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Non-agricultural Activities and Household Time Use in Ethiopia: A Computable General Equilibrium Model Analysis

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presented by

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Stutgart-Hohenheim, June 2018

Declaration

I hereby declare that I have independently completed this dissertation and it is original. No aid is used other than the sources and resources that are properly documented. I confirm that all quotations and statements that have been inferred literally or in a general manner from published or unpublished writings are marked as such. This work has been used neither partially nor fully for achieving any other academic degree.

Stuttgart-Hohenheim, June 2018

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List of Abbreviations

AFR	African Region
AGSS	Agricultural Sample Survey
AMR	Region of the Americas
BCR	Benefit-Cost Ratio
CCA	Caucasus and Central Asia
CGE	Computable General Equilibrium
CET	Constant Elasticity of Transformation
CPI	Consumer Price Index
CES	Constant Elasticity of Substitution
CSA	Central Statistical Agency
EA	Enumeration Area
EDRI	Ethiopian Development Research Institute
EMR	Eastern Mediterranean Region
ER	Exchange Rate
ERCA	Ethiopian Revenues and Customs Authority
ERSS	Ethiopian Rural Socio-Economic Survey
ETUS	Ethiopian Time Use Survey
EUR	European Region
EV	Equivalent Variation
GTAP	Global Trade Analysis Project
GDP	Gross Domestic Product
GAMS	General Algebraic Modeling System
GTP	Growth and Transformation Plan of Ethiopia
HICES	Household Income, Consumption and Expenditure Survey
HPHC	Home Production for Home Consumption
IAP	Indoor Air Pollution
LAC	Latin America and Caribbean

List of Abbreviations (continued)

IEA	International Energy Agency
MIRAGE	Modeling International Relationships in Applied General Equilibrium
MOFED	Ministry of Finance and Economic Development
NGO	Non-government Organization
OECD	The Organization for Economic Cooperation and Development
PPI	Producer Price Index
RICS	Rural Investment Climate Survey
SAM	Social Accounting Matrix
SEAR	South-East Asia Region
SNA	System of National Account
SNNPR	Southern Nations, Nationalities and Peoples' Region
TFP	Total Factor Productivity
UNICEF	United Nations Children's Fund
UNMDG	United Nation Millennium Development Goals
VIF	Variance Inflation Factor
WB	World Bank
WHO	World Health Organization
WPR	Western Pacific Region

Summary

Large shares of rural households engage, next to agricultural activities, in non-agricultural activities in most regions of Ethiopia. Non-agricultural activity is indispensable to reduce rural poverty and income inequality and contributes to livelihoods. The sector is crucially relevant for those who lack alternatives especially for women and landless rural households. However, the constraints of non-agricultural activities are not well studied and documented in Ethiopia. Few attempts have been made to identify the impediments to non-agricultural activities based on household surveys with limited coverage that are hardly representative of the whole country.

Furthermore, to secure the potential benefits gained from the development of non-agricultural activities, it is essential to recognize and reduce the barriers confronted by the sector. To the author's best knowledge, the potential economy-wide benefits drawn by reducing the impediments of non-agricultural activities are barely been studied and recognized. In other words, the potential effects of different policy instruments for facilitating non-agricultural activities are unexplored by the empirical literature on Ethiopia.

Against this background, this study uses a comprehensive and country representative household survey to identify the constraints of non-agricultural activities in Ethiopia. Furthermore, two policy options for promoting rural non-agricultural activities are examined and discussed: First, the non-agricultural labor supply is stimulated by freeing labor time from labor-intensive home activities such as collecting water and firewood and second, the effect of improved access to road transport infrastructure for enhancing non-agricultural activities and its economy-wide outcomes are analyzed.

The study reveals that major constraints of non-agricultural activities are limited access to finance, lack of market opportunities, limited education/training and poor access to roads, transport and communication. Rural households participate in non-agricultural activities due to a lack of access to agricultural land, low/volatile earnings, to look for a means to invest in agriculture and social/economic independence. The major non-agricultural activities are services (such as carpentry and transport), trade (wholesale and retail trade) and manufacturing (such as grain milling and brewing).

