Economic Studies in Inequality, Social Exclusion and Well-Being

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Almas Heshmati *Editors*

# Efficiency, Equity and Well-Being in Selected African Countries

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Pia Nilsson • Almas Heshmati
Editors

# Efficiency, Equity and Well-Being in Selected African Countries

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# Blurb

This volume focuses on several central issues in development studies. It is a collection of empirical studies on poverty and well-being, vulnerability to poverty, women's empowerment, health and smallholders' efficiency in selected African countries. The contributions are grouped into three parts: studies on measuring and analyzing well-being and vulnerability to poverty; studies on women's empowerment, children's health, caregiving and women's access to microfinance; and studies with a focus on sustainability, income and food security among rural smallholders. The studies increase our knowledge about the factors that influence poverty and well-being. This is important as it can help to alleviate many of the persistent challenges observed across Africa. The studies highlight multidimensional measures of well-being and vulnerability to poverty, social exclusion and the need to address these issues across geographic locations and segments of the population. They arrive at conclusions that can be used for informing public policies aimed at women's empowerment and improved children's health.

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Aarseth, W.
Abebe, S.
Abs, L.
Adams, R.
Addai, B.
Adelman, I.
Adesina, A.A.
Adetola, A.
African Development Bank
Agarwal, B.
Ahmed, A.
Ahn, S.C.
Ahola, T.
Aigner, D.
Akhter, A.
Akresh, R.
Alatartseva, E.
Albornoz, F.
Alderman, H.
Alemu, B.
Alkire, S.
Amanor-Boadu, V.
Amato, P.R.
Amdissa, T.
Amemiya, T.
Andersen, B.
Antman, F.
Appleton, S.
Arellano, M.
Arndt, C.

Arulampalam, W.
Asadullah, M.N.
Assefa, M.
Atella, V.
Aterido, R.
Atkinson, A.B.
Attree, P.
Bajalan, C.S.J.
Bakker, H.
Balisacan, A.
Ballon, P.
Banerjee, A.
Banerjee, R.
Banker, R.D.
Bargain, O.
Barnwal, P.
Barrett, C.B.
Bask, M.
Battese, G.E.
Bauer, J.M.
Baulch, B.
Beck, T.
Becker, G.S.
Bedin, L.
Belotti, F.
Ben-Arieh, A.
Benn, S.
Bereket, K
Berenger, V.
Beresford, B.
Berger, L.M.
Berisso, O.M.
Bettio, F.
Beyan, A.
Bhagirath, B.
Bhala, A.
Bhattamishra, R.
Bhuiyan, C.
Bidani, B.
Biewen, M.
Bigsten, A.
Björklund, A.
Block, S.
Blundell, R.
Bogale, A.

Boland, H.
Bond, S.R.
Boorsma, M.
Booth, A.L.
Bourguignon, F.
Bradbury, B.
Bradshaw, J.
Brandolini, A.
Brent, A.C.
Brody, A.
Bronfenbrenner, U.
Brooks, A.M.
Brooks-Gunn, J.
Brouwer, W.B.
Brown, M.
Bruhn, M.
Brundin, E.
Bundervoet, T.
Burchardt, T.
Bureau of Finance and Economic Development (BoFED)
Bureau of Women, Children and Youth Affairs (BoWCYA)
Burges, S.
Burnham, G.
Calandrino, M.
Calvo, C.
Carmichael, F.
Campbell, J.Y.
Campos, R.M.
Canagarajah, S.
Cantó, O.
Carletto, C.
Carvalho, M.L.
Carvalho, M.M.
Casas, F.
Caserta, T.A.
Castel, R.
Castro, R.
Cater, R.C.
Central Statistics Agency (CSA)
Chakravarty, S.
Charles, S.
Chaudhuri, S.
Chen, C.A.
Chen, K.T.
Chettri, H.K.

Chou, C.
Christiansen, L.J.
Christy, G.
Cichello, P.L.
Cline, W.R.
Cochran, W.G.
Coelli, T.J.
Colombet, H.
Colombi, R.
Colombo, F.
Corral, L.
Cottrell Jr, L.S.
Coudouel, A.
Cragg, J.
Craig, C.
Creswell, J.W.
Cuesta, J.
D'Ambrosio, C.
Daidone, S.
D'Alessio, G.
Dang, H.
Dang, T.
Dasgupta, P.
Davis, J.
Dawit, A.
Deaton, A.
Decancq, K.
Delap, E.
Demirguc-Kunt, A.
Demissie, D.
Dercon, S.
Dereje, K.
Derje Fekadu Deressa, A.
Dhongda, S.
Dickson, M.
Diepeveen, S.
Dil Bahadur, R.
Ditch, J.
Do, Y.K.
Donni, O.
Doocy, S.
Dorothe, S.
Dorphy, C.
Duncan, G.
Dunphy, D.

Durkheim, E.
Dzanku, F.M.
Ebisa, D.
Edoumiekumo, S.
EDPRS
Ekström, E.C.
Ellis, F.
Emwanu, T.
Endrias, G.
Escobal, J.
Fantu, G.
FAO
Faria, R.
Farrell, M.J.
Feeny, S.
Fekadu, D.
Field, A.
Fields, G.
Fikadu, M.
Fistum, T.
Fitttousi, J.P.
Fletschner, D.
Foster, J.
Freije, S.
Gaiha, R.
Gebru, M.
Getachew, N.
Getaneh, G.
Gezahegn, A.
Ghosh, S.
Giger, J.
Glewwe, P.
Goldberger, A.S.
González-Jaen, L.F.
Goodhead, A.
Googins, B.
Gordon, A.
Gould, D.
Gowon, S.
Greene, W.
Greer, J.
Gregg, P.
Griffiths, A.
Grobler, W.C.J.
Grootaert, C.

Gross-Manos, D.
Ground, M.
Grupp, H.
Gujarati, D.
Gunther, I.
Haddad, L.
Hagedorn, K.
Haggblade, S.
Ham, J.
Han, C.K.
Hanafin, S.
Hanmer, L.
Hardaker, J.B.
Harris, I.
Hassink, W.H.
Härtel, C.E.J.
Harttgen, K.
Harvey, P.A.
Hashemi, S.
Hazell, P.
HDR
Heckman, J.
Heger, D.
Heitmueller, A.
Hentschel, J.S.
Hernandez, R.D.
Heshmati, A.
Hill, J.
Hjalmarsson, L.
Hoddinott, J.
Hoelscher, P.
Hoff, A.
Hoff, S.J.
Holmes, H.
Horncastle, A.P.
Horney, M.J.
Hotelling, H.
Howsam, P.
Hu, T.
Huang, C.J.
Hulme, D.
Iacovone, L.
Ilardi, G.
Imai, K.
Ismayilova, L.

Jaikishan, D.
Jalan, J.
Janis, I.L.
Jäntti, M.
Jarvis, S.
Jema, H.
Jemal, Y.
Jenkins, S.P.
Jha, R.
Jirstrom, M.
John, P.
Johns, G.
Jolliffe, I.T.
Jondrow, J.
Jones, C.
Jones, P.D.
Joo, M.
Jöreskog, K.G.
Joseph, J.K.
Kabeer, N.
Kagugube, J.
Kakwani, N.
Kamerman, S.B.
Kanbur, R.
Kang, S.M.
Kang, W.
Kapinga, M.
Karangwa, L.
Karimo, T.
Kasirye, I.
Kayizzi-Mugerwa, S.
Kellick, T.
Khor, N.
King, E.M.
Klasen, S.
Klugman, J.
Koch, S.
Kogan, F.N.
Komives, K.
Koopmanschap, M.A.
Korf, B.
Kostenko, W.
Kotani, K.
Krishna, A.
Krishna, S.

Krishnan, P.
Kristin, J.
Kumar, A.
Kumbhakar, S.C.
Kunieda, M.
Kuri, P.
Labuschagne, C.
Laha, A.
Lai, H.P.
Laketch, M.I.
Land, K.C.
Lanjouw, J.O.
Lanjouw, P.
Lapeyre, F.
Latif, E.
Lawson, D.
Lee, P.
Legesse, B.
Leibbrandt, M.
Lemi, A.
Leora, K.
Lépine, A.
Lewi, N.
Lien, G.
Ligon, E.
Lindert, K.
Lippman, L.
Lister, D.H.
Littlefield, E.
Liu, J.T.
Llena-Nozal, A.
Lloyd-Walker, B.
Loening, J.
Lovell, C.A.K.
Lu, Z.
Lugo, M.A.
Lumsdaine, A.A.
Lumsdaine, M.H.
Lundberg, S.
Lundin, R.A.
Luo, X.
Lusigi, A.
Mogee, M.E.
Maasoumi, E.
MacKerron, G.

Madau, F.A.
Mahajan, V.
Malapit, H.J.L.
Malik, M.
Malyadri, P.
Manser, M.
Marcelino-Sádaba, S.
Markowska, M.
Marks, A.J.
Marstrop, H.
Martens, M.
Martens, M.L.
Martini, G.
Martorell, R.
Materov, I.S.
Matshe, I.
Mayhew, E.
Mayoux, L.
McCulloch, N.
McDonald, J.
McDonald, L.
McElroy, M.B.
McGinnis, M.D.
McGuckin, J.T.
Mckay, A.
McKenzie, D.J.
Meghir, C.
Meinzen-Dick, A.
Mekonnen, T.
Melendez, A.
Menendez, M.
Menon, J.
Mercier, J.
Ministry of Finance and Economic Development (MOFED)
Mirvis, P.
MOFED (Ministry of Finance and Economic Development)
Mohan, K.
Mooi, H.
Morduch, J.
Morris, P.
Moses, T.
Mosley, P.
Moummi, A.
Muchai, D.
Mulat, D.

Mullis, N.C.
Murdoch, J.
Murie, A.
Murtaza, M.
Musabyimana, G.
Muwonge, J.
Muzola, A.
Naiditch, M.
Natali, L.
Natarajan, R.
National Bank of Ethiopia
Naved, R.T.
Ndiaye, A.
Negassa, M.
Neilands, T.B.
Neuman, M.
Newman, C.
Nguyen, P.
Nicolini, D.
Nilsson, P.
Nolan, B.
Noorbakhsh, F.
Ñopo, H.
Norell, D.
North, D.C.
Nuppenau, E.A.
O'Connor, J.M.
Oaxaca, R.L.
Ofuoku, A.U.
Ogada, M.J.
Oh, G.
Ok, E.A.
Okello, J.
Okidi, J.
Økland, A.
Okland, C.
Osborn, T.J.
Oskam, A.
Ostrom, E.
Otero, M.
Paniagua, S.
Papadopoulos, F.
Parikh, A.
Patrick, H.
Pattanaik, P.

Pearce, D.
Pearson, K.
Pérez-Ezcurdia, A.
Peterman, A.R.
Peters, H.E.
Pirttilä, M.
Pizzolitto, G.
Poggi, A.
Polad, M.
Pollak, R.A.
Porter, M.
Pradyot, R.J.
Preston, S.H.
Propper, C.
Puerta, M.L.S.
Punamäki, L.
Qasim, M.
Quisumbing, A.R.
Rabechini Jr, R.
Rabinovic, L.
Raghbendra, J.
Ramakrishnan, U.
Ramírez-Pasillas, M.
Rashidghalam, M.
Ravallion, M.
Ravestijn, W.
Reardon, T.
Reed, R.A.
Reinhard, S.
Repkova, K.
Richard, L.K.
Richardson, D.
Ridge, T.
Riverson, J.
Roberts, P.
Roelen, K.
Ross, K.L.
Rutaganda, J.M.V.
Sachs, J.
Sano, J.
Santos Pais, M.
Sarriera, J.C.
Sarumathi, S.
Sousa-Poza, A.
Schechter, L.

Schiller, U.
Schipper, R.
Schmidt, P.
Schreiner, M.
Schultz, T.W.
Scuttella, R.
Sen, A.
Senadza, B.
Senik, C.
Shah, K.
Shanoyan, A.
Sharma, P.
Sherlund, S.M.
Shiferaw, F.
Shimeles, A.
Shorrocks, A.F.
Sickles, R.C.
Sicular, T.
Silber, J.
Silver, H.
Silvius, A.J.G.
Simanowitz, A.
Simar, L.
Singh, R.P.
Sisay, A.
Sisay, B.
Sloper, T.
Smith, L.C.
Smith, M.B.
Sobolewski, J.M.
Söderholm, A.
Sperber, E.
Sraboni, E.
Sricharoen, T.
Ssewanyana, S.N.
Stake, R.
Stamoulis, K.
Stevens, K.
Stiglitz, J.E.
Stouffer, S.A.
Strelhow, M.R.
Strobl, E.
Subbarao, K.
Sujatha, G.
Sumarto, S.

Suryahadi, A.
Tadele, F.
Tadesse, F.
Tafara, A.C.
Tan, P.H.
Tarozzi, A.
Tarp, F.
Tashrifov, Y.
Tausch, A.
Taylor, E.
Taylor, B.
Taylor, J.E.
Taylor, M.P.
Tefera, M.
Teferra, S.
Tegegne, G.
Tesfaye, B.
Tesfaye, L.
Tesliuc, E.
The World Bank
Thijssen, G.A.
Thorbecke, E.
Tjadens, F.
Tombofa, S.
Triantafillou, J.
Truyts, T.
Tsakloglou, P.
Tu Dang, R.
Tuffino, S.P.
Tyrrel, S.F.
Ucal, M.Ş.
UNFCCC
UNICEF
UNIFEM (United Nations Development Fund for Women)
United Nations
Uwase, E.
Vaaltein, S.
Van den Berg, B.
van Marrewijk, M.
Venkatachalam, L.
Verashchagina, A.
Verdire Chouchane, A.
Verwimp, P.
Vihiteford, P.
Vijayakumar, N.

Vittadini, G.
Vrooman, J.C.
Waldvogel, J.
Walker, D.
Walker, W.M.
Wan, G.
Wang, H.J.
Wang, X.
Washbrook, E.
Weatherly, H.
Webb, P.
Welter, F.
Werre, M.
Whelan, C.T.
White, H.
Wilkins, R.
Williams Jr, R.M.
Wilson, P.
Wintersberger, H.
Wodon, Q.T.
Wolday, A.
Woldehanna, T.
Woolard, I.
Wooldridge, J.M.
World Bank Institute (WBI)
World Health Organization (WHO)
Xiao, S.
Xu, L.
Xu, T.
Xu, Y.
Yenenesh, T.
Yimer, F.
Yin, R.K.
Yishak, G.
Yoong, J.
Young, T.
Zereyesus, Y.A.
Zerihun, B.W.
Zezza, A.
Zhang, S.
Zhang, Y.
Zhu, N.
Ziaei, S.

# List of Topics

# Contents

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# Abbreviations

| | |
|---|---|
| AfDB | African Development Bank |
| ATEMP | Annual Maximum Temperature |
| BoFED | Bureau of Finance and Economic Development |
| BoWCYA | Bureau of Women, Children and Youth Affairs |
| CIA | Central Intelligence Agency |
| CO2 | Carbon Dioxide |
| CPI | Consumer Price Index |
| CRC | Rights of the Child |
| CSA | Central Statistical Agency |
| CSG | Child Support Grant |
| DGP | Data Generating Process |
| DHS | Demographic and Health Survey |
| DMU | Decision Making Unit |
| DTR | Diurnal Temperature Range |
| EA | Enumeration Areas |
| EDHS | Ethiopian Demographic and Health Survey |
| EDPRS | Economic Development and Poverty Reduction Strategy |
| ERHS | Ethiopian Rural Household Survey |
| ETB | Ethiopian Birr |
| FA | Factor Analysis |
| FAO | Food and Agricultural Organization |
| FDI | Foreign Direct Investment |
| FGLS | Feasible Generalized Least Squares |
| FGT | Foster, Greer and Thorbecke |
| GDP | Gross Domestic Product |
| HAZ | height-for-age |
| HBS | Household Budget Surveys |
| HCES | Household Consumption and Expenditure Surveys |
| HDI | Human Development Index |
| HDR | Human Development Report |

| | |
|---|---|
| HIV/AIDS | Human Immunodeficiency Virus/Acquired Immunodeficiency syndrome |
| ICTSD | International Center for Trade and Sustainable Development |
| IES | Income and Expenditure Surveys |
| IFPRI | International Food Policy Research Institute |
| IPV | Intimate Partner Violence |
| IV | Instrumental Variables |
| JIBS | Jönköping International Business School |
| MDG | Millennium Development Goals |
| MDU | Man-Day Units |
| MFI | Microfinance Institution |
| MLE | Maximum Likelihood Estimation |
| MMT | Monthly Mean Temperature |
| MOFED | Ministry of Finance and Economic Development |
| MPI | Multidimensional Poverty Index |
| NBS | Tanzania National Bureau of Statistics |
| NISR | National Institute of Statistics of Rwanda |
| OECD | Organisation for Economic Co-operation and Development |
| OLS | Ordinary Least Squares |
| ORECIP | Annual Mean Precipitation |
| OTE | Overall Technical Efficiency |
| PCA | Principal Component Analysis |
| PTE | Persistent Technical Efficiency |
| REMA | Rwanda Environmental Management Agency |
| RTE | Residual (transient) Technical Efficiency |
| RURA | Rwanda Regulatory and Utility Agency |
| SFA | Stochastic Frontier Analysis |
| SIDA | Swedish International Development Aid Agency |
| SNNPR | Southern Nations, Nationalities and People's Region |
| SSA | sub-Saharan Africa |
| TLU | Tropical Livestock Units |
| TTE | Transient Technical Efficiency |
| TZNPS | Tanzania National Panel Survey |
| UNCDF | United Nations Capital Development Fund |
| UNDP | United Nations Development Program |
| UNFCCC | United Nations Framework Convention on Climate Change |
| UNICEF | United Nations International Children's Emergency Fund |
| UNIFEM | United Nations Development Fund for Women |
| US | United States |
| VEP | Vulnerability as Expected Poverty |
| VER | Vulnerability as uninsured Exposure to Risk |
| VEU | Vulnerability as low Expected Utility |
| WASAC | Water supply and sanitation in Rwanda |
| WAZ | weight-for-age |
| WB | World Bank |

| | |
|---|---|
| WBI | Wellbeing Index |
| WDI | World Bank's Development Indicators |
| WHO | World Health Organization |
| WHZ | weight-for-height |

# List of Figures

# List of Tables

# Chapter 1
# Introduction and Summary

**Pia Nilsson and Almas Heshmati**

## 1 Background

This volume is a collection of studies on poverty and well-being, vulnerability to poverty, women's empowerment and smallholders' efficiency in selected African countries. It has a collection of 12 empirical studies that have an overall focus on poverty, well-being and vulnerability to poverty and includes contributions by 19 authors. The studies aim at increasing our knowledge about the factors that influence poverty and well-being. This is important as it can help alleviate many of the persistent challenges observed across Africa.

The focus areas of this volume have gained much attention in literature and several recent studies have addressed a wide array of topics related to poverty and well-being (Heshmati 2018a, 2018b; Howe and McKay 2007; Lustig and Silber 2016), multidimensional poverty (Ambel et al. 2015; Deutsch and Silber 2005; Levine et al. 2014; Stoeffler et al. 2016) and the determinants of income and efficiency among smallholder farmers (Ansoms and McKay 2010; Dawson et al. 2016; Hirons et al. 2018; Nilsson 2018).

The studies highlight multidimensional measures of well-being, vulnerability to poverty and social exclusion. Concepts such as social exclusion and poverty are determined by a range of economic, social, political and cultural factors (Samuel et al. 2018) which have implications for the methods used for measuring poverty (Alkire and Santos 2014; Alkire et al. 2017). The studies in this volume also highlight the need of addressing poverty distribution and vulnerability to poverty across geographies and segments of the population as there are assertions that there are regional disparities in people's well-being.

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Other key topics that the studies in this volume address are linked to women's empowerment and children's well-being in the context of sub-Saharan Africa. These perspectives have received increasing attention in literature and several studies highlight a need for further studies on this topic (Duflo 2012; Ganle et al. 2015). Women's empowerment is also implicitly related to children's health as women's ability to take decisions also impacts on their children's health and care giving. The living conditions of many children around the world do not meet basic human rights because of poor income status, political instability and factors related to wars, gender, religion and ethnicity. A large number of children today are food insecure and lack access to basic care and opportunities. Several chapters in this volume address women's empowerment and children's health thus adding to current literature. They arrive at conclusions that can be used for informing public policies aimed at women's empowerment and children's health.

One of the most important challenges facing smallholders in Africa, particularly those in rural areas, is how to achieve food security in the context of on-going climate change. Such challenges call for an increase in crop production, altered cropping practices and improved capacity to cope with risks related to rapidly changing external conditions (Rosegrant and Cline 2003). This is particularly relevant in countries such as Ethiopia and Rwanda, where as much as 70–80 percent of the population lives in rural areas, has agriculture as its primary source of income and cultivates landholdings smaller than one hectare. Among the challenges facing Ethiopia and Rwanda is the need for efficient policies that can respond to climate change and be both socially and environmentally sustainable (Dercon and Krishnan 2000; Dethier and Effenberger 2012; Diao et al. 2010; Heshmati 2018c; Nilsson et al. 2019). Improving our understanding of the factors that lead to pro-poor agricultural growth is one of the most difficult challenges and there is need for further studies that can arrive at conclusions that can guide policymaking in this (Dorward et al. 2004).

The first two parts of this manuscript consists of studies that aim at increasing our knowledge about the factors that influence multidimensional poverty and well-being and vulnerability to poverty and social exclusion. The studies in the third part of this volume focus on sustainability and the role of climate variabilities in influencing poverty and food security among farm households in Ethiopia, Rwanda and Uganda. These studies contribute to existing knowledge on the role that climate variabilities play in food security, poverty and sustainability in water projects' management.

The studies included in this volume look at a number of factors that influence poverty and well-being and they can be largely grouped into three research areas: measuring and analyzing well-being and vulnerability to poverty; women's empowerment; children's health, care giving, and access to microfinance and the dynamics and determinants of income and efficiency among smallholders. The book as a whole argues that we need to account for different dimensions of poverty and well-being in its measurement and classification and also for identifying its determinants and underlying mechanisms. The studies in this volume provide readers a comprehensive picture of the state of poverty and well-being, its measurement and causal factors. The studies' conclusions can guide efficient policymaking and practices in the selected countries.

The studies cover selected parts of the African continent and focus on countries (Ethiopia, Ghana, Tanzania, Uganda and Rwanda) that are on the path of rapid economic and social development.

## 2 Introduction to and Summary of the Studies

This volume is a collection of 12 selected empirical studies that have an overall focus on poverty, well-being and vulnerability to poverty. The volume includes contributions from 19 authors which can be grouped into the following three parts: (i) studies on measuring and analyzing well-being and vulnerability to poverty, (ii) studies on women's empowerment, children's health, care giving, access to microfinance and (iii) studies with a focus on sustainability, income and food security among rural smallholders.

The aim of the studies included in the first part is increasing our understanding of the factors that influence poverty, well-being and vulnerability to poverty with a focus on households in Ethiopia, Tanzania and Rwanda. One focus area of these studies is spatial and temporal heterogeneity and understanding assertions of regional disparities in conditions for children's well-being. These studies take multidimensional approaches in measuring well-being, social exclusion and poverty and focus on countries that are on a path of rapid economic and social development.

The studies included in the second part focus on the factors that can empower women which implicitly have important implications for children's well-being and health, as well as care giving. They also address women's access to microfinance in Ethiopia building on the assertion that access to microfinance is an indicator of financial inclusion.

The studies in the third part focus on sustainability and the role of climate variabilities in influencing poverty and food security among farm households in Ethiopia, Rwanda and Uganda. These studies contribute to existing knowledge on climate variability's role in providing food security and reducing poverty in Ethiopia and sustainability in water project management in Rwanda.

In summary, the volume focuses on several central issues in development studies. The contents and contributions of the individual chapters are now summarized.

### *2.1 Part I: Measurement and Analysis of Well-Being and Vulnerability to Poverty*

This part has four studies on measuring and analyzing well-being, social exclusion and vulnerability to poverty. The first study (Chap. 2) *Measurement and Analysis of Poverty in Rwanda* by Almas Heshmati and Masoomeh Rashidghalam addresses regional disparities in poverty levels across Rwanda. The authors consider four categories of determinants of household poverty and compile a comprehensive household-level dataset that includes per capita income and consumption for a large set of households across Rwanda observed in three waves. Its findings indicate significant heterogeneity in poverty levels and the gap and incidence of poverty across districts and provinces. It shows that location in particular plays an important role as the probability of a household being poor increases in rural and semi-urban areas. The study also finds that households with older heads and female heads are more likely to be poor and that asset ownership and education are some of the factors that significantly decrease the probability of a household being poor. Based on these findings, the authors emphasize the importance of investing in physical infrastructure, job creation for female-headed households and improved educational levels for poverty reduction in Rwanda.

The second study in this part (Chap. 3) *Measurement and Analysis of Multidimensional Well-Being in Rwanda* by Almas Heshmati, Masoomeh Rashidghalam and Pia Nilsson investigates multidimensional well-being but with a focus on children. This study addresses an important issue as Rwanda's current development agenda gives high priority to children's well-being. By computing both overall and decomposed well-being indices and by controlling for a broad set of household and community characteristics this study contributes to our understanding of the factors that can alleviate poverty among children and their families in Rwanda. The results show significant heterogeneity in the factors that determine children's well-being across space as certain districts have relatively better conditions as compared to the others. The results of this study can be used to inform public policies aimed at improving children's well-being in the country.

The third study in this part (Chap. 4) *Vulnerability to Poverty in Ethiopia* by Getu Tigre focuses on vulnerability to poverty in the context of Ethiopia and highlights the importance of considering multidimensional measures of vulnerability to poverty over one-dimensional measures in its analysis. The study uses a set of household cross-sectional surveys and shows that the estimated levels of poverty varied substantially depending on the method used for measuring it. Specifically, the study shows that 38 percent of the population in Ethiopia is vulnerable to poverty using a unidimensional measure, whereas the corresponding level is 89 percent using a multidimensional measure. The study also finds that households who have been poor at any given point of time may differ from those who are vulnerable to poverty. Based on these findings the author emphasizes that interventions and programs that are targeted at reducing vulnerability need to be different compared to those aimed at poverty alleviation.

The last study in this part (Chap. 5) *Persistence of Social Exclusion in Tanzania* by Amedeus Malisa focuses on the reasons and persistence of social exclusion in the context of Tanzania. One key argument of this study is that the concept of social exclusion should be analyzed multidimensionally as it can be associated with a range of economic, social, political and cultural factors. The study examines the reasons why an individual experiences social exclusion persistently by considering two underlying processes. The first is linked to heterogeneity at the individual level and the second to state dependency. Using data from the Tanzania National Panel Survey (TZNPS), this study provides new evidence on the state of social exclusion and its causes in Tanzania.

## *2.2 Part II: Women Empowerment, Children's Health, Caregiving and Access to Microfinance*

The first study in this part (Chap. 6) *Women's Empowerment and Children's Health: The Case of Ghana* by Meital Izraelov and Jacques Silber addresses women's empowerment in Ghana. The study takes a multidimensional approach in measuring women's empowerment and distinguishes several domains including their abilities to take decisions, women's attitudes towards the use of violence by husbands and the resources and information available to them. Given the importance of different domains, it uses an aggregation method borrowed from literature on the fuzzy approach for measuring multidimensional poverty to derive an overall indicator. The study emphasizes that children's health is a latent variable and women's abilities to take decisions has a significant positive impact on the health of their children. The study finds that children's health is generally better if the mother's body mass index, age and educational level are better. Children's health is also shown to be better if their mother is married.

The second study in this part (Chap. 7) *Women's Access to Microfinance Services in Southern Ethiopia: Assessing the Promises, Impacts, Challenges and Gaps* by Mitiku Kebede and Nigatu Regassa examines the participation of women in microfinance institutions (MFIs) in Ethiopia. The data is collected from over 11,000 households in 43 districts and from focus group discussions and key informant interviews with village elders and microfinance institutions' staff members. Its findings indicate women's low participation in MFIs (17 percent). Among the participants, 75 percent used borrowed money for income generating activities. The results of a logistic regression indicate that education, age, religion, size of landholding, job status, family size, type of crops grown and the use of informal credit sources were the main determinants of women's participation in MFIs. The study also found that some of the main challenges to MFI participation were high loan requirements and gender gaps in the distribution of loans, insufficient provision of entrepreneurial training for skill development and financial outlays and frequent dropouts.

The third study of this part (Chap. 8) *The Economic Cost of Informal Caregiving to In-patients: The Case of Jimma University Referral Hospital in Jimma, Ethiopia* by Habtamu Legese analyses the economic cost of providing informal healthcare with special emphasis on the labor market-related opportunity costs of informal caregiving to in-patients at the Jimma University Referral Hospital. The study uses primary data collected from 238 principal informal caregivers. It conducts an empirical regression analysis. The estimation results show that paid job experience, educational levels and employment status are positively related to the cost of informal care through the wage difference. Unexpectedly, the number of external caregivers positively relate to the informal caregiving. On the other hand, the age of informal care recipients and the interaction term (female informal caregivers from urban areas) is also negatively related to the value of informal care. Based on its findings this study recommends the government's intervention and that of other concerned bodies in generating awareness about policies, providing financial support and work accommodation and improving accessibility and facilities in the hospital.

### *2.3 Part III: Dynamics and Determinants of Income and Efficiency Among Smallholders*

This part has five studies that focus on different aspects of sustainability, poverty and food security among smallholders. The first study (Chap. 9) *Poverty and Food Security Effects of Climate Variability on Smallholders: The Case of Western Hararghe Zone, Ethiopia* by Arega Shumetie and Molla Alemayehu focuses on climate change and its impact on smallholders. The study examines the effect of climate variability on poverty and food security among rural households in three districts in Ethiopia. The study uses cross-sectional data collected from sample households in the study area (Western Hararghe Zone) with an emphasis on crop production's sensitivity to climate variability. Its findings indicate a negative association between family size and food security and the absolute poverty status of households in the study area. The study also finds a positive association between frequent moisture stress on crop production and land fragmentation and land fertility, indicating that moisture stress may be detrimental to food security.

The second study in this part (Chap. 10) *Analysis of Factors Affecting Persistent and Transient Inefficiency of Ethiopia's Smallholder Cereal Farming* by Oumer Berisso focuses on persistent and transient inefficiency effects among smallholder cereal farmers in Ethiopia. The study uses household-level panel data for the period 1999–2015 and a four component stochastic frontier model to estimate the determinants of inefficiency. Its findings show that transient efficiency is positively associated with household size and the number of plots, and negatively associated with age and temperature variations. Another key conclusion is that omission of weather factors from the estimated model affects not only the model's precision but also results in biased inefficiency scores and estimates of the determinants. Its findings can be used for initiating policy options when planning climate change adaptation strategies and agricultural policies in Ethiopia.

The third study in this part (Chap. 11) *Diversification Into Non-Farm Activities in Ethiopia: Determinants and Income Distribution Effects. Application of a*

*Two-Part and Regression Based Inequality Decomposition* by Gutu Gutema focuses on the determinants of income diversification towards non-farm activities in Ethiopia. The study uses data from the Ethiopian rural household survey (2009) and a breakdown of income inequality using Gini and regression-based inequality decompositions. Its findings show the following relative contribution of each source of income to overall income inequality: farm income 0.44, non-farm income 0.05 and off-farm income 0.03. It also shows that non-farm wage employment accounts for the largest share of non-farm income and is also the largest contributor to overall income inequality. An analysis of the determinants of diversification shows that female-headed households are more likely to participate in rural non-farm activities and gather higher incomes from non-farm activities as compared to male-headed households.

The fourth study in this part (Chap. 12) *Determinants of Income Mobility in Uganda* by Susan Namirembe-Kavuma and Edward Bbaale investigates the rate and determinants of income mobility in Uganda. The study uses three waves of household panel survey data (2009, 2010 and 2011) and the Markov transition matrices and Probit techniques. Its findings indicate a higher rate of income mobility (60 percent) at the bottom of the income distribution as compared to the top (43 percent). The study also shows that the size of the capital stock, human or physical, has the most economically significant impact on income mobility. Specifically, having a university degree increases the probability of moving up the income distribution level by 36 percent. The finding of the analysis is that the gender of the household head, the main source of income and geographical location of the household increase the probability of moving up the income distribution level. Based on these results the authors emphasize the importance of investing in education, especially at higher levels, along with efforts aimed at strengthening women's empowerment.

The last study (Chap. 13) *Contextualizing Sustainability in Water Project Management: The Case of Bugesera District, Rwanda* by Marcela Ramirez Pasillas, Emilienne Uwase and Hans Lundberg focuses on sustainability in water project management in one district in Rwanda. The study uses a contextual approach and the data used for the analysis is collected through interviews and field visits to three water project sites in the district. Its findings show that water project management is influenced by several factors including social, cultural, environmental and economic sustainability and that the management is directed by existing policies and regulations. Specifically, it shows that cultural sustainability is important for capturing contextual practices in the delivery process including Umuganda meetings and committees. Such contextual practices allow the inclusion of the local community by identifying their water needs, defining their benefits and conveying project ownership to the local community. Based on these findings the study proposes a model that offers a contextual approach to sustainability in water project management which can be useful in identifying new contextual phenomena and for advancing theory.

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# Part I
# Measurement and Analysis of Well-Being and Vulnerability to Poverty

# Chapter 2
# Measurement and Analysis of Poverty in Rwanda

**Almas Heshmati and Masoomeh Rashidghalam**

## 1 Introduction

Poverty is a global concern. Like inequality, the burden of poverty is unfairly spread among the regions of the developing world. In Africa, poverty is severe, and various reports have indicated that poverty increased significantly during the 1980s and 1990s and led to the “Africanization of global poverty”(White and Kellick 2001).

Most countries in sub-Saharan Africa (SSA) with very low saving rates and per capita gross domestic product (GDP) are in urgent need of substantial public investments through external assistance to reverse the current increasing poverty trends. A report published by the Economic and Social Research and Training Center for Islamic Countries (2007) points out that on average, sub-Saharan Africa’s 726 million (45 percent) people lived under the international poverty line (US $1 a day). The highest level of interregional poverty is in SSA, where close to 50 percent of the population is classified as poor. After SSA, the next poorest region is South Asia in terms of poverty headcount indices (about 30 percent of the region’s population in 2000).

The facts are worse in Rwanda. The country is one of the poorest in the world. According to the data retrieved from the World Bank’s Development Indicators (WDI), Rwanda is one of the poorest countries in Africa. Rwanda is a landlocked, resource-poor country that is ranked 15 out of the 25 poorest countries in Africa with a GDP per capita of US$ 689 in 2016. It was also ranked 167 out of 182

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countries in the 2009 United Nations Development Program's (UNDP) Human Development Index (HDI) (Rashidghalam 2017).

The most recent survey data available for estimating the multidimensional index (MDI) for Rwanda indicated that 69 percent of its population lived in multidimensional poverty and about 19.4 percent were vulnerable to multiple deprivations. On the other hand, the intensity of deprivation was 50.8 percent. The country's multidimensional poverty index (MPI) value, which is the share of the population that is multidimensionally poor adjusted by the intensity of the deprivations, was 0.35 (HDR 2013). Therefore, as in many other developing countries, even in Rwanda, there is an urgent need to address the issue of poverty and to incorporate poverty reduction policies into development strategies. However, the most important question is: How is the government going to achieve this goal?

This question cannot be adequately addressed unless we have information on the level of relative and absolute poverty and characteristics of the poor and how these characteristics determine poverty in the country. With this background, studying these issues in terms of finding the causes and analyzing the ways of alleviating them is very important. This can be done at a microlevel on some groups of society or by concentrating on a particular area, or it can be studied at the macro level. The aim of our paper is: (i) to measure the level of relative and absolute poverty in Rwanda and to analyze the poverty gap and poverty severity in the country, (ii) to compare provinces and districts with regard to different poverty indices, (iii) to single out the major determinants of poverty on households, and (iv) to suggest suitable policy measures to alleviate poverty in the country.

The issue of poverty has been an important target of researchers in development literature, and various studies point out the level of poverty and its determinants. Assefa (2003) found that female headship did not have a significant direct impact on poverty levels of households in urban Ethiopia. On the other hand, household size, educational attainment of the head, and the settlement location of the household were key determinants of poverty in this region.

Fistum (2002) compares poverty indices between female- and male-headed households in Addis Ababa. He identifies the determinates of welfare and poverty in households. The results of his study indicate that female headship had a positive influence on the welfare of the households. He concludes that educational attainment of the household head and the number of children in the household are important determinants of poverty. Joo (2011) examined the changes in anti-inequality and antipoverty effects of children's programs between 1995 and 2007 and suggests that although the poverty reduction effects of the federal child programs increased during this period, the programs' effects on reduction of children's relative and absolute poverty gaps decreased. Also, the antipoverty effects of the federal child programs were weak for children in immigrant, female-headed, and nonworking families.

Asadullah and Chaudhury (2012) studied subjective well-being and relative poverty in rural Bangladesh. They show that households reported higher satisfaction levels when they experienced an increase in their incomes over the past years. Also, households which had incomes lower than their neighbors in the village showed less satisfaction with life. Similarly, individuals reported less satisfaction with life in villages with higher levels of inequality. According to their results, when compared to the effects of absolute income, relative income and local inequality are modest. Vaaltein and Schiller (2014) addressed multidimensional child poverty in the Eastern Cape of South Africa. They suggest that monetary support through the child support grant (CSG) should be increased to better accommodate the multidimensional child poverty needs of CSG recipients.

Rashidghalam (2017) studied poverty and its determinants in different provinces and districts of Rwanda in 2012. She concluded that a household's residence in the rural area and distance to market increased the probability of its being poor. She also found that female-headed households were poorer than male-headed ones. Her results show that literate household heads and ownership of property and assets reduced the probability of falling into poverty. Ucal (2014), Menon et al. (2015), Dzanku et al. (2015), and Grobler (2016) have also analyzed this important issue. Therefore, our study could be relevant to better emphasize and address the issue of poverty. It could contribute in filling the gaps in literature that have been left untouched by previous studies. Hence, unlike previous studies, our study's scope has been extended to different areas and provinces in Rwanda, and the models that we employ look into the determinants of different aspects of poverty.

## 2 Methodology

A poverty analysis involves a number of steps. The first step and starting point is establishing the poverty line, which is a tool to separate the poor from the nonpoor. Absolute versus relative poverty lines can be set in relative or absolute terms. A relative poverty line is related to the general standard of living in a society (explained by median or mean income or consumption). The relative poverty line is not fixed over time; therefore, it changes as the standard of living of society decreases or increases (e.g., change in the distribution of income will reduce the number of people in relative poverty). On the other hand, absolute poverty refers to the position of a family or an individual in relation to a fixed poverty line (Ravallion 1992). The absolute poverty line is fixed over time and in different locations. Adjustments for inflation can be used to change the level of absolute poverty over time. An absolute poverty line has elasticity of zero with respect to changes in society's living standards. Economic growth of a society results in a reduction in the number of people in absolute poverty. A distinction between relative and absolute poverty lines is important in legislation and in poverty reduction policies. Relative poverty lines are mostly applicable in developed countries, while absolute poverty lines are commonly used in developing countries (Assefa 2003).

The second step in a poverty analysis is constructing poverty measures based on poverty lines including the headcount index, the poverty gap index, and poverty severity. In the literature, absolute and relative poverty lines are treated as constant across provinces, districts, household characteristics, and over time. This is a very strong assumption as in reality prices and living costs develop differently across these dimensions.

## 2.1 Headcount Index

The headcount index ($P_H$) measures the proportion of the population with incomes less than the poverty line, regardless of its absolute or relative measurement; these people are considered as poor. $P_H$ is denoted by:

$$P_H = N_P / N \tag{2.1}$$

where N is the total population and $N_P$ is the number of poor. Eq. 2.1 can be rewritten as:

$$P_H = 1/N\sum_{i=1}^{N} I\left(C_i < z\right) \tag{2.2}$$

where (z) is the poverty line and ($C_i$) is income or consumption expenditure. If the bracketed expression is true, the index I(.) takes the value of one and zero otherwise. If expenditure is less than the poverty line, then I(.) equals 1, and the household is counted as poor. Headcount index has three weaknesses: (i) it does not take the intensity of poverty into account; (ii) it does not indicate how poor the poor persons are and hence does not change if people below the poverty line become poorer; and (iii) poverty estimates should be calculated for individuals and not households. On the other hand, the advantage of the headcount index is that as a frequency measure, it is simple to construct and easy to understand.

## 2.2 Poverty Gap Index

The other index which is used for measuring poverty is the poverty gap index ($P_G$). This index measures the extent to which households on average fall under the poverty line. This index does not indicate the inequality changes among the poor. Poverty gap ($G_i$) is defined as:

$$G_i = \left(z - y_i\right) I\left(C_i < z\right). \tag{2.3}$$

For the poor, poverty gap equals poverty line less actual income or consumption, and for the nonpoor above the poverty line, it is considered to be zero. The sum of these aggregate gaps is used for measuring the cost of eliminating poverty in a society. Using the index function, the poverty gap index ($P_G$) is written as:

$$P_G = 1/N\sum_{i=1}^{N} G_i / Z. \tag{2.4}$$

## 2.3 Poverty Severity Index

Headcount and poverty gap indices do not take into account the inequalities among the poor. Hence, some researchers have used the squared poverty gap index to measure the severity of poverty. Poverty severity ($P_s$) is a weighted sum of poverty gaps. This takes into account not only the distance separating the poor from the poverty line (measuring the poverty gap) but also the inequalities among the poor. That is, a higher weight is placed on those households which are further away from the poverty line (see Rashidghalam 2017). The index is written as:

$$P_G = 1/N\sum_{i=1}^{N} \left(G_i / z\right)^2. \tag{2.5}$$

This measure may be thought of as one of a family of measures proposed by Foster, Greer, and Thorbecke (1984), which may be written, quite generally, as:

$$P_\alpha = 1/N\sum_{i=1}^{N} \left(G_i / z\right)^\alpha, \quad (\alpha \geq 0) \tag{2.6}$$

where α is a parameter; when α is larger, the index puts more weight on the position of the poorest (WBI 2005).

## 2.4 Determinants of Poverty

Measuring the incidence of poverty, its intensity and severity are important in themselves. However, poverty's causal factors are equally important as a means of its alleviation. An econometric analysis is useful in identifying the factors that influence the extent of poverty. We used the Probit and Tobit models and standard regression analysis for this.

A. *Probit Model of Incidence of Poverty*

A Probit model is used to measure the incidence of poverty. In other words, it is adopted to model factors that determine the probability of a household being poor or nonpoor. Therefore, the dependent variable is binary, indicating whether a household is poor (1) or not poor (0) relative to the poverty line. The binary Probit model is expressed as:

$$Y_i^* = X_{ij}' \beta_j + \varepsilon_i, \quad (\mathrm{i} = 1,2,\ldots,\mathrm{n}) \tag{2.7}$$

where $Y^*$ is the underlying response variable in which Yi equals one if the household is poor and zero otherwise. $X$ is a vector of household characteristics serving as explanatory variables determining the households' state of poverty, $\beta$ is a vector of unknown parameters to be estimated, and $\varepsilon_i$ is the residual.

B. *Tobit Models of Poverty Gap and Poverty Severity*

We used a generalized Tobit model to analyze jointly the incidence of poverty and poverty gap and poverty severity. It allowed us to estimate the effects of the determinants of poverty gap and poverty severity. In a Tobit model, the dependent (response) variable is not a binary variable and has a limited range. In other words, the response variable of nonpoor is excluded. If the sample in this model is a subset of a whole population and only households which are below the poverty line are included, then the model is estimated using the ordinary least squares method accounting for sample selection by including the Mills ratio from the first-step Probit model. We analyzed household factors that influence poverty gap and poverty severity through a generalized Tobit regression analysis that accounts for sample selection. Negative coefficients in the model indicate that their variables inversely affected the poverty gap and poverty severity, and the coefficient of the variables with a positive sign had a direct positive effect on poverty gap and poverty severity (see Gebru 2010).

## 3 Data

We obtained the data for our research from three household surveys in Rwanda. Both incomes and consumption per capita are used in the analysis of poverty. The income-based data for the household surveys covered 14,810 household observations. There were 2711, 5351, and 6748 observations in 2006, 2009, and 2012, respectively. The consumption data-based poverty analysis is based on CFSVA 2012 household data with 7498 observations. The two datasets do not match. The dataset includes urban, semi-urban, and rural areas which in turn form the Southern, Western, Northern, and Eastern provinces. Each province is further divided into a number of districts. Nyanza, Gisagara, Nyaruguru, Ruhango, Muhanga, and Kamonyi districts are in the Southern province. The Western province includes Karongi, Rutsiro, Rubavu, Nyabihu, Ngororero, Rusizi, and Nyamasheke districts, and Rulindo, Gakenke, Musanze, Burera, and Gicumbi districts are in the Northern province. The Eastern province includes Rwamagana, Nyagatare, Gatsibo, Kayonza, Kirehe, and Ngoma districts.

Table 2.1a presents the summary statistics of the income-based variables used in our study, while Table 2.1b shows the consumption-based variables. This table can be divided into four broad parts. Income and livelihood variables are described in the first part (Part A). This part shows that about 6 and 26 percent of the households were producers of cash crops and had access to credit, respectively. The second part (Part B) describes the demographics and education variables. This part includes age

**Table 2.1a** Summary income statistics of the variables (N = 14,810)

| Variables | Definition | Mean | Std. Dev. | Minimum | Maximum |
|---|---|---|---|---|---|
| *A. Income and livelihood* | | | | | |
| Income | Total income from all income-generating primary activities | 39774.82 | 60940.27 | 0 | 2,544,000 |
| Income | Income | 12139.07 | 38102.69 | 0 | 2,544,000 |
| Mincome | Mean income | 12139.07 | 2902.24 | 7153.98 | 19,442 |
| Dincome | Median income | 4683.31 | 922.04 | 3547.20 | 6609.26 |
| Nrincome | Number of income-generating activities undertaken by household | 1.77 | 0.68 | 0 | 10 |
| Nrcrops | Total number of farmed crops | 3.37 | 1.73 | 0 | 10 |
| Cashcrop | Equals 1 if the household is a producer of cash crops | 0.06 | 0.24 | 0 | 1 |
| Credd | Access to credit (=1 if household have access to credit) | 0.26 | 0.44 | 0 | 1 |
| *B. Demographics and education* | | | | | |
| Agehead | Age of household head | 44.38 | 14.81 | 15.00 | 103 |
| Size | Number of people in the household | 5.26 | 2.15 | 1 | 18 |
| Mshead | Marital status of head, equals 1 if the head is married | 0.59 | 0.49 | 0 | 1 |
| Dfemale | Gender of head, equals 1 if the head is female | 0.23 | 0.42 | 0 | 1 |
| Popdens | Population density - number of inhabitants per square kilometer | 634.06 | 762.10 | 1.90 | 13,009 |
| Populg | Population growth | 3.16 | 3.37 | -5.67 | 25.02 |
| lithead | Household head can read and write a simple message | 0.83 | 0.78 | 0 | 9 |
| *C. Location* | | | | | |
| Rural | Equals 1 if the households live in a rural area | 0.87 | 0.33 | 0 | 1 |
| Semi-urb | Equals 1 if the households live in a semi-urban area | 0.08 | 0.27 | 0 | 1 |
| Distroad | Distance to road | 3760.76 | 3525.21 | 0 | 21924.65 |
| Distmark | Distance to market | 77.22 | 61.95 | 0 | 1200 |
| *D. Household assets and migration* | | | | | |
| Worksend | Working elsewhere and sending home remittances | 0.05 | 0.22 | 0 | 1 |
| Fland | Access to farmland (=1 if household has access to farmland) | 0.93 | 0.26 | 0 | 1 |
| Vegetd | Vegetable garden (=1 if household owns a vegetable garden) | 0.56 | 0.50 | 0 | 1 |
| Nranimal | Number of animals | 2.99 | 5.69 | 0 | 203 |
| bantrnr | Number of banana trees owned by the household | 22.06 | 112.86 | 0 | 3500 |

**Table 2.1b** Summary statistics of consumption data, Rwanda 2012, 7498 obs

| Variable | Mean | Std Dev | Minimum | Maximum |
|---|---|---|---|---|
| Head age | 46.997 | 15.598 | 15.000 | 103.000 |
| Head literacy | 0.607 | 0.488 | 0.000 | 1.000 |
| Marital status | 0.687 | 0.464 | 0.000 | 1.000 |
| Number of spouses or partners | 1.012 | 0.279 | 0.000 | 5.000 |
| Roof material | 2.443 | 0.544 | 0.000 | 6.000 |
| Floor material | 1.277 | 0.729 | 1.000 | 7.000 |
| Number of rooms | 2.506 | 1.028 | 1.000 | 11.000 |
| Toilet and types | 2.861 | 0.851 | 1.000 | 6.000 |
| Electricity improved source | 0.475 | 0.499 | 0.000 | 1.000 |
| Number of income activities | 1.642 | 0.635 | 0.000 | 4.000 |
| Farming land | 0.837 | 0.369 | 0.000 | 1.000 |
| Vegetables plot | 0.581 | 0.494 | 0.000 | 1.000 |
| Number of crops cultivated | 2.550 | 1.372 | 0.000 | 4.000 |
| Access to credit | 0.007 | 0.082 | 0.000 | 1.000 |
| Per capita income | 16716.093 | 43768.483 | 0.000 | 1350000.000 |
| Altitude | 1725.014 | 288.152 | 955.000 | 2739.000 |
| Distance to road | 3565.761 | 3639.801 | 0.000 | 21925.000 |
| Distance to school | 24.624 | 23.469 | 0.000 | 150.000 |
| Distance to market | 72.157 | 69.202 | 0.000 | 1200.000 |
| Household size | 4.967 | 2.184 | 1.000 | 18.000 |
| Sources of water | 3.997 | 2.311 | 1.000 | 8.000 |
| Payment for water | 0.304 | 0.477 | 0.000 | 6.000 |
| Head female | 0.287 | 0.453 | 0.000 | 1.000 |
| Food expenditure | 17636.109 | 24673.353 | 0.000 | 144062.000 |
| Items expenditure | 31731.004 | 65622.570 | 0.000 | 448617.000 |
| Total expenditure | 49808.171 | 86103.343 | 83.000 | 579133.000 |
| Urban | 0.120 | 0.325 | 0.000 | 1.000 |
| Rural | 0.797 | 0.402 | 0.000 | 1.000 |
| Semi-urban | 0.083 | 0.275 | 0.000 | 1.000 |
| Monthly food exp. per capita | 3843.529 | 5443.219 | 0.000 | 86800.000 |
| Monthly item exp. per capita | 6629.058 | 15373.576 | 0.000 | 418067.000 |
| Monthly total exp. per capita | 10503.976 | 19431.630 | 48.333 | 475133.000 |

of household head, household size, marital status of the head, gender of the head, literacy of the head, population density, and population growth; 59 percent of the household heads were married. Table 2.1a also shows that 23 percent of the households were women headed. Part C includes the location of the household. We included the location category to know the importance of the region of residence in the poverty status of a household. This part of the table also covers area, distance to a road, and distance to the market. In Rwanda, a majority of the households (about 87 percent) are in rural areas, and only 4 and 8 percent of them are located in urban and semi-urban areas, respectively. We included these characteristics to study the effect of household assets and migration on the poverty status of households. Part D of Table 2.1a includes five variables, including the — number of income generating activities, having access to a farmland, vegetable garden, number of animals, crops and banana trees. According to the survey, about 93 and 56 percent of the households had access to farmland and a vegetable garden, respectively.

## 4 Results and Analysis

An estimation of the poverty line facilitates the identification of the poor from the nonpoor. Different poverty measurements for Rwanda are presented in Table 2.2. According to this table, the per capita relative poverty line based on income equaled 2342, and based on this poverty line, the relative headcount index was about 29 percent. This value indicates that at least 29 percent of the households in Rwanda were unable to meet the minimum income levels. Poverty gap, which is the average distance of a household from the poverty line, was found to be 340. The poverty gap square shows that the severity of poverty was 532,078. Coming to absolute poverty, the share of individuals whose incomes were below the absolute poverty line was 89 percent, which is 60 percent greater than the proportion of people who were living under the relative poverty line. Based on the absolute measure of poverty, absolute poverty gap ($P_{G2}$) and poverty severity ($P_{S2}$) were 15,698 and 300,487,390, respectively (all the figures are in Rwandan francs measured in per capita household).

Consumption poverty analysis shows that when using relative poverty line based on 50 percent of median consumption, on the average, 26 percent are classified as poor. The share increases to 53 percent using the mean of consumption. This suggests a skewed distribution of consumption despite 1 percent extreme high consumptions were censored at the 99 percent. When using absolute poverty line of \$1.25 converted to Rwf and on a monthly basis, consumption poverty headcount is much higher 89 percent. This is despite the shameless poverty line of \$1.25 per household capita and day.

Table 2.3a compares the extent of poverty indices across different districts, provinces, and regions. Part A of this table includes different districts and gives the following information: First, Nyagatare district had the largest amount of mean per capita income (56,009), therefore the least value of absolute headcount poverty ratio (0.84) and the relative headcount poverty ratio (0.25). Second, the highest value of the relative headcount poverty ratio was in Kamonyi and Gakenke districts, while Nyaruguru had the highest absolute headcount poverty ratio. Therefore, these districts are considered the poorest districts in Rwanda.

Part B of Table 2.3a provides the same information for Rwanda's different provinces. Due to lack of information for Kigali, we exclude this province from our study. The Southern province had the lowest total income; it also had the lowest relative poverty line. On the other hand,the maximum relative headcount poverty ratio, poverty gap, and poverty severity were in this province.

The households were divided into three groups by region – urban, semi-urban, and rural. Based on Part C of Table 2.3, headcount poverty ratio in the semi-urban

**Table 2.2** Income- and consumption-based poverty measurements

| Variables | Definition | Mean | Std. Dev. | Minimum | Maximum |
|---|---|---|---|---|---|
| *Relative income poverty* | | | | | |
| $Z_1$ | Relative poverty line based on 50% of median | 2341.65 | 461.02 | 1773.60 | 3304.63 |
| $P_{H1}$ | Headcount poverty ratio by relative poverty line | 0.29 | 0.45 | 0 | 1.00 |
| $P_{G1}$ | Poverty gap by relative poverty line | 339.93 | 645.41 | 0 | 3304.63 |
| $P_{S1}$ | Poverty severity by relative poverty line | 532078.40 | 1,298,410 | 0 | 10920575.00 |
| *Absolute income poverty* | | | | | |
| $Z_2$ | Absolute poverty line based on $1.25 per day | 23,250 | 0 | 23250.00 | 23250.00 |
| $P_{H2}$ | Headcount poverty ratio by absolute poverty line | 0.89 | 0.31 | 0 | 1.00 |
| $P_{G2}$ | Poverty gap by relative absolute line | 15697.83 | 7353.17 | 0 | 23250.00 |
| $P_{S2}$ | Poverty severity by absolute poverty line | 300487390.10 | 177680136.60 | 0 | 540562500.00 |
| *Relative consumption poverty* | | | | | |
| $Z_1$ | Relative poverty line based on 50% of median | 2387.50 | 0 | 2387.50 | 2387.50 |
| $Z_{1x}$ | Relative poverty line based on 50% of mean | 5252.00 | 0 | 5252.00 | 5252.00 |
| $P_{H1}$ | Headcount poverty ratio by relative poverty line median | 0.26 | 0.44 | 0 | 1.00 |
| $P_{H1x}$ | Headcount poverty ratio by relative poverty line – mean | 0.53 | 0.50 | 0 | 1.00 |
| $P_{G1}$ | Poverty gap by relative poverty line | 275.14 | 553.98 | 0 | 2339.17 |
| $P_{S1}$ | Poverty severity by relative poverty line | 382563.92 | 94695.20 | 0 | 5471701.00 |
| *Absolute consumption poverty* | | | | | |
| $Z_2$ | Absolute poverty line based on $1.25 per day | 23250.00 | 0 | 23250.00 | 23250.00 |
| $P_{H2}$ | Headcount poverty ratio by absolute poverty line | 0.89 | 0.31 | 0 | 1.00 |
| $P_{G2}$ | Poverty gap by absolute poverty line | 15645.45 | 7168.67 | 0 | 23201.67 |
| $P_{S2}$ | Poverty severity by absolute poverty line | 296162997.71 | 170317427.30 | 0 | 538317336.11 |

Note: $1.25 x 620 Rwf x 30 = 23,250 Rwf

**Table 2.3a** Means of income-based poverty measure variables by district, province, and area

| | | Income | | Poverty line | | Head count | | Poverty gap | | Poverty severity | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | hhsize | Total income | Income per capita | Relative Pov line | Absolute Pov line | Head C relative | Head C absolute | Gap relative | Gap absolute | Gap2 relative | Gap2 absolute |
| *A. Means by district* | | | | | | | | | | | |
| Nyanza | 5 | 30,057 | 7747 | 1774 | 23,250 | 0.28 | 0.92 | 232 | 16,682 | 253,040 | 324,242,197 |
| Gisagara | 5 | 37,317 | 12,497 | 2700 | 23,250 | 0.27 | 0.91 | 376 | 15,218 | 659,070 | 284,355,789 |
| Nyaruguru | 6 | 25,344 | 7154 | 1831 | 23,250 | 0.29 | 0.96 | 273 | 17,878 | 337,344 | 352,779,215 |
| Huye | 5 | 43,693 | 12,662 | 2757 | 23,250 | 0.30 | 0.87 | 393 | 14,908 | 677,878 | 280,510,641 |
| Nyamagabe | 5 | 35,573 | 12,239 | 1875 | 23,250 | 0.29 | 0.91 | 330 | 16,890 | 454,074 | 333,206,966 |
| Ruhango | 5 | 40,873 | 12,511 | 2623 | 23,250 | 0.25 | 0.87 | 323 | 15,023 | 526,693 | 282,224,020 |
| Muhanga | 5 | 31,101 | 9952 | 1875 | 23,250 | 0.28 | 0.93 | 262 | 16,672 | 308,789 | 325,317,460 |
| Kamonyi | 5 | 33,495 | 9226 | 1800 | 23,250 | 0.33 | 0.91 | 306 | 16,463 | 354,452 | 325,280,245 |
| Karongi | 5 | 42,495 | 14,365 | 2724 | 23,250 | 0.28 | 0.88 | 360 | 15,186 | 601,274 | 283,345,227 |
| Rutsiro | 5 | 39,801 | 11,006 | 2248 | 23,250 | 0.31 | 0.90 | 329 | 15,763 | 481,543 | 302,672,124 |
| Rubavu | 6 | 49,709 | 11,508 | 2932 | 23,250 | 0.29 | 0.90 | 459 | 14,726 | 898,349 | 270,820,617 |
| Nyabihu | 5 | 42,085 | 10,566 | 2400 | 23,250 | 0.27 | 0.92 | 272 | 16,015 | 373,677 | 301,284,185 |
| Ngororero | 5 | 30,157 | 8815 | 1809 | 23,250 | 0.31 | 0.92 | 326 | 16,811 | 423,886 | 330,666,518 |
| Rusizi | 6 | 46,646 | 14,302 | 2400 | 23,250 | 0.26 | 0.89 | 286 | 15,581 | 423,564 | 295,815,926 |
| Nyamasheke | 6 | 38,308 | 10,401 | 2155 | 23,250 | 0.29 | 0.89 | 303 | 15,768 | 403,890 | 302,776,711 |
| Rulindo | 5 | 31,498 | 9466 | 1916 | 23,250 | 0.25 | 0.92 | 249 | 16,827 | 319,880 | 327,479,206 |
| Gakenke | 5 | 30,302 | 8668 | 1902 | 23,250 | 0.33 | 0.91 | 330 | 16,654 | 423,835 | 329,586,729 |
| Musanze | 5 | 49,056 | 15,527 | 3143 | 23,250 | 0.31 | 0.85 | 477 | 14,113 | 921,259 | 261,239,830 |
| Burera | 5 | 44,368 | 13,223 | 2315 | 23,250 | 0.32 | 0.87 | 392 | 15,175 | 609,749 | 292,862,616 |
| Gicumbi | 5 | 43,590 | 11,728 | 2582 | 23,250 | 0.30 | 0.88 | 397 | 15,240 | 653,969 | 289,396,758 |
| Rwamagana | 5 | 42,464 | 16,879 | 2032 | 23,250 | 0.31 | 0.89 | 323 | 15,900 | 431,847 | 309,269,200 |
| Nyagatare | 5 | 56,009 | 19,442 | 3305 | 23,250 | 0.27 | 0.84 | 431 | 13,741 | 951,568 | 250,470,972 |

(continued)

**Table 2.3a** (continued)

| | | Income | | Poverty line | | Head count | | Poverty gap | | Poverty severity | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | hhsize | Total income | Income per capita | Relative Pov line | Absolute Pov line | Head C relative | Head C absolute | Gap relative | Gap absolute | Gap2 relative | Gap2 absolute |
| Gatsibo | 5 | 35,175 | 11,344 | 1916 | 23,250 | 0.27 | 0.90 | 272 | 16,213 | 340,305 | 315,768,651 |
| Kayonza | 5 | 48,078 | 14,918 | 2884 | 23,250 | 0.30 | 0.86 | 398 | 14,461 | 715,518 | 269,874,841 |
| Kirehe | 5 | 46,331 | 14,893 | 2918 | 23,250 | 0.28 | 0.87 | 419 | 14,434 | 806,899 | 266,683,718 |
| Ngoma | 5 | 37,605 | 15,204 | 1938 | 23,250 | 0.31 | 0.88 | 348 | 15,922 | 482,526 | 312,721,988 |
| Bugesera | 5 | 35,404 | 9274 | 2000 | 23,250 | 0.27 | 0.93 | 267 | 16,492 | 365,690 | 317,130,149 |
| *B. Means by province* | | | | | | | | | | | |
| Southern | 5 | 34,716 | 10,550 | 2164 | 23,250 | 0.28 | 0.91 | 314 | 16,217 | 451,348 | 313,404,070 |
| Western | 5 | 41,417 | 11,675 | 2384 | 23,250 | 0.29 | 0.90 | 333 | 15,674 | 513,011 | 297,820,783 |
| Northern | 5 | 40,044 | 11,809 | 2395 | 23,250 | 0.30 | 0.89 | 373 | 15,556 | 596,903 | 298,974,171 |
| Eastern | 5 | 43,099 | 14,469 | 2444 | 23,250 | 0.28 | 0.88 | 351 | 15,289 | 589,391 | 291,016,712 |
| *C. Means by area* | | | | | | | | | | | |
| Urban | 5 | 54,853 | 17,354 | 2370 | 23,250 | 0.23 | 0.83 | 311 | 13,899 | 542,857 | 259,119,936 |
| Semi-urban | 5 | 40,937 | 14,600 | 2474 | 23,250 | 0.32 | 0.89 | 402 | 15,785 | 647,803 | 303,045,054 |
| Rural | 5 | 38,843 | 11,628 | 2328 | 23,250 | 0.29 | 0.90 | 336 | 15,788 | 520,869 | 302,517,432 |
| *D. Means by year* | | | | | | | | | | | |
| 2006 | 5 | 40,829 | 13,794 | 2416 | 23,250 | 0.30 | 0.87 | 375 | 15,358 | 635,436 | 2.9E+08 |
| 2009 | 6 | 40,111 | 8482 | 2326 | 23,250 | 0.23 | 0.93 | 273 | 15,654 | 431,687 | 2.9E+08 |
| 2012 | 5 | 39,084 | 14,375 | 2324 | 23,250 | 0.33 | 0.88 | 378 | 15,869 | 570,185 | 3.1E+08 |

areas was 32 percent, which is 9 percent more than urban areas (23 percent). The rural areas fell in between. On the other hand, the absolute poverty headcount ratio in rural Rwanda was the highest (0.90), indicating that 90 percent of Rwanda's households in the rural areas were in absolute poverty. Poverty gap and poverty severity were the highest in semi-urban areas.

According to Part D of Table 2.3a which compares different poverty indices in different years of the study, in 2012, almost one-third of the population of Rwanda was in relative poverty, and about 88 percent was in absolute poverty. At the all-Rwanda level, the relative poverty gap declined from 375 in 2006 to 273 in 2009 and then increased to 375 in 2012. Accordingly, poverty severity decreased from 635,436 in 2006 to 431,684 in 2009 and then increased to 570,185 in 2012. Again, all the figures are per capita and in Rwandan francs.

The measure of consumption-based poverty and their variations across districts, provinces, and urban-rural areas is presented in Table 2.3b. It shows, despite the use of relative poverty line, evidence of large variations in poverty rate, its gap and severity by location suggesting high degree of inequality related to fertility of land, development infrastructures, etc. The gaps are bigger when considering the application of unified absolute poverty line to the entire country. Figure 2.1a, b show the per capita consumption expenditure levels across districts, provinces, and areas in 2012.

A multivariate econometric analysis can be used for identifying the determinants of poverty. Hence, the second part of our results is adapted to identify the determinants of poverty incidence, poverty gap, and poverty severity in Rwanda. For this, we used the Probit and Tobit models. Before the estimation, we followed the dependent and explanatory exploration process. We provide a simple correlation coefficient matrix to test whether multicollinearity and the risk of confounded effects exist between variables. The results are presented in Table 2.4a. The correlation matrix in Table 2.4b shows that mean and median consumption per capita are low correlated (0.562). The incidence of poverty is highly correlated with poverty gap (0.830) and severity (0.523) in case of relative consumption poverty, and they are also highly correlated (0.749 and 0.597) when using absolute poverty line. Figure 2.2a, b show the incidence of poverty in consumption expenditures across districts, provinces, and areas in 2012. Different absolute and relative poverty lines are used. The gaps in consumption poverty using absolute and relative poverty lines are shown in Fig. 2.3a, b.

Gujarati (1995) has a rule of thumb that says that there is a serious multicollinearity problem if the correlation coefficient is 0.8 or above. In general, econometrics literature uses 0.5 as the threshold for the multicollinearity problem between explanatory variables. As Table 2.4a and 2.4b show, we did not find a problem since the correlation between the dependent and explanatory variables was less than 0.1. These results indicate that each variable in different models can capture a distinct feature of poverty.

We estimated six models. Models 1 and 2 are Probit models of the determinants of incidence of poverty using income data where poverty is defined based on relative and absolute poverty lines, respectively. Income is defined as total real monthly income per capita with equal weights for household members. The relative poverty

**Table 2.3b** Mean consumption variables by province, district, and urban areas, 2012 data, 7498 obs

| | Food exp | Item exp | Total exp | poor1 | poor1 x | poor2 | pgap1 | pgap2 | pgap1s | pgap2s |
|---|---|---|---|---|---|---|---|---|---|---|
| District | | | | | | | | | | |
| Casabo | 12,113 | 17,682 | 30,000 | 0.02 | 0.08 | 0.50 | 8 | 5401 | 6311 | 77,277,230 |
| Kickiro | 9540 | 15,020 | 24,844 | 0.08 | 0.22 | 0.66 | 83 | 9285 | 109,560 | 155,891,668 |
| Nyarugenge | 14,710 | 24,519 | 39,818 | 0.03 | 0.06 | 0.45 | 16 | 4804 | 23,785 | 67,644,446 |
| Nyanza | 2009 | 2824 | 4634 | 0.57 | 0.81 | 0.98 | 724 | 19,584 | 1,146,405 | 404,832,445 |
| Gisagara | 2369 | 3161 | 5367 | 0.30 | 0.69 | 0.98 | 258 | 18,240 | 306,000 | 354,910,967 |
| Nyaruguru | 2968 | 4864 | 7953 | 0.28 | 0.61 | 0.92 | 258 | 16,740 | 336,179 | 320,433,715 |
| Huye | 3038 | 3911 | 6951 | 0.34 | 0.67 | 0.94 | 296 | 17,524 | 356,907 | 343,649,823 |
| Nyamagabe | 3056 | 6342 | 9397 | 0.30 | 0.59 | 0.92 | 306 | 16,643 | 412,149 | 318,536,623 |
| Ruhango | 2434 | 5517 | 8141 | 0.36 | 0.62 | 0.95 | 357 | 17,330 | 479,364 | 336,823,150 |
| Muhanga | 2050 | 2933 | 4971 | 0.35 | 0.66 | 0.98 | 365 | 18,462 | 511,187 | 360,285,199 |
| Kamonyi | 1773 | 4378 | 6082 | 0.46 | 0.69 | 0.95 | 541 | 18,006 | 805,356 | 361,146,094 |
| Karongi | 2639 | 6019 | 8597 | 0.32 | 0.61 | 0.94 | 292 | 17,059 | 372,539 | 327,631,849 |
| Rutsiro | 2085 | 1797 | 3800 | 0.44 | 0.78 | 0.99 | 536 | 19,501 | 784,006 | 393,480,184 |
| Rubavu | 4866 | 6924 | 11,823 | 0.12 | 0.38 | 0.87 | 90 | 13,856 | 89,807 | 244,176,161 |
| Nyabihu | 4190 | 4317 | 8668 | 0.17 | 0.44 | 0.94 | 123 | 15,835 | 139,119 | 284,296,471 |
| Ngororero | 1554 | 3085 | 4639 | 0.39 | 0.70 | 0.98 | 410 | 18,698 | 563,964 | 369,158,621 |
| Rusizi | 3416 | 4094 | 7489 | 0.28 | 0.53 | 0.94 | 371 | 16,339 | 566,911 | 311,147,036 |
| Nyamasheke | 2574 | 5515 | 8187 | 0.28 | 0.56 | 0.94 | 224 | 16,546 | 284,934 | 314,922,273 |
| Rulindo | 2380 | 4232 | 6618 | 0.40 | 0.73 | 0.96 | 378 | 18,253 | 474,334 | 363,824,642 |
| Gakenke | 2781 | 3820 | 6473 | 0.26 | 0.59 | 0.96 | 235 | 17,179 | 314,966 | 325,852,114 |
| Musanze | 6028 | 9092 | 14,981 | 0.05 | 0.24 | 0.83 | 41 | 11,868 | 47,252 | 192,791,104 |
| Burera | 3094 | 5863 | 8847 | 0.27 | 0.58 | 0.92 | 283 | 16,090 | 395,020 | 306,246,122 |
| Gicumbi | 2620 | 6818 | 9440 | 0.25 | 0.56 | 0.92 | 292 | 16,307 | 404,402 | 310,215,817 |
| Rwamagana | 3049 | 8788 | 11,985 | 0.22 | 0.45 | 0.90 | 235 | 15,001 | 321,947 | 274,294,375 |
| Nyagatare | 3351 | 7105 | 10,523 | 0.15 | 0.41 | 0.90 | 164 | 14,683 | 234,558 | 262,447,422 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Gatsibo | 2427 | 3402 | 5650 | 0.28 | 0.65 | 0.97 | 293 | 17,955 | 377,921 | 347,470,526 |
| Kayonza | 3277 | 8019 | 11,261 | 0.14 | 0.47 | 0.88 | 168 | 14,597 | 249,990 | 264,259,883 |
| Kirehe | 3085 | 7303 | 10,701 | 0.12 | 0.42 | 0.91 | 103 | 14,854 | 112,411 | 262,825,562 |
| Ngoma | 3676 | 7032 | 10,668 | 0.18 | 0.45 | 0.90 | 184 | 15,011 | 264,278 | 272,056,048 |
| Bugesera | 2143 | 4480 | 6585 | 0.49 | 0.67 | 0.94 | 619 | 17,727 | 985,297 | 356,693,468 |
| Province | | | | | | | | | | |
| Kigali | 12,121 | 19,074 | 31,554 | 0.04 | 0.12 | 0.54 | 36 | 6497 | 46,552 | 100,271,115 |
| Southern | 2462 | 4241 | 6687 | 0.37 | 0.67 | 0.95 | 388 | 17,816 | 544,193 | 350,077,252 |
| Western | 3046 | 4535 | 7600 | 0.29 | 0.57 | 0.94 | 292 | 16,833 | 400,199 | 320,683,543 |
| Northern | 3381 | 5965 | 9272 | 0.25 | 0.54 | 0.92 | 246 | 15,939 | 327,195 | 299,785,960 |
| Eastern | 3001 | 6592 | 9627 | 0.23 | 0.50 | 0.91 | 252 | 15,689 | 363,764 | 291,403,288 |
| Urban-rural | | | | | | | | | | |
| Urban | 10,731 | 18,108 | 29,115 | 0.07 | 0.18 | 0.59 | 60 | 7786 | 76,211 | 127,038,910 |
| Semi-urban | 2828 | 4929 | 7748 | 0.29 | 0.58 | 0.94 | 307 | 16,797 | 428,896 | 321,057,972 |
| Rural | 3634 | 6355 | 10,061 | 0.27 | 0.54 | 0.90 | 284 | 15,954 | 380,537 | 301,629,974 |
| Sample | | | | | | | | | | |
| Mean | 2387 | 5252 | 23,250 | 0.264 | 0.531 | 0.895 | 275 | 15,645 | 382,564 | 296,162,998 |
| Std Dev | 0.000 | 0.000 | 0.000 | 0.441 | 0.499 | 0.307 | 554 | 7169 | 946,952 | 170,317,427 |

Notes: Poor1, relative poverty line based on 0.50 of median; poor1x, relative poverty line based on 0.50 of mean; poor2, absolute poverty line based on $1.25 per day; pgap1, poverty gap based on poor1; pgap1x, poverty gap based on poor2; pgap1s, poverty severity based on pgap1; pgap2s, poverty severity based on pgap2

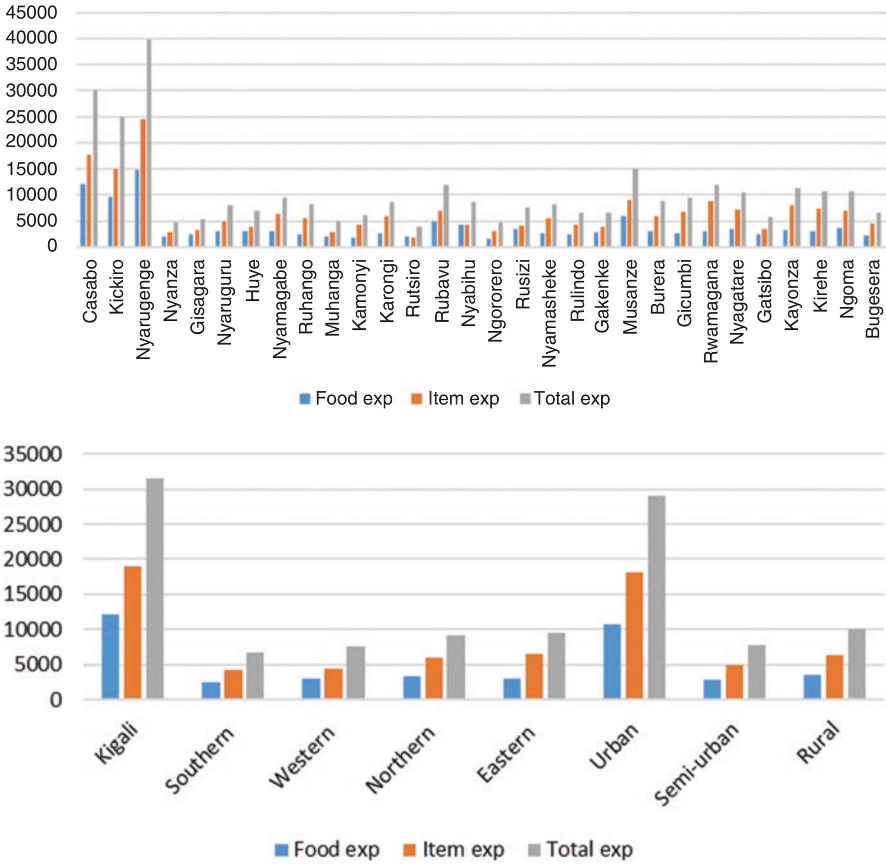


**Fig. 2.1** (**a**) Mean consumption poverty among districts in Rwanda, Rwf in 2012. (**b**) Mean consumption poverty among provinces and areas in Rwanda, Rwf in 2012

line is defined as 50 percent of median income which varies by district. The absolute poverty line is defined as monthly income expressed in Rwf ($1.25/day multiplied with 30 days multiplied with Rwf 620 per dollar). Models 3 and 4 are Tobit models of the determinants of poverty gap, where poverty gap is defined as done earlier. Tobit models 5 and 6 estimate the effects of the determinants of poverty severity, and again, poverty is defined based on relative and absolute poverty lines.

Table 2.5a presents estimation results for the six different models on the determinants of poverty in Rwanda. The models differ in the way in which the poverty line is measured, namely, relative and absolute approaches. These models include two Probit models (models 1 and 2) and four Tobit models (models 3–6). The Probit model helps identify the determinants to explain the probability that a household is poor given normal distribution of the error term. Coefficients of variables with positive signs are positively correlated with the probability of becoming poor, and coefficients with negative signs are negatively associated with the probability of becoming poor.

**Table 2.4a** Correlation matrix of the variables (N = 14,810)

| | Year | Househ. Size | Total income | Income per-capita | Povline relative | Povgap relative | Povgap2 relative | Povgap absolute | povgap2 absolute | Populg growth | Dis-tance road | Dis-tance market | Age head | Nr income | Farm land | Vege-table garden | Nr animal | Nr crops | Cash crops | Banana tees nr |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1.00 | | | | | | | | | | | | | | | | | | | |
| House size | −0.09 (0.00) | 1.00 | | | | | | | | | | | | | | | | | | |
| Total income | −0.01 (0.18) | −0.23 (0.00) | 1.00 | | | | | | | | | | | | | | | | | |
| Income per cap | 0.03 (0.00) | −0.29 (0.00) | 0.81 (0.00) | 1.00 | | | | | | | | | | | | | | | | |
| Povline relative | −0.06 (0.00) | 0.01 (0.17) | 0.11 (0.00) | 0.05 (0.00) | 1.00 | | | | | | | | | | | | | | | |
| Povgap relative | 0.02 (0.01) | 0.34 (0.00) | −0.30 (0.00) | −0.16 (0.00) | 0.08 (0.00) | 1.00 | | | | | | | | | | | | | | |
| Pgap2 relative | 0.00 (0.85) | 0.28 (0.00) | −0.24 (0.00) | −0.12 (0.00) | 0.14 (0.00) | 0.94 (0.00) | 1.00 | | | | | | | | | | | | | |
| Povgap absolute | 0.03 (0.00) | 0.53 (0.00) | −0.65 (0.00) | −0.45 (0.00) | −0.13 (0.00) | 0.48 (0.00) | 0.38 (0.00) | 1.00 | | | | | | | | | | | | |
| povgap2 absolute | 0.04 (0.00) | 0.53 (0.00) | −0.61 (0.00) | −0.39 (0.00) | −0.14 (0.00) | 0.60 (0.00) | 0.48 (0.00) | 0.97 (0.00) | 1.00 | | | | | | | | | | | |
| Popul growth | −0.03 (0.00) | 0.02 (0.00) | 0.06 (0.00) | 0.03 (0.00) | 0.21 (0.00) | 0.02 (0.00) | 0.04 (0.00) | −0.03 (0.00) | −0.04 (0.00) | 1.00 | | | | | | | | | | |
| Distance to road | 0.00 (0.86) | −0.02 (0.02) | −0.03 (0.00) | −0.01 (0.27) | 0.06 (0.00) | 0.02 (0.03) | 0.02 (0.01) | 0.01 (0.51) | 0.01 (0.43) | 0.09 (0.00) | 1.00 | | | | | | | | | |
| Distance market | −0.02 (0.02) | −0.01 (0.10) | −0.05 (0.00) | −0.02 (0.01) | 0.02 (0.03) | 0.01 (0.32) | 0.00 (0.59) | 0.03 (0.00) | 0.03 (0.00) | 0.02 (0.05) | 0.18 (0.00) | 1.00 | | | | | | | | |
| Age head | 0.10 (0.00) | 0.07 (0.00) | −0.05 (0.00) | 0.01 (0.31) | −0.04 (0.00) | 0.08 (0.00) | 0.07 (0.00) | 0.05 (0.00) | 0.07 (0.00) | 0.00 (0.61) | −0.02 (0.01) | −0.02 (0.07) | 1.00 | | | | | | | |

(continued)

**Table 2.4a** (continued)

| | Year | Househ. Size | Total income | Income per-capita | Povline relative | Povgap relative | Povgap2 relative | Povgap absolute | povgap2 absolute | Populg growth | Dis-tance road | Dis-tance market | Age head | Nr income | Farm land | Vege-table garden | Nr animal | Nr crops | Cash crops | Banana tees nr |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nr income | −0.18 (0.00) | 0.15 (0.00) | 0.09 (0.00) | −0.01 (−0.14) | 0.04 (0.00) | −0.11 (0.00) | −0.10 (0.00) | −0.07 (0.00) | −0.09 (0.00) | −0.02 (−0.03) | 0.02 (0.02) | 0.01 (0.15) | −0.08 (0.00) | 1.00 | | | | | | |
| Farm land | −0.07 (0.00) | 0.07 (0.00) | −0.11 (0.00) | −0.10 (0.00) | −0.10 (0.00) | 0.01 (0.18) | 0.00 (0.83) | 0.09 (0.00) | 0.09 (0.00) | −0.08 (0.00) | 0.09 (0.00) | 0.09 (0.00) | 0.04 (0.00) | 0.20 (0.00) | 1.00 | | | | | |
| Vege-table garden | 0.16 (0.00) | 0.11 (0.00) | 0.00 (0.63) | −0.05 (0.00) | −0.01 (0.24) | −0.02 (0.01) | −0.02 (0.00) | 0.02 (0.00) | 0.01 (0..09) | −0.06 (0.00) | 0.00 (0.77) | 0.01 (0.11) | 0.00 (0.94) | 0.03 (0.00) | 0.10 (0.00) | 1.00 | | | | |
| Nr animal | −0.06 (0.00) | 0.19 (0.00) | 0.06 (0.00) | 0.02 (0.02) | 0.03 (0.00) | −0.02 (0.02) | −0.02 (0.02) | 0.00 (0.57) | −0.01 (0.18) | 0.10 (0.00) | 0.03 (0.00) | −0.01 (0.13) | 0.06 (0.00) | 0.18 (0.00) | 0.06 (0.00) | 0.06 (0.00) | 1.00 | | | |
| Nr crops | −0.08 (0.00) | 0.14 (0.00) | −0.01 (0.50) | −0.06 (0.00) | −0.06 (0.00) | −0.04 (0.00) | −0.04 (0.00) | 0.01 (0.47) | −0.01 (0.15) | −0.02 (0.04) | 0.09 (0.00) | 0.02 (0.01) | −0.01 (0.35) | 0.19 (0.00) | 0.50 (0.00) | 0.14 (0.00) | 0.15 (0.00) | 1.00 | | |
| Cash crops | 0.02 (0.03) | 0.06 (0.00) | 0.03 (0.00) | 0.00 (0.91) | −0.06 (0.00) | −0.04 (0.00) | −0.04 (0.00) | −0.01 (0.18) | −0.02 (0.03) | −0.04 (0.00) | −0.01 (0.12) | −0.01 (0.10) | 0.05 (0.00) | 0.04 (0.00) | 0.07 (0.00) | 0.06 (0.00) | 0.04 (0.00) | 0.19 (0.00) | 1.00 | |
| Banana tees nr | −0.17 (0.00) | 0.07 (0.00) | 0.03 (0.00) | 0.00 (0.88) | 0.09 (0.00) | −0.02 (0.00) | −0.02 (0.05) | −0.03 (0.00) | −0.04 (0.00) | 0.07 (0.00) | 0.05 (0.00) | 0.02 (0.06) | −0.02 (0.02) | 0.04 (0.00) | 0.05 (0.00) | 0.01 (0.38) | 0.07 (0.00) | 0.12 (0.00) | 0.00 (0.97) | 1.00 |

**Table 2.4b** Correlation matrix, consumption data, 7498 obs

| | Poor1 | Poor1x | Poor2 | Pgap1 | Pgap2 | Pgap1s | Pgap2s |
|---|---|---|---|---|---|---|---|
| Poor1 | 1.0000 | 0.5620 | 0.2054 | 0.8301 | 0.5226 | 0.6752 | 0.6468 |
| P-value | | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| Poor1x | 0.5620 | 1.0000 | 0.3654 | 0.4665 | 0.7590 | 0.3794 | 0.8530 |
| P-value | 0.0001 | | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| Poor2 | 0.2054 | 0.3654 | 1.0000 | 0.1705 | 0.7490 | 0.1387 | 0.5968 |
| P-value | 0.0001 | 0.0001 | | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| Pgap1 | 0.8301 | 0.4665 | 0.1705 | 1.0000 | 0.4579 | 0.9568 | 0.5813 |
| P-value | 0.0001 | 0.0001 | 0.0001 | | 0.0001 | 0.0001 | 0.0001 |
| Pgap2 | 0.5226 | 0.7590 | 0.7490 | 0.4579 | 1.0000 | 0.3835 | 0.9667 |
| P-value | 0.0001 | 0.0001 | 0.0001 | 0.0001 | | 0.0001 | 0.0001 |
| Pgap1s | 0.6752 | 0.3794 | 0.1387 | 0.9568 | 0.3835 | 1.0000 | 0.4935 |
| P-value | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | | 0.0001 |
| Pgap2s | 0.6468 | 0.8530 | 0.5968 | 0.5813 | 0.9667 | 0.4935 | 1.0000 |
| P-value | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | |

Notes: Poor1, relative poverty line based on 0.50 of median; poor1x, relative poverty line based on 0.50 of mean; poor2, absolute poverty line based on \$1.25 per day; pgap1, poverty gap based on poor1; pgap1x, poverty gap based on poor2; pgap1s, poverty severity based on pgap1; pgap2s, poverty severity based on pgap2

According to Table 2.5a and in terms of region, it was observed that living in urban and suburban areas had a positive effect on the probability of being poor, which was expected from Part C of Table 2.3a. This thus confirms the results of Table 2.3a. Bigsten et al. (2002) showed that in terms of regions, living standards are significantly higher for households in urban areas. On the other hand, Table 2.4a shows that population growth and population density had a negative effect on the probability of being poor. The negative coefficients of community characteristics such as distance to market and distance to road variables indicate that the households which were far from the road or the market were poorer. A study done by Christiaensen and Subbarao (2001) showed that households' market accessibility decreased the vulnerability to consumption shortfalls.

