190,852	Distributional Fact. & Non-Fact.Income 98,726		Distributional Fact. & Non-Fact. Income from RoW 125,924	Disposable Income for Corporations 2,572,813
Government	Taxes & subsidies on commodities 849,058	Other Taxes on production and imports 352,639		Direct taxes 158,251	Direct taxes 130,921			Non-Factor Income from RoW 1,080,258	Disposable income for Government 2,571,127
Consolidated Capital account		Consumption of Fixed Capital 520,770		Net Savings for Households 500,000	Net Savings for Corporations 382,989	Net Savings for Government 537,970			Total Resources for Domestic Investment 1,941,729
Rest of the World (RoW)	Imports of Goods and Services: cif 2,950,080		Compensation of Employees to RoW 83,376	Distributional Fact. & Non-Fact.Income to RoW 578,659	Distributional Fact. & Non-Fact.Income to RoW 200,545	Distributional Fact. & Non-Fact.Income to RoW 55,247	Net Lending to Row -478,483		Current Incoming: RoW plus Net Lending 3,389,424
	Total Supply at Producer's prices 22,509,743	Gross Input at Basic prices 18,710,605	Primary Factor Income distributed 10,062,458	Current Outlays, Households including savings 11,462,312	Current Outlays, Corporations including savings 2,572,814	Current Outlays, Government including savings 2,571,128	Total Investment Expenditure plus Net Lending 1,941,729	Current Outgoings, RoW 3,389,424	

Source and Note: Derived from the Micro-SAM; UgaSAM, 2002. All empty cells are zero either by default, design of by definition. For example, it is not uncommon that activities receive subsides from government and factors of production receive income remittances from abroad. Information on these incomes was either not available or insignificant when the original SAM was constructed.

A.3 Matrix of Aggregate Multipliers (M_a)