The study also investigates the impact of water fetching and firewood collection on non-agricultural activities in Ethiopia. Since the sources of water and firewood are not easily accessible, households spend long hours per day for collecting water and firewood. For instance, rural households on average spend 0.64 hours per day for fetching water and 0.58

hours per day for firewood collection. The finding of this study reveals that water fetching and firewood collection adversely affect the adoption of non-agricultural activities in Ethiopia. Specifically, households that spend more labor hours for collecting water and firewood are less likely to engage in non-agricultural activities.

The current study analyzes and discusses the effect of two alternative policy interventions for promoting non-agricultural activities in Ethiopia. The first policy option is facilitating the non-agricultural labor supply by freeing labor from water fetching and firewood collection. Improved access to drinking water infrastructure and energy efficient technology (for example, improved cooking stoves) significantly reduces the time spent on water fetching and firewood collection. The freed labor from water fetching and firewood collection is partly reallocated to marketed activities such as agricultural and non-agricultural activities or partly reallocated to leisure. Labor reallocated to market activities has economy-wide implications. This study examines the scenario of a 50% increase in the total factor productivity (TFP) of water fetching and firewood collection activities because of improved access to water infrastructure and energy efficient technology. Domestic and international sources of finance are used for funding water infrastructure and energy technology

The simulation results show that improved access to water and energy efficient technology ensures reallocation of labor across different economic sectors. Since a large percentage of water fetchers and firewood collectors are agricultural laborers, agriculture absorbs a larger share of the released labor relative to other sectors (such as industry and services). Accordingly, the labor released from water fetching and firewood collection stimulates agricultural and non-agricultural production. Better access to drinking water and improved energy technology also enhances household welfare. Households that allocate a relatively large proportion of labor to water fetching and firewood collection gain relatively more welfare. Macroeconomic indicators such as GDP, total domestic production, absorption and imports are also positively affected due to improved access to water and energy efficient technology.

The second policy option analyzed in this study is the role of improved access to road transport infrastructure for enhancing non-agricultural activities. Better access to road infrastructure reduces trade and transport margins and enhances efficiency of activities that produce trade and transport services. This study explores the policy scenarios of a 1.8% to 2.1% reduction of trade and transport margins and a 1.1% increase in the total factor productivity (TFP) of activities that produce trade and transport services. The cost of funding road infrastructure is obtained from domestic and international sources. The simulation results indicate that improved access to road transport infrastructure reduces consumer prices of marketed commodities and enhances domestic production in agricultural and non-agricultural sectors. The simulations also exhibit welfare improvement among rural and urban households and facilitate economic growth. Therefore, improved access to road transport infrastructure is important for the development of non-agricultural activities.

In general, improved access to the road transport network, drinking water supply and energy saving technologies should be recognized as a fundamental component for facilitating rural non-agricultural activities in Ethiopia. This study has revealed that policy interventions targeted towards promoting non-agricultural activities lead to considerable economy-wide positive outcomes and stimulate the entire economic activities in the country.

Zusammenfassung

In Äthiopien beteiligt sich ein großer Anteil der ländlichen Haushalte neben der Landwirtschaft auch an nichtlandwirtschaftlichen Tätigkeiten. Dies gilt für die meisten Regionen Äthiopiens, wo nichtlandwirtschaftliche Tätigkeiten unerlässlich sind, um ländliche Armut zu reduzieren, Einkommensungleichheit zu verringern und zum Lebensunterhalt beizutragen und den Wohlstand der Armen zu verbessern. Nichtlandwirtschaftliche Tätigkeiten sind äußerst relevant für diejenigen, die alternative Einkommensquellen suchen, insbesondere für Frauen und landlose ländliche Haushalte. Jedoch sind die Hindernisse für nichtlandwirtschaftliche Tätigkeiten in Äthiopien wenig untersucht und dokumentiert. In den letzten Jahren wurden einige Versuche unternommen, um diese Hindernisse zu identifizieren. Die Studien basieren allerdings auf Haushaltsbefragungen mit begrenzten Erfassungsbereichen und sind kaum repräsentativ für das gesamte Land.

Um die potenziellen Vorteile zu nutzen, die sich aus der Entwicklung nichtlandwirtschaftlicher Aktivitäten ergeben, ist es wichtig, die Hindernisse, mit denen der Sektor konfrontiert ist, zu erkennen und zu beseitigen. Nach bestem Wissen des Autors wurden die potenziellen gesamtwirtschaftlichen Vorteile der Beseitigung der Hindernisse für nichtlandwirtschaftliche Tätigkeiten bisher kaum untersucht und erkannt. Die möglichen Auswirkungen verschiedener politischer Instrumente zur Förderung nichtlandwirtschaftlicher Aktivitäten in Äthiopien sind in der empirischen Literatur noch nicht ausreichend erforscht.