In terms of households' age, Table 2.5a shows that the age of the household head was inversely linked with the incidence of poverty. The negative sign of the literacy status variable shows that a household head's literacy level reduced the probability of being poor. This result was expected because education is considered as one of the key determinants of poverty and educated people can improve their chances of getting better jobs and mean incomes. Another important demographic characteristic is marital status and gender of the household head. As indicated in Table 2.5a, households with married heads were among the poor households; this contradicts the general expectation. On the other hand, female-headed households were poorer than male-headed households in Rwanda.

The other demographic variable to be considered is household size; households with larger family sizes had a higher probability of falling into the poverty gap. As expected, having access to productive inputs such as credit decreased the probability of being poor. Also by increasing the number of income-generating activities makes

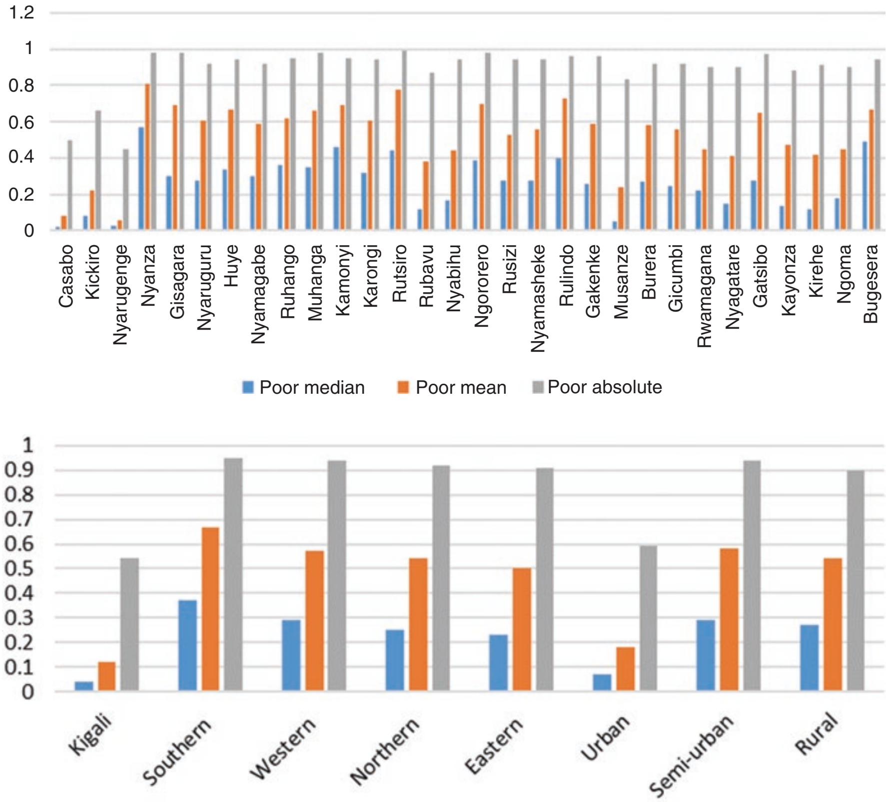


**Fig. 2.2** (**a**) Incidence of consumption poverty among districts in Rwanda, % in 2012. (**b**) Incidence of consumption poverty among provinces and areas in Rwanda, % in 2012

a household less likely to be poor. Asset ownership (e.g., having a garden, cash crops, banana trees) decreased the probability of being poor.

The same measures of poverty (headcount, gap, and severity) computed based on total consumption per capita household data for 2012 are used to estimate their determinants. The poverty incidence models are estimated using Probit model, while poverty gap and poverty severity are estimated using Tobit models. The results are presented in Table 2.5b. The result shows that majority of the selected determinants influence the level and gap and severity of poverty.

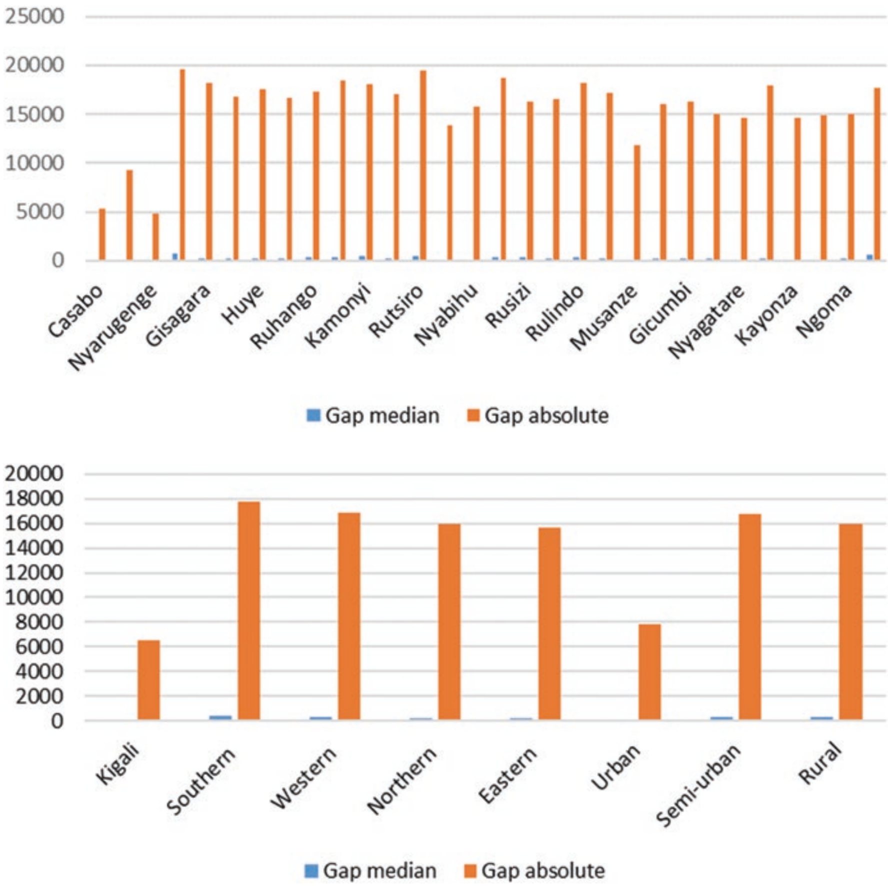


**Fig. 2.3** (**a**) Consumption poverty gap among districts in Rwanda, Rwf in 2012. (**b**) Consumption poverty gap among provinces and areas in Rwanda, Rwf in 2012

## 5 Conclusion and Policy Implications

Understanding poverty in Rwanda requires an understanding of its measurement. It is only with accurate measurement tools that we can understand poverty and thus how well we are doing as a society in reducing it. In this regard, we used data which covered 14,810 households in 2006, 2009, and 2012. Poverty is measured based on both income and consumption. Consumption is a better measure as it is closer to the needs and suffers less from income reporting problem. We did a descriptive analysis as well as a poverty measurement using different poverty indices and a multivariate regression analyses. In addition, our study also identified some of the key

**Table 2.5a** Probit and Tobit models' estimation results

| | Probit, Headcount | | | | Tobit, Poverty gap | | | | Tobit, Poverty severity | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Model 1: Relative | | Model 2: Absolute | | Model 3: Relative | | Model 4: Absolute | | Model 5: Relative | | Model 6: Absolute | |
| | Coeff. | StdErr | Coeff. | StdErr | Coeff. | StdErr | Coeff. | StdErr | Coeff. | StdErr | Coeff. | StdErr |
| Intercept | −1.79 | 0.10 | −0.94 | 0.13 | −1.42 | 38.36 | 7495.43 | 385.87 | 62246.55 | 79839.99 | 109270000.00 | 9202477.00 |
| Rural | 0.19 | 0.06 | 0.23 | 0.08 | 25.54 | 23.75 | 1311.94 | 238.85 | −10093.60 | 49420.14 | 31740460.00 | 5696239.00 |
| Semiurb | 0.34 | 0.07 | 0.27 | 0.10 | 97.46 | 28.50 | 1533.98 | 286.69 | 123099.10 | 59317.61 | 36978269.00 | 6837036.00 |
| Popdens | −0.00 | 0.00 | −0.00 | 0.00 | −0.01 | 0.01 | −0.65 | 0.07 | 0.82 | 14.63 | −15418.60 | 1686.32 |
| Populg | −0.01 | 0.00 | −0.01 | 0.01 | 1.04 | 1.52 | −65.89 | 15.30 | 8814.60 | 3165.25 | −1788472.00 | 364830.90 |
| Distroad | −0.00 | 0.00 | −0.00 | 0.00 | 0.00 | 0.00 | −0.01 | 0.01 | 10.83 | 3.02 | −148.76 | 347.81 |
| Distmark | −0.00 | 0.00 | −0.00 | 0.00 | 0.05 | 0.08 | 2.07 | 0.80 | 59.41 | 166.08 | 42607.89 | 19142.53 |
| Agehead | −0.00 | 0.00 | −0.00 | 0.00 | −0.35 | 0.37 | −28.91 | 3.69 | −32.33 | 763.06 | −581072.00 | 87951.31 |
| Lithead | −0.12 | 0.02 | −0.17 | 0.03 | −34.45 | 7.30 | −658.13 | 73.46 | −46837.60 | 15198.50 | −16170000.00 | 1751802.00 |
| Mshead | 0.02 | 0.03 | −0.04 | 0.05 | 4.77 | 13.05 | 197.88 | 131.26 | 7440.65 | 27159.00 | 3811217.00 | 3130387.00 |
| Dfemale | 0.10 | 0.04 | 0.20 | 0.05 | 37.28 | 15.49 | 567.40 | 155.85 | 70684.91 | 32245.95 | 13065744.00 | 3716716.00 |
| Hhsize | 0.34 | 0.01 | 0.70 | 0.02 | 127.57 | 2.49 | 2122.56 | 25.03 | 209290.60 | 5179.15 | 52100272.00 | 596956.80 |
| Nrincome | −0.36 | 0.02 | −0.30 | 0.03 | −145.99 | 7.57 | −1600.40 | 76.15 | −262164.00 | 15756.74 | −43940000.00 | 1816146.00 |
| Credd | −0.25 | 0.03 | −0.37 | 0.04 | −82.86 | 11.58 | −1523.48 | 116.44 | −137696.00 | 24093.02 | −37330000.00 | 2776998.00 |
| Worksend | −0.07 | 0.06 | −0.13 | 0.08 | −27.12 | 21.84 | −567.50 | 219.64 | −47180.90 | 45444.29 | −10760000.00 | 5237977.00 |
| Fland | 0.40 | 0.06 | 0.59 | 0.07 | 117.43 | 22.56 | 2987.80 | 226.92 | 155985.10 | 46950.73 | 73359017.00 | 5411611.00 |
| Vegetd | −0.12 | 0.03 | −0.02 | 0.04 | −43.79 | 10.12 | −274.81 | 101.75 | −77724.00 | 21052.55 | −9179226.00 | 2426549.00 |
| Mranimal | −0.02 | 0.00 | −0.02 | 0.00 | −7.00 | 0.89 | −94.31 | 8.95 | −12348.20 | 1850.79 | −2415835.00 | 213324.90 |
| Nrcrops | −0.04 | 0.01 | −0.06 | 0.01 | −11.01 | 3.47 | −224.16 | 34.87 | −14587.80 | 7214.20 | −5832576.00 | 831519.50 |
| Cashcrop | −0.26 | 0.05 | −0.19 | 0.08 | −117.36 | 20.80 | −892.37 | 209.22 | −222821.00 | 43288.44 | −25350000.00 | 4989490.00 |
| Bantrnr | −0.00 | 0.00 | −0.00 | 0.00 | −0.13 | 0.04 | −2.69 | 0.44 | −238.06 | 90.87 | −67502.00 | 10474.06 |
| d2009 | −0.43 | 0.04 | −0.09 | 0.06 | −182.33 | 15.77 | −1204.06 | 158.65 | −336037.00 | 32824.88 | −39650000.00 | 3783445.00 |
| d2012 | 0.05 | 0.04 | −0.11 | 0.05 | −32.84 | 14.53 | 131.72 | 146.11 | −132718.00 | 30231.54 | 4748735.00 | 3484532.00 |
| Scale | – | – | – | – | 583.21 | 3.39 | 5866.04 | 34.09 | 1213726.00 | 7053.19 | 139900000.00 | 812961.40 |

**Table 2.5b** Probit and Tobit estimation of determinants of headcount, poverty gap, and poverty severity

| | Probit | Probit | Probit | Tobit | Tobit | Tobit | Tobit |
|---|---|---|---|---|---|---|---|
| | Poor1 | Poor1x | Poor2 | Pgap1 | Pgap2 | Pgap1s | Pgap2s |
| Parameter | Estimate | Estimate | Estimate | Estimate | Estimate | Estimate | Estimate |
| Intercept | 1.4808a | 1.1511a | −0.3394b | 101.898b | 7391.433a | 157783.00b | 118990000a |
| Rural | −0.7066a | −0.8283a | −0.7668a | 184.005a | 5892.334a | 272988.50a | 127150000a |
| Semiurb | −0.6895a | −0.7689a | −0.6779a | 175.110a | 5617.385a | 243532.30a | 120090000a |
| Distroad | 0.0000b | 0.0000a | 0.0000b | 0.004b | 0.085a | 6.61b | 2063a |
| Distmark | −0.0003 | −0.0006a | −0.0028a | 0.139 | 6.008a | 294.78c | 127046a |
| Agehead | −0.0038a | −0.0015 | 0.0045a | 2.264a | −3.936 | 4097.05a | 91,830 |
| Lithead | 0.2886a | 0.3677a | 0.5746a | −114.480a | −2400.180a | −181801.00a | −57070000a |
| Mshead | 0.0173 | −0.1466b | −0.2087b | −21.768 | 844.660a | −45389.30 | 16782314b |
| Dfemale | −0.1139 | −0.2992a | −0.3025a | 36.651 | 1547.484a | 48382.37 | 35800756a |
| Hhsize | −0.0412a | −0.0650a | −0.0873a | 14.575a | 384.591a | 20244.29a | 9170200a |
| Nrincome | 0.2353a | 0.2370a | 0.3011a | −92.211a | −1480.640a | −143969.00a | −36,180,000 |
| Credd | −0.0849 | 0.0469 | 0.0816 | 56.987 | −426.994 | 112654.40 | −13600000a |
| FLand | −0.7891a | −0.8669a | −0.7723a | 271.295a | 5370.623a | 394751.50a | 129030000a |
| Vegetd | 0.1960a | 0.2111a | 0.1396a | −94.629a | −794.300a | −159806.00a | −23810000a |
| Nrcrops | 0.1132a | 0.0684a | −0.0270 | −54.625a | −210.613b | −88330.80a | −8,770,799 |
| Scale | .. | .. | .. | 530.996 | 6138.447 | 913641.80 | 148,640,000 |
| 0 | 5521 | 3514 | 790 | 5521 | 790 | 5521 | 790 |
| 1 or # 0 | 1977 | 3984 | 6708 | 1977 | 6708 | 1977 | 6708 |
| Obs | 7498 | 7498 | 7498 | 7498 | 7498 | 7498 | 7498 |

Notes: Poor1, relative poverty line based on 0.50 of median; poor1x, relative poverty line based on 0.50 of mean; poor2, absolute poverty line based on $1.25 per day; pgap1, poverty gap based on poor1; pgap1x, poverty gap based on poor2; pgap1s, poverty severity based on pgap1; pgap2s, poverty severity based on pgap2. Significant at less than 1% (a), 1–5% (b), 6–10% (c), not significant ()

determinants of poverty in Rwanda. We used Probit and Tobit models for analyzing the determinants of household poverty. We also investigated the determinants of poverty gap and poverty severity in which the dependent variable was no more binary and was continuous with limited ranges.

The use of absolute and relative poverty measure and mean or median income or consumption provides different pictures of poverty and its intensity due to skewed distributions. Median is a better measure. The two measures are close once one omits the extreme outliers. Our results indicate that in 2012, almost one-third of the population in Rwanda was in relative poverty, and about 88 percent of the population of Rwanda (Kigali excluded) was in absolute poverty. On the other hand, the Southern province had the highest poverty ratio among the provinces, while the largest relative poverty ratio was in Kamonyi and Gakenke districts. The results of the Probit and Tobit models show that female-headed households were poorer and that a larger family had a higher probability of falling into poverty. Also, as expected, asset ownership decreased the probability of being poor.

Based on our empirical findings, we draw the following policy implications to decrease poverty at the household level in Rwanda. First, since a majority of the poor live in rural and semi-urban areas, there is an urgent need to increase the incomes of households in these areas to help reduce poverty. Second, providing more credit to households is an effective way of reducing poverty. Third, it is important to facilitate improved educational levels of household heads so that they can provide their families with better jobs and sources of income. Fourth, by enhancing poor physical assets, most notably vegetable gardens, the government can generate livelihood options. Fifth, creation of special economic, educational, and job opportunities for female-headed households will have strong implications for family welfare. Finally, increasing investments in public physical infrastructure (e.g., rural roads and markets) will also be an effective way of alleviating poverty.

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# Chapter 3
# Measurement and Analysis of Multidimensional Well-Being in Rwanda

**Almas Heshmati, Masoomeh Rashidghalam, and Pia Nilsson**

## 1 Introduction

Many children around the world do not have natural human rights due to various reasons including families' income status, the political situation, lack of safety nets, war, religion, ethnicity, gender discrimination and disabilities (Peters and Mullis 1997; Santos Pais 1999; Ridge 2002; Gregg et al. 2005; Mayhew 2005; Sobolewski and Amato 2005). They do not receive enough food, care and opportunities to attend school and learn new skills. As a result they do not reach their full human potential (Sen 2000; Attree 2004). Family support, good nutrition, consistent care and encouragement to learn in the early years of life help children perform better in school, be healthier, have an active and productive participation in society, be more creative and have higher earnings in the future (Duncan and Brooks-Gunn 2000; Bradshaw 2002; Kamerman et al. 2003; Bargain and Donni 2007). This issue is even more important for children in poverty. The number of children under the age of 5 who die of hunger is increasing; 7.6 million of them die each year, while others who survive (over 200 million children) usually do not reach their full potential. As a result, their societies have problems of low labor productivity, development and welfare. The early years of a child's development are of crucial importance since this is a period of growth and also of vulnerability to adverse conditions (UNICEF 2013).

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In Africa, children's well-being is of great importance since children are the greatest resource of this continent. According to key statistics provided by the United Nations Children's Fund (UNICEF 2014), by 2050, one in every three births and almost one in every three children under 18 will be African. The number of stunted children has increased by one-third in Africa, while other regions have halved the number of stunted children. Although mortality rates among children under-5 have decreased by 45 per cent, still half of the world's 6.6 million under-5 annual deaths occur in Africa. Statistics confirm that Africa has over 300 million out of school children. They fail to complete full primary education and hence fail to master basic literacy and numeracy skills. Between 2010 and 2025, the child population in sub-Saharan Africa will increase by 130 million. This region will also be the single region with the greatest number of children under 18 from around 2030 (UNICEF, 2014). Africa's population is estimated to quadruple by 2100 (United Nations 2015). Kayizzi-Mugerwa et al. (2017) suggest inclusive growth in Africa to cope with poverty.

Rwanda is one of the first countries that ratified the Convention on the Rights of the Child (CRC). The country, despite its very low gross domestic product (GDP) per capita, has one of the best child well-being indicators on the continent. Recently Rwanda also had two important achievements in the area of children's protection. First, it established the National Commission for Children which protects children's rights. Second, it launched a Strategy for National Child Care Reform, which aims to integrate children into families that are supported to provide needed care to these children. These successes are largely the result of strong laws and policies many of which have been developed with support from UNICEF. UNICEF is among the Government of Rwanda's key partners in preventing and responding to violence, abuse, exploitation and neglect, with a particular focus on the most vulnerable, including children without parental care and children with different forms of disabilities. This cooperation helps Rwanda and its vulnerable population to create an environment to protect children's rights, provide them opportunities for normal growth and for developing their potential.

Despite the progress made by the government and other stakeholders in improving children's living standards in Rwanda, serious challenges still remain. One of the most important problems is the low rate of primary school completion. Further, students who complete primary school often do not have the skills that they need for successful employment in the future. According to a mini survey conducted by 'Rwanda Today' in Kigali, many children still beg on the streets because they have been abandoned. Many Rwandan children are struggling to deal with the effects of war and genocide, especially those born during the 1994 mayhem. In addition, many children face poverty in families while domestic violence has denied others a chance to be raised in proper homes. Some parents have neglected their children for various reasons. These children are now orphans and as part of the daily struggle many of them end up in petty crimes and drug and substance abuse.

These problems in Rwanda will lead to loss in adult productivity and persistent difficulties in the future. What happens during the early years is of crucial importance for every child's development. It is a period of great opportunity, but also of vulnerability to negative influences. On the other hand, the need to promote children's well-being is widely accepted as a moral imperative. Hence, the objective of this research is to estimate the multidimensional well-being of children and their families in Rwanda. Its aim is to compute an overall well-being index and decompose it into its underlying main components. The families are ranked by level of well-being across household, district and community characteristics. The results shed light on the state and changes in children's well-being in Rwanda indicating which provinces and districts have relatively better conditions for them. This can serve as a model for the general development of the well-being of children and their families in Rwanda.

The rest of this study is organized as follows. Section 2 provides a literature review which is followed by an introduction to the method of measurement in Sect. 3. The area of study, Rwanda, and the data are presented in Sect. 4. Section 5 discusses the empirical results and Sect. 6 gives a conclusion.

## 2 Literature Review

Literature on well-being in general and on related areas of economic research including capabilities, human development, freedom, poverty, happiness, sustainability, income distribution and social status and their direct association with well-being in income theory and practice has developed rapidly. The literature is divided into subjective and objective aspects (Alatartseva and Barysheva 2015) referring to internal and external levels of well-being. Each level consists of 4 key contextual attributes that together constitute well-being. They include: (i) one's existence in accordance with their natural essence, (ii) an innate understanding of what is good for oneself, and the presence of the ability and willingness to achieve it, (iii) one's the ability to realize their human potential and plan for life, and (iv) the creation of a society and empowering people to fulfill the above stated positions, and increase activity and awareness. This study covers many dimensions of objective well-being in general and those of children in particular. This section covers a review of literature found in journals, handbooks and other academic books (see, for example, Bronfenbrenner and Morris 1998; Sen 1985, 1999; Ridge 2002; Kakwani and Silber 2006, 2007; Senik 2010; Truyts 2010; MacKerron 2012; Alatartseva and Barysheva 2015; Arndt and Tarp 2016; Qasim 2017).

Literature on children's well-being has also developed very fast and as a result of theories, methods and their applications using increasingly available detailed household level data, numerous studies address this important issue. Research examples include Attree (2004) who provides a systematic review of the quantitative evidence on growing up in disadvantageous conditions. Bargain and Donni (2007) emphasize the theory of targeting children to influence their productivity and well-being, while Gregg et al. (2005) investigate the effects of mothers' decisions of returning to work on child development. The issues of measurement, decomposition of well-being and the underlying indicators are investigated by Brooks and Hanafin (2005). Kamerman et al. (2003) discuss social policies, family types and child outcomes. Land (2007) studies the foundation for child development. Stevens et al. (2005) focus on reinforcing the importance of family for successful child outcomes.

Most studies dealing with a measurement and analysis of child well-being use data from developed countries. Heshmati et al. (2008) investigated child well-being in middle and high income countries. Sarriera et al. (2015) examined the relationship between children's perceptions of available material resources and their subjective well-being in eight developed and developing countries. Sachs (2016) discusses subjective well-being over life. Brandolini (2007) computed multidimensional well-being indices focusing on income and health inequalities in the four advanced and largest European economies. Stiglitz et al. (2009) in viewing that well-being is a multi-dimensional phenomenon based on key dimensions that should be simultaneously taken into account. The dimension include: material living standards, health, education, personal activities including work, political voice and governance, social connections and relationships, environment and uncertainty. Maasoumi and Hu (2015) derive weights and substitution degree in multidimensional well-being of social groups in China. The well-being dimensions include: income, assets, house, health and education. Bradshaw (2002) estimated the relationship between child poverty and child outcomes and Bradshaw et al. (1993, 2006, and 2007) computed the index of child well-being in OECD and in the European Union. Jäntti and Bradbury (1999) studied child poverty in industrialized nations. Kamerman et al. (2003) studied the effects of social policies and family types on child outcomes in OECD countries.

Finally, UNICEF (2007) provides an overview of child well-being in 'rich' countries. Individual country case studies of child well-being include Beresford et al. (2005), Gregg et al. (2005) and Mayhew (2005) in the case of UK, Lippman (2004) and Berger et al. (2005) in the case of USA and Hanafin and Brooks (2005) in the case of Ireland.

Heshmati et al. (2008) analyzed the UNICEF Innocenti database and present three composite indices (two parametric and one non-parametric) of children's well-being in middle and high income countries. These indices are composed of six well-being components including material, health and safety; educational; family and peer relationships; behaviors and risks; and subjective well-being. Each of the components is generated from a number of well-being indicators. They conclude that the Scandinavian countries performed quite well in comparison to other regions in and outside Europe. Their empirical results show that the UK performed extremely poorly in child well-being and the Russian Federation occupied the lowest rank in all the three indices. In addition, the authors provide guidelines on how to empirically link well-being to factors such as inequalities, poverty and growth.

Despite an urgent need for comprehensive child well-being studies covering developing countries only a few such studies have been done. Limited data availability and advanced research capacity explain the poor research in this field. However, the initiation of the millennium development goals and systematic data collection by the World Bank have led to changed conditions in the last two decades. Some cross-country studies have been done since then, while other single country studies too have been carried out. Among the few general studies are those by Ben-Arieh (1997) and Ben-Arieh and Wintersberger (1997) who study indicators of children's well-being to measure and monitor the state of children. Roelen et al. (2017) investigate the role of social protection in improving child well-being and childcare in sub-Saharan Africa. Sarriera et al. (2015) examine the relationship between children's perceptions of available material resources and their subjective well-being in eight developed and developing countries. Other studies focusing on developing countries include Akresh et al. (2011), Caserta et al. (2016), Ssewamala et al. (2010) and UNICEF (2013, 2014). These are discussed in more detail later.

With regard to developing countries Roelen et al. (2017) studied the impact of social protection on loss of parental care and quality of care and well-being in sub-Saharan Africa. They investigated large-scale nationally implemented cash transfer and public works programs in South Africa, Ghana and Rwanda. According to the results of their study social protection will prevent the loss of parental care thereby providing much needed financial support to kinship or foster care providers. They also found that social protection could improve the quality of care and child well-being for all children in the studied societies.

A few studies have also been done on children's living conditions in Rwanda. In a study based on Rwandan data, Akresh et al. (2011) examined the impact of Rwanda's distinct shocks (defined as localized crop failure and armed conflict) on children's health status. According to their study, in both poor and non-poor households the boys and girls who were born during the conflict in regions experiencing fighting were negatively affected. On the other hand, only girls were negatively affected by crop failure and this impact was even worse for girls in poor households.

Caserta et al. (2016) studied the effects of various living environments for children (including child-headed households, orphanages, street children and foster homes), the quality of care and demographic factors on orphan children's psychosocial well-being in Rwanda. They conclude that children in orphanages exhibited higher levels of emotional well-being and lower levels of mental distress and risk-taking behavior than other non-orphan children. Decision-making abilities were the highest among child-headed households, while they were the lowest among those in orphanages. Demographic factors (such as age and sex) along with the quality of care (such as meal availability and length of time spent in a particular living environment) were also important predictors of psychosocial well-being among the studied children.

Ssewamala et al. (2010) examined the effect of economic assets on sexual risk-taking intentions among school-going AIDS-orphaned adolescents in rural Uganda. According to the results of this study, in Uganda which is a country devastated by poverty and disease (including HIV/AIDS), having access to economic assets played an important role in influencing adolescents' sexual risk-taking intentions. The findings of this study have implications for the care and support of orphaned adolescents, especially in poor African countries devastated by poverty and sexually transmitted diseases.

Other studies indicate that Africa has become a better place for children as compared to 5 years ago. Despite its relatively low GDP per capita, the Child Friendliness Index ranked Rwanda at number six among Africa's 52 countries, having moved up five places from its 11th position in 2008. Rwanda has an impressive achievement – it has achieved most of the millennium development goals' (MDGS) targets by the 2015 deadline. Improving access to education is one of the biggest successes of the country. Rwanda has the highest primary school enrollment rates in Africa.

Sarriera et al. (2015) examined the relationship between children's perceptions of their available material resources and their subjective well-being. They found that children in Uganda had limited access to material resources and the lowest average of well-being among children from the sample countries studied.[1] Together with Algeria and South Africa, Uganda also had the strongest associations between well-being and access to material resources. Even with access to all the material resources evaluated, well-being scores were lower in South Korea. Children from Israel, Brazil, Spain and England had similar levels of satisfaction and well-being in looking at material resources and children's subjective well-being in eight countries. The ppreliminary results underscore the importance of assessing material well-being in children and highlighting the role that material resources play in influencing children's subjective well-being, especially in cases of children experiencing severe resource deprivation.

## 3 Measurement of the Well-Being Index

A principal component analysis (PCA) is a variable dimension reduction method. PCA tries to identify the patterns of the data. It also directs the data by highlighting similarities and differences between related variables. It is used when researchers need to determine the minimum number of factors that will explain the maximum variance in the data. The indicators that form the principal components are highly correlated within a component, but they are not correlated across the components. The method helps reduce the dimensions in the data thereby limiting the many alternative ways to rank the units of observation.

Classical PCA originated in Pearson (1901) and was further developed in Hotelling (1933); this is widely used in political economy, macroeconomics, finance and many other fields. It is useful when one has obtained data on a number of variables and believes that there is some redundancy in these variables. In this case, redundancy means that some of the variables are correlated with one another, possibly because they measure the same construct. Hence, it should be possible to reduce the observed variables into a smaller number of principal components (artificial variables) that will account for most of the variances in the observed

[1] The sample countries include: Algeria, Brazil, England, Israel, Spain, South Africa, South Korea, and Uganda.

variables (Jolliffe 2002). Estimation of the eigenvalues of the sample covariance matrix is the key step towards PCA to reduce the dimensions of the data.

The method is described in Xiao et al. (2017) as (using their notations): Assume that the m-dimensional output Y is represented as Y = g(X), where X is a vector of n-dimensional inputs. The inputs are assumed to be independent of each other and are characterized by the probability density function f(x). PCA is a multivariate statistical method that can be performed through the eigenvalue decomposition of the covariance matrix of outputs Y. PCA transforms the original variables into a set of new orthogonal variables, the first few of which with the largest variance contain the most information.

The procedure involves a number of steps. First, outputs Y are centered by subtracting the mean vector and denote the centered outputs ($Y^C$) as:

$$Y^C = Y - \mu_Y \tag{3.1}$$

Second, perform the eigenvalue decomposition of the covariance matrix as:

$$\Sigma_Y = \Gamma \ \Lambda \ \Gamma^T \tag{3.2}$$

where $\Lambda$ is the diagonal eigenvalue matrix and $\Gamma$ is a matrix of normalized eigenvectors associated with the eigenvalues.

Third, the centered outputs $Y^C$ are transformed into independent variables $H$ through:

$$H = Y^C \Gamma \tag{3.3}$$

where $H$ contains the principal components which are orthogonal to each other. $Y^C$ can also be expressed as:

$$Y^C = H\Gamma' \tag{3.4}$$

Thus, the original outputs $Y$ can be expanded by the mutually orthogonal principal components in $H$ by:

$$Y = \mu_Y + H\Gamma' \tag{3.5}$$

Usually, the first of the $K$ principals contain the most variance if the original outputs are selected, then $Y$ can approximately be expressed as:

$$Y = \mu_Y + H_K \Gamma_K^{'} \tag{3.6}$$

where $H_K$ and $\Gamma_K$ contain the first $K$ principal components of $H$ and the first $K$ eigenvectors of $\Gamma$.

Well-being indices are computed non-parametrically assuming the components' weights used in their aggregation on an ad-hoc basis or parametrically where the weights are estimated. Each approach has their benefits in the form of not assuming the weights rather than estimating them and limitations in the form of an assumption of a functional form and choice of computation method. The performance of the two composite indices' approaches are compared by Heshmati et al. (2008) in the context of child well-being and in Heshmati and Oh (2006) in the context of the development strategy.

Kang (2002) conducted a sensitivity analysis of the composite environmental index while Decancq and Lugo (2008) discuss how to set weights in multidimensional indices of well-being. The robustness of composite indicators in the context of national science and technology policy were investigated by Grupp and Mogee (2004). Noorbakhsh (1998) also investigates alternative development indices.

These studies together shed light on the strengths and weaknesses of the indices and on how to improve upon their performance in measuring children's well-being. Xiao et al. (2017) propose new kinds of sensitivity indices based on PCA to measure the effects of input variables on multivariate outputs. Existing sensitivity indices focus on the variance of principal components representing a magnitude of uncertainty in the corresponding coordinate axes. Our research employs a weighted average of the principal components with eigenvalues greater than 1 where the share of the variance explained by the components is used as weights in the aggregation.

## 4 Data

The data used in our study consists of household surveys in Rwanda. Rwanda is located in Central/Eastern Africa and is bordered by the Democratic Republic of the Congo to the west, Uganda to the north, Tanzania to the east and Burundi to the south. With an area of 26,338 square kilometers, Rwanda is the world's 149th largest country and the fourth smallest on the African mainland. The country has five provinces – Kigali City, Southern, Western, Northern and Eastern provinces which were ascertained by borders in 2006. The Eastern Province and Kigali with an area of 9458 $km^2$ and 730 $km^2$ are the largest and smallest provinces respectively. The five provinces of Rwanda are divided into 30 districts.[2] These 30 districts are further sub-divided into 418 administrative sectors. Different administrative sectors are sub-divided into cells, which in turn are divided into villages.[3]

A 3-year period population growth in Rwanda according to the National Institute of Statistics of Rwanda (NISR) was about 7.0 per cent in 2015 (11.3 million

[2] The districts are Nyarugenge, Gasabo, Kicukiro, Nyanza, Gisagara, Nyaruguru, Huye, Nyamagabe, Ruhango, Muhanga, Kamonyi, Karongi, Rutsiro, Rubavu, Nyabihu, Ngororero, Rusizi, Rulindo, Gakenke, Musanze, Burera, Gicumbi, Rwamagana, Nyagatare, Gatsibo, Kayonza, Kirehe, Ngoma, Bugeser and Nyamasheke.

[3] Central Intelligence Agency (CIA) provides a country profile of Rwanda covering various socio-economic characteristics of the country. at: https://www.cia.gov/library/publications/the-world-factbook/geos/rw.html

persons in 2015 as compared to 10.5 million persons in 2012). A majority of the people live in rural areas and the population is young, with a density among the highest in Africa. NISR (2014) recorded that in 2012, 43.3 per cent of the population was aged 15 years and under and 53.4 per cent was aged between 16 and 64 years. Therefore, Rwanda is considered a young country in Africa. Rwanda's population density is amongst the highest in Africa at 445 inhabitants per square kilometer. Meanwhile the Southern and Western provinces are the most populated provinces in the country.

The data for the household surveys covered 14,810 household observations in Rwanda in 2006, 2009 and 2012. There were 2711, 5351 and 6748 yearly observations respectively. In our study the overall family well-being index is composed of seven well-being components: household, community, education, housing, nutrition, farming and economics. Each of these components is in turn generated from a number of well-being indicators. The farming and economics components are a part of the family well-being index while the remaining five components are related to children's well-being. Data availability and previous studies such as those by Stevens et al. (2005), Bradshaw et al. (2007), Heshmati et al. (2008), Ssewamala et al. (2010), Akresh et al. (2011), Sarriera et al. (2015), Caserta et al. (2016) and Roelen et al. (2017) influenced the modeling and determined the composition of the index. Summary statistics of data grouped component-wise is presented in Table 3.1.

The first index component represents households; this consists of four indicators: gender, age, and marital state of the household head and the number of spouses. Household represents how optimal the environment is for a child to grow up in. The second index component is labeled as community and is constructed using six indicators including the number of inhabitants per square kilometer; urban, rural and semi-urban areas; and population structures in 2002 and 2012. Community and its provision of services and safety is an extension of the household environment. The third component is associated with education consisting of six indicators among others: literacy, education in years, primary and secondary education of the head, number of children in the household attending school and distance to the road. This component captures availability and facilitation of education. Education and its access and quality are drivers of well-being that define the education component.

The next component is related to housing and is built by using nine indicators covering material for the roof and floor, number of rooms, number of people in the household, source of lighting, main source of drinking water, payment for drinking water and distance to the main water source. High quality and standard of housing increase children's well-being. Nutrition is the fifth index component that is composed of five nutrition-related indicators among others: owning a vegetable garden, number of animals, number of crops, number of banana trees owned by the household and number of banana trees used for making beer owned by the household. The latter has an indirect income effect. Nutrition affects students' growth, health and educational outcomes.

The sixth component captures farming and is composed of four indicators: percentage of farmland cultivated on marshland in a district, altitude, number of animals and number of crops. Farming provides conditions for children's improved

**Table 3.1** Summary statistics of means of data (N = 14,810)

| Variable | Description | Mean | Std. Dev. | Minimum | Maximum |
|---|---|---|---|---|---|
| A. household | | | | | |
| dfemale | Equals 1 if the head is female | 0.231 | 0.421 | 0 | 1 |
| agehead | Age of hh head | 44.381 | 14.811 | 15 | 103 |
| mshead | Marital state of head, equals 1 if the head is married | 0.589 | 0.492 | 0 | 1 |
| spousnr | Number of spouses | 1.042 | 0.270 | 0 | 5 |
| B. community | | | | | |
| popdens | Number of inhabitants per square kilometer | 634.070 | 762.026 | 1.9 | 13,009 |
| urban | Dummy urban area | 0.048 | 0.213 | 0 | 1 |
| rural | Dummy rural area | 0.872 | 0.334 | 0 | 1 |
| semiurb | Semi-urban area | 0.080 | 0.271 | 0 | 1 |
| pop2002 | Population in 2002 | 20,383.050 | 5353.609 | 9225 | 51,461 |
| pop2012 | Population in 2012 | 26,564.180 | 8446.499 | 10,384 | 58,847 |
| C. Education | | | | | |
| lithead | Hh head can read and write a simple message | 0.826 | 0.783 | 0 | 9 |
| eduhead | Head's education in years | 3.187 | 1.802 | 0 | 10 |
| eduha | Equals one if head has completed primary | 0.266 | 0.442 | 0 | 1 |
| eduhb | Equals one if head has completed secondary | 0.015 | 0.122 | 0 | 1 |
| schoola | Number of children in hh that are attending school | 1.197 | 1.214 | 0 | 7 |
| distroad | Distance to road | 3760.419 | 3524.973 | 0 | 21,925 |
| D. Housing | | | | | |
| mroof | Metal shee 1; Clay tiles 2; Other spe 3; Straw/That 4; Wood/bambo 5; | 3.294 | 2.291 | 0 | 8 |
| mfloor | Earth/Mud 1; Cement con 2; bricks 3; Other spe 4; Hardened 5; Clay tiles 6, | 1.601 | 0.658 | 0 | 8 |
| rooms | Numbers of rooms | 2.491 | 2.158 | 0 | 99 |
| hhsizer | Number of people in the hh | 2.440 | 1.283 | 0 | 12 |
| electra | Equals 1 if the source of lightning is electricity base is kerosene, candles, battery or no lightning | 0.051 | 0.220 | 0 | 1 |
| electrb | Equals one if the fuel used for cooking is gas or electricity base is wood, charcoal, kerosene or other fuel | 0.006 | 0.080 | 0 | 1 |
| watera | Equals 1 if the main source of drinking water is public tap base is pond, lake, borehole, rain water or spring | 0.491 | 0.500 | 0 | 1 |

(continued)

**Table 3.1** (continued)

| Variable | Description | Mean | Std. Dev. | Minimum | Maximum |
|---|---|---|---|---|---|
| waterb | Equals 1 if the hh pays for water | 0.232 | 0.422 | 0 | 1 |
| waterc | Distance to main water source in minutes | 28.822 | 126.887 | 0 | 6000 |
| E. Nutrition | | | | | |
| vegetd | Equals 1 if hh owns a vegetable garden | 0.564 | 0.496 | 0 | 1 |
| nranimal | Number of animals | 2.994 | 5.688 | 0 | 203 |
| nrcrops | Number of crops | 3.373 | 1.730 | 0 | 10 |
| bantrnr | Number of banana trees owned by the hh | 22.056 | 112.847 | 0 | 3500 |
| bantrbnr | Number of banana trees used for making beer owned by the hh | 31.237 | 116.929 | 0 | 4000 |
| F. Farming | | | | | |
| marshlan | Percentage of farmland cultivated on marshlands in district | 0.530 | 0.499 | 0 | 1 |
| altitude | Altitude in meters | 1747.481 | 281.373 | 955 | 2739 |
| nranimal | Number of animals | 2.994 | 5.688 | 0 | 203 |
| nrcrops | Number of crops | 3.373 | 1.730 | 0 | 10 |
| G. Economics | | | | | |
| nrincome | Number of income generating activities undertaken by hh | 1.766 | 0.685 | 0 | 10 |
| tincome | Total income from all income generating (four primary) activities | 179,793.200 | 236,125.300 | 0 | 7,200,000 |
| cashcrop | Equals one if the hh is a producer of cash crops (Tea, Coffee, Sugar) | 0.059 | 0.236 | 0 | 1 |
| distmark | Distance to market | 77.226 | 61.950 | 0 | 1200 |
| distroad | Distance to road | 3760.419 | 3524.973 | 0 | 21,925 |
| worksend | Equals one if the extended family member sends back money | 0.052 | 0.222 | 0 | 1 |
| credd | Equals one if the hh has access to credit | 0.264 | 0.440 | 0 | 1 |

Note: household (hh)

welfare and well-being. It may also imply engagement of children in farming activities as child labor. Economics is the last index component that captures the number of income generating activities undertaken by the household, total income from all income generating activities, producing cash crops, distance to the market, distance to the road, members of the extended family sending back money and having access to credit. Farming and economics influence the welfare of children in a very similar way. The overall composite index of well-being includes 41 indicators forming these seven index components.

# 5 An Analysis of the Results

## *5.1 Principal Component Analysis*

The principal component analysis of different well-being components and the overall composite index estimated for children and their families are presented in Table 3.2. Only the eigenvalues which are bigger than 1 were used in computing the different components of the index. The different components were estimated separately and their principal components with eigenvalues exceeding 1 were aggregated using the share of variance that they explain. Traditional researchers rank units only by the first principal component. Our approach is superior as it allowed us to fully utilize information from all principal components with eigenvalues larger than 1. This applies to the overall composite children and family indices as well

**Table 3.2** Principal component analysis (individual components, children and family composite indices), n = 14,810 obs

| Variable | Eigenvalue | Proportion | Cumulative | Variable | Eigenvalue | Proportion | Cumulative |
|---|---|---|---|---|---|---|---|
| I. Individual index components: | | | | II. Overall composite index: | | | |
| A. Household | | | | Composite family wellbeing index | | | |
| PC1 | 1.90 | 0.38 | | PC1 | 3.38 | 0.08 | |
| PC2 | 1.12 | 0.22 | 0.60 | PC2 | 2.85 | 0.07 | |
| B. Community | | | | PC3 | 2.13 | 0.05 | |
| PC1 | 1.90 | 0.47 | | PC4 | 1.89 | 0.05 | |
| PC2 | 1.03 | 0.25 | 0.73 | PC5 | 1.77 | 0.04 | |
| C. Education | | | | PC6 | 1.60 | 0.04 | |
| PC1 | 1.94 | 0.32 | | PC7 | 1.37 | 0.03 | |
| PC2 | 1.04 | 0.17 | 0.49 | PC8 | 1.28 | 0.03 | |
| D. Housing | | | | PC9 | 1.24 | 0.03 | |
| PC1 | 1.68 | 0.19 | | PC10 | 1.20 | 0.03 | |
| PC2 | 1.49 | 0.17 | | PC11 | 1.13 | 0.03 | |
| PC3 | 1.25 | 0.14 | | PC12 | 1.05 | 0.03 | |
| PC4 | 1.01 | 0.11 | 0.60 | PC13 | 1.04 | 0.03 | |
| E. Nutrition | | | | PC14 | 1.03 | 0.03 | 0.57 |
| PC1 | 1.57 | 0.31 | | Composite children wellbeing index | | | |
| PC2 | 1.12 | 0.22 | 0.53 | PC1 | 2.70 | 0.10 | |
| F. Farming | | | | PC2 | 2.36 | 0.08 | |
| PC1 | 1.59 | 0.26 | | PC3 | 1.95 | 0.07 | |
| PC2 | 1.48 | 0.25 | 0.51 | PC4 | 1.51 | 0.05 | |
| G. Economic | | | | PC5 | 1.36 | 0.05 | |
| PC1 | 1.36 | 0.19 | | PC6 | 1.27 | 0.04 | |
| PC2 | 1.19 | 0.17 | | PC7 | 1.13 | 0.04 | |
| PC3 | 1.01 | 0.14 | 0.51 | PC8 | 1.09 | 0.04 | |
| | | | | PC9 | 1.05 | 0.04 | |
| | | | | PC10 | 1.01 | 0.04 | 0.55 |

where full information from various indicators was used for estimating and drawing inferences about the multidimensionality of well-being. As an example the household weighted index was computed using two principal components and the share of the variance that they explained was obtained.[4] The weighted index was normalized, where the households with minimum and maximum values attained index values of 0 and 1.[5]

In order to explain the index components in more detail, we first consider the household component; only two of the principal components are bigger than 1. Number of eigenvalues bigger than 1 and share of variance explained by these principal components are: households (2, 0.60), community (2, 0.73), education (2, 0.49), housing (4, 0.60), nutrition (2, 0.53), farming (2, 0.51) and economic (3, 0.51). In the case of the overall well-being index 14 principal components are bigger than 1 and together they explain 57 per cent of the total variations (14, 0.57). The corresponding figures for children's well-being are (10, 0.55). In the case of family well-being, the contribution of the principal components to the explanation of the variance is reduced from 8 per cent by the first component and 3 per cent by the last component. The corresponding figures for the children's well-being are 10 per cent and 4 per cent respectively.

Now we explain the differences and relationships between the different index components and the composite indices for children and their families. The correlation matrix for the seven well-being components, year, composite children and family indices and income per capita are reported in Table 3.3. With the exception of a few cases all pair-wise relations are statistically significant at the 1 per cent level of significance. Concerning year and other components, only education and household are positively correlated with year while other components are negatively correlated with time. In general, we expected a positive improvement in well-being over time. The negative correlation indicates a declining level of the well-being component over time. A high negative association is found among housing and year (−0.738), between economics and year (−0.589) and between farming and year (−0.458). Farming and nutrition are highly and positively correlated (0.612). The correlation between household and housing (−0.132), community and education (−0.021) and also between education and housing (−0.111) are significant and negative. The correlation between economics and other components is statistically significant and positive, but low. The relationship between household and farming shows that these two components are positively and significantly correlated (0.257).

With the exception of farming (−0.046), there are positive correlations between the children and family well-being indices and their individual components. The size of the correlation coefficient varies in the range of 0.01 and 0.527. It approximately reflects individual component's contribution share to the overall well-being index. The correlation coefficient between children and family well-being indices is 0.455. The two indices differ by economics and farming components. Unlike

[4] The household weighted index is obtained as: H = (PC1x0.38 + PC2x0.22)/0.60.

[5] The normalized index is obtained as: $H_n = (H_{obs}-H_{min})/(H_{max}-H_{min})$. The H variables are observed, minimum and maximum in sample values.

**Table 3.3** Correlation matrix among index components, n = 14,810 obs

| | Year | Household | Community | Education | Housing | Nutrition | Farming | Economic | Family | Children | Income |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1.000 | | | | | | | | | | |
| Household | 0.041 | 1.000 | | | | | | | | | |
| | 0.001 | | | | | | | | | | |
| Community | −0.144 | −0.010 | 1.000 | | | | | | | | |
| | 0.001 | 0.227 | | | | | | | | | |
| Education | 0.132 | 0.228 | −0.021 | 1.000 | | | | | | | |
| | 0.001 | 0.001 | 0.009 | | | | | | | | |
| Housing | −0.738 | −0.132 | 0.183 | −0.111 | 1.000 | | | | | | |
| | 0.001 | 0.001 | 0.001 | 0.001 | | | | | | | |
| Nutrition | −0.286 | 0.196 | 0.049 | 0.059 | 0.148 | 1.000 | | | | | |
| | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | | | | | | |
| Farming | −0.458 | 0.257 | −0.011 | 0.036 | 0.052 | 0.612 | 1.000 | | | | |
| | 0.001 | 0.001 | 0.175 | 0.001 | 0.001 | 0.001 | | | | | |
| Economic | −0.589 | 0.084 | 0.096 | 0.020 | 0.371 | 0.327 | 0.463 | 1.000 | | | |
| | 0.001 | 0.001 | 0.001 | 0.014 | 0.001 | 0.001 | 0.001 | | | | |
| Family wellbeing | 0.235 | 0.049 | 0.271 | 0.220 | 0.106 | 0.391 | −0.191 | 0.010 | 1.000 | | |
| | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.236 | | | |
| Children wellbeing | 0.197 | 0.527 | 0.094 | 0.384 | 0.062 | 0.214 | −0.046 | 0.000 | 0.455 | 1.000 | |
| | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.952 | 0.001 | | |
| Income | −0.246 | 0.088 | 0.055 | 0.149 | −0.031 | 0.193 | 0.425 | 0.481 | −0.224 | 0.038 | 1.000 |
| | 0.001 | 0.001 | 0.001 | 0.001 | 0.000 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | |

expectations, the income per capita variable is negatively (−0.246) correlated with time suggesting a deterioration of income per capita over time. Income is positively correlated with child well-being (0.038) but negatively correlated (−0.224) with family well-being. Again the negative relationship is unexpected. A measurement error might explain this pattern. It should be noted that these correlation coefficients are pair-wise correlations and as such unconditional on other components. Conditional correlations in the form of a regression analysis are presented later.

## *5.2 Variations in Levels of Well-Being Indices by Characteristics*

Variations in the levels of different well-being components and the overall composite indices can be analyzed by household and environmental characteristics. In this section we analyze heterogeneity by comparing the average levels of the well-being components of different districts, provinces and areas over time. In Part A of Table 3.4, Nyagatare has the highest family index value while Ngoma has the highest children's index and income per capita. Ruizi enjoys the highest housing standards and Nyabihu the highest nutrition component of well-being. The highest farming index level belongs to Rubavu. Gicumbi performs well in community and education. In total the five highest ranked districts are Nyagatare, Kayonza, Kirebe, Gatsibo and Nyanza, while the five lowest districts are Gicumbi, Rusizi, Nyaruguru, Burera and Nyahibu.

According to Part B of Table 3.4 the highest/lowest contributing components to a province's rank in different well-being indices are: household (Northern/Eastern), community (Eastern/Northern), education (Southern/Eastern), housing standard (Eastern/Southern), nutrition (Eastern/Western), farming (Southern/Western) and finally the economics component (Eastern/Southern). In sum, the Eastern Province enjoys the highest family well-being, while the Northern Province has the lowest level of family well-being. The highest and lowest children's well-being are assigned to Western and Southern provinces.

The districts are classified into three groups by different areas as urban, semi-urban and rural. According to Table 3.4 Part C, in urban areas, education, housing and the overall composite indices are the highest. Also the highest income index belongs to urban areas. On the other hand, the lowest numbers of household, community, nutrition and farming indices belong to urban areas. In rural areas, household, community, nutrition, farming and economics indices are the highest and housing and overall composite indices are the lowest. The lowest education, economic and income indices belongs to semi-urban areas. The largest difference is in the children's well-being index where urban areas enjoy the highest level, while rural areas the lowest level.

Part D of Table 3.4 presents different indices by the periods of study. The three periods differ by 3 years each. According to this table the number of community, housing, nutrition and economics indices decreased over time. Only household,

**Table 3.4** Summary of all indices by district, province, area and year, sorted by family index, sorted by change in family index, n = 14,810 obs

| | Household | Community | Education | Housing | Nutrition | Farming | Economic | Family wb | Children wb | Income |
|---|---|---|---|---|---|---|---|---|---|---|
| A. District | | | | | | | | | | |
| Musanze | 0.063 | 0.002 | 0.061 | 0.081 | 0.178 | 0.195 | 0.057 | 0.069 | 0.047 | 0.376 |
| Nyagatare | 0.051 | 0.004 | 0.082 | 0.093 | 0.172 | 0.133 | 0.038 | 0.067 | 0.058 | 0.422 |
| Rusizi | 0.050 | 0.001 | 0.069 | 0.117 | 0.190 | 0.149 | 0.048 | 0.063 | 0.053 | 0.387 |
| Nyabihu | 0.057 | 0.000 | 0.061 | 0.073 | 0.200 | 0.212 | 0.043 | 0.062 | 0.056 | 0.258 |
| Burera | 0.051 | 0.003 | 0.065 | 0.068 | 0.111 | 0.086 | 0.044 | 0.060 | 0.056 | 0.418 |
| Rubavu | 0.056 | 0.002 | 0.068 | 0.078 | 0.189 | 0.230 | 0.054 | 0.055 | 0.029 | 0.311 |
| Ngoma | 0.060 | 0.000 | 0.066 | 0.094 | 0.132 | 0.117 | 0.071 | 0.055 | 0.081 | 0.522 |
| Karongi | 0.059 | 0.001 | 0.066 | 0.060 | 0.129 | 0.053 | 0.062 | 0.052 | 0.053 | 0.394 |
| Rwamagana | 0.056 | 0.001 | 0.053 | 0.074 | 0.139 | 0.100 | 0.044 | 0.050 | 0.054 | 0.468 |
| Bugesera | 0.056 | 0.001 | 0.060 | 0.076 | 0.143 | 0.091 | 0.054 | 0.049 | 0.068 | 0.496 |
| Nyaruguru | 0.050 | 0.001 | 0.067 | 0.070 | 0.101 | 0.048 | 0.058 | 0.043 | 0.049 | 0.351 |
| Huye | 0.059 | 0.001 | 0.058 | 0.078 | 0.129 | 0.053 | 0.064 | 0.043 | 0.064 | 0.379 |
| Nyamagabe | 0.054 | 0.002 | 0.081 | 0.066 | 0.111 | 0.061 | 0.058 | 0.042 | 0.053 | 0.503 |
| Gakenke | 0.052 | 0.000 | 0.083 | 0.061 | 0.079 | 0.009 | 0.059 | 0.041 | 0.047 | 0.470 |
| Kamonyi | 0.051 | 0.001 | 0.055 | 0.072 | 0.100 | 0.068 | 0.081 | 0.038 | 0.054 | 0.493 |
| Ngororero | 0.064 | 0.000 | 0.088 | 0.042 | 0.107 | 0.053 | 0.045 | 0.038 | 0.052 | 0.473 |
| Rulindo | 0.059 | 0.000 | 0.089 | 0.066 | 0.093 | 0.047 | 0.046 | 0.037 | 0.042 | 0.398 |
| Ruhango | 0.060 | 0.001 | 0.063 | 0.075 | 0.128 | 0.056 | 0.054 | 0.035 | 0.072 | 0.352 |
| Gisagara | 0.065 | 0.001 | 0.066 | 0.071 | 0.120 | 0.058 | 0.027 | 0.033 | 0.058 | 0.342 |
| Gatsibo | 0.057 | 0.003 | 0.078 | 0.091 | 0.100 | 0.057 | 0.059 | 0.033 | 0.055 | 0.477 |
| Muhanga | 0.055 | 0.000 | 0.062 | 0.076 | 0.071 | 0.023 | 0.064 | 0.032 | 0.043 | 0.401 |
| Kayonza | 0.065 | 0.000 | 0.079 | 0.078 | 0.094 | 0.101 | 0.047 | 0.032 | 0.053 | 0.429 |
| Nyanza | 0.052 | 0.002 | 0.065 | 0.051 | 0.127 | 0.145 | 0.049 | 0.031 | 0.057 | 0.240 |
| Kirehe | 0.064 | 0.000 | 0.074 | 0.063 | 0.095 | 0.081 | 0.026 | 0.031 | 0.051 | 0.314 |
| Gicumbi | 0.047 | 0.010 | 0.103 | 0.066 | 0.086 | 0.037 | 0.046 | 0.029 | 0.044 | 0.326 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Rutsiro | 0.048 | 0.000 | 0.099 | 0.056 | 0.110 | 0.042 | 0.059 | 0.028 | 0.043 | 0.373 |
| Nyamasheke | 0.061 | 0.000 | 0.063 | 0.090 | 0.075 | 0.048 | 0.048 | 0.027 | 0.039 | 0.414 |
| B. Province | | | | | | | | | | |
| Southern | 0.400 | 0.321 | 0.356 | 0.219 | 0.128 | 0.424 | 0.223 | 0.219 | 0.241 | 0.064 |
| Western | 0.411 | 0.328 | 0.350 | 0.267 | 0.114 | 0.388 | 0.234 | 0.212 | 0.273 | 0.072 |
| Northern | 0.415 | 0.281 | 0.346 | 0.227 | 0.118 | 0.398 | 0.236 | 0.199 | 0.272 | 0.073 |
| Eastern | 0.385 | 0.396 | 0.333 | 0.311 | 0.138 | 0.402 | 0.254 | 0.254 | 0.257 | 0.068 |
| C. Area | | | | | | | | | | |
| Urban | 0.380 | 0.299 | 0.373 | 0.342 | 0.106 | 0.313 | 0.216 | 0.249 | 0.357 | 0.075 |
| Semi-urban | 0.391 | 0.327 | 0.339 | 0.267 | 0.123 | 0.388 | 0.211 | 0.235 | 0.280 | 0.061 |
| Rural | 0.404 | 0.338 | 0.346 | 0.253 | 0.126 | 0.410 | 0.240 | 0.220 | 0.252 | 0.069 |
| D. Year | | | | | | | | | | |
| 2006 | 0.331 | 0.366 | 0.283 | 0.603 | 0.154 | 0.421 | 0.339 | 0.253 | 0.208 | 0.043 |
| 2009 | 0.461 | 0.338 | 0.370 | 0.207 | 0.138 | 0.538 | 0.298 | 0.136 | 0.267 | 0.150 |
| 2012 | 0.383 | 0.321 | 0.353 | 0.161 | 0.103 | 0.290 | 0.147 | 0.280 | 0.274 | 0.015 |
| E. Sample | | | | | | | | | | |
| Mean | 0.402 | 0.335 | 0.346 | 0.259 | 0.125 | 0.404 | 0.237 | 0.223 | 0.259 | 0.069 |
| Std Dev | 0.148 | 0.111 | 0.149 | 0.194 | 0.072 | 0.160 | 0.134 | 0.115 | 0.109 | 0.106 |

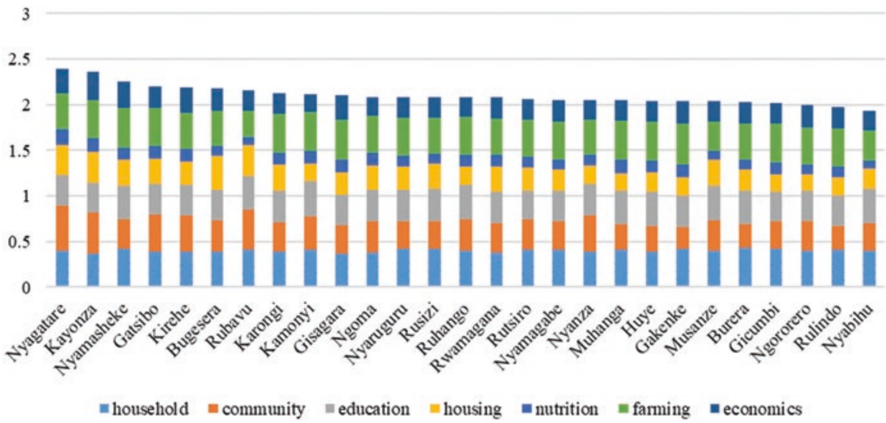


**Fig. 3.1** Family wellbeing level by districts

education and farming indices increased in 2009 as compared to 2006 and then these indices decreased again in 2012. The maximum amount of income index (0.155) was in 2009 while the minimum value (0.021) is associated with 2012. The aggregate family index fluctuated over time. It decreased from 0.253 in 2006 to 0.136 in 2009 and then increased to 0.280 in 2012. The children's index had an increasing trend from 0.208 to 0.267 and 0.274. In sum, the development in children's well-being from 2006 to 2012 was positive but the development in family well-being index was not smooth. In mid-period, 2009, the development in the family index tended to be negative.

Part E of Table 3.4 shows the sample mean and the dispersion around mean of the indices and their components. The largest variations relative to mean values are those attributed to housing and economics and the lowest to household and community components. Dispersion in child well-being was smaller than the corresponding dispersion for family well-being.

Figure 3.1 shows the levels of different components and aggregate family well-being. The housing and community components are the main sources of variations in family well-being among districts. Figure 3.2 shows the different components and their aggregate well-being of children by districts. Again housing and community are the main contributors to the differences in children's well-being among the districts. Contributions of education and the housing standard components are very similar across districts.

## 5.3 *Change in Indices and Their Components by Characteristics*

A correlation matrix of the percentage annual changes in different index components, the overall composite indices and income are presented in Table 3.5. A large number of the pair-wise correlation coefficients are positive and significantly

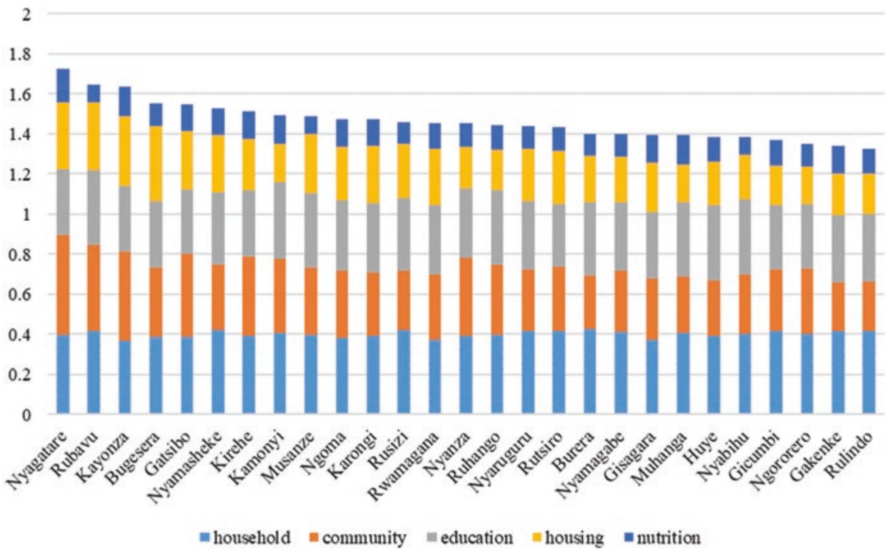


**Fig. 3.2** Children wellbeing level by districts

different from zero. The largest pair-wise correlations are those between changes in household and nutrition (0.188), household and education (0.154), nutrition and education (0.105), and in particular in changes between nutrition and education (0,591) over time.

Table 3.5 further shows that education, nutrition, farming and economics are the main contributors to changes in family well-being. The corresponding segments for changes in children's well-being over time are household, education, housing and nutrition. As expected the changes in the children and family well-being indices are highly correlated (0.556).

Table 3.6 presents percentage changes per annum in different index components. According to this table average percentage changes in all indices are positive and they vary between 0.001 (community index) to 0.400 (income index). The percentage change in the nutrition index is 0.123 with minimum of −0.329 and maximum of censored extreme observation of 2.000. Censoring is conducted to eliminate the influence of a few outlier observations as a way to avoid distortions in the distribution of households. Changes in housing and education indices are almost the same. Maximum changes in all the indices (except for income) are the censored value 2.000. Maximum amount of dispersion belongs to the income index (0.074) and minimum to the community index (0.002) indicating that this index did not change much.

Like Table 3.4 which shows the levels of the indices, changes in the indices in Table 3.6 are composed of four parts, representing percentage yearly changes in all indices by district, province, area and survey years. Part A of Table 3.6 shows that the districts differ in performance or percentage changes in respective well-being index components. The range of changes in individual components and well-being indices also differ across districts. The largest percentage changes are those of

**Table 3.5** Correlation matrix of changes in index components, n = 14,810 obs

| | House-hold | Community | Education | housing | Nutrition | Farming | Economic | Family | Children | Income |
|---|---|---|---|---|---|---|---|---|---|---|
| Household | 1.000 | | | | | | | | | |
| Community | 0.012 | 1.000 | | | | | | | | |
| | 0.172 | | | | | | | | | |
| Education | 0.154 | 0.016 | 1.000 | | | | | | | |
| | 0.001 | 0.072 | | | | | | | | |
| Housing | 0.101 | 0.033 | 0.036 | 1.000 | | | | | | |
| | 0.001 | 0.000 | 0.001 | | | | | | | |
| Nutrition | 0.188 | −0.003 | 0.105 | 0.001 | 1.000 | | | | | |
| | 0.001 | 0.731 | 0.001 | 0.922 | | | | | | |
| Farming | 0.123 | −0.009 | 0.036 | −0.004 | 0.591 | 1.000 | | | | |
| | 0.001 | 0.341 | 0.001 | 0.674 | 0.001 | | | | | |
| Economic | 0.031 | 0.011 | 0.069 | 0.049 | 0.097 | 0.091 | 1.000 | | | |
| | 0.001 | 0.222 | 0.001 | 0.001 | 0.001 | 0.001 | | | | |
| Family wellbeing | 0.244 | 0.065 | 0.385 | 0.081 | 0.581 | 0.392 | 0.342 | 1.000 | | |
| | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | | | |
| Child wellbeing | 0.492 | 0.010 | 0.332 | 0.266 | 0.271 | 0.052 | 0.097 | 0.556 | 1.000 | |
| | 0.001 | 0.281 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | | |
| Income | −0.133 | −0.006 | 0.048 | −0.009 | 0.028 | 0.004 | 0.262 | 0.103 | −0.037 | 1.000 |
| | 0.001 | 0.478 | 0.001 | 0.325 | 0.002 | 0.623 | 0.001 | 0.001 | 0.001 | |

**Table 3.6** Summary of percentage changes in all indices by district, province, area and year, n = 14,810 obs

| | Household | Community | Education | Housing | Nutrition | Farming | Economic | Family wb | Children wb | income |
|---|---|---|---|---|---|---|---|---|---|---|
| A. District | | | | | | | | | | |
| Nyanza | 0.052 | 0.002 | 0.065 | 0.051 | 0.127 | 0.145 | 0.049 | 0.031 | 0.057 | 0.240 |
| Gisagara | 0.065 | 0.001 | 0.066 | 0.071 | 0.120 | 0.058 | 0.027 | 0.033 | 0.058 | 0.342 |
| Nyaruguru | 0.050 | 0.001 | 0.067 | 0.070 | 0.101 | 0.048 | 0.058 | 0.043 | 0.049 | 0.351 |
| Huye | 0.059 | 0.001 | 0.058 | 0.078 | 0.129 | 0.053 | 0.064 | 0.043 | 0.064 | 0.379 |
| Nyamagabe | 0.054 | 0.002 | 0.081 | 0.066 | 0.111 | 0.061 | 0.058 | 0.042 | 0.053 | 0.503 |
| Ruhango | 0.060 | 0.001 | 0.063 | 0.075 | 0.128 | 0.056 | 0.054 | 0.035 | 0.072 | 0.352 |
| Muhanga | 0.055 | 0.000 | 0.062 | 0.076 | 0.071 | 0.023 | 0.064 | 0.032 | 0.043 | 0.401 |
| Kamonyi | 0.051 | 0.001 | 0.055 | 0.072 | 0.100 | 0.068 | 0.081 | 0.038 | 0.054 | 0.493 |
| Karongi | 0.059 | 0.001 | 0.066 | 0.060 | 0.129 | 0.053 | 0.062 | 0.052 | 0.053 | 0.394 |
| Rutsiro | 0.048 | 0.000 | 0.099 | 0.056 | 0.110 | 0.042 | 0.059 | 0.028 | 0.043 | 0.373 |
| Rubavu | 0.056 | 0.002 | 0.068 | 0.078 | 0.189 | 0.230 | 0.054 | 0.055 | 0.029 | 0.311 |
| Nyabihu | 0.057 | 0.000 | 0.061 | 0.073 | 0.200 | 0.212 | 0.043 | 0.062 | 0.056 | 0.258 |
| Ngororero | 0.064 | 0.000 | 0.088 | 0.042 | 0.107 | 0.053 | 0.045 | 0.038 | 0.052 | 0.473 |
| Rusizi | 0.050 | 0.001 | 0.069 | 0.117 | 0.190 | 0.149 | 0.048 | 0.063 | 0.053 | 0.387 |
| Nyamasheke | 0.061 | 0.000 | 0.063 | 0.090 | 0.075 | 0.048 | 0.048 | 0.027 | 0.039 | 0.414 |
| Rulindo | 0.059 | 0.000 | 0.089 | 0.066 | 0.093 | 0.047 | 0.046 | 0.037 | 0.042 | 0.398 |
| Gakenke | 0.052 | 0.000 | 0.083 | 0.061 | 0.079 | 0.009 | 0.059 | 0.041 | 0.047 | 0.470 |
| Musanze | 0.063 | 0.002 | 0.061 | 0.081 | 0.178 | 0.195 | 0.057 | 0.069 | 0.047 | 0.376 |
| Burera | 0.051 | 0.003 | 0.065 | 0.068 | 0.111 | 0.086 | 0.044 | 0.060 | 0.056 | 0.418 |
| Gicumbi | 0.047 | 0.010 | 0.103 | 0.066 | 0.086 | 0.037 | 0.046 | 0.029 | 0.044 | 0.326 |
| Rwamagana | 0.056 | 0.001 | 0.053 | 0.074 | 0.139 | 0.100 | 0.044 | 0.050 | 0.054 | 0.468 |
| Nyagatare | 0.051 | 0.004 | 0.082 | 0.093 | 0.172 | 0.133 | 0.038 | 0.067 | 0.058 | 0.422 |
| Gatsibo | 0.057 | 0.003 | 0.078 | 0.091 | 0.100 | 0.057 | 0.059 | 0.033 | 0.055 | 0.477 |
| Kayonza | 0.065 | 0.000 | 0.079 | 0.078 | 0.094 | 0.101 | 0.047 | 0.032 | 0.053 | 0.429 |

(continued)

**Table 3.6** (continued)

| | Household | Community | Education | Housing | Nutrition | Farming | Economic | Family wb | Children wb | income |
|---|---|---|---|---|---|---|---|---|---|---|
| Kirehe | 0.064 | 0.000 | 0.074 | 0.063 | 0.095 | 0.081 | 0.026 | 0.031 | 0.051 | 0.314 |
| Ngoma | 0.060 | 0.000 | 0.066 | 0.094 | 0.132 | 0.117 | 0.071 | 0.055 | 0.081 | 0.522 |
| Bugesera | 0.056 | 0.001 | 0.060 | 0.076 | 0.143 | 0.091 | 0.054 | 0.049 | 0.068 | 0.496 |
| B. Province | | | | | | | | | | |
| Southern | 0.056 | 0.001 | 0.065 | 0.070 | 0.111 | 0.063 | 0.057 | 0.037 | 0.056 | 0.384 |
| Western | 0.056 | 0.001 | 0.073 | 0.074 | 0.142 | 0.110 | 0.051 | 0.046 | 0.047 | 0.375 |
| Northern | 0.054 | 0.003 | 0.080 | 0.068 | 0.109 | 0.075 | 0.051 | 0.047 | 0.047 | 0.397 |
| Eastern | 0.059 | 0.001 | 0.071 | 0.081 | 0.125 | 0.097 | 0.049 | 0.045 | 0.060 | 0.447 |
| C. Area | | | | | | | | | | |
| Urban | 0.058 | −0.003 | 0.066 | 0.082 | 0.216 | 0.205 | 0.065 | 0.052 | 0.045 | 0.452 |
| Semi-urban | 0.060 | 0.007 | 0.074 | 0.066 | 0.137 | 0.126 | 0.071 | 0.043 | 0.035 | 0.375 |
| Rural | 0.056 | 0.001 | 0.072 | 0.074 | 0.116 | 0.077 | 0.050 | 0.043 | 0.055 | 0.399 |
| D. Year | | | | | | | | | | |
| 2009 | 0.039 | 0.002 | 0.093 | 0.070 | 0.104 | 0.056 | 0.053 | 0.051 | 0.060 | 0.385 |
| 2012 | 0.070 | 0.001 | 0.054 | 0.077 | 0.136 | 0.110 | 0.051 | 0.037 | 0.047 | 0.411 |
| E. Sample | | | | | | | | | | |
| Mean | 0.056 | 0.001 | 0.071 | 0.074 | 0.123 | 0.087 | 0.052 | 0.044 | 0.053 | 0.400 |
| Std Dev | 0.005 | 0.002 | 0.013 | 0.015 | 0.036 | 0.057 | 0.012 | 0.013 | 0.010 | 0.074 |

nutrition and farming. These greatly influence the ranks of Musanze, Nyagatare, Ruizi, Nyabihu and Burera to have the five highest changes in family well-being, while Nyanza, Kirebe, Gicumbi, Rutsiro and Nyamasheke are among the districts with five lowest family well-being indices. The ranks of the districts are not very closely related to changes in income per capita of the families.

Part B of Table 3.6 shows large variations in percentage changes in the nutrition and farming components as well as in income per capita, while the corresponding variations for the remaining components are low. Like levels, the Eastern Province enjoyed a high change rate or growth in well-being over time. The Northern Province had the highest changes in community and education indices and the lowest changes in housing and nutrition indices. The community index did not change much in different provinces.

Part C of Table 3.6 indicates that urban districts are superior to semi-urban and rural areas in case of income per capita and family well-being. The same applies to the main contributing well-being components of nutrition and farming, but it does not necessarily apply to other individual well-being components. It is worth mentioning here that heterogeneity in both the indices and their components is very large by location area. We did not find a clear one-to-one relationship between the well-being indices and their underlying components.

Part D of Table 3.6 shows low changes in 2009 in the indices as compared to 2012. It suggests that the high levels of indices and their components are associated with low annual percentage changes in the well-being indices – that is a negative relationship between level and percentage changes. We note that most of the changes in the different indices (household, housing, nutrition and farming) happened in 2012. As other parts of this table indicate, the community component did not change much over time. Unlike the two well-being indices, changes in the per capita income index increased over time. This suggests that income is not the main contributor to well-being when well-being is defined multidimensionally.

Figure 3.3 shows the annual percentage changes in different components and aggregate changes in family well-being. Among the districts, growth in nutrition and farming were the main sources of variations in family well-being. Figure 3.4 shows changes in the different components and the aggregate well-being of children by districts. Again housing and community are the main contributors to the differences in changes in children's well-being among the districts. The contribution of education is very similar across districts.

## *5.4 Determinants of Income and Well-Being*

Using the principal component analysis we identified various indicators that contributed to well-being in Rwanda. The well-being index was further decomposed into its underlying main components. In addition, we distinguished between well-being of children and their families. We investigated the differences in both levels and percentage changes over time in well-being indices and their components

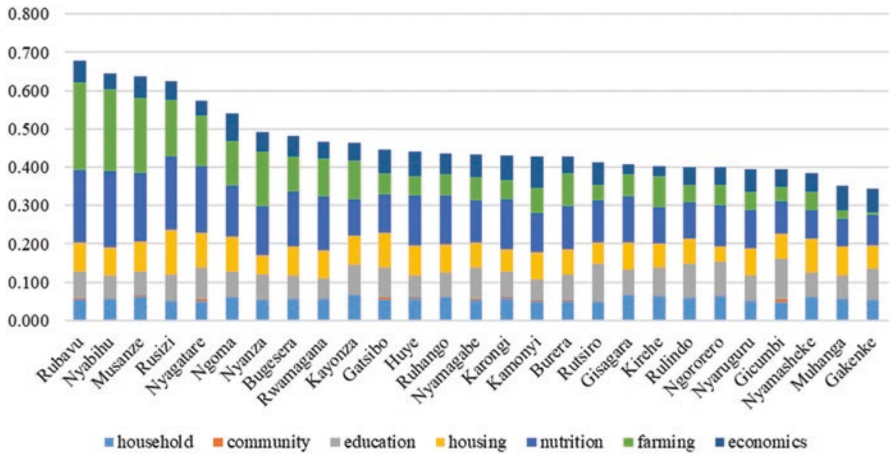


**Fig. 3.3** Sum and annual changes in family wellbeing components across districts

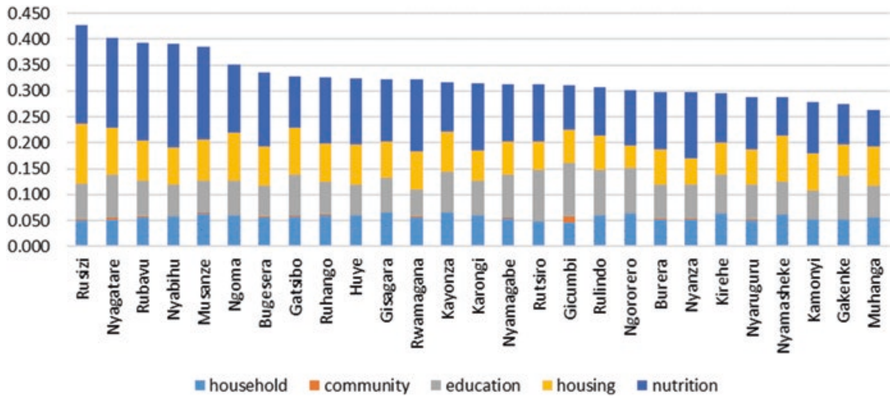


**Fig. 3.4** Sum and annual changes in children wellbeing components across districts

amongst different districts, provinces and location areas in Rwanda and their temporal patterns over time. This included income per capita which is a common unidimensional measure of well-being. The income measure was compared with the previous well-being measures which are multidimensional.

PCA helped us reduce the dimensionality of well-being to a few specific components and composite indices of children and their families. In this section we estimate models of income and well-being using a regression analysis to identify their determinants and estimate the effects on levels of per capita income and well-being. The estimation results from the ordinary least squares regression of income per capita on different components of well-being and other determinants such as provincial location, area and time periods are reported in Table 3.7a. Since there might be a two-way causal relationship between income and well-being, family and children's well-being are also regressed on income and other determinants. Alternatively, an estimation of the income and well-being index as a system of two equations accounts for endogeneity and simultaneity issues. The two sets of well-being models differ by economic and farming components of well-being.

The estimation results in Table 3.7a are heteroscedasticity consistent following the White test method. In each case four models were specified, estimated and tested. The model specifications differed by generalization of the basic model with the overall index as the determinant, different well-being components and added control variables including time, location, area and province characteristics. The decomposition of the overall index into underlying components was used to study the impact of various indices on Rwanda's family and children's well-being.

In Model A1 which is our basic model in the per capita income, family well-being was the only determinant of level of income. An increase in well-being led to an increased income. This is consistent with the fact that families with higher well-being are more educated and healthier and as such are more productive in terms of their earning capacity. A disaggregation of family well-being in Model A2 led to both positive and negative effects on the level of income. The housing and farming components were negative, while the others were positively related to income. A disaggregation of well-being increased $R^2$ performance of the model from 0.009 to 0.136. Adding control variables to each of two models labeled as Models A3 and A4 further increased $R^2$ performance of the income model from 0.047 to 0.160. A speci-

**Table 3.7a** Determinants of per capita income, n = 14,810 obs

| | Model A1 | | Model A2 | | Model A3 | | Model A4 | |
|---|---|---|---|---|---|---|---|---|
| | Coeff | Std Err | Coeff | Std Err | Coeff | Std Err | Coeff | Std Err |
| Intercept | 9.727a | 0.024 | 9.554a | 0.051 | 9.484a | 0.063 | 8.737a | 0.101 |
| Household | | | −1.562a | 0.072 | | | −1.848a | 0.074 |
| Community | | | 0.556a | 0.098 | | | 0.704a | 0.100 |
| Education | | | 0.963a | 0.066 | | | 0.735a | 0.066 |
| Housing | | | −0.782a | 0.059 | | | 0.448a | 0.097 |
| Nutrition | | | 1.745a | 0.167 | | | 2.156a | 0.192 |
| Farming | | | −0.751a | 0.091 | | | −0.513a | 0.126 |
| Economic | | | 3.367a | 0.095 | | | 3.640a | 0.107 |
| d2009 | | | | | 0.453a | 0.033 | 0.776a | 0.050 |
| d2012 | | | | | −0.177a | 0.029 | 0.899a | 0.060 |
| Family | 1.032a | 0.096 | | | 2.441a | 0.114 | | |
| Suburban | | | | | −0.273a | 0.060 | −0.256a | 0.056 |
| Rural | | | | | −0.270a | 0.050 | −0.380a | 0.047 |
| Western | | | | | 0.192a | 0.027 | 0.223a | 0.026 |
| Northern | | | | | 0.136a | 0.031 | 0.141a | 0.029 |
| Eastern | | | | | 0.100a | 0.029 | 0.024 | 0.028 |
| F-value | 130.360 | | 333.520 | | 92.720 | | 202.790 | |
| R2 adj | 0.009 | | 0.136 | | 0.047 | | 0.160 | |

Notes: Significant at less than 1% (a) and 5% (b) levels of significance. Urban area, Southern province and 2006 are references. Standard errors are corrected for heteroscedasticity

fication test suggested that the most general Model A4 was the accepted model specification. All included explanatory variables were statistically significant at less than the 1 per cent level of significance with the exception of one province dummy (Eastern) which was not significantly different from the Southern Province that served as the reference province.

The estimation results from models with determinants of family well-being are reported in Table 3.7b. The models were estimated by OLS with heteroscedastic consistent standard errors. In Model B1 which is our basic family well-being model, per capita income was the only determinant of level of family well-being. An increase in income increased family well-being. This is consistent with our expectation that a higher income increases a family's welfare and well-being. Adding the control variables representing time, province and area locations to Model B2 suggests they had very positive effects on the performance of the model. $R^2$ increased from 0.009 to 0.370. Inclusion of the components of the family well-being (Model B3) showed their contributions to well-being. Housing and farming negatively affected family well-being. However, the effect of the housing component was not significant. Finally, a generalization of family well-being to include income and well-being components and control variables (Model B4) led to improved performance of the model where $R^2$ increased to 0.793. A specification test of the models suggested that the most general Model B4 was the accepted model specification.