Table A.3.1: Accounting Multiplier Matrix (M_a), Uganda, 2002

			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
			AGR-A	MIN-A	PRO-A	MAN-A	UTL-A	CON-A	TRD-A	TRM-A	TRS-A	FIS-A	RES-A	GOV-A	EDU-A	HLT-A	OTH-A
1	AGR-A	Agriculture	1.771	0.514	0.887	0.303	0.401	0.404	0.469	0.564	0.372	0.379	0.623	0.467	0.532	0.462	0.425
2	MIN-A	Mining	0.005	1.005	0.004	0.008	0.003	0.014	0.004	0.004	0.003	0.003	0.006	0.004	0.004	0.004	0.004
3	PRO-A	Food processing	0.321	0.266	1.388	0.139	0.210	0.211	0.255	0.293	0.201	0.206	0.321	0.253	0.273	0.241	0.229
4	MAN-A	Other Manufacturing	0.201	0.203	0.194	1.238	0.144	0.235	0.179	0.167	0.185	0.186	0.195	0.187	0.205	0.219	0.212
5	UTL-A	Public utilities	0.088	0.088	0.076	0.044	1.072	0.060	0.081	0.074	0.064	0.065	0.088	0.084	0.088	0.088	0.124
6	CON-A	Construction	0.055	0.051	0.049	0.027	0.038	1.063	0.053	0.051	0.048	0.053	0.136	0.076	0.057	0.060	0.061
7	TRD-A	Trade	0.400	0.346	0.408	0.227	0.259	0.288	1.323	0.344	0.288	0.309	0.381	0.332	0.363	0.355	0.332
8	TRM-A	Tourism	0.066	0.057	0.052	0.026	0.047	0.046	0.056	1.058	0.050	0.070	0.069	0.061	0.073	0.056	0.068
9	TRS-A	Transport & comm.	0.145	0.125	0.136	0.079	0.098	0.116	0.170	0.130	1.103	0.146	0.139	0.180	0.131	0.138	0.139
10	FIS-A	Financial services	0.136	0.155	0.202	0.145	0.102	0.120	0.197	0.147	0.260	1.765	0.134	0.207	0.151	0.127	0.205
11	RES-A	Real estate/housing	0.196	0.195	0.163	0.086	0.135	0.133	0.206	0.192	0.153	0.175	1.200	0.194	0.208	0.206	0.193
12	GOV-A	Government services	0.012	0.012	0.011	0.006	0.008	0.008	0.019	0.011	0.009	0.011	0.011	1.029	0.011	0.011	0.014
13	EDU-A	Education	0.132	0.113	0.098	0.047	0.091	0.088	0.107	0.114	0.085	0.092	0.138	0.220	1.185	0.185	0.101
14	HLT-A	Health	0.040	0.030	0.033	0.020	0.023	0.026	0.027	0.029	0.025	0.031	0.034	0.030	0.031	1.027	0.026
15	OTH-A	Others	0.066	0.054	0.051	0.025	0.043	0.043	0.051	0.054	0.041	0.048	0.065	0.054	0.055	0.049	1.047
Total Gross output Multiplier			**3.632**	**3.214**	**3.752**	**2.422**	**2.674**	**2.854**	**3.197**	**3.233**	**2.887**	**3.539**	**3.539**	**3.377**	**3.366**	**3.227**	**3.179**
16	AGR-C	Agriculture	0.759	0.498	0.871	0.298	0.388	0.391	0.452	0.545	0.359	0.366	0.603	0.450	0.515	0.447	0.410
17	MIN-C	Mining	0.008	0.008	0.007	0.014	0.005	0.023	0.006	0.007	0.006	0.006	0.009	0.007	0.007	0.007	0.006
18	PRO-C	Food processing	0.428	0.352	0.520	0.178	0.280	0.276	0.339	0.391	0.265	0.272	0.429	0.336	0.362	0.318	0.302
19	MAN-C	Other Manufacturing	0.538	0.550	0.517	0.659	0.388	0.643	0.483	0.447	0.506	0.506	0.522	0.505	0.555	0.596	0.579
20	UTL-C	Public utilities	0.090	0.091	0.079	0.046	0.075	0.062	0.084	0.077	0.066	0.067	0.091	0.087	0.091	0.091	0.128
21	CON-C	Construction	0.056	0.052	0.049	0.027	0.038	0.063	0.053	0.051	0.048	0.053	0.139	0.077	0.058	0.061	0.061
22	TRD-C	Trade	0.354	0.305	0.366	0.201	0.228	0.253	0.278	0.304	0.252	0.254	0.337	0.283	0.320	0.313	0.291
23	TRM-C	Tourism	0.068	0.059	0.052	0.026	0.048	0.047	0.057	0.060	0.050	0.070	0.071	0.062	0.075	0.057	0.070
24	TRS-C	Transport & comm.	0.230	0.199	0.217	0.126	0.156	0.186	0.271	0.208	0.164	0.233	0.221	0.288	0.208	0.219	0.221
25	FIS-C	Financial services	0.157	0.182	0.242	0.176	0.118	0.140	0.234	0.173	0.317	0.949	0.153	0.247	0.177	0.147	0.246
26	RES-C	Real estate/housing	0.217	0.215	0.180	0.095	0.150	0.147	0.227	0.213	0.169	0.193	0.221	0.215	0.230	0.227	0.213
27	GOV-C	Government services	0.005	0.006	0.005	0.003	0.003	0.004	0.014	0.006	0.004	0.004	0.005	0.023	0.005	0.006	0.009
28	EDU-C	Education	0.132	0.113	0.098	0.045	0.090	0.087	0.106	0.114	0.083	0.089	0.138	0.224	0.187	0.188	0.098
29	HLT-C	Health	0.065	0.046	0.052	0.028	0.036	0.039	0.043	0.045	0.038	0.049	0.054	0.047	0.048	0.041	0.039
30	OTH-C	Others	0.064	0.055	0.047	0.022	0.044	0.042	0.051	0.055	0.040	0.043	0.067	0.053	0.054	0.048	0.047
Total Domestic Supply Multiplier			**3.172**	**2.731**	**3.303**	**1.944**	**2.048**	**2.405**	**2.699**	**2.695**	**2.368**	**3.153**	**3.059**	**2.903**	**2.893**	**2.767**	**2.722**