Vor diesem Hintergrund ist es Ziel dieser Dissertation, anhand einer umfassenden und landesweiten repräsentativen Haushaltsbefragung die Hindernisse nichtlandwirtschaftlicher Aktivitäten in Äthiopien zu identifizieren und zu analysieren. Darüber hinaus werden zwei politische Optionen zur Förderung nichtlandwirtschaftlicher Aktivitäten in ländlichen Gebieten untersucht und diskutiert. Erstens wird das nichtlandwirtschaftliche Arbeitskräfteangebot dadurch stimuliert, dass die Arbeitszeit aus arbeitsintensiven Tätigkeiten wie Sammeln von Wasser und Brennholz freigesetzt wird. Zweitens werden die Auswirkungen eines verbesserten Zugangs zur Straßenverkehrsinfrastruktur zur Erhöhung nichtlandwirtschaftlicher Aktivitäten analysiert.

Die Studie zeigt die Haupthindernisse von Haushalten, die an nichtlandwirtschaftlichen Tätigkeiten teilnehmen: Geringer Zugang zu Finanzmitteln, fehlende Marktchancen, begrenzte Bildung/Ausbildung sowie schlechter Zugang zum Straßenverkehrsnetz und zu Kommunikationstechnologien. Ländliche Haushalte beteiligen sich an nichtlandwirtschaftlichen Aktivitäten, da sie keinen Zugang zu landwirtschaftlichen Flächen

haben, geringe und volatile Erträge erwirtschaften, nach Investitionen in der Landwirtschaft suchen und nach sozialer und wirtschaftlicher Unabhängigkeit streben. Die wichtigsten nichtlandwirtschaftlichen Tätigkeiten sind Dienstleistungen (z.B. Zimmerei und Transport), Handel (Groß- und Einzelhandel) und Herstellung (z.B. Mahlen von Getreide und Brauen).

Die Studie untersucht auch die Auswirkungen von Wasserholen und Brennholzsammeln auf nichtlandwirtschaftliche Aktivitäten in Äthiopien. Da die Quellen für Wasser und Brennholz nicht leicht zugänglich sind, verbringen die Haushalte viele Stunden am Tag damit, Wasser zu holen und Brennholz zu sammeln. Zum Beispiel verbringen ländliche Haushalte im Durchschnitt 0,64 Stunden pro Tag mit Wasserholen und 0,58 Stunden pro Tag mit dem Sammeln von Brennholz. Das Ergebnis dieser Studie zeigt, dass das Sammeln von Wasser und Brennholz die Einführung nichtlandwirtschaftlicher Aktivitäten in Äthiopien beeinträchtigt. Insbesondere nehmen Haushalte, die mehr Arbeitsstunden für das Sammeln von Wasser und Brennholz benötigen, seltener an nichtlandwirtschaftlichen Aktivitäten teil.

Die vorliegende Studie analysiert und diskutiert außerdem die Auswirkungen von zwei alternativen politischen Maßnahmen zur Förderung nichtlandwirtschaftlicher Aktivitäten in Äthiopien. Die erste politische Option besteht darin, das Angebot an nichtlandwirtschaftlichen Arbeitskräften zu erhöhen, indem Arbeitskräfte aus dem Holen von Wasser und dem Brennholzsammeln freigesetzt werden. Ein verbesserter Zugang zur Trinkwasserinfrastruktur und energieeffizienter Technologie (zum Beispiel verbesserte Kochherde) führen zu einer signifikanten Reduzierung der bisher benötigten Zeit. Die freigewordene Zeit wird teilweise auf vermarktete Tätigkeiten wie landwirtschaftliche und nichtlandwirtschaftliche Tätigkeiten und teilweise auf die Freizeit umverteilt. Die Arbeitszeit, die den marktbezogenen Aktivitäten zugewiesen wird, hat volkswirtschaftliche Auswirkungen. Diese Studie untersucht das Szenario einer 50%igen Steigerung der Gesamtfaktorproduktivität (TFP) von Wasser- und Brennholz-Sammelaktivitäten aufgrund des verbesserten Zugangs zu Wasserinfrastruktur und energieeffizienter Technologie. Zur Finanzierung der Wasser- und Energieinfrastruktur werden nationale und internationale Finanzierungsquellen genutzt.