**Table 3.7b** Determinants of family wellbeing, n = 14,810 obs

| | Model B1 | | Model B2 | | Model B3 | | Model B4 | |
|---|---|---|---|---|---|---|---|---|
| | Coeff | Std Err | Coeff | Std Err | Coeff | Std Err | Coeff | Std Err |
| Intercept | 0.138a | 0.008 | 0.133a | 0.008 | 0.103a | 0.007 | −0.122a | 0.007 |
| Household | | | | | 0.026a | 0.005 | 0.063a | 0.003 |
| Community | | | | | 0.234a | 0.009 | 0.307a | 0.007 |
| Education | | | | | 0.150a | 0.006 | 0.152a | 0.005 |
| Housing | | | | | −0.004 | 0.004 | 0.075a | 0.006 |
| Nutrition | | | | | 1.245a | 0.017 | 0.794a | 0.017 |
| Farming | | | | | −0.506a | 0.008 | −0.032a | 0.008 |
| Economic | | | | | 0.043a | 0.008 | 0.223a | 0.006 |
| d2009 | | | −0.113a | 0.002 | | | −0.074a | 0.003 |
| d2012 | | | 0.033a | 0.003 | | | 0.140a | 0.003 |
| Income | 0.008a | 0.001 | 0.013a | 0.001 | 0.002a | 0.001 | 0.001b | 0.000 |
| Suburban | | | −0.011b | 0.005 | | | −0.023a | 0.003 |
| Rural | | | −0.022a | 0.004 | | | −0.047a | 0.002 |
| Western | | | −0.007a | 0.002 | | | 0.006a | 0.001 |
| Northern | | | −0.014a | 0.002 | | | 0.007a | 0.001 |
| Eastern | | | 0.029a | 0.002 | | | −0.001 | 0.001 |
| F-value | 130.360 | | 1088.500 | | 2198.180 | | 3773.350 | |
| R2 adj | 0.009 | | 0.370 | | 0.543 | | 0.793 | |

Notes: Significant at less than 1% (a) and 5% (b) levels of significance. Urban area, Southern province and 2006 are references. Standard errors are corrected for heteroscedasticity

With the exception of two variables, income and the Eastern Province dummy, the remaining explanatory variables were statistically significant at the less than 1 per cent level of significance. Income effect was only weakly significant.

Estimation results from models with determinants of children's well-being are reported in Table 3.7c. The key difference between Models 7B and 7C is that in Model 7C child well-being was primarily effected by only child related components. The models were again estimated by OLS with heteroscedastic consistent standard errors. In the simplest Model C1 which is the basic model per capita income served as the only determinant of the level of children's well-being. An increase in income increased children's well-being. This is consistent with our expectation that a higher income will increase children's well-being. Similar to the family well-being model's specifications we added the different control variables to Model C2 which showed very positive effects on the performance of the model. $R^2$ increased from 0.002 to 0.124. Again, inclusion of the children's well-being indicators (Model C3) showed evidence of their positive contributions to children's well-being. The effects of the household and education components were the highest. Finally, a generalization of the model to include the control variables in Model C4 led to further improvements in the fit of the model. The performance of the model measured in $R^2$ increased to 0.662. A specification test of the models suggested that the most general Model C4 was the accepted model specification. All included explanatory variables were statistically significant at less than the 1 per cent level of significance.

**Table 3.7c** Determinants of children wellbeing, n = 14,810 obs

| | Model C1 | | Model C2 | | Model C3 | | Model C4 | |
|---|---|---|---|---|---|---|---|---|
| | Coeff | Std Err | Coeff | Std Err | Coeff | Std Err | Coeff | Std Err |
| Intercept | 0.225a | 0.007 | 0.262a | 0.008 | −0.051a | 0.007 | −0.237a | 0.009 |
| Household | | | | | 0.345a | 0.005 | 0.309a | 0.004 |
| Community | | | | | 0.073a | 0.010 | 0.118a | 0.008 |
| Education | | | | | 0.207a | 0.006 | 0.150a | 0.004 |
| Housing | | | | | 0.072a | 0.005 | 0.429a | 0.011 |
| Nutrition | | | | | 0.117a | 0.015 | 0.371a | 0.011 |
| d2009 | | | 0.065a | 0.002 | | | 0.186a | 0.005 |
| d2012 | | | 0.072a | 0.002 | | | 0.256a | 0.006 |
| Income | 0.003a | 0.001 | 0.002a | 0.001 | 0.004a | 0.001 | 0.002a | 0.000 |
| Suburban | | | −0.080a | 0.005 | | | −0.062a | 0.003 |
| Rural | | | −0.115a | 0.005 | | | −0.100a | 0.003 |
| Western | | | 0.041a | 0.002 | | | 0.033a | 0.001 |
| Northern | | | 0.035a | 0.002 | | | 0.037a | 0.002 |
| Eastern | | | 0.031a | 0.002 | | | 0.004a | 0.001 |
| F-value | 24.420 | | 363.060 | | 1577.300 | | 2229.720 | |
| R2 adj | 0.002 | | 0.124 | | 0.390 | | 0.662 | |

Notes: Significant at less than 1% (a) and 5% (b) levels of significance. Urban area, Southern province and 2006 are references. Standard errors are corrected for heteroscedasticity

According to Models 7B and 7C the different well-being components' effects on well-being were positive and significant. The time effect differed among the two models suggesting different development of children and family well-being. On the other hand, farming had a negative effect on the well-being of families. Results from Models 7B and 7C suggest that 2009 had negative effects on family well-being, but 2012 had positive effects. This is interpreted to mean that family well-being has progressed over time in Rwanda. The area and province effects in Models B4 and C4 showed similar positive effects on children and family well-being.

## 6 Summary and Conclusion

Rwanda is a low income country even by African standards. Despite its limited resources the Government of Rwanda in cooperation with NGOs has been able to give high priority to well-being of families and their children. The country, despite its very low GDP per capita, has succeeded in having one of the best child well-being indicators in Africa. Recently Rwanda fulfilled two important achievements in the protection of children. These reform measures aim to protect children's rights and integrate children into families that provide needed care to them. The success in child welfare is positively influenced by policies developed with support from UNICEF.

This research aimed to estimate multidimensional well-being of children and their families in Rwanda. Composite indices of well-being decomposed into their underlying components were estimated using the principal component analysis method and stratified household surveys. The households were then ranked by level of well-being and by various household, district and community characteristics. The results shed light on both the level and changes in well-being of children and their families. They allow identification of provinces and districts with relatively better living condition for children and families. This can serve as a model for public policies aimed at improving the general development of well-being and its specific components in Rwanda.

In this research we identified various indicators contributing to the well-being of households in Rwanda. A composite index of well-being was also constructed. The aggregate well-being index was further decomposed into several main components including household, community, education, housing standard, nutrition, farming and economics. A grouping of the components allowed us to distinguish between well-being of children and their families. The measure of well-being is household specific and as such it allowed us to investigate the differences in both levels and percentage changes in well-being indices and their components amongst different districts, provinces and areas in Rwanda and their development over time. The two well-being indices are multidimensional and were compared with the commonly used unidimensional measure defined as income per capita.

The principal component analysis helps reduce the dimensionality of well-being to a few specific components. In computing the index for individual households the different principal components with eigenvalues larger than 1 were aggregated using the share of the total variance in the data explained by the different components. This method allowed us to use all information in computing the composite indices of children and their families. The two indices differed by economics and farming components. The selection of well-being components and aggregate indices were determined by data availability and maximum use of data from an economics point of view. Thus, there is room for significant improvements in the indices' definitions and their measurements.

Variations in the levels and percentage annual changes in different well-being components and composite indices were analyzed by location characteristics of households such as district, province and area over time. The analysis showed evidence of significant heterogeneity in various components and by different dimensions of household characteristics. There is clear evidence that some provinces, districts and areas remained high or low ranked. The index components' levels and changes over time were found to be different by characteristics. Different districts and provinces were found to be endowed with different conditions to promote the well-being of residing households. Any public policy measure to enhance well-being must account for both common and unique locality conditions of households.

In addition to the principal component analysis-based estimated indices to rank households by various characteristics as a complement we also estimated several models of income and well-being using a regression analysis. The objective was to identify their determinants and estimate their effects on levels of per capita income and well-being. This approach helped us establish the correlation or the best causality between the indices and their determinants. The estimation results from ordinary least squares regression of the income per capita on different components of well-being and other determinants such as provincial location, area and time periods were reported. Since there might be a two-way causal relationship between income and well-being, family and children's well-being were also regressed on income and other determinants. The two sets of well-being models differed by the economics and farming components of well-being.

The estimation result from a regression of income per capita as a unidimensional measure of well-being and the principal component analysis based multidimensional indices of children and their families' well-being regressed on various control variables helped identify important characteristics and their effects on well-being. The basic model's specifications were generalized and tested to identify and use the finally accepted model specification in the analysis of the factors influencing well-being in Rwanda. The results show evidence of heterogeneity in effects and the necessity of designing public policies that are adapted to local conditions.

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# Chapter 4
# Vulnerability to Poverty in Ethiopia

**Getu Tigre**

## 1 Introduction

Ethiopia is one of the least developed countries in the world. Poverty in Ethiopia is deep-rooted and pervasive. Like in many other developing countries, poverty reduction is the top policy priority in Ethiopia. Poverty reduction policies in most developing countries, including in Ethiopia, focus on people or households' that are currently poor and ignore those who are likely to be poor in the future. For more than two decades now, poverty assessments or analyses have been done to inform policymakers about alleviating poverty in developing economies. These poverty assessments have shown detailed profiles of the poor to understand the incidence or depth of poverty in various segments of the population. But poverty is a stochastic phenomenon; poor households today may or may not be poor tomorrow. Households that are non-poor today may face some adverse shocks and become poor in the near future. Among the currently poor households there may be some who will continue to be poor in the future. In general, a poverty analysis (households' current poverty levels) is an ex-post measure of a household's well-being and may not be a good guide to the household's vulnerability to poverty in the future. Inadequate research in the area of vulnerability to poverty has contributed to this focus on current poverty. For policy purposes, what really matters is the likelihood of households or individuals falling into poverty in the near future or vulnerability to poverty. The most effective way of ensuring households' economic well-being is by preventing them from falling into poverty rather than concentrating on poverty after it has occurred.

Although Ethiopia has achieved economic growth, it is unclear whether vulnerability to poverty has also declined in the country. Households' vulnerability to poverty is essential for any poverty reduction effort and for bringing about

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sustainable growth and development in the country. Risk is inherent in human life and households in Ethiopia are exposed to different risks (for example, droughts, crop and animal diseases and floods). Households' exposure to different risks, whether idiosyncratic or covariate, is the main reason for examining vulnerability to poverty. Vulnerability is seen as the probability of a non-poor person or household becoming poor in the future or the prospect of a poor person or household continuing to be poor in the future (Christiansen and Subbarao 2004).

Policies designed for reducing poverty should take into consideration the current non-poor but vulnerable to poverty households with the poor households. As pointed out by Raghbendra et al. (2009) the part of the population that faces vulnerability to poverty is considerably different from the part that is observed to be poor. In Ethiopia, around 48 percent of the households are highly vulnerable to poverty and about 18 percent of the non-poor households are highly vulnerable to poverty (Fekadu 2013). Moreover, the distribution of vulnerability to poverty across different regions differs significantly from the distribution of poverty. Hence, poverty reduction strategies need to consider not just poverty alleviation but also poverty prevention (vulnerability to poverty).

Poverty and vulnerability to poverty are closely related concepts. According to Hoddinott and Quisumbing (2003) vulnerability is uninsured exposure to different risks or it can be defined as the risk of non-poor individuals or households falling below the poverty line or those already below the poverty line remaining in poverty. This means that vulnerability is measured as the probability of a household falling into poverty in the near future. The poor are typically the most exposed to different risks and they also have the fewest instruments to deal with these risks. Hence, poverty and vulnerability are two sides of the same coin (Chaudhuri et al. 2002; Tu Dang 2009).

Vulnerability is high in developing nations but data which can help understand the risks that households may face in the future is not readily available. In developing countries, financial markets are not well established and they are also less efficient so households have limited market-based instruments like insurance. Social insurance programs related to unemployment, sickness and injury are also not well established in developing nations.

It has now been widely recognized that policies aimed at combating poverty ought to focus not only on those who are currently poor but also on those who face the risk of moving into poverty and those already trapped in it. This is why an analysis of households' vulnerability to poverty is becoming the main focus of development economics literature.

There is widespread poverty in Ethiopia, and many households suffer spells of chronic and transient poverty. Research indicates that expected poverty (vulnerability) is much higher in Ethiopia than the point in time estimates of poverty (Fekadu 2013; Negassa et al. 2014). Various interventions have been made to reduce the incidence of poverty. However, it is difficult to solve this problem due to the depth and complexity of poverty and vulnerability to poverty. Hence, vulnerability to poverty has to be a point of concern in Ethiopia and this needs a rigorous analysis. However, little empirical work has been done to examine the extent of vulnerability to poverty in the country. The available studies on vulnerability to poverty focus only on one-dimensional vulnerability to poverty by using income or consumption expenditure (Dercon and Krishnan 2000; Negassa et al. 2014) and ignore vulnerability to multidimensional poverty. Some studies on unidimensional vulnerability to poverty are also region specific. For example, Fekadu (2013) studied vulnerability to poverty in the Oromia regional state which does not show vulnerability to poverty among households in the country. Others are gender based, for example Negassa et al.'s (2014) study on vulnerability of female headed households to poverty. It does not give a comprehensive picture of households' vulnerability to poverty in the country.

This research, however, studies vulnerability to poverty both from one-dimensional and multidimensional perspectives and provides a detailed account of vulnerability in Ethiopia. This paper uses rigorous modeling techniques to estimate households' vulnerability to both unidimensional and multidimensional poverty and makes a contribution to literature on vulnerability to poverty.

The rest of the paper is structured as follows: Sect. 2 discusses the conceptual framework of the research, Sect. 3 reviews related literature and Sect. 4 discusses the data and methodology. Section 5 presents the results and discusses its findings. Section 6 gives a conclusion and provides some recommendations.

## 2 Conceptual Framework

Vulnerability to poverty can be conceptualized as having two components: exposure to a shock and the ability to manage the shock. Shocks include natural shocks such as droughts, floods and crop failures or economic shocks such as economic crises. Households can use different mechanisms to protect themselves from such risks or vulnerabilities – by drawing on their savings, diversifying their livelihoods or by building social networks that provide informal social assistance. People become vulnerable when all these risk coping mechanisms fail. An assessment of vulnerability also includes household welfare incorporating both average expenditure and the risks that households face.

One of the greatest developmental challenges facing the world today is the elimination of poverty by reducing people's vulnerability to poverty because societies that are characterized by high levels of poverty and vulnerability to poverty are seen as lacking the potential needed to move out of underdevelopment. Poverty and vulnerability to poverty are complex and multifaceted concepts that are interlinked in such a way that each causes the other. While poverty makes people vulnerable to various shocks such as droughts, diseases and other natural disasters because the poor have less resources to deal with these shocks. This vulnerability to shocks exacerbates their poverty and hence their vulnerability to future shocks.

Hence, a poverty assessment that includes an analysis of vulnerability to poverty is both desirable and necessary for various reasons. First, for thinking about appropriate forward-looking anti-poverty interventions it is clearly necessary to go beyond cataloging who is currently poor and how poor they are to an assessment of households' vulnerability to poverty – who is likely to be poor, how likely are they to be poor and why are they likely to be poor. Second, focusing on vulnerability to poverty helps in highlighting the distinction between poverty prevention interventions and poverty alleviation interventions. Third, vulnerability is an inherent aspect of human well-being and exposure to risks and uncertainties about the future affect current well-being (Tu Dang 2009).

For instance, if there are two households (A and B) on the same iso-poverty surface and if household A is relatively healthy and well educated but deprived incomewise, it may be less vulnerable and better able to withstand a shock than household B that possesses a higher income but is more deprived in terms of health and education. In other words, when present measures of multidimensional poverty compare individuals they ignore the differential risks and vulnerability conditions of alternative attributes yielding the same level of poverty today (Thorbecke 2008). Dependence exists between the form that poverty takes today and possible poverty outcomes in the future.

## 3 Literature Review

Poverty affects the lives of millions of people worldwide. Governments and international organizations widely use poverty measures to design poverty alleviation policies. These policies are future focused. However, the most commonly used poverty measures indicate the current poverty or poverty history of a country and do not say anything about future poverty or households' vulnerability to poverty and hence do not provide forward looking information. If policymakers design poverty alleviation policies on the basis of the poverty status in the current year, the poor may have escaped from poverty and the non-poor may have slipped into poverty in the future due to various reasons. The question is who is likely to suffer the most poverty in the future and an important way of measuring this is by considering vulnerability to poverty. Therefore, any poverty analysis should consider households' vulnerability to poverty for designing appropriate poverty reduction policies. It is also suggested that ex-ante measures for preventing households from becoming poor as well as ex-post measures to alleviate those already in poverty should be combined in evaluating poverty.

There is no consensus on a definition of vulnerability to poverty. However, research is increasingly defining vulnerability to poverty as the probability of falling into poverty (Chaudhuri et al. 2002). Vulnerability to poverty can also be defined as the probability that an individual or a household may be poor in the near future regardless of whether he or the household is currently poor or not. Vulnerability can be defined as a probability or a risk that a household will fall into poverty at least once in the near future. Vulnerability, unlike poverty, is a more future oriented concept that considers households' possible welfare changes in the future. Therefore, vulnerability has the nature of a probability forecast and is seen as expected poverty (Gowon et al. 2013; Tu Dang 2009). Poverty is an ex-post realization of variables such as well-being or income with respect to a socially determined minimum threshold (poverty line), while vulnerability is the ex-ante expectation of that variable relative to this threshold (Dercon 2005). The World Development Report (2000–2001) defines vulnerability as a risk that a household or an individual will experience an episode of income or health poverty over time. Vulnerability is also defined as the probability or risk today of being in poverty or falling into deeper poverty in the future.

There are three widely used approaches for measuring vulnerability to poverty (Hoddinott and Quisumbing 2003): vulnerability as expected poverty (VEP), vulnerability as low expected utility (VEU) and vulnerability as uninsured exposure to risk (VER). All share a common characteristic, namely they construct a model that predicts a measure of welfare. VEP and VEU share two more commonalities; they refer to a benchmark for this welfare indicator, z, and enumerate a probability of falling below this benchmark. Vulnerability is the likelihood that realized consumption will fall below the poverty line. The VEP and VEU approaches measure vulnerability at the individual level. However, aggregation over all the individuals or households considered gives a measure of aggregate vulnerability. Because expected poverty is more easily measurable than utility-based measures (Ligon and Schechter 2003), conceptualizing vulnerability in terms of expected poverty seems reasonable in assessing ex-ante household welfare.

VER assesses whether observed shocks generate welfare losses but does not measure vulnerability as it does not construct probabilities. They are ex-post assessments of the degree to which a negative shock causes a household to deviate from the expected welfare. In terms of policy implications, the VEP approach can help distinguish between those who are currently poor and those who are permanently poor and hence could help design preventive measures before an adverse event occurs. Vulnerability as expected poverty has been widely used in literature (Gunther and Harttgen 2009; Imai et al. 2010; Jha et al. 2010; McCulloch and Calandrino 2003; Sricharoen 2011). This approach has also been used for estimating vulnerability to poverty in different contexts in different developing countries like Vietnam (Imai et al. 2011a), rural China (Zhang and Wan 2006) and Guatemala (Tesliuc and Lindert 2004).

Different ideas have been expressed on the relationship between poverty and vulnerability and the poverty line. According to one idea, in vulnerability to poverty the poverty line is adjusted in such a way that the utility of a person at the current poverty line and that at the adjusted poverty line become equal. The adjusted poverty line is a simple relative augmentation of the current poverty line under a multiplicative model of vulnerability with constant Arrow-Pratt relative risk aversion. Therefore, a household or a person who is non-poor (poor) currently may not be treated as non-poor (poor) in a vulnerable situation. We studied the implications of vulnerability to the poverty line and the issue of adjusting the poverty threshold under vulnerability so that the corrected poverty line also represents the standard of living in an environment of vulnerability.

According to Dang and Lanjouw (2014) two thresholds are important for identifying the poor and vulnerable groups. These are the poverty line and vulnerability line, below which non-poor households can face high risks of falling back into poverty. The first approach is identifying a population that is not vulnerable and seeing the lower bound income level for this population group as the vulnerability line. The second approach considers the population that is clearly not poor but faces a real risk of falling into poverty and the upper bound income level for this population can be set as the vulnerability line. This approach avoids the arbitrariness and indirectness of scaling up the poverty line by a certain factor to get the vulnerability line.

Vulnerability as an area of economic research using panel data has been widely explored. However, due to the limitations imposed by the lack of reliable and up to date panel data in developing countries, vulnerability analyses using cross-sectional data that uses the variance of consumption to estimate households' expected poverty is now widely used (Chaudhuri et al. 2002; Fekadu 2013; Gowon et al. 2013; Imai et al. 2010; Jha et al. 2010; McCulloch and Calandrino 2003; Raghbendra et al. 2009; Sricharoen 2011). Besides the lack of long panel data for an analysis of vulnerability to poverty, most current surveys often do not contain sufficient information about the shocks that households face when estimating the impact of these shocks on vulnerability. Important shocks that households face which make them likely to be vulnerable to poverty are illnesses, flooding, droughts and cyclones. There may be other shocks such as asset losses, labor market disturbances, harvest failures and civil unrest. Economists have also recognized that households' well-being depends not just on their average income or expenditure, but also on the risks that they face, hence vulnerability is a more satisfactory measure of welfare (Dercon and Krishnan 2000; Raghbendra et al. 2009; Tu Dang 2009). Hence, collecting data on some of these and other relevant indicators may prove valuable for an analysis of vulnerability to poverty.

Literature indicates that there are demographic, socioeconomic and community characteristics that affect households' vulnerability to poverty. Poverty and vulnerability to poverty vary across regions and seasons. Household head's education and ownership of agricultural land have a positive effect on consumption and hence reduce variability in consumption or vulnerability to poverty. Vulnerability studies have also shown that location is an important determinant of vulnerability to poverty. This is not surprising because infrastructure is not evenly distributed across regions in most developing countries as a result of which economic conditions are different across different locations. Location matters for access to markets and credit and other public services, hence understanding the underlying causes of vulnerability at each location is the first step in determining appropriate location-specific policies to cope with vulnerability. Research, however, underscores that currently there is little knowledge about how location-specific characteristics affect vulnerability.

Chaudhuri et al. (2002) used cross-sectional data in Indonesia and a three-stage feasible generalized least squares procedure to estimate the variance of the log of consumption on household characteristics. Their results indicate that at the national level, 23 percent of the Indonesians were poor and 45 percent were vulnerable to poverty. A study in Bangladesh using data from the Household Income and Expenditure Survey (HIES) for 2005 showed that poverty was not the same as vulnerability as a substantial share of those currently above the poverty line was highly vulnerable to poverty in the future. The study stated that those without education were likely to be the most vulnerable. The geographical diversity of vulnerability is considerable, for example, vulnerability in the coastal division, that is, the Chittagong division is almost double that in Dhaka and almost four times higher than Khulna division. In investigating the factors that affect vulnerability, McCulloch and Calandrino (2003) found that demographic characteristics, education, household location and assets were important factors in vulnerability to poverty.

Using a large repeated cross-sectional survey dataset collected under the Chinese Household Income Project, Imai et al. (2010) found that poverty and vulnerability to poverty significantly decreased in China during the study period (1988–2002). They also indicate that household head's education and access to electric power were negatively associated with both poverty and vulnerability to poverty. On the other hand, agricultural land size and irrigated land were associated with vulnerability to poverty but not poverty. Their study also indicated that education and location were among the factors that consistently emerged as significant covariates of vulnerability to poverty.

Using the expected poverty measures approach, Imai et al. (2011b) estimated the vulnerability of various ethnic groups in Vietnam. They found that households in ethnic minority groups were poor and more vulnerable than those in ethnic majority groups. Their study highlighted the importance of ethnic considerations in studies on vulnerability to poverty. An analysis of poverty and vulnerability in Tajikistan, using a panel dataset and an expected poverty approach revealed that rural households were poorer and more vulnerable than urban households (Jha et al. 2010).

Using a panel dataset of villages in rural Ethiopia, Dercon and Krishnan (2000) showed that on average, year-to-year poverty in Ethiopia was very similar. However, they found high vulnerability in consumption and poverty over the seasons and year-by-year. They computed poverty under different scenarios: whether there was a safety net program, whether the rainfall in the area where the household was located was normal or bad and whether there were seasonal price fluctuations. A comparison of these scenarios indicated that poverty can change substantially within a relatively short period of time and a large number of households were vulnerable to shocks than what was implied by standard poverty statistics. The number of households falling below the poverty line when serious shocks hit the household and community in rural Ethiopia was about 50–75 percent more than the poverty estimates obtained using the current cross-section estimates in each period (Dercon and Krishnan 2000). Based on the Ethiopian Rural Household Survey for 1999–2000, Negassa et al. (2014) showed that on average 38 percent of the sampled households were highly vulnerable to poverty and 16.38 percent of the non-poor were highly vulnerable to poverty. However, based on recent data used for their study, only 35.26 percent of the households in rural Ethiopia were poor. This indicates that expected poverty or vulnerability to poverty were greater than the point in time estimates of poverty, which connotes the importance of a forward-looking poverty analysis (vulnerability to poverty).

Literature on vulnerability to poverty in Ethiopia using the same Ethiopian Rural Household Survey data shows some differences in results. For example, using Ethiopian Rural Household Survey data, vulnerability to poverty in Ethiopia was estimated to be 51 percent. Villages in the northern (Tigray) and southern regions (SNN) were found to have the highest average vulnerability of approximately 52 percent which is a bit higher than the national average (51 percent). Vulnerability to poverty in the Amhara and Oromia regions was 50 percent and 49 percent respectively which is less than SNN (52 percent) and even the national average (51 percent). This implies that vulnerability to poverty among rural households in Ethiopia is not the same; farmers in different regions have different levels of vulnerability to poverty. Research also indicates that this could be linked to variations in rainfall in different parts of the country.

Most studies on vulnerability to poverty are unidimensional and are based primarily on monetary outcome measures such as consumption per capita. However, vulnerability can be analyzed by other observable multidimensional outcomes. Vulnerability to multidimensional poverty is the threat of facing multidimensional poverty in the future related to both predicted shortfalls in any particular well-being dimension and also to the effect of any uncertainty or risk on well-being. A vulnerability analysis involves identifying threats and responses in exploiting opportunities and resisting or recovering from the negative effects of a changing environment. Therefore, the assets and entitlements available to individuals and households are critically related to vulnerability. Our study underscores the importance of building productive assets for increasing incomes and decreasing income variances to escape from the threat of poverty. Some literature redefines poverty and draws attention away from shortfalls in income or consumption expenditure to other forms of deprivation (Calvo 2008). Existing research also discusses vulnerability to multidimensional poverty using data from Peru (1998–2002) and discusses bidimensional vulnerability to poverty and sheds some light on the importance of vulnerability to multidimensional poverty. However, this research limits itself only to two dimensions (consumption and leisure). Therefore, studies on vulnerability to multidimensional poverty using health, education and other important well-being indicators are important to bridge this gap.

# 4 Data and Methodology

## *4.1 Data*

This research used the 2011 Household Consumption and Expenditure Survey's (HCES) data for unidimensional vulnerability to poverty in the analysis. Household Consumption and Expenditure Surveys (HCES) are complex surveys conducted on a nationally representative sample to characterize important aspects of household socioeconomic conditions. These surveys are done by the Central Statistical Agency (CSA) of Ethiopia since 1995–96 at four- or five-year intervals. The 2010–11 HCES is the fourth survey in the series. The survey covered all rural and urban areas except the non-sedentary population in Afar and Somali and households in the selected sample except homeless persons and foreigners. The primary purpose of the survey is providing information on poverty monitoring, calculating national accounts and as an input for consumer price indices. The food data collected in HCES can be used for producing a variety of food security and nutrition indicators.

The survey provides income, expenditure and other socioeconomic data at the household level, which is useful in an analysis of poverty and vulnerability to poverty. The household-based questionnaire provides information on the population's basic characteristics such as sex, age, household size, marital status, education and employment. It also includes households' consumption (food and non-food) and also the quantities consumed and their values. Non-food consumption includes cigarettes, alcohol, clothes, household goods, transport, health and education. We consider land ownership as a proxy for physical capital ownership and household head's education as proxy for the human capital ownership of a household as shown in most poverty research.

For an analysis of vulnerability to multidimensional poverty, we use Ethiopian Demographic and Health Survey (EDHS) data for 2011. EDHS surveys are done by Ethiopia's Central Statistical Agency (CSA) with support from the worldwide Demographic and Health Survey (DHS) project. It is a comprehensive dataset that consists of samples from all regions in the country and represents the national population of Ethiopia. The sample was selected using a stratified, two-stage cluster design while enumeration areas (EAs) were the sampling units for the first stage and households comprised the second stage of the sampling.

DHS is cross-sectional data collected in Ethiopia almost every 5 years. The data collected contains information on household characteristics, households' dwelling units such as the sources of water, types of sanitation facilities, access to electricity, types of cooking fuel, materials used for the floor and ownership of various assets like TV, radio, telephone, land, car, bicycle, cattle, sheep, goat and others. The data also contains household members' level of education, children's school attendance, child health, child mortality, maternal mortality and nutrition status (Central Statistical Agency of Ethiopia and ICF International 2012).

## 4.2 *Unidimensional Poverty*

The unidimensional measure of poverty has been widely used in poverty analyses, but this measure has been criticized as it considers only income or consumption expenditure. Hence, literature also focuses on analyses of multidimensional poverty as these include many dimensions of well-being. Despite its limitations, the unidimensional measure of poverty provides good information for assessing public policies and evaluating the impact of the interventions. Therefore, before we analyze vulnerability to poverty using consumption expenditure, it is essential to assess unidimensional poverty as poverty and vulnerability to poverty are related concepts.

We used the family of Foster, Greer and Thorbecke (FGT) poverty measure ($P_\alpha$), that is widely used because it is consistent and additive decomposable (Foster et al. 1984). The FGT index is given by:

$$P_\alpha = \frac{1}{N}\sum_{i=1}^{q}\left(\frac{Z - CE_i}{Z}\right)^\alpha \tag{4.1}$$

where Z is the poverty line, $CE_i$ is the per capita consumption expenditure in increasing order of $CE_1 \leq CE_2 \leq \ \ldots \ \ldots \ \leq CE_q \leq Z < CE_{q+1} \leq . \ldots \ \ldots \ \leq CE_N$ for all households N, q is the number of poor people in the pupation of size N and $\alpha$ measures policymakers' degree of aversion to inequality among the poor, that takes the values 0, 1 and 2. The higher the value of $\alpha$, the higher is the weight attached to the poorest of the poor. Three indices of poverty can be measured using different values of $\alpha(\alpha = 0, \alpha = 1, \alpha = 2)$. For $\alpha = 0$, the poverty index is the head count poverty index ($P_0$), which measures the proportion of the population whose consumption expenditure per capita is less than the poverty line or it measures the incidence of poverty. Poverty rate is simple to compute and easy to understand. But the index ignores differences in well-being between poor households, it does not take the intensity of poverty into account and is not sensitive to changes in consumption or income as long as they remain below the poverty line. For $\alpha = 1$, the poverty measure is the poverty gap index ($P_1$), which measures how far the poor households are from the poverty line. It gives a better understanding of the depth of poverty and shows how much would have to be transferred to the poor to bring their expenditure up to the poverty line. Finally, for $\alpha = 2$ we get the squared poverty gap index ($P_2$) which measures the severity of poverty. It measures the inequalities among the poor on top of measuring the distance from the poverty line.

## 4.3 Vulnerability to Unidimensional Poverty

The key to estimating a household's vulnerability to poverty is obtaining an estimate of the household's variance of consumption expenditure (Suryahadi and Sumarto 2003). A reliable estimate of consumption expenditure variance can be obtained from panel data with a sufficiently long period of observations (Ligon and Schechter 2003). But most household survey data available to date in most developing nations are cross-sectional. Hence, there is clearly a need of developing a method for estimating the variance in a household's consumption expenditure using cross-sectional data. Such a method has been developed by Chaudhuri et al. (2002).

In principle, measuring vulnerability to poverty needs to know the resources that the households can draw on in the next period including assets such as land and education, skills and experience and the risks that each household faces such as droughts, family illnesses and higher prices for food and the probability of handling each set of risks, for example, family support and borrowing money. However, it is clearly impossible to collect all the information needed for such an analysis and hard to model all the possible behavioral responses of the households. The solution, as in all models, is simplifying it enough to make the problem tractable. In the simplest case, three pieces of information and one additional assumption are enough to allow us to measure households' vulnerability to poverty. The required information is: the household's expected consumption per capita in the next period $E(c_{t+1})$, variance in the household's expected level of consumption per capita in the next period $\delta^2$ and the poverty line Z. The assumption required is that the expected level of consumption follows a known distribution such as the normal distribution.

Although we do not know exactly what a household's level of consumption will be next year, it is possible to arrive at reasonable estimates by building a model of the determinants of consumption and then using the model to predict next year's consumption. A household's probability of being poor in the future depends both on its mean consumption expenditure and the variation in consumption expenditure. Therefore, an estimation of vulnerability to poverty requires an estimation of future mean consumption as well as its variability or volatility.

As done by Chaudhuri et al. (2002) we begin by assuming that the stochastic process generating the consumption of household h is given by:

$$\ln C_h = X_h \beta + e_h \tag{4.2}$$

where $C_h$ is per capita consumption expenditure, $X_h$ represents a bundle of observable household characteristics such as household size, location and the educational attainments of the household head, β is a vector of parameters to be estimated and $e_h$ is a disturbance term that captures idiosyncratic factors.

Household future consumption is further assumed to be dependent on uncertainties in some idiosyncratic and community characteristics. To have a consistent estimator of the parameter it is necessary to allow heteroskedasticity. We do, however, allow the variance of eh (and hence of lnch) to depend on observable household characteristics in some parametric way. There are a number of ways in which this can be done. The estimates we report are generated assuming the following simple functional form:

$$\delta_{e,h}^2 = X_h \theta \tag{4.3}$$

We estimate β of Eq. (4.2) and θ using a three-step feasible generalized least squares (FGLS) procedure suggested by Amemiya (1977). Equation (4.2) is first estimated using an ordinary least squares (OLS) procedure, then the estimated residuals from Eq. (4.2) are used for estimating the following equation, again by using OLS:

$$\hat{e}_{ols,h}^2 = Z_h \theta + \eta_h \tag{4.4}$$

The estimation from is then used to transform Eq. (4.4) to:

$$\frac{\hat{e}^2_{ols,h}}{Z_h\hat{\theta}_{ols}} = \left(\frac{Z_h}{Z_h\hat{\theta}_{ols}}\right)\theta + \frac{\eta_h}{Z_h\hat{\theta}_{ols}} \tag{4.5}$$

This transformed equation is estimated using OLS to obtain an asymptotically efficient FGLS estimator $\hat{\theta}_{FGLS}$ . $Z_h\hat{\theta}_{FGLS}$ is a consistent estimate of $\delta^2_{eh}$, which is the variance of the idiosyncratic component of household consumption. This is then used to transform Eq. (4.2) to:

$$\frac{\ln C_h}{\sqrt{Z_h\hat{\theta}_{FGLS}}} = \left(\frac{X_h}{\sqrt{Z_h\hat{\theta}_{FGLS}}}\right)\beta + \frac{e_h}{\sqrt{Z_h\hat{\theta}_{FGLS}}} \tag{4.6}$$

Using the estimates $\hat{\beta}$ and $\hat{\theta}$ we can directly estimate the expected log consumption:

$$E\left[\ln C_h | X_h\right] = X_h\hat{\beta} \tag{4.7}$$

The variance of log consumption given the characteristics of household $X_h$ is:

$$\hat{V}\left[\ln C_h | X_h\right] = \delta^2_{e,h} = X_h\hat{\theta} \tag{4.8}$$

For each household h, by assuming that consumption is log-normally distributed (that is, ln $C_h$ is normally distributed), we form an estimate of the probability that a household with characteristics, $X_h$ will be poor, that is, the household's vulnerability level. Letting Φ(.) denote the cumulative density of the standard normal, the estimated probability is given by:

$$\hat{V}_h = \hat{P}_r\left(\ln C_h < \ln Z | X_h\right) = \Phi\left(\frac{\ln Z - X_h\hat{\beta}}{\sqrt{X_h\hat{\theta}}}\right) \tag{4.9}$$

Equation (4.9) gives us vulnerability to poverty $\widehat{V_h}$ or the probability that the per capita consumption level ($C_h$) will be less than the poverty line ($Z$), conditioned on the household characteristics ($X_h$) and Φ(.) denotes the cumulative density of the standard normal distribution. Our measure of vulnerability as a probability of poverty captures the likelihood that incomes will fall below the poverty line at some point in the future. The advantage of this vulnerability measure is that it can be measured with cross-sectional data but this measure requires a large sample in which some households experience a good time and others suffer from negative shocks and it is also likely to reflect unexpected large negative shocks.

The most important identifying assumption is that cross-sectional variance can be used for estimating the inter-temporal variance (Sricharoen 2011). Due to the idiosyncratic components of the model, cross-sectional variance can most likely explain a part of the inter-temporal variance. An advantage of a FGLS approach for estimating the variance of household consumption is that it yields a consistent estimate even when consumption is measured with an error (Tesliuc and Lindert 2004). In such models, a low R square value is very common due to the measurement error (from unobserved and omitted variables) associated with the use of cross-sectional data in consumption studies (Sricharoen 2011).

Identifying whether a given household is vulnerable or not is an important exercise that can have important implications for targeting development assistance. Generally speaking, we require a threshold probability level of poverty above which a household is qualified as being vulnerable. There are two vulnerability thresholds (Chaudhuri et al. 2002): the observed current poverty rate in the population and the alternative threshold which is 0.5. The most commonly used threshold in existing literature is the poverty probability of 0.5. This threshold indicates that a household whose poverty probability level is greater than 50 percent is more likely to be poor and thus can be considered to be vulnerable (Chaudhuri et al. 2002). The use of this line has been justified based on several features. First, this threshold defines the point in Eq. (4.9) where expected income exactly equals the poverty line. Second, a 50 percent or more chance of a household falling into poverty makes intuitive sense and seems a reasonable threshold to demarcate the vulnerable from those who are not vulnerable. We use this vulnerability threshold.

According to MOFED (2013), in Ethiopia the poverty line per adult person per year for 2011 was determined as birr 3781.

The covariates that we use in our analysis are: linear and quadratic terms in the age of household head, variables of household characteristics including number of children and the dependency ratio, characteristics of household head such as sex, marital status, educational attainment (can read and write, has formal education and highest grade completed), occupational characteristics and religion. Variable descriptions and summary statistics of the variables used in the unidimensional vulnerability analysis are shown in Table 4.4. The FGLS estimation results for expected consumption and variance for the whole sample (rural and urban) is given in Table 4.1.

## *4.4 The Multidimensional Poverty Measure*

Vulnerability is complex and is a multidimensional concept that must be understood in relation to the outcomes of interest (poverty). Communities, households and individuals are responsive or have different coping strategies to deal with vulnerability to poverty. Policy interventions too can address vulnerability in many ways. Vulnerability to poverty is based on the multidimensional poverty index (MPI). We now discuss the multidimensional measures of poverty. MPI is the most prominent household poverty assessment measure which goes beyond the monetary (income

**Table 4.1** Description of variables used in the determinants of vulnerability to unidimensional poverty

| Variables | Description |
|---|---|
| Age | Age of the household head |
| Age2 | Age square of the household head |
| Fsize | Number of household members |
| nchildren | Number of children in the household |
| depratio | Dependency ratio of the household |
| HGC | Highest grade completed by the household head |
| Sex | Sex of the household head |
| RAW | The household head can read and write (1 = yes, 2 = no) |
| AFE | The household head has formal education (1 = yes, 2 = no) |
| Residence | Residence of the household |
| Mstatus | Marital status of the household head |
| Religion | Religion of the household head |
| Occupation | Occupation of the household head |

or consumption expenditure) measure and accounts for the multidimensionality of poverty. MPI measures a range of deprivations such as living standard, health, education, empowerment and threat of violence and is currently used in more than 100 countries. In academic literature, interest in measuring multidimensional poverty is growing (for example, Adetola 2014; Bourguignon and Chakravarty 2003; Dhongda et al. 2015; Maasoumi and Xu 2015). This paper uses the Demographic and Health Survey (DHS) data for Ethiopia and examines the extent of multidimensional poverty using the MPI measure by adapting the method on which MPI is based to better address local realities, needs and the available data.

MPI has the deprivation cut-off and the poverty cut-off. A deprivation cut-off vector is used for determining whether a household is deprived in that indicator. If a household's achievement level in a given dimension is less than the respective deprivation cut-off, the household is said to be deprived in that indicator and will have a value of 1. If a household's level of achievement is greater than or equal to the deprivation cut-off, the household is not deprived in that indicator and will have a value of 0 in that indicator. Finally, we have a deprivation score matrix with values of 0 and 1.

After identifying the dimensions and indicators, the crucial problem is assigning suitable weights to the indicators (Berenger and Chouchane 2007). In a multidimensional poverty analysis, there is no general consensus on the relative weights of the indicators (Decancq and Lugo 2013; Maasoumi and Xu 2015; Ravallion 2011). Various authors (Atkinson 2003) have used the equal weight approach. However, this approach has been criticized because most multidimensional poverty indicators are assumed to be correlated and this approach fail to consider these correlations (Ravallion 2011). Following this criticism, another weighting approach has also been used. One of the weighting systems proposed and used is a factor analysis. The factor analysis (FA) model makes no prior assumptions regarding the pattern of the relationships among the observed indicators and can be used for cardinal and categorical data. Further, a factor analysis is also useful for placing variables into meaningful categories as doing so reduces the number of variables. Therefore, we use the factor analysis model to determine the weight of the indicators. Each component or factor ($F_i$) is a linear weighted combination of the initial variables. Suppose we have variables denoted by $X_1, X_2, \ldots, X_m$, then we have:

$$\begin{aligned} F_1 &= \lambda_{11}X_1 + \lambda_{12}X_2 + \lambda_{13}X_3 + \ldots + \lambda_{1m}X_m \\ F_2 &= \lambda_{21}X_1 + \lambda_{22}X_2 + \lambda_{23}X_3 + \ldots + \lambda_{2m}X_m \\ &. \\ &. \\ F_n &= \lambda_{n1}X_1 + \lambda_{n2}X_2 + \lambda_{n3}X_3 + \ldots + \lambda_{nm}X_m \end{aligned} \tag{4.10}$$

In Eq. (4.10), $\lambda_{nm}$ is the weight which is the eigenvector of the correlation matrix. In this MPI computation, each household is assigned a deprivation score according to its deprivations in the component indicators. The deprivation score of each household ($dC_h$) is calculated by taking a weighted sum of the deprivations experienced, and the score increases as the number of deprivations increase:

$$dc_h = W_1 I_1 + W_2 I_2 + \ldots + W_n I_n \tag{4.11}$$

where $I_i = 1$ if the household is deprived in indicator i and 0 otherwise, and $W_i$ is the weight attached to indicator i with $\sum_{i=1}^{d} W_i = 1$.

Once the deprivation score is obtained, the households are categorized based on the poverty cut-off. In the applied method of the MPI measure, a household is categorized as being multidimensionally poor if its deprivation score is greater than or equal to one-third (33 percent) and non-poor otherwise.

MPI combines two key pieces of information – the proportion or incidence of households whose share of weighted deprivations is k or more (H). This measure is the head count ratio and is given by:

$$H = \frac{q}{n} \tag{4.12}$$

Here q is the number of households who are multidimensionally poor and n is the total population. However, the head count ratio (H) violates dimensional monotonicity. To solve the dimensional monotonicity of the head count ratio, the second component in MPI is the intensity (or breadth) of poverty (A). It is the average deprivation score of multidimensionally poor households and can be expressed as:

$$A = \frac{\sum_{h=1}^{q} dc_h}{q} \tag{4.13}$$

where $dc_h$ is the censored deprivation score of household h and q is the number of households who are multidimensionally poor. MPI is the product of both incidence (H) and severity or depth (A) components:

$$\mathrm{MPI} = \mathrm{H} \times \mathrm{A} \tag{4.14}$$

where H is the head count ratio or the percentage of people who are multidimensionally poor and A is the average intensity of poverty among the poor.

## 4.5 Vulnerability to Multidimensional Poverty

Literature has so far focused on vulnerability to poverty defined in terms of a single measure of consumption expenditure (Chaudhuri et al. 2002; Hoddinott and Quisumbing 2003). However, this approach has a limitation as poverty reflects deprivation in multiple dimensions and hence vulnerability to poverty should also be multidimensional. Hoddinott and Quisumbing (2003) state that there is no reason why vulnerability cannot be measured without consumption expenditure that is often used for measuring vulnerability. Feeny and McDonald (2015) also acknowledge that vulnerability can, and should, be expressed with other well-being indicators including health and education rather than only with consumption expenditure. Other authors too underscore the importance of other dimensions such as body mass indices (Decron and Krishnan 2000) or access to social services (Coudouel and Hentschel 2000) in multidimensional vulnerability studies. In vulnerability to multidimensional poverty, the multidimensional deprivation score can be used as a welfare indicator and can be a solution for the inherent limitation of relying on only consumption expenditure in measuring vulnerability to poverty (Feeny and McDonald 2015). Moreover, in a country like Ethiopia where more than 85 percent of the population lives in rural areas and has limited access to formal markets, consumption expenditure does not fully reflect household welfare for measuring vulnerability. Therefore, vulnerability to multidimensional poverty should include other well-being indicators in the analysis to address the inherent limitations of relying on consumption-based measures of vulnerability to poverty.

Besides analyzing vulnerability to unidimensional poverty, this paper also addresses vulnerability as a multidimensional concept. Equation (4.15) provides a reduced form equation for the household deprivation score ($dc_h$), which is used as the well-being indicator in an analysis of vulnerability to multidimensional poverty:

$$dc_h = X_h\beta + e_h \tag{4.15}$$

Household deprivation score $dc_h$, in this case is the weighted deprivation score of households according to Alkire and Foster's (2011) method of calculating the multidimensional poverty index (MPI). The deprivation score can be used as a well-being indicator in an analysis of multidimensional poverty. An increase in $dc_h$ represents an increasing level of destitution in one or more of the three dimensions of the deprivations: health, education and living standards. $X_h$ is household characteristics including family size, number of children under 5 years, household head's age, land for agriculture, wealth index, bank account and marital status of the household head. Further, a dummy variable is used for assessing the differences in vulnerability to multidimensional poverty between regions. $\beta$ is the parameter to be estimated and $e_h$ is the disturbance term. According to Sricharoen (2011) the error term in this equation is inter-temporal variance. The usual OLS assumption of constant variance across households is somewhat restrictive. However, this also presumes that the model is fully specified, given that a household's experience of shocks and its responses to these shocks are not excluded, which is a somewhat strong assumption.

Therefore, multidimensional vulnerability to a household's poverty $i$ at time $t$ ($V_{i,t}$) is given as the probability that the weighted deprivation score one period ahead ($dc_{i,t+1}$) will be greater than the multidimensional poverty cut-off ($k$):

$$V_{i,t} = \Pr\left(dc_{i,t+1} > k\right) \tag{4.16}$$

Households face different risks and have different risk management strategies and hence the variance of the disturbance term is interpreted as the inter-temporal variance of well-being (Chaudhuri et al. 2002). They, therefore, allow for heteroskedasticity in the model by regressing the variance of the disturbance term on the observed characteristics of household $X_i$ as:

$$\delta_{e,h}^2 = X_i\theta + u_i \tag{4.17}$$

The level of variance of a household's deprivation ($\delta_{e,h}^2$) is considered to be a function of its demographic and local characteristics ($X$) as well as the stochastic nature of the shock. Presence of heteroskedasticity makes OLS estimates inefficient. Therefore, the estimation of $\beta$ and $\theta$ requires a three-stage feasible generalized least square (FGLS) procedure as indicated by Amemiya (1977). FGLS' main advantage is that the mean and the variance of household well-being are unbiased predictors of future well-being, even when there is a measurement error (unless there is a systematic variation in the measurement error).

To overcome any systematic measurement error in well-being, given the differences in employment sources and domestic food production, a number of authors stratify household samples in developing countries according to rural and urban regions (for example, Chaudhuri et al. 2002). Accordingly, we too estimate vulnerability to poverty by separating the sample into rural and urban areas.

First, we estimate Eq. (4.15) using OLS, then from this estimation we get the residual. We use the squared residual as the dependent variable in Eq. (4.17) and X as the independent variable in the estimation. Equation (4.17) is transformed to produce asymptotically efficient FGLS estimates of the variance of future well-being as:

$$\frac{\hat{\delta}^2_{e,h}}{X_i\theta} = \left(\frac{X_i}{X_i\theta}\right)\theta + \frac{u_i}{X_i\theta} \tag{4.18}$$

The variance of well-being in Eq. (4.18) is used to transform Eq. (4.15) to produce an asymptotically efficient estimator of $\hat{\beta}_{FGLS}$

$$\frac{dC_h}{\sqrt{X_i\hat{\theta}_{FGLS}}} = \left(\frac{X_i}{\sqrt{X_i\hat{\theta}_{FGLS}}}\right)\beta + \frac{u_i}{\sqrt{X_i\hat{\theta}_{FGLS}}} \tag{4.19}$$

Given this, households' vulnerability to multidimensional poverty ($V_{i,\,t}$) is estimated using:

$$\hat{V}_{i,t} = \hat{P}_r\left(dC_{i,t+1} > K|X_i\right) = \Phi\left(\frac{X_i\hat{\beta}_{FGLS} - K}{\sqrt{X_i\hat{\theta}_{FGLS}}}\right) \tag{4.20}$$

where $dc_{i,\,t+1}$ is the estimated household weighted multidimensional poverty deprivation score in the next period, $K$ is the conventional multidimensional poverty cut-off and is equal to 33 percent. The probability density function which is denoted by ($\Phi$) is the cumulative density function of the standard normal distribution.

# 5 Results and Discussion

## *5.1 Unidimensional Vulnerability to Poverty*

We did an analysis of unidimensional vulnerability to poverty using the FGLS method. It is well understood that one of the basic assumptions of the ordinary least squares (OLS) is that the error term has a mean zero and constant variance. If this assumption is violated, there is heteroscedasticity, and this requires using FGLS. The results of the model for the log consumption expenditure and variance of the log consumption expenditure are given in Table 4.1. We use vulnerability as expected poverty in this research. Log per capita household consumption expenditure is used as the dependent variable and different demographic and socioeconomics variables are used as independent variables. The description variables (Table 4.1) and summary statistics of the explanatory variables used in the regression are given in Table 4.2. Variables family size, highest grade completed, number of children, dependency ratio and age of the household head and its square are included in the model because of the possible non-linear relationship between them (Tables 4.3 and 4.4).

A unidimensional poverty analysis using household income and consumption expenditure data for 2011 shows that in Ethiopia 35 percent of the population was below the poverty line (62 percent rural population and 19 percent urban population). Our results also show that 38 percent of the households in Ethiopia were vulnerable to poverty; this is similar to vulnerability estimates in other studies. These estimates appear to support the claim that the observed incidence of poverty underestimates the percentage of the population that is vulnerable to poverty (Dercon and Krishnan 2000; Raghbendra et al. 2009). Among the rural people, 89 percent were vulnerable to poverty while only 22 percent of the urban people were vulnerable to poverty (Table 4.5). Controlling for all other determinants of vulnerability, a large family size tended to reduce the future consumption of the household, thereby increasing household vulnerability; this is almost similar to other findings (Edoumiekumo et al. 2013; Tu Dang 2009). We also found that the larger the dependency ratio, the larger a household's vulnerability to poverty. It is well-known that households with many children and other non-productive family members are on average poorer than households with fewer children and fewer dependent family members.

Households with older heads tend to have lower consumption per capita with a non-linear effect as the household head's age coefficient is negative and significant (and its square is positive and significant). A dummy variable is used if there are regional variations in consumption expenditure. Taking Tigray as the reference region, our analysis showed that there were regional variations in per capita consumption. Consumption per capita in all other regions (except Somali) was significantly less than that in Tigray. If all other factors affecting vulnerability remain constant, vulnerability to poverty will be higher in other regions as compared to Tigray.

Female headed households are associated with significantly lower mean future consumption expenditures as compared to their male counterparts.

We also compared people living in rural areas, towns and big cities and our results show that households in big cities and towns tended to have higher expectations of per capita future consumption as compared to rural households as infrastructure will provide access to markets, health and education. However, transportation facilities, production support services and social infrastructure is less developed in rural areas leading to a reduction in opportunities for earning in these areas. Further, there is significant evidence that households in urban areas have lower variance or volatility in consumption expenditure. We also considered marital status in our analysis. Never married households (the reference) had higher per capita consumption as compared to others (married, divorced, separated and widowed) in Ethiopia and were more vulnerable to poverty. This finding is similar to the find-

**Table 4.2** Summary statistics of variables used in unidimensional vulnerability analysis (n = 17,487)

| Variables | Description | Mean | Std Dev | Minimum | Maximum |
|---|---|---|---|---|---|
| Age | Age of the household head | 40.1 | 15.473 | 12 | 96 |
| Age2 | Square age of the household head | 1846.82 | 1452.21 | 144 | 9216 |
| Fsize | Number of family members | 3.8 | 2.319 | 1 | 28 |
| nchildren | Number of children in the household | 1.29 | 1.479 | 0 | 13 |
| depratio | Dependency ratio of the household | 0.303 | 0.266 | 0 | 1 |
| HGC | Highest grade completed by the household head | 9.4 | 4.860 | 0 | 20 |
| Sex | Sex of the household head (1 = male, 2 = female) | 1.368 | 0.482 | 1 | 2 |
| RAW | The household head can read and write (1 = yes, 2 = no) | 1.286 | 0.452 | 1 | 2 |
| AFE | The household head attended formal education (1 = yes, 2 = no) | 1.293 | 0.455 | 1 | 2 |

**Table 4.3** Summary statistics of variables used in an analysis of multidimensional vulnerability (n = 2683)

| Variables | Description | Mean | Std Dev | Minimum | Maximum |
|---|---|---|---|---|---|
| Fsize | Household family size | 4.7 | 2.501 | 1 | 22 |
| Childrenunder5 | Number of children under 5 years | 0.86 | 0.980 | 0 | 10 |
| HHheadage | Household head's age | 43.6 | 16.431 | 15 | 95 |
| Educ | Household head's education | 3.4 | 2.762 | 0 | 8 |
| depratio | Dependency ratio | 1.408 | 1.254 | 0 | 10 |
| TLU | Tropical livestock unit | 3.125 | 7.619 | 0 | 166.7 |
| Landforagri | Land for agriculture | 0.642 | 0.297 | 0 | 1 |
| Bankaccout | Bank account | 0.098 | 0.297 | 0 | 1 |
| HHheadsex | Household head's sex | 1.293 | 7.619 | 1 | 2 |
| Mstatus | Marital status | 1.496 | 1.243 | 0 | 9 |
| wealthindex | Wealth index | 2.987 | 1.566 | 1 | 5 |

ings of other studies. This difference was also observed in urban Ethiopia, but it was not significant in rural areas. Our analysis also indicated that religion mattered in consumption expenditure. Per capita log consumption expenditure of Catholic, Protestant and Muslim households was significantly less than that of Orthodox (the reference) households. This implies that if we keep all other factors that affect vulnerability constant, Catholic, Protestant, Waq feta and followers of traditional religions are more vulnerable to poverty than Orthodox followers.

An increase in schooling or the highest grade completed (HGC) by the household head had an impact on productivity and hence on a household's earnings and could also influence the productivity of other family members. Therefore, educational attainment is a variable that needs to be considered. An increase in the highest grade completed by the household head had a significant positive

**Table 4.4** Head count ratio (H), intensity (A) the and Multidimensional poverty index (MPI) for Ethiopia and its regions

| Region or residence | H | A | MPI |
|---|---|---|---|
| Ethiopia | 0.908 | 0.789 | 0.717 |
| Urban | 0.634 | 0.522 | 0.330 |
| Rural | 0.993 | 0.836 | 0.831 |
| Regions: | | | |
| Tigray | 0.941 | 0.810 | 0.762 |
| Afar | 0.932 | 0.822 | 0.766 |
| Amhara | 0.984 | 0.805 | 0.792 |
| Oromia | 0.969 | 0.821 | 0.796 |
| Somali | 0.994 | 0.857 | 0.852 |
| Benishangul | 1.00 | 0.845 | 0.845 |
| SNNP | 0.991 | 0.819 | 0.812 |
| Gambela | 0.929 | 0.791 | 0.735 |
| Harari | 0.873 | 0.692 | 0.604 |
| Addis Ababa | 0.546 | 0.461 | 0.251 |
| Diredawa | 0.730 | 0.795 | 0.580 |

impact on per capita consumption expenditure. This conforms with other studies that concluded that literacy and education attainment decreased poverty and vulnerability to poverty (Fekadu 2013). But there is no statistical evidence that a household head's ability to read and write and formal education significantly affected vulnerability to poverty.

It is assumed that as the skills of the household head increase productivity and thereby earnings will also increase. Our results indicate that the more skilled and professional the household head, the higher the per capita consumption; this is more pronounced in urban than in the rural areas. Keeping all other things that affect vulnerability constant, as the skills and profession of the household head improve the household's vulnerability to poverty tends to decrease.

## 5.2 *Multidimensional Vulnerability to Poverty*

This research also studied multidimensional vulnerability to poverty. The results indicate that 90 percent of the population was multidimensionally poor while 89 percent was vulnerable to multidimensional poverty. This shows that multidimensional poverty and vulnerability to multidimensional poverty are very high in Ethiopia. Further, multidimensional poverty is by far greater than unidimensional poverty in the country. This difference is attributed to the use of health and education indicators in an analysis of multidimensional poverty in addition to income or living standard indicators used in an analysis of unidimensional poverty. This can also be mentioned as one of the reasons for shifting from a traditional

**Table 4.5** Results of estimation of vulnerability to unidimensional poverty

| | Total sample | | Rural | | Urban | |
|---|---|---|---|---|---|---|
| Variables | Consumption | Variance | Consumption | Variance | Consumption | Variance |
| Age | −0.0089*** | 0.0006 | −0.0036 | −0.0022 | −0.0090*** | 0.0019 |
| Age2 | 0.0001*** | 0.0000 | 0.0001 | 0.0000 | .0001*** | −0.0000 |
| Fsize | −0.1709*** | 0.0132*** | −0.1154*** | 0.0201*** | −0.1747*** | 0.0127*** |
| nchildren | 0.1418*** | −0.0162*** | 0.0775*** | −0.0101 | .1368*** | −0.0244*** |
| depratio | −1.0339*** | −0.0137 | −0.8373*** | −0.0685 | −1.0100*** | 0.0251 |
| HGC | 0.0255*** | 0.0002 | 0.0169*** | −0.0038 | .0257*** | 0.0008 |
| Sex_2(1 = M, 2 = F) | −0.0777*** | −0.0333*** | −0.0175 | −0.0074 | −0.0879*** | −0.0393*** |
| RAW_2(1 = yes, 2 = no) | 0.0130 | −0.0006 | −0.0176 | −0.0121 | 0.0049 | −0.0067 |
| AFE_2(1 = yes, 2 = no) | 0.0294 | 0.0125 | −0.0065 | −0.0036 | 0.0411 | 0.0502 |
| Residence (rural is base): | | | | | | |
| Big city | 0.4198*** | −0.0032 | −0.0368 | 0.0342 | 0.0091 | −0.2869*** |
| Other town | 0.2985*** | −0.0014 | 0.1699 | −0.1093 | −0.1252 | −0.2868*** |
| Mstatus (never married): | | | | | | |
| Married | −0.1357*** | −0.0307** | −0.0264 | −0.0212 | −0.1308*** | −0.0355** |
| Divorced | −0.0490** | −0.0090 | −0.00015 | −0.0064 | −0.0402* | −0.0124 |
| Separated | −0.1358*** | −0.0036 | −0.1046 | −0.0255 | −0.1258*** | −0.0072 |
| Widowed | −0.1248*** | 0.0129 | −0.0509 | −0.0649 | −0.1134*** | 0.0179 |
| Living together | −0.0944* | −0.0213 | −0.2655 | 0.0764 | −0.0900* | −0.0246 |
| Religion (Orthodox is base): | | | | | | |
| Catholic | −0.0856* | −0.0589* | −0.1685*** | −0.0473 | −0.0479 | −0.0507 |
| Protestant | −0.0669*** | −0.0138 | −0.0956*** | −0.0086 | −0.0612*** | −0.0176 |
| Muslim | −0.0210* | −0.0277*** | −0.0413* | −0.0427** | −0.0259** | −0.0246** |
| Waq feta | −0.0425 | 0.0604 | 0.0179 | −0.0389 | −0.1995 | 0.2347 |
| Traditional | −0.5350*** | 0.1094 | −0.4304*** | 0.1174 | – | – |
| Others | −0.0212 | −0.0205 | −0.1258 | 0.0981 | 0.0077 | −0.1089 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Occupation (senior officials): | | | | | | |
| Professional | −0.0916*** | −0.0292 | 0.4377*** | −0.0999 | −0.1070*** | −0.0253 |
| Associate professional | −0.1131*** | −0.0264 | 0.4677*** | −0.0657 | −0.1315*** | −0.0220 |
| Clerk | −0.1440*** | 0.0146 | 0.3015** | 0.1834* | −0.1548*** | 0.0127 |
| Service/market worker | −0.0387 | 0.0910*** | 0.3408*** | 0.0348 | −0.0488* | .0978*** |
| Skilled agriculture | −0.1979*** | −0.0047 | 0.0857 | −0.0789 | −0.1507*** | 0.0344 |
| Craft worker | −0.2153*** | 0.0254 | 0.2223* | −0.0005 | −0.2303*** | 0.0284 |
| Machine operator | −0.0987*** | 0.0115 | 0.4764** | −0.0789 | −0.1135*** | 0.0165 |
| Elementary Occup. | −0.3361*** | 0.0145 | 0.0271 | −0.0399 | −0.3460*** | 0.0222 |
| Defense force | −0.2020*** | −0.0274 | 0.2615 | −0.1560 | −0.2136*** | −0.0150 |
| Region (Tigray as base): | | | | | | |
| Afar | −0.1117*** | −0.0743*** | −0.0677 | −0.0962** | −0.1445*** | −0.0850*** |
| Amhara | −0.1825*** | −0.0228 | −0.0655** | −0.0386 | −0.2227*** | −0.0231 |
| Oromia | −0.1671*** | −0.0235 | 0.0121 | 0.0039 | −0.2188*** | −0.0381* |
| Somali | 0.0286 | −0.0562** | −0.0097 | 0.0137 | 0.0189 | −0.0727** |
| Benishangul | −0.1065*** | −0.0240 | −0.0169 | 0.0495 | −0.1422*** | −0.0588** |
| SNNP | −0.1875*** | −0.0273 | −0.1445*** | −0.0060 | −0.1936*** | −0.0414* |
| Gambela | −0.1480*** | −0.0611*** | 0.0178 | −0.0891** | −0.1928*** | −0.0458* |
| Harari | −0.0655** | −0.0581** | 0.2774*** | −0.0350 | −0.1460*** | −0.0690** |
| Addis Ababa | −0.1590*** | −0.0388** | – | – | −0.1989*** | −0.0506** |
| Diredawa | −0.2085*** | −0.0489* | 0.0858 | −0.0257 | −0.2831*** | −0.0604* |
| _Cons | 9.8904*** | 0.2143*** | 9.0933*** | 0.3284*** | 10.3716** | 0.4738*** |
| N | 13,978 | 13,978 | 3266 | 3266 | 10,712 | 10,712 |
| R2 | 0.5943 | 0.0156 | 0.4012 | 0.0313 | 0.5321 | 0.0183 |
| R2_a | 0.5931 | 0.0127 | 0.3937 | 0.0193 | 0.5304 | 0.0146 |

Note: * $P < 0.1$; ** $P < 0.5$; *** $P < 0.01$

one-dimensional poverty analyses to an analysis of multidimensional poverty and vulnerability to poverty.

Our study of multidimensional vulnerability to poverty, showed that family size had a vulnerability increasing impact in Ethiopia in general and in rural Ethiopia in particular as the coefficient is positive and statistically significant, which is consistent with other studies (for example, Fekadu 2013). Increase in the household head's level of education and age decreased multidimensional poverty because as people get older they have more life and work experience and have better capacities to get out of multidimensional poverty. Similarly, as the household head's education increases multidimensional poverty decreases. The dummy variable wealth index revealed that when a household head gets richer, multidimensional poverty decreases; however, vulnerability to multidimensional poverty increases, especially in rural areas. Land for agriculture increases variance or vulnerability to multidimensional poverty in rural areas as agricultural land is the most important resource for the rural people engaged in agriculture.

Marital status also matters in vulnerability to multidimensional poverty. As compared to the never married households (the reference), the deprivation score is higher for others (married, divorced, separated, widowed). If we keep other factors affecting vulnerability to multidimensional poverty constant, vulnerability is higher for other marital situations as compared to the never married household heads. Regional comparisons are important in poverty and vulnerability studies because regional differences in poverty and vulnerability to poverty are common in many developing economies (Chaudhuri et al. 2002). The deprivation scores of Amhara, Oromai, Somali and SNNP were significantly greater than that of Tigray but deprivation scores of Harari, Addis Ababa and Diredawa were less than that of Tigray. Vulnerability to poverty in the Diredawa region was higher than that in Tigray but vulnerability to poverty was less in Afar and Harari regions as compared to Tigray (the reference) (Table 4.6).

## 6 Conclusion

Like other developing countries, Ethiopia is still challenged by poverty and vulnerability to poverty. Our study considered vulnerability because the current poverty level may not necessarily be a good guide for determining expected poverty in the future. We used the expected poverty approach to assess vulnerability to poverty. Studies on vulnerability to poverty require panel data. However, in developing countries panel data is rarely available. So, estimating vulnerability with cross-sectional data is the second best alternative but this requires the strong assumption that the environment is stationary so that the cross-sectional variance can be used for estimating inter-temporal variance.

We implemented the methods we proposed using household income and consumption expenditure data and demographic and health survey data for Ethiopia. Much of the variation can be attributed to the differences in the households' observ-

**Table 4.6** Estimation results of vulnerability to multidimensional poverty

| Variables | Total sample | | Rural | | Urban | |
|---|---|---|---|---|---|---|
| | Deprivation score | Variance | Deprivation score | Variance | Deprivation score | Variance |
| Fsize | 0.0001 | 0.0008*** | 0.0014 | 0.0004** | −0.0167*** | 0.0002 |
| Childrenunder5 | −0.0028 | −0.0006 | −0.0091*** | −0.0005 | −0.0231** | 0.0033 |
| HHhead age | −0.0006*** | −0.0000 | −0.0001 | −0.0000 | −0.0009* | 0.0001 |
| Educ | −0.0161*** | −0.0002 | −0.0169*** | 0.0001 | −0.0059** | −0.0004 |
| depratio | 0.0146*** | −0.0005 | 0.0120** | −0.0001 | .0275*** | 0.0004 |
| TLU | −0.0000 | −0.0000 | −0.0003 | 0.0000 | −0.0095** | −0.0008 |
| Land for Agri. | −0.0047 | 0.0027** | −0.0320*** | 0.0031** | −0.0185 | −0.0008 |
| Bank account | −0.0764*** | 0.0025 | 0.0100 | 0.0009 | −0.0912*** | −0.0016 |
| HHhead sex | 0.0005 | −0.0008 | 0.0056 | −0.0007 | −0.0005 | 0.0015 |
| Mstatus (never married): | | | | | | |
| Married | 0.0243** | 0.0023 | 0.0226* | 0.0024 | 0.0244 | −0.0010 |
| Divorced | 0.0516*** | 0.0033 | 0.0282 | 0.0044 | 0.0745*** | −0.0008 |
| Separated | 0.0233* | 0.0032 | 0.0258* | 0.0033 | 0.0157 | −0.0078 |
| Widowed | .0413*** | 0.0064** | 0.0109 | 0.0074*** | 0.0812*** | −0.0005 |
| Living together | 0.0444 | −0.0010 | 0.0185 | −0.0003 | 0.0257 | −0.0237 |
| Wealth index (the poorest): | | | | | | |
| Poorer | −0.0375*** | 0.0044*** | −0.0409*** | 0.0037*** | −0.1088 | 0.0042 |
| Middle | −0.0432*** | 0.0043*** | −0.0463*** | 0.0037*** | −0.1091 | −0.0035 |
| Richer | −0.1263*** | 0.0096*** | −0.1240*** | 0.0070*** | −0.1235** | −0.0012 |
| Richest | −0.3813*** | 0.0242*** | −0.2889*** | 0.0182*** | −0.2975*** | 0.0072 |
| Region (Tigray as base): | | | | | | |
| Afar | −0.0156 | 0.0008 | −0.0284** | 0.0018 | 0.0988*** | 0.0102 |
| Amhara | 0.0362*** | −0.0010 | 0.0050 | 0.0003 | 0.1723*** | 0.0006 |
| Oromia | 0.0255** | −0.0026 | 0.0074 | −0.0019 | 0.1304*** | 0.0174** |
| Somali | 0.0314** | 0.0046* | −0.0174 | 0.0037** | 0.3362*** | −0.0004 |
| Benishangul | 0.0117 | −0.0008 | −0.0083 | 0.0001 | – | – |
| SNNP | 0.0351*** | −0.0008 | 0.0093 | −0.0002 | – | – |
| Gambela | −0.0054 | 0.0008 | −0.0218 | 0.0030 | 0.1121*** | 0.0057 |
| Harari | −0.0551*** | 0.0002 | −0.0849*** | 0.0040** | 0.0390 | 0.0064 |
| Addis Ababa | −0.0979*** | −0.0027 | – | – | 0.0366 | 0.0094 |
| Diredawa | −0.0265* | 0.0055** | 0.0641*** | −0.0045** | −0.0009 | 0.0083 |
| _Cons | 0.9161*** | −0.0010 | 0.9447*** | −0.0012 | 0.7057** | 0.0031 |
| N | 2585 | 2585 | 1963 | 1963 | 622 | 622 |
| R2 | 0.7646 | 0.1513 | 0.5332 | 0.1300 | 0.5133 | 0.0401 |
| R2_a | 0.7620 | 0.1420 | 0.5267 | 0.1178 | 0.4926 | 0.0018 |

Note: * $P < 0.1$; ** $P < 0.5$; *** $P < 0.01$

able characteristics; all the variables included in the analysis had some influence on household well-being. For instance, the number of children, family size and dependency ratio had a negative influence on a household's consumption expenditure. Three main conclusions emerge from this analysis. First, the percentage of the population that faces a non-negligible risk of poverty is more than the percentage that is observed to be poor. While 35 percent of the population is poor, over 38 percent of the population is vulnerable to poverty. In an analysis of multidimensional poverty, the proportion of the population under multidimensional poverty (90 percent) and the proportion vulnerable to multidimensional poverty (89 percent) are quite high. This highlights the importance of shifting from a one-dimensional analysis to an analysis of multidimensional poverty and vulnerability to poverty. Second, the distribution of vulnerability across different segments of the population can differ markedly from the distribution of poverty. We argue that this highlights the need for a distinction between poverty prevention programs, that is, those aimed at reducing vulnerability and poverty alleviation programs.

Third, we find differences in the sources of vulnerability for different segments of the population. For rural households, the main sources of vulnerability are prospects of low mean consumption and high consumption volatility. This has important implications for poverty prevention programs that are needed to address different groups' vulnerability. In general, poverty reduction strategies in Ethiopia need to incorporate not just alleviation efforts but also prevention efforts. Further, the distribution of vulnerability across different regions can differ significantly from the distribution of poverty; therefore, programs that aim to reduce vulnerability need to be targeted differently from programs that are aimed at poverty reduction even at the regional level.

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# Chapter 5
# Persistence of Social Exclusion in Tanzania

**Amedeus Malisa**

## 1 Introduction

Of late exclusion has attracted considerable attention in poverty studies and led to policy debates in both developing and developed countries. Although the concept is still new in literature, it has become an increasingly common concept for many economists and it is often addressed in public policy discussions linked to social welfare. Nevertheless, the concept still lacks a straightforward definition and its operationalization in empirical analyses is still under debate. Poggi (2007) defines social exclusion as a practice where individuals are fully or partially excluded from social, economic and cultural networks. Hence, social exclusion is multidimensional in nature and relates to different economic, social, political and culture aspects. Additionally, social exclusion is understood differently in different research areas and emphasis is often placed on the aspects that are crucial in a certain area (Bask 2008). Existing literature suggests three vital elements when discussing social exclusion and identifying socially excluded individuals: relativity, dynamics and agency (Atkinson 1992). The concept of social exclusion is relative because one needs to observe an individual relative to the rest of society to judge whether she/he is excluded or not. It is also argued that failure to participate in social activities, which is one aspect of social exclusion, may also be due to an individual's voluntary choice. Hence, it is important to identify agents connected to the occurrence of social exclusion. Social exclusion can also be a result of dynamic processes that depend on how situations and/or circumstances change over time.

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Social exclusion has become a key issue in policy debates and it has also sparked economic debates among the European Union's member states. As required by the Lisbon Summit, the EU states are obliged to recognize individuals who are likely to be socially excluded, together with those who are prone to remain or become excluded (Poggi 2007). The International Institute of Labor Studies (Geneva) recommends that social cohesion should be regarded as one of the aspects of development, and therefore anything happening to social exclusion is a fundamental question of development and its patterns. Following these directives, member states have taken a number of steps for fighting poverty and social exclusion (Bask 2008). However, the notion of social exclusion has so far attracted little attention in the context of developing countries even though marginalization and extreme poverty create persistent problems in these countries (Bhala and Lapeyre 1997).

Due to different policy implications, existing literature suggests a distinction between two different processes of social exclusion (Poggi 2007). The first is that persistence of social exclusion can be viewed as a process that arises from an individual's heterogeneity, either observable or unobservable. The former refers to individual characteristics that are significant in explaining the probability of experiencing social exclusion, for example, gender, level of education and household status. The latter refers to unobserved heterogeneity which may lead to persistence of social exclusion. An individual who is socially excluded at any point in time due to these characteristics is likely to experience it also at other times because of the persistence of these characteristics. On the other hand, the process of social exclusion can be the result of a process called true state dependence. This implies that experiencing social exclusion at any time increases the probability of experiencing it in subsequent periods (Poggi 2007).

Different policies are required for tackling the two situations implying that it is important to distinguish between the two. For example, to minimize someone as being socially excluded in time $t$, due to true state dependence, one must somehow remove this person from social exclusion at this time to save her/him from experiencing it in the future. Therefore, to break out from this circularity it is reasonable to intervene in aspects that generate this state dependence. On the other hand, if persistence of social exclusion is due to unobserved heterogeneity, short term policies aimed at pulling an individual out of social exclusion at time $t$, will not be effective because removing this individual from social exclusion today does not affect his/her persistent characteristics and therefore does not reduce his/her chances of facing social exclusion in subsequent periods.

Therefore, understanding the reasons for the persistence of social exclusion not only helps to stir up debates on the extent of social exclusion in a country, but it also contributes to the framing policies for addressing it (Poggi 2007). If social exclusion continues for many years without understanding its real causes, then this should be of concern for policymakers. Most government policies and donor fund programs in developing countries tend to channel efforts towards poverty alleviation by aiding individuals who are excluded in certain aspects.

Literature on social exclusion mainly focuses on long-term unemployment and social networks which are considered examples of social exclusion. Studies have also focused on developing appropriate definitions and measures of social networks, including how to identify someone who is socially excluded at a particular point in time (Chakravarty and D'Ambrosio 2006; Nolan et al. 2001). Some other studies center their arguments on the number of years for which a person is excluded and the degree of exclusion based on different scopes and durations (Burchardt 2000). A few studies also focus on the dynamic aspects of social exclusion. Poggi (2007) uses Spain as a reference country for analyzing the processes leading to the persistence of social exclusion. To our knowledge, no attempts have been made to analyze these processes in the context of developing countries.

Hence, the objective of this paper is providing some new insights about the dynamic process of social exclusion in a developing country. It specifically explores how the state of being socially excluded has evolved in Tanzania. Its overall aim is to increase our understanding of how individuals who are socially excluded in one period are likely (or not) to experience it in the future. Hence, the paper investigates the processes which lead to persistence in social exclusion in a different setting as compared to existing literature that focuses on developed countries.

The paper focuses on Tanzania which has some relevant features: it belongs to the poorest countries in the world and is witnessing increasing levels of poverty. Approximately 68 percent of Tanzanians live below the $1.25 a day poverty line. In addition, the country is currently implementing different policy strategies in line with the Millennium Development Goals (MDGs) to improve its economy and for reducing poverty.

The rest of the paper is organized as follows. The next section provides a brief review of relevant literature on income dynamics and social exclusion. Section 3 covers the data and methodology used and Sect. 4 discusses the results. Section 5 gives the conclusion.

## 2 Literature Review

### *2.1 The Concept of Social Exclusion and Theoretical Foundations*

Social exclusion is a common term which appears often in public policy debates and in discussions related to social welfare. Although a number of studies have been done on social exclusion, the concept is not well defined. The concept of social exclusion is derived from the French term 'exclusion sociale' which is used to link individuals with various kinds of disadvantages such as being mentally or physically handicapped. According to the French Republican view, the term refers to a process of 'social disqualification' or 'social disaffiliation' which leads to the failure of the relationship between society and an individual (Castel 1995). Therefore, the concept is deep-rooted in the Republican custom of solidarity in which the state plays a role. The French notion of social exclusion has a direct link to this tradition where integration is thought to be achieved only by key state institutions. Thus, the failure of the state in protecting society's solidarity can be viewed as social exclusion (see Bhala and Lapeyre 1997 for a more detailed discussion).

In contrast, the Anglo-Saxon tradition perceives social integration in terms of freely chosen relationships between individuals and society (Silver 1994). This thinking is rooted in the liberal paradigm and pictures society as a bulky group which consists of atomized individuals who are competitive in one market place. Based on this view, exclusion may echo voluntary individual choices, patterns of interest or a pre-determined relationship between actors or alterations to the system such as discrimination, market failures or unforced rights (Bhala and Lapeyre 1997).

Studies on social exclusion have mainly been motivated by these two theoretical backgrounds. The Anglo-Saxon approach dates back to Stouffer et al.'s (1949) study on American soldiers' attitude during World War II. This research invented the idea of relative deprivation, referring to the idea that individuals tended to regard themselves as well-off or bad-off in comparison to those they considered to be important. This school of thought emphasizes an empirical analysis of distributional features of social exclusion which largely relate to material deprivations.

The French tradition on the other hand, builds on Durkheim's (1897) study of normlessness. The emphasis here is on institutions' role as an indicator of social facts and communal ways of thinking and feeling. Therefore, exclusion is regarded as social disintegration and the inability to support social relations (Vrooman and Hoff 2013).

The European Commission stresses that it is each citizen's right to access a basic standard of living and to participate in both social and occupational institutions in society. These include being employed and having access to housing, healthcare and education. Social exclusion occurs when citizens are unable to secure these social rights or they become disadvantaged by accessing them. In the context of globalization and changing economic situations, social exclusion has a close connection with economic restructuring which has been brought about by the emerging global economy (Poggi 2007).

From these definitions it can be seen that the concept of social exclusion is complex and multidimensional. Due to its multidimensionality, social exclusion not only refers to individuals and societies but also to their disadvantages, isolations and absence of freedoms. It encompasses the advantages which individuals perceive, together with institutions' efforts to minimize exclusion and bring about social integration. Due to the complexity of social exclusion's definition, many people have used the term very loosely and it is sometimes confused with notions of poverty and marginalization. However, broadly speaking the definition of social exclusion is similar to that of poverty, that is, it is a concept that evolves over time and includes economic, social and political aspects (Bhala and Lapeyre 1997).

A broad approach to poverty which is attributed to social exclusion is provided by Sen (2000) and is based on individual capabilities. Based on Sen's concept, social exclusion is the concept of individuals' capabilities which provide them with prospects for achieving valuable 'dimensions' or 'states of being'. According to Sen's view, life can be portrayed as a set of inter-related functionings which consist of being and doing. Sen proposes that to address poverty one has to focus on various valuable functionings which represent factors of well-being in both physical elements and complex social achievements. Therefore, the process of exclusion in one aspect can instrumentally generate other important impoverishments in life through its causal impacts. Theoretically, social exclusion occurs when an individual is deprived concurrently on several dimensions (Vrooman and Hoff 2013).

Our study also uses this line of thought. Hence, we view social exclusion as a process which leads to a state of being deprived from valuable dimensions. A state of being socially excluded is a result of a combination of some relevant deprivations in the basic functionings (Poggi 2007). The working definition of social exclusion in our paper follows Poggi's (2007) definition according to which an individual is considered as socially excluded at a specific point in time if he/she is deprived of at least two or more important dimensions. The process of social exclusion starts when one more deprivation is added to an individual who is already social excluded.

### 2.1.1 Multidimensional Aspects of Social Exclusion

The definitions given in the previous section, leave open the question of which dimensions should be considered relevant when analyzing social exclusion; selecting and identifying excluded individuals is also still a matter of discussion. Different studies on the topic have emphasized different appropriate dimensions. For example, Lee and Murie (1999) identify eight relevant dimensions of social exclusion: labor markets, health, education, welfare, poverty spells, housing, public utilities and social networks. The European Commission categorizes individuals as socially excluded in terms of distribution of income, proportion of individuals below the poverty line, persistence of poverty, low education, unemployment and regional disparities. Burchardt (2000) proposes four dimensions: ability to purchase goods and services, being able to participate in social and economic activities, involvement in political aspects and social interacting. Bhala and Lapeyre (1997) give three aspects of social exclusion: economic, social and political. The economic aspects cover questions related to income, production and access to goods or services; the social aspects examine relationship issues related to public goods and services, labor market and social participation; the political aspects cover aspects connected to individual security, political participation, freedom of expression and equal opportunities.

As this discussion shows there is no collective agreement on relevant dimensions which are important for analyzing social exclusion. Nevertheless, the definitions of social exclusion emphasize the relevance of each dimension in its own aspect. Sen (2000), provides some aspects which need to be considered as relevant dimensions of social exclusion including employment, accessibility to healthcare and education opportunities, social safety, facilities for disabled individuals, credit market inclusion and political and rational inclusion. Our paper does not go into detail about these dimensions but follows the empirical framework already developed in literature to analyze the dynamic aspects of social exclusion. Specifically, our framework and subsequent measures on social exclusion build on Sen (2000), Poggi (2007) and Scuttella et al. (2009) for studying social exclusion in Tanzania.

#### 2.1.2 Dynamic Aspects of Social Exclusion

When analyzing social exclusion, Atkinson (1992) provides three fundamental themes that should be taken into consideration: relativity, agency and dynamics. Relativity implies that social exclusion experienced in a society is relevant only for that particular society, that is, material standards, or any aspect considered reasonable as a standard of living in a particular society need not necessarily be the same in another society or in the same society in a different period. Agency means that it is essential to recognize the agents who are responsible for the exclusion process. Dynamics of social exclusion are also related to the fact that one should not only be concerned with one's current circumstances that affect exclusion and that it is also important to focus on future factors in the social exclusion process.

Existing empirical literature agrees that social exclusion is a dynamic process. This implies that an individual's deprivation is not only connected to his/her current status but also his/her past experiences and how they evolved over time (Poggi 2007). It is important to consider this aspect because various scenarios of social and economic circumstances may influence households' level of exclusion from different areas. Therefore, the dynamic method focusses on factors causing social exclusion using these different paths.

Literature on the dynamic aspects of social exclusion discusses various causes which may lead an individual to be socially excluded. Burchardt (2000) relates the cause of social exclusion to factors which profit an individual to undertake normal activities. They include individual characteristics, events in life, features of the area where one lives, social interaction and political institutions in society. In the same vein, Atkinson (1992) relates the causes of social exclusion to labor markets and consumption misfortunes.

Despite this focus on the dynamic aspects of social exclusion, its empirical framework has not been well developed. Understanding the dynamics underlying social exclusion is crucial for policies related to poverty. In particular, the dynamic theme has drawn significant attention in literature and is also a significant aspect in our study.

## 3 Methodology

### *3.1 Data*

Social exclusion is a process in which an individual or groups is/are fully or partially excluded from social, economic and cultural network(s) in the environment (he/she) they live(s) in. This implies that the process of social exclusion leads to a state of exclusion which is a combination of important deprivations. To construct an indicator which represents an individual's state of social exclusion, this paper uses three available waves of Tanzania's National Panel Surveys (TZNPSI-TZNPSIII). TNPS are series of countrywide household panel surveys that have extensive information on different topics including agricultural production, non-farm income generating activities, consumption expenditures and other socioeconomic activities. The surveys are done by the Tanzania National Bureau of Statistics (NBS). Three TZNPS were conducted between October 2008 and October 2009 (first survey), October 2010 and November 2011 (second survey) and October 2012 and November 2013 (third survey) (NBS Tanzania, 2012–13).