31	LSKD-RM	Low skilled, rural male	0.231	0.161	0.133	0.054	0.060	0.071	0.088	0.084	0.064	0.067	0.093	0.090	0.097	0.077	0.080
32	LSKD-RF	Low skilled, rural female	0.035	0.021	0.020	0.007	0.009	0.009	0.012	0.013	0.010	0.011	0.014	0.027	0.016	0.012	0.017
33	LSKD-UM	Low skilled, urban male	0.034	0.061	0.035	0.034	0.021	0.031	0.047	0.024	0.029	0.021	0.026	0.037	0.025	0.024	0.060
34	LSKD-UF	Low skilled, urban female	0.013	0.014	0.027	0.008	0.008	0.008	0.014	0.013	0.026	0.009	0.012	0.011	0.013	0.011	0.025
35	SKD-RM	Skilled, rural male	0.030	0.016	0.027	0.015	0.025	0.022	0.022	0.017	0.030	0.016	0.019	0.047	0.036	0.034	0.016
36	SKD-RF	Skilled, rural female	0.017	0.017	0.021	0.015	0.011	0.013	0.022	0.016	0.025	0.161	0.016	0.026	0.024	0.029	0.021
37	SKD-UM	Skilled, urban male	0.048	0.038	0.057	0.039	0.050	0.039	0.086	0.053	0.055	0.074	0.042	0.088	0.045	0.041	0.066
38	SKD-UF	Skilled, urban female	0.008	0.008	0.008	0.005	0.059	0.006	0.012	0.011	0.006	0.008	0.008	0.011	0.012	0.013	0.015
39	HSKD-RM	High skilled, rural male	0.055	0.045	0.042	0.038	0.056	0.062	0.045	0.044	0.035	0.043	0.054	0.130	0.322	0.173	0.077
40	HSKD-RF	High skilled, rural female	0.018	0.012	0.015	0.006	0.010	0.010	0.017	0.013	0.010	0.010	0.015	0.023	0.085	0.044	0.014
41	HSKD-UM	High skilled, urban male	0.068	0.065	0.075	0.058	0.068	0.059	0.104	0.065	0.118	0.308	0.067	0.336	0.142	0.125	0.160
42	HSKD-UF	High skilled, urban female	0.040	0.036	0.041	0.022	0.034	0.029	0.059	0.121	0.043	0.104	0.040	0.099	0.134	0.121	0.059
43	MixedInc	Mixed Income	1.359	1.151	0.856	0.305	0.466	0.717	0.885	0.972	0.510	0.583	1.633	0.601	0.658	0.673	0.734
44	OpSurplus	Operating Surplus	0.262	0.246	0.294	0.162	0.831	0.465	0.392	0.540	0.529	0.019	0.273	0.301	0.330	0.353	0.278
Total GDP Multiplier			**2.219**	**1.891**	**1.652**	**0.767**	**1.707**	**1.542**	**1.803**	**1.985**	**1.491**	**1.396**	**2.312**	**1.826**	**1.939**	**1.730**	**1.622**
45	CR-HD	Central Rural	0.495	0.410	0.349	0.155	0.314	0.312	0.362	0.396	0.284	0.300	0.504	0.348	0.400	0.352	0.321
46	CU-HD	Central Urban	0.703	0.630	0.549	0.261	0.539	0.492	0.636	0.688	0.502	0.557	0.795	0.679	0.576	0.563	0.594
47	ER-HD	Eastern Rural	0.348	0.288	0.242	0.104	0.217	0.218	0.251	0.277	0.194	0.176	0.359	0.233	0.277	0.241	0.220
48	EU-HD	Eastern Urban	0.077	0.070	0.064	0.034	0.068	0.058	0.078	0.082	0.065	0.076	0.084	0.094	0.073	0.071	0.075
49	NR-HD	Northern Rural	0.153	0.124	0.111	0.055	0.110	0.102	0.112	0.120	0.097	0.105	0.139	0.138	0.178	0.136	0.110
50	NU-HD	Northern Urban	0.036	0.034	0.033	0.019	0.036	0.030	0.041	0.040	0.037	0.050	0.038	0.061	0.040	0.038	0.044
51	WR-HD	Western Rural	0.420	0.342	0.286	0.122	0.246	0.255	0.287	0.315	0.219	0.204	0.416	0.264	0.359	0.294	0.249
52	WU-HD	Western Urban	0.132	0.120	0.104	0.051	0.100	0.093	0.121	0.124	0.097	0.111	0.149	0.136	0.106	0.104	0.116
53	CORP	Corporations	0.286	0.268	0.319	0.176	0.900	0.505	0.426	0.586	0.574	0.018	0.298	0.328	0.359	0.384	0.303
Total Income Multiplier			**2.650**	**2.287**	**2.058**	**0.977**	**2.531**	**2.065**	**2.315**	**2.627**	**2.068**	**1.562**	**2.783**	**2.279**	**2.370**	**2.181**	**2.031**
Total			**11.67**	**10.12**	**10.77**	**6.11**	**8.96**	**8.87**	**10.01**	**10.54**	**8.81**	**9.65**	**11.69**	**10.38**	**10.57**	**9.91**	**9.55**

Source and Notes: Author's calculations based on UgaSAM, 2002. First column numbering corresponds to economic activities (1-15), commodities (16-30), factors of production (31-44), households and corporations (45-53). Column-wise, the values indicate the income increase of all the endogenous accounts (row accounts) due to unit-income injection into the respective column accounts while the within-account sums of columns show the total effect on gross output, commodity output, GDP and institutional incomes (respectively) of the same unit-income increase.

Table A.3.1: Accounting Multiplier Matrix (M_a), Uganda, 2002 (cont.)