Den Simulationsergebnissen zufolge sorgt ein verbesserter Zugang zu wasser- und energieeffizienter Technologie dafür, dass Arbeitskräfte vom Wasserholen und Sammeln von Brennholz in marktnahe Sektoren wie landwirtschaftliche und nichtlandwirtschaftliche Tätigkeiten verlagert werden. Ein Teil der freigesetzten Arbeit wird auch für Freizeitaktivitäten verwendet. Die Landwirtschaft absorbiert einen größeren Teil der freigesetzten Arbeitskräfte im Vergleich zu anderen Sektoren (wie Industrie und Dienstleistung), da ein hoher Prozentsatz der Wasserbeschaffer und Brennholzsammler auch in der Landwirtschaft tätig sind. Entsprechend stimuliert die durch Wasserholen und Sammeln von Brennholz freigesetzte Arbeit die landwirtschaftliche und nichtlandwirtschaftliche Produktion. Ein besserer Zugang zu Trinkwasser und verbesserten Energietechnologien verbessert insbesondere die Wohlfahrt der Haushalte, die einen relativ großen Anteil ihrer Arbeitskraft für das Wasserholen und das Sammeln von Brennholz einsetzen. Auch makroökonomische Indikatoren wie das Bruttoinlandsprodukt (BIP), die gesamtwirtschaftliche Produktion, die Absorption und die Importe werden durch den verbesserten Zugang zu Wasser und energieeffizienten Technologien positiv beeinflusst.

Die zweite in dieser Studie analysierte politische Option ist die Rolle eines verbesserten Zugangs zum Straßentransportnetz zur Erleichterung nichtlandwirtschaftlicher Aktivitäten. Ein besserer Zugang zur Straßeninfrastruktur verringert die Handels- und Transportmarge und erhöht die Effizienz von Aktivitäten, die Handel und Transportdienstleistungen erzeugen. Diese Studie untersucht die politischen Szenarien von 1,8% bis 2,1% Verringerung der Handels- und Transportmargen und 1,1% Steigerung der totalen Faktorproduktivität (TFP) von Aktivitäten, die Handels- und Transportdienstleistungen generieren. Die Kosten für die Finanzierung der Straßeninfrastruktur stammen aus nationalen und internationalen Quellen. Die Simulationsergebnisse zeigen, dass ein verbesserter Zugang zur Straßenverkehrsinfrastruktur den Verbraucherpreis der vermarkteten Waren senkt und die heimische Produktion sowohl in landwirtschaftlichen als auch in nichtlandwirtschaftlichen Sektoren verbessert. Die Simulationen zeigen auch eine Wohlfahrtsverbesserung bei ländlichen und städtischen Haushalten und ein höheres Wirtschaftswachstum. Daher ist ein verbesserter Zugang zur Straßenverkehrsinfrastruktur wichtig für die Entwicklung der nichtlandwirtschaftlichen Tätigkeiten.

Nicht zuletzt sollten der verbesserte Zugang zum Straßentransportnetz, die Trinkwasserversorgung und energiesparende Technologien als grundlegende Komponenten für die Erleichterung nichtlandwirtschaftlicher Aktivitäten in ländlichen Gebieten in Äthiopien erkannt werden. Diese Studie zeigt, dass politische Interventionen, die auf die Förderung nichtlandwirtschaftlicher Aktivitäten abzielen, zu positiven und signifikanten gesamtwirtschaftlichen Ergebnissen führen können.

Chapter 1: Introduction

1.1 Background of the study

Ethiopia is located in East Africa, bordered by Eritrea in the North, Sudan and South Sudan in the West, Kenya in the South, Somalia in the East and Djibouti in the Northeast (Figure 1.1) The country's total area is 1,104,300 square kilometers (Central Intelligence Agency, 2016). Ethiopia is the second populous African country with a population size of nearly 100 million with annual growth rate of 2.6% (United Nations, 2017).