The TZNPS have advantages over household budget surveys since they provide high quality household-level data to different stakeholders when monitoring poverty dynamics and they enable the tracking and monitoring of other major national-level government policy initiatives. Therefore, using this data enables our study to examine economic and social household situations from a dynamic perspective. However, due to selection problems, TZNPS might be less representative since there is a very high chance that the homeless population which has a higher probability of being socially excluded is omitted from the information gathered. Another limitation that may arise is when suitable individuals refuse to take part in the interviews. TZNPS address these issues by giving cross-sectional weights which reflect population characteristics in terms of age, sex and area. Our study uses these weights to try to correct for these biases.

In addition, there is the problem of attrition for panel related data where for one reason or another, an individual in the first wave may not be interviewed in the subsequent waves. In the TZNPS data, attrition between the first and third waves is about 3.9 percent and is slightly higher in Dar es Salaam (about 10 percent) while in other urban and rural areas it is lower. However, the most likely cause of attrition is the inability to find the household rather than refusal to participate in the survey, hence the bias based on refusal should not be that severe.

However, since our study intends to study the persistence of social exclusion based on functioning's, the data needs to be cleaned to accommodate only those individuals who have no missing data in all the three waves. After cleaning the data, 13,028 individuals were left in each wave and only 7255 individuals (aged 16+ years) were included in the sample. The data also includes longitudinal weights which are also available in TZNPS. However, we do not include them in our estimation because of econometric efficiency. We used the definitions of social exclusion explained earlier to construct a summary measure of social exclusion. This implies choosing relevant dimensions and factors that represent them. This paper uses the summary measure from these dimensions to identify deprived individuals and finally aggregates these functionings to obtain an overall measure of social exclusion.

### 3.2 Selection of Functionings

There is an on-going discussion on appropriate 'functionings' that should be used in determining whether an individual is excluded. Therefore, compiling a comprehensive list is relatively unambiguously established (Poggi 2007). Sen (2000) provides some guidance in this as does the famous 'Scandinavian approach' suggested by Brandolini and D'Alessio (1998). Our study follows Poggi (2007) and Scuttella et al. (2009) who use the mentioned guidelines to select important dimensions to capture the primary characteristics of social exclusion.

Following previous empirical frameworks, our chosen functionings include fulfilment of basic needs, having a sufficient income, ability to attain a particular quality of life, adequate housing, social interactions, the general health of a person, being able to live in a safe and unpolluted environment and ability to perform paid or unpaid job activities. The first four dimensions represent the economic features of social exclusion while the remaining focus on its social dimensions. It should be noted that each of the selected functionings is seen as being important on its own, regardless of the interactions among them. Some of these dimensions can be considered as causes of social exclusion while others act as instruments in causing social exclusion (Poggi 2007). Therefore, some dimensions may not be the cause of a deprivation at some point but can result in impoverishments through causal effects. Inclusion of environmental circumstances and health status, for example, may have significant effects in the analysis although they themselves do not lead to social exclusion.

Due to data problems, we could not include social and health aspects of social exclusion and therefore only cover six dimensions in our study.[1] However, even if not exhaustive, these dimensions appear to be reasonable and coherent with the empirical framework discussed earlier. To replace some items in the basic needs dimension, we used the relativity principle of social exclusion to include other proxies which are considered basic according to living standards at least in the least developed countries, and in Tanzania in particular. Table 5.1 gives a summary of the six dimensions of social exclusion, their respective weights and operationalization items selected from TZNPS. The items in the list are a mixture of household level and individual level items. It should also be noted that while some dimensions focus on subjective well-being, others are inescapably biased towards a group. Since the unit of measurement is an individual, there is a high probability that there will be intra-household correlations in the exclusion status.

The predictive relationships between the different dimensions and the correlation test results are given in Table 5.8 in Appendix A. Generally, there is low degree of association across the dimensions where most coefficients on average have absolute values below 0.2. However, the correlation between housing and quality of life is slightly higher. In addition, economic dimensions have a stronger

[1] The information available in the three waves did not allow us to trace items in the social and health dimensions because questions asked about the items varied over the three waves.

**Table 5.1** Functionings used in the analysis

| Dimensions and their respective components | Weights |
|---|---|
| Basic needs fulfilment (BASIC) | 1/6 |
| Not eating three meals a day | |
| Households unable to buy basic items (e.g. soaps, toothpaste) | |
| Universal primary education | |
| Being unable to pay bills | |
| Having an adequate income (INCOME) | 1/6 |
| Income in general | |
| To reach a certain quality of life (QUALITY) | 1/6 |
| Car or van | |
| TV | |
| Video recorder | |
| Mobile phone | |
| Having an adequate house (HOUSING) | 1/6 |
| Not having an indoor flushing toilet | |
| Not having running water | |
| Not having enough space | |
| Not having enough light | |
| Not having dump walls, floors | |
| Not having a leaky roof | |
| Living in a safe and clean environment (LIVING) | 1/6 |
| Vandalism or crime in the area | |
| Being able to perform paid or unpaid work activities (WORK) | 1/6 |
| Being unemployed | |

correlation which suggests that these dimensions capture slightly complementary aspects.

### 3.2.1 Weighting Structure

Comprehensively determining how the dimensions represent the overall well-being of an individual also requires a representative weighting structure for each dimension. Different weight structures reflect different opinions. Some studies suggest using data frequency and multivariate techniques (Tsakloglou and Papadopoulos 2002). Bhala and Lapeyre (1997) suggest considering weights depending on the degree of development of the country under consideration. That means, industrialized countries' weight on economic and social aspects should almost be the same while in developing countries the economic aspects should remain the most important ones. However, following Poggi (2007), we use equal weights since using different weights may result in arbitrariness within dimensions.[2] This approach gives equal weight to each of the six dimensions and gives equal weight to each item within these dimensions. This is based on the implicit assumption that each dimension is an equally important contributor to social exclusion.

Therefore, for every item all individuals are assigned scores between zero and one. An individual is assigned a score of one if he/she can afford the item, has no problem with the item or has the item. An individual is assigned a score of zero if he/she is deprived of that item. All items corresponding to every dimension are aggregated by adding up their scores and the results are divided by the weight of the dimension. This means that all individuals obtain a score between 0.167 and 0, and values which are between zero and 0.167 refer to intermediate situations. A value of 0.167 implies that a dimension is fully achieved and a value of zero means a dimension is not achieved while intermediate values signify intermediate conditions.

Each item represents an individual's ability to afford or possess a good or the absence of a problem for at least 50 percent of the sample.

## *3.3 Measuring Social Exclusion*

Being in a situation of inclusion or exclusion for the selected dimensions is a matter of degree (Poggi 2007). Therefore, at different points in time a dimension may be achieved depending on the choice of the threshold used below which an individual is regarded as being deprived. However, the choice of this threshold is subject to some degree of uncertainty.

### 3.3.1 Determination of the Cut-Off Point

To find group attribute levels and for clustering individuals in different groups, there is a need to establish cut-off points. Literature on income and social exclusion thresholds is vast and subject to discussion. While in some developed countries like Britain official statistics suggest 50 percent as the income distribution cut-off point, Eurostat uses 60 percent as the median; both these show a level of arbitrariness. Tsakloglou and Papadopoulos (2002) did a sensitivity analysis of various cut-off points – 50 percent, 60 percent and 70 percent – and concluded that the robustness of the results is not subject to the cut-off points chosen.

Since some attempts which specify the required cut-off points have been made in literature we use the common cut-off points that earlier studies have arrived at. In each dimension, the fixed threshold is set at 50 percent of the mean distribution of

[2] See Appendix B.

the dimension.[3] We consider each person below this established cut-off point to be deprived in that particular dimension and therefore a person can be deprived in more than one functioning. Using this threshold for each dimension at each period, together with information on deprivation in each dimension, we created a summary measure of social exclusion. A summary measure of social exclusion for an individual was obtained by adding together each dimension's deprivation. Following the definition of social exclusion explained earlier, we considered a person being excluded if he/she was deprived in at least two or more dimensions. The summary measure of social exclusion takes a value of one if an individual is socially excluded and zero otherwise.

## 3.4 The Model

To provide a better understanding of the persistence of social exclusion this section describes the model that we used. As mentioned earlier, persistence is generated by two processes: unobserved heterogeneity and true state dependence. The former means that individuals can be heterogeneous in terms of characteristics that are vital for someone to experience social exclusion and which are persistent over time. In this case, a person experiencing social exclusion at a particular point in time due to unobserved (adverse) characteristics, is likely to experience the same social exclusion in any subsequent period because of the same adverse characteristics. The latter process explains the situation where an individual experiencing social exclusion at any specific time increases his/her chances of experiencing social exclusion in other periods (Poggi 2007). For each individual, a score of social exclusion indicators is calculated where a social exclusion indicator is one if the individual is excluded and zero otherwise. The sample is comprised of individuals aged 16+ years who were observed in all the three waves of the survey resulting in 21,765 observations.

There are some methodological problems in estimating persistence of a discrete choice variable, in particular, the presence of true state dependency and unobserved heterogeneity. The problem is how to come up with a consistent estimation in a non-linear model. Existing literature suggests two ways to deal with this problem: the random effects and the fixed effects models. Both these models rely on the assumptions that they put forward. This paper follows Poggi's (2007) approach who used a random effects model. This enables us to specify the model in a way that can predict and calculate quantities for all variables of interest including average partial effects and effects of 'what-ifs' from the estimation results.

In addition, the initial condition of the model and its assumptions about the initial observations need to be specified for the model's results to be fully param-

[3] For robustness, other cut-offs were also tested (40 and 60 percent) in the analysis. The descriptive statistics are given in Table 5.2. Although the results for social exclusion were higher compared to those at the 50 percent cut-off, the significance of the coefficients did not change.

eterized and to allow interpretations. This is a problem when there is no concurrence between the start of the observation period and the stochastic process which generates experiences of social exclusion (Arulampalam et al. 2000). A number of studies have suggested how to handle the initial condition in dynamic models which have additional unobserved effect and initial condition problems. There seems to be an agreement that handling the initial condition is much harder to resolve especially in non-linear models (for example, Ahn and Schmidt 1995; Arellano and Bond 1991). In our study, the individuals might have experienced social exclusion before the period under study. Hence, those individuals excluded in the first wave might be there in the study because they had earlier history of exclusion or some other characteristics which affect their exclusion susceptibility. Wooldridge (2005), proposes a simple solution to handle such a problem which this paper follows closely. He suggests finding individual-specific effect distribution, conditional on the initial value and the observed history of strictly exogenous explanatory variables. This makes it possible to account for a probable correlation between individual specific effects (which are time invariant unobserved individual determinants of social exclusion) and levels of social exclusion experienced by individuals in the initial period. This also makes it possible to relax the exogeneity assumption in that one can allow a correlation between unobserved and observed individual characteristics.

To analyze how this calculated indicator for social exclusion changes over time, we used a dynamic panel data logit model. This model can predict an outcome variable that is categorical from predictors that are both continuous and/or categorical. A brief description of the model as presented by Wooldridge (2005) is:

Given an individual observed from time $t = 1$ to $t = 3$ the conditional probability that exclusion occurs is provided by:

$$P\left(y_{it} = 1 \middle| y_{it-1}, \ldots y_{i0}, z_i, c_i\right) = \phi\left(z_{it}\gamma + \rho y_{it-1} + c_i\right) \tag{5.1}$$

where $\phi$ is a functional form of logistic distribution; $y_{it}$ is the dependent variable where $it$ represents the exclusion state of individual $i$ in time $t$; $z_i$ and $z_{it}$ are vectors of time-constant and time varying explanatory variables respectively; $c_i$ is individual specific effects; and $\rho$ and $\gamma$ are parameters to be estimated.

As stated in Wooldridge (2005), it is assumed that the equation complies with the following assumptions. First, the dynamics are assumed to be of first order once $z_i$ and $c_i$ are conditioned on. Second, the unobserved effect is an addition to the distribution function, $\phi$; third, $z_{it}$ fulfils a strict exogeneity assumption. The parameters in Eq. (5.1) can be consistently estimated by assuming a density for the individual specific effects given the initial condition of an exclusion state, $y_{i0}$, and the time invariant explanatory variables, $z_i$. Therefore, it is assumed that:

$$c_i \middle| y_{i0}, z_i \sim \phi\left(a_0 + a_1 y_{i0} + z_i \alpha_2, \sigma_a^2\right) \tag{5.2}$$

where $\sigma_a^2$ is the conditional standard deviation of individual specific effect ($c_i$) while $a_0$, $a_1$ and $\alpha_2$ are the parameters to be estimated. Since we want to identify coefficients for time constant covariates, the vector $z_i$ appears in Eq. (5.2) and not on the right side of Eq. (5.1).

Following Eqs. (5.1) and (5.2), conditional density for the conditional distribution is given by:

$$f\left(y_{it},\dots y_{iT}|y_{i0},z_i,c_i;\gamma,\rho\right)=\prod_t\Big\{\phi\left(z_{it}\gamma+\rho y_{it-1}\right.\\ \left.+c_i\right)^{yt}\left[1-\phi(z_{it}\gamma+\rho y_{it-1}+c_i\right]^{1-yt}\Big\} \tag{5.3}$$

To maximize the density, Eq. (5.3) is integrated with respect to the logistic distribution density in Eq. (5.2) to obtain parameters $\rho$, $\gamma$, $a_0$, $a_1$ $\alpha_2$ and $\sigma_a^2$ where the estimation is consistent under the assumption that the model is correctly specified.

In this specification, the coefficient of $\rho$ determines if the exclusion structure of the dependent variable, $y_{it}$, features true state dependence. It tells us whether experiencing exclusion at one point in time increases the chances of being socially excluded in subsequent periods. That is, if $\rho > 0$, then experiencing exclusion at time $t-1$, increases the probability of experiencing it in year $t$. In addition, the estimate of $a_1$ gives information about the direction of the relationship between unobserved individual characteristics and the level of social exclusion in the first period. Moreover, an estimate of $\sigma_a^2$ denotes the magnitude of dispersion accounted for by unobserved heterogeneity.

As proposed by Wooldridge (2005) this specification of the model needs a balanced panel and therefore attrition and selection problems are not allowed. However, since selection and attrition problems both depend on initial conditions, this allows attrition to also vary across the initial level of social exclusion. Therefore, it is okay to consider these problems without necessarily modeling them based on initial conditions. For a balanced panel, as in the current study, the problems become less complicated since there is compensation for loss of information.

# 4 Results

## *4.1 Social Exclusion and Its Persistence in Tanzania*

From the descriptive statistics in Table 5.2 it can be observed that social exclusion in Tanzania is very large; about 88 percent of the sample was excluded. A significant proportion of the population was excluded in the economic dimension (income 62 percent, work 32 percent, quality of life 75 percent and basic needs 59 percent). On the other hand, only 24 percent of the population in the sample lived in urban areas while a small percentage of the sample had higher education (about 1 percent).

**Table 5.2** Descriptive statistics

| | For all $N = 21,765$ | | | |
|---|---|---|---|---|
| Variable | Mean | Std. dev. | Min | Max |
| Region | 17.58 | 16.68 | 1 | 55 |
| Locality | 1.75 | 0.83 | 1 | 3 |
| Sex | 0.47 | 0.49 | 0 | 1 |
| High_ed | 0.01 | 0.10 | 0 | 1 |
| Age | 38.60 | 16.71 | 16 | 106 |
| Urban | 0.24 | 0.43 | 0 | 1 |
| SE | 0.87 | 0.33 | 0 | 1 |
| Income SE | 0.62 | 0.48 | 0 | 1 |
| Work SE | 0.32 | 0.46 | 0 | 1 |
| Living SE | 0.07 | 0.26 | 0 | 1 |
| Quality SE | 0.75 | 0.43 | 0 | 1 |
| Housing SE | 0.66 | 0.47 | 0 | 1 |
| Basic SE | 0.59 | 0.49 | 0 | 1 |
| Northern zone | 0.11 | 0.32 | 0 | 1 |
| Coastal zone | 0.30 | 0.46 | 0 | 1 |
| Central zone | 0.08 | 0.27 | 0 | 1 |
| Lake zone | 0.18 | 0.38 | 0 | 1 |
| Southern zone | 0.14 | 0.34 | 0 | 1 |
| Zanzibar | 0.16 | 0.37 | 0 | 1 |
| cc | 0.49 | 0.50 | 0 | 1 |
| cwc | 0.08 | 0.28 | 0 | 1 |

Note: SE = Social exclusion based on the definition discussed in Sect. 3; cc = individuals cohabiting and having children; and cwc refers to cohabitation without children

**Table 5.3** Deprivation percentages based on a particular dimension (balanced panel) (in percentage)

| | 2008 | 2010 | 2012 |
|---|---|---|---|
| Basic | 55 | 75 | 49 |
| Quality | 79 | 78 | 69 |
| Housing | 69 | 67 | 63 |
| Living | 10 | 8 | 5 |
| Work | 45 | 33 | 18 |
| Income | 64 | 64 | 58 |
| Social exclusion | 92 | 93 | 78 |

Table 5.3 indicates the percentage of individuals aged 16+ years who were below the threshold for each of the dimensions in the three waves. In 2008, about 92 percent of the sample was deprived in at least two dimensions while this figure dropped to 78 percent in 2012. High deprivation proportions are also observed in the quality of life, basic needs, housing quality and income dimensions while the living dimension had the lowest proportion of deprivation. Most of these dimensions reflect economic aspects of social exclusion implying that a significant number of individuals in Tanzania were socially excluded in economic aspects as compared to other dimensions.

**Table 5.4** Persistence of social exclusion in subsequent waves in various spells

| Individuals excluded in *j* consecutive years in | | Percentage of individuals experiencing the following number of spells. In percentages | | | | |
|---|---|---|---|---|---|---|
| | Total | One | Two | Three | Four | Five or more |
| Only 1 year | 98 | 92 | 79 | 52 | 19 | 1 |
| 2 years | 98 | 93 | 76 | 45 | 13 | 1 |
| 3 years | 93 | 78 | 57 | 27 | 6 | 0 |

It should be noted that the proportion of individuals regarded as socially excluded is subject to a threshold selected in every dimension. Therefore, the higher the cut-off, the more the proportion of people who are considered deprived in a particular dimension, and more will be the socially excluded and vice-versa. Hence, attention should be focused on the pattern and relationship between the dimensions in which there is social exclusion at a particular point in time rather than looking at the level of exclusion per-se.

Across the dimensions of exclusion, we observe that at a particular point in time more than 50 percent of the sample suffered from social exclusion in at least three dimensions. The proportion of deprivation was relatively higher in the first wave and decreased in the subsequent waves though it was still high. The proportion of individuals deprived in more than three dimensions was relatively lower than those deprived in at least three dimensions and evidence shows that there was a significant proportion of individuals excluded in all dimensions. Although this study considers only six dimensions, its results are different from those obtained by Poggi (2007) who found no evidence of individuals who were excluded in all the dimensions in UK and Spain.

The relationship of social exclusion over time is rather resilient over the three waves. Social exclusion in one wave had a strong correlation with social exclusion in the subsequent wave. Table 5.3 also shows how social exclusion evolved over time for each dimension. The rates of deprivation observed in wave 3 were slightly lower than those registered in the first wave for each dimension. This implies that there was a decrease of social exclusion over time although this decrease was not very significant given the number of waves available.

Considering the patterns of social exclusion, Table 5.4 shows the proportion of individuals who were excluded in one or more waves over the period of study. As time evolved there was an increasing proportion of individuals who moved from being socially excluded and correspondingly, there was a decrease in the percentage of people who experienced social exclusion during the period of study. Only about 4 percent of the population had never experienced exclusion for the entire study period. About 98 percent of the sample had experienced social exclusion at least once in the entire period and a decreasing proportion had observed social exclusion when we consider two or more consecutive waves. This decrease in frequency from the first wave to the third wave suggests that inclusion or exclusion in Tanzania varied over time. These results are in line with those obtained by Poggi (2007).

However, there was a significant proportion of long-stayers which also represents a significant level of total exclusion. About 31 percent of all observations of social exclusion were represented by those individuals who remained excluded in the final wave. These long-stayers have significant implications for policy because policy interventions need to focus on helping them find a pathway out of social exclusion. There is also an indication of some degree of mobility where a proportion of the individuals experienced some social exclusion but were not excluded throughout the entire study period. Focusing on the frequency of the exclusion in Table 5.4 it is observed that about 50 percent experienced multiple spells of social exclusion. In particular, 52 percent in wave 1, 45 percent in wave 2 and 27 percent in wave 3 experienced three or more spells of exclusion.

## *4.2 Empirical Results*

### 4.2.1 Estimates of Persistence

Using the dynamic logit model discussed earlier, Table 5.5 presents the estimates of the conditional maximum likelihood with asymptotic standard errors. As the first step, the analysis considered only lag of social exclusion and initial condition

**Table 5.5** Social exclusion-three waves balanced panel

| SE | Model 1 | | Model 2 | | Model 3 | |
|---|---|---|---|---|---|---|
| | Coef. | Std. err. | Coef. | Std. err. | Coef. | Std. err. |
| SE_lag | 0.839*** | 0.152 | 0.684*** | 0.108 | 0.689*** | 0.108 |
| SE_0 | 2.094*** | 0.191 | 1.561*** | 0.103 | 1.564*** | 0.103 |
| Edu_h | – | – | −1.594*** | 0.196 | −1.590*** | 0.198 |
| Male | – | – | −0.138** | 0.054 | −0.135* | 0.054 |
| Age | – | – | −0.422*** | 0.010 | −0.042*** | 0.010 |
| Square of age | – | – | 0.000*** | 0.000 | 0.000*** | 0.000 |
| Urban | – | – | −1.049*** | 0.061 | −1.057*** | 0.061 |
| Northern zone | – | – | −0.173 | 0.105 | −0.182 | 0.105 |
| Southern highlands | – | – | 0.109 | 0.108 | 0.101 | 0.109 |
| Central zone | – | | 0.802*** | 0.145 | 0.793*** | 0.153 |
| Lake zone | – | – | 0.333*** | 0.107 | 0.329*** | 0.104 |
| Coastal | – | – | −0.450*** | 0.074 | −0.460*** | 0.075 |
| cc | – | – | −0.069 | 0.064 | 0.5669*** | 0.198 |
| cwc | – | – | −0.233* | 0.096 | 0.120 | 0.297 |
| Constant | −0.716*** | 0.068 | 1.201*** | 0.231 | 1.186*** | 0.233 |
| cc dummies | No | No | No | No | Yes | Yes |
| cwc dummies | No | No | No | No | Yes | Yes |
| Sigma_a | 0.208** | 0.397 | 0.005 | 0.020 | 0.005 | 0.020 |
| LR test | – | | 807.28*** | | 27.71*** | |
| *N* | 14,510 | | 14,510 | | 14,510 | |

Notes: $*p < 0.1$, $**p < 0.05$, $***p < 0.01$
SE_lag = social exclusion at time $t - 1$; SE_0 = social exclusion in the initial period; Edu_h = high level of education; cc = cohabitation with children; cwc = cohabitation without children. Northern zone, Southern highlands, Central zone, Coastal zone and the Lake zone are base year constant variables. (*) means statistically significant at 10 percent, (**) means statistically significant at 5 percent and (***) means statistically significant at 1 percent

**Table 5.6** Social exclusion-three waves balanced panel (odds-ratios)

| SE | Model 1 | | Model 2 | | Model 3 | |
|---|---|---|---|---|---|---|
| | Coef. | Std. err. | Coef. | Std. err. | Coef. | Std. err. |
| SE_lag | 2.315*** | 0.353 | 1.982*** | 0.214 | 1.992*** | 0.215 |
| SE_0 | 8.119*** | 1.558 | 4.766*** | 0.493 | 4.776*** | 0.494 |
| Edu_h | – | – | 0.203*** | 0.039 | 0.203*** | 0.040 |
| Male | – | – | 0.870** | 0.047 | 0.873** | 0.047 |
| Age | – | – | 0.958*** | 0.009 | 0.960*** | 0.009 |
| Square of age | – | – | 1.000*** | 0.000 | 1.000*** | 0.000 |
| Urban | – | – | 0.350*** | 0.021 | 0.347*** | 0.021 |
| Northern zone | – | – | 0.840 | 0.088 | 0.833 | 0.088 |
| Southern highlands | – | – | 1.115 | 0.121 | 1.106 | 0.120 |
| Central zone | – | – | 2.231*** | 0.342 | 2.211*** | 0.339 |
| Lake zone | – | – | 1.395*** | 0.145 | 1.390*** | 0.144 |
| Coastal | | | 0.637*** | 0.047 | 0.630*** | 0.047 |
| cc | – | – | 0.932 | 0.059 | 1.762*** | 0.349 |
| cwc | – | – | 0.792* | 0.076 | 1.127 | 0.335 |
| Constant | 0.488*** | 0.033 | 3.323*** | 0.770 | 3.277*** | 0.765 |
| cc dummies | No | No | No | No | Yes | Yes |
| cwc dummies | No | No | No | No | Yes | Yes |
| Sigma_a | 0.207*** | 0.3947 | 0.005 | 0.020 | 0.005 | 0.020 |
| LR test | – | | 807.28*** | | 27.71*** | |
| *N* | 14,510 | | 14,510 | | 14,510 | |

Notes: *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$
SE_lag = social exclusion at time $t - 1$; SE_0 = social exclusion in the initial period; Edu_h = high level of education; cc = cohabitation with children; cwc = cohabitation without children. Northern zone, Southern highlands, Central zone, Coastal zone and Lake zone are base year constant variables. (*) means statistically at significant at 10 percent, (**) means statistically significant at 5 percent and (***) means statistically significant at 1 percent

as explanatory variables (Model 1). Additional explanatory variables were included to account for observed heterogeneity (Models 2 and 3). To explicitly control for problems associated with probable intra-household correlations, the results include estimates of robust variances. Estimates of the odds ratio are presented in Table 5.6.

In Model 1, the coefficient of lagged social exclusion is highly significant. This also applies to the initial value of social exclusion which indicates a significant correlation between unobserved heterogeneity and the initial condition. Specifically, the coefficient of initial social exclusion is 2.1 which is larger than that of lagged social exclusion which is approximately 0.8. Further, the coefficient of the conditional standard error of $c_i$ ($\sigma_a$) is equal to 0.21 and is statistically different from zero, implying the presence of unobserved heterogeneity.

Presence of unobserved heterogeneity in Model 1 suggests that there is a need to control for observed heterogeneity. Hence, Model 2 includes the base year constant dummy variables representing gender, age and square of age and time varying variables demonstrating cohabitation status with or without children in the family. The estimation also includes some base year time constant zonal dummies to account for regional differences. Zonal dummies correspond to five zones identified by NBSTZ – the Northern zone, Southern Highlands, Lake zone, Central zone and Zanzibar. Note that the reference group is composed of females who are living alone in the Zanzibar area with low educational levels. After the inclusion of these variables, there is a sharp decrease in unobserved heterogeneity that cannot be described by explanatory variables. The estimated $\sigma_a$ is now 0.005 and statistically insignificant. Hence, in Model 2 there is now a low correlation between the initial condition and the unobserved heterogeneity as in Model 1. Using the likelihood ratio test (LR-test), it is observed that Model 2 also has a better fit than Model 1. Among the explanatory variables included in Model 2, the level of education appears to considerably reduce the chances of undergoing social exclusion. The coefficient of male is also negative indicating that males are somewhat less likely to experience social exclusion as compared to females. The same applies to individuals who live in urban areas as compared to those living in rural areas. Coefficient estimates of age and its square show that the probability of experiencing social exclusion decreases with age and the phenomenon reverses in old age. However, the magnitude of these coefficients is relatively low. Individuals living in the Central and Lake zones face lower risks of experiencing social exclusion as compared to the reference group. This also applies to individuals who cohabit without children. These results are similar to those obtained by Poggi (2007) though the magnitude of coefficients is relatively larger in our study.

To further control for unobserved heterogeneity as suggested by Wooldridge (2005) Model 3 includes the corresponding time invariant dummies for each time varying-variable. Although the estimated $\sigma_a$ is still 0.005, Model 3 has the best fit compared to the other three models. Dummy variables for each wave were also included to capture time trends. However, the variables were dropped due to collinearity and the results had the least power compared to the models discussed earlier probably because of the number of waves in the study so that time varying variables did not change significantly over the period of study.

The coefficients returned from the logistic regression in Table 5.5 are log-odds ratios. They indicate how the log-odds of a socially excluded individual changed with a one-unit change in the explanatory variables. Hence, the sign of the log-odds ratio shows the direction of its relationship. However, all odds-ratios in Table 5.6 have positive values and the distinction regarding the positive and negative relationship in the odds-ratio is determined by the side that they fall in. While the values of one indicate no relationship, less than one values indicate a negative relationship while greater than one values show a positive relationship. Therefore, the results in Table 5.6 have the same interpretation and are equal to those discussed in Table 5.5.

As Poggi (2007) points out, the strict exogeneity assumption from the econometric point of view is relatively difficult to test. The assumption requires that conditional on the previous level of social exclusion and on unobserved individual features, present social exclusion must not be correlated to other values of other past or future variables. The assumption is violated if responses from social exclusion are associated with values of the explanatory variables included as predictors in the model. The assumption can be even stricter since the covariates included in the analysis comprise of individual aspects such as age, geographical location of residents and education which are less likely to be altered by previous social exclusion. In addition, variables such as marital status and children in the household may be more challenging since it is expected that, social exclusion may have a negative effect on marriage and fertility (Biewen 2004). However, we did not do any formal tests to test this and only present the results by comparing the estimates of Models 2 and 3 in Table 5.5. The models represent, respectively two cases where one is estimated with time constant variables (cohabitation status with or without children) and the other without. It is clearly observed that there are no substantial differences in the estimates and the coefficients of the lagged social exclusion given in Model 3 are relatively lower than those in Model 1 where no exogenous variables are included. Therefore, it can be concluded that estimated state dependence in Model 3 is not biased considering that it is hard to tell whether the covariates added in Model 2 violate the exogeneity assumption.

Generally, the estimation of the models shows that the probability of experiencing social exclusion is to a large extent explained by observed heterogeneity and state dependence. This is observed in Tanzania as a significant proportion of the population (68 percent) still lives below the poverty line of $1.25 a day. The main problems facing the country in poverty reduction efforts include low education levels, unemployment, rising income disparities and failure to fully exploit its natural resources. Secondly, a significant part of the persistence of social exclusion is attributed to past social exclusion, that is, someone experiencing social exclusion now has a higher probability of experiencing it in the future. These findings are vital for policymakers as the results are suggestive of having proper policies which will get people out of social exclusion and reduce their susceptibility to future exclusion.

### 4.2.2 Importance of the Dynamics and Effects of Observed Heterogeneity

To assess the importance of the dynamics in the model we estimated average partial effects. This is to test whether there are dynamic effects in the model by calculating the magnitude of marginal partial effects and testing the relevance of state dependence. The marginal effects will be more robust in analyzing the impact of observed heterogeneity in social exclusion conditional on past social exclusion status. The average partial effects conditional on response probability are given by:

$$E\left[\phi\left(\rho y_{it-1} + c_i\right)\right] \tag{5.4}$$

where expectation is computed with respect to the distribution of individual specific effects, $c_i$. The consistent estimator as proposed by Wooldridge (2005) is provided by:

**Table 5.7** Partial effects

| Estimated probability of being socially excluded in wave 3 given that the individual is or not excluded in wave 2 | | | |
|---|---|---|---|
| | Excluded in wave 2 | Not excluded in wave 2 | Estimated dependence |
| Probability | 0.865 | 0.786 | 0.079 |
| Probability of being excluded in wave 3 if: | | | |
| Male | 0.859 | 0.776 | 0.082 |
| Female | 0.872 | 0.794 | 0.077 |
| Lives in | | | |
| Urban | 0.782 | 0.660 | 0.122 |
| Another area | 0.902 | 0.833 | 0.069 |
| Has: | | | |
| A higher education level | 0.639 | 0.498 | 0.141 |
| Lower education level | 0.869 | 0.789 | 0.080 |

$$N^{-1}\sum_{i=1}^{N}\phi\left(\hat{\rho}_a y_{it-1} + \hat{a}_{0a} + \hat{a}_{1a} y_{i0} + z_i \hat{a}_{2\mathrm{a}}\right) \tag{5.5}$$

The subscript $a$ in Eq. (5.5) refers to a multiplication by $\left(1+\hat{\sigma}_a^2\right)^{-1/2}$ and the coefficients are estimated using conditional maximum likelihood estimations.

Based on the results of Model 3 and this estimator we estimated the effects of variations in some explanatory variables conditional on the probability of facing social exclusion as a mean over other distribution characteristics in the sample. First, we estimated the probability of exclusion for wave 3 given an individual's status of exclusion in wave 2. The results are given in Table 5.7.

State dependence is the estimated difference between being either socially excluded or not in wave 3 as compared to the previous wave (wave 2). The probability of experiencing social exclusion in wave 3 given that the person is excluded in wave 2 is 0.8658 and it decreases to 0.7860 if the person is not excluded in wave 2. Therefore, estimation of state dependence on social exclusion is approximately 0.0798. This implies that persons experiencing social exclusion in a previous period have a 7.9 percent higher chance of being socially excluded in the subsequent period as compared to those who were not excluded.

For an individual living in an urban area, who is also excluded in wave 2 the probability of being excluded in the subsequent period is 0.7826. This probability is much higher if the person is excluded and lives in another area (about 0.9), which means people living in rural areas have higher chances of being socially excluded compared to those living in urban areas. Moreover, for an individual living in an urban area and not excluded in wave 2, the probability of social exclusion is 0.66, but it increases to 0.90 if the person does not live in an urban area. However, estimated state dependence for people living in urban areas is 12 percent which is much higher than that for individuals living in other areas (7 percent). Finally, it can be noted that the probability of being excluded for a male (0.85) in wave 3 is somewhat lesser than that for a female (0.87) and their state dependence is relatively similar although for males it is slightly higher. In the same vein, persons with a higher education have a relatively lower probability of being excluded in wave 3 compared to those with lower education levels. The same applies to those individuals who were not excluded in wave 2. Nevertheless, the estimated dependence is higher for those with higher education compared to those with lower education.

The general message from this analysis is that there is higher probability of experiencing social exclusion in the future for those who are socially excluded today compared to those who are not socially excluded. The impact of the dynamics of the past is also significant and is more than 6 percent on average. These results are similar to those found by Poggi (2007) though the magnitude is relatively higher for Tanzania compared to what they obtained in Spain. Differences in magnitude make sense given the differences in the economic conditions in the two countries.[4]

## 5 Conclusion

This paper studied the dynamics of social exclusion in Tanzania for the three available National Panel Surveys from 2008 to 2013. Literature on the topic provides conflicting explanations for empirical consistencies. It is frequently observed that individuals who have experienced social exclusion in a previous period are prone to experience it in subsequent periods. One argument is that the probability of experiencing social exclusion is due to true state dependence. Another explanation is that individuals differ in certain observed and unobserved characteristics which may influence their chances of experiencing social exclusion.

Using both descriptive and econometric analyses, our results show that social exclusion in Tanzania is relatively high. Over the period of study, about 98 percent of the sample had experienced social exclusion at least once over the period. Only about 4 percent of the population under study had never experienced social exclusion over the period under study. Regardless of this high proportion of individuals experiencing social exclusion, our results also show that not all individuals were excluded during the entire period. This suggests that there is some degree of movement between individuals who become socially excluded and those who move out of social exclusion in Tanzania.

The paper makes a contribution to our understanding of social exclusion and the mechanisms underlying transitions in social exclusion. Additionally, it also presents applied evidence of social exclusion's dynamics from one of the poorest countries, Tanzania. Our results suggest that social exclusion dynamics in Tanzania are to a large extent triggered by observed characteristics (economic adversities) as compared to unobserved heterogeneity. These results can help formulate and improve policies which are directed at poverty reduction and social exclusion. In particular, they can assist in proposing policies which will help get people out of

[4] Additional results and the robustness test are presented in Tables 5.9 and 5.10 in Appendix B and in Table 5.11 in Appendix C.

social exclusion and prevent people from being socially excluded. The analyses indicate how different social exclusion processes are related to both which implies that there is a need for a right policy mix when addressing social exclusion. Further research can be done by allowing flexible transitions in the model. This can be done by splitting the measure of social exclusion into sub-groups where ordinal logit or count data can be used instead.

## Appendix A

## Appendix B: Extent of Social Exclusion Using Different

**Table 5.8** Correlation matrix between different dimensions

| | Basic | Quality | Living | Housing | Income | Work |
|---|---|---|---|---|---|---|
| Basic | 1 | | | | | |
| Quality | 0.2733 | 1 | | | | |
| Living | −0.049 | −0.0485 | 1 | | | |
| Housing | 0.2127 | 0.4401 | −0.0336 | 1 | | |
| Income | 0.0709 | 0.0218 | −0.0095 | 0.0381 | 1 | |
| Work | 0.0793 | −0.01 | −0.0094 | −0.0809 | 0.2425 | 1 |

## Weights

**Table 5.9** Deprivation percentages based on a particular dimension and various spells at 40 percent of mean distribution (in percentages)

| | 2008 | 2010 | 2012 |
|---|---|---|---|
| Basic | 31 | 45 | 18 |
| Quality | 27 | 27 | 45 |
| Housing | 52 | 50 | 47 |
| Living | 10 | 8.5 | 5 |
| Work | 44 | 31 | 15 |
| Income | 64 | 56 | 55 |
| SE | 84 | 84 | 69 |

| Individuals excluded in $j$ consecutive years in | | Percentage of individuals experiencing the following number of spells (in percentages) | | | | |
|---|---|---|---|---|---|---|
| | Total | One | Two | Three | Four | Five or more |
| Only 1 year | 84 | 68 | 41 | 21 | 7.8 | 0 |
| 2 years | 84 | 62 | 37 | 18 | 5.8 | 0 |
| 3 years | 69 | 42 | 17 | 7 | 1.9 | 0 |

**Table 5.10** Deprivation percentages based on a particular dimension and various spells at 60 percent of mean distribution

| | 2008 | 2010 | 2012 |
|---|---|---|---|
| Basic | 82 | 94 | 78 |
| Quality | 97 | 84 | 92 |
| Housing | 85 | 83 | 80 |
| Living | 10 | 8.5 | 5 |
| Work | 89 | 72 | 66 |
| Income | 97 | 96 | 96 |
| SE | 99.5 | 99.5 | 98.6 |

| Individuals excluded in *j* consecutive years in | | Percentage of individuals experiencing the following number of spells (in percentages) | | | | |
|---|---|---|---|---|---|---|
| | Total | One | Two | Three | Four | Five or more |
| Only 1 year | 99 | 95 | 82 | 56 | 23 | 5 |
| 2 years | 98 | 96 | 81 | 51 | 19 | 3 |
| 3 years | 95 | 82 | 62 | 31 | 13 | 1 |

# Appendix C

**Table 5.11** Time invariant variables for the time-varying variables of Model 3

| | Model 3 | | Model 3 (Odds-ratios) | |
|---|---|---|---|---|
| Variables | Coef. | Std. err. | Coef. | Std. err. |
| cc2 | −0.061 | 0.471 | 0.940 | 0.443 |
| cc3 | −2.029*** | 0.385 | 0.131*** | 0.050 |
| cwc2 | 0.751 | 0.703 | 2.120 | 1.491 |
| cwc3 | −1.963*** | 0.521 | 0.140*** | 0.073 |

Notes: *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$, indicates statistical significance at the 10, 5 and 1 percent level respectively.
cc2–cc3 and cwc2–cwc3 are the time invariant variables related to cc and cwc respectively; cc1 and cwc1 are dropped due to collinearity. Robust standard errors

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# Part II
# Women Empowerment, Children's Health, Caregiving and Access to Microfinance

# Chapter 6
# Women's Empowerment and Children's Health: The Case of Ghana

**Meital Izraelov and Jacques Silber**

## 1 Introduction

In a report to the World Bank, Klasen (1999) described the way greater gender inequalities in the use of human resources has an impact on growth. First, if the distribution of abilities and talent do not depend on gender, the failure to educate and use women's abilities and talent to the same extent as that of men will lower the average productivity of human capital. Moreover, if women's access to education and economic opportunities is likely to lead to greater investments in their children's human capital as suggested by a considerable body of micro-level evidence, this improves the productivity of the next generation of workers. In addition, higher levels of female education and their labor force participation are major factors in bringing about a decline in fertility rates. This in turn reduces the dependency burden in the economy and increases savings. Many of these effects operate through the increased bargaining power associated with women's education and employment and the associated increase in their ability to exercise control over their own fertility and influence investments in their children.

However, Kabeer and Natali (2013) argue that while "there is persuasive evidence that certain aspects of gender equality do have a positive impact on

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economic growth, it is also clear, that the strength of the impact, and the pathways through which it occurs, is mediated by various contextual factors." These include the nature of growth strategies, the structure of the economy, the sectoral nature of job segregation, levels of economic development and cultural factors. These authors believe that evidence that gender equality, particularly in education and employment, contributes to economic growth is far more consistent and robust than checking whether economic growth has an impact on gender equality in terms of health, well-being and rights. They also contend that while economic growth has a positive effect on various measures of gender equality in well-being, one observes such impacts mainly in wealthier countries. On the contrary, there is by now enough evidence that women's access to jobs, cash transfers, education, credit, land and other assets has positive implications for poverty reduction, a decline in fertility rates, children's welfare and agricultural productivity.

There are also reciprocal influences between health and economic development. As argued by Preston (1975), if income leads to good health, people will live longer and be healthier in rich countries than in poor countries. They will live longer and be healthier than their grandparents and great-grandparents who lived in poorer times. In addition, within a country at a moment in time, rich people will live longer and be healthier than the poor people. If this relationship is concave, income will have a larger effect on health and longevity among the poor than among the rich. Income redistribution from the rich to the poor within countries or between countries will therefore improve the population's health.

Health also has an impact on the standard of living. Here is a story told by Anirudh Krishna in his book *One Illness Away* (2010), "Kadijja Nantoga was 45 years old when I met her, in 2004, in a village of Central Uganda. Ten years previously, in 1994, Kadijja and her husband held full time jobs in a coffee-processing plant. They owned the house in which they lived as well as a plot of land on which they planted cassava and beans. Their daughter and son attended a private school. Kadijja's saga of misfortunes began in 1996. First, her husband died as a result of a road accident. Ten other people, riding in the same matatu (minibus), were also killed, or fatally wounded. Overnight, the family lost one of its primary earners. No monetary compensation was paid out. Kadijja had to spend a great deal of money for her husband's funeral ceremony. 'But we could still manage', she told me, 'because I had my job, and we owned some land, some cows, and a few goats'. Five years after her husband's death, however, Kadijja was laid out from work. Disease devastated the local coffee crop, and the processing factory was shut down. With her job gone, Kadijja lost her steady income. Worse, her expenses shot up at the same time. Her 10-year-old son was stricken by an illness that was never clearly diagnosed, even though she spent large amounts of money and consulted different healers and doctors. Kadijja sold her cows and goats and ultimately her land in order to pay for these medical treatments, but they did not help save her son's life. Two years after he had fallen ill, he died. She lives with her daughter now in the house that she still owns. They have no productive assets and no steady income. Odd jobs come by occasionally. Kadijja is called upon to cook for weddings. When people from her village go away for a while, she tends their animals and crops. She does not earn very much from doing any of these things. Her daughter no longer goes to school. They get by precariously from one day to the next, working for wages whenever some opportunity arises but are often forced to look for handouts. Kadijja has fallen into dire poverty. Indications are that she will continue to remain poor."

Using data from surveys and interviews conducted in Kenya, Uganda and Peru, Krishna (2010) gave the following list of events that may lead a household/an individual into poverty: Bad health and expenditures related to health; important expenditure related to a wedding or a dowry; important expenditure related to a funeral; paying high interest rates following a debt that an individual incurred; drought, a bad irrigation system, parasites and diseases which destroy crops; and the soil being no longer fertile.

In short, there are reciprocal influences not only between gender and growth but also between health and development. The focus of this paper is on the more specific impact of gender equality on children's health.

The rest of the paper is organized as follows. The next section defines the commonly used indicators of children's health (measures of child malnutrition) and gives a literature review on the determinants of child malnutrition in developing countries. Section 3 looks at one important aspect of gender equality in developing countries, women's empowerment, and examines the various aspects of this issue. Section 4 focuses on empirical studies on the link between women's empowerment and children's health. Section 5 presents an empirical investigation of the link between women's empowerment and children's health in Ghana while concluding comments are given in Sect. 6.

## 2 Determinants of Children's Health

There are three important indicators of child malnutrition. First, underweight (overall measure) which refers to the proportion of under-fives falling below minus 2 standard deviations (moderate and severe) and minus 3 standard deviations (severe) from the median weight-for-age of the reference population. Second, stunting (being too short) which refers to the proportion of under-fives falling below minus 2 standard deviations (moderate and severe) and minus 3 standard deviations from the median height-for-age of the reference population. Third, wasting (being too thin) which refers to the proportion of under-fives falling below minus 2 standard deviations (moderate and severe) and minus 3 standard deviations from the median weight-for-height of the reference population.

Smith and Haddad (2000) explain child malnutrition in developing countries. Their study uses a cross-country analysis and covers the period 1970–95. They conclude that there are four "underlying" determinants of child malnutrition: the health environment, women's education, women's relative status and per capita food availability. Two other "basic" determinants that are important are per capita national income and democracy. For them the immediate determinants of child nutritional status are dietary intake (energy, protein, fat and micronutrients) and health status.

These factors are interdependent because a child with an inadequate dietary intake is more susceptible to diseases, but diseases depress appetite, inhibit the absorption of nutrients in the food and compete for a child's energy. Dietary intake must be adequate in quantity and in quality and one has to consume nutrients in appropriate combinations for the human body to be able to absorb them.

However, these immediate determinants of child nutritional status are affected by three underlying determinants (at the household level): food security, adequate care for mothers and children and a proper health environment including access to health services. Food security involves the resources necessary for gaining access to food like food production, income for food purchases and in-kind food transfers.

Care refers to the provision of "time, attention, and support to meet the physical, mental, and social needs of the growing child and other household members" (International Conference on Nutrition 1992) in households and communities. Examples of caring practices are child-feeding, health seeking behavior, support and cognitive stimulation for children and care and support for mothers during pregnancy and lactation. The adequacy of such care is a function of a caregiver's control over economic resources, autonomy in decision making and physical and mental status. All these resources for care are affected by a caretaker's status relative to other household members. A final resource for care is a caretaker's knowledge and beliefs.

The health environment and services refer to the availability of safe water, sanitation, healthcare and environmental safety including shelter. A key factor affecting all the underlying determinants is poverty.

Finally, the underlying determinants of child nutrition depend on some basic determinants, that is, the potential resources available to a country or a community which are limited by its natural environment, access to technology and the quality of human resources. Political, economic, cultural and social factors affect the utilization of these potential resources and how they are transformed into resources for the food security, care and health environment and services.

Smith and Haddad (2000) estimated the relative contribution of these underlying and basic factors. They used high quality data from 63 developing countries to explain the relative contribution of underlying and basic causes of undernutrition in a reduction in the average prevalence of underweight children. They distributed the relative contribution of the underlying causes to the total reduction in undernutrition as: 43 percent came from improvements in childcare as represented by women's education measured by female enrolments in schools; 26 percent came from increases in per capita food availability; 19 percent came from improvements in the health environment measured by access to safe water; and 12 percent came from improvements in women's status measured by female to male life expectancy.

In relation to the basic causes, Smith and Haddad (2000) found that increases in per capita national income accounted for roughly 50 percent of the total reduction in undernutrition. No reduction due to overall improvements in democracy was identified despite the potentially powerful influence that democracy can exert by giving people a voice in how government resources are allocated and in ensuring some level of accountability. However, public accountability had not improved over the period of their study for the developing countries as a whole.

An extensive study by Smith et al. (2003) using Demographic and Health Survey data on 117,242 children under 3 years of age in 36 developing countries (in South Asia, sub-Saharan Africa, Latin America and the Caribbean), found that increasing the status of women had a significant and positive effect on children's nutritional status in all the three regions. Their findings also showed that the very high rates of child undernutrition in South Asia compared to sub-Saharan Africa were associated with the much lower status of women in South Asia. Combined with the impact of poor sanitation and rapid urbanization, this lower status had a strong impact on undernutrition. They identified the pattern of improved child nutrition in South Asia as women's nutritional status (as measured by body mass index), prenatal and birthing care for women, complementary feeding practices for children, treatment of illnesses, children's immunization and the quality of substitute child caretakers.

A survey of 819 households conducted by Doocy et al. (2005) in Ethiopia showed that in the primary survey site, Sodo, WISDOM Microfinance Institution's female clients and their children had significantly better nutritional status and significantly better household food and nutrition security than those in the comparison groups. The authors concluded that targeting the provision of credit to women can reduce undernutrition but acknowledged that additional research was needed on this.

King et al. (2007) identified four priority policy options for improving gender equity: microfinance targeted at women; cash transfers to women conditional on girls' attendance in school; reservation of positions for women in legislative bodies; and providing support for women's reproductive roles for a combination of family planning and maternal health initiatives.

In a critical response to this paper, Haddad (2007) agreed that based on available evidence the four policy options chosen by King et al. (2007) will give good returns on investment. But he challenged their implicit assumption that individual agency was the only way to effect change. He pointed out King et al.'s complete lack of reference to social development literature on the way that power can be shifted using participatory methodologies to strengthen social capital and create spaces for negotiation and contestation to enable women to have a voice. Haddad concluded that more economists need to recognize that gender relations are about power and politics and work with those who will challenge their assumptions, hence the need for introducing the concept of women's empowerment.

## 3 Women's Empowerment

During the past decades, research has indicated women's opportunities are limited by gender differences in time use and in access to assets and credit. To analyze this issue, feminist economists have intensively used the concept of "gender norms", as a feature of intra-household bargaining, an influence on women's labor force participation or as a determinant of women's access to land and resources. Gender norms are related to the concept of women's empowerment.

## *3.1 The Concept of Women's Empowerment*

Kabeer (2011) discusses the notion of women's empowerment that she considers a multidimensional process of change covering many aspects of a woman's life. She refers to several features including women's sense of self-worth and social identity, their willingness and ability to question their subordinate status in society and their capacity to exercise strategic control over their own lives and to negotiate better terms in their relationships with others. Finally, their ability to participate on equal terms with men in reshaping society in the direction which conforms to their vision of social justice is also important.

Kabeer (2011) adds that the pathways through which processes of empowerment take place are shaped by the gender-related structures of constraints that prevail in societies in which they occur. She explains that in Bangladesh, family and kinship relations are organized along corporate patriarchal lines, "with authority vested in a senior male household head. Descent and property are transmitted through the male line, leaving women effectively without property and genealogically irrelevant. Patrilocal marital practices mean that they must leave their natal home on marriage to reside with their husband's family and become part of his patrilineal group. Their position within marriage is strongly bound up with their capacity to produce sons to carry on the family name and inherit the family property. Purdah, or female seclusion, restricts their mobility and opportunities in the public domain while simultaneously conferring on them the status of a protected group. Their social interactions tend to be restricted to the 'given' relations of family and kinship. They remain dependent on male family members for much of their lives, passing from the responsibility of father to husband to son. This marked dependence on men for economic needs and social protection leaves women particularly vulnerable to the likelihood of abrupt declines in their economic welfare and social status, should they find themselves bereft of male guardianship. The risks and uncertainties attendant on women's dependent status within such structures paradoxically engender in them greater incentives to comply with, rather than challenge, male dominance, and to manipulate the norms of male obligation and protection to shore up their own position within their families."

## *3.2 Women's Empowerment and Their Ability to Make Choices*

Kabeer (1999) argues that women's empowerment is about the process by which those who have been denied the ability to make strategic life choices acquire this ability. For her, *choice* necessarily implies the possibility of alternatives and the ability to choose otherwise. Some choices are evidently more crucial in terms of their consequences for people's lives. There is hence a case for making a distinction between first- and second-order choices. The former are strategic life choices which are critical for people to live the lives they want (such as a choice of livelihood, whether and whom to marry and whether to have children). Second-order choices are less consequential even though they may affect one's quality of life. Since empowerment is assumed to be about change, it must refer to an expansion of people's abilities to make strategic life choices.

## *3.3 Women's Empowerment and Intra-household Resource Allocations*

Since the early 1990s, growing literature has paid attention to the role that intra-household resource allocations play in the outcomes of development policies. This literature questions the traditional view that individuals within a household share the same preferences or pool their resources (see, Becker 1981). These unitary models represent a special case of cooperative collective models where preferences are identical and therefore, resources are pooled. In such a model, individuals have a choice between remaining single or forming a household. They choose the latter option when the advantages associated with being in a household outweigh those derived from being single. It has, however, been argued that a model of household behavior that assumes that individuals share the same preferences and pool their resources (the so-called unitary model) is likely to lead to policy failures (Haddad et al. 1997).

Alternative models have been proposed such as the "collective models" where "nothing is assumed a priori about the nature of the decision process; that is, it does not directly address the question of how individual preferences lead to a collective choice. If one is willing to put more structure on the decision making process, two subclasses of collective models emerge, one rooted in cooperative and the other in non-cooperative game theory" (Quisumbing 2003).

Cooperative models assume that household decisions are the outcome of some bargaining process and apply the tools of cooperative game theory (see, Manser and Brown 1980; McElroy and Horney 1981). Here the emphasis is on the influence of outside options ("exit options") on the bargaining power of spouses and hence on intra-household welfare. Policymakers may therefore try to affect intra-household welfare by modifying exit options for disadvantaged groups.

Non-cooperative game theory models (for example, Lundberg and Pollak 1993) assume that individuals cannot enter into binding and enforceable contracts with each other and that an individual's actions are conditional on those of others. Such a conditionality of actions implies that not every non-cooperative model leads to a Pareto optimal allocation of resources.

Agarwal (1997) and Sen (1990) have treated norms as being endogenous to households. Agarwal argues that norms can operate in four ways: set limits on what can be bargained for; determine or constrain bargaining power; affect how bargaining is conducted (for example, covertly or overtly, aggressively or quietly);

and constitute a factor to be bargained over, that is, social norms can be endogenous, themselves subject to negotiations and change.

## 3.4 Women's Empowerment and Capability

Another crucial notion is that of *agency*, that is, the ability to define one's goals and acting on them. Agency refers not only to decision-making but also to bargaining and negotiations, deception and manipulation, subversion and resistance. This concept is related to what Sen calls *capabilities,* that is, the potential that people have for living the lives they want, of achieving valued ways of "being and doing".

## 3.5 Women's Empowerment and Violence Against Women

Traditional beliefs that men have a right to control women make women and girls vulnerable to physical, emotional and sexual violence by men. Violence against women is most often perpetrated by an intimate partner, but it may take other forms: violence by a family member, sexual harassment and abuse by authority figures, trafficking for prostitution, child marriages, dowry-related violence, honor killings and sexual violence committed by soldiers during conflicts. The health consequences of such violence can be physical injuries and unwanted pregnancies, sexually transmitted infections, depression and even homicide or suicide (see, World Health Organization 2009). Empowering women by giving them access to assets and decent employment can significantly decrease gender-based violence because women will be able to escape such violence, whereas if they are poor and economically dependent on their husbands/partners they have limited alternatives.

## 3.6 Women's Empowerment and Mobility

The impact of social norms on women's mobility is particularly striking in the case of policies aimed at providing bicycles in rural areas. Many cultures do not accept women using bikes. Riverson et al. (2005) stress that in most developing countries, women have very limited access to transport services and technology. The distances to sources of water and firewood are thus critical factors in determining the scale of tasks for women and the consumption of water tends to decrease when the source is more than a kilometer away. Several studies show that very few women have access to or use donkeys, mules or other intermediate means of transport for getting water, fuel, household goods and food so they experience not only the *physical burden of transportation by back loading and head loading* but also *the time burden as a result of the lack of transport*.

### 3.7 Empirical Studies on Women's Empowerment

Hanmer and Klugman (2016) empirically examined the issue of women's empowerment by exploring what can be learned from data from the Demographic and Health Surveys in 58 countries, representing almost 80 percent of the female population in the developing world. They concluded that women living in richer households were more likely to be able to exercise their agency, but the impact of wealth was not as large as that of education. As far as violence is concerned, they concluded that the risk of suffering violence at home was systematically related to the husband's use of alcohol, as well as to the woman's own attitude to violence. Education has a protective effect against violence but this impact is evident only at secondary and higher levels of education for women and with higher education for men. Data also indicates that countries that have made progress in advancing women's reproductive health and rights have lower levels of violence against them (see, UNIFEM 2010).

Ballon (2012) proposes a structural model for measuring female empowerment using a capability perspective. Like Kabeer (1999) Ballon defines empowerment as a woman's decision-making abilities regarding her strategic and non-strategic life choices. Strategic decisions are divided into self-choices that refer to decisions concerning the woman herself and familial choices which mainly involve her children. In Ballon's model, resources, values/traditions and decision-outcomes interact with a system of structural equations. Resources refer to factors that pre-condition the ability to choose and include a woman's age at marriage, the household's wealth or assets, the woman's educational level, her parents' level of education (or years) and the age and educational differences between the spouses. Ballon (2012) uses a MIMIC model and applies it to a study of female empowerment in Cambodia in 2005.

In addition to studies on women's empowerment in general, research has also been done on the link between women's empowerment and children's health.

## 4 Empirical Studies on the Link Between Women's Empowerment and Children's Health

Yimer and Tadesse (2015) maintain that maternal and child dietary diversity are associated not only with the circumstances of the household in general, but with the status of the woman in particular. Their argument is that the extent to which women have access to and control over resources largely determines the kind of care they provide for their children and for the rest of the household. Using Ethiopian household survey data from 2013, these authors investigated the impact of women's empowerment in agriculture on the nutritional outcomes for their children. They collected data from five regions in the country which cover more than 7000 households in 84 districts (woredas).

Applying the concept of women's empowerment in agriculture (see, Alkire et al. 2013) they made a distinction between the following domains:

1. *Production: decisions about agricultural production*

   The first indicator is inputs in production decisions which is constructed from answers on:

   - Decision making: whether the individual has sole or joint inputs in taking decisions about food crop farming, cash crop farming, livestock raising and fish culture, and
   - The extent to which the individual feels that he or she can make his or her own personal decisions about the following aspects of household life if he or she wanted to: (a) agricultural production (b) which inputs to buy (c) which types of crops to grow (d) when to take or who will take the crops to the market and (e) whether to engage in livestock raising.

     The second indicator of autonomy reflects a person's ability to act on what he or she values.

     The areas of autonomy refer to agricultural production: which inputs to buy, which types of crops to grow, when to take or who will take the crops to the market and livestock production. An individual has adequate autonomy if his or her actions are more motivated by his or her own values than by coercion or fear of others' disapproval. Unlike decision making this autonomy indicator captures the situation of women living in female-only households who may be empowered as sole decision makers but whose autonomy may still be deeply constrained by social norms or force of circumstances. It also distinguishes situations in joint households where a "joint" decision may be more or less autonomous depending on circumstances.

2. *Resources*

   Yimer and Tadesse (2015) selected three indicators: ownership of land and assets; decisions regarding the purchase, sale or transfer of land and assets; access to and decisions about credit.

   The first indicator examines whether an individual has sole or joint ownership of land and assets (including agricultural land, large and small livestock, fish ponds, farm equipment, house, household durables, cell phone, non-agricultural land and means of transportation). The second indicator, defined with similar assets, deals with who takes the decisions regarding the purchase, sale or transfer of land and assets. The third indicator examines decision making about whether to obtain credit and how to use the credit from various sources (non-governmental organizations, formal and informal lenders, friends or relatives, rotating savings and credit associations). To have adequacy on this indicator, a person must belong to a household that has access to credit (even if it does not use credit). If the household used a source of credit then the person should have participated in at least one decision about it.

3. *Income*

   This domain concerns sole or joint control over the use of income and expenditure. The single indicator for this dimension measures the degree of inputs that go into taking decisions about the use of income generated from productive/income-generating activities mentioned earlier and the extent to which an individual feels that he or she can take his or her own decisions regarding wage or salary employment.
4. *Leadership*

   The fourth domain concerns leadership in the community which is measured by membership of economic or social groups, agriculture producers' or marketing groups, water users' groups, forest users' groups, credit or microfinance groups, mutual help or insurance groups (including burial societies), trade and business associations, civic or charitable groups, local government groups, religious groups and women's groups. It also refers to whether the person is comfortable speaking up in public about at least one of the following issues: questions related to infrastructure (like small wells, roads) to be built, proper payment of wages for public work and the readiness to protest against the misbehavior of authorities.
5. *Time*

   This final domain concerns the allocation of time to productive and domestic tasks and the satisfaction with the time available for leisure activities. It is derived from a detailed 24-hour time allocation module. An individual has an excessive workload if he or she worked more than 10.5 hours in the previous 24 hours, with hours worked defined as the sum of the time in work-related tasks in the primary activity plus 50 percent of the time in work-related tasks in secondary activities. This indicator asks whether an individual is subjectively satisfied with his or her available time for leisure activities such as visiting neighbors, watching TV, listening to the radio, seeing movies or engaging in sports.

## *4.1 Overall Empowerment*

Each person is attributed a binary score in each of the ten indicators, reflecting whether she has adequate or inadequate achievements in each indicator. Then, an empowerment score is derived in which the weights of those indicators in which she enjoys adequacy are summed to create a score that lies between 0 percent and 100 percent. A woman or man is empowered if she or he has adequate achievements in four of the five domains or is empowered in some combination of the weighted indicators that reflect 80 percent total adequacy or more.

To examine the relationship between women's empowerment in agriculture and mothers and children's nutritional outcomes, Yimer and Tadesse (2015) estimated regressions where the dependent variables were women and child nutritional outcomes measured by dietary diversity. The explanatory variables were:

Women's Empowerment in Agriculture Index: The age of the woman (in years), her education level (no education, primary education, secondary education and tertiary education), the size of the household, dependency ratio, the quintile to which the household belongs (a production diversity score based on seven food groups) and shocks (whether the household has experienced drought, erosion, flood and/or price rise in the last 10 years).

Note that dietary diversity for children referred to the mean number of food groups consumed by children under 72 months of age on the day preceding the interview. The food the children ate was categorized into seven major food groups: grains, roots and tubers; legumes and nuts; dairy products (milk, yogurt, cheese); flesh foods and other miscellaneous small animal protein, including organ meat; eggs; vitamin A rich vegetables and fruits; and other fruits and vegetables (WHO 2009).

Dietary diversity for women was measured via the mean number of food consumed by women of reproductive age in the day preceding the interview. Nine food groups were used: grains, roots and tubers; legumes and nuts; dairy products (milk, yogurt, cheese); organ meat; eggs; flesh foods and other miscellaneous small animal protein; vitamin A dark green leafy vegetables; other vitamin A rich vegetables and fruits; and other fruits and vegetables.

It turned out that the Women Empowerment in Agriculture Index (WEAI) used by the authors had a very significant positive impact on children's dietary diversity. The other factors that significantly contributed to an improvement in children's dietary diversity include production diversity and mothers' education especially primary education. On the other hand, the family experiencing a shock had negative implications for children's dietary diversity. The other factors that significantly affected women's dietary diversity are production diversity, women's education and the wealth of the household. Since the empowerment indicators all have a positive and significant impact on women's dietary diversity, even after controlling for individual and household level effects, empowering women in agriculture gives them more power to improve their own well-being and nutritional outcomes. In short, using multivariate regression methods and instrumental variable techniques to establish the relationship between women's empowerment and women and children's dietary diversity, the authors conclude that all the women's empowerment indicators used were positively associated with better dietary diversity for both children and women. The policy implications of these findings are clear: interventions that increase women's empowerment will contribute to improving child nutrition as well as women's own well-being.

Malapit et al. (2015) provide empirical evidence on the relationship between empowerment gaps between men and women in the same household and children's well-being. Their analysis uses nationally representative data from the 2012 Bangladesh Integrated Household Survey (BIHS).

They estimated children's well-being outcomes as a function of child characteristics and relative bargaining power. They estimated the regression where the dependent variables were various well-being outcomes for children: height-for-age (HAZ), weight-for-height (WHZ) and weight-for-age (WAZ) z-scores and education measured as deviations from the cohort's means. The explanatory variables were the differences between the husband and wife's human capital;

the differences in the husband and wife's empowerment measures (measured via the Women Empowerment in Agriculture Index); gender and other characteristics of the child; household characteristics and other controls. The authors concluded that when the gender gap in credit decision making was smaller, girls were more likely to be taller than their reference age group. Households led by a well-educated male head were more likely to have taller children. It also appears that an increase in women's life satisfaction increased boys' weight-for-height, but less so for girls. A narrower male-female gap in asset decision making was associated with better nutritional status for girls in the short run. Women's higher involvement in groups relative to men may end up reducing girls' weight-for-height (this could point to excessive demands on women's time owing to participation in group activities or a possible backlash from the men in the household). An increase in women's participation in groups and life satisfaction relative to their husbands was likely to improve children's weight-for-age (more for boys than for girls). Households led by well-educated male household heads were more likely to have children with higher weight-for-age than their reference age group. For children aged 6–10 years, a higher gender gap in asset ownership was associated with more education for both boys and girls. A smaller gender gap in asset decision making was weakly correlated with an increase in education favoring boys.

Women's education had a strong and positive association with the education of young girls. Households where the head was more educated were likely to invest more in their children's education. For children aged 11–17 years, smaller gender gaps in overall empowerment and participation in groups were more likely to increase education for both boys and girls. Households where the primary female and household head were more educated were also more likely to have more educated boys and girls.

Lépine and Strobl (2013) looked at the impact of women's bargaining powers on child nutritional status using data from rural Senegal. Their dataset consisted of a rich sample of 505 farming households located in the Saint Louis region of Senegal. The data allowed them to focus on direct measures of female power incorporated in the questionnaire. To control for the potential endogeneity of empowerment, they took advantage of the fact that for historical reasons women of different ethnicities have different degrees of bargaining powers and that the extent of this may depend on the ethnicity of the neighborhood that they are living in, but that ethnicity is not directly related to children's nutritional status. They therefore introduced an exogenous instrument (IV), information on a mother's ethnicity relative to that of the community she resided in. The following information was available on women's empowerment: whether she had worked during the last 12 months; how much did her income contribute to the total household income (nothing; less than half; half; more than half); what was the share of total household expenditure under her control (nothing; less than half; half; more than half); who took the decisions concerning her health (the respondent; both spouses; the husband; another person); who took decisions concerning children's health; who took decisions concerning the schooling of the children; who took the decisions concerning daily expenditure; who took decisions concerning the large expenditures of the household; who took the decisions concerning the food cooked every day; who took the decisions concerning a visit to the woman's relatives; and could the woman go out without her husband's permission.

The determinants of child health were as follows:

- The nutritional status of children measured by the z-score of MUAC (Mid-Upper Arm Circumference, that is, the circumference of the left upper arm measured at the mid-point between the tip of the shoulder and the tip of the elbow).
- A measure of the endogenous bargaining power of the mother.
- A vector of parental and household characteristics.
- A vector of the child's characteristics and a set of dummy variables meant to capture community characteristics.

The authors derived a women's empowerment variable via a correspondence analysis based on 11 questions on decision-making. They concluded that the mother's bargaining power had a positive and significant impact on the nutritional status of the child.

Ziaei et al. (2014) looked at the links between intimate partner violence (IPV) and children's health in Bangladesh and concluded that IPV was likely to impair maternal caretaking abilities. Mistreated mothers are physically and emotionally less capable of providing their children's needs. This can also result in unintended pregnancies which can also affect maternal caretaking behavior. In addition, it appears that witnessing violence between parents may increase children's psychological stress which is likely to negatively influence their health. IPV against women was a risk factor for child abuse and maltreatment which will affect children's physical and mental health and lead to higher odds of their getting diarrhea, respiratory tract infections and acute infant illnesses. These were observed among children of mothers who were exposed to IPV in Bangladesh as women's exposure to IPV was shown to reduce birth weight. Ziaei et al. (2014) used data from the Bangladesh 2007 Demographic and Health Survey. The authors investigated the association between women's exposure to IPV and their children's nutritional status. Of the 2042 women in the BDHS survey with at least one child under 5 years of age, 49.4 percent reported lifetime experience of physical partner violence while 18.4 percent reported experience of sexual partner violence. Using a logistic regression, the authors concluded that women were more likely to have stunted children if they had lifetime experience of physical IPV. The policy implications of these findings are that there is a need to incorporate efforts to address IPV in child health and nutrition programs.

## 5 Women's Empowerment and Children's Health in Ghana

### *5.1 Ghana*

A multicultural nation, Ghana has a population of approximately 27 million with a variety of ethnic, linguistic and religious groups. Around 70 percent of the population is Christian while 24 percent is Muslim with the remaining 5–6 percent practicing traditional faiths. Ghana has 10 administrative regions of which the Ashanti region, located in south Ghana, is the most populated with a population of about 4,800,000 according to the 2010 census, accounting for almost 20 percent of Ghana's total population. The Ashanti region is the third largest in the country, occupying a bit more than 10 percent of the total land area of Ghana. The Ashanti ethnic group was originally a matrilineal society where the line of descent was traced through the female.

### *5.2 Database*

Demographic and Health Surveys (DHS) were conducted in Ghana in 1988, 1993, 1998 and 2003. We used the 2008 survey. This survey provides data on fertility, nutrition, violence in the family and the educational levels of individuals, where they live, the ethnic group to which they belong, religion, the ownership of various durable goods, information related to women's degree of empowerment and health data (height, weight, level of hemoglobin).

### *5.3 The Methodology*

We implemented the MIMIC model which distinguishes between structural and measurement equations.

The *structural equation* is:

$$y^* = x\beta + u \tag{6.1}$$

where $y^*$ is a ($n$ by 1) latent variable referring to children's health, $n$ being the number of individuals in the sample and $x$ (a $n$ by $k$ matrix) refers to a set of exogenous variables assumed to affect a child's health. $\beta$ is a ($k$ by 1) vector of parameters and $u$ a $n$ by 1 vector reflecting the stochastic error.

The *measurement equation* considers the observed child health variables to be imperfect indicators of a child's health. In other words:

$$y = y^* \Lambda + \varepsilon \tag{6.2}$$

where $y$ is a $n$ by $m$ matrix referring to a set of $m$ independent indicators of a child's health, $\Lambda$ denotes a 1 by $m$ vector of factor loadings and $\varepsilon$ is a $n$ by $m$ matrix of measurement errors.

Combining Eqs. (6.1) and (6.2) we obtain the following reduced form:

$$y = x\beta\Lambda + u\Lambda + \varepsilon = x\pi + v \tag{6.3}$$

where $\pi = \beta\Lambda$ is a $k$ by $m$ matrix of coefficients and $v = u\Lambda + \varepsilon$ is a $n$ by $m$ matrix of reduced form disturbances.

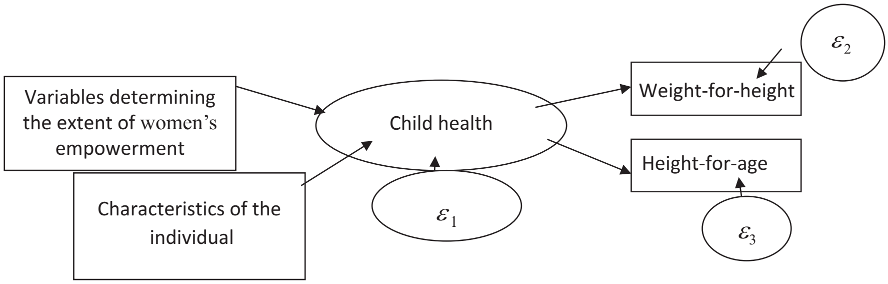


**Fig. 6.1** A simple graphical representation of the MIMIC model

Details on the estimation method are given in Jöreskog (1973, 2002), Jöreskog and Goldberger (1975) and Ballon (2012).

A graphical representation of the MIMIC model is given in Fig. 6.1.

## 5.4 *The Results of the Empirical Investigation*

Table 6.1 gives the summary statistics of individual characteristics. As can be seen from the table 64 percent of the female headed households had a high school or a higher education while among households headed by men this percentage is only 49. The percentage of partners with a high school or higher education is approximately the same (41–43 percent) for households headed by a man or a woman respectively. As far as the partner's occupation is concerned, among female-headed households, 82 percent did not work in agriculture, this percentage being only 62 percent among male-headed households. The percentage of households practicing the Pentecostal religion is higher among female-headed households (38 percent) than among male-headed households (32 percent). As far as the wealth index is concerned, 44 percent of the female-headed households belonged to the rich strata of the population, the corresponding percentage among male-headed households was 39 percent. We also observe that 61 percent of the female-headed households lived in urban areas, this percentage was 38 percent among male-headed households. Finally, 53 percent of the female headed households belonged to the Akan ethnic group, the corresponding percentage being 38 percent among male headed households.

Table 6.2 gives data on the variables determining the extent of a woman's empowerment. Among female headed households, 25–32 percent of the women took decisions concerning healthcare, large and daily purchases and visits to family members, but only 15 percent of them decided how to use the money earned by their husbands. These percentages are comparatively higher among male-headed households (42–59 percent take decisions concerning healthcare, large and daily purchases and visits to family members, and 31 percent decide how to use the money earned by the husband).

**Table 6.1** Summary statistics of individuals' characteristics

| | Female head of household | | Male head of household | |
|---|---|---|---|---|
| Number of observations | 1783 | | 3133 | |
| | Absolute frequency | Relative frequency in % | Absolute frequency | Relative frequency in % |
| Region = 0 (non-Ashanti area) | 1394 | 78.18 | 2707 | 86.40 |
| Region = 1 (Ashanti area) | 389 | 21.82 | 426 | 13.60 |
| City = 0 (Rural area) | 823 | 46.16 | 1931 | 61.63 |
| City = 1 (Urban area) | 960 | 61 | 1202 | 38.37 |
| Education = 0 (No schooling or only elementary schooling) | 634 | 35.56 | 1609 | 51.36 |
| Education = 1 High school or higher education) | 1149 | 64.44 | 1524 | 48.64 |
| Religion = 0 (non-Pentecostal) | 1103 | 61.86 | 2117 | 67.57 |
| Religion = 1 (Pentecostal) | 680 | 38.14 | 1016 | 32.43 |
| Ethnic = 0 (Does not belong to the Akan ethnic group) | 832 | 46.66 | 1948 | 62.18 |
| Ethnic = 1 (Belongs to Akan ethnic group) | 951 | 53.34 | 1185 | 37.82 |
| Wealth index = 0 (does not belong to those who are rich or very rich) | 990 | 55.52 | 1917 | 61.19 |
| Wealth index = 1 (belongs to the richest strata of the population) | 793 | 44.48 | 1216 | 38.81 |
| Marital status = 0 (other marital status) | 1092 | 61.25 | 874 | 27.90 |
| Marital status = 1 (married or lives with a partner) | 691 | 38.75 | 2259 | 72.10 |
| Partner education = 0 (partner did not complete high school or have a higher education) | 1008 | 56.53 | 1836 | 58.60 |
| Partner education = 1 (partner completed high school or has a higher education) | 775 | 43.47 | 1297 | 41.40 |
| Partner occupation = 0 (partner not working in agriculture) | 1469 | 82.39 | 1938 | 61.86 |
| Partner occupation = 1 (partner is independent or salaried employee) | 314 | 17.61 | 1195 | 38.14 |

As far as violence against women is concerned, the percentage of women who believed that being beating by the husband is justified is high when the issue is children's neglect (72 percent among female-headed households and 69 percent among male headed households). It is much lower when the issues are "going out without permission", "arguing with her spouse", "refusing to have sexual relations with her spouse" or "burning food" (13–23 percent among female headed households and 8–26 percent among male headed households).

**Table 6.2** Summary statistics of empowerment variables

| | Female head of household | | Male head of household | |
|---|---|---|---|---|
| Number of observations | 1783 | | 3133 | |
| | Absolute frequency | Relative frequency in % | Absolute frequency | Relative frequency in % |
| The woman takes decisions concerning healthcare (variable equal to 1) | 485 | 27.20 | 1492 | 47.62 |
| The woman takes decisions concerning large purchases (variable equal to 1) | 451 | 25.29 | 1311 | 41.84 |
| The woman takes decisions concerning daily purchases (variable equal to 1) | 570 | 31.97 | 1753 | 55.95 |
| The woman decides whether and when to visit family members (variable equal to 1) | 581 | 32.59 | 1841 | 58.76 |
| The woman decides how to use the money earned by her husband (variable equal to 1) | 263 | 14.75 | 965 | 30.80 |
| The woman believes that beating is justified when she goes out without permission (variable equal to 1) | 413 | 23.16 | 819 | 26.14 |
| The woman believes that beating is justified when she neglects children (variable equal to 1) | 1282 | 71.90 | 2160 | 68.94 |
| The woman believes that beating is justified when she argues with her spouse (variable equal to 1) | 392 | 21.99 | 750 | 23.94 |
| The woman believes that beating is justified when she refuses to have sexual relations with her spouse (variable equal to 1) | 229 | 12.84 | 605 | 19.31 |
| The woman believes that beating is justified when she burns food (variable equal to 1) | 261 | 14.64 | 251 | 8.01 |
| The woman knows how to read and write | 993 | 55.69 | 1337 | 42.67 |
| The woman reads a newspaper regularly | 473 | 26.53 | 591 | 18.86 |
| The woman listens to the radio regularly | 1501 | 84.18 | 2564 | 81.84 |
| The woman watches television regularly | 1180 | 66.18 | 1689 | 53.91 |
| Height of the child with respect to his age (children 5 years old or less) given that the z-score is higher than 2 standard deviations (variable equal to 1) | 1438 | 80.65 | 2204 | 70.35 |
| Weight of the child with respect to his age (children 5 years old or less) given that the z-score is higher than 2 standard deviations (variable equal to 1) | 1581 | 88.67 | 2576 | 82.22 |

Table 6.2 also shows that among female headed households 56 percent of the women knew how to read and write, 84 percent listened to the radio regularly, 66 percent watched television regularly but only 27 percent read a newspaper on a regular basis (the corresponding percentages for women among male headed households are 43 percent, 82 percent, 54 percent and 18 percent).

Table 6.3, which gives details of female-headed households, gives the results of the MIMIC model using the Alkire and Foster (2011) approach[1] to aggregate the variables determining the extent of a woman's decision-making, her attitude towards beating and the amount of information she is aware of. The procedure may be summarized as follows: Let us take the case of the decision-making variables. Table 6.2 indicates that there are five variables which describe the extent of decision making by a woman. All these variables are dichotomous. The Alkire and Foster (2011) approach in a simple case of binary variables which amounts to considering that an aggregate variable "woman's decision making ability" will be equal to 1 if she has the power to take decisions in at least $k$ of the five aspects of decision making for which information is available (corresponding to the five variables just mentioned). In our empirical investigation, we assumed that this would be equal to three. A similar procedure was applied to aggregate the variables referring to the attitude towards beating.

As far as the structural equations are concerned, it appears that children's health (whether the latent variable is stunting or wasting) is lower among married women. It is higher among women who have completed high school or have a higher education, increases at a decreasing rate with the age of the woman, is higher when the woman can take decisions and is lower when the partner has completed high school or has a higher education.[2] Footnote numbers need to be checked Finally, when the woman belongs to the Akan ethnic group, the health of her children is lower, although the coefficients of the stunting and wasting equations are then significant only at the 10 percent level.

In Table 6.4, rather than using the Alkire and Foster (2011) approach to aggregate variables in the domain of decision-making, attitude towards beating and information, we include all the variables defining these three domains. We also add the following explanatory variables: an index of wealth equal to 1 if the household is classified as rich; a variable indicating whether the woman lives in a city; a regional variable equal to 1 if the household lives in the Ashanti region; and the partner's occupation, a variable equal to 1 if he works in agriculture either as an employee or as an independent. It appears that a woman's education no more has a significant (positive) impact on children's health. The signs of the impact of marital status and age (and its square) are the same as in Table 6.3. Partner's education has, as previously, a negative coefficient, but is now significant. Wealth has

[1] Alkire and Foster (2011) devised a procedure to derive a multidimensional index of poverty. Their approach may be applied to other issues such as women's empowerment (see, Alkire et al. 2013). We use it here to aggregate variables in several domains of women's empowerment.

[2] Zereyesus et al. (2017) found that the educational level of the husband had a negative impact on children's health though the coefficient was generally not significant.

**Table 6.3** MIMIC model when taking the Alkire and Foster (2011) approach: Female-headed households

| | Dependent latent variable: absence of stunting | | | | Dependent latent variable: absence of wasting | | | |
|---|---|---|---|---|---|---|---|---|
| | Coeff. | Stand. coeff. | Stand. error | $P > \|z\|$ | Coeff. | Stand. coeff. | Stand. error | $P > \|z\|$ |
| Marital status[a] | −0.289 | −0.365 | 0.041 | 0.000* | −0.177 | −0.365 | 0.041 | 0.000* |
| Education[b] | 0.053 | 0.066 | 0.024 | 0.005* | 0.033 | 0.066 | 0.024 | 0.006* |
| Partner's education[c] | −0.052 | −0.067 | 0.027 | 0.014* | −0.032 | −0.067 | 0.027 | 0.015* |
| Ethnic[d] | −0.036 | −0.046 | 0.024 | 0.051** | −0.022 | −0.046 | 0.024 | 0.052** |
| Woman's age | 0.015 | 0.544 | 0.115 | 0.000* | 0.009 | 0.544 | 0.115 | 0.000* |
| Age square | −0.0002 | −0.549 | 0.115 | 0.000* | −0.0001 | −0.549 | 0.115 | 0.000* |
| Decision making[e] | 0.087 | 0.103 | 0.039 | 0.008* | 0.054 | 0.103 | 0.039 | 0.008* |
| Justify beating[f] | 0.021 | 0.017 | 0.023 | 0.452 | 0.013 | 0.017 | 0.023 | 0.450 |
| Height for age | 1.000 | 0.978 | 0.028 | 0.000* | 1.632 | 0.978 | 0.024 | 0.000* |
| Weight for height | 0.613 | 0.746 | 0.024 | 0.000* | 1.000 | 0.746 | 0.028 | 0.000* |
| Measurement model | | | | | | | | |
| CD: Coefficient of determination ($R^2$) | | | | 0.131 | | | | |
| Number of observations | | | | 1774 | | | | |
| Log likelihood | | | | −25,516 | | | | |

*5% significance level
**10% significance level
[a]Variable equal to 1 if the individual is married
[b]Variable equal to 1 if the individual has completed high school or has a higher education
[c]Variable equal to 1 if the partner has completed high school or has a higher education
[d]Variable equal to 1 if the individual belongs to the Akan ethnic group
[e]Variable equal to 1 if the woman has the right to take at least three types of decisions (following the Alkire and Foster approach)
[f]Variable equal to 1 if there are at least three cases in which the woman believes that beating by her husband is justified (following the Alkire and Foster approach)

a positive impact on children's health, but the coefficient is significant only at the 10 percent level. Living in a city and the regional variable have no significant effect. As far as the decision-making variables are concerned, children's health is higher when a woman can decide about daily and large purchases (but the coefficients in the stunting and wasting equations are generally significant only at the 10 percent level), but lower when a woman can decide how to use the money her husband earns. The two other decision making variables have no significant impact on children's health.