			16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
			AGR-C	MIN-C	PRO-C	MAN-C	UTL-C	CON-C	TRD-C	TRM-C	TRS-C	FIS-C	RES-C	GOV-C	EDU-C	HLT-C	OTH-C
1	AGR-A	Agriculture	1.680	0.311	0.865	0.128	0.384	0.402	0.469	0.546	0.268	0.316	0.607	0.460	0.515	0.445	0.397
2	MIN-A	Mining	0.005	0.590	0.004	0.003	0.003	0.014	0.004	0.004	0.002	0.003	0.005	0.004	0.004	0.004	0.004
3	PRO-A	Food processing	0.310	0.160	1.049	0.072	0.201	0.213	0.255	0.284	0.145	0.172	0.318	0.249	0.264	0.236	0.214
4	MAN-A	Other Manufacturing	0.193	0.157	0.185	0.446	0.140	0.242	0.179	0.165	0.130	0.153	0.195	0.184	0.199	0.207	0.192
5	UTL-A	Public utilities	0.083	0.053	0.067	0.018	1.025	0.059	0.081	0.073	0.046	0.054	0.092	0.083	0.085	0.095	0.104
6	CON-A	Construction	0.053	0.031	0.043	0.012	0.036	1.040	0.053	0.050	0.034	0.044	0.129	0.075	0.056	0.058	0.056
7	TRD-A	Trade	0.382	0.210	0.349	0.099	0.248	0.287	1.319	0.352	0.268	0.275	0.407	0.328	0.371	0.500	0.373
8	TRM-A	Tourism	0.063	0.034	0.049	0.011	0.045	0.046	0.056	0.972	0.036	0.062	0.078	0.060	0.071	0.058	0.063
9	TRS-A	Transport & comm.	0.138	0.076	0.118	0.033	0.094	0.116	0.172	0.128	0.699	0.121	0.141	0.178	0.128	0.141	0.134
10	FIS-A	Financial services	0.130	0.095	0.166	0.058	0.097	0.129	0.197	0.145	0.191	1.413	0.152	0.205	0.148	0.156	0.336
11	RES-A	Real estate/housing	0.187	0.117	0.144	0.037	0.130	0.132	0.206	0.188	0.111	0.145	1.102	0.192	0.202	0.199	0.179
12	GOV-A	Government services	0.011	0.007	0.009	0.003	0.007	0.008	0.019	0.011	0.011	0.011	0.017	1.014	0.011	0.013	0.074
13	EDU-A	Education	0.125	0.068	0.088	0.024	0.087	0.087	0.107	0.152	0.062	0.078	0.146	0.216	1.126	0.151	0.100
14	HLT-A	Health	0.038	0.018	0.029	0.014	0.022	0.026	0.027	0.029	0.017	0.027	0.034	0.029	0.030	0.582	0.025
15	OTH-A	Other services	0.062	0.033	0.045	0.011	0.041	0.043	0.052	0.054	0.034	0.042	0.067	0.053	0.056	0.307	0.756
Total Gross output Multiplier			**3.459**	**1.960**	**3.209**	**0.968**	**2.560**	**2.844**	**3.196**	**3.154**	**2.055**	**2.916**	**3.491**	**3.329**	**3.265**	**3.151**	**3.006**
16	AGR-C	Agriculture	1.723	0.302	0.730	0.125	0.371	0.390	0.452	0.528	0.259	0.305	0.587	0.443	0.499	0.431	0.383
17	MIN-C	Mining	0.008	1.005	0.006	0.005	0.005	0.023	0.006	0.006	0.004	0.005	0.009	0.007	0.007	0.007	0.006
18	PRO-C	Food processing	0.408	0.212	1.433	0.076	0.268	0.274	0.339	0.379	0.191	0.227	0.418	0.331	0.350	0.312	0.283
19	MAN-C	Other Manufacturing	0.513	0.343	0.452	1.251	0.372	0.639	0.483	0.441	0.354	0.417	0.516	0.498	0.538	0.562	0.521
20	UTL-C	Public utilities	0.086	0.055	0.069	0.019	1.072	0.061	0.084	0.075	0.048	0.056	0.089	0.086	0.088	0.098	0.108
21	CON-C	Construction	0.053	0.031	0.043	0.011	0.037	1.063	0.053	0.050	0.035	0.044	0.130	0.076	0.056	0.059	0.057
22	TRD-C	Trade	0.337	0.185	0.312	0.081	0.219	0.252	1.278	0.296	0.179	0.210	0.330	0.279	0.309	0.296	0.266
23	TRM-C	Tourism	0.065	0.035	0.047	0.011	0.046	0.047	0.057	1.059	0.036	0.057	0.070	0.061	0.073	0.059	0.064
24	TRS-C	Transport & comm.	0.219	0.121	0.188	0.052	0.150	0.185	0.271	0.203	1.123	0.193	0.221	0.284	0.203	0.224	0.214
25	FIS-C	Financial services	0.150	0.112	0.198	0.070	0.113	0.145	0.234	0.170	0.222	1.763	0.165	0.243	0.173	0.184	0.294
26	RES-C	Real estate/housing	0.206	0.129	0.159	0.040	0.143	0.146	0.227	0.208	0.123	0.160	1.218	0.212	0.223	0.220	0.197
27	GOV-C	Government services	0.005	0.004	0.005	0.001	0.003	0.004	0.014	0.006	0.004	0.004	0.005	1.023	0.005	0.008	0.009
28	EDU-C	Education	0.125	0.067	0.088	0.020	0.086	0.086	0.106	0.114	0.061	0.074	0.136	0.221	1.180	0.148	0.099
29	HLT-C	Health	0.061	0.028	0.046	0.011	0.034	0.039	0.043	0.044	0.027	0.040	0.052	0.046	0.046	1.040	0.038
30	OTH-C	Other services	0.061	0.033	0.043	0.009	0.042	0.042	0.051	0.054	0.029	0.036	0.065	0.052	0.053	0.048	1.044
Total Domestic Supply Multiplier			**4.020**	**2.662**	**3.819**	**1.784**	**2.961**	**3.396**	**3.698**	**3.633**	**2.693**	**3.593**	**4.013**	**3.861**	**3.805**	**3.694**	**3.583**
31	LSKD-RM	Low skilled, rural male	0.219	0.096	0.126	0.023	0.058	0.071	0.088	0.082	0.047	0.056	0.091	0.088	0.094	0.078	0.074
32	LSKD-RF	Low skilled, rural female	0.034	0.013	0.019	0.003	0.009	0.009	0.012	0.013	0.007	0.009	0.014	0.027	0.015	0.013	0.016
33	LSKD-UM	Low skilled, urban male	0.032	0.037	0.030	0.013	0.020	0.030	0.047	0.024	0.022	0.018	0.027	0.036	0.025	0.037	0.050
34	LSKD-UF	Low skilled, urban female	0.013	0.008	0.022	0.003	0.007	0.008	0.014	0.012	0.017	0.008	0.012	0.011	0.013	0.015	0.020
35	SKD-RM	Skilled, rural male	0.029	0.010	0.024	0.006	0.024	0.022	0.022	0.017	0.020	0.013	0.020	0.047	0.034	0.027	0.017
36	SKD-RF	Skilled, rural female	0.016	0.010	0.018	0.006	0.011	0.014	0.022	0.016	0.019	0.129	0.018	0.025	0.024	0.025	0.033
37	SKD-UM	Skilled, urban male	0.046	0.023	0.048	0.016	0.048	0.040	0.085	0.052	0.041	0.061	0.044	0.086	0.045	0.054	0.065
38	SKD-UF	Skilled, urban female	0.008	0.005	0.007	0.002	0.056	0.006	0.012	0.011	0.005	0.007	0.009	0.011	0.011	0.013	0.013
39	HSKD-RM	High skilled, rural male	0.053	0.027	0.038	0.017	0.053	0.061	0.045	0.054	0.026	0.036	0.057	0.128	0.307	0.125	0.070
40	HSKD-RF	High skilled, rural female	0.017	0.008	0.014	0.003	0.009	0.010	0.017	0.015	0.007	0.009	0.016	0.022	0.081	0.031	0.013
41	HSKD-UM	High skilled, urban male	0.064	0.040	0.064	0.024	0.065	0.060	0.104	0.067	0.085	0.249	0.073	0.331	0.137	0.128	0.169
42	HSKD-UF	High skilled, urban female	0.038	0.022	0.035	0.010	0.032	0.029	0.059	0.117	0.032	0.085	0.043	0.098	0.129	0.093	0.061
43	MixedInc	Mixed Income	1.290	0.685	0.793	0.133	0.446	0.710	0.883	0.933	0.383	0.490	1.545	0.592	0.644	0.711	0.671
44	OpSurplus	Operating Surplus	0.250	0.149	0.249	0.068	0.794	0.457	0.392	0.515	0.356	-0.003	0.280	0.297	0.322	0.333	0.240
Total GDP Multiplier			**2.109**	**1.133**	**1.485**	**0.327**	**1.632**	**1.527**	**1.802**	**1.928**	**1.067**	**1.166**	**2.247**	**1.799**	**1.879**	**1.683**	**1.513**
45	CR-HD	Central Rural	0.470	0.246	0.316	0.066	0.300	0.310	0.361	0.385	0.205	0.250	0.488	0.343	0.388	0.339	0.301
46	CU-HD	Central Urban	0.668	0.377	0.489	0.111	0.516	0.488	0.636	0.664	0.362	0.463	0.773	0.669	0.560	0.572	0.557
47	ER-HD	Eastern Rural	0.330	0.172	0.220	0.045	0.208	0.216	0.251	0.269	0.140	0.148	0.347	0.229	0.268	0.233	0.203
48	EU-HD	Eastern Urban	0.073	0.042	0.057	0.014	0.065	0.058	0.078	0.079	0.046	0.063	0.083	0.092	0.071	0.072	0.071
49	NR-HD	Northern Rural	0.146	0.074	0.100	0.023	0.105	0.101	0.112	0.119	0.069	0.087	0.136	0.136	0.172	0.123	0.103
50	NU-HD	Northern Urban	0.034	0.021	0.029	0.008	0.035	0.030	0.041	0.039	0.027	0.041	0.038	0.060	0.039	0.039	0.042
51	WR-HD	Western Rural	0.399	0.204	0.261	0.053	0.235	0.252	0.287	0.308	0.158	0.171	0.402	0.260	0.347	0.276	0.231
52	WU-HD	Western Urban	0.126	0.072	0.093	0.022	0.095	0.092	0.121	0.120	0.070	0.092	0.145	0.134	0.104	0.108	0.109
53	CORP	Corporations	0.273	0.163	0.271	0.074	0.860	0.496	0.426	0.558	0.386	-0.002	0.305	0.323	0.350	0.362	0.262
Total Income Multiplier			**2.520**	**1.372**	**1.837**	**0.415**	**2.420**	**2.043**	**2.314**	**2.542**	**1.464**	**1.313**	**2.716**	**2.246**	**2.299**	**2.125**	**1.881**
Total			**12.11**	**7.13**	**10.35**	**3.49**	**9.57**	**9.81**	**11.01**	**11.26**	**7.28**	**8.99**	**12.47**	**11.24**	**11.25**	**10.65**	**9.98**