Figure 1.1: Geographical map of Ethiopia

Source: Central Intelligence Agency (2016)

Agriculture is the cornerstone of the country and a major contributor to the Ethiopian economy. More than 80% of Ethiopian people live in rural areas and rely on agriculture for their livelihood. However, Ethiopian agriculture has multiple constraints. It is mainly subsistence and the population density is high. Furthermore, land is highly degraded and fragmented and largely rain fed (Demeke, 1997; Tegegn, 2000; Tesfaye, 2008; Woldehanna, 2000). In addition to the above-mentioned limitations of Ethiopian agriculture, shortage of cultivable land is the most pressing constraint of rural households. The average existing landholding size is 1.06 hectare per household (Central Statistical Agency, 2016). On the other hand, the population is growing by 2.6% annually. This further aggravates the scarcity of land whereby agriculture cannot absorb the growing population pressure. In response to this economic situation, rural households mainly exploit the following alternative strategies as exit options: divert into non-agricultural activities, rural-urban migration and rural-rural migration (Dorosh et al., 2011; Fransen & Kuschminder, 2009).

Migration to urban areas had been adopted as an alternative livelihood option for a long period but urban centers are not able to provide opportunities for all those who migrate from rural areas. The urban unemployment rate of Ethiopia is 16.5% which is by far larger than the rural unemployment rate which is 2% (Central Statistical Agency, 2014). On the other hand, migrating to other rural areas is hampered by the scarcity of land. Diversifying into local non-agricultural activities seems the reliable livelihood option compared to rural-urban migration and rural-rural migration. Non-agricultural activities cover major economic sectors such as manufacturing, services and mining except agriculture related activities. This definition holds true regardless of the location (rural or urban) and functional classification such as wage employment or self employment (Barrett et al., 2001; Haggblade et al., 1989; Lanjouw & Feder, 2001). Figure 1.2 describes the broad economic sector classification based on the national accounting system.

For many centuries, Ethiopian rural households practiced non-agricultural activities besides agriculture. Households in many parts of the country have been traditionally involved in a variety of non-agricultural activities such as iron melting, tanning hides and skins and weaving cloths being crucial for livelihoods. These traditional handcrafts were locally developed (Pankhurst, 2002). Currently, non-agricultural activities extended to incorporate a broader range of activities. Some of the non-agricultural activities in Ethiopia include pottery, tannery, blacksmithing, tailoring, wearing apparels (for example, shoemaking), small shops, stove making, fruit and vegetable trade, grain trade, grain milling, small restaurants, carpentry and repair services. Sale of traditional alcohols, production of food and beverages and transport services (for example, pack animals and horse drawn carts) are also part of non-agricultural activities. Other non-agricultural activities include wood work, masonry, river sand and stone quarrying, selling of wood and charcoal, traditional medicine, basket making, roof thatching, mat making, preaching and public work (safety net participation) among others (Beyene, 2008; Carswell, 2002; Kune & Mberengwa, 2012; Tesfaye, 2008; Woldehanna & Oskam, 2001).