**Table 6.4** MIMIC model with detailed empowerment variables: the case of a female-headed household

| | Dependent latent variable: absence of stunting | | | | Dependent latent variable: absence of wasting | | | |
|---|---|---|---|---|---|---|---|---|
| | Coeff. | Stand. coeff. | Stand. error. | $P > \|z\|$ | Coeff. | Stand. coeff. | Stand. error. | $P > \|z\|$ |
| Marital status | −0.280 | −0.352 | 0.056 | 0.000* | −0.172 | −0.352 | 0.056 | 0.000* |
| Education | −0.013 | −0.016 | 0.031 | 0.603 | −0.008 | −0.016 | 0.031 | 0.604 |
| Partner's education | −0.055 | −0.070 | 0.027 | 0.011* | −0.033 | −0.070 | 0.027 | 0.012* |
| Wealth index[a] | 0.037 | 0.048 | 0.029 | 0.095** | 0.023 | 0.048 | 0.029 | 0.096** |
| Ethnic | −0.025 | −0.033 | 0.025 | 0.187 | −0.015 | −0.033 | 0.025 | 0.188 |
| Age | 0.014 | 0.510 | 0.115 | 0.000* | 0.009 | 0.510 | 0.115 | 0.000* |
| Age square | −0.00015 | −0.509 | 0.115 | 0.000* | −0.00009 | −0.509 | 0.115 | 0.000* |
| Region | −0.004 | −0.004 | 0.024 | 0.877 | −0.002 | −0.004 | 0.024 | 0.877 |
| City | 0.008 | 0.010 | 0.028 | 0.723 | 0.005 | 0.010 | 0.028 | 0.724 |
| Partner's occupation[b] | −0.018 | −0.018 | 0.026 | 0.492 | −0.011 | −0.018 | 0.026 | 0.492 |
| Dec about large purchases | 0.067 | 0.075 | 0.041 | 0.070** | 0.041 | 0.075 | 0.041 | 0.071** |
| Dec about money[c] | −0.062 | −0.057 | 0.027 | 0.040* | −0.038 | −0.057 | 0.027 | 0.037* |
| Dec about visits | −0.013 | −0.016 | 0.051 | 0.756 | −0.008 | −0.016 | 0.051 | 0.756 |
| Dec about healthcare | −0.009 | −0.010 | 0.042 | 0.804 | −0.006 | −0.010 | 0.042 | 0.804 |
| Dec about daily purchases | 0.087 | 0.105 | 0.054 | 0.050* | 0.053 | 0.105 | 0.054 | 0.052** |
| Beat argue with | −0.052 | −0.056 | 0.029 | 0.051** | −0.032 | −0.056 | 0.029 | 0.052** |
| Beat neglects children | 0.003 | 0.003 | 0.031 | 0.923 | 0.002 | 0.003 | 0.031 | 0.923 |
| Beat going out[d] | 0.045 | 0.049 | 0.030 | 0.108 | 0.028 | 0.049 | 0.030 | 0.106 |
| Beat sex | 0.035 | 0.030 | 0.027 | 0.263 | 0.021 | 0.030 | 0.027 | 0.261 |
| Beat burn food | 0.040 | 0.029 | 0.027 | 0.272 | 0.024 | 0.029 | 0.027 | 0.273 |
| Literacy[e] | 0.030 | 0.038 | 0.033 | 0.246 | 0.018 | 0.038 | 0.033 | 0.244 |
| Reading newspaper[f] | 0.059 | 0.067 | 0.028 | 0.016* | 0.036 | 0.067 | 0.028 | 0.017* |
| Listen radio[g] | 0.097 | 0.092 | 0.024 | 0.000* | 0.060 | 0.092 | 0.024 | 0.000* |
| Watch TV[h] | −0.003 | −0.004 | 0.027 | 0.890 | −0.002 | −0.004 | 0.027 | 0.891 |
| Height for age[i] | 1.000 | 0.981 | 0.026 | 0.000* | 1.631 | 0.981 | 0.026 | 0.000* |

(continued)

**Table 6.4** (continued)

| | Dependent latent variable: absence of stunting | | | | Dependent latent variable: absence of wasting | | | |
|---|---|---|---|---|---|---|---|---|
| | Coeff. | Stand. coeff. | Stand. error. | $P > \|z\|$ | Coeff. | Stand. coeff. | Stand. error. | $P > \|z\|$ |
| Weight for height[j] | 0.613 | 0.747 | 0.023 | 0.000* | 1.000 | 0.747 | 0.023 | 0.000* |
| Measurement model | | | | | | | | |
| CD: Coefficient of determination ($R^2$) | | | | 0.154 | | | | |
| Log likelihood | | | | −33,716 | | | | |
| Number of observations | | | | 1774 | | | | |

*5% significance level
**10% significance level
[a]Variable equal to 1 if the individual is rich
[b]Variable equal to 1 if the partner is employed or works as an independent in agriculture
[c]Variable equal to 1 if the woman is involved in decision making (for all the variables describing the extent of decision making)
[d]Variable equal to 1 if the wife justifies the beating (for all variables describing reasons for beating)
[e]Variable equal to 1 if the woman knows how to read and write
[f]Variable equal to 1 if the woman regularly reads a newspaper
[g]Variable equal to 1 if the woman regularly listens to the radio
[h]Variable equal to 1 if the woman regularly watches television
[i]Height of the child with respect to his age (children 5 years old or less) given that the z-score is higher than 2 standard deviations (in which case the variable is equal to 1)
[j]Weight of the child with respect to his age (children 5 years old or less) given that the z–score is higher than 2 standard deviations (in which case the variable is equal to 1)

We also observe that four out of the five attitudes to the beating variables have no significant impact, whether in the stunting or the wasting equations. The only significant result here is that if a woman thinks that her husband is entitled to beat her when she argues with him, the children's health will be poorer (the coefficient of this variable is significant only at the 10 percent level).

Finally, among the information variables we observe that when a woman regularly reads a newspaper or listens to the radio, her children's health is better. The two other information variables (literacy and watching television regularly) have no significant impact on children's health.

Table 6.5 gives the results of the MIMIC model for a male-headed household. As in Table 6.4 we include all the variables related to decision making by the woman, her attitude towards beating and the level of her information. Many coefficients have signs similar to those observed in Table 6.4. Note, however, that the wealth variable is now significant at the 5 percent level, that reading a newspaper has no impact on children's health while watching television and literacy do have a significant impact. Being able to take decisions about large or daily purchases as well as about using the money earned by the partner has no significant effect on children's health.

**Table 6.5** MIMIC model with detailed empowerment variables: male-headed household

| | Dependent latent variable: absence of stunting | | | | Dependent latent variable: absence of wasting | | | |
|---|---|---|---|---|---|---|---|---|
| | Coeff. | Stand. coeff. | Stand. error | $P > \|z\|$ | Coeff. | Stand. coeff. | Stand. error | $P > \|z\|$ |
| Marital status[a] | −0.247 | −0.243 | 0.035 | 0.000* | −0.149 | −0.243 | 0.035 | 0.000* |
| Education | −0.006 | −0.007 | 0.026 | 0.798 | −0.004 | −0.007 | 0.026 | 0.798 |
| Partner occupation | −0.035 | −0.037 | 0.024 | 0.119 | −0.021 | −0.037 | 0.024 | 0.119 |
| Partner education | −0.022 | −0.024 | 0.023 | 0.308 | −0.013 | −0.024 | 0.023 | 0.309 |
| Ethnic | 0.026 | 0.028 | 0.020 | 0.159 | 0.016 | 0.028 | 0.020 | 0.162 |
| Age | 0.011 | 0.325 | 0.097 | 0.001* | 0.007 | 0.325 | 0.097 | 0.001* |
| Age square | −0.00008 | −0.252 | 0.096 | 0.009* | −0.00005 | −0.252 | 0.097 | 0.010* |
| Wealth index[b] | 0.062 | 0.067 | 0.023 | 0.004* | 0.038 | 0.067 | 0.023 | 0.004* |
| Region[c] | −0.019 | −0.015 | 0.018 | 0.415 | −0.012 | −0.015 | 0.018 | 0.415 |
| Reading newspaper | 0.010 | 0.008 | 0.021 | 0.683 | 0.006 | 0.008 | 0.021 | 0.683 |
| Listen radio | −0.040 | −0.033 | 0.018 | 0.068 | −0.024 | −0.033 | 0.018 | 0.069** |
| Watch TV | 0.041 | 0.045 | 0.022 | 0.043* | 0.025 | 0.045 | 0.022 | 0.044* |
| Literacy | 0.058 | 0.063 | 0.027 | 0.020* | 0.035 | 0.063 | 0.027 | 0.021* |
| Dec about healthcare | −0.028 | −0.030 | 0.024 | 0.210 | −0.017 | −0.030 | 0.024 | 0.212 |
| Dec about large purchases | 0.026 | 0.028 | 0.024 | 0.242 | 0.015 | 0.028 | 0.024 | 0.243 |
| Dec about daily purchases | −0.021 | −0.023 | 0.028 | 0.400 | −0.013 | −0.023 | 0.028 | 0.401 |
| Dec about visits | 0.015 | 0.016 | 0.028 | 0.575 | 0.009 | 0.016 | 0.028 | 0.576 |
| Dec about money | 0.023 | 0.023 | 0.020 | 0.242 | 0.014 | 0.023 | 0.020 | 0.246 |
| Beat going out | 0.012 | 0.012 | 0.024 | 0.623 | 0.007 | 0.012 | 0.024 | 0.624 |
| Beat neglects children | −0.022 | −0.023 | 0.024 | 0.347 | −0.013 | −0.023 | 0.024 | 0.348 |
| Beat sex | 0.014 | 0.012 | 0.021 | 0.560 | 0.008 | 0.012 | 0.021 | 0.559 |
| Beat argue with | −0.061 | −0.057 | 0.022 | 0.009* | −0.037 | −0.057 | 0.022 | 0.010* |
| Beat burn food | 0.028 | 0.019 | 0.020 | 0.331 | 0.017 | 0.019 | 0.020 | 0.332 |
| Height for age[d] | 1.000 | 0.998 | 0.022 | 0.000* | 1.661 | 0.998 | 0.022 | 0.000* |
| Weight for height[e] | 0.602 | 0.718 | 0.018 | 0.000* | 1.000 | 0.718 | 0.018 | 0.000* |

(continued)

**Table 6.5** (continued)

| | Dependent latent variable: absence of stunting | | | | Dependent latent variable: absence of wasting | | | |
|---|---|---|---|---|---|---|---|---|
| | Coeff. | Stand. coeff. | Stand. error | $P > \|z\|$ | Coeff. | Stand. coeff. | Stand. error | $P > \|z\|$ |
| CD: Coefficient of determination ($R^2$) | | | | 0.146 | | | | |
| Log likelihood | | | | −62,261 | | | | |
| Number of observations | | | | 3133 | | | | |

*5% significance level
**10% significance level
[a]Variable equal to 1 if the mother is married
[b]Variable equal to 1 if the individual is rich
[c]Variable equal to 1 if the individual lives in the Ashanti region
[d]Height of the child with respect to his age (children 5 years old or less) given that the z-score is higher than 2 standard deviations (in which case the variable is equal to 1)
[e]Weight of the child with respect to his age (children 5 years old or less) given that the z–score is higher than 2 standard deviations (in which case the variable is equal to 1)

## 6 Concluding Comments

This paper looked at the impact of women's empowerment on children's health in Ghana. It distinguished between several domains of women's empowerment (ability to take decisions, a woman's attitude to the use of violence by her husband and the resources and information available to a woman). To aggregate the variables available in each domain we borrowed a technique implemented in literature in the fuzzy approach to multidimensional poverty measurement.

The paper assumed that children's health is a latent variable. The indicators available on children's health were their height and weight for age. The empirical analysis based on the 2008 Health and Demographic Survey in Ghana and on the implementation of the MIMIC approach, led to several policy relevant conclusions. First, a woman's ability to take decisions has a significant positive impact on children's health. Second, variables describing a woman's attitude towards her husband's violence do not seem to have an impact on children's health. This is also the case for the extent of information available to a woman. Third, children's health is generally higher with the higher educational level of the mother and her body mass index; this is the when the woman is married and is older.

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# Chapter 7
# Women's Access to Microfinance Services in Southern Ethiopia: Assessing the Promises, Impacts, Challenges and Gaps

**Mitiku Kebede and Nigatu Regassa**

## 1 Introduction

After the establishment of the modern banking system, credit and other services were exclusively used by one part of society which could afford the heavy collaterals. To overcome this limited coverage, governments in some developing countries adopted specialized subsidized credit institutions and programs with the principal intention of helping the poor in the 1960s and 1970s. However, these efforts failed in the 1980s because of severe criticism about their inability to reach poor farmers and also providing unsustainable financial services. Women formed a significant group in these excluded groups (Mayoux 1998). Moreover, because women have fewer resources available to them, they tend to be more vulnerable when economic challenges or unforeseen circumstances arise.

According to Beck (2015), microfinance is defined as an attempt to provide financial services to households and micro-enterprises that are excluded from traditional commercial banking services because of low incomes or no formalized ownership titles for their assets. Schreiner and Colombet (2001) define microfinance as an effort to improve access to small deposits and small loans for poor households that are neglected by banks. Hence, we can conclude that microfinance is a small-scale financial service, primarily credit and savings, provided to individual entrepreneurs and small businesses which do not have access to banking and its related services. According to the World Bank (2015a), the microfinance industry is estimated to be worth \$60 to \$100 billion with 200 million clients.

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Ethiopia's modern finance history dates back to the beginning of the twentieth century when it established the Bank of Abyssinia in 1905 (National Bank of Ethiopia 2001). For a long time, the single source of credit for the rural and urban poor was the informal sector: friends, usurers (*arata*), *eqquib*,[1] *iddir*[2] and other similar social networks. However, there was a paradigm shift in the finance sector after the fall of the socialist regime in 1991 and Ethiopia started its reforms process in 1992 as a transition from a planned to a market economy. The financial reforms included liberalizing the financial sector, relaxing foreign exchange controls, dismantling the administered interest rate regime and establishing a new framework for banks, insurance companies, MFIs and cooperatives.

Following the issuance of Proclamation No. 40/1996 in July 1996, the first group of microfinance institutions (MFIs) was established in early 1997. Since then many MFIs have flourished in different parts of the country. These MFIs basically use the group guarantee lending model developed by Grameen Bank. Under this, potential clients are required to organize a peer group that commits to a mutual loan repayment guarantee. Credit is then delivered through small, affinity-based groups (usually five to seven members each) with about 10–15 groups meeting at one center. Monthly (or more frequent) meetings are held to discuss group dynamics and for collecting payments and savings. Priority is given to the poorest members, especially women in giving credit.

Since the first Proclamation of 1996 that gave legal sanction to micro-financing businesses, the industry has witnessed a major boom. There are 35 microfinance institutions (up from four in 1999) operating in the country, all of which are deposit taking. These MFIs have mobilized total savings of around birr 13.0 billion ($600 million at the 2015 exchange rate). The five largest MFIs are regional institutions supported by the government (Amhara, Dedebit, Oromia, Omo and Addis credit and savings institutes) which account for 93.6 percent of the savings and 90 percent of the credit of the MFI sector. Oromia and Amhara have the most branches (242 and 229 respectively) and the largest number of active clients (694,993 and 503,000 respectively). These two MFIs have a predominately rural focus (with less than 20 percent urban clients). On the other hand, Addis and Omo have a strong urban focus (approximately 80–100 percent and 40–60 percent urban clients respectively).

The 1996 Proclamation also brought about remarkable growth in terms of outreach and sustainability because it also considered women (Dereje et al. 2013). The National Action Plan proposed in 2005 and the revised Development and Transformation Package of the Bureau of Women, Children and Youth Affairs (BoWCYA 2014) states that its main development target is enhancing women's economic capacities and encouraging saving habits among them.

However, despite several efforts, women's access to and control over microfinance services in Ethiopia is still low. A study undertaken at the industry level

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[1] A*ssociations* where friends, relatives or some community members contribute a fixed amount of money every month or week and the collected money circles around every term.

[2] Communal associations where the people mainly gather to help each other in time of need (joy or sadness) and contribute in cash or kind for as a part of the service.

indicates that only 38.4 percent of the women used microfinance services and women's participation in credit access at the individual MFI level was below 50 percent even though the MFIs wanted to give 60–70 percent of the loans to women (Getaneh 2010). In the Southern Regional State of Ethiopia, out of the total MFI beneficiaries in 2010, only 28 percent were women. This was mainly due to the heavy collaterals needed for taking credit.

To the best of our knowledge, no comprehensive regional level study has been done on MFIs since their establishment in the Southern Regional State in the late 1990s. Hence, the estimates are solely based on the limited beneficiary specific case studies conducted by graduate students. Our study is a large region level analysis based on data collected from all zones and all categories of beneficiaries and non-beneficiaries. Its specific aim is examining women's participation in MFIs and the impact, opportunities, challenges and gaps in the sector. The study addresses three questions: (1) what is the overall status of MFIs in terms of women's participation and what are the barriers to women's membership? (2) What are MFIs' main impacts on women and/or their households? (3) What are the prevailing opportunities, challenges and gaps in MFIs in the region?

## 2 Literature Review

In many developing countries, a large share of self-employment is among women. But on average, they are less likely to have access to formal financial services than men (Demirguc-Kunt et al. 2013). They are more restricted in their access to finance and control over land and capital (Fletschner 2009). A study by the World Bank (2015b) shows that an estimated 70 percent of small and medium businesses owned by women in developing countries could not get enough finance to grow.

Traditional banks consider women to be less creditworthy. Aterido et al.'s (2013) study on sub-Saharan Africa and Bruhn's (2009) study on Latin America showed gender gaps as critical factors that determined access to formal financial services. The other factors included employment and income status, legal restrictions (such as in asset ownership and holdings in some countries) and education.

According to Mayoux (1998), there are four basic views on the link between microfinance and women's empowerment:

- Those which emphasize the positive impact of MFIs and in their worldwide empowering of women;
- Those which recognize the limitations in empowerment, but say this is due to poor program design;
- Those which recognize their limitations but see them as key ingredients in alleviating poverty;
- Those which see microfinance programs as a waste of resources.

Mayoux (2001) tries to justify the view of the positive impact of microfinance services and gender interactions using three paradigms:

1. The financial self-sustainability paradigm: targeting women with the justification of high female repayment rates and women's economic activities helping economic growth.
2. The poverty alleviation paradigm: due to women's responsibilities for household well-being, targeting women and increasing their access to microfinance will improve household well-being.
3. The feminist empowerment paradigm: microfinance is promoted as an entry point in the context of a wider strategy for women's economic and socio-political empowerment.

The analysis of the impact of MFIs shows that microfinance plays a role in supporting women's economic participation and promoting gender equalities. It is also assumed that because of microfinance facilitates parents can send their children to school, or buy essential medicines and maintain their children's nutritional in-take. This implies that microfinance is likely to have positive long-term impacts on productivity. As noted by Dasgupta (1995), when nutrition and healthcare are poor, any increase in consumption improves future labor productivity and if nothing else, it reduces morbidity. Otero (1999) shows that at its core, microfinance helps in combating poverty by the poor accessing productive. Commentators such as Littlefield et al. (2003) and Simanowitz and Brody (2004) also state MFI services' immense contributions in achieving development goals.

Other researches support the opposite view. Hulme and Mosley (1996) indicate that poor households do not benefit from microfinance; it is only non-poor borrowers (with incomes above the poverty line) who can do well with microfinance and enjoy sizable positive impacts. According to their study a vast majority of those with starting incomes below the poverty line actually ended up with less incremental incomes after getting micro-loans as compared to a control group which did not get such loans. Yoong et al. (2012) also show that there is no conclusive evidence of microcredit's positive impact on women's empowerment. One of the reasons that they give for this is that most of the poor people do not have basic education or experience to understand and manage even low-level business activities. They are mostly risk-averse, often fearful of losing whatever little they have and are struggling to survive. So, microcredit's empowering impact is negligible. The same ideas are provided by Mahajan (2005).

Littlefield et al. (2003) state that access to MFIs can empower women to become more confident, more assertive, more likely to take part in family and community decisions and better able to confront gender inequalities. However, they also state that just because women are MFIs' clients does not mean that they will automatically become empowered. Similarly, Hulme and Mosley (1996) also substantiate this point by emphasizing the idea that not all the money provided to women brings a positive result in their lives. However, with careful planning and designing, a woman's position in the household and community can be improved. Addai (2017) did a study on Ghana's MFIs and found a statistically significant positive relationship between microfinance and women's empowerment in both their economic and social relationships. But such relationships are dependent on a woman's marital status and educational levels with age having no controlling effect. In addition, the study also showed that women encountered numerous problems in accessing microfinance services of which high interest rates were the most dominant.

Laha and Kuri (2014) studied how microfinance outreach programs contributed to women's empowerment in India. Their study established that states having more microfinance programs were also the states with relatively higher levels of women's economic empowerment. They also found that participants experienced an increase in monthly incomes and concluded that an all-inclusive microfinance system would strengthen the process of financial inclusion in India thereby promoting women's economic empowerment. A cross-sectional study by Sujatha and Malyadri (2015) on women in the state of Andhra Pradesh, India showed that microfinance was a powerful tool in enhancing women's empowerment on all indicators like household economic decision making, legal awareness, mobility, economic security and family decision making. On the other hand, Sarumathi and Mohan (2011) used psychological, social and economic indicators to examine the role of microfinance in women's empowerment in Pondicherry, India. Their findings showed that microfinance assisted women in gaining psychological and social empowerment more than economic empowerment.

Littlefield et al.'s (2003) study on the women's empowerment program in Nepal found that 68 percent of the participants took decisions about buying and selling property, sending their daughters to school and planning their families, decisions that in the past had been taken by their husbands.

Various studies on women's empowerment have also been done in Ethiopia to understand MFIs' role in empowering women. For instance, a study in Amhara and Oromiya (the two largest regions) regions of Ethiopia (Tarozzi et al. 2015) concluded that MFIs led to a substantial increase in both the probability of borrowing and the loan size, but there was limited evidence that this increased household incomes, improved school attendance or empowered women in household decision-making. A study on OMFI's beneficiaries in southern Ethiopia (Tesfaye 2012) reported that OMFI's microcredit and micro-saving services had a positive impact on improving its clients' incomes at the household level; 77.4 percent of the respondents indicated an increase in their annual incomes due to access to microcredit programs, which enabled them either to expand their existing businesses or to start new enterprises.

Studies done by Getaneh (2010) and Ebisa et al. (2013) found that microfinance was a good strategy for mitigating poverty as it created an opportunity for the marginalized segments to get access to finance. However, in some areas there was an increase in women's work loads and many women spent their incomes for family purposes which increased the stress of repayments. In addition, even if there was a significant change on the economic side, there was no significant change in their political empowerment.

A study in Yirgalem town showed that loans from MFIs as working capital and/or for purchasing household items and assets brought positive changes for the participants. Dereje et al.'s (2013) study on women's empowerment in Diredawa, Ethiopia revealed that the amount of monthly savings, family size and landholding in hectares were significant determinants of women's decisions to participate in microfinance services. They found a positive correlation between MFI membership and women's empowerment and concluded that for maximizing benefits, the priorities should be creating enabling land access institutions and capital asset accumulation.

# 3 Methods

## *3.1 The Study Area*

The Southern Nations, Nationalities and People's Region (SNNPR) is one of the nine states under the federal Government of Ethiopia. Administratively, the region is divided into 14 zones, one city administration and four special woredas/districts – Hadiya, Sidama, Gedio, Silte, Gurage, KambataTembaro, Gamogoffa, South Omo, Bench Maji, Kafa, Sheka, Dawro, Wolyta and Segen people's zones and Basketo, Yem, Konta and Halaba special woredas. The region is multi-ethnic with 56 nations and nationalities. Its population in 2012–13 was 17,855,710 (8,885,204 males and 8,970,506 females). The region started using microfinance services in 1997. There are about seven MFIs operating in the region – Omo (OMFI), Sidama, Wisdom, Agar, Leta, Metemamen and Meklit (BoFED 2013).

This study uses a cross-sectional survey design applying qualitative and quantitative methods. The main data was generated through both primary and secondary sources. A large part of the data was collected from households and key informants at four different levels (kebele, woreda, zones and region). Secondary data was collected from relevant authorities in the region to supplement the household survey.

## *3.2 Sampling Design and Model Specification*

To determine the sample size, it was imperative to consider a wide range of women's empowerment indicators in SNNPR taken from recent studies. These include, but are not limited to, women's education/participation rates (64.3 percent, CSA 2011), autonomy and decision-making (69.1 percent), headship rate (26 percent, CSA 2011), ownership of land/house (61 percent, CSA 2011) and employment status (40.7 percent, CSA 2011). Once the key indicators of women's empowerment were identified, it was assumed that these indicators did not vary much across all zones/districts in the region. The sample size for the study was determined by using the formula for a cross-sectional household-based survey as was done by Cochran (1977):

$$n = \frac{\frac{Z^2 p(1-p)}{d^2}}{1 + \frac{1}{N}\left(\frac{Z^2 p(1-p)}{d^2} - 1\right)} \tag{7.1}$$

where $Z$ is the upper $\alpha/2$ points of the standard normal distribution with a $\alpha = 0.05$ significance level, which is $Z = 1.96$, $d$ is the degree of precisions (0.04), $p$ is taken as 0.5.

The estimated sample size for each zone (14 zones, one city administration and four special woredas/districts) was 383 and was weighted by 1.5 (Cochran 1977) to get a size of 575. A 5 percent contingency was added to get the final sample of 604 households from each zone, giving a total sample of 11,476 from the region. Individual households were selected using the multi-stage sampling technique and the process of sampling for the household level survey was started with a purposeful selection of two representative districts/woredas from each zone with a total of 43 study woredas. In the third stage of the sampling, 5–10 percent kebeles (sub-districts) from all the kebeles in each selected woreda (proportionally representing urban and rural kebeles) was considered. Based on information from the Central Statistics Authority, it was assumed that the kebeles in a district had more or less similar characteristics and sizes. Once the households were identified, information was collected from women respondents.

We examined the key determinants of membership in MFIs using the binary logistic regression. Several household and individual level variables were regressed against the dependent variable – women's membership in MFIs. The equation for the simple linear regression from the equation of straight line is:

$$\mathrm{Y_i} = \alpha_0 + \beta_1 \mathrm{X_{1i}} + \beta_2 \mathrm{X_{2i}} + \cdots + \beta_n \mathrm{X_{ni}} + \varepsilon_i \tag{7.2}$$

where $\alpha_0$ is the Y intercept, β is the coefficient and X is the independent variable and $\varepsilon_i$ is a residual term. The logistic regression is the, "prediction of the probability of Y occurring given known values of X's" (Field 2009). The logistic model equation with P(Y) the probability of Y occurring, e the base of natural logarithms, $\beta_n$ regression coefficient of variable $X_n$ I is:

$$\mathrm{P(Y)} = \frac{1}{1 + e^{-(\alpha_0 + \beta_1 \mathrm{X_{1i}} + \beta_2 \mathrm{X_{2i}} + \cdots + \beta_n \mathrm{X_{ni}})}} \tag{7.3}$$

The dependent variable "membership of microfinance institutions" is taken as a binary variable where membership takes a value of 1 and a value is 0 for not being a member. Therefore, the unobserved variable Y in the binary logistic regression is:

$$\mathrm{Y} = \begin{cases} 1 & \text{if } \mathrm{Y} > 0 \\ 0 & \text{if } \mathrm{Y} \le 0 \end{cases} \tag{7.4}$$

Educational status, land ownership certificate, age, religion, job status, husband's education level, total family size, use of informal credit, cattle ownership, family headship and size of landholding are considered independent variables that will control MFI membership. The regression is run with a 95 percent confidence interval.

# 4 Empirical Findings

## *4.1 Overall Findings of the Study*

This study aimed at examining women's participation in saving and credit schemes, impacts, opportunities and challenges in the Southern Nations, Nationalities and People's Region. The analysis in the results section was based on primary data collected from all zones in the region and secondary data got from the concerned regional offices. It is noted that women's participation in saving and credit schemes through MFIs was fairly low in all the zones while the performance of some zones (such as Gurage, Sheka and Sidama) was encouraging. Further, the distribution of MFIs was uneven. Though about seven institutions were operating in the region, there were districts where no such scheme existed.

Table 7.1 presents the distribution of the respondents by selected background characteristics. The table shows that there were only 22.4 percent female headed households while a majority (78.6 percent) were male headed households. More than 72 percent of the respondents were in the age range of 18 and 39 years, which is the productive age group. With regard to the household size, nearly 50 percent had a size of 5–8 members and 40 percent were 2–4 member households. A considerable percentage of the respondents was not able to read and write (41.1 percent); 33.9 percent had only primary level education. A further analysis showed that 53 percent of the illiterate women's spouses were also illiterate. As expected, a very small fraction of the respondents (5.9 percent) reported having either a diploma or degree level education.

The MFIs' clients were unevenly distributed across the zones. As can be seen from Table 7.2, some zones had more members than others. Gurage, Sheka and Sidama zones had the highest concentration of microfinance clients (33.1 percent, 31.3 percent and 28 percent respectively). On the other hand, zones such as Halaba, Hadiya and Basketo had the lowest number of clients. Concerning the distribution of membership by the type of institution, there were only 17.1 percent women members in the savings and credit institutions. OMFI alone covered 80.1 percent, Sidama Microfinance 1 percent and the remaining 2.2 percent were covered by the remaining five institutions (Wisdom, Agar, Leta, Metemamen and Meklit). As mentioned earlier, about 17 percent of the households lived in districts not covered by MFIs.

Among the borrowers, 75 percent of the women participated in income generating activities. The rest met their basic needs and for related purposes. This is also manifested in the last money they borrowed; 75 percent of the women used it for animal fattening, food crop production and selling fruits and vegetables.

**Table 7.1** Percentage distribution of respondents by select background characteristics, SNNPR ($n$ = 11,462)

| Characteristics | Number | Percent |
|---|---|---|
| Sex of the respondent | | |
| Female | 2498 | 22.4 |
| Male | 8664 | 77.6 |
| Total | 11,162 | 100.0 |
| Age of the respondent | | |
| 18–28 | 3873 | 34.7 |
| 29–39 | 4176 | 37.4 |
| 40–50 | 2243 | 20.1 |
| Above 50 | 664 | 7.7 |
| Total | 11,162 | 100.0 |
| Education | | |
| Illiterate | 4587 | 41.1 |
| Practical oriented adult education | 695 | 6.2 |
| 1–4 grade | 1709 | 15.3 |
| Grade 5–8 | 2072 | 18.6 |
| Grade 9–10 | 1139 | 10.2 |
| Grade 11–12 (preparatory) | 297 | 2.7 |
| Above high school | 653 | 6.0 |
| Total | 11,162 | 100.0 |

### 4.1.1 Women in Decision Making

Around 47.3 percent of the women reported that either they took a decision to borrow money themselves or with their husbands. In only 12 percent of the households did the husbands take this decision. The rest decided either by talking to MFI's staff members or after consulting member friends. When it comes to administering the borrowed money, 60 percent of the women did this either independently or with their husbands. The findings also show that the influence of family members and siblings was high both in the decision to borrow and in the administration of the money indicating strong social ties among people.

Many women borrowed from MFIs because they believed that they could get start-up capital for their businesses. Only a few of them said that low interest rates and the simple repayment schedules were motivating factors for borrowing. But they said that the process was not smooth. For instance, 10 percent of the borrowers reported that they faced challenges and opposition from their husbands. However, women who used MFIs' services experienced a dramatic change in their monthly incomes. About 30 percent of the women earned more than birr 2000 per month. In addition, around 75 percent tried to repay their loans from the money they made from running their enterprises and the products that they sold. The rate of voluntary savings reached 90 percent and only 5 percent of the households had to either sell their property or rent their land to repay their loans.

However, about 20 percent of the borrowers said that they faced problems in making repayments. The main reasons for this were low rates of return or profits, using

**Table 7.2** Distribution of MFI memberships by zone, SNNPR ($n$ = 11,162)

| Zone | Membership in MFI | | |
|---|---|---|---|
| | Yes | No | Total |
| BASKETO | 42 | 561 | 603 |
| BENCH MAJI | 116 | 493 | 609 |
| DAWURO | 102 | 494 | 596 |
| GAMOGOFA | 46 | 564 | 610 |
| GEDEO | 73 | 414 | 487 |
| GURAGHE | 199 | 403 | 602 |
| HADIYA | 30 | 569 | 599 |
| HALABA | 24 | 480 | 504 |
| HAWASSA | 110 | 491 | 601 |
| KAFFA | 86 | 421 | 507 |
| KANBATA | 103 | 512 | 615 |
| KONTA | 90 | 511 | 601 |
| SOUTH OMO | 122 | 489 | 611 |
| SEGENE | 53 | 550 | 603 |
| SHEKA | 185 | 407 | 592 |
| SIDAMA | 169 | 435 | 604 |
| SILTE | 110 | 499 | 609 |
| WOLAYITA | 146 | 457 | 603 |
| YEM | 107 | 499 | 606 |
| Total | 1913 | 9249 | 11,162 |

the loan for subsistence, husband's extravagant habits and using the money for family healthcare and related issues. Untimely withdrawal of savings became a major challenge in mobilizing resources. For instance, in 2013, out of cumulative total savings of birr 2.38 billion, birr 1.6 billion (67 percent) was withdrawn. In addition to this, there are also issues of clients dropping out and stakeholders' reluctance in mobilizing savings.

Over 16 percent of the respondents reported that they did not have access to the services which is a direct indicator of the challenges in providing financial inclusion. This leaves a huge gap between the reality on the ground (17 percent participation rate) and the figures mentioned in the revised Development and Transformation Package of the Bureau of Women, Children and Youth Affairs (BoWCYA), which plans to take women's share in MFIs to 60 percent or more. The most commonly cited problems were institutional limitations, women's lack of capacity to meet their savings' requirements and weak support from husbands and other stakeholders.

In nearly all the focus group discussions, women cited financial incapacity to save for six consecutive months before they could borrow, which is a policy followed by MFIs as the main reason for their inability to be financially included. This is partly due to the fact that most of the women did not have any source of income from which they could save for 6 months. It should be noted that urban MSE clients need to return 20 percent of the required loan by depositing an equal amount of money for six consecutive months prior to receiving the loan; 10 percent of the required loan if they are first comers and borrow less than 50,000 Birr or 5 percent if they need more than 50,000 Birr for urban MSE business loans. Those taking loans for agricultural and micro-business purposes need to save 10 percent of the loan as a group saving for the first cycle loans, 8 percent for the second cycle loans and 5 percent for the third cycle and above loans. Not having a guarantor or a co-guarantor for borrowing the money was another reason cited by the clients. Despite this, more and more women in the last few years are aspiring to take loans.

Previous studies in the two major regions of Ethiopia (Oromia and Amhara) have documented that despite the lack of efforts in targeting women, the proportion of loans initiated by women increased in villages where micro-lending became available (Tarozzi et al. 2015). Additionally, bureaucratic red tape discouraged many women from joining MFIs and led to large dropouts from the service. Even though the regional development package is meant to help women in the production of market oriented products and extending the markets and networks to reach these poor women, many still complained that after they got the money they used it for consumption purposes partly because of their lack of understanding about what to do with it.

The data from OMFI also substantiates the above discussion. Since 2006 client dropout showed sustainable growth over the periods with annual growth rate of −83 percent, 312 percent, 5 percent and 111 percent in the year 2006, 2007, 2008, and 2009, respectively. The number of total dropouts was 3873 clients in 2004 which went up to 27,324 in 2009. Within these 6 years the dropout rate increased by 605.50 percent which is very high and needs immediate attention. Despite the fact that MFI facilities have been available in many of the zones for some time now, most of the MFIs' clients became involved only recently (75 percent of the users became members in the last 3 years, of which 26.5 percent joined just a year ago). This shows weak mass mobilization or the poor role of the media/other partners or both in getting more people to join MFIs.

About 55 percent of the respondents got their primary information about microfinance services from MFIs' staff members. While clients may get access to comprehensive messages/information from MFIs' staff members, one particular problem is that the staff may not be gender sensitive. A study in Amhara region reported that microfinance staff members were less gender sensitive, and only about 20 percent of the field-level microfinance staff members in Ethiopia were women. This may limit an important impact of the program wherein women clients view female loan officers as positive role models for their daughters. The media too has played a very insignificant role in creating awareness and providing relevant information. Only 1 percent of the respondents said that the media was their primary source of information when in fact media has the potential to reach 45 percent of the population.

On the other hand, a cross-tab analysis indicates that women with educated husbands had three times more access to information from their husbands about MFIs than their illiterate counterparts.

Poor educational levels coupled with cultural pressures considerably affected women's participation in saving and credit schemes, and hence diminished the positive impacts that such schemes might have on their households.

The FGDs in districts such as Konta, Segen-Konso and Basketo, indicated that the cultural challenges from their spouses hindered women from moving forward and overcoming their economic challenges. Participants in these districts said that women got acceptance and assistance from their husbands and the community at large only if they could practically justify the importance of microfinance services in their lives for helping their families and repaying their loans without damaging the family's reputation or selling the household's property. This problem was partly caused by the infamous experience of some borrowers using the money for consumption and then defaulting in their payments. Further, women in these areas are thought to be incapable of doing jobs other than being housewives. Then the market is also very small which prevents businesses from expanding. However, it is important to note that some educated husbands had a positive impact on their wives' participation in MFIs. For instance, 4.3 percent of the women whose husbands had a degree or a higher educational level were helped by their spouses to participate in MFIs while only 1.3 percent of the women with illiterate spouses got assistance from them. Household based limitations were also observed.

### *4.2 Determinants of Participation in Microfinance Activities*

We used a binary logistic regression analysis to understand the factors that affect membership in MFIs (Table 7.3).

The model included a range of socioeconomic variables based on a literature review. These included family headship, educational status, size of landholding, land ownership certificate, age, religion, job status, husband's education level, family size, decision maker about a family's earnings, type of crop grown, cattle ownership and use of informal credit sources. Our results indicate that except for family headship, land ownership and cattle ownership, the remaining variables were significant in determining the likelihood of being a member of a MFI (5 percent confidence interval). Women who were involved in adult education were 0.506 times less likely to borrow from MFIs as compared to illiterate women. Generally, with a slight upward swing in educational levels the likelihood of borrowing from microfinance institutions declined which indicates that MFIs' target is the economically lower class.

Regarding the impact of age, younger women (18–25 years) were more likely to be members of MFIs as compared to other age groups. From the job point of view, the results indicate that employees of private companies, housewives and farmers were 3, 2 and 1.6 times more likely to be members of MFIs as compared to government employees. This is an encouraging message for both the government and the MFIs because MFIs are intended for the poor. As the size of the family increased,

**Table 7.3** Results of the logistic regression (odds ratio) for the determinants of participation in MFIs in the region ($n$ = 11,162)

| | | | | | 95% C.I. for EXP(B) | |
|---|---|---|---|---|---|---|
| | B | S.E. | Sig. | Exp(B) | Lower | Upper |
| Family headship | 0.058 | 0.086 | 0.499 | 1.060 | 0.895 | 1.255 |
| Educational status<br>Illiterate (RC) | | | 0.000 | | | |
| Adult education | −0.681 | 0.123 | 0.000 | 0.506 | 0.398 | 0.643 |
| Grade 1–4 | −0.723 | 0.091 | 0.000 | 0.485 | 0.406 | 0.581 |
| Grade 5–8 | −0.743 | 0.093 | 0.000 | 0.475 | 0.396 | 0.570 |
| Grade 9–10 | −0.708 | 0.115 | 0.000 | 0.493 | 0.393 | 0.617 |
| Grade 11–12 (Preparatory) | −0.783 | 0.181 | 0.000 | 0.457 | 0.321 | 0.651 |
| TVET diploma | −0.529 | 0.182 | 0.004 | 0.589 | 0.412 | 0.842 |
| Degree | 0.465 | 0.294 | 0.114 | 1.592 | 0.894 | 2.833 |
| Above degree | 0.239 | 1.142 | 0.834 | 1.270 | 0.135 | 11.917 |
| Size of landholding | | | 0.151 | | | |
| Land ownership certificate<br>Husband's (RC) | | | 0.000 | | | |
| Own | −0.289 | 0.113 | 0.011 | 0.749 | 0.600 | 0.935 |
| Joint with a husband | −0.293 | 0.085 | 0.001 | 0.746 | 0.631 | 0.881 |
| Children's | −0.773 | 0.159 | 0.000 | 0.462 | 0.338 | 0.631 |
| Age<br>18–21 (RC) | | | 0.000 | | | |
| 29–39 | −0.290 | 0.071 | 0.000 | 0.748 | 0.651 | 0.860 |
| 40–50 | −0.188 | 0.091 | 0.039 | 0.829 | 0.694 | 0.991 |
| 51–60 | 0.321 | 0.163 | 0.048 | 1.379 | 1.003 | 1.896 |
| >60 | 0.542 | 0.304 | 0.075 | 1.719 | 0.947 | 3.120 |
| Religion<br>Orthodox (RC) | | | 0.001 | | | |
| Catholic Christian | −0.184 | 0.175 | 0.291 | 0.832 | 0.591 | 1.171 |
| Evangelical Christian | 0.009 | 0.068 | 0.892 | 1.009 | 0.884 | 1.152 |
| Muslim | 0.313 | 0.095 | 0.001 | 1.368 | 1.136 | 1.648 |
| Cultural | 0.138 | 0.266 | 0.604 | 1.148 | 0.681 | 1.935 |
| Others | 1.276 | 0.467 | 0.006 | 3.584 | 1.436 | 8.943 |
| Job status<br>Govt. employee (RC) | | | 0.000 | | | |
| Private company employee | 1.163 | 0.426 | 0.006 | 3.198 | 1.387 | 7.376 |
| Private job | −0.010 | 0.163 | 0.953 | 0.991 | 0.720 | 1.363 |
| Contract employee | 0.447 | 0.479 | 0.350 | 1.564 | 0.612 | 4.000 |
| Farmer | −0.273 | 0.222 | 0.219 | 0.761 | 0.493 | 1.176 |
| Housewife | 0.758 | 0.178 | 0.000 | 2.133 | 1.504 | 3.026 |
| Both farmer & housewife | 0.522 | 0.153 | 0.001 | 1.686 | 1.248 | 2.277 |
| Other | 0.390 | 0.168 | 0.020 | 1.478 | 1.063 | 2.053 |

(continued)

**Table 7.3** (continued)

| | B | S.E. | Sig. | Exp(B) | 95% C.I. for EXP(B) | |
|---|---|---|---|---|---|---|
| | | | | | Lower | Upper |
| Husband's education level<br>Illiterate (RC) | – | – | 0.003 | – | – | – |
| Adult education | −0.221 | 0.172 | 0.198 | 0.802 | 0.573 | 1.122 |
| Grade 1–4 | −0.276 | 0.105 | 0.008 | 0.759 | 0.618 | 0.931 |
| Grade 5–8 | −0.251 | 0.093 | 0.007 | 0.778 | 0.649 | 0.933 |
| Grade 9–10 | −0.347 | 0.111 | 0.002 | 0.707 | 0.569 | 0.878 |
| Grade 11–12 (Preparatory) | −0.555 | 0.142 | 0.000 | 0.574 | 0.434 | 0.759 |
| TVET diploma | −0.119 | 0.136 | 0.381 | 0.888 | 0.681 | 1.158 |
| Degree | −0.195 | 0.160 | 0.224 | 0.823 | 0.601 | 1.126 |
| Total family size<br>No family (RC) | | | 0.000 | | | |
| 2–4 | −0.750 | 0.223 | 0.001 | 0.472 | 0.305 | 0.731 |
| 5–8 | −0.969 | 0.226 | 0.000 | 0.379 | 0.244 | 0.591 |
| 9–12 | −1.202 | 0.244 | 0.000 | 0.301 | 0.186 | 0.485 |
| 13–14 | −2.465 | 0.444 | 0.000 | 0.085 | 0.036 | 0.203 |
| >15 | −.373 | 0.850 | 0.661 | 0.689 | 0.130 | 3.643 |
| Decision maker for earning<br>Own(RC) | | | 0.000 | | | |
| Husband | 0.471 | 0.115 | 0.000 | 1.602 | 1.278 | 2.009 |
| Joint with a husband | 0.242 | 0.073 | 0.001 | 1.274 | 1.104 | 1.471 |
| Children | 0.743 | 0.214 | 0.001 | 2.103 | 1.383 | 3.197 |
| Type of crop grown<br>Cash crop (RC) | | | 0.002 | | | |
| Food crop | 0.022 | 0.115 | 0.851 | 1.022 | 0.815 | 1.281 |
| Both cash & food crop | 0.146 | 0.121 | 0.229 | 1.157 | 0.912 | 1.468 |
| No production | 0.461 | 0.149 | 0.002 | 1.585 | 1.183 | 2.124 |
| Cattle ownership right | | | 0.262 | | | |
| Use of informal credit | | | 0.000 | | | |
| Yes (RC) | −1.931 | 0.110 | 0.000 | 0.145 | 0.117 | 0.180 |
| Constant | 2.812 | 0.371 | 0.000 | 16.649 | | |

the likelihood of being a member of a MFI declined. The results indicate that women who were in informal credit services (*eqquib*) considered MFIs as a substitute. The regression analysis indicates that those women who were not members of informal credit options like *eqquib* were almost seven times more likely to be in formal MFI services. There was not much difference in membership patterns based on the crops that the households produced. However, women who participated in other agricultural activities like animal fattening and bee hives were 1.5 times more likely to participate in MFIs than cash crop producers. A further analysis suggested that those women who were young, with small family sizes and an entrepreneurial mentality had a high likelihood of being in MFIs than the others.

Measuring the actual impact of participation in MFIs is somewhat difficult because of three reasons. First, as has already been noted more than 75 percent of those reporting active membership are new members who joined MFIs during the last 3 years. This by itself limits their amount of saving and borrowing capacity.

Second, those small segments of clients who reported taking loans for business expansion and household use were not able to talk of any visible or quantifiable changes that such loans had made on their household incomes, education, wealth and other livelihood options mainly due to poor data record. Third, it would be very difficult to determine the sustainability of any positive impacts if they exist as they are short lived. Thus, the impacts reported by about 17 percent of the clients should be cautiously interpreted.

This study is not without limitations. First, the study was based on cross-sectional data which entails collection of information at a specific point of time in the lives of the respondents. It may also suffer from self-selection bias and omission and commission errors. Further, the secondary data made available by the concerned authorities had very few details to effectively show the impact and sustainability of MFIs. On the other hand, because the analyses are based on large scale data collected from all zones in the region, the comprehensiveness and policy relevance of the findings are greater. We suggest future research to focus on collecting time series data to determine the changes, impacts and sustainability of membership to MFIs.

## 5 Summary and Conclusion

This study documented women's low participation in saving and credit activities. Their participation was constrained by some institutional and household factors. The study concluded that some institutional challenges (such as poor mobilization, high loan requirements) and household socio-demographic variables (such as household size, husband's education, type of crops grown) were significant predictors of memberships to MFIs. Further, the uneven distribution of MFIs coupled with bureaucratic red tape discouraged many from joining the institutions and led to a large number of dropouts from the service which heavily affected repayment rates. We also noticed insufficient provision of entrepreneurial training in skill development and financial outlays which led to a mismatch between existing market demand and wastage of financial resources. However, there is some evidence that suggests that active members (though small in number) have seen some positive impacts of their membership in MFIs.

In view of the nature of the variables that this study used, we suggest addressing the unreached majority by expanding services and creating awareness to avoid social seclusion as the most important measure that the regional government should take up. Additionally, opening sub-branches in different villages/districts, promoting the service using both formal and informal mechanisms, encouraging the existing microfinance institutions, facilitating the service by removing institutional and regulatory red tape, designing mechanisms to ensure women's control over loans and rewarding successful women entrepreneurs are some measures that can assist in the expansion of microfinance services to a larger part of society.

The Development and Transformation Package should be backed by quantitatively expressed targets to help the monitoring and evaluation process. Lastly, the Bureau of Women, Children and Youth Affairs, Omo Microfinance, Bureau of Finance and Development, the Agriculture and Rural Development Sector. Production Exchange and unions and other MFIs should work collectively not only to remove the gaps in service provision but also to implement the newly designed Development and Transformation Package.

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# Chapter 8
# The Economic Cost of Informal Caregiving to In-patients: The Case of Jimma University Referral Hospital in Jimma, Ethiopia

**Habtamu Legese**

## 1 Introduction

Informal care is voluntarily provided care to those in need of assistance. The term has been defined differently by different researchers. Informal caregivers are people who provide unpaid help or arrange for paid help for a relative or friend who is ill or has a disability because of which she/he is unable to help herself/himself or because she/he is getting older or sicker. This kind of help can be through doing household chores or looking after the financial, personal or medical needs of the care receiver (Gould 2004).

On the basis of heterogeneity related to the time that is invested, the duration of the care and the number of care activities provided, informal care is defined as a non-market composite commodity consisting of heterogeneous parts produced by one or more members of the social environment of the care's recipient.

In most countries, informal care forms a major share of the healthcare and thus it is not reflected in social statistics. Despite the fact that informal caregivers mostly serve without any payment, care provision can still come at a certain cost. In particular, the provision of such care is often time-consuming, mentally stressful and physically exhausting, which can negatively affect the caregivers' careers and health (Bettio and Verashchagina 2014).

Ethiopia is among the countries with the lowest health status in the world. This is mainly due to poor socioeconomic development resulting in widespread poverty, low standard of living, poor environmental conditions and inadequate health services (MOFED 2002). The low level of health status is coupled with large numbers of in-patients who need informal care.

Although informal or voluntary care forms the basis of many community-based healthcare services and is a major aspect of their feasibility, relatively little economic

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information exists about such care because informal care is a less visible part of care both in terms of costs and effects. Moreover, it has often been ignored in economic evaluations and policymaking (Van den Berg et al. 2004).

Information about the prevalence and value of informal work is of importance for policymakers because changes in its supply are linked to public welfare and influence a country's social security balance sheet. Although data about informal care can be obtained from insurance providers in countries that publicly support informal care, such data focuses on care recipients (not caregivers) and excludes those who do not apply for benefits or who do not fit any of the entitlement requirements. As a result, most of the information on the magnitude of informal care is derived from surveys, often in the form of interviews with representative sub-samples (Bauer and Sousa-Poza 2015).

Several studies have been done on the cost of informal caregiving for specific patients, disabilities, elders and informal care recipients mainly in developed countries. However, there is no research on the valuation of the economic costs of informal caregiving for in-patients in Ethiopia.

Hence, this study's objective is presenting new empirical evidence on the economic valuation of informally supplied healthcare with special emphasis on the labor market-related opportunity costs of informal caregiving for in-patients. The study specifically investigates the impact of socioeconomic factors on the value of informal caregiving for in-patients, examines the extent to which women are principal informal caregivers and the labor opportunity costs incurred by them as compared to male principal informal caregivers. It also measures principal informal caregivers' vulnerability to hospital acquired infections.

This study provides information and insights for policymakers. Besides, it also adds to existing knowledge and helps initiate further studies in the area as it shows how difficult it is to resolve the empirical question on the costs incurred by informal caregivers.

The rest of the paper is organized as follows. The next part presents theoretical and empirical literature on informal caregivers with a focus on the costs and valuation of informal caregiving. It then discusses the research methodology which specifies the theoretical model, the empirical model and the data. The next part presents the empirical findings and their interpretations. The last part draws some conclusions and policy implications based on the findings of the study.

## 2 Background

Informal caregivers are individuals who provide on-going care (assistance) to family members and friends in need of support due to physical, cognitive or mental conditions without pay. Informal caregivers can be primary or secondary caregivers or part of an informal network of multiple informal caregivers such as siblings who share a parent's caring responsibilities. The different tasks of informal family care can be categorized into three groups: personal care with routine daily activities; household work and emotional support; and administrative help (Triantafillou et al. 2010).

A unique feature of informal care is that it is economically invisible, or it is not easily measurable in monetary terms (Goodhead and McDonald 2007). Informal caregivers are either primary caregivers' non-primary caregivers or other informal caregivers including unconfirmed primary caregivers. The demand and supply for informal care is not limited to some specific people, country or continent, it is a routine and on-going socioeconomic problem in the world.

The need for informal care is growing due to an increase in life expectancy, accidents, a large number of diseases and lifestyle changes. However, the supply of informal caregivers is decreasing due to low birth rates, children living further away from their parents and because labor market participation among women, who traditionally had a lion's share of informal caregiving has increased. In response to the growing need for care, policymakers in several developed countries encourage informal caregiving to reduce the financial pressure on public care systems. However, the effects of caregiving on caregivers are not yet fully understood or considered by policymakers (Heger 2014).

Throughout history the amount of time spent at work has never been much higher than that spent on other activates. Even a work week of 14 hours (eight in the case of Ethiopia) a day for six working days leaves time for sleeping, eating and doing other normal daily activities. The standard neoclassical approach models allocate time (T), a fixed resource, between two uses: paid labor rewarded at a fixed wage rate (W), and 'leisure.' Hours of work are chosen to maximize a single period function with utility dependent on leisure (L) and the consumption of goods (C), subject to financial budget constraints imposed by the wage rate (W) and non-wage income (Latif 2006).

If a caregiver is time constrained and has to divide time between working in the labor market and providing informal care, there is a substitution effect. The scarcity of time may put pressure on the responsibility of providing care which may lead to a reduction in the labor supply and an increase in informal caregiving hours (Heitmueller 2007). The second effect is the income effect: as an individual increases her/his caregiving hours she/he reduces the working hours (working less generally means earning less). The income effect implies that it is more likely that caregivers will remain in the labor force if caring requires extra expenditure leading to incentives to earn more by increasing wage labor (Carmichael and Charles 2003).

Generally, if the substitution effect exceeds the income effect, then informal caregivers will choose not to work. But if the income effect exceeds the substitution effect the caregivers will remain in the labor force (Do 2008).

Hassink and Van den Berg (2011) who reviewed more than four studies say, "From an economic point of view, the actual hours of care are determined by the care needed (demanded) by the care recipient and the opportunity costs incurred by the (potential) caregivers." This is highly related to the concept of income effect and substitution effect.

## 2.1 Approaches for Measuring the Cost of Informal Caregiving

Different researchers have used different methodologies to estimate or measure the value of informal care (informal care provision). This section presents an overview of the main measures that have been used in literature for measuring the cost or the value of informal care provision.

Estimating the monetary value of non-market goods and services is important for taking many decisions involving both public and private expenditure. Despite such valuations are not explicit, decisions may still involve the use of implicit values (Pearce 2002). Generally, there are two dominant methods of valuing time spent on informal care: the revealed preference method and the stated preference method.

The revealed preference method uses data on real-life decisions to estimate the value of informal care. This means a preference for informal caregivers deducted from informal caregivers' decisions or from the market's decision for providing close substitutes for informal care. This method uses the uncompensated or Marshallian demand theory. The revealed preference method can be calculated based on opportunity costs and proxy good or replacement costs. It applies the compensated or Hicksian demand theory and this can use contingent valuation or a conjoint analysis (Van den Berg et al. 2004).

### 2.1.1 The Revealed Peference Method

The revealed preference method requires observational data based on decisions taken by individuals regarding goods or services which are assumed to be equivalent to informal care. In general, the revealed preference method uses real wages or income data to derive monetary values (Faria et al. 2012).

The Opportunity Cost Method

The opportunity cost (the value of the resources that the next best alternative uses) valuation method is one of the most important and most commonly used method in the valuation of forgone income or time. Often, the opportunity cost method values informal care according to the equation:

$$\textit{The value of informal care}\left(VIC\right) = t_i w_i \tag{8.1}$$

where ***t;*** = time spent on informal care provision by the principal caregiver i, and *W* = the net market wage rate of informal caregiver i. If the informal caregiver is unemployed some proxy for *wi* is used (Van den Berg et al. 2004).

#### The Proxy Good Valuation Method

The proxy good valuation method is one of the revealed preference valuation methods that can be used to value or estimate the price (cost) of a non-market commodity (service).

Informal caregiving involves many types of activities such as assessing personal hygiene, helping with medication and doctor visits, managing finances, acting as a patient advocate and providing emotional support. To use the proxy good valuation method, one needs to know the exact allocation of time for the caregiver's tasks and we should have a good proxy (market substitute) for each activity. The proxy good valuation method uses the equation:

$$\textit{Value of informal care}\left(VIC\right) = \textit{price of market substitute} \tag{8.2}$$

### 2.1.2 The Stated Preference Method

The stated preference method involves asking people how much a non-market commodity is worth. This information should be collected through questionnaires or opinion polls (surveys). It obtains individuals' valuation of a service by asking individuals to state a money value or by asking individuals to evaluate characteristics of the service using price or cost.

#### The Contingent Valuation Method

The contingent valuation method is a valuation based on a questionnaire that offers the respondents an opportunity to make an economic decision on a good (especially for non-market goods and services). That is, the valuation is contingent on the simulated market presented to the respondents. The advantage of the contingent valuation method is that it is able to obtain option price estimates in the presence of uncertainty to value goods not previously available and to estimate all existing class benefits. Further, the relevant ordinary (or inverse demand) curves are estimable and the relevant Hicks compensated demand or inverse demand is also directly estimable (Venkatachalam 2004).

#### The Conjoint Measurement Method

A conjoint analysis is generally used for consumer products, durable goods, pharmaceutical products and in transportation and service industries. In addition, it is also useful in health economics. The conjoint analysis assesses individuals' evaluations of a product's different features. These evaluations are analyzed to yield estimates of product preferences that equate to choosing (market) share estimates.

## 3 Data and Empirical Model

This study on the cost of principal informal caregivers at Jimma University Referral Hospital used a cross-sectional study design and analyzed the collected data by using both qualitative and quantitative (econometrics) methods using the STATA 13 software. It also employed the ordinary least squares method of regression.

### *3.1 Description of Jimma University Referral Hospital*

The Jimma University Specialized Hospital (JUSH) is one of the oldest public hospitals in Ethiopia. JUSH is in the Oromia region, Jimma zone, Jimma town, 352 kilometers to the south-west of capital Addis Ababa. The hospital was established in 1930 EC by Italian invaders for their soldiers. After the withdrawal of the colonial occupants, it was governed by the Ethiopian government under the name 'Ras Desta Damtew Hospital.' During the Dergue regime its name was changed to 'Jimma Hospital' and it is currently known as the Jimma University Specialized Hospital (Jimma University Teaching Hospital) (Jimma University 2016).

The Jimma University Specialized Hospital is the only teaching and referral hospital in the country with a 590 bed capacity in the south-western part of Ethiopia. The hospital provides services for approximately 15,000 in-patients, 160,000 out-patient attendants, 11,000 emergency cases and 4500 deliveries a year. These patients come from a catchment population of about 15 million people. The patients are from the south-western parts of Oromia, a part of SNNP and from the Gambella region including South Sudan refugees.

### *3.2 Data Sources and Sample Size*

This research uses cross-sectional data with the primary data collected through a questionnaire from selected informal caregivers for in-patients in the Jimma University Specialized Hospital. Secondary data was collected from the Jimma University Specialized Hospital's statistics office. The sample size was estimated based on Yamane's formula (Yamane 1967s). All the respondents are principal informal caregivers and by definition principal informal caregivers are more likely to provide the most hours of informal care and coordinating the care provided by other informal caregivers (Van den Berg et al. 2004).

$$\boldsymbol{n = N / \left(1 + Ne \,^\wedge\, 2\right)} \tag{8.3}$$

**Table 8.1** Number of samples from each ward

| No. | Wards (strata) | Number of beds in the ward | Number of samples |
|---|---|---|---|
| 1 | Surgical | 136 | 55 |
| 2 | Medical | 80 | 32 |
| 3 | Neonatal | 39 | 16 |
| 4 | Ophthalmology | 38 | 15 |
| 5 | Maternity | 81 | 33 |
| 6 | Gynecology and obstetrics | 26 | 10 |
| 7 | Psychiatry | 32 | 13 |
| 8 | Pediatric | 131 | 53 |
| 9 | Intensive care unit (ICU) | 5 | 2 |
| 10 | S.ped | 12 | 5 |
| 11 | Stroke | 8 | 3 |
| 12 | Recovery | 2 | 1 |

where n = sample size, N = number of total population and e = level of precision, sampling error (the 'degree of precision' is the margin of permissible error between the estimated value and the population value).

Based on the Yamane formula, the sample had 238 respondents.

The Jimma University Specialized Hospital has 12 wards (departments) and we consider the number of departments (wards) as the number of strata. By using stratified random sampling, the study selected sample respondents from each stratum (wards) (Table 8.1).

## 3.3 *The Rationale for Using Opportunity Cost Valuation Methods*

The alternative stated preference valuation methods have a number of limitations including ambiguity on people's valuation and what the people are valuing; the methods are also hypothetical as people are not calibrated to value non-market goods and lack a definitive yardstick with which to compare these measures. These methods are also based on the concept of willingness to pay (WTP) and willingness to accept (WTA) and it is difficult to conduct such a study in Ethiopia because its religions and cultures do not allow assistance or help for in-patients, the disabled, elders and others in need of informal care to be calculated in monetary terms.

This study employed stratified random sampling by considering each ward as a stratum. Currently, the hospital has 12 wards including psychiatry and neonatal wards whereas stated preference valuation methods are based on the willingness to pay and the willingness to accept and it is difficult to ask such questions to get appropriate answers from in-patients in the psychiatry and neonatal wards.

## 3.4 Description of the Variables and the Model Specification

The opportunity cost valuation methods measure the value of informal care (informal care provided by the principal caregivers) by using the formula:

$$Value\ of\ informal\ care\left(VIC\right) = \beta_i W_i \tag{8.4}$$

where $\beta_i$ is the number of hours spent on informal caregiving by the principal caregiver i and $W_i$ is hourly wage for person i. If the principal caregiver is unemployed, a proxy for $W_i$ has been used. For example, for an informal caregiver who has been in a formal job or has been an employee this study uses the informal caregiver's former hourly wage rate as a proxy for hourly wage (Francis et al. 2011). However, for the informal caregiver with zero paid job experience, the study used the minimum Ethiopian government employee wage per hour (4.04 Birr per hour) as a proxy (Table 8.2).

According to a report of the statistics office at Jimma University Specialized Hospital, the 2016–17 GC an in-patient's average length of stay in the hospital was 7.1 days. As a result, this research calculates the value of informal care per week. See Fig. 8.1.

## 3.5 Specification of the Model

$$\begin{aligned} &LnVIC_i + \beta_0 + \beta_1 HHS_i + \beta_2 EXP_i + \beta_3 AGEP_i + \beta_4 AGER_i + \beta_5 NEC_i + \beta_6 PE_i \\ &+\beta_7 SE_i + \beta_8 TE_i + \beta_9 DF_i + \beta_{10} SEXCRM_i + \beta_{11} I_i + \beta_{12} P_i + \beta_{13} S_i + \beta_{14} C_i \\ &+\beta_{15} DMM_i + \beta_{16} HSS_i + \beta_{17} HSM_i + \beta_{18} HSSV_i + \beta_{19} DUR_i + \beta_{20} FFU_i + U_i \end{aligned} \tag{8.5}$$

## 3.6 Descriptive Statistics and an Econometrics Analysis

### 3.6.1 Descriptive Statistics

The study used 238 respondents for collecting primary data. The respondents had differing employment status, educational levels, gender, age and the areas to which they belonged. Of the total respondents, 122 (51.26 percent) were from rural areas while 116 (48.74 percent) were from urban areas of Jimma University Referral Hospital's catchment area (specifically, south-western Ethiopia).

In terms of employment status, 67 (28.15 percent) were unemployed and 50 (74.6 percent) of the total unemployed informal caregivers were female. This shows the presence of a high number of female unemployed principal informal caregivers. Based on this we can conclude that very little has been done in terms of women's employment. The remaining 171(71.85 percent) were employed principal informal

**Table 8.2** Description of the variables

| *Variable* | Description |
|---|---|
| LnVICi | The log of value of informal care of the principal informal caregiver i per week |
| HHS | Household size of the in-patient |
| EXP | Job experience of the principal caregiver |
| AGEP | Age of the principal caregiver |
| AGER | Age of informal care recipient |
| NEC | Number of external caregivers |
| DF | Dummy variable which stands for female principal caregivers |
| SEXCRM | Dummy variable which stands for male informal care recipients |
| DMM | Dummy variable which stands for married principal informal caregivers |
| DUR | Dummy variable which stands for principal caregivers from the urban area |
| FFU | Interaction term for female principal informal caregivers from urban areas |
| *Employment status (categorical variable) with the base group of unemployed respondents* | |
| PE | Permanently employed (PE) |
| SE | Self-employed (SE) |
| TE | Temporarily employed (TE) |
| *Educational level (categorical variable) with the base group of degree and above degree holders* | |
| I | Illiterate principal informal caregivers (I) |
| P | Primary education level (P) |
| S | Secondary education level (S) |
| C | Certificate/diploma holder (C) |
| *Health status of the in-patients (categorical variable) with the base group extreme health problem* | |
| HSS | Slight health problem (HSS) |
| HSM | Moderate health problem (HSM) |
| HSSV | Severe health problem (HSSV) |

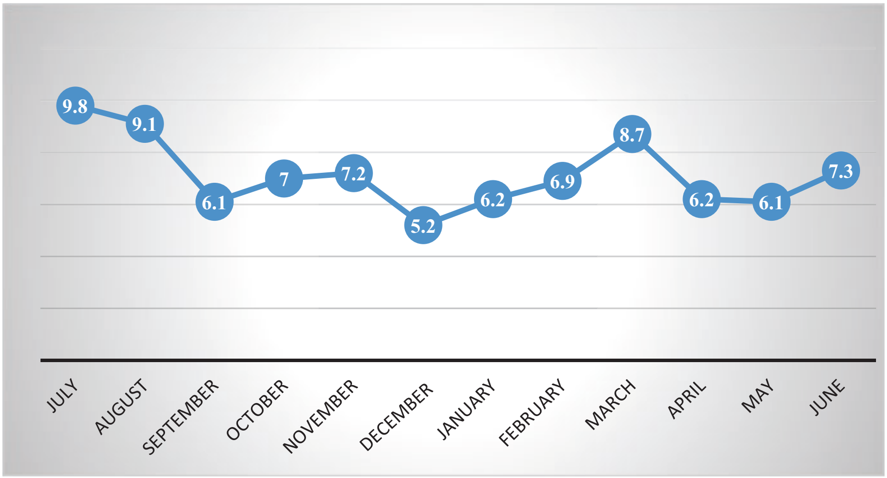


**Fig. 8.1** Average length of stay in days

caregivers with different employment status like being permanently employed, self-employed and temporarily employed.

The number of external caregivers per in-patient varied from zero to seven persons with a mean of 0.954 (we can consider this as one person). According to our observations, in-patients from rich families had more than one principal informal caregivers but on average in-patients from low-income families had one and only principal informal caregiver. The household size of the in-patients varied from two to 16 with a mean and standard deviation of 5.33 and 1.90 respectively and there was no correlation between the number of informal caregivers and household size.

In terms of educational background, 76 (31.93 percent) of the respondents were illiterate or they were not able to read and write. There were 79 (33.19 percent) respondents with primary school level education and 36 (15.13 percent) had studied till the secondary school level were. There were also respondents with certificate, diploma and degree level education. Regarding the gender composition of the principal informal caregivers, literature shows the dominance of women in informal caregiving. However, according to our study a majority of the respondents (146 or 61.34 percent) were male principal informal caregivers (92 or 38.66 percent female principal informal caregivers). However, these figures can change if research is done on home based informal caregiving.

The minimum age of informal care recipients was 0.008 years (3 days) and the maximum was 98 years with a mean and standard deviation of 25.29 and 20.75 respectively. On the other hand, the age of the principal informal caregivers varied from 17 to 75 years. Paid job experience also varied from zero to 40 years.

Since our study is on the cost of informal caregiving for in-patients, no respondent indicated ‘no health problem’ which is normal because the target group was formed of in-patients in the Jimma University Referral Hospital. Even though there were five categories in the health status variables in our study, we only had in-patients with slight health problems, moderate health problems, severe health problems and extreme health problems.

The paid work income of the principal informal caregivers varied as compared to the hours spent on informal caregiving. According to our results, the minimum monthly paid work income of the respondents was zero (unemployed) and the maximum was 15,000 Birr (permanently employed) with a mean and standard deviation of 1774.041 and 2121.819 Birr respectively. The hours spent on informal caregiving were relatively common for all types of the informal care recipients.

The value of informal care per week varied from Birr 70 (temporarily employed respondents) to Birr 3500 (permanently employed respondents) with a mean of 483.4586. See Table 8.3.

According to the principal informal caregivers’ self-reported data, 30 (12.60 percent) respondents were affected by pain associated with common cold, muscular aches and backaches and they considered this pain a result of hospital-acquired infections. This result shows higher vulnerability of principal informal caregivers to hospital acquired infections and it is related to hygiene in the hospital.

Like most Ethiopian hospitals, the Jimma University Referral Hospital does not pay much attention to informal caregivers. Of the total respondents, 88(36.97 per-

**Table 8.3** The average value of informal care by gender

| Unit/gender | Male | Female |
|---|---|---|
| VIC per week | 541.98 | 390.58 |

cent) were not satisfied with the treatment and services for informal caregivers in the hospital while the rest 150(63.03 percent) were satisfied by the services. However, in our focus group discussions we observed that most of the respondents accepted the burden as their fortune and they did not want to blame the hospital or any other responsible body.

# 4 Estimation Results

Before interpreting the regression results, we used different statistical tests like the normality test, the heteroscedasticity test, the multicollinearity test, the omitted variable test, the link test and significance tests like the t-test and F-test. According to the results of the OLS regression the variables ‘paid job experience’, ‘educational levels’ and ‘employment status’ (except for temporarily employed respondents) were positively related to the log of the value of informal care via the wage difference. The number of external caregivers was also positively related to the log value of informal caregiving. On the other hand, the age of informal care recipients and the interaction term (females from urban areas) was negatively related to the log of value of informal care. See Table 8.4.

# 5 Summary, Conclusion and Policy Recommendations

## *5.1 Summary and Conclusion*

Informal caregiving transcends national boundaries and it is provided by persons of all ages (usually unpaid) to someone who is chronically ill, disabled or has some other long lasting health or care needs. This caregiving is provided outside the professional or formal employment framework.

This study measured the value of informal care for in-patients to identify the direction of the relationship between the value of informal care and socioeconomic factors. It had 238 sample respondents from whom primary data was collected. The respondents varied in their employment status, educational levels, gender, age and the area from which they came. Of the total respondents, 122(51.26 percent) were from rural areas while 116(48.74 percent) were from urban areas of Jimma University Referral Hospital’s catchment area (specifically, south-western Ethiopia).

Sixty-seven (28.15 percent) of the respondents were unemployed while there were 50(74.6 percent) females which shows the high number of female unemployed principal informal caregivers. Based on this we can conclude that very little has

**Table 8.4** Estimated results

| | Coeff. | Std. err. |
|---|---|---|
| LnVIC | | |
| Household size | 0.013 | 0.015 |
| Job experience | 0.015** | 0.004 |
| Age of caregiver | 0.003 | 0.003 |
| Age of care recipient | −0.003** | 0.001 |
| No̲ of external caregivers | 0.053*** | 0.029 |
| Permanently employed<br>Self-employed<br>Temporarily employed | 0.299**<br>0.311*<br>−0.519** | 0.109<br>0.078<br>0.199 |
| D of female caregivers | 0.029 | 0.072 |
| D of male care recipients | −0.031 | 0.053 |
| Illiterate caregivers<br>Primary level<br>Secondary level<br>Certificate/diploma level | −1.04*<br>−0.865*<br>−0.692*<br>−0.544* | 0.183<br>0.170<br>0.162<br>0.135 |
| D of married caregivers | 0.080 | 0.071 |
| Slight health problem<br>Moderate health problem<br>Severe health problem | 0.075<br>−0.047<br>−0.030 | 0.099<br>0.097<br>0.112 |
| D of caregivers from urban | 0.303** | 0.114 |
| (female*urban) | −0.218*** | 0.119 |
| Constant(intercept) | 6.078* | 0.227 |

Note: *, **, *** indicate statistical significance at the 1, 5 and 10 percent levels respectively
D stands for dummy

been done in the country in terms of women's employment. The remaining 171(71.85 percent) informal caregivers were employed as principal informal caregivers with different employment status like permanently employed, self-employed and temporarily employed.

The number of external caregivers per one in-patient varied from zero to seven persons with a mean of 0.954 (we can consider this as one person). According to our research in-patients from rich families had more than one principal informal caregiver while on average in-patients from low-income families had one and only principal informal caregiver. The household size of the in-patients varied from two to 16 with a mean and standard deviation of 5.33 and 1.90 respectively and there was no correlation between the number of informal caregivers and household size.

In terms of educational background, 76(31.93 percent) of the informal caregivers were illiterate or they were unable to read and write. Seventy-nine (33.19 percent) respondents had primary school level education while 36 (15.13 percent) had secondary school level education. There were also respondents with certificates, diplomas and degrees. Regarding the gender composition of the principal informal caregivers' literature shows the dominance of women in informal caregiving but according to our survey most of the respondents (146 or 61.34 percent) were male principal informal caregivers while there were 92(38.66 percent) female principal informal caregivers.

The minimum age of informal care recipients was 0.008 years (3 days) and the maximum was 98 years with a mean and standard deviation of 25.29 and 20.75 respectively. On the other hand, the age of principal informal caregivers varied from 17 to 75 years. Their paid job experience varied from zero to 50 years.

The paid work income of the principal informal caregivers varied as compared to the hours spent on informal caregiving. According to the results, the minimum monthly paid work income of the respondents was zero (unemployed) and the maximum was 15,000 Birr (permanently employed) with a mean and standard deviation of 1774 and 2121 Birr respectively. The hours spent on informal caregiving were similar for all types of informal care recipients.

This study also touched upon hospital acquired infections. The principal informal caregivers were seen to be vulnerable to hospital acquired infections as 30(12.60 percent) respondents had been affected by hospital-acquired infections.

Like in most Ethiopian hospitals, the Jimma University Referral Hospital does not pay much attention to informal caregivers – 88(36.97 percent) of the respondents were not satisfied with the treatment and services for informal caregivers while the remaining 150(63.03 percent) were satisfied by the services for informal caregivers.

Generally speaking, informal caregiving has been happening in Ethiopia for a long time though it seems to be a new concept theoretically. There is no government policy which considers the burden of principal informal caregivers and the services which the hospitals provide to them do not keep their needs in mind. It can also be said that the environment for informal caregivers in Ethiopia is not good and the government and non-governmental organizations need to change this through appropriate policies and strategies targeted at principal informal caregivers. For example, the Ethiopian government has a five-year growth and transformation plan (GTP) which includes improving the health sector but it does not mention principal informal caregivers. This plan needs to specify the role of principal informal caregivers.

## *5.2 Policy Recommendations*

There are different types of caregivers and the diversified nature of informal caregiving needs the support of the community, the government and of non-governmental organizations. Based on the findings of this study and by considering the experience of developed countries the following policy recommendations are made:

### 5.2.1 Creating Awareness and Opting for Respite Care

Information needs to include understanding the diseases and what resources are available for principal informal caregivers. They also need to be trained in how to care for in-patients and how to prevent and deal with the challenging behaviors of the in-patients. In addition, principal informal caregivers need to be supported by providing them advice, counseling and respite support.

### 5.2.2 Policy Related to Workplace Accommodation

It is difficult to combine formal paid work and informal caregiving, especially for those providing high intensity care. Our study indicates the presence of low labor force participation, absenteeism, irregular attendance (coming late and having to leave work) and lack of concentration at work (Colombo et al. 2011). To reduce the pressures of these dual responsibilities for principal informal caregivers, the recommendations that this study makes are:

- Leave for caregivers: There are two types of leave arrangements for principal informal caregivers -- paid leave (short-term care leave) and unpaid leave (long-term care leave). In most European countries paid care leave is limited to less than one month or to a terminal illness.
- Flexible work arrangements: In addition to leave from work, a flexible working arrangement may help carers to remain in the labor force while taking care of their caregiving tasks. Flexible work schemes offer good solutions to balance care obligations and work by providing carers sufficient income and a social network through work.

### 5.2.3 Improving Accessibility in Hospitals

- To provide necessary services every hospital should be designed based on hospital science, the needs of hospital staff and the needs of in-patients and informal caregivers. Many principal informal caregivers in our study suffered from lack of a sufficient number of toilets, showers and hostels. This situation needs to be addressed.
- Of the total respondents, only 58(24.37 percent) were from Jimma town and the remaining 180(75.63 percent) came from other parts of south-western Ethiopia. Therefore, the Ethiopian ministry of health should work to improve the health services provided at the locality (kebele), district (wereda) and city levels.

### 5.2.4 Financial Assistance

Caregivers need financial assistance to be able to provide appropriate care and to continue their caregiving duties in the long term. The main aim of financial support should be reducing their income loss via income support payments. Financial support for principal informal caregivers can take different forms like:

- Caregiver's allowance: Payments to people from low-income groups who are looking for a person who needs support because of age, disability or illness (including mental illness). This will also recognize the informal caregivers and the work that they do.
- Cash-for-care benefits to in-patients: Cash-for-care benefits (also referred to as cash-for-care allowances) are more beneficial for those in-patients who do not have families. The amount given as benefit for the care recipient depends on her/his care needs and it should be investigated whether a formal contract can be established between the informal caregiver and the owner of the cash-for-care allowance.
- Unemployment benefits for caregivers: If the principal informal caregiver decides to stop working to provide informal care she/he needs to be compensated through unemployment benefits. However, unemployment benefits should be given under certain conditions if a person provides informal care either during the unemployment period or during unpaid leave.

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# Part III
# Dynamics and Determinants of Income and Efficiency Among Smallholders

# Chapter 9
# Poverty and Food Security Effects of Climate Variability on Smallholders: The Case of Western Hararghe Zone, Ethiopia

**Arega Shumetie and Molla Alemayehu**

## 1 Introduction

Agriculture is the key for development as it improves human civilization. Animal husbandry and plants also form a source of food and contribute to other required materials. Extreme meteorological events like spells of high temperatures, heavy storms, floods and droughts disrupt smallholders' crop production systems. Of late, a number of studies have been done on the possible changes in climatic conditions which conclude that some crop varieties are growing near their maximum temperature tolerance limits. Frequent droughts not only reduce water availability but also increase the amount of water released through evapo-transpiration (Bhuiyan et al. 2006). Climate change challenges current efforts to protect the lives and livelihoods of over 1 billion food insecure people in the world; it is expected to increase risks of hunger and malnutrition on an unprecedented scale in the coming decades. Malnutrition is the main reason for child mortality and morbidity in developing countries that kills about 3.5 million people every year (UNFCCC 2009). This implies that it will not be possible to ensure food security for the growing world population under changing climate conditions unless urgent action is taken.

Achieving food security with the on-going climate change requires a substantial increase in food production on the one hand and improving access to nutritious food and raising capacities to cope with risks on the other. Climate change reduces food availability as it negatively affects the basic elements of food production like water, biodiversity and soil. Moreover, in Ethiopian agriculture which is purely rain-fed the effects of climate change are more pronounced in the sense that here

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the amount and distribution of rain are the basic pre-requisites for crop production. The International Center for Trade and Sustainable Development (ICTSD) suggests that climate change can cause farm output in sub-Saharan Africa to decrease by 12 percent by 2080 although this figure could be as high as 60 percent for some African countries.

Climate change multiplies risks to food security and it has an amplified effect on the lives and livelihoods of the poorest and most vulnerable including women, children and marginalized groups because of their high exposure to natural hazards, direct dependence on climate-sensitive sources of livelihood like agriculture and limited capacity to adapt. Rural communities frequently face risks including recurrent crop failures, loss of livestock and reduced availability of forest products. At the same time, more extreme weather events have serious effects on livelihoods of both rural and urban dwellers. The growing push towards industrial agriculture and globalization with an emphasis on export crops and the rapid expansion of bio-fuels are increasingly reshaping the world's agriculture and food supply with potentially severe food shortages. Such a change together with climate change and variability can have large and far-reaching effects on food crop productivity and supply. Hazards like increased flooding, greater frequency and severity of droughts in semi-arid areas and excessive heat conditions have the power to limit agricultural productivity resulting in food insecurity.

In terms of food security, Ethiopia is one of the seven African countries that constitute half of the food insecure population in sub-Saharan Africa (Sisay 1995 cited in Shiferaw et al. 2003). The social groups that are most likely to be chronically poor in rural areas of Ethiopia are: the landless, female headed households, the elderly, the disabled, the chronically ill and pastoralists. Chronic poverty in the rural areas is concentrated in areas with high populations, drought prone areas and areas with lower average cropland holdings (Taylor and Amdissa 2007). Across the country, the per capita area of cultivated land fell from 0.5 ha in the 1960s to only 0.11 ha in 1999 (the World Bank 2004).

Over the past three decades, Ethiopia has been challenged by food insecurity (Shiferaw et al. 2003). Climate variability can affect all four dimensions of food security: availability, accessibility, stability and utilization. This can reduce food availability by affecting the basic elements (soil, water and biodiversity) of food production. Recent studies indicate that Ethiopia will face a productivity decline of 31 percent because of climate change and variability (Cline 2007). Rising temperatures and changing weather patterns will create a conducive environment for the emergence of new pests and diseases that affect animals and crops thus reducing yields drastically. This will have a direct effect on the quality and quantity of yields as well as availability and price of food and feed. At the same time, more extreme weather events have serious effects on livelihood assets in both rural and urban areas and threaten the stability of food supply. The existing inequalities in food security, food safety and nutrition are likely to be further worsened by the adverse effects of climate change and variability (UNFCCC 2009). Thus, this paper examines the main determinants of food security and absolute poverty of smallholders in West Hararghe zone. It also discusses the effects of climate variability on smallholders' food security and poverty.

Rest of this study is organized as follows. Chapter 2 presents the methodology. The data is described in Chap. 3. Chapter 4 presents the conclusions and recommendations.

## 2 Methodology

### *2.1 Sampling Method and Data Collection*

This research used both primary and secondary data. Secondary data included published and unpublished works by different institutions including governmental, non-governmental and others. It used a multi-stage sampling technique to select a representative sample from the population for the primary data. In the first stage, three districts that have severe moisture stress were selected purposively and in the second stage seven peasant associations (PAs) from these districts were selected randomly. Finally, sampled households were selected systematically from the sample PAs. It was believed that a larger sample size will make the sample more representative (Fig. 9.1).

Primary data was collected from smallholders using structured questionnaires that were distributed and collected by enumerators who know the culture and language in the research area. The study also used focus group discussions with the farming community to find common problems in the study area.

### *2.2 Data Analysis*

Some objectives require a descriptive analysis while others may require econometric or mathematical models that have the power to estimate variables' interaction and allow verifying or refuting the hypotheses that are drawn up (Cochran 1977).

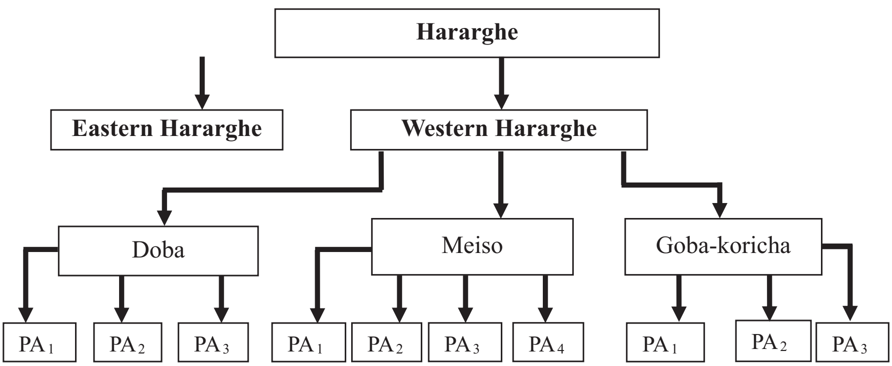


**Fig. 9.1** The sample frame. (Source: Authors' formulation (2014))

Hence, the method employed for analyzing the data is selected depending on the objectives and nature of the available data. This study considered the crop production sub-sector and allied activities in the production process to analyze the determinants of smallholders' food security and poverty.

### 2.2.1 Binary Logistic Regression

Primarily, measuring food security is based on an assessment of behaviors and situations that are associated with food insecurity and, therefore, require identifying suitable quantitative, qualitative, psychological and social parameters. This is difficult to do and involves a lot of subjectivity (Campbell 1991). Methodologies (approaches) that are used for measuring food insecurity/security levels are mainly based on one of the following three approaches: diet diversity and food frequency, coping strategies and food poverty (purchasing power). This research used the last approach which is consistent with the data collected on sample households' consumption and expenditure aspects.

Given a set of independent variables the logistic regression model can predict the probability of different possible outcomes of a categorically distributed dependent variable. The binary version of a logistic regression model best fits when the dependent variable has two categories that are mutually exclusive and cannot be ordered in any meaningful way. The logit model assumes that the data is case specific, that is, each independent variable is free to take any value for each case and the dependent variable cannot be perfectly predicted from independent variables for any case. To simplify the notations and represent the conditional mean of Y given X the logistic distribution will be:

$$P(X) = E(Y / X) \tag{9.1}$$

The binary logit model for identifying the determinants of food security and absolute poverty is:

$$P(X) = \frac{\exp(\alpha + \beta X)}{1 + \exp(\alpha + \beta X)} \tag{9.2}$$

The log of odds ratio can, therefore, take the form:

$$\log^{\left(\frac{P_i}{1-P_i}\right)} = \alpha + \beta X_i \tag{9.3}$$

log odds (P) = $\alpha + \beta$ for $X_i = 1$, log odds (P) = $\alpha$ for $X_i = 0$.

The marginal effect of $X_i$ on the dependent variable can be measured as:

$$\left(P_i\left(1 - P_i\right)\right)\beta_i \tag{9.4}$$

The unknown parameters $\beta_j$ are typically estimated by maximum a posteriori (MAP) estimation which is an extension of maximum likelihood.