Source and Notes: Author's calculations based on UgaSAM, 2002. First column numbering corresponds to economic activities (1-15), commodities (16-30), factors of production (31-44), households and corporations (45-53). Column-wise, the values indicate the income increase of all the endogenous accounts (row accounts) due to unit-income injection into the respective column accounts while the within-account sums of columns show the total effect on gross output, commodity output, GDP and institutional incomes (respectively) of the same unit-income increase.

Table A.3.1: Accounting Multiplier Matrix (M_a), Uganda, 2002 (cont.)

			31	32	33	34	35	36	37	38	39	40	41	42	43	44
			LSKD-RM	LSKD-RF	LSKD-UM	LSKD-UF	SKD-RM	SKD-RF	SKD-UM	SKD-UF	HSKD-RM	HSKD-RF	HSKD-UM	HSKD-UF	MixedInc	OpSurplus
1	AGR-A	Agriculture	0.762	0.766	0.497	0.499	0.753	0.764	0.497	0.490	0.751	0.749	0.501	0.487	0.646	0.452
2	MIN-A	Mining	0.006	0.006	0.004	0.004	0.006	0.006	0.004	0.004	0.006	0.006	0.004	0.004	0.005	0.003
3	PRO-A	Food processing	0.368	0.375	0.284	0.285	0.364	0.368	0.285	0.281	0.364	0.362	0.287	0.280	0.333	0.234
4	MAN-A	Other Manufacturing	0.207	0.207	0.167	0.168	0.204	0.208	0.168	0.167	0.203	0.202	0.168	0.166	0.191	0.134
5	UTL-A	Public utilities	0.101	0.101	0.075	0.075	0.100	0.101	0.075	0.074	0.099	0.098	0.075	0.074	0.090	0.063
6	CON-A	Construction	0.056	0.054	0.057	0.058	0.055	0.056	0.057	0.059	0.054	0.057	0.057	0.058	0.059	0.041
7	TRD-A	Trade	0.438	0.440	0.324	0.326	0.433	0.439	0.325	0.322	0.431	0.429	0.327	0.320	0.390	0.273
8	TRM-A	Tourism	0.073	0.073	0.066	0.066	0.073	0.075	0.066	0.066	0.070	0.069	0.066	0.065	0.071	0.050
9	TRS-A	Transport & comm.	0.146	0.145	0.129	0.130	0.144	0.147	0.130	0.130	0.142	0.143	0.129	0.129	0.141	0.099
10	FIS-A	Financial services	0.141	0.141	0.116	0.117	0.140	0.142	0.117	0.116	0.138	0.139	0.117	0.116	0.132	0.092
11	RES-A	Real estate/housing	0.208	0.206	0.193	0.196	0.207	0.212	0.194	0.196	0.203	0.201	0.193	0.194	0.206	0.144
12	GOV-A	Government services	0.012	0.012	0.010	0.010	0.012	0.012	0.010	0.010	0.012	0.012	0.010	0.010	0.012	0.008
13	EDU-A	Education	0.144	0.139	0.134	0.136	0.141	0.144	0.135	0.136	0.138	0.143	0.134	0.135	0.143	0.100
14	HLT-A	Health	0.039	0.039	0.028	0.028	0.038	0.039	0.028	0.028	0.038	0.038	0.028	0.028	0.034	0.024
15	OTH-A	Other services	0.070	0.068	0.060	0.061	0.069	0.070	0.060	0.061	0.067	0.069	0.060	0.060	0.068	0.047
Total Gross output Multiplier			**2.770**	**2.773**	**2.144**	**2.160**	**2.737**	**2.783**	**2.151**	**2.140**	**2.715**	**2.717**	**2.156**	**2.127**	**2.523**	**1.764**
16	AGR-C	Agriculture	0.742	0.745	0.477	0.478	0.733	0.744	0.476	0.470	0.731	0.730	0.480	0.467	0.625	0.437
17	MIN-C	Mining	0.010	0.010	0.007	0.007	0.009	0.010	0.007	0.006	0.010	0.010	0.007	0.006	0.008	0.006
18	PRO-C	Food processing	0.492	0.501	0.380	0.380	0.486	0.491	0.381	0.375	0.487	0.483	0.383	0.374	0.445	0.313
19	MAN-C	Other Manufacturing	0.552	0.553	0.448	0.451	0.546	0.555	0.449	0.447	0.542	0.540	0.450	0.444	0.512	0.358
20	UTL-C	Public utilities	0.104	0.105	0.077	0.078	0.103	0.105	0.077	0.077	0.102	0.101	0.078	0.076	0.093	0.065
21	CON-C	Construction	0.057	0.054	0.058	0.059	0.056	0.057	0.058	0.060	0.054	0.057	0.057	0.059	0.060	0.041
22	TRD-C	Trade	0.390	0.393	0.284	0.286	0.386	0.391	0.285	0.282	0.385	0.383	0.286	0.280	0.345	0.242
23	TRM-C	Tourism	0.075	0.075	0.068	0.068	0.075	0.077	0.068	0.068	0.072	0.071	0.068	0.067	0.074	0.051
24	TRS-C	Transport & comm.	0.233	0.230	0.205	0.207	0.230	0.235	0.206	0.207	0.226	0.227	0.206	0.205	0.225	0.157
25	FIS-C	Financial services	0.163	0.163	0.132	0.134	0.161	0.163	0.133	0.133	0.159	0.160	0.133	0.132	0.152	0.106
26	RES-C	Real estate/housing	0.230	0.228	0.213	0.216	0.229	0.234	0.214	0.217	0.225	0.223	0.213	0.214	0.228	0.159
27	GOV-C	Government services	0.005	0.005	0.004	0.004	0.005	0.005	0.004	0.004	0.005	0.005	0.004	0.004	0.005	0.003
28	EDU-C	Education	0.144	0.139	0.135	0.136	0.141	0.143	0.136	0.136	0.138	0.143	0.135	0.135	0.144	0.100
29	HLT-C	Health	0.062	0.062	0.044	0.044	0.062	0.063	0.044	0.044	0.061	0.061	0.044	0.044	0.055	0.038
30	OTH-C	Other services	0.070	0.068	0.064	0.065	0.069	0.070	0.064	0.065	0.067	0.070	0.064	0.064	0.070	0.049
Total Domestic Supply Multiplier			**3.330**	**3.333**	**2.595**	**2.613**	**3.291**	**3.345**	**2.604**	**2.590**	**3.264**	**3.265**	**2.610**	**2.574**	**3.041**	**2.126**
31	LSKD-RM	Low skilled, rural male	1.111	0.111	0.075	0.075	0.109	0.111	0.075	0.074	0.109	0.109	0.075	0.074	0.095	0.067
32	LSKD-RF	Low skilled, rural female	0.017	1.017	0.011	0.011	0.017	0.017	0.011	0.011	0.016	0.016	0.011	0.011	0.014	0.010
33	LSKD-UM	Low skilled, urban male	0.029	0.029	1.022	0.022	0.028	0.029	0.022	0.022	0.028	0.028	0.022	0.022	0.026	0.018
34	LSKD-UF	Low skilled, urban female	0.013	0.013	0.010	1.010	0.013	0.013	0.010	0.010	0.013	0.013	0.010	0.010	0.012	0.008
35	SKD-RM	Skilled, rural male	0.021	0.021	0.016	0.016	1.021	0.021	0.016	0.016	0.021	0.021	0.016	0.016	0.019	0.013
36	SKD-RF	Skilled, rural female	0.016	0.016	0.013	0.013	0.016	1.016	0.013	0.013	0.016	0.016	0.013	0.013	0.015	0.011
37	SKD-UM	Skilled, urban male	0.046	0.046	0.036	0.036	0.045	0.046	1.036	0.035	0.045	0.045	0.036	0.035	0.042	0.029
38	SKD-UF	Skilled, urban female	0.009	0.009	0.007	0.007	0.009	0.009	0.007	1.007	0.009	0.009	0.007	0.007	0.008	0.006
39	HSKD-RM	High skilled, rural male	0.056	0.054	0.049	0.049	0.055	0.056	0.049	0.049	1.054	0.055	0.049	0.049	0.054	0.038
40	HSKD-RF	High skilled, rural female	0.016	0.016	0.014	0.014	0.016	0.016	0.014	0.014	0.016	1.016	0.014	0.014	0.015	0.011
41	HSKD-UM	High skilled, urban male	0.071	0.070	0.059	0.059	0.070	0.071	0.059	0.059	0.069	0.070	1.059	0.058	0.067	0.046
42	HSKD-UF	High skilled, urban female	0.043	0.043	0.036	0.037	0.043	0.043	0.037	0.036	0.042	0.042	0.036	1.036	0.041	0.028
43	MixedInc	Mixed Income	0.813	0.814	0.608	0.613	0.804	0.819	0.610	0.608	0.798	0.796	0.612	0.603	1.730	0.510
44	OpSurplus	Operating Surplus	0.275	0.274	0.221	0.223	0.272	0.277	0.222	0.221	0.268	0.268	0.222	0.220	0.255	1.178
Total GDP Multiplier			**2.535**	**2.534**	**2.178**	**2.187**	**2.517**	**2.544**	**2.181**	**2.176**	**2.503**	**2.504**	**2.184**	**2.169**	**2.394**	**1.974**
45	CR-HD	Central Rural	0.629	0.627	0.348	0.359	0.683	0.765	0.352	0.366	0.590	0.446	0.347	0.361	0.525	0.359
46	CU-HD	Central Urban	0.508	0.507	1.039	1.101	0.501	0.510	1.067	1.161	0.497	0.497	1.026	1.136	0.826	0.567
47	ER-HD	Eastern Rural	0.422	0.460	0.232	0.229	0.394	0.355	0.232	0.226	0.387	0.475	0.231	0.225	0.374	0.255
48	EU-HD	Eastern Urban	0.059	0.059	0.147	0.123	0.058	0.059	0.178	0.132	0.058	0.058	0.152	0.157	0.087	0.071
49	NR-HD	Northern Rural	0.242	0.397	0.122	0.121	0.279	0.285	0.119	0.109	0.355	0.146	0.130	0.109	0.143	0.122
50	NU-HD	Northern Urban	0.033	0.030	0.099	0.095	0.030	0.030	0.096	0.059	0.029	0.029	0.125	0.068	0.039	0.037
51	WR-HD	Western Rural	0.620	0.423	0.220	0.220	0.533	0.517	0.216	0.214	0.540	0.811	0.220	0.210	0.434	0.290
52	WU-HD	Western Urban	0.096	0.096	0.246	0.225	0.095	0.096	0.195	0.182	0.094	0.094	0.232	0.161	0.155	0.106
53	CORP	Corporations	0.300	0.299	0.243	0.245	0.296	0.302	0.244	0.243	0.293	0.293	0.244	0.241	0.279	1.275
Total Income Multiplier			**2.907**	**2.898**	**2.696**	**2.717**	**2.870**	**2.920**	**2.698**	**2.691**	**2.842**	**2.850**	**2.708**	**2.670**	**2.861**	**3.082**
Total			**11.54**	**11.54**	**9.61**	**9.68**	**11.41**	**11.59**	**9.63**	**9.60**	**11.33**	**11.33**	**9.66**	**9.54**	**10.82**	**8.94**

Source and Notes: Author's calculations based on UgaSAM, 2002. First column numbering corresponds to economic activities (1-15), commodities (16-30), factors of production (31-44), households and corporations (45-53). Column-wise, the values indicate the income increase of all the endogenous accounts (row accounts) due to unit-income injection into the respective column accounts while the within-account sums of columns show the total effect on gross output, commodity output, GDP and institutional incomes (respectively) of the same unit-income increase.

Table A.3.1: Accounting Multiplier Matrix (M_a), Uganda, 2002 (cont.).