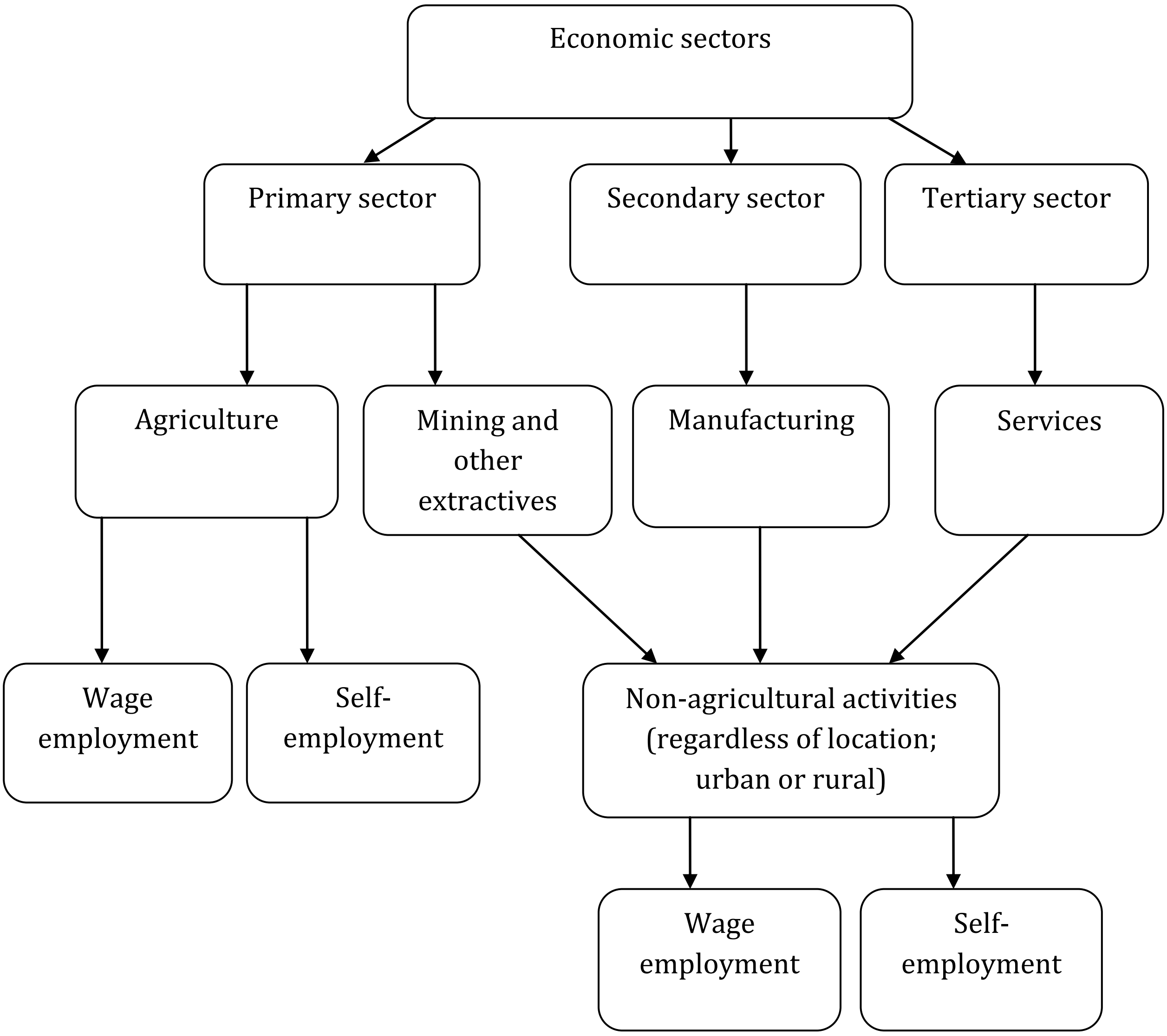

Figure 1.2: **Structure of the economic sectors**

Source: Author's compilation based on data from Barrett et al.(2001)

Non-agricultural activities can be conducted as a complement and/or as a substitute to agriculture. Households engage in non-agricultural activities seasonally as a substitute for agriculture and on a part time basis as a complement to agriculture. For instance, during growing and harvest season (September to February) households focus on farming while during off harvest season (March to August) they diversify into non-agricultural activities (Kune & Mberengwa, 2012). Non-agricultural activities absorb an enormous amount of the rural labor force of Ethiopia. In aggregate, nearly 25% of households in rural Ethiopia are involved in the non-agricultural sector in addition to agriculture. The non-agricultural sector contributes approximately 13% of total rural household income being the second contributor to income after agriculture (Loening et al., 2008).

The non-agricultural activity is indispensable to alleviate rural poverty, reduce income inequality, contribute to livelihoods and improve the welfare of the poor. The non-agricultural sector is relevant for those who lack other alternatives especially for women and landless rural households. In some cases rural households diversify into non-agricultural activities as a survival strategy during rainfall fluctuations and to mitigate risks and shocks (Block & Webb, 2001; Van Den Berg & Kumbi, 2006; Carswell, 2002; Lemi, 2006; Sisay, 2010). Furthermore, large parts of the Ethiopian non-agricultural sectors are linked to agriculture directly or indirectly. For example, extra capital generated from non-agricultural activities is invested on the farm for purchasing farm inputs including fertilizer and pesticides, hiring labor and renting land. There are also strong consumption linkages between agricultural and non-agricultural activities. For example, surplus income from agriculture can be allocated to locally produced non-agricultural goods (Tegegn, 2000; Woldehanna, 2000). On the other hand, since the Ethiopian economy is dominated by agriculture; this sector has high growth multiplier linkages (Diao et al., 2007). This is an indication that policies that affect agriculture indirectly influence the non-agricultural sector.