### 2.2.2 Foster-Greer-Thorbecke (FGT) Indices

Poverty and the income distribution effects are measured in terms of a change in the Gini coefficient before and after a policy intervention. The formula for Gini coefficient is:

$$\text{Gini Coefficient} = \left(\frac{\mathbf{1}}{\mathbf{2}\,\boldsymbol{X}\,\boldsymbol{n}^{\mathbf{2}}}\right) \mathrm{X} \left(\sum_i w_i \, X \sum_j w_j \left| y_{i-} y_j \right|\right) \tag{9.5}$$

where n is the overall population; i and j are household indices; $w_i$ and $w_j$ are the number of individuals in household i and j respectively (note that $\Sigma_i w_i = n_1$ and $\Sigma_j w_j = n_2$); and $Y_i$ and $Y_j$ are income of household i and j respectively. On the other hand, the effect of an intervention on poverty can be measured using the change in the Foster-Greer-Thorbecke (FGT) indices before and after a policy intervention. Thus, the FGT poverty measure is:

$$p_\alpha = \frac{1}{n}\sum_{i=1}^{q}\left(\frac{\mathrm{z}-\mathrm{y_i}}{\mathrm{z}}\right)^{\alpha} \tag{9.6}$$

where n is population size, q is the number of people below the poverty line, $Y_i$ is income and z is the poverty threshold. Where Z, an agreed upon poverty line of $ 1.25 per day adjusted for purchasing power parity is one of the two most common used poverty lines by the World Bank. Poverty threshold is equal to the food plus non-food threshold, where this threshold refers to the cost of basic food and non-food requirements per day. The parameter α can have three values, each one indicating a measure of poverty. The headcount index of poverty $\alpha = 0$ is the common index of poverty which measures the proportion of the population (q/n) whose income (consumption) falls below the poverty threshold. The poverty gap index $\alpha = 1$ measures the depth of poverty in the sense that it indicates how far below average the poor are from the poverty threshold. The poverty severity index $\alpha = 2$ measures sensitivity to the distribution among the poor as more weight is given to the poorest below the poverty threshold. This is because the poverty severity index corresponds to the squared average distance of the poor people's income from the poverty line. The change in household income and the change in the nominal value of the poverty threshold after a policy experiment generates a new set of FGT indices. There has to be a comparison of the two FGTs (the base and the one after a policy intervention) to determine whether a policy change is poverty-improving or not.

# 3 Data Analysis and Discussion

## 3.1 Demographic Characteristics of the Sampled Households

The study area is one of the densely populated parts of Ethiopia where families have large sizes. A majority of the sampled households had large family sizes ranging from 4 to 8 persons per household, with an average family size of 6.03 people per household (Table 9.1). About 75 percent of the sampled smallholders had a family size between 5 and 8 members per household which indicates that most households had families above the national average. Households in Doba district had the largest family size as compared to the other two districts. This large family size in the district led to a relatively high dependency ratio.

Households in Goba-koricha had a relatively large number of dependent family members that may create difficulties in being food secure and having incomes more than the absolute poverty level. A larger sized family requires more for consumption and has a high probability of being food insecure compared to households having similar crop production levels. A majority (85.94 percent) of the sampled household heads had ages below 50 years which may have a higher economic effect especially in the crop production sub-sector that demands huge labor. Since crop production and animal husbandry need active labor, having younger household heads is a crucial input in expanding agricultural productivity.

Further, our results also show that 86 percent of the household heads were in an economically active age. About 82 percent of the households in Doba, 84 percent in Meiso and more than 90 percent in Goba-koricha had household heads aged below 50 years. In general, most of the sampled households had younger heads and were male headed which may be very useful in the efficient management of crop production. More than half (59.4 percent) of the sample household heads did not have formal education; they did not have even basic education. This may create difficulties in expanding new technologies since uneducated people are reluctant to use new production systems and technologies. About one-fifth (16.8 percent) of the household heads had attended the second cycle and high school level education (Table 9.2).

**Table 9.1** Family size and dependency ratio of sample households

| Family size | % | District | Family size | Dependency ratio |
|---|---|---|---|---|
| ≤2 | 1.5 | Doba | 6.5 | 1.72 |
| 2–4 | 20 | Meiso | 5.9 | 1.65 |
| 4–6 | 34.4 | Goba-koricha | 5.9 | 1.72 |
| 6–8 | 40.4 | Average | 6.03 | 1.69 |
| 8–10 | 3.4 | | | |

Source: Authors' calculations (2014)

**Table 9.2** Education level and sex of household heads

| Education level | Percent | Sex | Percent |
|---|---|---|---|
| No education | 59.4 | Male | 96.9 |
| 1st cycle | 23.7 | Female | 3.1 |
| 2nd cycle | 15.6 | Total | 100.0 |
| High school | 1.2 | | |

Source: Authors' calculations (2014)

## 3.2 *Absolute Poverty Levels in the Study Area*

The incidence of poverty (number of poor) is determined using a poverty line that is a threshold level of per capita income or consumption below which an individual is considered to be poor. Establishing the poverty line starts with defining and selecting a 'basket' of food items typically consumed by the poor. The quantity in the basket is determined in such a way that the given food basket meets a pre-determined level of minimum calorie intake. This basket is valued in a nationally representative average price level to reach a consistent poverty line across regions and groups. Once this is done, an allowance is made for the non-food component which is consistent with the household's spending patterns. This method yields a representative poverty line since it provides a monetary value to the poverty line that accounts for the food and non-food components. This method of determining the food poverty line uses a basket of food that provides 2200 kilocalories per adult equivalent per day (MOFED 2002 cited in Tefera 2009). In Ethiopia poverty is pervasive, deep-rooted, multi-faceted and trapped by a similar range of structural constraints. The chronically starved people lack capabilities and assets to meet their daily needs and thus escape from poverty. They lack financial, human, physical, social and natural assets using which they can build sustainable livelihoods (Taylor and Amdissa 2007).

Though the use of multiple poverty lines can help in distinguishing different levels of poverty, but there are two main ways of setting poverty lines – relative or absolute poverty lines. Relative poverty lines are defined in relation to the overall income or consumption distribution in a country, for example, the poverty line may be set at 50 percent of the country's mean income or consumption. On the other hand, absolute poverty lines are anchored in some absolute standard of what households should be able to count to meet their basic needs. On some occasions, household consumption requirements, that is, the kilocalorie intake per day can also be used (Bogale et al. 2002). For monetary measures, the absolute poverty lines are often based on estimates of basic food costs (that is, the cost of the basket of food considered the minimal level for the healthy survival of a typical family), to which a contingent is added for non-food needs. In developing countries where large shares of the population survive on the bare minimum or less, it is often more relevant to rely on absolute rather than relative poverty lines.

**Table 9.3** Sales from the two sectors

| District | Crop | Livestock | Head count index | Poverty deficit (FGT(α = 1)) | Poverty severity FGT(α = 2) |
|---|---|---|---|---|---|
| Doba | 643.36 | 5043.00 | 0.918 | 0.634 | 0.494 |
| Meiso | 4124.33 | 7935.44 | 0.687 | 0.395 | 0.272 |
| Goba-koricha | 1060.00 | 6089.36 | 0.848 | 0.579 | 0.449 |
| Overall | 2263.76 | 6663.00 | 0.7940 | 0.512 | 0.383 |

Source: Authors' calculations (2014)

This study considered purchasing power of the local currency and living conditions of society in the study area to determine the absolute poverty level. For an understanding and acceptance of a poverty line, it is important to ensure that the poverty line chosen reflects the social norms (with a common understanding of what represents a minimum amount). In some countries, it might make sense to use minimum wages or the value of some existing benefits which is widely known and recognized as representing a minimum level. Using qualitative data can also be useful in deciding what merchandise needs to be included in the basket of basic needs in constructing the absolute poverty line.

Based on the absolute poverty line measurement that was calculated through annual household incomes, 79.4 percent of the sampled households were under the absolute poverty line, which means their daily income budgeted for meeting their basic needs for daily subsistence was lower than one dollar. This percentage is the share of the poor in the sample households in the area in which can be calculated when $\alpha = 0$ using the poverty formulation of FGT model. Given this, the remaining 20.6 percent of the sampled households were above the poverty line though they were not very far from the threshold level (Table 9.3).

After identifying the percentage of households under the absolute poverty line the study considered the gap or poverty deficit by using $\alpha = 1$ in the model mentioned earlier. Households in Doba district were very far from the absolute poverty line followed by households in Goba-koricha based on the value gained under FGT($\alpha = 1$). This measure captures the mean aggregate income shortfall relative to the poverty line across the whole population. In other words, it estimates the total resources needed to bring all the poor to the poverty line. Note also that, poverty gap can be used as a measure of the minimum amount of resources necessary to eradicate poverty, that is, the amount budgeted to escape out of poverty (Coudouel et al. 2002). It is an amount that ought to be budgeted for each poor person targeting the amount he/she needs to be out of poverty. Thus, based on Table 9.3, there should be a 63.34 percent increase in incomes for households in Doba to bring the whole population out of absolute poverty. The value of FGT at $\alpha = 2$ measures poverty severity or the households' squared poverty gap in the study area. This takes into account not only the distance that separates the poor from the poverty line (poverty gap), but also the inequalities among the poor. A higher weight is placed on households further away from the poverty line and the higher values at $\alpha = 2$ for Doba's household shows that inequalities are higher here than in the other districts.

We expected households in Doba to perform better in their poverty levels because the weather conditions in this district are relatively better for crop production. However, the district is densely populated wherein each household has a relatively large size that ought to result in poverty when there is sharing of the already insufficient income among more people. On the other hand, households in Meiso and Goba-koricha districts had relatively large livestock that meant a lower probability of being poor. The model that we used was based on households' annual income sourced from both livestock and crop production. Households in Meiso and Goba-koricha are bordered by pastoralists that have a positive external effect in holding larger livestock resulting in lower poverty levels. Households in Meiso had 9 TLU on average which resulted in changing the initial expectation of this research. Poverty deficit reflects total deficit of all the poor households relative to the poverty line (Ravallion and Bidani 1994). It is, therefore, a much more powerful measure than the head count ratio because it takes into account the distribution of the poor below the poverty line and it also reflects the per capita cost of eliminating poverty (Bogale et al. 2002).

The conversion showed that more resources were needed to reduce poverty in Doba than in the other two districts. Since livestock and land holdings in this district are very small, it needs more resources; there is also a need to look for other methods of eradicating poverty. An overall poverty depth of 0.512 implies that if the country could mobilize resources equal to 51.2 percent of the poverty line for every individual and distribute it to the poor as per the amount needed each individual could be above the poverty line; then poverty can be eliminated at least in theory.

## 3.3 Determinants of Food Security and Absolute Poverty

Basically, food security is an integration of three issues (accessibility, availability and utilization of food). Finding an efficient measurement level for food security has been a big conceptual challenge for academicians and development practitioners. Some researchers have adopted household level consumption survey data in which detailed information about food consumption expenditure forms the backbone of poverty measurement in most countries. Thus, collecting this type of data is essential, irrespective of the difficulties and costs that need to be incurred. Ensuring that food quantities are collected alongside expenditure information makes its applicability possible. It can then also be for food security analyses of households. Countries currently measure food security with varying degrees of success using different surveys like household budget surveys (HBS) and income and expenditure surveys (IES), 24-hour nutrition surveys (24HNS) and other methods depending on the characteristics of the studied households and/or the objective of the research. Recording periods may vary from country to country but 7 or 14 days are the most common (Carletto et al. 2013).

Based on the kilocalorie intake method of determining a household's food security, 52 percent of the sampled households were food secure and 48 percent were

**Table 9.4** Proportion of food insecure households in the three districts

| No | Name of the district | Food insecurity (in %) |
|---|---|---|
| 1 | Doba | 80.33 |
| 2 | Meiso | 18.66 |
| 3 | Goba-koricha | 64.00 |
| 4 | Overall | 48.13 |

Source: Authors' calculations (2014)

food insecure (Table 9.4). These percentages are similar to the food security status based on household heads' perceptions and the number of households who were food aid dependent. In the sample, 52.8 percent households were food aid dependent. Climate is a particularly important driver of the food system's performance at the farm end of the food chain affecting the quantity and type of food produced and the adequacy of production-related incomes (FAO 2008). FAO argues that extreme weather events can damage or destroy transport and infrastructure and affect other non-agricultural elements of the food system.

Both West and East Hararghe zones are prone to chronic food insecurity owing to variations in maize and sorghum yields that are the dominant cereals in the area. Our study also identified the main determinants of households' food security. It considered rainfall variability which is one dimension of climate variability by approximating it with the previous year's rainfall in the study area. This dimension of climate variability was a dummy variable based on the rainfall in the previous year's cropping season. The logic behind incorporating last year's rainfall in the area as a dummy variable is because of the direct interaction of this year's rainfall with consumption in the next year. Since the crops consumed this year are those produced based on the previous year's rain, it is logical to consider a one-year lag in rainfall in the regression.

Table 9.5 shows that all the independent variables have the expected sign in affecting households' food security. The results also show that it is more probable that households with younger heads would be food secure because younger people have higher physical capabilities to produce the demanded food. Family size affected food security negatively and significantly which implies that a large family means sharing what the household has with many people. Additionally, the climate variability dimension of moisture shortage in the previous production year also affected food security negatively and significantly. The overall effect of climate variability may be reducing agricultural production and employment opportunities for the labor that will expose individuals to hunger, food insecurity, poverty and malnutrition (Kumar and Sharma 2013). Based on information from sample households there was an average loss of 8.06 quintal of crops wherein the maximum loss was 20 quintals per household. Additionally, TLU, cropland and farming experience affected households' food security positively and significantly.

Information from the focus group discussions showed that there were different governmental and non-governmental organizations providing technical support (material and financial aid) to improve households' capacity to be food secure

**Table 9.5** Determinants of household food security and absolute poverty

| | Food security | | Absolute poverty level | |
|---|---|---|---|---|
| Variables | Coefficient | R.Sta. error | Coefficient | R.Sta. error |
| Family size | −0.644*** | 0.105 | 0.691*** | 0.113 |
| Education | 0.032 | 0.057 | −0.068 | 0.063 |
| Age head | 0.128* | 0.078 | −0.075 | 0.089 |
| Age head$^2$ | −0.002** | 0.001 | 0.002 | 0.001 |
| TLU | 0.144** | 0.062 | −0.079** | 0.032 |
| Cropland | 0.929** | 0.416 | −0.572*** | 0.215 |
| Farming experience | 0.054** | 0.025 | −0.059** | 0.024 |
| Moisture stress | −0.893* | 0.413 | 2.084*** | 0.586 |
| Market access | 0.007 | 0.019 | −0.034 | 0.052 |
| Constant | −0.184 | 1.609 | −1.295 | 1.873 |

Note: ***, **, and * indicate that estimates are significant at the 1, 5 and 10% significance level respectively

though their participation was not sufficient to achieve the required food security levels. These organizations come to the area and provide their services after the problem of food shortages emerges and they provide aid to fulfil the subsistence level until the next harvesting season.

Households with better livestock and cropland had a lesser probability of being in the absolute poverty level (Table 9.5). Studies have reported that the causes of food insecurity and poverty include demographic trends, recurrent droughts, widespread land degradation, shrinking and fragmentation of land holdings, inappropriate policies, poor infrastructure and inefficient agricultural practices. Wolday (1995) also argues that food insecurity and poverty in Ethiopia can also be attributed to agriculture's poor performance, which in turn is attributed to both policy and non-policy factors. Table 9.5 indicates that households with large family sizes had a greater probability of being in absolute poverty. To put it differently, there is a kind of positive association between a household's size and its poverty level. Moisture stress, which is a proxy for climate variability dimensions, is identified as the main determinant of poverty implying that households with frequent moisture stress have a higher probability of being in absolute poverty and vice-versa. Significant variations in rainfall patterns like droughts or flooding can damage households' assets and agricultural produce resulting in an increase in poverty that is a serious threat in agriculturally intensive countries (Kumar and Sharma 2013).

Our study examined the marginal effects of each independent variable on food security and absolute poverty keeping all covariates as fixed at their respective average values. Table 9.6 shows that family size had the largest negative marginal effect on pushing a household towards being food insecure. Contrary to this, land allocated for crop production had a big positive marginal effect in enhancing households' food security levels in the study area. An additional hectare of land allocated for crop production increased the probability of a household being food secure by 23 percent. This is because households in the area consume what they produce.

**Table 9.6** Marginal effects of significant variables

| | Food security | | | Absolut poverty | | | Average |
|---|---|---|---|---|---|---|---|
| Variables | dy/dx | Z | P-value | dy/dx | z | P-value | X |
| Total family | −0.1592 | −6.28 | 0.000*** | 0.0784 | 6.04 | 0.000*** | 6.03 |
| Agehhh$^2$ | −0.0005 | −2.10 | 0.035** | 0.0002 | 1.35 | 0.177 | 1615.76 |
| TLU | 0.0355 | 3.21 | 0.001*** | −0.009 | −3.09 | 0.002*** | 6.23 |
| Cropland | 0.2296 | 3.86 | 0.000*** | −0.0650 | −2.78 | 0.005*** | 1.48 |
| Farming experience | 0.0133 | 2.32 | 0.020** | −0.0067 | −2.13 | 0.033** | 22.76 |

Note: ***, **and *indicate that the estimates are significant at the 1, 5 and 10% probability levels respectively

Family size had a significant and positive effect on a household's poverty level, implying that keeping all other variables fixed at their average values, an increase in family size by one member increased the probability of the household being in absolute poverty by 7.8 percent. The probability of a household being in absolute poverty increased significantly if there was a subsequent increase in the family size. Our results also show that the consumption aspects of a family's size are greater than the production aspects and that is why this variable has a positive coefficient in affecting the probability of a household being in absolute poverty. Since households in the study area practice agriculture on small plots of cropland, each additional labor makes a negative contribution to the productivity of the sector. An increase in cropland and TLU increases the probability of a household being food secure and free from absolute poverty. Increasing the cropland by one hectare increases the probability of a household being food secure and getting out of absolute poverty by 23 and 8 percent respectively (Table 9.6).

## 4 Conclusion and Recommendations

This study examined the main determinants of smallholders' food security and absolute poverty levels in the drought prone districts (Meiso, Doba and Goba-koricha) of West Hararghe zone, Eastern Ethiopia. The data analysis showed that a significant proportion of sampled households (48.13 percent) were food insecure and about 79 percent of the sampled households were under the absolute poverty line. Both food security and absolute poverty conditions indicate that rural households in the study area were in a critical condition.

Most of the sampled households were far from the absolute poverty level implying that huge capital investments and integrated efforts by stakeholders are required to reduce the chronic poverty in the area to lift smallholders out from chronic poverty.

The results also show that one of the dimensions of climate variability (previous year's moisture stress) significantly affected households' food security and poverty levels. This implies that there should be proactive policies and interventions to help deal with weather conditions in the crop production season.

Cropland and TLU are core elements in crop production and for generating incomes. Thus, a parallel increase in these may improve smallholders' food security and poverty levels. This holds true for the entire western Hararghe region since smallholders in the study area practiced mixed farming on small and fragile plots of land.

The findings of the study also show that the consumption effect of family size outweighed its production effect and contributed positively to increasing the probability of smallholders being food insecure and in absolute poverty. Thus, the cumulative effect of having a large family and frequent moisture stress on agriculture practiced on infertile and fragmented plots of land worsened farm households' problems in the study area. Addressing this situation requires appropriate interventions by stakeholders to reduce the synergic effects of large family size and moisture stress.

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# Chapter 10
# Analysis of Factors Affecting Persistent and Transient Inefficiency of Ethiopia's Smallholder Cereal Farming

**Oumer Berisso**

## 1 Introduction

Agriculture plays an important role in overall economic growth in Ethiopia (WB 2010), and it has significant spillover effects on the other sectors of the economy as well. Ethiopia's agriculture is largely characterized by rainfall dependence and is dominated by smallholder production mainly for subsistence. Agriculture accounts for 38.5 percent of the country's gross domestic product, up to 81 percent of total export earnings and provides livelihood to more than 83 percent of the population (AfDB 2016). Despite frequent droughts and traditional farming practices in the country, Ethiopia has huge agricultural potential due to its ample arable land, an abundant workforce and diverse AEZs (Beyan et al. 2013). However, despite the widely believed view of the central role of agriculture in economic transformation, the sector has not performed as per expectations. The sector is characterized by inefficiencies and low productivity in which cereals have shown a steady low-growth rate in the last two decades. Hence, being an agriculture dependent country with limited capacity for developing and adopting new technologies, increasing production and enhancing farming efficiencies with the existing technologies is not a matter of choice but is instead a must for Ethiopia.

In his classic hypothesis, Schultz (1964) argued that traditional farmers in developing economies are 'poor but efficient'. He argued that given a long enough period of time to learn their production processes they will identify their respective optimal input and output bundles. This famous hypothesis has made researchers and policymakers believe that increase in production and hence efficiency cannot be realized

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with the given resources and technologies and the focus should be on investing in new technologies to shift the frontier upward. Yet, countless empirical studies have refuted Schultz's claim, finding the existence of widespread inefficiencies among smallholder farmers and recommending ways in which these farmers can reallocate their resources for redressing their technical inefficiency levels. Recent research in the area reveals that inefficiencies in production can arise because of different reasons – time-invariant production heterogeneities (such as land quality) and the varying effects of climatic factors – and these cannot be eliminated by the farms themselves. However, primarily due to data limitations only a few studies have controlled for these time-invariant effects which potentially affect production.

Moreover, recent efficiency studies also question the accuracy of results of the classic models due to the sensitivity of efficiency results to the way they are modeled and interpreted mainly when panel data is used (Kumbhakar et al. 2014). When panel data is available productive efficiency can be seen composed of persistent and transient components which are not captured distinctively by the earlier models. Thus, long term factors exist which cannot be altered by the farmers and should not be ruled out from the efficiency term. Recent efficiency studies, therefore, recommend advanced efficiency modeling that allows distinguishing between long-term fixed factors (heterogeneity) and equally long-term, but alterable persistent inefficiencies, while accounting for the other inefficiency components. While the distinction of two long term factors allows more accurate estimations, the additional separation of the two inefficiency components permits a more elaborate evaluation of policy implications because both components convey different types of information. When thinking of appropriate policy recommendations for the sector, it is therefore essential to distinguish between the influence-able short and long-term efficiencies, while controlling for exogenous factors. However, efficiency scores obtained from efficiency estimating models alone have little use for policy implications and management purposes if the empirical studies do not investigate the sources of the inefficiency.

Several studies have analyzed efficiency of crop production in Ethiopia; however, only a few focus on linking productive efficiency with climate/weather effects or to its variations. Most previous studies have paid relatively little attention to assessing the influence of agro-eco-climatic factors and adaptation strategies on farm efficiency in the country. More importantly most studies in the area ignore farm-heterogeneity and fail to capture the distinctively transient and persistent efficiency components. Therefore, a comprehensive analysis with the newly developed efficiency model's specifications including sources of inefficiency differentials is overdue.

This paper aims to bridge this gap in literature by considering a 4-component panel data stochastic frontier model to estimate and explain persistent, transient and overall technical inefficiencies while controlling for time-invariant farm-heterogeneities in Ethiopia's smallholder cereal farms using a household-level panel dataset for 1999–2015. It pays particular attention to incorporating farmer-specific characteristics, climate change adaptation strategies and weather and agro-ecological factors in explaining the effects of productive inefficiencies.

The study contributes to efficiency literature as it is the first to use a 4-error component panel data SF model and extends the model to accommodate factors that can explain inefficiency components in Ethiopia's crop farming. It thus helps in identifying if inefficiencies have been persistent overtime or they are time varying in the country's cereal farming by distinguishing farm heterogeneity effects from inefficiencies. In particular, the essay estimates the production frontier with and without the weather variables' specifications to examine the effects of omitting weather factors in model specifications on technical efficiency estimates and correlates of technical inefficiency effects. Moreover, it also considers technical inefficiencies from both specifications (with and without weather factors) and campers the results using different regression techniques. Hence, contributes to a modeling approach in which the inclusion of climate variables improves the precision with which one can estimate and explain technical inefficiencies. The study is also unique in the methods that it uses to explain persistent, transient and overall technical efficiencies. It uses a mixed efficiency analysis approach in two steps. In addition to the usual farmer-specific characteristics in similar studies on Ethiopia this study incorporates climate change adaptation strategies and weather and agro-ecological factors as factors that explain inefficiency. Thus, it contributes to identifying a number of key policy-relevant technology shifters by examining their effects on inefficiency components from which it draws policy implications.

The remainder of the study is organized as follows. Section 2 provides a short overview of recent empirical literature on panel data SF models. It also lists the methods and dataset used in the analysis. Section 3 provides estimation results and discusses the empirical findings. The last section gives concluding remarks and policy implications.

## 2 Methodology and Data

### *2.1 Review of Stochastic Frontier Production Models*

Following the pioneering work of Farrell (1957) various modifications and improvements have been made to the measurement of production efficiency. Among others, Aigner et al. (1977) translated Farrell's frontier into a production function and suggested the SF approach. This approach deals with stochastic noise and permits statistical tests of the hypothesis pertaining to the production structure and the degree of inefficiency. As a result, SFA has been considered a standard approach for evaluating efficiency in a variety of research areas. While the initial studies were limited to cross-sectional data, the utilization of panel datasets soon became customary. The use of panel data considerably enriched the econometric analyses of SPF models and has several advantages over cross-sectional data. According to Schmidt and Sickles (1984) and Heshmati et al. (1995) panel data offers a more efficient estimation of the SPF model and provides consistent estimators of farm inefficiencies. Panel data also permits the simultaneous identification of stable long-term (persistent) and short-term (transient) inefficiency components.

The first panel data versions of the standard 1990s SPF models can be written as:

$$y_{it} = x_{it}\beta + \varepsilon_{it} - \tau_{it} \quad = x_{it}\beta + \phi_{it} \tag{10.1}$$

where, $i = 1, \ldots, n$ denotes observations and $t = 1, \ldots, T$ denotes time period. In a SPF model, the outcome variable $y_{it}$ is the logarithm of output, $x_{it}$ is the row vector of constant logarithms of the input variables and possibly other observed covariates that include environmental variables that are not primary inputs but nonetheless affect output. $\beta$ is a vector of unknown parameters to be estimated; $\varphi_{it}$ is the error term composed of two independent elements such that: $\phi_{it} = \varepsilon_{it} - \tau_{it}$. The idiosyncratic component $\varepsilon_{it}$ is the noise term, assumed to be *i.i.d.* normal with zero mean; and variance $\sigma_{\varepsilon}^{2}$, captures random variation in output resulting from factors outside the control of the farm as well as measurement errors and left-out explanatory variables. Similarly, the one-sided component $\tau_{it} \geq 0$ reflects time-varying inefficiency relative to the SF of the $i^{th}$ firm in year t, assumed to be identically independently distributed *(i.i.d.)* as half normal, that is:

$$\tau_{it} = \left|\mathrm{T}_{it}\right|, \textit{ where } \mathrm{T}_{it} \sim i.i.d.\ N^{+}\left(0, \sigma_{\mathrm{T}}^{2}\right).$$

A number of SPF models in panel data have been developed successively giving rise to alternative measures of technical inefficiency. Kumbhakar and Heshmati (1995) interpreted $\tau_{it} \geq 0$ as time-varying technical inefficiency and added an extra component $\eta_i \geq 0$ to represent persistent inefficiency. The persistent component is consistent with the models used in the 1980s (Schmidt and Sickles 1984), whereas the time-varying component is consistent with the models developed in the 1990s (Battese and Coelli 1992). More recently Colombi et al. (2014) and Kumbhakar et al. (2014) presented the first panel data SPF model including both arguments. They introduced a model that accounts for heterogeneity and persistent inefficiency by splitting the error term into four components – persistent and transient inefficiency, random farm-effects and noise.

The separation of persistent inefficiency from transient inefficiency is important because they have different policy implications. Transient inefficiency is interpreted as short-run technical inefficiency associated with changes in managerial skills or disruptions resulting from the adoption of new technologies that can be changed in the short-run. By contrast, persistent inefficiency can be seen as long-run technical inefficiency due to structural or institutional factors which evolve slowly overtime.

In efficiency analyses, efficiency scores obtained from efficiency estimating models have little use for policy implications and management purposes unless the empirical work includes an analysis of the sources of inefficiency. Given that in reality farm efficiencies (both persistent and transient) systematically differ across farms and over time, a model that can produce not only the magnitude of these inefficiencies but can also explain their systematic difference in terms of some covariates is needed (Lai and Kumbhakar 2016). Moreover, if the inefficiency component is purely random, farmers do not know how to improve their efficiency irrespective of whether the public provides incentives or not.

**Models for Assessing Inefficiency Effects**

Most of inefficiency effects models in existing literature are subject to controversies. In this regard, despite the fact that the approaches vary to some extent as per the methodologies that they employ, the most commonly followed procedure is what is usually referred to as a one-stage approach or the two-stage approach. Some authors like Parikh and Shah (1994) estimated SPFs to predict firm/farm level (in) efficiency indices and then regressed these predicted efficiencies on firm/farm specific variables to explain variations in inefficiencies between firms in an industry. To overcome inconsistencies in assumptions regarding the independence of inefficiency effects in this two-stage estimation procedure, Kumbhakar et al. (1991), and Huang and Liu (1994) proposed a single-stage SF in which the inefficiency effects are expressed as an explicit function of the vector of firm/farm specific variables and a random error. Battese and Coelli (1995) generalized Huang and Liu's (1994) model to allow for panel data, extending the earlier approaches and suggested that technical inefficiency effects, $u_{it}$, could be replaced by a function of explanatory variables that are supposed to explain inefficiency directly incorporated into the MLE under the one-stage approach SFA models.

This essay uses the mixed efficiency analysis approaches. Firstly, it uses a one-stage SFA approach by extending the 4-error component model to accommodate factors that can explain persistent and transient inefficiencies. Under this approach we estimated the persistent technical efficiency (PTE) and the transient technical efficiency (TTE) scores, and simultaneously used the respective inefficiency effects model and computed the marginal effects of the determinants of each type of inefficiency. Meanwhile, we used a two-stage approach to explain the overall technical efficiency (OTE) differentials. Here the OTE scores are estimated as a product of PTE and TTE from the first stage efficiency estimates and successively regressed on the covariates at the second-stage using panel data models. The two-stage approach in SFA has been criticized by several authors due to its inconsistency in the assumption of inefficiency parameters' distribution.

However, as underlined by Reinhard et al. (2002), a two-stage procedure can consistently be used as long as the efficiency scores are calculated from a particular kind of fractional or proportional data generating process (DGP) from the first-stage parameter estimates instead of being estimated econometrically at the first stage. Hence, by applying the two-stage approach at the first-stage we obtained the persistent, PTE and TTE scores econometrically. Then we generated the OTE scores as a product of PTE and TTE scores and used them as a dependent variable in the second-stage regression.

Regarding second-stage regression techniques, a researcher can choose to use the desired regression techniques as discussed by Hoff (2007) and Banker and Natarajan (2008), particularly when the efficiency scores are not generated by a censoring process but are fractional data. For instance, following Reinhard et al.'s

(2002) procedure, Madau (2011) used a MLE technique to estimate inefficiency effects parameters in his second-stage regression.

Consequently, in line with Lai and Kumbhakar (2016) this essay uses the 4-error component SPF models to estimate and explain persistent and transient inefficiency components and employs Reinhard et al. (2002) recommendations to explain overall technical inefficiency. Such a model not only provides estimates of persistent and transient inefficiency but also generates marginal effects of the determinants of inefficiencies. The marginal effects give estimates of inefficiency changes due to changes in the corresponding factors (which are often policy variables). Such a comprehensive analysis (separation of inefficiency components and identification of their determinants) is important for providing evidence to the government whose objective is to ensure that the farmers operate as efficiently as possible.

## 2.2 Model Specifications and the Estimation Procedure

Kumbhakar et al. (2014) among others decomposed the error term in Eq. 10.1 into $\tau_{it} = \eta_i + u_{it}$ *and* $\varepsilon_{it} = \mu_i + \upsilon_{it}$ to obtain a 4-error component SPF model:

$$y_{it} = x_{it}\beta + \phi_{it} = f\left(x_{it};\beta\right) + \mu_i + \nu_{it} - \eta_i - u_{it} \tag{10.2}$$

where, $\mu_i$ is random farm-effects which captures farms' heterogeneity (Greene 2005a, b); $\eta_i \geq 0$ is long-run (persistent) inefficiency; $u_{it} \geq 0$ captures time-varying inefficiency; and $v_{it}$ is the random noise term. They also derived a closed form expression of the likelihood function of the composed error term '$\phi_{it}$' based on the assumption that each component is distributed independently and identically, and that the components are also independent of each other. More specifically, they assumed $\mu_i$~i. i. i. $N(0, \sigma^{\mu}{}_2)$ , $v_{it}$~$N(0, \sigma_v{}^2)$, while the non-negative components are both assumed to be half-normal, truncated at zero from below, that is, $\eta_i$~$N^+(0, \sigma_\eta{}^2)$ and $u_{it}$~i. i. d. $N^+(0, \sigma_u{}^2)$.

This model is an extension of the true fixed-effects (TFE) or true random-effects (TFE) models proposed by Greene (2005a, b) respectively. This model can be estimated assuming that either the inefficiency component ($u_{it}$) is a fixed parameter that directly influences the dependent variable (the fixed-effects model) or assuming that the inefficiency component ($u_{it}$) is a random variable that has a correlation with the independent variables (the random-effects model).The model is known as the 'Generalized TFE', labeled as the GTFE model in case one considers a FE model or 'Generalized TRE', labeled the GTRE model for a RE model in several recent studies.

There are several ways to introduce the determinants of inefficiency in a SPF model. Perhaps the simplest way is to make the variance parameters of inefficiency terms ($\eta_i$ and $u_{it}$) functions of the determinants respectively. Accordingly, for persistent and transient inefficiency effects introducing the neutral SF model, we assume $\eta_i \sim N^+(0, \sigma_\eta^2(z_i))$ and $u_{it} \sim N^+(0, \sigma_u^2(z_{it}))$, that is, the technical inefficiency parameter is related to a vector of farmer-specific variables subject to statistical errors. To ensure that $\sigma_\eta(z_i)$ and $\sigma_u(z_{it})$ are positive, we re-parameterized $\sigma_\eta(z_i) = \exp(\lambda^T z_i)$ and $\sigma_u(z_{it}) = \exp(\delta^T z_{it})$ where the $z_i$ and $z_{it}$ variables are determinants of persistent and transient inefficiency respectively.

**Multi-step Estimation Procedure**
To estimate the parameters of SPF and the efficiency scores from a model in Eq. 10.2, we used a fixed-effects model which allows addressing the influences of omitted variables and provides consistent estimators. We employed a multi-stage ML estimation method (Kumbhakar et al. 2015). To implement this multi-step procedure the model in Eq. 10.2 is rewritten as:

$$y_{it} = \alpha_0^* + f\left(x_{it}, w_{it}; \beta\right) + \alpha_i + \omega_{it} \tag{10.3}$$

where, $\alpha_0^* = \alpha_0 - E\left(\eta_i\right) - E\left(u_{it}\right);\ and\ \alpha_i = \mu_i - \eta_i - E\left(\eta_i\right);\ and\ \varepsilon_{it} = v_{it} - u_{it} + E\left(u_{it}\right)$

With this specification $\alpha_i$ *and* $\omega_{it}$ have zero mean and constant variance. This model can be estimated in three steps: In step 1 the standard fixed-effects panel regression is used to estimate the coefficients $\beta$ as well as the predicted values of $\alpha_i$ and $\varepsilon_{it}$.

In step 2, the prediction of $\varepsilon_{it}$ is exploited to estimate transient (in) efficiency using the standard SF technique and the corresponding inefficiency effects parameters simultaneously. This procedure predicts the time-varying residual technical inefficiency index following Jondrow et al. (1982) or residual (transient) technical efficiency (RTE) index (and marginal effects). In step 3, following a similar procedure as in step 2, $\eta_i$ is used to obtain the PTE estimates and the corresponding inefficiency effects parameters simultaneously. The PTE index (and marginal effects) can be estimated using the BC formula. Lastly, as mentioned in Kumbhakar et al. (2015), the OTE estimate is acquired from the product of transient or residual and persistent technical efficiency estimates, that is, $OTE_{it} = PTE_i \times RTE_{it.}$

## 2.3 *The Empirical Models*

### 2.3.1 The Stochastic Production Frontier Model

The production function $f(x_{it}; \beta)$ in Eq. 10.2 is specified using a flexible translog functional form to approximate the underlying technology. The translog specification is preferred and allows an interaction of inputs, non-constant elasticity of substitution and provides valuable information from the interaction terms. To examine the effects of omitting weather factors in the model's specifications in technical inefficiency estimates and correlates of technical inefficiency effects, we estimated the production frontier with and without the weather variables.

Thus, assuming multiplicative separability of $X_{it}$, $W_{it}$, and $Z_{it}$ to conserve degrees of freedom in estimating the 'full' specification – production frontier with the weather variables (that is, $f(x_{it}, w_{it}; \beta)$) the 'full' specification has the form:

$$
\begin{aligned}
y_{it} &= x_{it}\beta + \varphi_{it} = f\left(x_{it}, w_{it}; \beta\right) + \mu_i + v_{it} - \eta_i - u_{it}; \quad \text{i.e.} \\
y_{it} &= \beta_0 + \sum_{j=1}^{7}\beta_j \ln X_{jit} + \beta_t T_t + \frac{1}{2}\left(\sum_{j=1}^{7}\sum_{h=1}^{7}\beta_{jh} \ln X_{jit} \ln X_{hit} + \beta_{tt} T_t^2\right) \\
&\quad + \sum_{j=1}^{7}\beta_{jt} \ln X_{jit} T_t + \sum_{k=1}^{4}\beta_k \ln W_{kit} + \mu_i + v_{it} - \eta_i - u_{it}
\end{aligned} \tag{10.4a}
$$

And the 'short' specification – production frontier without the weather variables, (that is, $f(x_{it}; \beta)$) may be written as:

$$
\begin{aligned}
y_{it} &= x_{it}\beta + \varphi_{it} = f\left(x_{it}; \beta\right) + \mu_i + v_{it} - \eta_i - u_{it}; \quad \text{i.e.} \\
y_{it} &= \beta_0^* + \sum_{j=1}^{7}\beta_j^* \ln X_{jit} + \beta_t^* T_t + \frac{1}{2}\left(\sum_{j=1}^{7}\sum_{h=1}^{7}\beta_{jh}^* \ln X_{jit} \ln X_{hit} + \beta_{tt}^* T_t^2\right) \\
&\quad + \sum_{j=1}^{7}\beta_{jt}^* \ln X_{jit} T_t + \mu_i + v_{it} - \eta_i - u_{it}
\end{aligned} \tag{10.4b}
$$

where, the outcome variable $y_{it}$ is the logarithm of output representing the normalized output measure of farmer $i$, $i = 1, 2, \ldots, N$ and time period $t$, $t = 1, 2, \ldots, T$. The function $f(.)$ describes the output technology; $X_{it}$ represents a vector of the normalized conventional production inputs and $W_{it}$ is a vector of weather variables. T is the time trend which is a proxy for the exogenous rate of technological change; β represent unknown parameters to be estimated. All other terms maintain their previous definitions as in Eq. 10.2.

### 2.3.2 The Inefficiency Effects Models

To specify the determinants of persistent and transient inefficiencies we make the variance parameters of $u_{it}$ and $\eta_i$ functions of the determinants respectively. That is, the inefficiency terms $\eta_i$ and $u_{it}$ as explained in Eq. 10.2 are expressed as:

$$
u_{it} = \delta_0 + \sum_{m=1}^{M}\delta_m Z_{mit} + \sum_{k=1}^{K}\delta_k E_{kit} + \delta_t T + \delta_{tt} T^2 + w_{it} \quad \textit{and} \quad \eta_i = \lambda_0 + \sum_{l=1}^{L}\lambda_l P_i + \varphi_i, \tag{10.5a}
$$

To explain the OTE differentials we use the following specification at the second-stage regression:

$$
\ln u_{it} = \alpha_0 + \sum_{m=1}^{M}\alpha_m Z_{mit} + \sum_{k=1}^{K}\alpha_k E_{kit} + \alpha_t T + \alpha_{tt} T^2 + \sum_{l=1}^{L}\alpha_l P_i + \xi_{it} \tag{10.5b}
$$

where, i denotes farmers and t the time period; $Z_{it}$ denotes the vector of farmer-specific characteristics and adaptation technologies and time-varying variables; and $E_{it}$ denotes the vector of weather factors. P represents vector of independent (time-invariant) variables assumed to influence persistent technical inefficiency. The terms δ, λ and α are unknown parameter vectors to be estimated including the constant parameters. Whereas $w_{it}$, $\xi_{it}$ and $\phi_i$ are the corresponding error terms that represent the statistical noise that are independently and identically distributed, whose distributions are truncated from below at the variables truncation point, that is, with $\omega_{it} \sim N\left(0,\sigma_w^2\right)$, $\varphi_i \sim N(0, \sigma_\varphi{}^2)$ and $\xi_{it} \sim N(0, \sigma_\xi{}^2)$. $T$ is the time trend. Battese and Coelli (1995) included time variables in SPF and inefficiency equations to account for both technical change and time varying technical inefficiency effects respectively. The trend variable in Eq. 10.4 accounts for Hicks neutral technological change while the trend variable in inefficiency in Eq. 10.5 takes into account inefficiency changes that occur during the period considered. Moreover, the square of weather variables and the trend term is also included in the specification to account for non-linearity effects. Hence, in the one-stage approach, all parameters – frontier production in Eq. 10.4b and inefficiency effects in Eq. 10.5 are estimated simultaneously. The OTE effects model in Eq. 10.5b is estimated using panel model techniques in the second-stage regression using a combination of explanatory variables used in the TTE and PTE effects models.

## *2.4 Data Source and Classification*

**Data Source** The data source for this essay is Ethiopian Rural Household Survey (ERHS) data collected from randomly selected farm households in rural Ethiopia. It includes farm production and economic data collected at 5-year intervals from local farmers associations (FAs) that were selected to represent the country's diverse farming systems. The first four waves of the survey were conducted in collaboration with the Department of Economics, Addis Ababa University and the International Food Policy Research Institute. The last round was extended to form a sub-sample from the original respondents covering eight FAs following a similar strategy. This comprised of 503 farm households and was conducted by this researcher in 2015.

The dataset was comprehensive addressing households' demographic and socioeconomic characteristics; production inputs and outputs; access to institutions; and climate change adaptation mechanisms. Moreover, important secondary data such as the FAs' geographical location and altitude and metrological data were obtained from the Ethiopian Meteorology Authority. The meteorological data includes monthly average observations of rainfall and maximum and minimum temperatures in 1994-2015 collected in stations close to the study villages. Consequently, this study employed data from 4-survey rounds (1999, 2004, 2009 and 2015) covering eight FAs, forming a partially balanced panel of 446 households. The 1994 survey was excluded as it does not have most of the important variables needed for the analysis.

**Variables** The production variable contains the value of cereal output (*Y*), which combines aggregate output of cereal crops measured in thousands of Ethiopian birr (ETB) used as a dependent variable for the SF function. The explanatory variables for frontier function include seven different conventional inputs: labor employed measured in man-day units (MDUs); cereal sown farmland in hectares; amount of fertilizers used in kilograms; agricultural machinery implements in ETB; livestock ownership in tropical livestock units (TLUs) as a proxy for wealth and livestock asset endowments; agro-chemicals in ETB including pesticides, herbicides and insecticides; and oxen as animal draft power in number of the oxen owned as these are mainly used in traditional farming during land preparation and harvesting periods. To capture technical changes (shift in the production function) we included the time trend variable (time) – a positive (negative) coefficient on which will reflect technical progress (regress) over time while the squared trend captures the non-linear shift in the production function over time. We define the time trend variables as time t = 1,…, 5; for years 1999,…,2015.

In addition to these input and output variables, we also included two sets of variables on *Z* variables as determinants of inefficiency. More specifically, we used the first set of variables – the time-invariant but location-specific factors as determinant of persistent inefficiency. The second set of variables includes time-varying farmer-specific characteristics while adaptation technologies and agro-ecological and climatic factors are used as determinants of transient inefficiency. The time trend variable is also included in transient inefficiency effects variables to capture temporal variations in transient inefficiency, ceteris paribus. All monetarily measured variables were transformed to fixed ETB prices. The input variable 'seeds' was excluded from the analysis due to lack of information.

**Climatic/weather variables** The climatic dataset contains annual mean precipitation (PRECIP) measured in millimeters (mm) and annual maximum temperature (ATEM) measured in degree Celsius (°C) and their variability (measured by their coefficients of variation from the corresponding means). According to climate model simulations, climate change causes variations in frequency and intensity of precipitation (Chou et al. 2012). These authors argue that the amount of rainfall, that is, its intensity (quantity), rainy-day frequency (how often it rains) and maximum temperature are important factors to consider when analyzing the sensitivity of agricultural production due to climatic variability particularly in rain-fed regions. ATEM is based on two indicators: the Monthly Mean Temperature (MMT) and the Diurnal Temperature Range (DTR). MMT is calculated as the median between the observed monthly maximum and minimum temperatures whereas DTR is the difference between the monthly maximum and minimum temperatures. Finally, ATEM is calculated by adding half of DTR to MMT (Harris et al. 2014) and is used as a measure of extreme temperature because it captures temperatures at a time when evaporation is higher. In addition to the mean of the weather variables, following Barnwal and Kotani (2013), we used the intra-annual standard deviation (coefficient of variation), which is a measure of monthly deviation within a year to capture variability. Finally, annual climatic data for the weather variables in the study were

**Table 10.1** Summary Statistics of Continuous Variables (NT = 1648)

| Variable | Mean | Std. Dev. | Min | Max | Growth rate |
|---|---|---|---|---|---|
| ***Stochastic frontier variables*** | | | | | |
| Output produced(kg) | 1952.251 | 2681.805 | 34.000 | 51,100.000 | 0.261 |
| Fertilizers used(kg) | 116.100 | 138.850 | 0.080 | 1400.000 | 0.131 |
| Agro-chemicals(ETB) | 133.900 | 447.170 | 0.010 | 8560.000 | 0.370 |
| Farm labor (MEU) | 342.620 | 714.210 | 3.000 | 8333.880 | 0.033 |
| Machinery(ETB) | 336.690 | 1775.800 | 0.500 | 36,540.000 | 0.192 |
| Livestock units (TLUs) | 6.490 | 5.930 | 0.001 | 58.800 | 0.049 |
| Number of ploughing oxen | 1.770 | 1.330 | 0.010 | 9.000 | −0.010 |
| Cultivated land area(HEC) | 1.750 | 1.280 | 0.020 | 11.000 | 0.055 |
| ***Weather factors*** | | | | | |
| Annual average rainfall (PRECIP)(mm) | 82.055 | 26.881 | 47.467 | 145.958 | −0.029 |
| Average minimum temperature(°C) | 10.921 | 2.983 | 6.358 | 17.217 | 0.023 |
| Average maximum temperature(°C) | 26.137 | 4.134 | 19.908 | 33.014 | 0.004 |
| Average temperature(°C) | 18.483 | 3.446 | 13.158 | 23.958 | 0.009 |
| Annual maximum temperature (ATEM) (°C) | 17.120 | 2.560 | 13.270 | 21.550 | 0.006 |
| Rainfall coefficient of variations | 0.015 | 0.008 | 0.0058 | 0.033 | −0.025 |
| Temperature coefficient of variations | 6.052 | 3.034 | 1.846 | 14.851 | 0.214 |
| ***Inefficiency effects variables*** | | | | | |
| Household's size | 5.830 | 2.670 | 1.000 | 18.000 | −0.012 |
| Number of plots cultivated | 3.620 | 2.440 | 1.000 | 16.000 | 0.026 |
| Total farm size | 3.450 | 4.440 | 0.030 | 61.250 | 0.071 |
| Population pressure | 0.634 | 0.797 | 0.003 | 11.000 | 0.043 |
| Household head's age(years) | 51.169 | 15.359 | 18.000 | 103.000 | |
| Altitude (m) | 1948.432 | 482.535 | 1351 | 2750 | |
| Distance to closest market center(km) | 8.220 | 7.000 | 0.250 | 24.000 | |
| Time = 1,…, 5; for years 1999,…,2015 | 2.540 | 1.150 | 1.000 | 4.000 | |

Source: Author's calculations

calculated as the 12-month average. Summary statistics of these variables are given in Tables 10.1 and 10.2.

# 3 Empirical Results and Discussion

## *3.1 Descriptive Discussion*

Because our interest is in doing a panel data analysis of smallholder farmers' cereal production, we excluded data from a few survey years as well as observations with missing data, leaving us with a partially balanced panel of 446 cereal farmers for

**Table 10.2** Summary Statistics for Dummy Variables (NT = 1648)

| Dummy Variables (0 = No, 1 = Yes) | Percentage |
|---|---|
| Credit access | 52.25 |
| If any oxen | 80.64 |
| Household head's gender (female) | 23.42 |
| Completed primary schooling | 40.17 |
| Completed secondary schooling | 7.90 |
| Completed tertiary schooling | 1.03 |
| Soilconservation | 39.87 |
| Waterharvesting | 26.58 |
| Irrigation | 19.42 |
| Off/non-farm | 31.25 |
| Agricultural advisory services | 38.29 |
| Remittances | 18.51 |
| Midland AEZ | 45.87 |
| Highland AEZ | 31.55 |
| Lowland AEZ | 22.57 |

Source: Author's calculations

estimation from an original sample of 503 farmers. Sample descriptive statistics are presented in Tables 10.1 and 10.2 for the relevant variables.

Table 10.1 presents descriptive statistics for the continuous variables with their trends over time – growth rates of cereal production and input variables. As is evident from the table, there was relatively little use of cultivated farmland which is typical of smallholders, cereal farming and considerable variations in the amount of fertilizers, agro-chemicals, machinery and farm labor use patterns, as well as weather conditions. Farmers' real value of output captured in thousands ETB was used as a dependent variable in the stochastic frontier models. As shown in Table 10.1, its mean was about 11, 313 birr ranging from 83 to 444,810 birr for the study period. The mean of cereal output produced during the period was about 1952 kg ranging between 34 kg and 51,100 kg per farm household during the study period. The farmers cultivated cereals on average on about 1.8 hectares and used 342.6 MDUs of labor. Fertilizer application was minimal with an average of 116.1 kg per farm household while the expenses on agro-chemicals were on average 133.9ETB. The farmers spent 336.27ETB for agricultural machinery used per farm household. Average livestock ownership was 6.5TLUs and average oxen ownership was around 1.8 oxen meaning that farms on average owned about two oxen ranging from no ox (which constituted 20 percent) to nine oxen per farm household.

The sample statistics show that production and input use except for the number of oxen had positive trends over time in the study area. An increase in cereal production during the study period was seen at a rate of about 0.261 percent per annum. The aggregate input use increased at an average annual rate of 0.29 percent. Most of the aggregate input growth is associated with agro-chemicals and the amount of fertilizers used at an average annual rate of 0.37 and 0.19 percent respectively.

Male-headed households constituted 76 percent (hence there were only 24 percent female-headed households) of the total sample. Average household age was 51.17 years with minimum and maximum of 18 and 103 years while household size ranged from one to18 members, with a mean of approximately six members. The two interaction variables: total farm size (interaction between area cultivated and number of plots) and population pressure (the ratio of the size of productive/working household members to the cultivated farm size) averaged 3.45 and 0.63 respectively.

Looking at the weather variables in the study area as shown in Table 10.1, we find that in general for the four panels the average annual rainfall (PRECIP) was 82.1 mm that varied between 47.5 and 145.6 mm. Average maximum temperature was 26 °C that varied from 19.9 to 33.01 °C and average minimum temperature was 10.92 °C, fluctuating from 6.36 to 17.22 °C while the average temperature was 18.48 °C ranging from 13.16 °C to 23.96 °C. When we see the annual weather variable trends, climate/weather data shows a significant declining trend of annual average rainfall and warming trends in the temperature variable. Average rainfall distribution declined over time at a rate of 0.029 mm annually and average temperature distribution increased at a rate of 0.009 °C percent annually, while annual maximum temperature (ATEM) increased at a rate of 0.006 °C annually during the study period.

A total of 38.3 percent of the farmers reported contact with extension agents (had 1–4 contacts per month, that is, on average 1.6 times). Extension participation was represented by extension visits per week/month in which the farmers reported contact with extension agents. However, we used a dummy variable that assigned a value of 1 if the farmer got agricultural advisory services, instead of number of contacts which might exaggerate the percentage of households who participated in extension programs. Accordingly, about 38.3 percent of the farmers reported seeking agricultural advisory services. Almost half (52.2 percent) of the sampled farmers had access to credit.

The descriptive results in Table 10.2 show that 40 percent of the sample farm households adopted soil conserving climate change adaptation technologies and 26.6 percent were involved in water harvesting activities. Moreover, 19.4 percent of them used irrigation for farming.

Besides, 19 percent of the households got remittances from different sources. Combining the four panels, the educational level of the household head also varied over the years with mean schooling of 5 years. About 57 percent had not attended any formal education and were hence illiterate of which 41.3 percent had not attained any formal schooling, 3.06 percent had some religious learning and 12.2 percent had participated in adult literacy programs. About 43.44 percent of them had attended formal schooling ranging from primary level to tertiary level; out of which 40 percent had completed primary level (1–8); 7.9 percent had completed secondary level (9–12); and 1 percent had done tertiary schooling in which a few had completed university education.

## 3.2 Econometric Analysis of the Results

### 3.2.1 The SPF Parameter Estimates

The data was checked for statistical diagnostic tests on the SPF model before conducting the estimation. It used the variance inflation factor to test the existence of multicollinearity in the hypothesized independent variables. The result reveals that there was no serious multicollinearity problem. We also investigated the correlation between cereal output and the explanatory variables. The result shows that the pairs had low correlation coefficients with each other, with no pairs having a value higher than 0.50 supporting the non-existence of the multicollinearity problem. The correlation result shows that cereal production was positively and highly correlated with production inputs, $X_{it}$, while it was negatively correlated with most of the weather variables, $W_{it}$. Moreover, the results show the existence of considerably non-zero correlation coefficients between production inputs and weather factors. Further, as reflected in the descriptive results the weather variables were asymmetrically distributed with statistically significant negative skewness. This is worthy of a separate investigation to underline the potential omitted variables' bias plaguing studies that omit weather variables. Finally, we performed the Hausman test (Wooldridge 2002) to see if the unobserved fixed effects were best treated as fixed or random effects. The result revealed that the individual effects and explanatory variables were correlated and thereby fixed-effects provided a consistent estimation as compared to random-effects. Accordingly, we estimated robust standard errors fixed-effects estimations. Further, we used the robust standard errors to diminish the heteroscedasticity problem.

**SPF Parameter Estimates**

We estimated SPF models' parameters, relying on a translog functional form with time trend and separate linear and quadratic climate responses. Prior to taking the logs we normalized the x-variables. Consequently, the first-order coefficients in the model can be interpreted as elasticities of output evaluated at the mean of the data. Parameter estimates of SPF arising from an estimation of the alternative specifications using the TL-GTFE model are reported in Table 10.4. The goodness of fit measured either by the $R$-squared (0.76) or by the log of the likelihood function, is satisfactory in the models indicating that the proposed model is a good representation of the data-generation process. Moreover, the $\gamma$ parameter associated with variances in SPF, the signal-to-noise ratio, is estimated to be positive and significant in both the models revealing the importance of inefficiency in production variability. The results indicate that inefficiency effects did make a significant contribution to the level and variations in cereal production in the study area. Hence, differences in technical efficiency among farms are relevant for explaining output variability in cereal growing farmers.

As shown in Table 10.3, most of the parameter estimates of the models were significantly different from zero at the 5 percent level or lower. Moreover, the estimated parameters satisfied all production economic theory regularity

**Table 10.3** MLEs of the Parameters from the Translog Production Frontier (NT = 1648)

| | | With weather factors | | Without weather factors | |
|---|---|---|---|---|---|
| Variables | Parameter | Estimate | Rob. Std. Err. | Estimate | Rob. Std. Err. |
| Constant | $\beta_0$ | $-11.265^{***}$ | 39.163 | $5.002^{***}$ | 0.419 |
| Fertilizers | $\beta_{x1}$ | 0.033 | 0.050 | 0.024 | 0.050 |
| Agro-chemicals | $\beta_{x2}$ | 0.018 | 0.030 | 0.020 | 0.030 |
| Labor | $\beta_{x3}$ | $0.307^{**}$ | 0.119 | $0.369^{***}$ | 0.119 |
| Machinery | $\beta_{x4}$ | $0.268^{***}$ | 0.067 | $0.280^{***}$ | 0.065 |
| Livestock | $\beta_{x5}$ | 0.070 | 0.070 | 0.057 | 0.070 |
| Oxen | $\beta_{x6}$ | 0.107 | 0.121 | 0.109 | 0.122 |
| Area | $\beta_{x7}$ | $0.463^{**}$ | 0.181 | $0.456^{**}$ | 0.180 |
| Fertilizer*Fertilizer | $\beta_{x11}$ | −0.003 | 0.010 | −0.002 | 0.010 |
| Agro-chemicals*Agro-chemicals | $\beta_{x22}$ | 0.005 | 0.007 | 0.005 | 0.007 |
| Labor*Labor | $\beta_{x33}$ | −0.017 | 0.023 | −0.027 | 0.023 |
| Machinery*Machinery | $\beta_{x44}$ | $0.062^{***}$ | 0.013 | $0.059^{***}$ | 0.013 |
| Livestock*Livestock | $\beta_{x55}$ | $0.024^{**}$ | 0.010 | $0.025^{**}$ | 0.010 |
| Oxen*Oxen | $\beta_{x66}$ | $0.081^{*}$ | 0.046 | $0.084^{**}$ | 0.046 |
| Area*Area | $\beta_{x77}$ | −0.077 | 0.069 | −0.066 | 0.069 |
| Fertilizer*Agro-chemicals | $\beta_{x12}$ | 0.000 | 0.002 | 0.001 | 0.002 |
| Fertilizer*Labor | $\beta_{x13}$ | 0.004 | 0.008 | 0.006 | 0.008 |
| Fertilizer*Machinery | $\beta_{x14}$ | −0.001 | 0.004 | −0.002 | 0.004 |
| Fertilizer*Livestock | $\beta_{x15}$ | $-0.011^{**}$ | 0.004 | $-0.010^{**}$ | 0.004 |
| Fertilizer*Oxen | $\beta_{x16}$ | $0.017^{***}$ | 0.009 | $0.016^{**}$ | 0.009 |
| Fertilizer*Area | $\beta_{x17}$ | $0.025^{***}$ | 0.013 | $0.020^{*}$ | 0.013 |
| Agro-chemicals*Labor | $\beta_{x23}$ | 0.003 | 0.005 | 0.001 | 0.005 |
| Agro-chemicals*Machinery | $\beta_{x24}$ | $-0.005^{*}$ | 0.003 | $-0.006^{*}$ | 0.003 |
| Agro-chemicals*Livestock | $\beta_{x25}$ | $0.009^{**}$ | 0.004 | $0.008^{**}$ | 0.004 |
| Agro-chemicals*Oxen | $\beta_{x26}$ | $-0.021^{***}$ | 0.006 | $-0.020^{***}$ | 0.006 |
| Agro-chemicals*Area | $\beta_{x27}$ | 0.005 | 0.009 | 0.001 | 0.009 |
| Labor*Machinery | $\beta_{x34}$ | $0.032^{***}$ | 0.008 | $0.032^{***}$ | 0.008 |
| Labor*Livestock | $\beta_{x35}$ | 0.013 | 0.011 | 0.014 | 0.011 |
| Labor*Oxen | $\beta_{x36}$ | −0.019 | 0.020 | −0.020 | 0.020 |
| Labor*Area | $\beta_{x37}$ | −0.042 | 0.030 | −0.045 | 0.029 |
| Machinery*Livestock | $\beta_{x45}$ | 0.002 | 0.006 | 0.002 | 0.006 |
| Machinery*Oxen | $\beta_{x46}$ | −0.002 | 0.011 | −0.004 | 0.011 |
| Machinery*Area | $\beta_{x47}$ | −0.015 | 0.016 | −0.009 | 0.016 |
| Livestock*Oxen | $\beta_{x56}$ | −0.012 | 0.013 | −0.012 | 0.013 |
| Livestock*Area | $\beta_{x57}$ | 0.002 | 0.018 | 0.002 | 0.018 |
| Oxen*Area | $\beta_{x67}$ | 0.020 | 0.035 | 0.010 | 0.035 |
| Time*Fertilizer | $\beta_{x1t}$ | −0.012 | 0.010 | −0.013 | 0.010 |
| Time*Agro-chemicals | $\beta_{x2t}$ | −0.007 | 0.006 | −0.003 | 0.006 |
| Time*Lobar | $\beta_{x3t}$ | $-0.126^{***}$ | 0.022 | $-0.130^{***}$ | 0.021 |
| Time*Machinery | $\beta_{x4t}$ | −0.027 | 0.016 | −0.016 | 0.015 |
| Time*Livestock | $\beta_{x5t}$ | −0.001 | 0.013 | 0.002 | 0.013 |

(continued)

**Table 10.3** (continued)

| Variables | Parameter | With weather factors Estimate | Rob. Std. Err. | Without weather factors Estimate | Rob. Std. Err. |
|---|---|---|---|---|---|
| Time*Oxen | $\beta_{x6t}$ | 0.017 | 0.023 | 0.020 | 0.022 |
| Time*Area | $\beta_{x7t}$ | $0.089^{***}$ | 0.032 | $0.092^{***}$ | 0.032 |
| Time(1 = 1999,…,4 = 2015) | $\beta_t$ | $0.245^{**}$ | 0.187 | $0.498^{***}$ | 0.164 |
| Time*Time | $\beta_{tt}$ | $0.505^{**}$ | 0.060 | $0.418^{***}$ | 0.053 |
| ***Weather factors*** | | | | | |
| PRECIP | $\beta_r$ | $8.990^{***}$ | 3.164 | | |
| ATEM | $\beta_T$ | $67.214^{**}$ | 25.998 | | |
| PRECIP*PRECIP | $\beta_{rr}$ | $-2.055^{***}$ | 0.741 | | |
| ATEM*ATEM | $\beta_{TT}$ | $-23.176^{**}$ | 8.830 | | |
| R - squared | Within | 0.764 | | 0.761 | |
| | Overall | 0.660 | | 0.704 | |
| Sigma_u | $\sigma_u$ | 0.613 | | 0.524 | |
| Sigma_v | $\sigma_v$ | 0.741 | | 0.744 | |
| Gamma | $\Gamma$ | 0.406 | | 0.332 | |

Notes: *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

conditions which require that the estimated first-order parameters be non-negative and less than one, whereas the bordered Hessian matrix of the first and second-order partial derivatives was negative semi-definite and so they are valid at the point of approximation. Estimates of the first-order parameters indicate that output was statistically significant with respect to labor, machinery and farm size usage in both models' specifications. Hence, an increase in the use of these inputs enhanced cereal production. This is consistent with observations of this cereal farming system as land and labor are both important determinants of output.

Estimates of the trend and its squared term) were significantly positive at the 5 percent or lower level meaning that technology shifted outwards. As a result, the cereal farmers experienced technical changes (TC) at an increasing rate over time, with an average estimated annual TC rate of 1.16 percent with 0.38 percent dispersion. Regarding technological biases the estimates of time interactions with labor and with farm-size are also significantly negative and positive respectively. This implies that there was labor-using and farm size-saving technical progress for cereal farmers over the period. Estimates of time interaction with other inputs were not significant implying technical neutrality with respect to these inputs.

Estimates of output elasticities evaluated at the mean of relevant data points show that the elasticities with respect to all inputs were positive, indicating positive marginal products of inputs. This indicates that each input contributed significantly to cereal production though the magnitude differed across inputs. The sum of these input elasticities was greater than one meaning that cereal production was characterized by increasing returns to scale, having an average parameter of 1.220 with 38.4 percent dispersion.

The empirical findings show that climatic/weather conditions clearly affected the production of cereal farming in the study area which was statistically significantly higher. The findings of the model with the weather variables show that weather variables had a positive impact on cereal production as linear parameters of the weather factors show a positive significant relation to cereal production. However, the coefficients of their quadratic terms were negatively significant, implying that the weather variables had a non-linear effect on cereal production. This suggests that climatic/weather conditions were favorable for cereal farming while extreme conditions could induce a significant impact on cereal production. Similar results are reported in previous studies in SSA (Sherlund et al. 2002; Ogada et al. 2014).

Further, the estimated marginal effects/elasticities of weather variables, i.e. the percentage change in cereal production, shows that precipitation affected the percentage change to output by 0.028 percent and temperature by about 1.65 percent. That is, any increase in average annual precipitation by 1 mm will increase cereal production by 0.028 percent and a 1 °C increase in annual temperatures could lead to an increase in cereal production by 1.65 percent. However, interpreting the precipitation results where there is a declining trend of average rainfall in the study area, the results show that a decrease in precipitation by 1 mm annually will lead to a decrease in cereal production by 0.028 percent. The percentage change in cereal production due to the $k^{th}$ weather variable ($w_k$) evaluated at the mean value of the variable and employed in Berisso (2017) is given by:

$$\frac{\partial \ln y}{\partial \ln w_k} = \left(\beta_{1k} + \beta_{2k} E\left(w_k\right)\right)^* E\left(w_k\right) \tag{10.6}$$

where, $\beta_{1k}$ and $\beta_{2k}$ are the estimated coefficients of linear and quadratic terms respectively and $E(w_k)$ are mean values of the corresponding weather variables. In general, the results show that the combined effect of the weather variables considered had a favorable influence on cereal production over time in the study area.

### 3.2.2 Technical Efficiency Estimates

The distribution of efficiency scores generated from full and the short specification is presented in Table 10.4. OTE is generated as a product of persistent and transient efficiency components under both specifications. The TTE component generated from the specification with (without) weather factors is found to be quite similar with the mean being 72.0 (71.2) percent respectively. On the other hand, the opposite is true for the PTE component, which is found to be about 63.0(80.0) percent for both specifications respectively. As for the estimated OTE, the result shows an average of about 45.0(57.0) percent from the specifications with (without) weather factors respectively.

Moreover, the variability between persistent and transient efficiency scores clearly demonstrates the existence of significant unobserved farm heterogeneity in

**Table 10.4** Summary Statistics of the Estimated Technical (In) Efficiencies (NT = 1648)

| | With weather factors | | | Without weather factors | | |
|---|---|---|---|---|---|---|
| Percentiles | RTE | PTE | OTE | RTE | PTE | OTE |
| 1% | 0.301 | 0.235 | 0.132 | 0.297 | 0.670 | 0.233 |
| 5% | 0.507 | 0.351 | 0.216 | 0.501 | 0.713 | 0.393 |
| 10% | 0.583 | 0.387 | 0.266 | 0.565 | 0.731 | 0.443 |
| 25% | 0.676 | 0.514 | 0.356 | 0.664 | 0.766 | 0.522 |
| 50% | 0.743 | 0.667 | 0.469 | 0.738 | 0.808 | 0.587 |
| 75% | 0.792 | 0.748 | 0.553 | 0.788 | 0.838 | 0.636 |
| 90% | 0.829 | 0.797 | 0.619 | 0.826 | 0.855 | 0.674 |
| 95% | 0.846 | 0.851 | 0.659 | 0.844 | 0.868 | 0.694 |
| 99% | 0.877 | 0.881 | 0.726 | 0.875 | 0.893 | 0.742 |
| Mean | 0.719 | 0.630 | 0.454 | 0.712 | 0.800 | 0.570 |
| Std. Dev. | 0.109 | 0.159 | 0.136 | 0.112 | 0.050 | 0.098 |
| Min | 0.056 | 0.168 | 0.022 | 0.049 | 0.559 | 0.034 |
| max | 0.932 | 0.931 | 0.798 | 0.930 | 0.918 | 0.804 |
| ***Yearly mean technical efficiency scores*** | | | | | | |
| 1999 | 0.747 | 0.624 | 0.467 | 0.733 | 0.799 | 0.587 |
| 2004 | 0.671 | 0.656 | 0.443 | 0.676 | 0.804 | 0.544 |
| 2009 | 0.738 | 0.624 | 0.461 | 0.726 | 0.799 | 0.580 |
| 2015 | 0.708 | 0.624 | 0.444 | 0.703 | 0.799 | 0.562 |

Source: Author's computations

the sample and should be considered in efficiency modeling and specifications. Further, a comparison of the descriptive statistics of the technical efficiency scores for the models reveals that average technical (in) efficiency differed in model specifications. Inefficiencies under specifications with weather variables were higher compared to models without the weather variables. This provides empirical support for the hypothesis that omission of weather factors could lead to a substantial downward (upward) bias in technical (in) efficiency estimates. The finding is in agreement with Sherlund et al. (2002) who concluded that the omission of environmental production conditions can result in a marked downward (upward) bias in technical inefficiency (efficiency) estimates.

This result is also in line with Simar and Wilson's (2007) result who introduced a separability condition and argued that efficiency factors did not influence the frontier but can influence the efficiency scores of units. Banker and Natarajan (2008) also argue that when correlated inefficiency factors are ignored in the first-stage estimation (whether it is done using parametric or non-parametric methods) it leads to biased estimates of productivity and hence to productive efficiency estimates.

The lower part of Table 10.4 shows yearly distribution of mean technical efficiency scores. The mean of OTE estimates with (without) weather variables scores were 47(59) percent in 1999; 44(54) percent in 2004; 46(58) percent in 2009; and 44(56) percent in 2015. The overall implication of the results of the analyses of farmers' (in) efficiency levels indicates that Ethiopia's smallholder cereal farmers in the study area were highly inefficient and there was a lot of room for improvement. For instance, the OTE scores imply that farmers will be able to increase their output by about 55(43) percent with (without) weather factors respectively. Hence, cereal farmers could use their disposable resources more effectively in general. Further, OTE estimates in particular with (without) weather factors, show that the 1999 output could still have been produced even if the inputs were reduced by 52(41) percent respectively. A similar interpretation is valid for the other years also.

### 3.2.3 Results of Technical Inefficiency Effects Models

Empirical findings on the sources of technical (in) efficiency differences among farms are presented in Tables 10.5 and 10.6. We ran several regressions using different inefficiency effects specifications for selecting appropriate explanatory variables to best fit the models. The data was also checked for the existence of multicollinearity in the hypothesized explanatory variables and the results confirmed that there was no multicollinearity problem.

The parameter estimates and their marginal effects from the one-stage MLE method are presented in Table 10.5 and the results of a second-stage regression are presented in Table 10.6. In all the results, a positive sign indicates that the variable increased inefficiency, that is, a parameter estimate with a negative sign shows that the parameter had a positive effect on technical efficiency. Note that in MLEs instead of interpreting the magnitude of the coefficients of the variables in the inefficiency function, we use them in computing marginal effects. Thus, we interpret the magnitude of the marginal effects for MLE results and the magnitude of the coefficients for the second-stage regressions as they are the same as marginal effects in the latter case. The empirical results of all inefficiency effects models show that most of the specified farmer-specific characteristics, adaptation strategies, agro-ecological and climatic factors explaining the inefficiency effects had a significant effect in determining cereal farming technical (in) efficiencies.

**Determinants of Persistent Technical (In) efficiency**

The empirical MLE results show that the coefficients of time-invariant and location-specific factors (midland and highland AEZs, and altitude) in the specification with weather factors related negatively and significantly to persistent inefficiency. This shows that these variables had a significant positive effect on the persistent technical efficiency level, which means that a one unit increase in these variables could ceteris paribus raise the PTE level by the same unit. On the other hand, the opposite is true for the specifications without weather factors for the effect of these variables (except for altitude) on persistent technical (in) efficiency which is inconsistent with previous similar studies.

**Determinants of Transient Technical (In) efficiency**

Similarly, MLE's empirical results on transient inefficiency effects show that transient inefficiency was positively and significantly affected by the age of the

**Table 10.5** MLEs of Determinants of Persistent and Transient Technical Efficiency (NT = 1648)

| ***Variables*** | ***Determinants of transient technical (in)efficiency (TTE)_MLE*** | | | | | |
|---|---|---|---|---|---|---|
| | *With weather factors* | | | *Without weather factors* | | |
| ***$\sigma_u$: (Time-variant)*** | Coef. | Std. Err. | Mean MEs | Coef. | Std. Err. | Mean MEs |
| ***Farm-specific factors*** | | | | | | |
| Household head's gender | −0.315* | 0.186 | −0.059 | −0.314* | 0.18 | −0.061 |
| Household head's age | 0.080** | 0.033 | 0.015 | 0.075** | 0.031 | 0.015 |
| Household head's age sq. | −0.064** | 0.03 | −0.012 | −0.061** | 0.029 | −0.012 |
| Household size | −0.060* | 0.035 | −0.011 | −0.052* | 0.033 | −0.010 |
| Primary educ. | −0.003 | 0.167 | −0.001 | −0.006 | 0.162 | −0.001 |
| Secondary educ. | 0.485* | 0.289 | 0.092 | 0.485* | 0.282 | 0.095 |
| Tertiary educ. | 0.456 | 0.702 | 0.086 | 0.396 | 0.7 | 0.077 |
| If any ox | −0.249 | 0.185 | −0.047 | −0.234 | 0.181 | −0.046 |
| Farm size | −0.012 | 0.035 | −0.002 | −0.015 | 0.033 | −0.003 |
| Credit use | 0.047 | 0.155 | 0.009 | 0.056 | 0.149 | 0.011 |
| Population pressure | 0.09 | 0.104 | 0.017 | 0.089 | 0.097 | 0.017 |
| Remitances | −0.277 | 0.218 | −0.052 | −0.387* | 0.222 | −0.075 |
| ***Adoption technologies*** | | | | | | |
| Number of plots | −0.115** | 0.059 | −0.022 | −0.097* | 0.054 | −0.019 |
| Soil conservation | −0.191 | 0.169 | −0.036 | −0.205 | 0.166 | −0.04 |
| Water harvesting | −0.175 | 0.191 | −0.033 | −0.273 | 0.189 | −0.053 |
| Irrigation | −0.113 | 0.221 | −0.021 | −0.213 | 0.219 | −0.042 |
| Off/non-farm activities | 0.149 | 0.17 | 0.028 | 0.113 | 0.165 | 0.022 |
| Agri. Ext. services | −0.246 | 0.165 | −0.046 | −0.237 | 0.159 | −0.046 |
| ***Weather factors*** | | | | | | |
| PRECIP | −0.03 | 0.031 | −0.006 | −0.076** | 0.03 | −0.015 |
| ATEM | −1.256 | 0.869 | −0.237 | −1.806** | 0.843 | −0.352 |
| PRECIP sq. | 0.733 | 0.538 | 0.062 | 0.001** | 0.001 | 0.001 |
| ATEM sq. | 0.073 | 0.051 | 0.014 | 0.106 | 0.049 | 0.021 |
| Rainfall variation | 3.374 | 68.18 | 0.637 | −59.151 | 67.514 | −11.54 |
| Rainfall variation sq. | −14.072 | 38.052 | −2.656 | 21.263 | 37.455 | 4.148 |
| Temperature variation | 0.318** | 0.115 | 0.06 | 0.323*** | 0.113 | 0.063 |
| Temperature variation sq. | −0.021* | 0.013 | −0.004 | −0.023* | 0.013 | −0.004 |
| Time | 0.056 | 0.545 | 0.011 | 0.303 | 0.528 | 0.059 |
| Time sq. | −0.05 | 0.208 | −0.009 | −0.155 | 0.202 | −0.03 |
| Constant | 8.445 | 6.594 | | 15.259** | 6.468 | |
| ***$\sigma_v$: (Time-variant)*** | | | | | | |
| Constant | −1.282*** | 0.069 | | −1.287*** | 0.068 | |
| log likelihood | −1504.467 | | | −1512.154 | | |
| | ***Determinants of persistent technical (in)efficiency (PTE)_MLE*** | | | | | |
| | With weather factors | | | Without weather factors | | |
| ***$\sigma_u$: (Time-invariant)*** | | | | | | |
| Constant | −0.824*** | 0.081 | | −2.413*** | 0.74 | |
| ***$\sigma_v$: (Time-invariant)*** | Coef. | Std. Err. | Mean MEs | Coef. | Std. Err. | Mean MEs |
| Midland AEZ | −2.178*** | 0.321 | −0.047 | 1.097*** | 0.217 | 0.127 |

(continued)

**Table 10.5** (continued)

| | | | | | | |
|---|---|---|---|---|---|---|
| Highland AEZ | −0.305 | 0.475 | −0.221 | 3.037*** | 0.444 | 0.145 |
| Altitude | −0.047*** | 0.005 | −0.001 | −0.003*** | 0.005 | −0.001 |
| Mkt proximity | −0.002 | 0.011 | −0.013 | 0.001 | 0.008 | 0.014 |
| Constant | −2.351*** | 0.468 | | 2.175*** | 0.404 | |
| Log likelihood | −1416.481 | | | −1175.201 | | |

Notes: *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

household head, secondary schooling level and extreme temperature variations under both specifications. This implies that an increase in each variable reduced TTE. However, transient inefficiency was negatively and significantly related to the gender of the household head, household size and the number of plots under the full specification. It was negatively and significantly related to remittances, annual average rainfall and average extreme temperature levels under the short specification. Hence, an increase in these factors, ceteris paribus, led to an increase in TTE during the period.

Interpreting the magnitude of the marginal effects of the MLE results, we find that the marginal effect of household head's gender (female) on the transient technical inefficiency function was negative for both specifications, the mean being about 0.060. Thus, on average, transient technical inefficiency reduced by 0.6 percent for a 10-point increase in the household head's gender. Similarly, an increase in the share of household size and number of plots by one percentage point, on average, reduced transient inefficiency by 0.011 and 0.022 percent respectively. A one unit increase in remittances reduced transient inefficiency by 0.075 percent. On the other hand, 1 percent increase in the age of the household head and secondary educational level, on average, increased transient inefficiency by 0.015and 0.001 percent respectively. A similar interpretation is valid for the other variables for each (in) efficiency component.

**Determinants of Overall Technical (In) efficiency**

The next concern related to estimates of technical inefficiency effects on OTE. We used the two-stage approach to explain factors that can affect OTE applying panel regression methods. For comparison, a POLS model and panel models with (respectively) fixed and random effects were also run with the efficiency score as the dependent variable. Results from the three OLS estimates were also compared with MLE estimates, after running the two-limit Tobit random effects model using censored efficiency values below by zero and above by one as the dependent variable. The conclusions (estimates) from OLS particularly those from random-effects are the same as those derived from the MLE/Tobit model due to the reasons discussed in the methodology section. We used the robust (clustered) standard errors in all OLS estimations to diminish the heteroscedasticity problem. More importantly, the usual standard errors of the POLS estimator are incorrect and tests based on them are not valid. Correct standard errors can be estimated with the so-called cluster-robust covariance estimator treating each individual as a cluster. For each specification we tested the suitability of POLS and RE models, using the BP/CW F-test. The test results reveal that POLS and RE were the same

**Table 10.6** Estimates of Determinants of the Overall (In) Efficiency (NT = 1648)

| | With weather factors (ϯRob.std. error) | | | | Without weather factors (ϯRob.std. error) | | | |
|---|---|---|---|---|---|---|---|---|
| | OLS | | | MLE | OLS | | | MLE |
| Variables | POLS | RE | FE | RE-Tobit | POLS | RE | FE | RE-Tobit |
| Constant | 1.517 | 1.021 | 1.436 | 1.002 | 6.202*** | 6.202*** | 3.829*** | 6.202*** |
| | 1.186 | 1.071 | 0.943 | 1.147 | 1.443 | 1.443 | 1.297 | 1.534 |
| ***Farm-specific factors*** | | | | | | | | |
| Household head’s gender | −0.026* | −0.052*** | −0.062*** | −0.053*** | −0.050*** | −0.050*** | −0.099*** | −0.050*** |
| | 0.015 | 0.011 | 0.013 | 0.01 | 0.011 | 0.011 | 0.018 | 0.01 |
| Household head’s age | 0.010*** | 0.010*** | 0.010*** | 0.010*** | 0.014*** | 0.014*** | 0.015*** | 0.014*** |
| | 0.002 | 0.001 | 0.001 | 0.001 | 0.002 | 0.002 | 0.002 | 0.002 |
| Household head’s age sq. | −0.008*** | −0.008*** | −0.008*** | −0.008*** | −0.011*** | −0.011*** | −0.012*** | −0.011*** |
| | 0.002 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.002 | 0.001 |
| Household size | −0.009*** | −0.009*** | −0.008*** | −0.009*** | −0.010*** | −0.010*** | −0.011*** | −0.010*** |
| | 0.002 | 0.002 | 0.002 | 0.001 | 0.002 | 0.002 | 0.003 | 0.002 |
| Primary educ. | −0.02 | −0.001 | −0.008 | −0.001 | −0.007 | −0.001 | −0.02 | −0.01 |
| | 0.013 | 0.009 | 0.009 | 0.008 | 0.01 | 0.001 | 0.014 | 0.01 |
| Secondary educ. | −0.01 | 0.051** | 0.078*** | 0.053*** | 0.073*** | 0.073*** | 0.113*** | 0.073*** |
| | 0.025 | 0.019 | 0.021 | 0.016 | 0.016 | 0.016 | 0.027 | 0.017 |
| Tertiary educ. | 0.106** | 0.06 | 0.133** | 0.065* | 0.039 | 0.04 | 0.140*** | 0.04 |
| | 0.044 | 0.042 | 0.047 | 0.038 | 0.036 | 0.036 | 0.042 | 0.041 |
| If any ox | −0.02 | −0.004 | −0.003 | −0.003 | −0.028** | −0.028** | −0.02 | −0.028** |
| | 0.017 | 0.01 | 0.01 | 0.01 | 0.012 | 0.012 | 0.016 | 0.011 |
| Farm size | −0.006*** | −0.003** | −0.002** | −0.003** | −0.005*** | −0.005*** | −0.004** | −0.005*** |
| | 0.002 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.002 | 0.001 |
| Credit use | 0.004 | 0.01 | 0.014** | 0.01 | 0.013* | 0.013* | 0.020** | 0.001 |
| | 0.009 | 0.007 | 0.007 | 0.007 | 0.008 | 0.008 | 0.001 | 0.009 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Population pressure | 0.005 | 0.01 | 0.011* | 0.010* | 0.009 | 0.01 | 0.01 | 0.01 |
| | 0.008 | 0.006 | 0.006 | 0.005 | 0.008 | 0.008 | 0.011 | 0.006 |
| Remitances | −0.027** | −0.037*** | −0.041*** | −0.038*** | −0.056*** | −0.056*** | −0.074*** | −0.056*** |
| | 0.014 | 0.01 | 0.01 | 0.01 | 0.012 | 0.012 | 0.014 | 0.012 |
| Mkt proximity | 0.001 | −0.003* | | −0.003* | 0.001 | 0.001 | | 0.001 |
| | 0.001 | 0.002 | | 0.002 | 0.001 | 0.001 | | 0.001 |
| ***Adoption technologies*** | | | | | | | | |
| Number of plots | −0.010*** | −0.012*** | −0.012*** | −0.012*** | −0.016*** | −0.016*** | −0.017*** | −0.016*** |
| | 0.003 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.003 | 0.003 |
| Soil conservation | −0.037*** | −0.031*** | −0.029*** | −0.031*** | −0.045*** | −0.045*** | −0.041*** | −0.045*** |
| | 0.011 | 0.008 | 0.008 | 0.008 | 0.01 | 0.01 | 0.012 | 0.01 |
| Water harvesting | −0.026** | −0.021** | −0.023** | −0.021** | −0.059*** | −0.059*** | −0.046*** | −0.059*** |
| | 0.012 | 0.009 | 0.009 | 0.009 | 0.011 | 0.011 | 0.013 | 0.011 |
| Irrigation | −0.001 | −0.001 | −0.001 | −0.001 | −0.029** | −0.029** | −0.01 | −0.029** |
| | 0.013 | 0.012 | 0.013 | 0.011 | 0.014 | 0.014 | 0.019 | 0.014 |
| Off/non-farm activities | 0.038*** | 0.033*** | 0.026** | 0.033*** | 0.030** | 0.030** | 0.032** | 0.030*** |
| | 0.012 | 0.009 | 0.01 | 0.008 | 0.011 | 0.011 | 0.014 | 0.01 |
| Agri. Ext. services | −0.021* | −0.033*** | −0.036*** | −0.033*** | −0.055*** | −0.055*** | −0.059*** | −0.055*** |
| | 0.012 | 0.008 | 0.008 | 0.008 | 0.009 | 0.009 | 0.013 | 0.009 |
| ***Agro-eco-climatic factors*** | | | | | | | | |
| PRECIP | −0.009*** | −0.008*** | −0.003** | −0.008*** | −0.018*** | −0.018*** | −0.021*** | −0.018*** |
| | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.002 | 0.002 |
| ATEM | −0.318*** | −0.261** | −0.280** | −0.259** | −0.717*** | −0.717*** | −0.516*** | −0.717*** |
| | 0.107 | 0.096 | 0.099 | 0.104 | 0.132 | 0.132 | 0.138 | 0.138 |
| PRECIPsq. | 0.002*** | 0.002*** | 0.002*** | 0.002*** | 0.002*** | 0.002*** | 0.002*** | 0.002*** |
| | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| ATEM sq. | 0.019*** | 0.016*** | 0.017*** | 0.016*** | 0.040*** | 0.040*** | 0.031*** | 0.040*** |
| | 0.006 | 0.005 | 0.005 | 0.005 | 0.007 | 0.007 | 0.007 | 0.007 |

(continued)

**Table 10.6** (continued)

| Variables | With weather factors (ϯRob.std. error) | | | | Without weather factors (ϯRob.std. error) | | | |
|---|---|---|---|---|---|---|---|---|
| | OLS | | | MLE | OLS | | | MLE |
| | POLS | RE | FE | RE-Tobit | POLS | RE | FE | RE-Tobit |
| Rainfall Variation | 32.553*** | 23.955*** | 8.173** | 23.404*** | 2.23 | 2.23 | −1.93 | 2.23 |
| | 4.083 | 3.441 | 4.069 | 3.991 | 3.742 | 3.742 | 5.65 | 4.555 |
| Rainfall Variation sq. | −167.35** | −137.89*** | −73.89*** | −135.89** | −34.89* | −34.89* | 0.001 | −34..991 |
| | 19.00 | 17.62 | 20.12 | 20.34 | 19.58 | 19.58 | 0.001 | 25.63 |
| Temperature Variation | 0.040*** | 0.044*** | 0.056*** | 0.045*** | 0.060*** | 0.060*** | 0.065*** | 0.060*** |
| | 0.007 | 0.007 | 0.007 | 0.006 | 0.009 | 0.009 | 0.011 | 0.007 |
| Temperature Variation sq. | −0.002** | −0.002*** | −0.004*** | −0.002*** | −0.004*** | −0.004*** | −0.003** | −0.004*** |
| | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Midland AEZ | −0.198*** | −0.232*** | | −0.233*** | 0.063 | 0.06 | | 0.06 |
| | 0.063 | 0.062 | | 0.062 | 0.066 | 0.066 | | 0.067 |
| Highland AEZ | −0.278*** | −0.359*** | | −0.361*** | 0.081 | 0.08 | | 0.08 |
| | 0.085 | 0.086 | | 0.091 | 0.085 | 0.085 | | 0.089 |
| Altitude | 0.0002 | 0.0002* | | 0.0002* | −0.0003* | −0.0001* | | −0.0003* |
| | 0.0001 | 0.0001 | | 0.0001 | 0.0002 | 0.0001 | | 0.0002 |
| Time trend | −0.03 | −0.028 | −0.007 | −0.028 | 0.068** | 0.068** | 0.011 | 0.068** |
| | 0.027 | 0.021 | 0.024 | 0.024 | 0.027 | 0.027 | 0.035 | 0.031 |
| Time trend sq. | 0.003 | 0.002 | −0.005 | 0.002 | −0.033*** | −0.033*** | −0.02 | −0.033** |
| | 0.01 | 0.008 | 0.009 | 0.009 | 0.01 | 0.01 | 0.013 | 0.012 |
| R-squared | 0.472 | 0.308 | 0.324 | | 0.417 | 0.32 | 0.338 | |
| Log likelihood | | | | 747.5 | | | | 632.3 |
| Sigma_u | | 0.139 | 0.201 | 0.146*** | | 0.001 | 0.145 | 0.001 |
| Sigma_e | | 0.12 | 0.12 | 0.119*** | | 0.173 | 0.173 | 0.165 |
| Rho | | 0.573 | 0.738 | 0.599*** | | 0.001 | 0.413 | 0.001 |

Note: *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$; and ϯ: the rubout std. errors displayed for each explanatory variable in the lower-cells of the sub-table and both were efficient under the short specification while the RE model was better than a pooled effects model under the full specification. Similarly, for comparing the RE model with the FE model we used the Hausman test and the test results favored the FE model.