			45	46	47	48	49	50	51	52	53	
			CR-HD	CU-HD	ER-HD	EU-HD	NR-HD	NU-HD	WR-HD	WU-HD	CORP	Total
1	AGR-A	Agriculture	0.745	0.488	0.775	0.513	0.819	0.594	0.784	0.563	0.452	30.712
2	MIN-A	Mining	0.005	0.004	0.006	0.004	0.007	0.005	0.006	0.004	0.003	1.838
3	PRO-A	Food processing	0.352	0.278	0.399	0.323	0.405	0.340	0.367	0.308	0.234	16.424
4	MAN-A	Other Manufacturing	0.208	0.169	0.210	0.171	0.215	0.184	0.210	0.177	0.134	11.157
5	UTL-A	Public utilities	0.103	0.075	0.104	0.078	0.104	0.082	0.099	0.082	0.063	6.195
6	CON-A	Construction	0.058	0.065	0.053	0.042	0.048	0.045	0.063	0.049	0.041	4.888
7	TRD-A	Trade	0.433	0.323	0.451	0.341	0.463	0.371	0.445	0.353	0.273	20.391
8	TRM-A	Tourism	0.085	0.066	0.078	0.071	0.065	0.072	0.066	0.069	0.050	5.129
9	TRS-A	Transport & comm.	0.153	0.133	0.147	0.131	0.142	0.130	0.148	0.129	0.099	8.487
10	FIS-A	Financial services	0.143	0.118	0.147	0.118	0.142	0.124	0.143	0.121	0.092	10.585
11	RES-A	Real estate/housing	0.224	0.205	0.196	0.174	0.206	0.178	0.212	0.190	0.144	11.390
12	GOV-A	Government services	0.013	0.011	0.013	0.010	0.012	0.010	0.012	0.011	0.008	2.661
13	EDU-A	Education	0.149	0.140	0.144	0.142	0.127	0.122	0.152	0.135	0.100	8.528
14	HLT-A	Health	0.040	0.028	0.041	0.031	0.038	0.029	0.038	0.030	0.024	3.130
15	OTH-A	Other services	0.073	0.063	0.075	0.057	0.060	0.057	0.071	0.064	0.047	4.860
Total Gross output Multiplier			**2.783**	**2.165**	**2.839**	**2.205**	**2.854**	**2.344**	**2.818**	**2.288**	**1.764**	**146.376**
16	AGR-C	Agriculture	0.727	0.467	0.750	0.486	0.796	0.569	0.766	0.542	0.437	28.760
17	MIN-C	Mining	0.009	0.006	0.009	0.006	0.011	0.008	0.011	0.008	0.006	1.421
18	PRO-C	Food processing	0.470	0.371	0.535	0.433	0.542	0.456	0.491	0.412	0.313	20.542
19	MAN-C	Other Manufacturing	0.556	0.453	0.559	0.458	0.575	0.492	0.562	0.475	0.358	27.229
20	UTL-C	Public utilities	0.106	0.077	0.108	0.080	0.108	0.085	0.103	0.085	0.065	5.373
21	CON-C	Construction	0.059	0.065	0.053	0.042	0.049	0.045	0.063	0.050	0.041	3.943
22	TRD-C	Trade	0.383	0.282	0.402	0.300	0.418	0.331	0.398	0.312	0.242	16.852
23	TRM-C	Tourism	0.088	0.068	0.081	0.074	0.066	0.075	0.067	0.072	0.051	4.280
24	TRS-C	Transport & comm.	0.243	0.212	0.235	0.209	0.225	0.207	0.236	0.205	0.157	11.929
25	FIS-C	Financial services	0.164	0.135	0.169	0.136	0.165	0.143	0.164	0.139	0.106	11.241
26	RES-C	Real estate/housing	0.248	0.227	0.217	0.192	0.228	0.197	0.234	0.210	0.159	11.480
27	GOV-C	Government services	0.005	0.004	0.006	0.004	0.006	0.005	0.006	0.005	0.003	1.312
28	EDU-C	Education	0.148	0.140	0.144	0.143	0.127	0.122	0.153	0.136	0.100	7.522
29	HLT-C	Health	0.065	0.044	0.066	0.049	0.061	0.047	0.062	0.048	0.038	3.473
30	OTH-C	Other services	0.074	0.067	0.077	0.058	0.058	0.059	0.072	0.068	0.049	3.898
Total Domestic Supply Multiplier			**3.346**	**2.620**	**3.411**	**2.671**	**3.434**	**2.839**	**3.387**	**2.765**	**2.126**	**159.254**
31	LSKD-RM	Low skilled, rural male	0.108	0.074	0.113	0.077	0.118	0.088	0.114	0.084	0.067	5.852
32	LSKD-RF	Low skilled, rural female	0.016	0.011	0.017	0.012	0.018	0.013	0.017	0.013	0.010	1.767
33	LSKD-UM	Low skilled, urban male	0.029	0.022	0.030	0.023	0.030	0.024	0.029	0.024	0.018	2.530
34	LSKD-UF	Low skilled, urban female	0.013	0.010	0.014	0.011	0.013	0.011	0.013	0.011	0.008	1.660
35	SKD-RM	Skilled, rural male	0.021	0.016	0.022	0.017	0.022	0.018	0.022	0.017	0.013	2.124
36	SKD-RF	Skilled, rural female	0.017	0.013	0.017	0.014	0.016	0.014	0.017	0.014	0.011	2.152
37	SKD-UM	Skilled, urban male	0.046	0.036	0.048	0.037	0.048	0.039	0.047	0.038	0.029	3.498
38	SKD-UF	Skilled, urban female	0.009	0.007	0.010	0.007	0.009	0.008	0.009	0.008	0.006	1.551
39	HSKD-RM	High skilled, rural male	0.057	0.051	0.056	0.051	0.051	0.046	0.058	0.050	0.038	4.492
40	HSKD-RF	High skilled, rural female	0.017	0.014	0.017	0.015	0.015	0.014	0.017	0.014	0.011	1.910
41	HSKD-UM	High skilled, urban male	0.072	0.060	0.073	0.060	0.070	0.061	0.072	0.061	0.046	5.937
42	HSKD-UF	High skilled, urban female	0.045	0.037	0.045	0.038	0.041	0.037	0.043	0.038	0.028	3.763
43	MixedInc	Mixed Income	0.821	0.616	0.816	0.604	0.846	0.664	0.831	0.653	0.510	40.112
44	OpSurplus	Operating Surplus	0.281	0.225	0.283	0.228	0.276	0.236	0.276	0.233	0.178	16.549
Total GDP Multiplier			**1.553**	**1.193**	**1.558**	**1.193**	**1.573**	**1.274**	**1.565**	**1.257**	**0.974**	**93.897**
45	CR-HD	Central Rural	1.327	0.406	0.328	0.249	0.333	0.267	0.331	0.264	0.359	20.692
46	CU-HD	Central Urban	0.514	1.397	0.515	0.396	0.519	0.423	0.516	0.418	0.567	32.879
47	ER-HD	Eastern Rural	0.228	0.210	1.229	0.333	0.233	0.186	0.231	0.316	0.255	14.646
48	EU-HD	Eastern Urban	0.060	0.058	0.060	1.047	0.060	0.050	0.060	0.092	0.071	4.990
49	NR-HD	Northern Rural	0.105	0.098	0.106	0.082	1.106	0.386	0.107	0.147	0.122	8.334
50	NU-HD	Northern Urban	0.030	0.029	0.031	0.024	0.030	1.030	0.030	0.044	0.037	3.186
51	WR-HD	Western Rural	0.270	0.205	0.271	0.205	0.276	0.220	1.296	0.319	0.290	16.944
52	WU-HD	Western Urban	0.097	0.075	0.097	0.075	0.098	0.080	0.097	1.079	0.106	7.044
53	CORP	Corporations	0.307	0.247	0.308	0.250	0.301	0.258	0.302	0.258	1.275	19.101
Total Income Multiplier			**2.939**	**2.726**	**2.945**	**2.661**	**2.957**	**2.900**	**2.970**	**2.937**	**3.082**	**127.816**
Total			**10.62**	**8.70**	**10.75**	**8.73**	**10.82**	**9.36**	**10.74**	**9.25**	**7.94**	**527.343**

Source and Notes: Author's calculations based on UgaSAM, 2002. First column numbering corresponds to economic activities (1-15), commodities (16-30), factors of production (31-44), households and corporations (45-53). Column-wise, the values indicate the income increase of all the endogenous accounts (row accounts) due to unit-income injection into the respective column accounts while the within-account sums of columns show the total effect on gross output, commodity output, GDP and institutional incomes (respectively) of the same unit-income increase.

Appendix B

Appendix for Essay 2

Table B.1: Alkire and Foster (2007, 2011) Multidimensional Child Poverty Indices by area of residence

Cutoff	Rural ($N = 2045$, pop. share =89.7%)						Urban ($N = 236$, pop. share =10.3%)					
	Headcount ratio H	Adjusted headcount MO	Adjusted poverty gap $M1$	Adjusted poverty gap squared $M2$	Average Deprivation share A	Average Deprivations$A(k)$	Headcount ratio H	Adjusted headcount MO	Adjusted poverty gap $M1$	Adjusted poverty gap squared $M2$	Average Deprivation share A	Average Deprivations$A(k)$
0.7	0.675	0.327	0.072	0.034	0.484	1.937	0.377	0.116	0.016	0.005	0.307	1.228
1.3	0.514	0.300	0.071	0.034	0.583	2.334	0.178	0.083	0.015	0.005	0.464	1.857
2.0	0.456	0.281	0.069	0.034	0.616	2.463	0.093	0.054	0.013	0.005	0.583	2.333
2.7	0.218	0.162	0.037	0.019	0.742	2.967	0.025	0.020	0.005	0.003	0.806	3.222
3.3	0.086	0.073	0.017	0.009	0.858	3.432	0.017	0.015	0.004	0.003	0.875	3.500
4.0	0.013	0.013	0.003	0.001	1.000	4.000	0.004	0.004	0.002	0.002	1.000	4.000

Source: Authors own calculations from UDHS 2006

Table B.2: The relative contribution to the Alkire and Foster (2007, 2011) Multidimensional Child Poverty Indices by area of residence

Cutoff	Rural ($N = 2045$, pop. share =89.7%				Urban ($N = 236$, pop. share =10.3%			
	Headcount ratio H	Adjusted headcount MO	Adjusted poverty gap $M1$	Adjusted poverty gap squared $M2$	Headcount ratio H	Adjusted headcount MO	Adjusted poverty gap $M1$	Adjusted poverty gap squared $M2$
0.7	0.939	0.961	0.975	0.982	0.061	0.039	0.025	0.018
1.3	0.962	0.969	0.977	0.983	0.038	0.031	0.023	0.017
2.0	0.977	0.978	0.979	0.983	0.023	0.022	0.021	0.017
2.7	0.987	0.986	0.983	0.983	0.013	0.014	0.017	0.017
3.3	0.978	0.977	0.971	0.967	0.022	0.023	0.029	0.033
4.0	0.963	0.963	0.914	0.846	0.037	0.037	0.086	0.154

Source: Authors own calculations from UDHS 2006

Table B.3: Alkire and Foster (2007, 2011) Multidimensional Child Poverty Indices by region

	Kampala				Central				Eastern				Northern				Western			
Cutoff	H	MO	$M1$	$M2$	H	MO	$M1$	$M2$	H	MO	$M1$	$M2$	H	MO	$M1$	$M2$	H	MO	$M1$	$M2$
0.7	0.333	0.076	0.004	0.000	0.492	0.212	0.033	0.010	0.685	0.335	0.062	0.022	0.737	0.390	0.119	0.007	0.684	0.295	0.042	0.001
1.3	0.114	0.039	0.003	0.000	0.318	0.184	0.032	0.010	0.552	0.313	0.062	0.022	0.618	0.370	0.118	0.008	0.443	0.255	0.041	0.001
2.0	0.008	0.004	0.001	0.000	0.282	0.171	0.031	0.010	0.475	0.288	0.060	0.022	0.566	0.353	0.117	0.009	0.378	0.233	0.039	0.001
2.7	0.000	0.000	0.000	0.000	0.133	0.097	0.016	0.005	0.215	0.158	0.030	0.010	0.275	0.207	0.065	0.005	0.183	0.136	0.021	0.001
3.3	0.000	0.000	0.000	0.000	0.046	0.039	0.007	0.002	0.073	0.063	0.011	0.004	0.125	0.107	0.034	0.002	0.070	0.060	0.009	0.000
4.0	0.000	0.000	0.000	0.000	0.005	0.005	0.001	0.000	0.013	0.013	0.002	0.001	0.018	0.018	0.005	0.000	0.012	0.012	0.002	0.000

Source: Authors own calculations from UDHS 2006

Table B.4: The relative contribution to the Alkire and Foster (2007, 2011) Multidimensional Child Poverty Indices by region

	Kampala				Central				Eastern				Northern				Western			
Cutoff	*H*	*MO*	*M*1	*M*2	*H*	*MO*	*M*1	*M*2	*H*	*MO*	*M*1	*M*2	*H*	*MO*	*M*1	*M*2	*H*	*MO*	*M*1	*M*2
0.7	0.030	0.014	0.004	0.001	0.139	0.127	0.090	0.060	0.260	0.269	0.231	0.172	0.337	0.377	0.533	0.070	0.234	0.213	0.142	0.009
1.3	0.014	0.008	0.003	0.001	0.121	0.120	0.089	0.059	0.282	0.276	0.232	0.172	0.380	0.393	0.537	0.077	0.204	0.202	0.139	0.010
2.0	0.001	0.001	0.001	0.000	0.123	0.121	0.089	0.059	0.278	0.274	0.231	0.172	0.399	0.405	0.543	0.083	0.199	0.200	0.136	0.010
2.7	0.000	0.000	0.000	0.000	0.122	0.120	0.084	0.056	0.265	0.262	0.213	0.147	0.409	0.415	0.565	0.082	0.204	0.203	0.138	0.010
3.3	0.000	0.000	0.000	0.000	0.106	0.105	0.077	0.050	0.229	0.230	0.171	0.111	0.469	0.469	0.632	0.090	0.196	0.196	0.121	0.008
4.0	0.000	0.000	0.000	0.000	0.074	0.074	0.084	0.055	0.259	0.259	0.190	0.126	0.444	0.444	0.565	0.082	0.222	0.222	0.162	0.011

Source: Authors own calculations from UDHS 2006

Table B.5: Dimension contribution to the Alkire and Foster (2007, 2011) Multidimensional Child Poverty Indices (Full sample)