However, when the time dimension of the panel is short, most of the variations in the dependent and independent variables are across units and so the fixed-effects approach can introduce problems of multicollinearity and reduce the precision of the estimates. Belotti et al. (2012) suggest that the fixed-effects approach is feasible when the length of the panel is at least 10 years. Our semi-unbalanced dataset contained farms whose age varied from 3 to 4 years and so we preferred the AREs model. Accordingly, the interpretation reported is primarily based on the results from random-effects estimations, unless otherwise stated. The parameter estimates of all models are presented in Table 10.6.

The empirical results show that overall technical inefficiency was negatively and significantly related to total farm size, gender of household head, household size, remittances, market proximity centers, climate change related adoption technologies (number of plots, soil conservation, participation in agricultural advisory services and water harvesting technologies), linear terms of weather factors and agro-ecological variables. Hence, an increase in these factors reduced the overall technical inefficiency and a declining trend in overall inefficiency ceteris paribus was observed during the period of our study which means that OTE increased with an increase in these variables.

However, overall technical inefficiency was positively significantly related to farmers' credit use, household head's age, secondary and tertiary educational levels, participation in off/non-farm activities, altitude, population pressure and linear terms of average extreme variations in weather variables from their optimal mean level. Hence, an increase in these factors reduced OTE ceteris paribus during the study period.

The estimation results show that most of the weather factors had a significant impact on the overall cereal farming production (in) efficiency. The coefficients of linear and squared terms of the weather variables show that cereal farming productive (in) efficiency was generally sensitive to weather factors. Moreover, the results of the squared terms show that weather factors had significant nonlinear effects on cereal productive (in) efficiency. The results indicate that average annual amount of (rainfall and temperature) was significantly negatively related to overall technical inefficiency demonstrating that both were beneficial for cereal farming technical efficiency. However, the results also show that excess temperature or rainfall was detrimental, as there is an inverted U-shaped relationship between weather variables and technical efficiency of cereal farming in the study area.

By contrast, the coefficients of weather variation terms showed a significant positive effect on technical inefficiency. This shows that what mattered most was not only the amount of rainfall and temperature but also their variability as represented by the coefficients of variations from mean rainfall and mean temperature which are supposed to be the optimal levels. When rainfall and temperature diverged from their mean values, the level of productive efficiency significantly diminished. This may be because in case of dry or excess rainfall conditions, fertilizer adoption may burn seeds and increase the probability of crop failure.

The positive significant effect of the average annual rainfall on cereal efficiency could be due to the fact that rainfall enhances crop production as it improves the soil's capacity and enables it to use the fertilizers and other inputs effectively hence enhancing productive efficiency. However, this is up to a point and then production, hence productive efficiency, starts declining as demonstrated by its significant squared terms' coefficients. On the other hand, as can be seen in Table 10.6, a considerable deviation from the optimal mean values as the extreme quantity, that is, its variability, as represented by the coefficients of variations have an unfavorable effect on cereal farming productive efficiency. This shows that an increase from this level will harm productive efficiency, while a decrease will have a benefit. Like annual precipitation, annual mean temperature enhanced cereal productive efficiency significantly but up to an optimal level as demonstrated by its significant parameters of the squared terms. Moreover, the results show that average extreme temperatures, as represented by their coefficients of variation had an unfavorable effect on cereal farming productive efficiency. This shows that an increase from this level will harm productive efficiency, while a decrease will have a benefit. This result coincides with the results of similar studies in SSA (Sherlund et al. 2002; Ogada et al. 2014).

The study also considered households located in different AEZs which differ in their location (altitude) and agro-ecological factors by using variables to account for geo-climatic and location heterogeneities in some efficiency analyses (Madau 2011). Under full specification, altitude influenced technical inefficiency negatively and significantly. Out of the regional dummy variables included in the regression or proxied for climatic conditions, soil types and quality the variables highland and midland AEZs considerably affected cereal productive inefficiency significantly and negatively. Farming in midland and highland areas as compared to lowland areas contributed to an increase in cereal productive efficiency. Therefore, efficient production is likely to be in areas in mid to higher altitudes where rainfall and temperature are favorable for cereal production; similar results were found by Madau (2011) and Alemu et al. (2009).

Our empirical findings suggest that a declining trend in overall inefficiency ceteris paribus is observed during the period under full specification. Thus, overall inefficiency declined over time, even though the magnitude of the decline was really low (0.028). This indicates a weak effect of time on efficiency levels. Hence, in general the empirical findings show that the frontier shifted upward and inefficiency declined over time during our sample period.

In the analyses of the inefficiency effects models we see that the estimated relationships between the technical inefficiency measures and the correlates are broadly similar across both specifications. Nevertheless, when the 'weather factors' are excluded, despite most of the inefficiency effects variables being statistically significant only a few result in inconsistent effects in reality than when specified with weather factors. For example, altitude, regional dummy variables and time trend variables were significant under both model specifications. Yet, under the short specification out of the regional dummy variables proxied for soil types and quality, highland and midland AEZs variables considerably affected all types of productive efficiency significantly and negatively; while they had the opposite effect in the full specification. This is counterintuitive and inconsistent with the reality and also the findings of previous studies on Ethiopian crop production. A more precise estimate is obtained when this parameter is generated by the full specification under which the model's adequacy is exhibited by fitness measures as a robust and more appropriate model. Hence, the inclusion of climate variables improves the precision with which one can explain apparent technical inefficiencies. Therefore, this essay concludes that the omission/inclusion of climate variables not only resulted in biased technical inefficiency estimates, but also significantly affected the estimates of the relationships between inefficiency scores and some inefficiency effects variables.

## 4 Conclusion and Policy Implications

This study estimated persistent and transient technical (in) efficiency and explained inefficiency differentials in both inefficiency components among smallholder cereal farmers in Ethiopia using household-level panel data for 1999–2015. The study used a 4-error component SPF panel data model that includes random noise, time-invariant farm-heterogeneity along with persistent and transient technical inefficiency. This model was extended to accommodate factors that can explain persistent (PTE) and residual (RTE) or transient components and compute marginal effects of the determinants on each type of inefficiency component. The study employed a mixed efficiency analysis approach in two steps; where first a one-stage approach SFA method was used to estimate PTE and RTE scores simultaneously to explain their differentials. Second, in a two-stage approach it explained the overall inefficiency effects. Here OTE scores were estimated as a product of PTE and RTE from the first stage efficiency estimates and were regressed on the covariates at the second-stage using the panel data estimation method.

The first-step estimates of the parameters from SPF indicated that agro-chemicals, livestock, machinery, cultivated land and farm labor significantly enhanced cereal production. The findings show that weather variables had a positive impact on cereal production. Estimates of production elasticities from both specifications showed each input contributed significantly to enhancing cereal production. The results further show that cereal farming was technically regressed at an increasing rate and exhibited increasing returns to scale. The estimated efficiency scores show that the transient efficiency component of specifications with (without) weather factors was quite similar with the mean being 72.0(71.2) percent respectively. The persistent efficiency component from both the specifications was about 63.0(80.0) percent, while mean of the OTE was 45.0(57.0) percent respectively.

Estimated efficiency results across different specifications in general illustrate significant variations in efficiency estimates across the different specifications showing that efficiency estimations were sensitive to a model's specifications. Moreover, variability between persistent and transient efficiency scores clearly demonstrates the existence of significant unobserved farm heterogeneity in the sample and should be considered in efficiency modeling and its specifications. The results of the estimated efficiency level analyses show that smallholder cereal farmers in the study area were highly inefficient, which indicates that there was a lot of room for improvement using the present state of technology. Results of the OTE score simply that cereal farmers can increase their output by about 55(43) percent with (without) weather factors respectively, using their disposable resources more effectively.

Results from all inefficiency effects models show that most of the farmer-specific characteristics, adaptation strategies and agro-eco-climatic factors had significant effects in determining cereal farming (in) efficiencies. In particular, the MLE empirical results show that midland and highland AEZs and altitude related negatively and significantly to persistent inefficiencies. Similarly, MLE's empirical results on the transient technical inefficiency effects show that transient inefficiency was positively and significantly affected by the age of the household head and head's secondary schooling and extreme temperature variations under both specifications. However, transient inefficiency was negatively and significantly related to the gender of the household head, household size and the number of plots under the full specification. It was negatively and significantly related to remittances, annual average rainfall and average extreme temperature levels under the short specification. The magnitude of the marginal effects of MLE's results differs substantially within and among cereal farmers and they were interpreted for significant variables for each (in) efficiency component.

The empirical results of the OTE effects models show that OTE was significantly enhanced by farm size, gender, household size, remittances, improved adaptation strategies (extension services, soil conservation, water harvesting and irrigation) and agro-ecological and climatic factors. Hence, these variables enhanced OTE, ceteris paribus. However, it was negatively influenced by credit use, age, tertiary education, off/non-farm activities and extreme weather variations. Hence, an increase in these factors reduced OTE ceteris paribus during the study period. In sum, despite the results of the weather factors in the context or trends of annual weather factors' distributions in the study area, the findings conclude a negative impact of the precipitation variables on cereal production and cereal productive efficiency while the opposite is true for the temperature variables.

Out of the set of regional dummy variables included in the regression to account for location differences, also proxied for soil types and quality, the variables highland and midland AEZs considerably affected cereals' OTE significantly and positively. Similarly, the variable altitude influenced technical inefficiency negatively and significantly. Hence, farming in midland or highland areas as compared to lowland areas contributed to an increase in overall cereal productive efficiency. Therefore, efficient production is likely to be in areas at mid to higher altitudes where rainfall and temperature are favorable for cereal crop production.

Further, the study also showed that neglecting heterogeneity such as environmental conditions in the model's specifications, could lead not only to less precision of the model which may be due to omitted variables' bias in the frontier model, but also to significantly inflated estimates of technical efficiency and to a bias in the correlates of technical inefficiency effects, hence resulting in inconsistent effects as compared to their true values. Hence, the study concludes that omission/inclusion of climatic conditions in the model's specification could not only affect the model's precision, but in addition it could also result in downward (upward) biases in technical (in)efficiency estimates and in biased estimates of the correlates of estimated technical inefficiency effects as well.

These findings are important and can be used to initiate government policy options to reduce farmers' inefficiencies by appropriately tackling sources of persistent and transient technical inefficiencies in particular and overall technical inefficiency in general. Policymakers should be aware of short-term and long-term policy options such as where to emphasize when planning climate change adaptation strategies and ways of promoting smallholder cereal productive efficiencies that are tailored to the peculiarities of the agro-ecological zones across the country. This essay recommends policies that will help improve production inputs supply and sustain improved adaptation strategies suitably designed to meet the needs of different agro-ecological areas to enhance short-term and long-term productive efficiencies of smallholder farmers.

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# Chapter 11
# Diversification into Non-Farm Activities in Ethiopia: Determinants and Income Distribution Effects. Application of a Two-Part and Regression Based Inequality Decomposition

**Gutu Gutema**

## 1 Introduction

In developing countries, the rural economy is traditionally viewed as an agrarian economy in which farm households exclusively engage in farming with only a few non-farm activities. However, there is increasing evidence that rural households also participate in a wide range of non-farm activities such as traditional handicrafts, processing and selling food and drinks and petty trading; they also get involved in wage and self-employment activities for their livelihood (Haggblade et al. 2010; Reardon et al. 2000). Income from these activities contributes significantly to farm households' total income including for the landless and near-landless poor and for rural women. In the face of credit constraints, income from such sources can positively affect agriculture's performance by providing farmers with cash to invest in productivity enhancing inputs (Mulat et al. 2006).

In the developing world, the rural population earns a large share of its income (35–50 percent) from non-farm economic activities and this is rapidly growing and contributing significantly to both employment and growth in rural incomes (Dorosh et al. 2009). In Africa, evidence from a wide range of rural household surveys suggests that non-farm incomes account for about 35 percent of rural incomes of which 28 percent is obtained from local non-farm businesses and employment (Haggblade et al. 2009). This share confirms the economic importance of part-time and seasonal non-farm activities in Africa. But the performance of these activities in Africa is less than that in Asian and Latin American countries where they contribute roughly 50 percent to rural incomes (Haggblade et al. 2010). In Ethiopia, the non-farm enterprise sector is sizable and significant. According to the World Bank

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(2005) about 25 percent of rural households in Ethiopia earned some income from non-farm enterprises. Despite high potential for the non-farm sector, little attention is paid to it because of limited knowledge about the sector in Ethiopia, where it is often believed that rural equals agriculture (Loening and Laketch 2009).

Little technological progress in agriculture, high population pressure, land scarcity, increasing fragmentation of already very small farms and land degradation lead to the need for developing the rural non-farm sector in the East African highlands (Block and Webb 2001) for reducing income inequalities, fighting poverty and improving food security. Rural development policies aimed at promoting the farm sector should consider the linkage role that the non-farm sector plays. Thus, identifying the factors that affect households' decision to choose non-farm activities is quite relevant if the objective of diversifying rural households' livelihoods is to be realized. It has been argued that the transformation and consolidation of the agriculture sector cannot be successful without the non-farm sector which provides gainful part time and full-time employment opportunities to the growing rural population. Diversifying into non-farm activities is thus necessary not only for creating employment for new entrants into the labor force but also for supplementing the incomes of landless and near landless families (Mulat et al. 2006).

However, promoting non-farm activities has been paid little attention partly because of little understanding about the sector and its contributions. Even though policymakers pay attention to the agricultural sector when it comes to the rural economy in Ethiopia, there is growing evidence that the rural non-farm sector is also growing (Yishak et al. 2014). This also shows that the role of the rural non-farm sector is the least understood component of the rural economy and its important contribution to the development process is understated. In addition, this sector faces problems of inadequate institutional support, weak market integration, poor financial services, lack of training and education and inadequate physical infrastructure.

In addition to promoting participation in non-farm activities to contribute to economic growth, it is also vital to consider income inequalities among households. Inequality as a concept is broader than poverty in that it is defined over the whole distribution and is not restricted to the distribution of individuals or households below a certain poverty line. Equal income distribution plays an important role in reducing poverty both in theory and in practice. Studies have reported that focusing on economic growth alone might not be the best way to halve poverty by 2015 outdated. So even if there is growth in a country, the way income is distributed among the households is critical and needs due attention. Given that income inequalities matter for reducing poverty it is important to know the determinants of the level of income inequality.

Several studies have been done on the diversification into non-farm activities in Ethiopia. However, most of them analyze the importance of diversification into non-farm incomes in rural livelihoods (Tegegne 2000; Woldehanna and Oskam 2001) and not the determinants of diversification strategies (Demissie and Legesse 2013; Lemi 2010). Secondly, to the best of our knowledge most of the previous studies conducted in developing countries like Ethiopia use Tobit, multinomial logit and Probit models for their analyses of participation in the rural non-farm economy assuming simultaneity of decisions. They do not consider the two-stage estimation procedure, that is, the decision to participate and earning positive incomes (Corral and Reardon 2001; Escobal 2001; Woldehanna and Oskam 2001).

We use a two-part model to analyze the determinants of non-farm diversification. This approach allows us to do joint modeling of the decision to participate in rural non-farm activities and the level of income from non-farm activities. Thirdly, Zerihun (2016) has dealt with the subject of our present study, that is, diversification into rural non-farm activities and has applied a related methodology. However, the major difference between his and our study is that we use the two-part model rather than the simple Cragg model which assumes the independence of error terms in the participation and level of income earned. In other words, we applied the Cragg type Double Hurdle model by assuming independence of error terms in participation and level of income equations by ignoring the first dominance assumption in which the two-part model is preferred to the Cragg model. Fourthly, the standard Gini decomposition method has been frequently used to analyze income inequalities in studies on Ethiopia (Woldehanna and Oskam 2001; Zerihun 2016). In addition to the Gini decomposition method which addresses how much a particular source of income such as non-farm or farm activities contributes to overall income inequality and which sources of income help to raise or lower total income inequality, we also use a regression based decomposition which shows how household level variables like education, land and family size determine income inequality (see Adams 2002; Fields 2003). We did this because it is useful to supplement the standard Gini decomposition with a regression-based decomposition approach. This approach provides a flexible and efficient way of quantifying the roles of different determinants of income using static inequality decomposition.

Finally, as per our knowledge there is no study on the determinants of diversification into non-farm activities in Ethiopia using a two-part model and regression-based decomposition of income inequality as developed by Fields (2003). Thus, our study makes some unique contributions in terms of the methodology that it uses in modeling determinants of diversification into non-farm activities and the decomposition of income inequality by using household level survey data from rural Ethiopia. This paper also clarifies the determinants of diversification into non-farm activities and analyzes the effects of non-farm incomes on rural income inequalities in Ethiopia:

- It uses a two-part model to analyze the decision to diversify into non-farm activities.
- It uses standard decomposition techniques based on the Gini coefficient to pinpoint the contributions of three different sources of rural incomes including non-farm income to overall rural inequality.
- It applies the regression-based inequality decomposition procedure which is extended by Fields (2003) to quantify the role of household level variables leading to income inequalities.

The study answers the following main research questions:

- What are the determinants of diversification into non-farm activities?

- What is the effect of rural non-farm income on total income distribution of households?
- What are the determinants of income inequality?

Its general objective is examining the rural non-farm economy in detail for a better understanding of the sector.

Its specific objectives are:

- Identifying the factors that influence farm households' diversification choices into non-farm activities.
- Quantifying the role of various household level variables in determining the level of income inequality among rural households.
- Analyzing the effect of rural non-farm income on the overall income distribution of rural households.
- Quantifying the contribution of household level variables leading to income inequalities.

## 2 Literature Review

The terms 'non-farm' and 'off-farm' are frequently used interchangeably in literature. The rural non-farm economy includes all rural economic activities outside agriculture (non-agricultural) and also includes small- and large-scale activities of widely varying technological sophistication (Barret et al. 2001; Ellis 1998, 2000).

Rural non-farm activities can be classified as productive and non-productive non-farm activities and self-employment and wage employment non-farm activities (Barret et al. 2001; Ellis 2000) and manufacturing, trading and services (Loening and Laketch 2009). These activities are also characterized in terms of their size, growth, composition and equity impact (Haggblade et al. 2010). Thus, rural non-farm activities include a heterogenous collection of manufacturing, commerce, service provision and both formal and informal wage employment activities.

Non-farm activities are playing an increasingly important role in sustainable development and poverty reduction (Gordon and Craig 2001). Non-farm activities also provide work in the slack periods of agriculture (Lanjouw and Lanjouw 2001) and contribute 35–50 percent to incomes in the developing world (Haggblade et al. 2010), function as a safety net through diversifying income sources (Zhu and Luo 2006), solve rural-urban migration by providing seasonal or alternative employment for those left out of agriculture and lower prices for the poor (Lanjouw and Lanjouw 2001), add value to farm activities (through processing, trading and storing) and provide opportunities to learn new skills, make new contacts or gain entry into new markets. Some studies have characterized the drive for livelihood diversification into two: distress-push and demand-pull situations. Pull-factors include returns in non-farm activities while push-factors are inadequate farm output (Gordon and Craig 2001). These characterizations as non-farm activities are an oversimplification, but they are a useful reminder that participation in rural non-farm activities may be driven by different circumstances and have different outcomes.

Decomposition by income source for first offered by Shorrock (1982, 1983) which was subsequently extended by Morduch and Sicular (2002) and Fields (2003) to regression-based decomposition by factors of income. But this regression-based decomposition dates to Oaxaca (1973). It overcomes many of the limitations of standard decomposition by sub-groups because it is built on techniques used by inequality factor decomposition. Since the Gini decomposition does not tell us the impact of a uniform increase in any income source including equally distributed income components on inequality, the regression-based decomposition method complements the results (Morduch and Sicular 2002), that is, the Gini decomposition method fails to satisfy the property of uniform addition. Further, it does not identify the factors of inequalities. For example, the Gini decomposition cannot describe how household level variables such as age, family size, education and land size affect income inequality. But the new regression-based decomposition supplements the method by answering the question of how much a given determinant of income contributes to income inequality (Morduch and Sicular 2002).

There are limited studies on income distribution in Ethiopia. Studies have found that non-farm income has an unequalizing effect on income distribution in northern Ethiopia because of entry barriers for the poor. According to Bigsten and Shimeles (2006) household characteristics such as occupation of the head of the household, educational level of the head of the household and other unobserved characteristics in Ethiopia are some significant factors that play a role in determining the Gini coefficient for urban areas. Rural areas with relatively high average land size tend to have lower consumption inequalities, though higher land inequalities translate directly into higher consumption inequalities. Access to education plays an important role in driving the Gini coefficient upwards in rural areas. Villages with a high concentration of educated family heads tend to be associated with a high level of the Gini coefficient which may partly explain the higher degree of differentiation in earning potential as well as consumption preferences.

## 3 Data

### *3.1 Description of Data*

This study used data from the Ethiopian Rural Household Survey (ERHS),[1] which is a panel household survey that includes 1477 households in 15 districts of rural Ethiopia and covers four major regions (Amhara, Tigray, Oromya and South) where

[1] This data was made available by the Economics Department of Addis Ababa University, the Centre for the Study of African Economies, University of Oxford and the International Food Policy Research Institute. Funding for data collection was provided by the Economic and Social Research Council (ESRC), the Swedish International Development Agency (SIDA) and the United States Agency for International Development (USAID); the preparation of the public release version of this data was supported, in part, by the World Bank. AAU, CSAE, IFPRI, ESRC, SIDA, USAID and the World Bank are not responsible for any errors in the data or for its use or interpretation.

the country's largest proportion of settled farmers live. The ERHS surveys can be considered as being broadly representative of households in non-pastoralist farming systems though they are not nationally representative. We used data from the seventh round of the survey (2009) which covered 1355 households.

In 2009, households were asked about their participation in a range of activities and the incomes obtained from these activities in the past 4 months. Data on income was collected both in monetary values and in-kind quantities. To obtain comparable in-kind quantities, we conversion factors were constructed at the peasant association (PA) levels and provided by IFPRI along with the official version of ERHS data which was used to convert local units to standard (metric) units. For missing units, we used the median conversion unit at the next aggregate level (district or region). After converting the in-kind amounts to standard units, we used the nominal prices collected at the PA level for the given round of the survey to obtain monetary values of the items. Similarly, we estimated items with missing prices using the median prices at the next aggregate level.

### *3.2 Method of Data Aggregation and Categorization of Income Sources*

Following Ellis (1998) the income sources included in this study are categorized into farm, off-farm and non-farm incomes. Farm income sources include crop income and livestock income. Crop income refers to the sum of the income earned from crop production converted to its monetary value including the value of the crop residue. Livestock income refers to the income earned from the sale of livestock and income from the sale of animal products such as milk, cottage cheese, meat, hides and skin. Based on the main distinction made in literature (Barret et al. 2001), non-farm income sources also include non-farm self-employment[2] and non-farm wage employment.[3] In addition, incomes earned from remittances and rents (land and oxen) were categorized as non-farm income. Finally, off-farm income mainly includes wage or exchange of labor in cash or in-kind away from one's own land within agriculture and natural resource extraction activities mainly charcoal making.

[2] Constitutes income earned from own-business activities such as weaving/spinning, milling, handicrafts including pottery, trade in grain/general trade, income from services such as traditional healer/religious teacher, transport (by pack animals) and the like.

[3] Non-farm wage income is composed of income earned from the following sources as reported in the data: Professional (teacher, government worker), skilled laborer (builder, thatcher), soldier, driver/mechanic, unskilled non-farm worker, domestic servant and guard.

## 3.3 Selection of the Explanatory Variables and Working Hypotheses

A summary of the names, labels and types of explanatory variables with their expected relationship with the dependent variables and the source of information (reference) are presented in Table 11.1.

**Table 11.1** Description of the variables and working hypotheses

| Variable Name | Variable definition | Type | Hypothesis |
|---|---|---|---|
| Imalehead_1 | Gender of household head | dummy variable (1 = male &0 = female) | – |
| Age | Age of household head | continuous variable (in years after birth) | – |
| formaleduc | Formal education level of household head | continuous variable (in years schooling) | + |
| HHSize | Number of family members | Continuous variable (in number) | + |
| Dependents (The size of dependents which comprise both the young (below 6 years) and elderly (above 75 years) members of the household included in our model is hypothesized to have a mixed effect on the probability of participation.) | Number of economically dependent household members | Continuous variable (in number) | Mixed effect |
| Land | Land owned by the household | continuous variable (in hectare) | – |
| Tlu | Possession of livestock | continuous variable (in of TLU) | – |
| Assetv | Total durable assets owned by the household | continuous variable (in monetary) | – |
| Cropincome | Crop income | continuous variable (in monetary) | + |
| Dcredit | Access to credit of the household | dummy variable (1 = if have access and 0 = otherwise) | |
| dregions | Dummy regions (To control the differences across region) | 0 = Tigray<br>1 = Amhara<br>2 = Oromia<br>3 = SNNPR | |

# 4 Methodology

## 4.1 Theoretical Framework

As a starting point, the theory of agricultural household models was used at the micro level, where a household has a dual role of producer and consumer. If markets are perfect, the household first maximizes profit by choosing different sets of income activities based on its resources and prices and then given profits it maximizes utility by choosing between different levels of consumption and leisure. However, in case of market imperfections, production and consumption decisions become non-separable (Taylor and Adelman 2003). This implies that households maximize utility given their resources, the available technology and (often household-specific) market-access and prices. The first order conditions of farm household models provide a system of supply and demand functions that permits formulating labor allocation decisions between different agricultural and non-agricultural activities. Labor participation in non-farm activities is a function of incentives and constraints (Barrett et al. 2001; Reardon et al. 2000). Incentives include the level and variability of prices and wages in both farm and non-farm activities. These prices may differ substantially among households due to heterogeneous access to markets, human capital and asset endowments. Constraints are related to a household's capacity to diversify into non-farm activities and include household assets, education, possession of livestock, land size, age, gender of the household head and access to credit resources. The decision to participate in non-farm activities depends on a combination of constraints and incentives (Reardon et al. 2000). Generally, a farm household will choose to work more on the farm if marginal productivity of the on-farm labor is above the expected income from non-farm employment. If marginal productivity of labor in on-farm work is less than the expected income from non-farm activities, then the household will engage more in non-farm activities.

## 4.2 Econometric Model

### 4.2.1 The Gini Decomposition Method

We used the Gini decomposition approach to evaluate the relative importance of non-farm income in determining income inequality. Most of the previous studies have adopted the Gini decomposition method by source to analyze the impact of a given income source on inequalities (Zerihun 2016; Zhu and Luo 2006).

Suppose that $y_1, y_2, \ldots, y_k$ stand for K components of household income and $y_0$ is the total income, $y_0 = \sum_{k=1}^{k} y_k$ . The Gini index of the total income, $G_0$, can be decomposed as:

$$G_0 = \sum_{k=1}^{K} R_k G_k S_k \tag{11.1}$$

where $S_k$ is the share of k's components in total income; $G_k$ is the Gini index corresponding to component k and $R_k$ is the correlation between the Gini indices of component k and total income.

Hence, the Gini index $G_0$ is decomposed into three components: (i) the share of component k in total income, $S_k$; (ii) the inequality of the distribution of the said component, $G_k$; and (iii) the correlation between component k and total income, $R_k$.

An analysis of the impact of change in each household's income source $k$ by ($e$) on overall inequality requires a partial derivative of the overall Gini $G_0$ with respect to a percentage change ($e$) in income source $k$ which gives:

$$\frac{\partial G_0}{\partial e_k} = S_k\left(R_k G_k - G_0\right) \tag{11.2}$$

Dividing Eq. (11.2) by $G_0$, the relative effect of a marginal change in income source $k$ on total income inequality is computed as:

$$\frac{\partial G_0}{\partial e_k}\cdot\frac{e}{G_0} = S_k\left(R_k G_k - G_0\right)\cdot\frac{1}{G_0} = \frac{S_k R_k G_k}{G_0} - S_k. \tag{11.3}$$

Accordingly, in our study the inequality impact of income from non-farm activities was computed using:

$$\frac{\partial G_0}{\partial e_{nf}}\cdot\frac{e}{G_0} = S_{nf}\left(R_{nf} G_{nf} - G_0\right)\cdot\frac{1}{G_0} = \frac{S_{nf} R_{nf} G_{nf}}{G_0} - S_{nf}. \tag{11.4}$$

The value can be obtained easily using the STATA 14 software package. The negative outcome of this marginal value indicates the inequality-decreasing impact of income from non-farm activities on overall inequality while the positive outcome implies an inequality-increasing impact. This method of decomposition provides a direct and simple measure of how non-farm income contributes to total income inequality. It is also a measure of inequality which meets the properties of the Pigou-Dalton transfer sensitivity (Adams 2002).

### 4.2.2 The Regression-Based Decomposition Method

The Gini decomposition of income inequality addresses how much a source of income contributes to the overall income inequality and which source of income helps raise or lower total income inequality. But this method does not identify the cause of the inequality. Therefore, it is useful to supplement the standard Gini decomposition by using the regression-based decomposition approach.

Unlike traditional methods of decomposition by population sub-groups and decomposition by income sources, regression-based approaches enable analysts to include any mix of explanatory factors including economic, social, demographic and policy variables. They also enable researchers to include continuous variables.

There have been many recent innovations in such methodologies, for example, Morduch and Sicular (2002) and Fields (2003). All approaches begin with an income generating function, which in linear form can be written as:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k + \varepsilon \tag{11.5}$$

where y measures income for different income units. The variables $x_k$ represent exogenous household endowments of resources that determine income. The term $\beta_k x_k$ can be regarded as the share of a household's income that flows from its endowment of$x_k$. The term ε is a random error.

We used the results of the estimation of the income generating function to quantify the contribution of factors to total inequality. The Fields method, for example, manipulates the equation so that it can be written in terms of covariances. The contribution of the independent variables to distributional change is then expressed as a function of the size of the coefficients of the income equation and the magnitude of the change in the variables relative to the variations in income. In the Morduch and Sicular method, the resulting coefficients are regarded as estimates of the income flows attributed to household variables. This allows the application of decomposition by income source or factor income to apportion inequality among a number of explanatory variables. However, the Morduch and Sicular method has been criticized on the grounds that although the methodology requires the inclusion of an error term in the original income generating equation it does not make any contribution to overall inequality (see Wan 2004). In contrast, Fields' decomposition methodology accounts for the contribution of the regression error in total inequality, but at times this tends to be large, leaving a major part of the inequality unexplained.

Given an income generating model such as in Eq. (11.2), Fields (2003) defines the contribution of the flow of income from any endowment, $x_k$, to total inequality as:

$$s_k = \frac{\mathrm{cov}\left(\beta_k x_k, \mathrm{y}\right)}{\sigma_{\mathrm{y}}^2} \tag{11.6}$$

The term $s_k$ is also known as the 'factor inequality weight.' The sign of $s_k$ indicates whether the income flow from $x_k$ is inequality increasing or decreasing. If $s_k = 0$, the distribution of income from factor k is as equal or as unequal as the distribution of total income. As a result, factor k has no impact on total inequality. The regression error shows how much of total income inequality remains unaccounted for by income flows from endowments denoted by the explanatory variables.

### 4.2.3 The Tobit Double Hurdle Model, Heckman Sample Selection and the Two-Part Model

In many household surveys the participants do not have any particular source of income. Therefore, in modeling the determinants of a decision to participate and level of income generated from a particular activity, it is very important to take into account the significant proportion of zeros, which are common in microeconomic datasets with highly disaggregated information. For instance, non-farm earnings are continuous but censored at zero and hence using OLS will give biased results. Hence, the Tobit regression method is usually used for such data. The Tobit regression method assumes that the decision to work in non-farm activities for earning an income occur simultaneously. However, this method has two important limitations. First, it assumes that explanatory variables have the same impact on the probability of being engaged in non-farm activities and on the size of income received from these activities. Second, the Tobit model considers zero values as a corner solution, but an individual may prefer not to engage in non-farm activities for social reasons irrespective of the value of exogenous variables.

Therefore, our study takes the double-hurdle approach to modeling non-farm diversification as its starting point. This approach assumes that individuals must pass two hurdles before being observed with a positive level of income. Both hurdles are the outcome of individual choices: a participation decision and the level of income earned. The precise form of the double-hurdle approach depends on crucial assumptions in two areas: the degree of independence between the error terms in the participation and income equations and the issue of dominance, that is, whether the participation decision dominates the consumption decision. Based on these two assumptions (the degree of independence between the error terms and the issue of dominance) the full double-hurdle model can be reduced to three different but interrelated models: the Heckman sample selection model, the Cragg model and the two-part model.

Heckman (2013) developed the Heckman selection model to modify the standard Tobit model. His model includes two-stage estimation procedures with the first step being the participation decision and the second step being the level of participation conditional on observed positive values. This model assumes first hurdle dominance (that is, there will be only positive observations in the second stage once the first-stage selection is passed). Hence, the Heckman selection model is a type of double-hurdle model with the assumption of first hurdle dominance and dependence of error terms. But this assumption may not hold true for the situation in which households choose to engage in non-farm activities but may not earn positive incomes from them (that is, there is a possibility of observing zero non-farm incomes in the second stage).

An alternative to the Tobit and Heckman models is the two-step double-hurdle (Cragg) model initially developed by Cragg (1971) to model the demand for durable goods. According to the Cragg model, households must pass through two hurdles before being observed with some positive level of income from non-farm activities where both hurdles are outcomes of the household's choices: participation decision and a decision to receive non-farm incomes. The reasons for separating these decisions are two-fold. First, due to psychological or social drives individuals may prefer not to engage in non-farm work whatever the values of exogenous variables (abstention). Second, an individual may be a potential participant in the non-farm labor market but for certain levels of relevant variables might decide not to do non-farm work (that is, a corner solution). The Cragg model is not relevant to our study because of the nature of the data which has first hurdle dominance (that is, there are positive observations in the second stage once the first-stage participation is passed).

Further, under the assumptions of first hurdle dominance and independence of error terms, the full double-hurdle model boils down to the two-part model. The two-part model assumes a Probit model for the participation decision and the ordinary least squares (OLS) or the generalized linear model (GLM) for the level of non-farm income earned.

Therefore, based on the theoretical framework to empirically estimate the participation decision rule as well as the intensity of participation thereof, our study adopted the full double-hurdle econometric technique which boils down to the Heckman model or the two-part model based on the assumption discussed earlier (Blundell et al. 1989; Ground and Koch 2008; Matshe and Young 2004; Patrick et al. 2014). Under this econometric technique, a farmer has to cross two hurdles to become a participant in rural non-farm work. She/he may be a potential participant after crossing the 'first hurdle'. Given that a farmer is a potential participant, the socioeconomic scenario will lead to his/her actual participation. This is termed the 'second hurdle'. The double-hurdle model is a two-equation framework:

$$d_i^* = z_i^{'}\alpha + \varepsilon_i \qquad \textit{first hurdle} \tag{11.7}$$

$$Y_i^* = X_i^{'}\beta + \mu_i \qquad \textit{second hudle} \tag{11.8}$$

where

$$\begin{pmatrix} \varepsilon_i \\ \mu_i \end{pmatrix} \sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & 0 \\ 0 & \sigma^2 \end{pmatrix}\right]$$

The log-likelihood function for the full double-hurdle model is:

$$LogL = \sum_0 \ln\left[1 - \varphi\left(Z_i^{'}\alpha\right)\varphi\left(\frac{X_i^{'}\beta}{\sigma}\right)\right] + \sum_+ \ln\left[\varphi\left(Z_i^{'}\alpha\right)\frac{1}{\alpha}\varphi\left(\frac{Y_i - X_i^{'}\beta}{\sigma}\right)\right] \tag{11.9}$$

The diagonality of the covariance matrix shows that the two error terms are assumed to be independently distributed; $d_i^*$ is the binary choice variable in the first hurdle equation; Z is a vector of capacity factors explaining the decision to participate in rural non-farm work, whereas α represents their respective influences; the second hurdle formula explains the factors affecting the extent of participation ($Y_i^*$

is the latent variable that reflects a farmer's engagement in income generating non-farm work), X; $\beta$ is the vector of factors explaining the intensity of participation and their influences respectively; and the observed variable, $Y_i$, is determined as:

$$Y_i = d_i^* Y_i^* \tag{11.10}$$

### 4.2.4 Model Specification and Diagnostic Tests

Before estimating the model, it is necessary to check if multicollinearity exists among the variables because the existence of multicollinearity will affect the parameter estimates. Accordingly, we used the variance inflation factor (VIF) technique to find out the problem of multicollinearity for the explanatory variables. Each selected variable was regressed on all the other explanatory variables, the coefficient of determination ($R_j^2$) being constructed in each case. If an approximate linear relationship exists among the explanatory variables, then this will result in a 'large' value for $R_j^2$ in at least one of the test regressions. A popular measure of multicollinearity associated with VIF is defined as:

$$\mathrm{VIF}\left(X_j\right) = \left(1 - R_j^{\,2}\right) \tag{11.11}$$

An increase in the value of $R_j^2$, that is, an increase in the degree of multicollinearity leads to an increase in the variance and standard errors of the model estimates. A VIF value greater than 10 (this will happen if $R_j^2$ exceeds 0.90), is used as a signal for the existence of severe multicollinearity. VIF's values were found to be small (less than 10). So, we conclude that there is no serious problem of multicollinearity (see Table 11.6 in Appendix A).

We used the likelihood ratio (LR) tests to identify the model that best identified the determinants of non-farm income diversification. These tests can be used to decide between the Heckman selection model and the two-part model. We first estimated the Tobit model, the Heckman model, the Cragg model and the two-part model (see Table 11.8 in Appendix C) separately and then did a likelihood ratio (LR) test as:

$$T = -2\left[\log L_x - \log L_y\right] \sim \chi_k^2 \tag{11.12}$$

where

$L_x$ is the log likelihood for 'x' model
$L_y$ is the log likelihood for 'y' model

The result of the specification test by comparing each pair of log likelihood values using the Eq. 11.12 and a theoretical discussion shows that the two-part model fits better than the other models. The specification test results are given in Table 11.7 in Appendix B.

# 5 Empirical Results

## 5.1 Standard Gini Decomposition Results of Income Inequality in Rural Ethiopia

To analyze income inequality in rural Ethiopia we used the standard Gini decomposition and regression-based decomposition. According to the standard Gini decomposition when the Gini coefficient gets close to zero the income distribution will be uniformly distributed, whereas when it gets close to one there will be unequal distribution of income. The Gini coefficient of per capita income for the household survey is 0.502 (Table 11.2) which shows that the income distribution is inequitable. This result is consistent with Zerihun (2016).

Table 11.2 reports the share of income components in total income, the Gini coefficient for each income source, the Gini correlation with total income rankings, the impact of a percentage change on income inequality, the relative concentration coefficient of each income source and the overall percentage contribution of the components to income inequality.

Our results also show that a larger share of the income sources comes from farm income which contributes 81.8 percent to total income, followed by non-farm income contributing 16.82 percent and off-farm contributing 1.4 percent. The percentage contribution to overall income inequality for farm income is 88.1 percent but this is only 11 percent for non-farm income. Even though the impact of non-farm income on inequality is low in magnitude, it is indicative of the positive role of non-farm activities on the equitable distribution of income in rural Ethiopia. Our

**Table 11.2** Decomposition of overall income inequality in rural Ethiopia

| Income source | Share in total income ($S_k$) | Gini coefficient for income source ($G_k$) | Gini correlation with total income ranking ($R_k$) | Contribution of income source to overall income inequality ($S_kG_kR_k$) | Impact of a1 percent change in income source on income inequality | Relative concentration coefficient of income source ($g_k = R_k(G_k/G)$) | Percentage contribution to overall income inequality |
|---|---|---|---|---|---|---|---|
| Farm income | 0.818 | 0.564 | 0.958 | 0.443 | 0.063 | 1.077 | 88.187 |
| Non-farm income | 0.168 | 0.709 | 0.465 | 0.056 | −0.057 | 0.658 | 11.072 |
| Off-farm income | 0.013 | 0.923 | 0.297 | 0.004 | −0.006 | 0.547 | 0.739 |
| Total | | 0.502 | | 0.502 | | | |

Source: Computed from ERHS data (2009)

results also show that non-farm income is distributed more equally than farm income (that is, the Gini coefficients ($G_k$) for non-farm and farm income are 0.709 and 0.564 respectively). In absolute terms, the contribution of income sources to overall income inequality ($S_kR_kG_k$) is found to be: farm 0.443, non-farm 0.056 and off-farm 0.004. The results show that a high proportion of income is generated from farm work and farm work's income inequality share is also the highest.

The decomposition results in Table 11.2 can also be used to distinguish between inequality increasing and inequality decreasing as a source of income. This means that, ceteris paribus, an additional increase in non-farm income will reduce overall income inequality. This result is in line with related studies such as Zhu and Luo (2006) and Zerihun (2016). In the same way, ceteris paribus, an additional increase in off-farm incomes will reduce overall income inequality. For instance, a 1 percent increase in incomes from non-farm and off-farm activities reduces income inequality by 5.75 and 0.06 percent respectively. In contrast, farm incomes are an inequality-increasing source of income. Accordingly, a 1 percent increase in incomes from farm activities increases income inequality by 6.36 percent.

Table 11.3 reports the results of the Gini decomposition for non-farm income components. Non-farm income is further decomposed into three income components: non-farm wage employment, non-farm self-employment and other non-farm income (transfer payments). According to our results, non-farm wage employment accounts for both the largest share of non-farm income ($S_k = 0.467$) and makes the largest contribution to overall income inequality ($S_kG_kR_k = 0.324$). In addition, the overall percentage contribution of non-farm wage employment income to income inequality is 45.75 percent followed by non-farm self-employment income. Non-farm self-employment income is more equally distributed than non-farm wage employment income with 0.81 and 0.89 Gini coefficients respectively. The results also show that non-farm wage employment tends to decrease income inequality while non-farm self-employment has the opposite effect on inequality. For instance, a 1 percent increase in incomes from non-farm wage employment reduces income inequality by 0.99 percent, whereas a 1 percent increase in incomes from non-farm self-employment increases income inequality by 1 percent. Other incomes like transfer payments decrease income inequality. This result is consistent with Senadza (2012) for Ghana and Zerihun (2016) for Ethiopia. The argument is that the rich engage in self-employment in the form of own businesses which require initial capital to start and because of the entry barriers because of the initial capital requirements the poor most likely engage in wage employment.

**Table 11.3** Decomposition of Non-farm Income Inequality in Rural Ethiopia

| Income source | Share in total income ($S_k$) | Gini coefficient for income source($G_k$) | Gini correlation with total income Ranking ($R_k$) | Contribution of income source to overall income inequality ($S_kG_kR_k$) | Impact of a 1 percent change in income source on inequality | Relative concentration coefficient of income source (gk = Rk(Gk/G) | Percentage contribution to overall income inequality |
|---|---|---|---|---|---|---|---|
| Non-farm wage employment income | 0.467 | 0.819 | 0.848 | 0.324 | −0.009 | 0.978 | 45.761 |
| Non-farm self- employment income | 0.267 | 0.894 | 0.822 | 0.197 | 0.010 | 1.037 | 27.758 |
| Other (transfer payment) | 0.264 | 0.890 | 0.796 | 0.187 | −0.000 | 0.999 | 26.481 |
| Total | | | | 0.710 | | | |

Source: Computed from ERHS data (2009)

## 5.2 An Analysis of the Regression-Based Approach to Inequality Decomposition

The issue of which sources of income contribute to overall income distribution and which sources of income help raise or lower total inequality is addressed by the Gini decomposition. However, this approach is of limited use in identifying the causes of inequality. So, supplementing the standard Gini method with regression-based decomposition to identify those exogenous household level factors which lead to income being produced and pinpointing the relative importance of each of these factors in producing different types of incomes is necessary.

As reported in Table 11.4 from the explanatory variables that are regressed on total income, farm income and non-farm income of a household depends on: household size, land owned by the household measured in hectares and total assets held by the household which are significant variables that positively affect these three sources of household income simultaneously. In addition to these variables, being a male headed household and the number of livestock owned in tropical livestock units are other significant variables that have a positive effect on households' total and farm incomes. Access to credit has a negative and significant effect on household non-farm income.

On the other hand, the number of dependents in a household has a negative and significant effect on total, farm and non-farm incomes of the household. Being a male headed household, the number of livestock owned in tropical livestock units and crop income also significantly and negatively affect non-farm income.

Table 11.4 provides the results of the income function and inequality decomposition by explanatory variables. Based on their effect on income inequality, the variables are classified into two categories: inequality reducing and inequality aggravating. Among all significant variables included in the total income function the most important ones that are inequality increasing are: asset holdings of a household, household size, number of livestock owned in tropical livestock units, land owned by a household in hectares and being male headed with inequality contributions of 30.73, 8.4, 6.79, 6.45 and 1.103 respectively.

In the case of farm income, assets owned by a household, the number of livestock owned in tropical livestock units, land owned by a household in hectares, household size and being male headed have inequality increasing effects with their contributions to inequality being 20.13, 9.49, 6.54, 5.22 and 5.49 respectively. On the other hand, household head's formal education, number of dependents in the household and access to credit have an equalizing effect with contributions of −0.089, −0.002 and − 0.001 respectively to inequality in farm incomes.

The most important variables that affect non-farm incomes with an inequality increasing effect are: crop income of a household, the number of livestock owned in tropical livestock units, number of dependents in a household and household access to credit with their contributions to inequality being 3.37, 1.58, 0.58, and 0.25 respectively. Land owned by a household in hectares, assets owned by a household, household size and household head's formal education have an

**Table 11.4** Results of income function and decomposition by explanatory variables

| Variables | Total income | Inequality weight | Farm income | Inequality weight | Nonfarm | Inequality weight |
|---|---|---|---|---|---|---|
| LnAgen | 0.031 | −0.006 | 0.041 | −0.002 | −0.00116 | −0.007 |
| | (0.039) | | (0.063) | | (0.120) | |
| lnage2 | −0.060 | 0.094 | −0.137** | 0.208 | 0.286** | 0.125 |
| | (0.038) | | (0.061) | | (0.118) | |
| _Imalehead_1 | 0.101** | 1.103 | 0.254*** | 1.929 | −0.434*** | 0.125 |
| | (0.043) | | (0.068) | | (0.138) | |
| Lnformaledu | 0.012 | 0.138 | −0.013 | −0.089 | 0.135 | −0.602 |
| | (0.031) | | (0.050) | | (0.0991) | |
| Lnhhsize | 0.482*** | 8.400 | 0.489*** | 5.223 | 0.474* | −2.201 |
| | (0.079) | | (0.126) | | (0.247) | |
| Lnhigestgr | 0.007 | 0.181 | 0.063 | 1.002 | 0.110 | 0.279 |
| | (0.030) | | (0.048) | | (0.0955) | |
| Lndependents | −0.228*** | −2.586 | −0.187** | −0.002 | −0.327* | 0.581 |
| | (0.053) | | (0.084) | | (0.170) | |
| Lnland | 0.191*** | 6.445 | 0.287*** | 6.524 | 0.0484 | −2.698 |
| | (0.020) | | (0.032) | | (0.0609) | |
| Lntlu | 0.105*** | 6.798 | 0.208*** | 9.496 | −0.223*** | 1.585 |
| | (0.014) | | (0.022) | | (0.0434) | |
| lnAssetv | 0.390*** | 30.726 | 0.429*** | 20.149 | 0.139** | −2.447 |
| | (0.019) | | (0.030) | | (0.0617) | |
| _IcreditD_1 | 0.013 | 0.007 | 0.022 | −0.001 | 0.134 | 0.248 |
| | (0.041) | | (0.064) | | (0.130) | |
| Lncropincome | | | | | −0.144*** | 3.370 |
| | | | | | (0.0259) | |
| Constant | 5.945*** | | 5.60*** | | 4.058*** | |
| | (0.319) | | (0.50) | | (0.995) | |
| Observations | 1354 | | 1321 | | 1166 | |
| R-squared | 0.513 | | 0.430 | | 0.077 | |
| Residual | | 48.689 | | 56.972 | | 86.076 |
| Total | | 100 | | 100 | | 100 |

Source: Computed from ERHS data (2009)
Note: Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

equalizing effect with contributions of −2.69, −2.45, −2.201 and − 0.60 respectively to inequality in non-farm incomes.

Age is associated with lowering inequality perhaps because with age come greater wisdom, knowledge and experience that improves the ability to generate income and improve the quality of life of even poor households.

Decomposition of inequality reveals that about 48.6 percent, 56.9 percent and 86.07 percent of inequality in total household income, farm income and non-farm income respectively is derived from the residual term. This residual contribution captures attributes in inequality that are not captured by regression. It captures the unobserved effects on inequality such as the effects of variables like economic growth. Though this value may seem high, it is consistent with other studies. In fact, several studies have found relatively higher contributions of the residual term to inequality (Morduch and Sicular 2002).

### *5.3 Determinants of Diversification into Non-farm Activities*

Table 11.5 provides estimates of the Heckman selection and the two-part models for non-farm income. Our primary focus is selecting the best fitting model for the determinants of the participation decision and the level of non-farm income. Based on the log likelihood test and theoretical arguments, we selected the Heckman sample selection and two-part model over the Tobit and Cragg models. We also compared the Heckman sample selection and the two-part model based on theory and the log likelihood test. Both the Heckman sample selection and two-part models assume first hurdle dominance. Their basic difference is that the Heckman sample selection model assumes the dependence of error terms of the participation and income equations whereas the two-part model assumes the independence of the error terms. Based on the log likelihood test results, the two-part model fits better than the Heckman selection model. In summary, the values and sizes of the estimated coefficients in Table 11.5 are generally quite plausible and, perhaps more interestingly, there is a comparatively small difference in the magnitude and level of significance between the Heckman selection and two-part models. Hence, this discussion is based on the results for the two-part model. Concerning the two-part model, the signs of the coefficients are in line with intuition except for age.

The level of a household's non-farm diversification is measured by the amount of non-farm income received annually after log-transformation. All continuous variables are transformed to their natural logarithms. The coefficients in the first tier indicate how a given variable affects the likelihood (probability) of participating in non-farm income generating activities, whereas the second tier presents the variables that influence the income generated from non-farm activities given that a decision is taken to participate in non-farm activities.

As reported in Table 11.5, male headed households, the number of livestock owned in tropical livestock units, total assets held and crop income have the same statistical significance and magnitude in the first and second tiers. Except for total assets held which have a positive impact, all the others have a negative effect on both the probability of participation decision and level of non-farm income. Age of the household head and region dummy (Damhara and Doromia) are variables which significantly affect the probability of participation decision in non-farm activities but not the level of non-farm incomes. In contrast, household size, formal education of household head, land owned by a household and the number of dependents in a household are variables which significantly affect the level of non-farm income but not the probability of a participation decision in non-farm activities.

**Table 11.5** Maximum likelihood estimates for Heckman Selection and the Two-part Model for Rural Non-farm Economy (2009)

| | Heckman | | Two-part | |
|---|---|---|---|---|
| VARIABLES | Selection | Level | Selection | Level |
| lnAgen | −0.105 | 0.083 | −0.049 | −0.029 |
| | (0.085) | (0.117) | (0.100) | (0.074) |
| lnage2 | 0.042 | 0.128 | 0.220** | 0.120 |
| | (0.072) | (0.122) | (0.091) | (0.075) |
| _Imalehead_1 | −0.154* | −0.236 | −0.306*** | −0.310*** |
| | (0.091) | (0.151) | (0.103) | (0.090) |
| Lnformaledu | 0.085 | −0.058 | 0.116 | 0.150** |
| | (0.066) | (0.114) | (0.072) | (0.067) |
| Lnhhsize | −0.037 | 0.439* | −0.147 | 0.541*** |
| | (0.146) | (0.259) | (0.175) | (0.158) |
| Lnhigestgr | −0.015 | 0.136 | −0.003 | 0.0511 |
| | (0.060) | (0.097) | (0.068) | (0.060) |
| Lndependents | 0.095 | −0.367* | 0.047 | −0.250** |
| | (0.105) | (0.195) | (0.115) | (0.112) |
| Lnland | 0.037 | 0.137** | −0.040 | 0.105** |
| | (0.034) | (0.066) | (0.065) | (0.043) |
| Lntlu | −0.151*** | −0.085** | −0.310*** | −0.090*** |
| | (0.043) | (0.038) | (0.061) | (0.027) |
| lnAssetv | 0.104** | 0.173** | 0.111** | 0.177*** |
| | (0.042) | (0.069) | (0.053) | (0.041) |
| _IcreditD_1 | 0.108 | −0.069 | 0.105 | 0.108 |
| | (0.085) | (0.141) | (0.094) | (0.085) |
| Lncropincome | −0.059* | −0.084*** | −0.162*** | −0.087*** |
| | (0.030) | (0.017) | (0.050) | (0.013) |
| AmharaD | −0.154 | −0.231 | −0.680** | −0.148 |
| | (0.158) | (0.179) | (0.272) | (0.120) |
| OromyaD | −0.425** | 0.287 | −1.158*** | 0.209 |
| | (0.172) | (0.217) | (0.270) | (0.141) |
| SNNPRD | 0.021 | −0.069 | −0.270 | −0.091 |
| | (0.156) | (0.145) | (0.282) | (0.107) |
| Constant | 1.221* | 4.975*** | 1.273 | 5.071*** |
| | (0.631) | (1.105) | (0.842) | (0.648) |
| Sigma | 0.867*** | −1.835*** | | |
| | (0.034) | (0.178) | | |
| Observations | 1354 | 1354 | 1354 | 1354 |

Note: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
Source: Results based on ERHS data (2009)

We observe a U-shaped relation between age of the household head and participation in non-farm activities: with an increase in age, the probability of participation in non-farm activities decreases initially and increases later. This result is consistent with Dil Bahadur et al. (2015) for Bhutan. The education level of the household head is positive and significant in the second tier. The level of non-farm income rises with an increase in formal education once the household head has decided to participate in non-farm activities. This result is expected and consistent with literature (Canagarajah et al. 2001; Escobal 2001).

Male-headed households are less likely to participate in rural non-farm income generating activities and this significantly reduces the level of non-farm income compared to female-headed households. This result shows that female-headed households garner higher incomes from non-farm activities than male-headed households. This result is consistent with Matshe and Young (2004) for Zimbabwe and Zerihun (2016) for Ethiopia.

Households with more members are less likely to participate in RNFE. However, once they decide to participate in non-farm activities the household size positively and significantly affects the level of non-farm income. On the contrary, the number of dependents in a household has a negative and significant effect on the level of non-farm income. This implies that a large household size and a lesser number of dependents in a household are positively associated with the level of income from non-farm activities.

Households' crop income and the number of livestock owned in tropical livestock units significantly reduces both the probability of engaging in non-farm activities and the income levels generated from them. Even if land size and the number of dependents in a household have no significant effect on the probability of participation, the sign of the coefficient which is negative for land size and positive for number of dependents has implications. These results jointly hint at the existence of 'push factors' since households with high crop incomes, more livestock, large land size and a lesser number of economically dependent household members may opt for non-farm activities. But once a household decides to participate in non-farm activities, households with a larger land size collect more non-farm incomes.

The variable 'assets' held by a household is significant and positive. This implies that the assets held strongly increase a household's likelihood to engage in local non-farm activities and level of income generated from non-farm work with a stronger effect on self-employment that requires initial investments.

We used regional dummies to capture the regional differences in the level of income diversification. There is a significant difference between regions concerning the probability of participation in rural non-farm activities. Our results also show that households in the Amhara and Oromia regions which are more suitable for agriculture are less likely to participate in rural non-farm activities than their counterparts in Tigray region. This suggests that the region which has better agricultural potential shows low household participation in rural non-farm activities. This result also confirms the existence of 'push factors' in Ethiopia. But once households in all regions decide to participate in non-farm activities there is no significant difference in the level of incomes from non-farm activities.

## 6 Conclusion and Recommendations

This study examined the determinants of participation in income generating non-farm activities using the two-part model: the effects of non-farm diversification on income inequality using the standard Gini decomposition and the determinants of income inequality using regression-based inequality decomposition. It used data from the Ethiopian Rural Household Survey (2009) consisting of 1355 rural households. The results of the Gini decomposition show that the largest share of income was farm income (81 percent) followed by non-farm income (16 percent). Non-farm income has a positive role in equitable distribution. According to the relative concentration of the coefficients, non-farm and off-farm incomes represent inequality-decreasing sources of income. In non-farm activities, wage employment accounted for the largest share of non-farm income and was the largest contributor to income inequalities. Non-farm wage employment tended to decrease income inequality while non-farm self-employment had a tendency of increasing inequalities in non-farm activities. This is perhaps because the rich are more engaged in self-employment than the poor because of capital requirements. The message that emerges from this study is that concerned institutions should pay attention to non-farm income generating activities. This further implies that policymakers can use the rural non-farm economy as an additional option to minimize problems like droughts, shortage of land and poverty.

Among the statistically significant household level variables, a household's asset holdings, the size of a household and possession of livestock and land have higher factor inequality loading in total and farm incomes' inequality simultaneously. A household's crop income, the number of livestock owned in tropical livestock units and the number of dependents have higher factor inequality loadings in non-farm incomes whereas land owned by a household in hectares, assets owned by a household, household size and household head's formal education have an equalizing effect in non-farm incomes.

Concerning the determinants of non-farm diversification our estimation results indicate that the following variables have similar statistical significance and magnitude in the first and second tiers: being a male headed household, the number of livestock owned in tropical livestock units, total assets held and crop income. Except for total assets held which has a positive impact, all the others have a negative effect on both the probability of deciding to participate in non-farm activities and the level of non-farm incomes. Age of the household head and region dummy (Damhara and Doromia) significantly affected the probability of participation decision in non-farm activities but not on the level of non-farm incomes. On the other hand, household size, formal education of the household head, land owned by a household and number of dependents in a household are variables which significantly affected the level of non-farm incomes but not the probability of participation decision in non-farm activities.

This study has a limitation as it uses only one cross-sectional (2009) data; the results would have been interesting if it had used panel data. The problem of endogeneity also needs to be checked and controlled.

## Appendix A

**Table 11.6** Variance inflation factors

| Variable | VIF | 1/VIF |
|---|---|---|
| lnhhsize | 4.06 | 0.246215 |
| OromyaD | 3.96 | 0.252738 |
| AmharaD | 3.73 | 0.267953 |
| SNNPRD | 3.53 | 0.283613 |
| lndependents | 3.12 | 0.320687 |
| lnAssetv | 1.81 | 0.551519 |
| lncropincome | 1.71 | 0.586314 |
| lnhigestgr | 1.69 | 0.591644 |
| lnformaledu | 1.62 | 0.618767 |
| lnage2 | 1.43 | 0.697518 |
| lntlu | 1.38 | 0.723696 |
| _Imalehead_1 | 1.26 | 0.795215 |
| lnland | 1.22 | 0.821506 |
| lnAgen | 1.16 | 0.863448 |
| _IcreditD_1 | 1.12 | 0.895399 |
| Mean VIF | 2.19 | |

## Appendix B

**Table 11.7** Specification tests for Tobit, Heckman, Cragg and Double hurdle models

| Model | Test value | Decision |
|---|---|---|
| Test for Heckman selection versus Tobit model | 494 (15)*** | Reject Tobit and accept Heckman |
| Test for Two-part versus Heckman selection model | 1150(15)*** | Reject Heckman and accept two-part |
| Test for Cragg and the Two-part model | 0 (15) | No difference (But due to the nature of our data i.e., the assumption of first hurdle dominance the two-part model is selected and presented) |

Source: Computed from ERHS data (2009)
Notes: The degree of freedom of the Chi-square statistics are given in parenthesis
***, **,* represent significance level at 1%, 5% and 10% respectively

# Appendix C

**Table 11.8** Maximum likelihood estimates for Tobit, Heckman Selection, Cragg and Two-part Models for Rural Non-farm Economy (2009)

| | | First tier | Second tier | First tier | Second tier | First tier | Second tier |
|---|---|---|---|---|---|---|---|
| VARIABLES | Tobit | Heckman | Heckman | Cragg | Cragg | 2 PM | 2 PM |
| lnAgen | −0.169 | −0.105 | 0.083 | −0.049 | −0.029 | −0.049 | −0.029 |
| | (0.162) | (0.085) | (0.117) | (0.100) | (0.074) | (0.100) | (0.074) |
| lnage2 | 0.520*** | 0.042 | 0.128 | 0.220** | 0.120 | 0.220** | 0.120 |
| | (0.174) | (0.072) | (0.122) | (0.091) | (0.075) | (0.091) | (0.075) |
| _Imalehead_1 | −0.804*** | −0.154* | −0.236 | −0.306*** | −0.310*** | −0.306*** | −0.310*** |
| | (0.212) | (0.091) | (0.151) | (0.103) | (0.090) | (0.103) | (0.090) |
| Lnformaledu | 0.378** | 0.085 | −0.058 | 0.116 | 0.150** | 0.116 | 0.150** |
| | (0.154) | (0.066) | (0.114) | (0.072) | (0.067) | (0.072) | (0.067) |
| Lnhhsize | 0.173 | −0.037 | 0.439* | −0.147 | 0.541*** | −0.147 | 0.541*** |
| | (0.362) | (0.146) | (0.259) | (0.175) | (0.158) | (0.175) | (0.158) |
| Lnhigestgr | 0.016 | −0.015 | 0.136 | −0.0038 | 0.0511 | −0.0038 | 0.051 |
| | (0.139) | (0.060) | (0.097) | (0.068) | (0.060) | (0.068) | (0.060) |
| Lndependents | −0.174 | 0.095 | −0.367* | 0.047 | −0.250** | 0.047 | −0.250** |
| | (0.262) | (0.105) | (0.195) | (0.115) | (0.112) | (0.115) | (0.112) |
| Lnland | 0.025 | 0.037 | 0.137** | −0.040 | 0.105** | −0.040 | 0.105** |
| | (0.088) | (0.034) | (0.066) | (0.065) | (0.043) | (0.065) | (0.043) |
| Lntlu | −0.463*** | −0.151*** | −0.080** | −0.310*** | −0.090*** | −0.310*** | −0.090*** |
| | (0.057) | (0.043) | (0.038) | (0.061) | (0.027) | (0.061) | (0.027) |
| lnAssetv | 0.217** | 0.104** | 0.173** | 0.111** | 0.177*** | 0.111** | 0.177*** |
| | (0.095) | (0.042) | (0.069) | (0.053) | (0.041) | (0.053) | (0.041) |
| _IcreditD_1 | 0.400* | 0.108 | −0.069 | 0.105 | 0.108 | 0.105 | 0.108 |
| | (0.204) | (0.085) | (0.141) | (0.094) | (0.085) | (0.094) | (0.085) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Lncropincome | −0.233*** | −0.059* | −0.084*** | −0.162*** | −0.087*** | −0.162*** | −0.087*** |
| | (0.028) | (0.030) | (0.017) | (0.050) | (0.013) | (0.059) | (0.013) |
| AAmharaD | −0.937*** | −0.154 | −0.231 | −0.680** | −0.148 | −0.680** | −0.148 |
| | (0.280) | (0.158) | (0.179) | (0.272) | (0.120) | (0.272) | (0.120) |
| OromyaD | −1.753*** | −0.425** | 0.287 | −1.158*** | 0.209 | −1.158*** | 0.209 |
| | (0.338) | (0.172) | (0.217) | (0.270) | (0.141) | (0.270) | (0.141) |
| SNNPRD | 0.022 | 0.021 | −0.069 | −0.270 | −0.091 | −0.270 | −0.091 |
| | (0.239) | (0.156) | (0.145) | (0.282) | (0.107) | (0.282) | (0.107) |
| Constant | 3.266** | 1.221* | 4.975*** | 1.273 | 5.071*** | 1.273 | 5.071*** |
| | (1.537) | (0.631) | (1.105) | (0.842) | (0.648) | (0.842) | (0.648) |
| Sigma | 3.359*** | 0.867*** | −1.835*** | | 1.298*** | | |
| | (0.088) | (0.034) | (0.178) | | (0.027) | | |
| Observations | 1354 | 1354 | 1354 | 1354 | 1354 | 1354 | 1354 |

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# Chapter 12
# Determinants of Income Mobility in Uganda

**Susan Namirembe-Kavuma and Edward Bbaale**

## 1 Introduction

Uganda registered impressive poverty reduction leading to the achievement of the millennium development goal (MDG) 1 of halving poverty from 56 percent in 1992–1993 to 24.5 percent in 2009–2010, 5 years ahead of time. Much of this progress was attributed to strong economic growth – an average of 7.4 percent in the study period – and improved human development indicators particularly in education and health. However, the growth was uneven across the country with some areas, particularly the northern region which experienced insurgency for two decades and the rural areas which predominantly earned low incomes from agricultural activities, lagging behind. For instance, between 2006 and 2013, the share of the poor population remained high in the northern region (47 percent from 39 percent earlier) and the eastern region (37 percent from 29 percent) as compared to the western region (10 percent from 17 percent) and the central the (6 percent from 15 percent) (the World Bank 2016).

This uneven poverty reduction triggered an increase in income inequality from 0.36 in 1992 to 0.43 in 2009–2010 (UoBS 2010) which is an issue of concern. Income inequality can be tolerated if low-income individuals have a chance of moving up the income distribution ladder (Campos and Melendez 2014). Therefore, it is useful for countries with high levels of inequality to understand the dynamics of income mobility for policymaking. It is believed that countries with segments of the society excluded from the growth process are more likely to experience low upward income mobility and conversely societies that address exclusion reflect high upward mobility (Cuesta et al. 2007). Individuals in societies that are susceptible to macroeconomic shocks and ineffective social protection schemes may experience high levels of downward mobility (Inchauste et al. 2003; Fields et al. 2007).

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An analysis of income mobility is useful because it is a measure of change in the well-being of economic agents over time. As economies grow, agents are bound to experience changes in their welfare, whether transitory or permanent, which may improve (upward movement) or worsen (downward movement) their welfare. However, without longitudinal data it is difficult to know those benefiting (moving up the income distribution levels) or losing (moving down the income distribution levels) from the growth process (Fields et al. 2007). A society that has a higher level of income mobility implies that individuals or households are less constrained socially and economically to take advantage of economic opportunities and therefore agents located at the lower end of the income distribution have an opportunity to move up and thus induce equality of income over time. Therefore, greater mobility is often seen as a measure of equality of opportunity although Jarvis and Jenkins (1998) warn that too much income mobility may signal economic insecurity.

This paper analyzes households' income mobility moving along income distribution over time and the determinants of their movements. It uses a binomial probit model to investigate the factors which influence upward and downward mobility. We hypothesize that households endowed with more human and physical capital are more likely to experience upward income mobility. Similarly, due to geographical disparities in economic development, households located in the urban and central regions are more likely to experience upward income mobility than their counterparts located elsewhere.

This paper addresses the following empirical questions: First, what is the estimated rate of income mobility for a given period in Uganda? In other words, what fraction of households change their position in the income distribution in a given period? Second, is income mobility higher at the bottom or top of the income distribution? Third, what is the role of human capital in the transition from one level to another? For instance, does education encourage upward mobility? Fourth, what is the role of physical capital in the transition? In other words, does the endowment of assets prevent downward mobility?

The aim of this paper is to provide evidence of the fluidity of income mobility in Uganda and the factors influencing income transitions. The study found a higher rate of income mobility (60 percent) at the bottom with income mobility of 43 percent at the top. It also found that a household's asset endowments, whether human or physical, had the most economically significant impact on income mobility.

The rest of the paper is structured as follows: Sect. 2 gives a review of literature related to this study and Sect. 3 gives the data and descriptive statistics. Section 4 describes the methodology used and Sect. 5 discusses the findings of the study. Section 6 gives a conclusion and provides policy implications on the basis of its findings.

## 2 Literature Review

Income mobility is a dynamic and multifaceted concept which analyzes changes in income for the same economic agents (individuals or households) over time. According to Fields and Zhang (2007) mobility can be viewed either as a time dependent or movement measure of income change. Empirical studies using the time dependent concept assume an influence of past income on income changes (Grootaert et al. 1997; Albornoz and Menendez 2002; Woolard and Klasen 2004; Antman and McKenzie 2007). On the other hand, the movement measure strand of studies considers a change in the rank or position of an agent between two periods (Castro 2011). Another dimension is an analysis of income mobility within generations (intragenerational) or between generations (intergenerational). Intergenerational income mobility focuses on the influence of parental background on income changes (Björklund and Jäntti 2000) while intragenerational mobility presupposes the influence of lifetime factors in determining income change (Albornoz and Menendez 2002; Fields et al. 2007; Castro 2011).

Income mobility has two major dimensions of measurement – absolute and relative measures. Absolute mobility analyzes the changes in absolute income over time while relative mobility examines the change in an agent's rank along income distribution between two periods. These two measures of mobility have their strengths and weaknesses. For instance, the use of absolute measures or single-stage indices such as Shorrock's rigidity index or Atkinson's index enable a researcher to use all the information inherent in income distribution for doing a comprehensive analysis. However, these measures are sensitive to measurement errors, which is a serious problem when data from two waves is used. Conversely, focusing on relative mobility, in particular using transition matrices, enables a researcher to summarize mobility inherent in income distribution. However, analyzing mobility using transition matrices comes at the cost of losing information on mobility within groups. In this respect, it may be useful to supplement an analysis of the transition matrix with other absolute measures of income mobility (Fields and Ok 1999).

Literature provides a number of studies on income mobility especially in developed countries with a few in developing countries which are mostly based in Latin America; there are very few studies in sub-Saharan Africa. Most of these studies consider the time dependence dimension of income mobility with studies which consider the movement dimension being limited in number. Both strands of studies investigate the impact of human capital variables (education), physical capital (household assets), individual characteristics of the household head (gender, age, marital status) and geographical location (urban/rural, region) on income changes or change in a household's ranking on its income distribution profile. Studies that investigate the determinants of change in rank along income distribution commonly use the binary probit or logit models (Castro 2011). However, Scott and Litchfield (1994) used an ordered probit model investigating three states: households that moved to a higher income position, those that stayed in the same position and those that moved to a lower income position.

The transition matrices follow stochastic processes like the Markov chain process where transitions across agents are independent. Notably, the Markovian model of income mobility has limitations that emanate from its two assumptions: stationarity of transitions over time and the probability of moving from one state to another which should be independent of history. Therefore, these results must be interpreted with these caveats. Studies which investigate the movement dimension of income mobility analyze the rate of transition between states and the factors which influence upward or downward mobility. Studies which have analyzed upward and downward mobility find the determinants of the occurrence to be symmetrical. For example, Castro (2011) found in Chile that upward mobility was enhanced by a change from unemployment to employment, higher education, urban residence, being married and female headship but it was inversely influenced by male headship and the number of children. The same factors (apart from gender and marital status) influenced downward mobility except they switched signs. In the case of gender, male headed households were less likely to move either up or down while marital status was only significant for upward movement.

The general observation in literature is that income mobility is higher in developing than in developed countries especially at the bottom of the income distribution. For instance, Scott and Litchfield (1994) cited in Castro (2011) found that half the households at the bottom of the income distribution moved upwards and only 26 percent moved downwards. They note that households that moved upwards did not go far although the extent of upward movement (number of states transited) was normally greater than the extent of downward movement.

Literature on income mobility in developing countries is scarce and is concentrated in Latin America partly because of the availability of longitudinal data and concerns about the high inequality levels amidst targeted social interventions in this region (Woolard and Klasen 2004; Castro 2011; Campos and Melendez 2014). Available studies on Uganda focus on analyzing poverty dynamics rather than income mobility. Mckay (2005), Lawson et al. (2006) and Ssewanyana (2009) examined poverty transitions and factors associated with chronic and transitory poverty using household panel data for 1992–1993 and 1999–2000. McKay and Lawson et al. analyzed four forms of poverty transitions: those non-poor in both periods (never poor), poor in 1992–1993 but non-poor in 1999–2000 (escaping poverty), non-poor in 1992–1993 but poor in 1999–2000 (falling into poverty) and poor in both periods (chronically poor). Mckay (2005) provides a descriptive analysis of income poverty transitions using household consumption per adult as an indicator for income. His study found significant income mobility (both upward and downward) for the poorest segments of the sample. Further, the results of his study suggest that income changes were unlikely to be permanent with the poorest escaping and falling into poverty reflecting volatility in incomes. Using a multinomial logit model, Lawson et al. (2006) analyzed poverty transitions and found a strong positive association between education and being never poor and a strong correlation between poverty and location of residence.

Ssewanyana and Kasirye (2013) add to the studies that analyze poverty dynamics in Uganda by using more recent data from 2009–2010 and 2010–2011; they also attempt to analyze income mobility. They provide a detailed descriptive analysis of poverty and inequality changes in the study period and their findings complement earlier studies that found poverty to be more transient than permanent. Consistently, they also find high household income mobility using household consumption as a proxy for income. They analyze income transitions using quintiles and find higher mobility at the bottom of the welfare distribution with more than half the households located in the lowest quintile in 2009–2010 moving up the welfare distribution in

2010–2011 and 40 percent of the households in the highest quintile in 2009–2010 moving down the welfare distribution in 2010–2011. The authors did not analyze the determinants of income changes which we attempt in this study.

## 3 Data and Descriptive Statistics

The data used in this study comes from the Uganda National Panel Surveys (UNPS) collected by the Uganda Bureau of Statistics (UBoS). The panel surveys were started in 2009–2010 and were preceded by a baseline survey in 2005–2006. We used three waves of this data: 2009–2010, 2010–2011 and 2011–2012 because these waves are more comparable than the 2005–2006 wave and the most recent wave of 2013–2014. The 2005–2006 data differs from these three waves because of the changes in the variables where some have been dropped and others introduced, while in the 2013–2014 data many of the households covered previously were missing. This would hence give a small sample. The 2009–2010 wave of data sought to trace 3123 households covered in the 2005–2006 panel data and consequently it covered 2975 households while 2716 and 2850 households were covered in 2010–2011 and 2011–2012 respectively. The attrition rate for households in the sample is about 10 percent.

We specifically used data from the socioeconomic module of the data collected both at household and individual levels. The module collected data on household income, household demographics, individual characteristics, consumption and shocks experienced by a household. The survey asked respondents to specify the income that they had earned over the past 12 months from different sources such as household enterprises, property, financial assets and transfers.[1] Similarly, households were also asked to specify consumption expenditure for a month.[2] Both the income and consumption expenditure nominal values were converted into real values using the consumer price index (CPI) considering 2009 as the base year. We accounted for household economies of scale by deflating the real income or consumption with adult equivalent scales adopted from Appleton et al. (1999).

We compiled descriptive statistics for our estimation sample to establish the household characteristics in the constructed quintiles (Table 12.1). These quintiles were endogenously determined and all households with reported incomes were distributed in the respective quintiles. As expected, the mean income and consumption increased with the quintile. We note that mean household incomes were more dispersed than mean household consumption and observe that for both well-being measures the gap between quintiles was the widest at the top. We also observe that all other variables increased with quintile except the number of children in the household and percentage of female headed households. Therefore, the raw data suggests a positive correlation between schooling, asset endowments, age and residence in an urban area with income status.

[1] Income excludes formal salaries/wages.

[2] The expenditure excludes non-consumption expenditure.

**Table 12.1** Sample means of the variables used in the model

| Quintile | Annual HH (equalized) | Monthly HH consumption (equalized) | HH years of schooling | HH assets (log values) | Children | HH age | Female headed HH (%) | Urban (%) |
|---|---|---|---|---|---|---|---|---|
| First (lowest) quintile | 160,139 | 25,629 | 4.7 | 14.4 | 4.45 | 46.65 | 22.51 | 6.99 |
| Second quintile | 270,621 | 36,758 | 5.5 | 15.23 | 4.76 | 46.02 | 19.43 | 8.27 |
| Third quintile | 356,673 | 47,497 | 6.3 | 15.61 | 4.66 | 46.13 | 22.20 | 11.72 |
| Fourth quintile | 623,037 | 65,888 | 7.2 | 16.16 | 4.34 | 47.38 | 21.64 | 22.75 |
| Fifth (highest) quintile | 1,700,520 | 275,300 | 9.4 | 17.38 | 3.85 | 48.47 | 22.59 | 46.19 |

Source: Authors' computation using 2009–2010, 2010–2011 and 2011–2012 UNPS data
Notes: Income and consumption reported in Uganda shillings. *HH* household

# 4 Methodology

Since we use longitudinal data our major interest is measuring the relative or dynamic aspects of income mobility using transition matrices which specify the state occupied at two points in time. The transition matrices measure relative income mobility by first assigning the households into groups which are endogenously determined such as the quintile. Consequently, we also measure the rate of income mobility using the matrix $P_{ij}$ which follows the Markov chain process, where *i* denotes the initial state occupied by a household and *j* represents the final state occupied by the household. The probability of movement between the states is given by the off-diagonal elements of the matrix. If the off-diagonal components increase at the expense of the diagonal elements this signals a high level of mobility. Conversely, if the diagonal elements increase at the expense of the off-diagonal components then it shows a low level of mobility. Transition matrices are useful in analyzing income mobility because they are able to summarize mobility at different positions in income distribution which is difficult to achieve with single-stage measures. Transitions are also more robust to measurement errors (Woolard and Klasen 2004). However, they too have limitations of disregarding changes within a group (Fields and Ok 1999).

Given that both measure well-being, while analyzing income mobility a researcher has a choice of using either income or expenditure data. Nonetheless, there are concerns over the use of income rather than expenditure data because the former is less susceptible to measurement errors. Normally, expenditure data is reported with more accuracy because of lack of stigma attached to expenditure values, a shorter recall period and figures that are fairly constant over time. Further, expenditure reflects the long-term well-being of a household (or its permanent income), since households apply consumption smoothing by using their savings to address erratic shortfalls in income (Deaton 1997). However, Fields et al. (2003) note that in some instances income data may be more accurately reported than expenditure data. In addition, expenditure data gives limited variations between households because of the lower level of satiation in consumption as compared to income. We use income data because it is the most appropriate way of analyzing income mobility as it enables a researcher to distinguish between demographic and economic events (Woolard and Klasen 2004). However, we use expenditure data for robustness checks.

An analysis of the dynamic economic well-being of households must take into account household economies of scale. In this respect, scholars have either used income per capita which adjusts for household size (Glewwe and Nguyen 2002; Fields et al. 2003) or used adult equivalent household income which accounts for household composition based on the calorie intake of household members (Jarvis and Jenkns 1997; Albornoz and Menendez 2002; Woolard and Klasen 2004; Castro 2011). Another data challenge is an attrition bias where agents that exit from the sample are significantly different from those that remain in the sample and therefore cause biased estimates. Studies that use panel data acknowledge the potential impact of attrition (Albornoz and Menendez 2002; Ssewanyana and Kasirye 2013). Albornoz and Menendez (2002) address this by using the inverse probability weight method. We also use the inverse probability weight method to account for an attrition bias.

We follow Castro (2011) and examine the determinants of income mobility using a binomial probit model that analyzes the relative movement of households along the income distribution using quintiles:

$$\Pr\left(Y_{ij}\right) = \Phi\left(\alpha + \beta X_i + \gamma \Delta Z_{ij}\right) \tag{12.1}$$

where $\Phi$ denotes a standard normal cumulative distribution function, $i$ indexes the first period and $j$ the second period, $Y_{ij}$ is a binary variable where one represents households which changed income quintiles either from the lowest quintile to upper quintiles (upward mobility) or from the highest quintile to lower quintiles (downward mobility) and zero represents households that stayed in the same quintile. The quintiles are computed using predicted real equivalized annual household incomes (we use household consumption expenditure as an identifying variable), $X_i$ denotes a vector of characteristics of a household or individual which do not change over time and are taken at their initial values and $Z_{it}$ represents a vector of household/individual characteristics that change over time; we use mean values in the estimation.

We estimate the probit model using the same individuals differently for upward and downward mobility between 2 years (2009–2010 to 2011–2012) and 1 year (2009–2010 to 2010–2011). To address measurement errors, we perform robustness checks by estimating model (1) using different samples and using the consumption variable as the dependent variable. We first employ an instrumental variable technique where we regress real equivalized household income on age of the household head, mean of schooling of the household, gender of the household head, geographical location and asset endowments and obtain predicted income values which are used to construct the transition variables for upward and downward income mobility.

In the transition model we analyze the impact of household characteristics such as the age of the household head, education of the household head, marital status of the household head, value of household assets, geographical location and whether a household experienced a shock such as death of the earner or theft of money[3] on the upward or downward movement of the household along income distribution. Upward movement refers to all households occupying the lowest quintile in the initial year moving to an upward quintile in the final year, while downward movement refers to all households occupying the highest quintile in the initial year moving to a lower quintile in the final year.

Because we have an unbalanced sample and observe a difference in sample means in the t-test (results provided in Table 12.6 in the appendix) for all variables for the households that remain in the sample and those that attrite we account for attrition by using the inverse probability weight method. We first construct an attrition variable *A* where one represents those who exit and zero represents those who remained in the sample for the three waves. In order to construct the inverse probability weight we generate a reverse variable *R* by reversing the attrition variable *A*. Consequently, we obtain predicted probabilities from a non-restricted regression model:

$$R_{it} = c_{it}\gamma + a_{it}\delta + v_{it} \tag{12.2}$$

where $c_{it}$ are the control variables affecting only attrition and $a_{it}$ are auxiliary variables that affect both household income and attrition. Subsequently, we compute predicted probabilities from a restricted model that excludes auxiliary variables:

$$R_{it} = c_{it}\gamma + \varphi_i \tag{12.3}$$

The inverse probability weight is obtained by the ratio of predicted values of the estimation sample of Eqs. (12.3) and (12.4) and is denoted as:

$$W_i = \frac{p^r}{p^u} \tag{12.4}$$

where $p^r$ represents predicted values from the restricted model (obtained from Eq. 12.2) and $p^u$ represents the predicted values from the unrestricted model (obtained from Eq. 12.3). The inverse probability weight is useful because it gives more weight to households with similar characteristics in the initial wave who subsequently attrite than to households with characteristics that make them more likely to remain in the sample.