	Adjusted headcount *MO*				Adjusted poverty gap *M*1				Adjusted poverty gap squared *M*2			
Cutoff (*k*)	Asset index	H/A	W/H	W/A	Asset index	H/A	W/H	W/A	Asset index	H/A	W/H	W/A
0.7	0.664	0.212	0.036	0.088	0.917	0.040	0.011	0.032	0.983	0.006	0.002	0.009
1.3	0.729	0.146	0.031	0.094	0.929	0.029	0.009	0.032	0.985	0.005	0.002	0.009
2.0	0.787	0.124	0.026	0.062	0.948	0.022	0.007	0.023	0.989	0.003	0.001	0.007
2.7	0.673	0.202	0.031	0.094	0.920	0.038	0.009	0.033	0.984	0.005	0.002	0.009
3.3	0.582	0.167	0.056	0.194	0.867	0.045	0.017	0.071	0.969	0.008	0.004	0.019
4.0	0.500	0.167	0.167	0.167	0.786	0.037	0.051	0.127	0.929	0.006	0.012	0.053

Source: Authors own calculations from UDHS 2006

Notes: H/A: Height-for-age; W/H: Weight-for-height; W/A:Weight-for-age

Table B.6: Dimension contribution to the Alkire and Foster (2007, 2011) Multidimensional Child Poverty Indices by area of residence

	Rural												Urban											
	Adjusted headcount, *MO*				Adjusted poverty gap, *M*1				Adjusted poverty gap squared ,*M*2				Adjusted headcount *MO*				Adjusted poverty gap *M*1				Adjusted poverty gap squared *M*2			
Cutoff (*k*)	Asset index	H/A	W/H	W/A	Asset index	H/A	W/H	W/A	Asset index	H/A	W/H	W/A	Asset index	H/A	W/H	W/A	Asset index	H/A	W/H	W/A	Asset index	H/A	W/H	W/A
0.7	0.676	0.206	0.033	0.085	0.922	0.038	0.009	0.031	0.984	0.005	0.002	0.008	0.366	0.366	0.110	0.159	0.746	0.104	0.064	0.086	0.925	0.020	0.023	0.032
1.3	0.736	0.144	0.030	0.090	0.932	0.029	0.008	0.031	0.986	0.004	0.002	0.008	0.513	0.205	0.060	0.222	0.800	0.067	0.041	0.092	0.936	0.015	0.016	0.033
2.0	0.788	0.124	0.026	0.062	0.949	0.022	0.007	0.022	0.989	0.003	0.001	0.006	0.779	0.104	0.039	0.078	0.905	0.028	0.015	0.052	0.966	0.006	0.004	0.024
2.7	0.674	0.202	0.031	0.093	0.921	0.038	0.009	0.033	0.984	0.005	0.002	0.009	0.621	0.207	0.034	0.138	0.883	0.039	0.014	0.064	0.973	0.006	0.003	0.018
3.3	0.583	0.166	0.057	0.194	0.867	0.045	0.017	0.071	0.969	0.008	0.004	0.019	0.571	0.190	0.048	0.190	0.867	0.037	0.017	0.079	0.972	0.005	0.003	0.020
4.0	0.500	0.167	0.167	0.167	0.776	0.038	0.053	0.133	0.919	0.007	0.014	0.060	0.500	0.167	0.167	0.167	0.884	0.018	0.033	0.065	0.979	0.001	0.004	0.016

Source: Authors own calculations from UDHS 2006

Notes: H/A: Height-for-age; W/H: Weight-for-height; W/A:Weight-for-age

Appendix C

Appendix for Essay 3

Table C.1: Children Nutritional Status in Uganda

	Height -for-age			Weight-for-height			Weight-for-age			
Characteristics	Severely Stunted < -3 SD	Stunted < -2 SD	Mean Z	Severely Wasted < -3 SD	Wasted < -2 SD	Mean Z	Severely Underweight < -3 SD	Underweight < -3 SD	Mean Z	No. of Children
Residence										
Urban	8.6	26.3	-0.98	3.1	7.5	0.04	2.4	11	-0.53	255
Rural	15.4	39.6	-1.60	2	6.5	-0.05	4.8	17.6	-0.96	2117
Region										
Central	9.5	29.6	-1.25	2.1	4.8	0.08	1.9	10.6	-0.65	567
Eastern	12.5	39.7	-1.57	2.4	7	-0.11	4.3	18.3	-0.98	585
Northern	16.8	39.7	-1.61	2.2	7.3	-0.18	6.9	21.1	-1.06	697
Western	19.9	43.6	-1.70	1.9	7.3	0.10	4.6	16.4	-0.92	523
Gender of the Child										
Boys	0.163	0.41	-1.61	0.01	0.76	-0.04	0.05	0.18	-0.95	1191
Girls	0.13	0.36	-1.46	0.02	0.06	-0.04	0.05	0.16	-0.87	1181
Child Age										
<6	4.6	15.8	-0.51	2.5	8.7	-0.01	2.5	10.8	-0.42	242
6-8	8.5	15.6	-0.57	2.1	12.1	-0.29	3.5	17	-0.65	141
9-11	12.4	30.7	-1.36	8.8	19.7	-0.88	13.9	30.7	-1.41	137
12-17	12.6	39.3	-1.63	5.6	14.1	-0.61	8.1	27	-1.24	270
18-23	14.3	43.8	-1.63	2.7	8.5	-0.21	5.8	16.3	-0.95	258
24-35	20.6	47.8	-1.83	0.8	3.8	0.18	4	16.6	-0.88	475
36-47	15.9	43.2	-1.80	0.5	1.6	0.26	2.5	12.6	-0.87	435
48-59	16.9	40.7	-1.77	0.5	1.7	0.21	2.7	14.2	-0.95	415
Mother Education Level										
no education	16	43.5	-1.69	2.7	6.9	-0.23	7.5	23	-1.15	549
incomplete primary	16.6	40.7	-1.60	1.9	6.3	0.01	4.2	17	-0.91	1261
complete primary	11.2	31.8	-1.45	2.6	7.3	0.01	2.6	14.2	-0.79	233
incomplete secondary	8.6	26.5	-1.19	2.2	7.5	0.00	3	9.7	-0.68	268
complete secondary	0	16.7	-0.02	0	16.7	-0.74	0	0	-0.69	6
Tertiary/University	3.6	12.7	-0.52	0	3.6	0.40	0	1.8	-0.07	55
Full Sample ($n = 2372$)	14.7	38.2	-1.53	2.2	6.6	-0.04	4.6	16.9	-0.91	2372

Source: Author's own calculations from UDHS 2006

Table C.2: Percent distribution of women in Uganda, by autonomy in decision-making and attitudes towards wife beating

Variables	*n*	Percentage
Autonomy in Decisonmaking (5354)		
Final say over health care, while nearly 30 percent reported being in a polygamous relationship.		
Woman	1176	21.9
Joint	2076	38.8
Partner	2102	39.3
Final say over large purchases		
Woman	801	14.9
Joint	1921	35.9
Partner	2633	49.2
Final say over households daily purchases		
Woman	1850	34.6
Joint	1646	30.7
Partner	1858	34.7
Final say over visiting family or relatives		
Woman	1090	20.4
Joint	2326	43.4
Partner	1938	36.2
Women's attitudes towards wife beating		
Okay to beat wife if she goes out without permission		
No	2373	44.5
Yes	2957	55.5
Okay to beat wife if she neglects children		
No	2194	41.1
Yes	2143	58.9
Okay to beat wife if she argues with her spouse		
No	2991	56.5
Yes	2302	43.5
Okay to beat wife if she refuses to have sex		
No	3479	66.0
Yes	1794	34.0
Okay to beat wife if she burns food		
No	4021	75.7
Yes	1293	24.3
Wife beating justified under any circumstance		
No	1451	27.1
Yes	3911	72.9

Source: Author's own calculations from UDHS 2006