[3] These shocks were selected because they were the most prevalent ones.

## 5 Results and Discussion

We first investigate the rate of transition of households between quintiles using the transition matrix $P_{ij}$, over a 2 and 1 year period. In Table 12.2 we present results for mobility within a period of 2 years. It can be seen from the table that the rate of income mobility at the bottom is higher than at the top but mobility is the highest in the middle quintiles. This finding is consistent with similar studies (Leibbrandt and Woolard 2001; Cantó 2002; Woolard and Klasen 2004; Niny and John 2006). The results suggest that within a period of 2 years (2009–2011), 60 percent of the households in the lowest quintile in 2009 moved to upper quintiles in 2011 although a majority did not go far (25 percent moved to the second quintile and 15 percent to the third). On the other hand, only 43 percent of the households occupying the highest quintile in 2009 moved to a lower quintile in 2011 with a similar pattern that a majority of them (20 percent) went to a nearby quintile (fourth). As a robustness check, we analyze the rate of transition within a one-year period (2009–2010) and find that the results are robust (Table 12.3). We further conduct a robustness check by analyzing the rate of transition using consumption data and the results are consistent with the observation that mobility is the highest at the bottom of the distribution in the two-year period though as expected households portray lower rates of mobility as shown in Tables 12.8 and 12.9 in the appendix.

We first estimate Eq. (12.1) for upward and downward mobility without accounting for attrition (unweighted model) but later address attrition (weighted model) and obtain marginal effects as shown in Table 12.4 which gives the results for upward mobility for the two-year period. We observe that the weighted model performs better than the unweighted model. Overall, we find that our results are robust whether we account for attrition or not but we note that the models are sensitive to the period of investigation where a longer period (2 years) performs better than the shorter period (1 year). The results for the one-year period are available on request. Consequently, we uphold the results for the weighted model for the two-year period as our main results. See Table 12.7.

According to empirical literature in our model the influence of the variables on income mobility should be symmetrical between upward and downward mobility. We observe this in our results. We, therefore, discuss the determinants of upward

**Table 12.2** Transition matrix by quintile (percentages), 2009–2011

| | Quintile 2011 | | | | | |
|---|---|---|---|---|---|---|
| Quintile 2009 | 1 | 2 | 3 | 4 | 5 | Total |
| 1 | 40.23 | 25.20 | 15.38 | 11.91 | 7.28 | 100 |
| 2 | 23.84 | 28.10 | 23.51 | 16.28 | 8.26 | 100 |
| 3 | 12.74 | 19.29 | 26.75 | 26.06 | 15.15 | 100 |
| 4 | 8.99 | 14.67 | 22.01 | 30.65 | 23.67 | 100 |
| 5 | 3.67 | 9.45 | 9.58 | 20.08 | 57.22 | 100 |

Source: Authors' computation using 2009–2010, 2010–2011 and 2011–2012 UNPS data

**Table 12.3** Transition matrix by quintile (percentages), 2009–2010

| | Quintile 2010 | | | | | |
|---|---|---|---|---|---|---|
| Quintile 2009 | 1 | 2 | 3 | 4 | 5 | Total |
| 1 | 41.56 | 26.58 | 14.56 | 10.55 | 6.75 | 100 |
| 2 | 26.58 | 26.14 | 22.00 | 17.65 | 7.63 | 100 |
| 3 | 13.04 | 18.91 | 27.83 | 26.96 | 13.26 | 100 |
| 4 | 7.41 | 16.54 | 22.47 | 32.59 | 20.99 | 100 |
| 5 | 4.49 | 8.71 | 9.83 | 21.07 | 55.90 | 100 |

Source: Authors' computation using 2009–2010 and 2010–2011 UNPS data

**Table 12.4** Determinants of upward income mobility, 2009–2011

| Variables | Unweighted | | Weighted | |
|---|---|---|---|---|
| | dy/dx | Robust Str. Err | dy/dx | Robust Str. Err |
| Primary education | 0.123* | 0.075 | 0.165*** | 0.033 |
| Lower secondary | 0.228** | 0.110 | 0.054 | 0.050 |
| Diploma | 0.380*** | 0.189 | 0.060 | 0.131 |
| Degree | | | 0.364*** | 0.140 |
| Female head | 0.054 | 0.076 | 0.159*** | 0.037 |
| Age of head | −0.031** | 0.012 | −0.010 | 0.007 |
| Age of head squared | 0.000** | 0.000 | 0.000** | 0.000 |
| Married head | −0.042 | 0.082 | 0.014 | 0.038 |
| Children | −0.040*** | 0.011 | −0.033*** | 0.004 |
| Urban | 0.178* | 0.107 | 0.256*** | 0.056 |
| Eastern region | −0.076 | 0.096 | −0.120*** | 0.044 |
| Northern region | −0.199** | 0.091 | −0.169*** | 0.043 |
| Western region | −0.289*** | 0.091 | −0.282*** | 0.041 |
| Owns land | 0.026 | 0.079 | 0.092*** | 0.033 |
| Asset endowment | 0.319*** | 0.048 | 0.243*** | 0.017 |
| Farm | 0.071 | 0.055 | 0.076*** | 0.025 |
| Non-farm | 0.512*** | 0.102 | 0.301*** | 0.045 |
| Observations | 2679 | | 3460 | |

*Notes:* Standard errors are clustered at the household level for the unweighted model. For the weighted model we use survey weights * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The reference group for education is no formal education and for region is central. There were no results for education 3 – upper secondary education for both models so it was dropped

and downward income mobility concurrently (Tables 12.4 and 12.5). Overall our results are consistent with existing literature which suggests that upward (downward) income changes are positively (negatively) influenced by human capital, physical capital, being female and location (Grootaert et al. 1997; Fields et al. 2007; Castro 2011). For instance, we find evidence that more educated household heads are more likely (less likely) to move up (move down) the income distribution ladder over time as shown in Tables 12.4 and 12.5.

Overall, the results of the unweighted and weighted models are robust though the weighted model tends to perform better with more significant variables and a higher

**Table 12.5** Determinants of downward income mobility, 2009–2011

| Variables | Unweighted | | Weighted | |
|---|---|---|---|---|
| | dy/dx | Robust Str. Err | dy/dx | Robust Str. Err |
| Primary education | −0.058 | 0.076 | 0.039 | 0.029 |
| Lower secondary | −0.102 | 0.064 | −0.090*** | 0.023 |
| Upper secondary | −0.121 | 0.085 | | |
| Diploma | −0.150** | 0.064 | −0.094*** | 0.025 |
| Degree | −0.207*** | 0.065 | | |
| Female head | −0.009 | 0.051 | −0.065*** | 0.021 |
| Age of head | 0.008 | 0.006 | 0.017*** | 0.003 |
| Age of head squared | −0.000 | 0.000 | −0.000*** | 0.000 |
| Married head | 0.019 | 0.053 | −0.003 | 0.025 |
| Children | 0.012 | 0.008 | 0.015*** | 0.003 |
| Urban | −0.216*** | 0.031 | −0.097*** | 0.017 |
| Eastern region | 0.051 | 0.051 | 0.028 | 0.022 |
| Northern region | 0.116* | 0.060 | 0.095*** | 0.023 |
| Western region | 0.042 | 0.047 | 0.074*** | 0.024 |
| Owns land | 0.020 | 0.048 | 0.009 | 0.022 |
| Asset endowment | −0.141*** | 0.022 | −0.181*** | 0.010 |
| Farm | −0.089* | 0.048 | 0.030 | 0.023 |
| Non-farm | −0.189*** | 0.045 | −0.170*** | 0.022 |
| Ill hh head | 0.065 | 0.074 | −0.078** | 0.035 |
| Theft of money | | | −0.105** | 0.045 |
| Observations | 2607 | | 3759 | |

*Notes:* Standard errors are clustered at the household level for the unweighted model. For the weighted model we use survey weights * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The reference group for education is no formal education and for region is central

level of precision. With reference to education, we find that the probability of upward (downward) mobility increases (decreases) with the level of education which is consistent with existing literature (Castro 2011). We note that the models for upward income mobility capture the effects of higher levels of education (for example, a degree) contrary to the downward income mobility models which perform better with lower levels of education. These results suggest that education has a strong effect on income mobility and cushions households against downward income mobility. For instance, in Table 12.5 (weighted model), if the household head possesses a university degree this increases the chance of the household moving up the income distribution by 36 percentage points which is the greatest impact in the model. Therefore, these results suggest that human capital is the most important determinant of upward income mobility. This is expected given the role of education in earnings.

On the other hand, households with more education are less likely to experience downward income mobility. For example, if a household head holds a diploma in education, the household is less likely to move down the income distribution levels by 9 percentage points.

Consistent with literature (Castro 2011), a household headed by a female has a higher chance of moving up (lower chance of moving down) the income distribution ladder than male headed households. In Table 12.5 (weighted model), the probability of a female headed household moving up the income ladder is higher by 16 percentage points. In Table 12.5, the probability of the household moving down the income distribution ladder reduces by 6 percentage points if the household head is a female.

As expected, we find that the number of children in a household inversely affect the household's upward income mobility (positively affect downward movement) though marginally. For example, an increase in the number of children reduces the likelihood of a household moving up the income distribution by 3 percentage points and movement down by 1 percentage point. We also find that residing in an urban area increases a household's chances of moving up the income distribution by 26 percentage points which is a large effect. Similarly, if a household resides in an urban area its probability of moving down the income distribution ladder reduces by 10 percentage points.

We also observe strong regional effects. The results suggest that households not residing in the central region have a lower probability of experiencing upward mobility in the range of 12–28 percentage points depending on the region of residence. For example, a household residing in the northern region is less likely to move up the income distribution by 17 percentage points than its counterparts in the central region. Similarly, a household residing in the northern region is more likely to move down the income distribution by 9 percentage points.

Physical assets play a significant role in moving households up (or down) income distribution levels. For instance, if a household is endowed with land[4] it increases its probability of shifting to an upward income position by 9 percentage points while the use of a composite value of all household assets (ranging from small assets such as a phone to big assets like land) further enhances a household's upward movement by 24 percentage points. In our models (Table 12.5), we investigate whether the main source of income, in particular earnings from farm activities and non-farm activities, affect income mobility. We find evidence of the impact of the source of earning on upward mobility which is higher for non-farm activities than for farm activities. For example, a household earning mainly from farm activities shows an increased likelihood of moving up the income distribution level by 8 percentage points while its earnings from non-farm activities increases the probability of its moving up the income distribution ladder by 30 percentage points. These results suggest that non-farm income plays a greater role in upward income mobility than farm income.

We do not find a significant impact of farm earnings on downward income mobility but find that a household earning from non-farm activities is less likely to move down the income distribution ladder by 17 percentage points. This casts doubts on the effectiveness of the land asset in income generation for households.

[4] Land was captured as a binary variable for those with and without land.

We include the variables of an ill household head and theft of money to capture shocks to a household's social and economic status. We expected these shocks to enhance a household's downward movement along income distribution. Our results are surprising. Perhaps these variables mask other effects like a household with a sick head receiving support from family and friends and being able to sustain its income stream or households that experience theft of money already being financially sound households.

We further check the robustness of our results by estimating Eq. (12.1) using consumption expenditure data (the results are presented in Tables 12.10 and 12.11 in the appendix). We present results both for the weighted and unweighted models for the two-year period. We find that the results are robust, except in two scenarios: lower levels of education (lower secondary and below) which reduce upward mobility and owning land which reduces upward mobility and increases downward mobility. The results for lower levels of education are plausible and are consistent with Castro (2011) who found that for education to enhance upward mobility it had to be higher than high-school education. The results for land are surprising but could be a signal for low factor productivity manifested in subsistence agricultural production in Uganda which has a limited impact on household welfare. As noted earlier, the weighted model performs better and confirms that education has the greatest positive (negative) economic significance on upward (downward) mobility.

## 6 Conclusion and Policy Recommendations

This study investigated the rate and determinants of households' income mobility in Uganda. It analyzed income mobility using a transition matrix that measured relative income mobility. Using predicted real equivalized household income, it assigned households into quintiles which were endogenously determined. Since we had data from three waves of the panel survey (2009–2010, 2010–2011 and 2011–2012) we analyzed income mobility for a period of 2 years (2009–2011) and 1 year (2009–2010). We investigated the determinants of income mobility using a probit model separately for households that moved up the income distribution ladder (upward mobility) and down the income distribution level (downward mobility). Further, since there was evidence that attrition could potentially bias our estimates we used the inverse probability weight method to address this issue. The paper presents results for both the unweighted model (attrition not addressed) and the weighted model (attrition addressed) for all our estimated models.

We investigated the fluidity of income mobility and found a higher rate of income mobility at the bottom (60 percent) than at the top (43 percent) for the two-year period. This finding was robust even when we reduced the period from two to one year and even when quintiles were constructed using monthly household consumption expenditure. While investigating the determinants of income mobility we found the human capital variable (education) to have the most economically significant impact on income mobility which increased with the level of education. For instance, if a household head held a university degree it increased the probability of the household moving up the income distribution ladder by 36 percentage points. Equally important was the physical asset variable (value of assets) which had a high economic significance. For example, a household more endowed with assets increased its chance of moving up the income distribution ladder by 24 percentage points and reduced the likelihood of its moving down the distribution ladder by 18 percentage points.

In case of gender, female headed households had a 16 percent higher chance of moving up and a 7 percent lower chance of moving down the income distribution level than their male counterparts. The study found a mixed impact of land on income mobility. When we used the income variable we obtained the expected results of land enhancing upward mobility. However, when we used the consumption variable we found that owning land reduced the probability of moving up by 17 percentage points and increased the chances of moving down by 15 percentage points. Our finding reinforces the stylized fact that most of the agricultural production in Uganda is subsistence and may not cushion households from a decline in welfare.

This study also establishes that the source of income matters, with incomes from non-farm activities playing a more significant role than income from farm activities. For instance, households whose main income source was farm activities increased their chances of moving up the income distribution ladder by 8 percentage points while earnings from non-farm activities were 30 percent more likely to help households move up the income ladder. Conversely, households earning from farm activities were 3 percent (though not statistically significant) less likely to move down the income distribution level and earnings from non-farm activities meant that households were less likely to go down the income ladder by 17 percent.

In conclusion, our study found that the education level and gender of the household head, marital status, physical capital, household composition, location and source of income determined whether a household was more (less) likely to move up (down) the income distribution ladder. Addressing the attrition bias made our results more robust and precise. We performed various robustness checks which confirmed the robustness of our results.

Based on our results we recommend increased investments in human capital, particularly in education which greatly enhances upward income mobility and at the same time protects households against downward mobility. We note that it is higher education (higher than the secondary level) that matters most; hence, this should be promoted. The study also establishes that investments in women pay dividends since they have a higher chance of moving up the income ladder than their male counterparts. Therefore, we recommend increasing women's empowerment for households to reap more dividends.

We find glaring differences in income mobility in household's geographical location in favor of households residing in urban areas or the central region. To promote equality in welfare, the government should encourage the dispersion of development to enable households in less developed areas to benefit from the development process.

There is also an urgent need to make the land asset in Uganda more economically viable by enhancing incomes from it. The government should design strategies that are aimed at increasing the viability of land as a factor of production. In this respect, the commercialization and modernization of agricultural programs should be promoted to address the limited role that land plays in income generation. Since our results show that income from non-farm activities plays a greater role in enhancing household incomes as compared to income from farm activities, households need to devise strategies that promote the diversification of income not only to spread economic risks but also to participate in more lucrative markets by selling high value products or services.

## Appendix

**Table 12.6** A comparison of sample means for exit and panel households

| Variable | Remained (balanced sample) | Exited | P-value |
|---|---|---|---|
| Education level of household head | 1.02 | 0.89 | 0.0000 |
| Age of head | 47.04 | 46.53 | 0.0333 |
| Female headed | 0.22 | 0.40 | 0.0000 |
| Married head | 0.82 | 0.67 | 0.0000 |
| Farm income | 0.54 | 0.37 | 0.0000 |
| Non-farm income | 0.20 | 0.26 | 0.0000 |
| Urban | 0.17 | 0.30 | 0.0000 |
| Children | 4.48 | 3.46 | 0.0000 |
| Log assets | 15.72 | 14.86 | 0.0000 |
| Land | 0.90 | 0.70 | 0.0000 |

Source: Authors' computation using the 2009–2010, 2010–2011 and 2011–2012 UNPS data

**Table 12.7** Factors influencing attrition

| Variable | dy/dx | Str. Err |
|---|---|---|
| Education head | −0.006 | 0.005 |
| Female head | 0.026* | 0.013 |
| Age head | −0.000 | 0.002 |
| Age head squared | 0.000 | 0.000 |
| Married head | −0.007 | 0.014 |
| Owns land | −0.043*** | 0.013 |
| Eastern region | −0.080*** | 0.016 |
| Northern region | −0.077*** | 0.016 |
| Western region | −0.048*** | 0.018 |
| Urban | 0.064*** | 0.013 |
| Children | −0.001 | −0.001 |
| Asset endowment | −0.032*** | 0.005 |
| Farm income | −0.015 | 0.011 |

(continued)

**Table 12.7** (continued)

| Variable | dy/dx | Str. Err |
|---|---|---|
| Non-farm income | −0.024* | 0.013 |
| Ill head | 0.004 | 0.016 |
| Theft of money | 0.007 | 0.020 |
| lnconsumption | 0.023*** | 0.007 |
| Year dummy – 2010 | −0.037*** | 0.007 |
| Year dummy – 2011 | 0.017*** | 0.005 |

*Notes*: The standard errors are clustered at household level, *p < 0.10, **p < 0.005, ***p < 0.01

**Table 12.8** Transition matrix by quintile (percentages), 2009–2011 using consumption

| | Quintile 2011 | | | | | |
|---|---|---|---|---|---|---|
| Quintile 2009 | 1 | 2 | 3 | 4 | 5 | Total |
| 1 | 56.45 | 24.64 | 11.71 | 5.49 | 1.72 | 100 |
| 2 | 33.48 | 30.35 | 19.63 | 12.87 | 3.67 | 100 |
| 3 | 16.63 | 27.88 | 28.83 | 19.24 | 7.42 | 100 |
| 4 | 6.59 | 16.69 | 27.43 | 29.82 | 19.47 | 100 |
| 5 | 2.18 | 3.15 | 6.88 | 24.57 | 63.22 | 100 |

Source: Authors' computation using the 2009–2010, 2010–2011 and 2011–2012 UNPS data

**Table 12.9** Transition matrix by quintile (percentages), 2009–2010 using consumption

| | Quintile 2010 | | | | | |
|---|---|---|---|---|---|---|
| Quintile 2009 | 1 | 2 | 3 | 4 | 5 | Total |
| 1 | 62.42 | 20.99 | 9.96 | 5.35 | 1.28 | 100 |
| 2 | 40.95 | 28.37 | 17.85 | 9.70 | 3.13 | 100 |
| 3 | 20.62 | 27.40 | 27.97 | 16.24 | 7.77 | 100 |
| 4 | 7.74 | 19.09 | 30.31 | 23.90 | 18.95 | 100 |
| 5 | 3.13 | 2.90 | 7.33 | 23.30 | 63.33 | 100 |

Source: Authors' computation using the 2009–2010, 2010–2011 and 2011–2012 UNPS data

**Table 12.10** Determinants of upward mobility using consumption data

| Variables | Unweighted | | Weighted | |
|---|---|---|---|---|
| | dy/dx | Robust Str. Err | dy/dx | Robust Str. Err |
| Primary education | −0.142* | 0.079 | −0.062* | 0.033 |
| Lower secondary | −0.078 | 0.076 | −0.088*** | 0.026 |
| Diploma | 0.340*** | 0.124 | 0.141* | 0.077 |
| Female head | 0.040 | 0.090 | 0.084* | 0.044 |
| Age of head | −0.028** | 0.012 | −0.013*** | 0.005 |
| Age of head squared | 0.000* | 0.000 | 0.000*** | 0.000 |
| Married head | −0.053 | 0.102 | 0.063 | 0.043 |
| Children | −0.011 | 0.012 | −0.016*** | 0.005 |
| Urban | 0.014 | 0.102 | 0.069* | 0.039 |

(continued)

**Table 12.10** (continued)

| Variables | Unweighted | | Weighted | |
|---|---|---|---|---|
| | dy/dx | Robust Str. Err | dy/dx | Robust Str. Err |
| Eastern region | 0.074 | 0.100 | −0.117*** | 0.043 |
| Northern region | −0.012 | 0.098 | −0.039 | 0.042 |
| Western region | 0.002 | 0.105 | −0.051 | 0.044 |
| Owns land | −0.076 | 0.097 | −0.165*** | 0.041 |
| Asset endowment | 0.091*** | 0.031 | 0.061*** | 0.012 |
| Farm | 0.032 | 0.067 | −0.070** | 0.029 |
| Non-farm | 0.059 | 0.093 | 0.057 | 0.039 |
| Observation | 3521 | | 4117 | |

*Notes:* Standard errors are clustered at the household level for the unweighted model. For the weighted model we use survey weights * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The reference group for education is no formal education and for region is central

**Table 12.11** Determinants of downward mobility using consumption data

| Variables | Unweighted | | Weighted | |
|---|---|---|---|---|
| | dy/dx | Robust Str. Err | dy/dx | Robust Str. Err |
| Primary education | −0.102 | 0.082 | −0.062* | 0.033 |
| Lower secondary | −0.018 | 0.073 | −0.088*** | 0.026 |
| Upper secondary | −0.060 | 0.123 | 0.084 | 0.051 |
| Diploma | −0.203*** | 0.066 | −0.173*** | 0.026 |
| Degree | −0.276*** | 0.068 | −0.188*** | 0.040 |
| Female head | −0.093* | 0.056 | −0.055** | 0.025 |
| Age of head | −0.004 | 0.008 | −0.002 | 0.004 |
| Age of head squared | 0.000 | 0.000 | 0.000 | 0.000 |
| Married head | −0.084 | 0.070 | −0.059** | 0.029 |
| Children | 0.029** | 0.012 | 0.014*** | 0.004 |
| Urban | −0.103** | 0.048 | −0.042** | 0.019 |
| Eastern region | −0.036 | 0.063 | 0.186*** | 0.027 |
| Northern region | 0.059 | 0.078 | 0.047* | 0.027 |
| Western region | −0.035 | 0.067 | 0.085*** | 0.025 |
| Owns land | 0.075 | 0.055 | 0.148*** | 0.020 |
| Asset endowment | −0.074*** | 0.014 | −0.082*** | 0.006 |
| Farm | 0.074 | 0.014 | 0.006 | 0.024 |
| Non-farm | 0.093* | 0.054 | −0.055** | 0.021 |
| Ill hh head | 0.120 | 0.094 | −0.009 | 0.038 |
| Theft of money | −0.039 | 0.091 | −0.048 | 0.048 |
| Observations | 3116 | | 4651 | |

*Notes:* Standard errors are clustered at the household level for the unweighted model. For the weighted model we use survey weights * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The reference group for education is no formal education and for region is central

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# Chapter 13
# Contextualizing Sustainability in Water Project Management: The Case of Bugesera District, Rwanda

**Marcela Ramirez Pasillas, Emilienne Uwase, and Hans Lundberg**

## 1 Problem Statement

Water supply programs have failed to deliver long-term benefits due to a pervasive focus on short-term activities because of which one of the United Nations' Sustainable Development Goals aims to guarantee universal and equitable access to clean water for all by recovering water quality, reducing pollution, decreasing the release of chemicals and securing water services. Sustainability of water services in rural Africa often lacks a consideration of sustainability, technical and management challenges (Harvey and Reed 2004).

Project management is a research discipline with recognized legitimacy (Walker and Lloyd-Walker 2016). In project management literature, sustainability is a relatively new topic (Marcelino-Sadaba et al. 2015; Silvius and Schipper 2012, 2014). Aarseth et al. (2017) identify two distinct perspectives addressing project sustainability. First, a perspective that focuses on how sustainability influences the delivery of assets by a project, and second, a perspective that focuses on the host organization and how it is influenced by the adopted sustainability approach. This paper focuses on the first perspective, the role of sustainability in water project organization, which emphasizes on the project's management or delivery process

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(Gareis et al. 2013) and how the project and the management process mutually shape each other (Labuschagne and Brent 2005).

Literature investigates sustainable water project management in African countries. Studies in Ghana suggest that multiple community stakeholders participate in project planning which relates to the sustainability of water projects (Marks et al. 2014). Furthermore, Nigerian water projects in rural areas showed that community members were either always or hardly ever involved in various stages of the project and their participation was linked to committees, weekly meetings or social groups (Ofuoku 2011; Tafara 2013). Since the role of the community varies, these findings signal that additional research on this topic is needed in different locations.

The 2013–18 Economic Development and Poverty Reduction Strategy defined clear ambitions for assuring water supply in Rwanda (EDPRS 2 2013). Given the differences between rural and urban areas and the prevalence of droughts and floods in the country ensuring access to water has been a priority. Hence, it required the private sector's engagement in the distribution and management of water services (UN 2014). The inclusion of sustainability in project management in Rwanda has been assessed quantitatively by a range of indicators (Malik et al. 2016; Samuel et al. 2016). Samuel et al. (2016) evaluated factors that influenced the sustainability of water projects in Muhanga district. The sustainability of water project management was affected in different manners by aspects related to community engagement, ethics and project management.

Existing literature also suggests that future research should be more in-depth and consider the influence of social and cultural factors on the long-term sustainability of water project management. This gap can be examined following a contextualized approach to the project management process keeping sustainability in mind. A contextual approach is relevant to first recognize that contexts differ within and across environments and for understanding when, where, why and how such differences exist (Johns 2006).

In addition, literature on the project management process from the point of the view of project organization does not consider the sustainability development stage in which the organization is done is done according to context and ranges from a dismissing position to a transformational stance to sustainability and influencing the practices that are incorporated and embraced by an organization. This gap can be addressed with the help of literature on social responsibility and can help in getting contextual considerations to sustainability in project management.

To examine these gaps, this paper considers sustainability in the water project management process following a contextual approach. It addresses the following research questions:

How is sustainability considered in the context of the water project management process?

What stage of sustainability influences a project's organization and what contextual practices influence the sustainability of the water project delivery process?

To fulfil this research purpose, we carried out an exploratory case study of Bugesera district in Rwanda with three water sites as an embedded unit of analysis

(Yin 1994). A water supply project linked to water sites were constructed in the Bugesera district in the Eastern province of Rwanda. Bugesera is predisposed to droughts and suffers from rain deficits (REMA 2015). The Eastern Province where the district is located has a low percentage of the population having access to safe water, which is available as needed (NISR 2010). The population of this district accesses water through water facilities linked to natural water sources. There are three rivers and nine lakes in Bugesera available for improving access to water (District Development Plan 2013–18). However, water scarcity and distribution in Bugesera district are still major concerns. Hence, the water project management in Bugesera district is a relevant case to explore in relation to sustainability.

## 2 Theoretical Background

### *2.1 Sustainability in Project Management*

Concerns about the sustainability of natural resources dates back to 1713 when Saxon Mining Officer Hans Carl von Carlowitz published *Sylvicultura oeconomica*, a treatise on sustainable yield forestry where he proposed to log as many trees as grew back (Silvius et al. 2017). It was, however, in 1962 that contemporary issues on sustainability in relation to natural resources were introduced by Rachel Carson in the book *Silent Spring* and then by Dennis Meadows, Donella Meadows and Jorgen Randers in *The Limits to Grow* in 1972. The term ‘sustainable development’ was coined at the 1972 Stockholm Conference on the Human Environment and was included in the 1980 World Conservation Strategy. After this, it took almost a decade till the Brundtland report *Our Common Future* defined sustainable development in 1987 as: “Humanity has the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs” (p.16). This definition helped get an initial understanding and concerns for sustainability.

The most common view of sustainability in business practices and research emerged out of the seminal work of John Elkington, *Cannibals with Forks: The Triple Bottom Line of the twenty-first Century Business* (Martens and Carlvalho 2016; Elkington 1997). The triple bottom line or triple Ps – people, planet and profits -- aimed to capture the effects and impact of human activity on the planet. Within a triple bottom line view, sustainability is about the balance or harmony between social sustainability, environmental sustainability and economic sustainability (Silvius and Schipper 2014). This holistic consideration of sustainability integrates the three aspects of sustainability. Some authors argue that there is a fourth aspect, that of cultural sustainability, but this does not have any clear agreement (Silvius et al. 2017). This said, very few attempts have been made in literature on project management as contextualized research. Thus, putting context in sustainability can help us gain an understanding of water project management as suggested by Härtel and O’Connor (2014).

Sustainability in project management involves the use and influence of sustainability in the initiation, planning, development, control and implementation of project delivery (Silvius 2015). Silvius (2012) contrasted the concepts of sustainable development and project management to stimulate a broader understanding of the role and importance of sustainability in project management (see Table 13.1). This comparison allows us to understand that the approaches to project management and sustainability are distinctly different. Therefore, when a sustainability view is adopted there is a change in the orientation of the processes and outcomes. The project manager's role is to create a system that fosters and maintains the project's long-term sustainability beyond its completion. This change is radical in nature for project managers as projects are temporary organizations with a clear purpose and deadlines. However, projects are also embedded in society (Lundin and Söderholm 1995), which in turn functions within socio-ecological systems (McGuinnis and Ostrom 2014), so the predisposition for long-term sustainability is at hand.

Boundaries of project management and projects are neither limited nor closed; instead they are open and fuzzy to shape processes and outcomes. However, context is not at the forefront but remains a suggestion for future research. Given that context is important since project delivery is influenced by different contexts in various ways, projects are developed in geographical contexts with existing contexts and new organizational contexts embedded in institutional settings. These complexities call for further research on the influence of context.

Even though context approaches are scarce, the situation is better when it comes to sustainability. Research on project management has seen an increased attention to sustainability (Aarseth et al. 2017; Marcelino-Sádaba et al. 2015). Silvius and Schipper (2014) provide an overview of how sustainability in relevant for project management. They identify relevant dimensions of sustainability in project management and argue that sustainability is about its balancing and harmonizing social, environmental and economic aspects (see also Silvius 2012; Økland 2015). However, the authors do not address culture as it is indirectly placed under social sustainability. Addressing culture is important since traditions, beliefs and values generate understandings and practices that work in specific circumstances.

**Table 13.1** Differences between sustainable development and project management

| Sustainable development | Project management |
|---|---|
| Long– and short–term oriented | Short–term oriented |
| Socio-ecological systems | Social systems |
| Open and fuzzy boundaries | Limited boundaries |
| Focus on the interests of this generation and future generations | Focus on the interests of stakeholders and sponsors |
| Lifecycle oriented | Result oriented |
| People, planet and profit | Scope, time and budget |
| Increasing complexity | Reduced complexity |

Source: Adapted from Silvius (2012)

Silvius and Schipper (2014) also indicate that sustainability includes both a short-term and long-term orientation as well as a local and a global orientation. Because of this sustainability encompasses generating resources that are consumed in line with a circular economy. It also embraces values and ethics that professionals, managers and consumers have which influence their behavior (Silvius et al. 2017). For instance, to complete projects on time, managers face the challenge of following ethical standards while they guarantee the project's social impact. Thus, sustainability is also about transparency and accountability of the organizations incorporating project management processes, decisions and practices. It emphasizes the relevance of stakeholder participation in projects including their interests, situation and the co-creation of solutions to their problems (Tuffino et al. 2013). Stakeholders with varied socio-economic and cultural backgrounds and interest interact with project managers (Silvius 2016). Project managers must focus on delivering high quality services in close interaction with these very varied stakeholders (Cater et al. 1999). Sustainability also includes risk reduction and risk mitigation in projects. Finally, sustainability is about eliminating waste and developing practices for waste management and waste reduction. In sum, Silvius et al. (2017: 1137) illustrate all these dimensions of sustainability in project management (Fig. 13.1).

Literature also links the concept of corporate social responsibility (CSR) to sustainability and examines the stages of development or adaption of sustainability in an organization (Dunphy et al. 2003; van Marrewijk and Werre 2003). These stages correspond to the levels of acceptance, incorporation, understanding and integration of CSR activities. Advancing prior research, Edwards (2009) identifies an embedded developmental approach to sustainability for addressing a spectrum of transformations available to organizations. This spectrum includes the following stages:

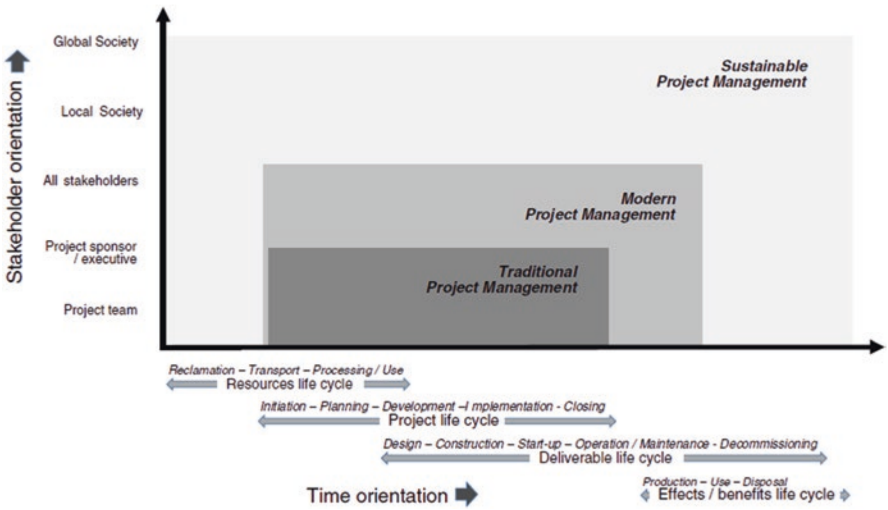


**Fig. 13.1** The enlarged scope of sustainable project management. (Source: Silvius et al. (2017: 1137))

- Subsistence organizations, where survival and maximization of profit constitute the main purpose of organizational activities.
- Avoidant organizations, where there is ignorance of ethical standards and legal responsibilities.
- Compliant organizations, where there is a preference for compliance and supporting industry regulations as a way of avoiding more challenging regulations on sustainability.
- Efficient organizations, where sustainability is a source of cost saving to support the organizations' efficiency and survival.
- Committed organizations, where there is a commitment to sustainability beyond legal compliance.
- Sustaining organizations, I (local), where sustainability is employed as a way of developing the organizations and their stakeholders and transformational strategies are established.
- Sustaining organizations II (global and local), where sustainability is integrated within all aspects of the organizations. Sustainability conveys a physical, economic, environmental, emotional, social and spiritual/deep meaning in a global sense.

Identifying the stages of development of sustainability in an organization implies that long-term sustainability is considered and there is a more balanced approach to it (Mirvis and Googins 2006). An organization and the areas within the organization do not necessarily develop in a linear manner through stages, but they move back and forth between stages depending on the sustainability issue at hand.

### *2.2 Sustainability in Water Project Management in Africa: Signaling a Need for a Contextual Approach*

Contextualizing organizational behavior research – *sustainability in project management for instance* – means considering the influence of context and revealing how context influences organizational behavior (Johns 2006). Focusing on context and contextual influences within research will help examine the effects, influences and relationships of how and why certain behaviors and practices exist in specific settings (Johns 2001). Welter (2011) examines the historical, temporal, institutional geographical, spatial, business and social contexts from an entrepreneurship theory perspective. Building on these ideas and advancing them Ramirez Pasillas et al. (2017) highlight the importance of diversity, multiplicity and multifacetedness of relevant and unexplored contexts in emerging economics and developing countries.

Literature on sustainability in water project management examines different geographical contexts in Africa and investigates the role of the social context through community participation in particular.

Marks et al. (2014) examined water hand pump projects to assess the relation between sustainability and community engagement in rural communities in Ghana. Their study showed that community members' participation in project planning was related to hand pump engagement. The long-term sustainability of hand pump water projects improved with the beneficiaries' involvement in management decisions, but it was undermined when they were responsible for technical decisions.

Tafara (2013) investigated community-based water projects in Kibwezi in Kenya and found that the water project management responded adequately to the concerns of the community whenever they were raised even though community participation in the water projects was low.

Ofuoku (2011) examined sustainability and community participation in water projects in the rural settlements of Delta state in Nigeria. The results showed that community citizens were either always or rarely involved in water project management. In most rural communities, the water projects were funded by the community and other donors. While the water projects financed by the communities and donors were more sustainable, those financed by government were less sustainable. The study concluded that there was a significant relationship between community participation and sustainability of water projects.

Murtaza et al. (2016) studied the sustainability of rural water sanitation and hygiene in four representative districts (Burera, Musanze, Nyabihu and Rubavu) in Rwanda. The sustainability of the projects in the four investigated districts was high. Samuel et al. (2016) specifically showed the interlinked effects of project management, committee responsibility and community participation in the sustainability of the water project in Muhanga district in Rwanda.

From existing studies on sustainability of water projects in Africa it can be seen that community participation tends to be present in all stages of the project in various degrees and forms, that is, the social context is in focus. This signals the need for investigating the relevance and influence of other contextual dimensions of sustainability in water project management (without eliminating the social context as it is a highly relevant one) and thus responding to an urgent call for contextualizing research in a more systematic manner (Härtel and O'Connor 2014).

## 3 Research Methodology

We used an exploratory case study method (Yin 1994) that examines sustainability in water project management in Bugesera district. We chose an exploratory case study to investigate a single case from the point of view of the managers, employees and beneficiaries. To investigate this, we selected three water sites to capture specific contextual features of the case (Stake 1995). Primary data was collected by Emilienne Uwase through 29 interviews with managers, employees and beneficiaries and reported in her master's thesis (Uwase 2017). She focused on delivered water projects managed by a public agency which included the construction of a treatment plant. Data was collected retrospectively on events that occurred in the management of the water projects as participants recalled them. The Government of Rwanda and its development partners funded various types of water projects, including water supply projects, water harvesting projects and water tank construction projects.

In Rwanda, there are 19 delivered water treatment plants linked to water supply sites (RURA, June 2016–2017). We selected Bugesera district as a case for this study because of the water scarcity in this region (REMA 2015) which is is needed to serve the population, grow food, and supply businesses. Thus, the sustainability of the project management needs to ensure long-term sustainability of the water site. According to Uwase (2017) the water project in the district was constructed between 2005 and 2007 by Sogea Construction through a contract with the Water and Sanitation Corporation (WASAC). The objective of the project was delivering clean water to the population of Bugesera district. The water treatment plant in Bugesera is in the south-west area of the district. The plant was built in 1998 and refurbished in 2014. Bugesera district has 15 water sites organized according to 15 sectors. The water treatment plant is near Lake Cyohoha (Nyarugenge sector) which constitutes the most important water source for the district (Uwase 2017).

We conducted interviews with two managers, two employees and 25 beneficiaries to examine sustainability in water project management. The managers and employees were selected based on the significance and diversity of information that they had on the water project. We also included interviews with beneficiaries of three of the 15 sites integrating the water supply project (10 beneficiaries at the Mayange site, nine beneficiaries at the Ntarama site and six beneficiaries at the Mareba site). These sites were selected based on the so-called water distribution zones. The water supply project in Bugesera district has three main distribution zones and we selected one site in each zone to get a broader understanding of sustainability (Uwase 2017).

### *3.1 Data Collection*

Information was collected using semi-structured interviews. The participants shared their thoughts on sustainability in the water projects. Details of the interviews are given in Table 13.2.

### *3.2 Data Analysis*

Data analysis included a process of transcribing interviews, organizing the data, comparing quotes, reducing data into themes, representing the data in tables and finally a discussion of the analysis (Creswell 2007). We used the software Atlas to classify the participants' responses into tables. Then, we deductively related the responses to social, environmental and economic aspects of sustainability as well as

**Table 13.2** Interviews conducted at Mayange, Ntarama and Mareba sites in Bugesera district, Rwanda

| Interview | Stakeholders | Length of the interview(s) | Dates |
|---|---|---|---|
| 1 | Manager in Bugesera | 23 minutes<br>26 minutes and 30 seconds | 9/06/2017<br>28/07/2017 |
| 2 | Manager | 21 minutes<br>3 minutes and 20 seconds | 5/06/2017<br>26/06/2017 |
| 3 | Employee 1 | 10 minutes and 5 seconds<br>8 minutes and 7 seconds | 12/06/2017<br>28/06/2017 |
| 4 | Employee 2 | 12 minutes and 33 seconds<br>9 minutes | 12/06/2017<br>28/06/2017 |
| Site 1: Mayange | | | |
| 5 | Beneficiary (Site 1) | 10 minutes | 9/06/2017 |
| 6 | Beneficiary (Site 1) | 12 minutes | 9/06/2017 |
| 7 | Beneficiary (Site 1) | 11 minutes | 9/06/2017 |
| 8 | Beneficiary (Site 1) | 11 minutes | 9/06/2017 |
| 9 | Beneficiary (Site 1) | 10 minutes | 9/06/2017 |
| 10 | Beneficiary (Site 1) | 13 minutes | 9/06/2017 |
| 11 | Beneficiary (Site 1) | 11 minutes and 20 seconds | 10/06/2017 |
| 12 | Beneficiary (Site 1) | 12 minutes | 10/06/2017 |
| 13 | Beneficiary (Site 1) | 10 minutes | 10/06/2017 |
| 14 | Beneficiary (Site 1) | 13 minutes | 10/06/2017 |
| Site 2: Ntamara | | | |
| 15 | Beneficiary (Site 2) | 12 minutes | 16/06/2017 |
| 16 | Beneficiary (Site 2) | 12 minutes | 16/06/2017 |
| 17 | Beneficiary (Site 2) | 11 minutes | 16/06/2017 |
| 18 | Beneficiary (Site 2) | 13 minutes | 16/06/2017 |
| 19 | Beneficiary (Site 2) | 11 minutes | 16/06/2017 |
| 20 | Beneficiary (Site 2) | 12 minutes and 15 seconds | 17/06/2017 |
| 21 | Beneficiary (Site 2) | 11 minutes | 17/06/2017 |
| 22 | Beneficiary (Site 2) | 11 minutes | 17/06/2017 |
| 23 | Beneficiary (Site 2) | 13 minutes | 17/06/2017 |
| Site 3: Mareba | | | |
| 24 | Beneficiary (Site 3) | 10 minutes and 40 seconds | 24/06/2017 |
| 25 | Beneficiary (Site 3) | 11 minutes | 24/06/2017 |
| 26 | Beneficiary (Site 3) | 12 minutes | 24/06/2017 |
| 27 | Beneficiary (Site 3) | 12 minutes | 24/06/2017 |
| 28 | Beneficiary (Site 3) | 10 minutes | 24/06/2017 |
| 29 | Beneficiary (Site 3) | 12 minutes and 8 seconds | 24/06/2017 |

the stages of CSR development. The data was related to the propositions of the theoretical background to find and match common patterns as proposed by Yin (1994). Pattern matching compares the empirical data pattern with the elements of the theoretical background to strengthen internal validity (Yin 1994). This technique implies that there is a comparison of the outcomes of the interview data with the theoretical background. We matched social, environmental and economic sustainability recognized in previous studies and also identified aspects specific to the context of sustainability in the water project management process in Bugesera district. Cultural sustainability emerged as a relevant theme during this analysis and so we added cultural sustainability as a relevant contextual influence in the water project management process.

# 4 Findings

## *4.1 Social Sustainability*

In social sustainability of the water delivery process we included hiring local people, providing social benefits to employees, using a code of conduct and promoting a gender balanced approach at the workplace.

Table 13.3 gives extracts of the interviews with managers and employees related to social sustainability. Manager A said: "*In project implementation, the contractor should employ local people. In our agreement, we specify this unless the local people are not fit to perform the job. For work that needs advanced skills, the contractor is allowed to hire outsiders. Local people benefit from full-time contracts, school discount fees for their children and can also buy medical insurance.*" Local private operators employed local people to construct the water project. Local people were thus able to obtain social and economic benefits. The employees emphasized signing permanent contracts with benefits attached, receiving training on safety procedures and project management skills. Employee A said: *"Training is provided on safety procedures and each employee at the site knows how to work especially in case of a breakdown or replacement of devices to prevent an injury or accident*."

The code of conduct was important for fostering ethical behavior as stated by Manager B: *"We have a code of conduct for the project management team as for any other employee of the agency. The employees and managers have to sign the code of conduct. If there is any ethical misconduct the law applies and sanctions are imposed."* The code of conduct addresses job responsibilities, focuses on the customer and an employee's overall professionalism. Perceptions of the code of conduct being a regulating instrument was confirmed by the employees. Employee B said: "*We follow a code of conduct that specifies what an employee has to do and when we omit to do it sanctions are applied."*

In addition, promoting a gender balanced view at the workplace is also important. Manager A said: "*In the management of the project we ensure that the project will benefit the local communities in the long term, we look at the gender issue, the quality of water, the materials used while supplying water and other technical issues.*" Manager B added: "*We hire adults to avoid child labor in our activities. The second requirement is that the worker should be from the area if the job does not need advanced skills; other requirements depend on the work to be performed and the needed competencies. Yes, it is gender responsive because women and men are*

**Table 13.3** Additional extracts from interviews with managers, employees and beneficiaries on social sustainability

| Stakeholder | Extract |
|---|---|
| Manager | |
| Manager A | Yes we have a code of conduct for all WASAC employees and the project management team also has to follow it. The employees and managers have to sign the code of conduct and in case of misconduct the law that governs all public servants applies to them as well.<br>During the project design, our agency consulted the local authorities to find out where the pipes to supply water will be installed based on community needs. |
| Manager B | The first requirement that we follow while hiring the local people is the age of the worker; we hire adults to avoid child labor in our activities. Another requirement is that the worker should be from the area if the job doesn't need advanced skills; other requirements depend on the work to be performed and the competencies needed for it. |
| Employee | |
| Employee A | I have a permanent contract and it allows me to get health and life insurance. I can easily contribute to the pension scheme and it is easy to get a loan from a bank with this contract. |
| Employee B | I have a permanent contract and I get health and life insurance and I can contribute to the pension scheme.<br>Yes we receive training on safety procedures and there are basic materials that we should have to provide first aid whenever an issue arises at the water site.<br>We have a code of conduct which has to be followed by each employee in the agency. There are articles stating what we should do as employees and sanctions are applied if a person doesn't respect them. |
| Beneficiary<br>Site 1: Mayange | |
| Beneficiary D | I worked for the contractor who installed these facilities as a temporary worker. |
| Beneficiary J | I have contributed to the implementation of this water supply project by working as a supervisor of temporary workers. I was hired by a company called Sogea. |

*given equal opportunities and no one is favored. Nowadays women have been empowered and can perform the work very well as compared to men*."

## *4.2 Cultural Sustainability*

Cultural sustainability of the water delivery process corresponded with the adoption of local practices for defining the water needs of the project and engaging the local community. Such practices comprised the creation of an inclusive process and reliance on Umuganda meetings and community committees. Table 13.4 presents extracts of the interviews with managers and employees relating to aspects of cultural sustainability.

Defining the water needs together with the beneficiaries was important for the development of the project. Manager B said: *"The local needs form the basis for*

**Table 13.4** Additional extracts from interviews with managers and employees on cultural sustainability

| Stakeholder | Extract |
|---|---|
| Manager | |
| Manager A | During the project design, our agency consulted the local authorities to find out where the pipes to supply water will be installed based on community needs.<br>In the implementation of the water supply project… we set community committees to ensure that the community owned the facilities. We comply with REMA's environmental regulations. |
| Manager B | In the implementation of the water supply project… we set community committees to ensure that the community had ownership of the facilities. |
| Employee | |
| Employee A | We participate in Umuganda and contribute to solutions for water problems raised by the community but in case there is a major problem that requires the intervention of higher authorities we report it to the concerned people and they provide the solutions by talking to the districts. |
| Employee B | The community participated in the design of the project because they are the ones who identified where the pipes should pass, and we did a geographic survey to ensure that the relief enabled the installation of the facilities. The community identified these during the meetings held with local leaders and the latter informed us about the needs of the people. he main challenge that we faced was water scarcity in this area, another issue was that the population did not understand the reason why they didn't get water as needed and some of them did not pay by the due date.<br>Beneficiaries were involved in identifying where the pipes should pass, and we did a geographic survey to ensure that the relief enabled the installation of the facilities. |

*government financed projects because needs are identified at the grassroots level where community leaders identify the needs for a project from the population."* Employee A explained: "*The community participates in the design of the water project because they are allowed to choose the person who will manage the water point in case each beneficiary does not have a tap in the house. The beneficiaries also identify where they need water facilities in a meeting at the local level and the leaders inform the agency in charge of water distribution."* Specifically, the delivery process looked into the types of benefits that the water project would generate for the community based on prevailing conditions. Manager A detailed: "*In the management of the project we ensure that the project will benefit the local communities in the long term, we look at the gender issue – for those little girls who fetch water from far away – the quality of water, the materials used while supplying water and other technical issues.*"

In the delivery process, the water project management relied on the use of community committees and Umuganda meetings. Managers stated that community committees were a tool for ensuring that the community was aware that it had ownership of the water project once the construction was over. Umuganda is a practice anchored in Rwandan culture; it means that members of the community gather to self-help, cooperate and find solutions to their problems (Rwanda Governance

Board 2017). Umuganda meetings provided an arena to discuss community concerns related to water. Employees confirmed their participation in Umuganda to deal with the water problems that the beneficiaries had. Employee B said: "*We participate in Umuganda where different problems are raised so that they can be solved. If it is a problem of water scarcity, we respond based on our capacity. In addressing technical issues we provide the solution immediately but when it is an issue that involves decision makers we make a promise to report it to the people concerned and to follow up.*"

However, the beneficiaries' responses differed from those of managers and employees (see Table 13.5). They both confirmed that the water project was relevant since they had a major problem of water scarcity. While some beneficiaries recognized the value of Umuganda as a place for dialogue, other beneficiaries felt that water delivery promises were not necessarily fulfilled via Umuganda meetings. Beneficiary B from the Mayange site stated: *"In Umuganda meetings, we discuss the issue of water because we don't get it as we need it and the issue is that the agency has to distribute it among all the beneficiaries and the area doesn't have enough water."* Another beneficiary at the Ntarama site said: "*During the meeting after Umuganda we sit in an area near the Umuganda site and people raise problems that they think should be solved for their well-being. We often raise the issue of water being insufficient, but we still have this problem especially in the summer and no solution has been found as yet that can last for long."* However, the beneficiaries agreed that Umuganda promoted inclusive processes. A beneficiary at the Mareba site said: "*In Umuganda meetings, we discuss different problems that we have and water problems are also included. Solutions are provided but sometimes there is a delay in their implementation*."

## *4.3 Environmental Sustainability*

Environmental sustainability of the water delivery process is related to environmental regulations, resource impact, assessing the quality of water provided to the population, avoiding CO2 emissions by using electricity instead of fuel and using the gravity system in water distribution networks to avoid electricity consumption and using safe chemical products to clean the water.

In relation to the delivery process, Manager A said, "*In planning water supply projects, we do socioeconomic, environmental and technical studies before submitting the plan for the water supply project to the line ministry. The line ministry also approves the project profile document before submitting it for fund mobilization. For example, we plan for the local population that will benefit from it, the type of material that will be used and the facilities which will not destroy the environment.*" Environmental sustainability is linked to the challenges posed by increased water consumption. Manager B said: *"Normally, water doesn't influence the environment, it is rather part of the environment, but an issue comes in when water is being consumed. When we are producing and treating the water from the lake, we are using a*

**Table 13.5** Exemplary extracts from interviews with beneficiaries on social sustainability

| Stakeholder | Extract |
|---|---|
| Site 1: Mayange | |
| Beneficiary A | Yes when we have Umuganda meetings we discuss water problems and get many promises, but water is still scarce in this area (necessity logic). |
| Beneficiary B | In the meeting after Umuganda we raise the issue of water scarcity especially in the summer period because we don't get enough water. The authorities tell us that it will be solved soon but it is persistent. |
| Beneficiary D | In Umuganda we raise the issue of water scarcity and people from the water provider agency tell us that it will be solved. Local authorities are present in the Umuganda as are people from different sectors. That is when we raise the problems that we have in different domains. When there are no representatives the local authorities become our ambassadors. |
| Site 2: Ntarama | |
| Beneficiary A | During the meeting after Umuganda we often raise the issue of water scarcity and people in charge provide solutions but the issue of extending the pipes hasn't been solved yet. |
| Beneficiary E | In Umuganda meetings we raise all the issues that we have and they tell us that they will be solved soon but the issue of insufficient water has not been solved. |
| Beneficiary F | I have contributed to the implementation of this project by being 'diagnostic participative' where the people provided ideas on what they needed and we raised the issue of water scarcity. |
| | In Umuganda meetings we often raise the problems that we have and the solutions that the authorities provide are that they will be solved soon but we still have a problem of insufficient water. |
| Beneficiary G | After Umuganda we have a meeting in which we raise all the problems that we have; the problem of insufficient water is also brought up but the solutions that are proposed are not implemented and we are still waiting. |
| Beneficiary I | During Umuganda meetings we raise the issue of scarcity of water but the issue has not been solved and it is always the same solution that is provided but it is not implemented. |
| Site 3: Mareba | |
| Beneficiary A | In Umuganda meetings we raise all the problems that we have on water, but we don't get any immediate solutions. |
| Beneficiary D | |
| Beneficiary E | In Umuganda meetings we often raise the issue of water scarcity but the solution provided doesn't last for long and in summer we don't get water as needed. |
| Beneficiary F | In Umuganda meetings when we ask about water problems we don't get the right solutions. |

*renewable resource. If the consumption of water increases, it will affect the environment in the long run because water renews at a slower pace compared to the increase in its consumption."*

Employees related environmental sustainability to technical issues. For instance, Employee B said: "*We use chemical products to treat water from the lake to make it purer for consumption because the water from the lake needs purification. The chemical products used are safe for humans, animals and plants because the ones* *we use are allowed by the World Health Organization."* Chlorine is used to disinfect the water in the treatment plant. Although there are safe levels of chlorine, it can have an indirect impact on human health if it is not used properly. Another consideration for environmental sustainability is the placement of water tanks and the construction of a facility that aims to reduce electricity consumption. Employee A said: *"The gravity system deals with installing water tanks to facilitate the distribution of water in a high-altitude zone and pipes connected to it and to the sites to distribute should be at a lower altitude compared to the main tanks. This was introduced in the implementation of this project and it is a better solution for electricity reduction.*" This employee further stated, *"I don't know the exact electricity consumption on a daily basis, but we have bought some engines that use less electricity. In the rainy season, we use less electricity because there is abundant water in the lake.*"

However, some aspects of environmental sustainability were not considered in the design of the water project. For instance, Employee B expressed, "*We don't have a recycling system to treat the water that has been used. This will be an issue in the future because water is a scarce resource which is needed for everyone to survive and it should be efficiently consumed by introducing a recycling system in the area. But we have also received training on sustainability and the local people have been trained on maintaining facilities in community works.*" These comments signal increasing awareness of aspects of environmental sustainability (Table 13.6).

Beneficiaries related some aspects of environmental sustainability linked to responsible water consumption. Responsible water consumption means the beneficiaries make a good use and consumption of water and also pay their water service on time. For example, a beneficiary at the Ntarama site said: *"We get a suggestion from the water provider that we should protect the facility and we are advised to close the taps when we are not using them. We are also advised to pay for the water consumed by the due date to avoid its being cut off by the agency."* According to the beneficiaries there was lack of information on the weekly water supply. They also agreed that they were not offered training on the maintenance of the water infrastructure since this was not considered their main responsibility. While most of the beneficiaries were satisfied with the quality of the water provided, some of them were not. Table 13.7 present additional extracts from interviews with the beneficiaries.

## *4.4 Economic Sustainability*

The economic sustainability of the water delivery process also included financial aspects of the water project with a subsidized logic driving the water project and the consumption of local products in the construction of the water sites, funding of the project and customer bills (see Tables 13.8 and 13.9).

Managers referred to the finance scheme of the water project, acknowledged a subsidized logic driving the water project and a preference for local products in the construction of the water sites. Manager A said: "*Water is a social good and the*

**Table 13.6** Additional extracts from interviews with managers and employees on environmental sustainability

| Stakeholder | Extract |
|---|---|
| Managers | |
| Manager A | In the planning of the water supply project, we did socioeconomic, environmental and technical studies before submitting the plan for the water supply project to the line ministry. The line ministry approved the project profile document before submitting it for fund mobilization. |
| | In other water projects in Bugesera we first did an environmental impact assessment to look at the effect of the project on the environment and we also included the beneficiaries in all stages of the project. |
| Manager B | When designing the water project in Bugesera, recycling was not introduced but we have started thinking about it because water is a scarce resource and we should find a way to preserve it by introducing a system which can help us use water for different purposes. This system will be environmentally friendly because it will reduce the quantity of water extracted from the lake to be supplied to the people. |
| Employees | |
| Employee A | We don't generate CO2 emissions because we no longer use fuel in our engines; we use electricity to pump water from the main source up to the water treatment plant. We have already eliminated CO2 emissions in the treatment plant. |
| | Yes we are satisfied with the quality of water provided to the community because we have employees in charge of quality. They collect samples from the treatment plant and from each distribution point to ensure that it is the same quality and that it meets the required standards. |
| | We use chemical products to treat water because the water from the lake is not clean and the people can't use it without purification. But those chemicals are not harmful, they are ISO certified. |
| | We don't have a recycling system in this area and we don't have a system for treating water for re-use for other purposes. |
| | Based on the report from the regulatory agency in the second quarter of last year, Bugesera lost 77,252 cubic meters of water compared to the quantity supplied. We are trying to make follow up at different sites to ensure that the facilities are in good condition because water is wasted in the distribution network. |
| | Yes we have received suggestions including the maintenance of facilities and follow up in case of a breakdown so that the facilities can continue functioning. The local people are trained in the maintenance of facilities. |
| Employee B | The water project in Bugesera doesn't have CO2 emissions because we have solved this problem by using only electricity in the treatment of water. The treatment plant doesn't use fuel in the engines because we know that combustible products generate CO2 which is not environmentally friendly. But we don't have a treatment system to re-use water for other purposes. |
| | The electricity that we use is consumed in the water treatment plant only because we use the gravity system in the networks. It uses around 4000 Kwh daily for pumping water from Lake Cyohoha south to the treatment plant because we can't use the gravity system there. The first thing that was done to reduce electricity is using the gravity system in the distribution networks. We also use new engines which consume less electricity in the plant. |

(continued)

**Table 13.6** (continued)

| Stakeholder | Extract |
|---|---|
| | Our gravity system is used in the three distribution zones to supply water to different sites. From Nsolo, we use the gravity system to the distribution zone in Ngenda and another to Gahembe which supplies water to the other two distribution zones. All the intake is on high altitudes to facilitate the gravity system in the networks. The system was introduced in this project in 2007. |
| | At the sites water is wasted at the junction of the pipes when they are broken and in the treatment plant water is wasted during the treatment because the water pumped from the lake is not the one that we distribute and during its purification a portion of the water is wasted. To prevent water wastage in the treatment plant we are planning to use efficient products for its purification. |

*government doesn't provide it because it needs profits to be economically sustainable. The government subsidizes water supply and that is why we cannot do a full cost recovery on investments as private companies do. We implement water supply projects for the well-being of the population."* Managers also stated that using local products in the construction of the water sites was prioritized. Said Manager B: *"We use local products while implementing the project. This is a must because they are cheaper compared to the imported ones but some products are imported because they are not available locally. For example, we purchase pipes and cement from CIMERWA while the stones are produced locally."* This practice was important to activate the local economy. Employees concentrated on the funding of the project and setting water tariffs when discussing the project's economic sustainability. Payment for the water was collected regularly each month as stated by Employee A: "*The funds are managed by the headquarters because we have the same account number country wide*."

One important aspect of the economic sustainability of the project is that the beneficiaries have contributed in financing it. Beneficiary C at the Mayange site said: "*I have purchased all the material used for supplying water to my house from the main pipes on the road and have financed all the installations*." The beneficiaries also mentioned that the water service is reasonably priced because the unit price is affordable. One beneficiary at the Mayange site said*: "Yes, it is easy for us to afford the cost of water used but I didn't contribute to setting the water supply tariff."* Another beneficiary at the Ntarama site shared: "*It is easy to afford the water used when we don't have debts. However, I didn't contribute to setting the water supply tariff, I just pay the tariff which is already set."* Affordability depends on the activities of the beneficiaries. Another beneficiary at the Ntarama site said*: "It is not easy to afford the cost of water used because of climate change. I can no longer get a good harvest as compared to the last few years."*

**Table 13.7** Exemplary extracts from interviews with beneficiaries on environmental sustainability

| Stakeholder | Extract |
|---|---|
| Site 1: Mayange | |
| Beneficiary A | We were not informed about the days in the week on which we will get water. No we don't receive the water project's ecological and financial reports. |
| | No I don't have a system for treating water to re-use it for other purposes. The water provider has informed us that we should not leave the tap open when we are not using the water and we should also inform them whenever the facilities are broken to avoid water being wasted. |
| | No I didn't get any training on the maintenance of facilities. |
| Beneficiary B | In the planning of this project we were not informed about the number of times that we will get water in a week. |
| | Yes I'm satisfied 100% with the quality of water provided because it is so clean. |
| Beneficiary C | The water provider advised us to consume water without wasting it and to protect the pipes in our farms; we have to keep them safe. |
| Beneficiary D | We consume water in a more sustainable manner by avoiding wastage and we close the tap when we are not using it at home. We also inform the agency when there is wastage from the pipes on the road. |
| Site 2: Ntarama | |
| Beneficiary A | Yes we have been advised by the water provider to avoid any wastage because we don't have enough water and also to inform the provider whenever there is a breakdown. |
| | No we don't have a system for treating water for re-use and no discussions have been held on this. |
| | I'm satisfied because I use clean water for different household activities. We didn't get any training on the maintenance of facilities. |
| Beneficiary B | No discussions have been held and I don't have a system for treating water to re-use it for other purposes. |
| | No I'm not totally satisfied because sometimes we get unclean water because the pipes are not clean. |
| Beneficiary C | We receive suggestions on how to consume water without wasting it and how to protect the water pipes which are on our farms. |
| | No we don't have a recycling system to recycle water for other purposes; this wasn't planned. |
| Site 3: Mareba | |
| Beneficiary A | The ecological and financial reports of the water project are not issued. |
| | No we don't have any system for treating water for re-use. |
| Beneficiary B | No we were not informed about the number of times that we will get water in a week. |
| | We manage water in a more sustainable manner because when I don't get it in the tap, I use the water tank. |
| | No the water treatment system for re-use hasn't been introduced. |
| | I haven't got any training on the maintenance of facilities. |

**Table 13.8** Additional extracts from managers' interviews on economic sustainability

| Stakeholder | Extract |
|---|---|
| Managers | |
| Manager A | The project plans that are funded by the government and donors are being coordinated and implemented by what we call the single project management unit. |
| | Once we prepare a project profile document, we submit it to the unit ministry. This ministry raises the funds for the projects. For projects funded by donors it is the donors who submit their plans. We assess them based on the country's priorities. |
| | Yes we use local products while implementing the project except for those products which are not available locally. These we have to import from abroad. We have also adopted the policy of using Made in Rwanda products, for example, pipes, cement from CIMERWA and stones. |
| Manager B | First of all, water is still a social good and most of the water supply projects are implemented by the government. It isn't feasible to calculate the return on investments because the tariffs that the beneficiaries pay are low compared to the cost of supplying water and this is why the government also has to provide subsidies. |
| | The water supply tariffs are set by RURA with the approval of the board of directors of the regulatory agency but in consultation with WASAC. |
| Employees | |
| Employee A | The funds are managed by the headquarters because we have the same account number country wide. |
| Employee B | Funds are collected each month and our customers pay to the agency's bank account. The funds are managed by the head office, but the cost incurred in producing a cubic meter of water can't be recovered if the government doesn't provide subsidies. |

## *4.5 Compliance with Regulations for Sustainability*

The water project in Bugesera district relied on different regulations for sustainability throughout its lifecycle and after the project's conclusion. Most of the regulations were issued by the Rwanda Regulatory and Utility Agency (RURA) including regulations on cleaning water, water service, rural water tariffs and decentralized wastewater treatment systems (RURA 2016). However, there were other regulations that were followed before the project was implemented including regulations by the Rwanda Environmental Management Agency (REMA). Then there were also regulations linked to the quality of water delivered to the community by the Rwanda Standards Board. Managers and employees were familiar with the regulations fostering and enforcing sustainability. Compliance with regulations influenced perceptions of sustainability as Manager A said: *"A project will be sustainable if at its completion it meets the expectations of the population, if the water continues to flow and if the environmental regulations that define sustainability in project management are respected."* Managers were also familiar with the successive actions that needed to be taken if the citizens or the environment were affected. Manager A said: "*In the planning and implementation of a water supply project, we follow RURA's regulations which specify the services that should be delivered to the population*

**Table 13.9** Exemplary extracts from beneficiary interviews on economic sustainability

| Stakeholder | Extract |
|---|---|
| Site 1: Mayange | |
| Beneficiary A | Yes I have contributed because I installed the facilities from the main pipes up to my house and I have also paid for technical assistance. |
| | Yes I can easily afford the cost of water used whenever I get the record. |
| | No I didn't contribute in the setting the water tariffs. I just use the tariffs that have been set. |
| Beneficiary B | Yes it is easy for me to afford the cost of water used. |
| | No I haven't contributed to setting the water supply tariffs. |
| Beneficiary F | Yes it is easy for me to afford the cost of water used because I sell it and make some profit. |
| Beneficiary G | Yes it is easy for me to afford the cost of water used when I get a good harvest. |
| Beneficiary J | Yes I have contributed financially because I paid for the materials and the technicians who installed the pipes up to my house. |
| Site 2: Ntarama | |
| Beneficiary D | Yes I can easily afford the cost of water used. |
| | No I haven't contributed to setting the water supply tariffs. |
| Beneficiary E | I have contributed because my family and I have purchased the materials that were used to supply water from the main pipe and now we use one water facility with my family members who live nearby. |
| | I don't have any problem in paying for the water that I use except when I have debts. |
| Beneficiary G | No I haven't contributed to setting the water tariffs, but I use the tariffs already set. |
| Site 3: Mareba | |
| Beneficiary A | Yes I can afford the cost of water used and the price per cubic meter is not so high. |
| | No I haven't contributed to setting the water supply tariffs. We use the tariffs already set. |
| Beneficiary B | Yes it is easy for me to afford the cost and the price is not so high. |
| | No I haven't made any contributions to setting the water tariffs. We use the tariffs already set. |

*and REMA's regulations on environmental issues, in addition to what is highlighted in policy documents on water and sanitation. We incorporate these in the project planning and we ensure that the implementation is done as planned.*" Manager B associated compliance with regulations to social, environmental and economic sustainability: *"There are regulations on the minimum required service level for water service provision issued by RURA which can be linked to social sustainability. The regulations linked to environmental sustainability are the ones governing the water supply to the population and the treatment and distribution of water. Regulations linked to economic sustainability show that the price is charged according to consumption and the underprivileged group is considered when setting water tariffs."* Private operators participated in the construction of the water project in Bugesera and local authorities guaranteed compliance with the rules issued by the agency in charge of the water supply. Manager B said: "*In rural areas there are registered private operators who are involved in the management of water projects but the local government is also involved to ensure that these private operators (called public-private partnerships) comply with the rules issued by the water provider.*"

The employees agreed that having information and knowledge about environmental sustainability regulations impacted the project. The management provided timely training to employees on new environmental regulations as the project advance. Employee A stated*: "In the induction period we received training and were informed about all the regulations issued by the regulatory agency which governs the water supply services in Rwanda."* Beneficiaries interviewed at the three sites agreed that they were not familiar with the regulations for water projects and those regarding sustainability. This situation created challenges since they were not familiar with their rights and obligations in the water supply services provided to them. As expressed by one beneficiary at the Mareba site: "*I don't have any idea about the regulations followed by the water project in Bugesera.*" Additional excerpts from the interviews with managers and employees are given in Table 13.10.

# 5 Discussion

Sustainability in the water project delivery process was driven by a compliance-to-regulations logic which influenced its management processes. This is in line with a compliant organization stage where awareness about sustainability is increasing and the management is identifying it as a relevant issue (see Edwards 2009). In our case, the water project management process followed policies, regulations and procedures defined by the government, private companies and/or donors. Compliance comprised regulations and procedures for project design and planning policies, environmental and labor regulations and health and safety guidelines. In line with previous studies, compliance with these in the water project management was in the hands of various stakeholders including government offices (RURA, REMA), companies (WASAC, Sogea) and the involved communities. A heightened contextual approach to the case in Bugesera district resulted in emphasis being placed on cultural sustainability in addition to social, environmental and economic sustainability in the water project delivery process. The four dimensions of sustainability include:

*Social sustainability* was influenced by compliance with labor rights and maintaining a gender balance. The water project management followed labor regulations and thus gave the employees contracts that include health insurance and life insurance (for example, Carvalho and Rabechini 2017). Human rights are also part of social sustainability (see Martens and Calvalho 2017). In our case, the management of the water project in Bugesera prohibited the use of child labour. Moreover, the management prioritized hiring local people and promoted a gender balance and equal rights approach. Further, the employees were trained in water regulations and received timely information on new regulations as the project developed.

**Table 13.10** Additional extracts from interviews on regulations for environmental sustainability

| Stakeholder | Extract |
|---|---|
| Managers | |
| Manager A | In the implementation we comply with REMA's environmental regulations. |
| | We also have to meet RSB's standards on the quality of water to be provided. For example, we have regulations on minimum required service levels for water service provision and regulations governing water supply services in Rwanda. |
| | When we do not follow regulations, we correct this by identifying the root cause for not doing so, so that we can do a better follow up and the public is informed on the way forward and the law provides sanctions whenever we violate the regulations. |
| Manager B | Yes in the planning and project implementation we follow the national water supply policy through different stages of the project. In addition, there are other agencies which collaborate with us in project plans and implementation. We follow RURA and REMA's regulations on environmental protection. |
| | When we do not follow the regulations, we correct the mistakes by following the regulations and the public is informed. But from my experience in this agency we haven't committed any mistakes that required us to announce them to the public. |
| | The regulations highlight the quality of service to be provided, monitoring the quality of the service and customers' rights in case the agency is not complying with the regulations. Based on these regulations, the priority during the distribution of water sources should be the supply of water and in case of an interruption beneficiaries should be informed in advance. |
| | The quality of water supplied should also comply with RSB's standards through testing samples. Penalties are imposed in case of non-compliance with the norms issued by the authorities. In the treatment plant, the agency has to take care of the waste because the law prohibits the pollution of water sources because there are organisms which live in it. |
| | There are also regulations stating the modalities of payment for beneficiaries and in case they fail to do so sanctions are imposed. The water provider agency should also comply with the water tariffs set by the regulatory agency when billing customers. |
| Employees | |
| Employee A | Yes we are familiar with regulations for water supply in general. |
| Employee B | We are familiar with the regulations in general and in case there are new regulations we are informed about them so that we can follow them for better service delivery to the public. For example, in case of an interruption in water supply we inform the local people through a public notice and we also communicate it to the local authorities. |
| Beneficiaries | |
| Site 1: Mayange | |
| Beneficiary B | No I don't know anything about the regulations for the water project in Bugesera |
| Site 2: Ntarama | |
| Beneficiary G | No I don't know that regulations exist which have to be followed by the water project in Bugesera. |
| Site 3: Mareba | |
| Beneficiary B | I am not familiar with the regulations for the water project in Bugesera. |

*Cultural sustainability* pertains to maintaining cultural beliefs, practices, ways of life and networks of meanings. Malik et al. (2016) recommend considering social and cultural aspects in projects. In relation to practices, in our case the managers, employees and beneficiaries participated in Umuganda to inform beneficiaries about the water project and also to define the needs and emerging problems being faced by the project. Prior research has indicated the importance of being aware of the community's opinions (Silvius et al. 2017). Umuganda meetings were held with every community to discuss current water concerns. In addition, community committees were employed to strengthen local ownership and long-term sustainability of the water project.

*Environmental sustainability* refers to reliance on gravity systems to gather and distribute water, the use of engines to reduce electricity consumption and CO2 emissions and respecting health relative to water consumption. These findings are in line with previous literature that states that the project management needs to actively work on the project's resource consumption, resource efficiency and environmental impact (Martens and Carvalho 2017) including health, hygiene and sanitation (Malik et al. 2016; Ofouku 2011; Samuel et al. 2016) if environmental sustainability has to be achieved. Our study shows mixed outcomes. On the upside environmental sustainability in particular was driven by a compliance-to-regulations logic and it worked as it guaranteed good quality water supply at acceptable prices while decreasing the use of electricity and chemicals. Further, the chemical products used by the water treatment plant were not harmful to human beings and the gravity system allowed avoiding the use of electricity in distribution networks. Also, the engines in use did not run on combustible products like fuel. On the down-side, however, employees lacked awareness of CO2 emissions generated by water plants driven by electricity (see Table 13.10), there was no system for recycling and re-use of water (even if beneficiaries tracked their consumption of water) and there was lack of approaches to cope with droughts and floods (beneficiaries still had water scarcity in the summer period). The most serious down-side effect was that the project did not include mechanisms for actively impeding or reducing water waste (although they were aware of the importance of this). Combined with the fact that there was no recycling system in place, this will become an issue in the long term as water increasingly becomes a scarce resource.

*Economic sustainability* was determined by a subsidized logic, which hindered the long-term financial sustainability of the project and impeded the overall understanding of water tariffs. Neither managers nor employees had any knowledge of, for instance, the return on investments and thus concentrated on issuing and collecting water bills on central water tariffs.

However, there are important achievements regarding economic sustainability: first, the use of local products in the project's implementation like cement, stones, and sand from the Bugesera region is important for boosting local and regional economies thus increasing the legitimacy of the project. Second, the beneficiaries showed their appreciation for the project because of its affordable prices. They contributed financially to the water project by purchasing the necessary pipelines to get access to the main water pipelines. Hence, we argue that a subsidized logic is a suitable one in our case. Of highest priority was problem-solving (‘fix water’), winning the acceptance of the communities and finding a business model that worked. Having a rigidly imposed return on investments logic in this context would not have worked; people would not have been able to afford the tariffs; and the adoption and acceptance rates would have been lower leading to lower legitimacy. The challenge in the long run is to take the next step, to raise awareness that this was the model for here and now, but not for long-term economic sustainability (Fig. 13.2).

## 6 Conclusions

The purpose of this study was to explore the sustainability of water project management in Bugesera following a contextual approach. An exploratory case study was conducted on the water project at three sites in Bugesera. This study shows that sustainability in water project management concentrated on a compliance-seeking behavior. Compliance was linked to regulations and traditions related to social, environmental and economic aspects of sustainability.

The compliance-seeking behavior was the result of an institutional context defined by formal and informal institutions (North 1990) which shaped the water project management process. Our study highlights that adding a fourth realm, cultural sustainability, allowed capturing local practices employed during the water project management process. Specific practices promoted socioeconomic inclusion and represented the social context shaping the delivery process. These practices were the use of Umuganda meetings and community committees to build inclusive decision-making processes that facilitated an interaction between the host organization and local communities.

Another important conclusion regarding the importance of contextual approaches comes from the way the project was designed regarding environmental sustainability. Environmental sustainability took advantage of the geographical context including the physical geography and hydrology of Bugesera district. A countryrich in hills permitted the adoption of water distribution based on water gravity systems. The distribution network uses gravity to move water to taps through pipes. Recognizing that water is a scarce resource and increasingly becoming costly, efforts were made to reduce energy consumption. This signals that environmental sustainability is shifting towards an efficiency logic.

Another important conclusion regarding the importance of contextual approaches comes from the way the project promoted economic sustainability. The generic, non-contextual ‘truth’ is following a sane long-term approach by implementing a return on investments logic to secure the financial health of a project and to make people aware of the actual costs of, in this case, water. In this project though, they dared to depart from that to gain other crucial things like solving the ‘fix water’ problem, winning the acceptance of the communities and finding a business model that worked. In more abstract terms, context ruled the action and not non-contextual ‘truths’ (even if they are sane and correct). One of the strengths of contextual

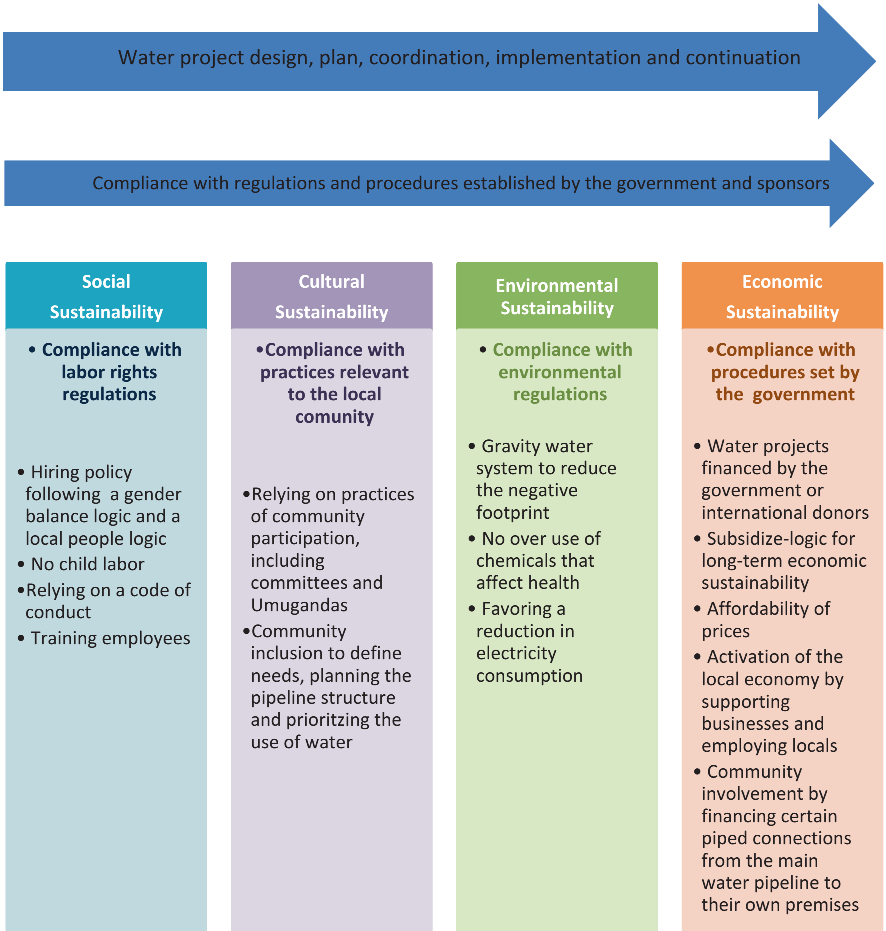


**Fig. 13.2** Contextualized sustainability in the water project in Bugesera, Rwanda

approaches is that they highlight the necessity of using one's judgment, of compromising with 'truth' when required and of choosing the *best available option* after lengthy stakeholder negotiations rather than the *best possible option* according to theory and established practices or other 'truths' that discursively and relentlessly 'instruct us' on what to do and how to do it.

To further advance our understanding of how the delivery process and the project influenced each other according to context, we suggest the model given in Fig. 13.3 for using contextualized approaches to sustainability in water project management in developing countries.

The key to sustainability in water project management is the interaction and involvement of all stakeholders so that they see sustainability as being embedded in the delivery and continuity of services (see Cater et al. 1999). With this model, we present six contextual dimensions that are important for achieving a holistic objective. As Fig. 13.3 shows, the six contextual dimensions we propose as a part of any context-sensitive analysis are *social context, spatial context, historical context, institutional context, temporal context and geographical context*. These dimensions are intertwined with social, cultural, environmental and economic sustainability.

*Social context* refers to interactions, relations and collaborations to support, adopt and learn about sustainability between organizations (that is, the host project organization, the new project organization, the community, the government and donors) or within organizations (that is, employees, managers, government officers, NGO representatives, citizens). The role of social context and the respective embeddedness of stakeholders has been noted by research since Granovetter's work (1973, 1985). What matters to our study is how sustainability is embedded in the water project management process.

*Spatial context* refers to the specific social construction of 'sustainable' spaces for any given water project with respect to global sustainability. The spatial context of sustainable water projects is complex and dynamic; water project management processes are dependent on socio-ecological systems in as much as the socio-ecological systems are impacted by water project management processes and water projects per se. Thus, the spatial context shapes the preferences for project agency and project communion (see Edwards 2005). While agency corresponds to regulations on sustainability by the host organization and its management and/or the project sponsors, project communion refers to relational regulations on sustainability that are generated and sustained through teams, community meetings or social groups and which hinder or support sustainability during the delivery process (and even after its conclusion).

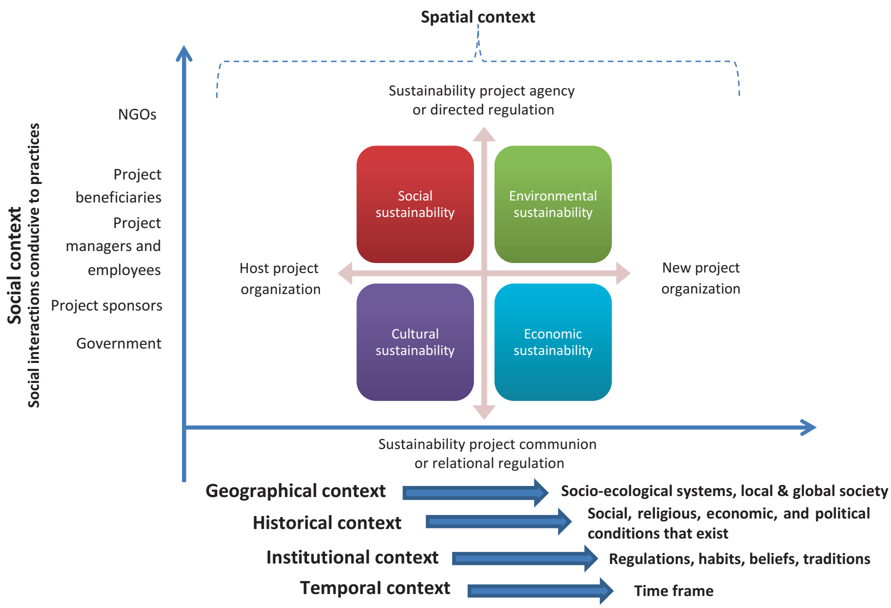


**Fig. 13.3** Model for using a contextual approach to sustainability in water project management

*Historical context* corresponds to the social, religious, economic, technological and political conditions that surround the sustainability of water project management in a certain community/region/country at a given time. Investigating the historical context can help examine the conditions that facilitate or hinder sustainability in water project management. It can also help examine why sustainability of water projects in certain communities/regions/countries can be embraced.

*Institutional context* comprises rules, regulations, policies and procedures that regulate, affect and impact the process and outcomes of sustainability in water project management. Thus, the institutional context can help us understand why certain features of sustainability in water project management are perpetuated and reinforced and where they originated.

*Temporal context* refers to the approach adopted to examine time in the sustainability of water project management processes. Time might not unfold in a linear or sequential manner in water project management. Time also might be perceived differently by the involved stakeholders at different times of the process. Stakeholders relate to sustainability in the present time (or how socio-ecological systems are at the start of the project), or past time (how socio-ecological systems were prior to the project) and future time (how socio-ecological systems are envisioned jointly with the water project). These aspects influence how the project management process evolves.

*Geographical context* refers to the influence of the socio-ecological systems and human activity as the sustainability of project management processes is affected and shaped by these. Examining the relationships between water project management, the people and their environment can help identify the effects and influences not only on the local community but also on global sustainability.

Our proposed model matches Nicolini's suggestion (2009) of zooming in and zooming out. As rich and new phenomena relevant for sustainable water project management are identified, research can zoom in to contexts and practices and then it can zoom out to advance and/or build theory. Context-sensitive approaches can help reposition concepts and theories of sustainability in water project management to move existing understandings and conceptualizations to richer, different or varied understandings of sustainability in water project management. Considering contextual approaches in depth is recognizing the multifacetedness of contexts in developing countries (Ramirez Pasillas et al. 2017). Water project management in developing countries creates an opening for investigating where, who, how, why and when sustainability practices occur. Answers to these questions are relevant for raising awareness about opportunities and challenges to ensure water access and supply in the long-term.

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