Few attempts have been made to identify the constraints of non-agricultural activities of Ethiopia. The major constraints of non-agricultural activities include limited capital or access to credit services, shortage of markets, access to road infrastructure and limited education/skill training (Beyene, 2008; Lemi, 2006; Tesfaye, 2008). However, most of the earlier studies were conducted based on household surveys with limited coverage that were hardly representative enough to be generalized for the whole country. The current study applied a comprehensive and representative household survey to identify the constraints of non-agricultural activities of Ethiopia.

Furthermore, the previous studies did not analyze the potential effect of reducing these constraints for promoting Ethiopian non-agricultural activities. In other words, they did not consider the effects of alternative policy options for facilitating non-agricultural activities. The potential policy options for promoting non-agricultural activities include better access to credit services, provision of skill training/education, improved access to road infrastructure, better access to drinking water supply and energy saving technology (for example, improved cooking stoves), electricity and telecommunication.

In the current study, two specific policy options are examined for facilitating non-agricultural activities in Ethiopia. The policy options are: i) improved access to road transport infrastructure and ii) freeing labor time from labor-intensive home activities such as water fetching and firewood collection.

The first policy option is the effect of improved access to road transport infrastructure for enhancing non-agricultural activities and its economy-wide outcome. Ethiopia has limited accessibility of road transport; only 10% of the rural population resided up to two kilometers away from all-weather roads. This is only half of the benchmark level for Sub-Saharan African countries (Foster & Morella, 2011). Poor road transport is the major constraint of market access in the country. Long travel time and high transport costs arise because of poorly developed road infrastructure. This adversely affects non-agricultural activities and market access of rural households. Better access to road transport reduces travel time, it also reduces trade and transportation costs. This facilitates access to markets and promotes rural non-agricultural activities that have economy-wide effects.

The second policy option is facilitating the non-agricultural labor supply by freeing labor time from labor-intensive home activities such as water fetching and firewood collection. The majority of Ethiopian households are unable to access drinking water close to their neighborhood. Households often spend several hours per day for collecting drinking water from remote sources. For instance, 16% of urban and 34% of rural households on average travel between one to two hours per round trip for water fetching. Rural households spend longer hours for fetching water. For example, 10% of rural households on average travel more than 2 hours per round trip for collecting water (Figure 1.3).

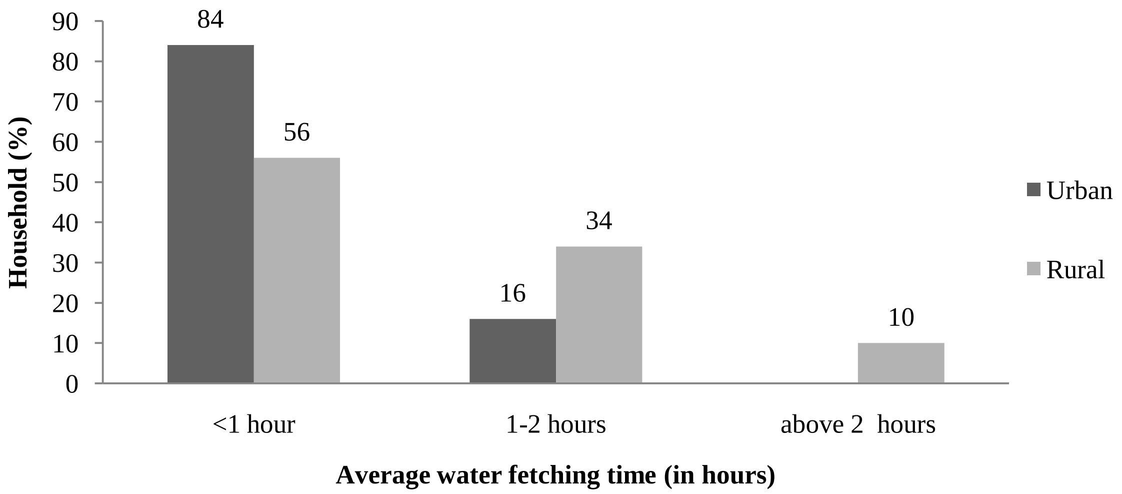

Figure 1.3: Classification of Ethiopian households by water fetching time per round trip

Source: Author’s compilation based on Central Statistical Agency (2014)

Furthermore, households also travel long distances and spend several hours for collecting firewood. For example, 22% and 36% of urban and rural households spend more than 2 hours per round trip for collecting firewood respectively (Figure 1.4)

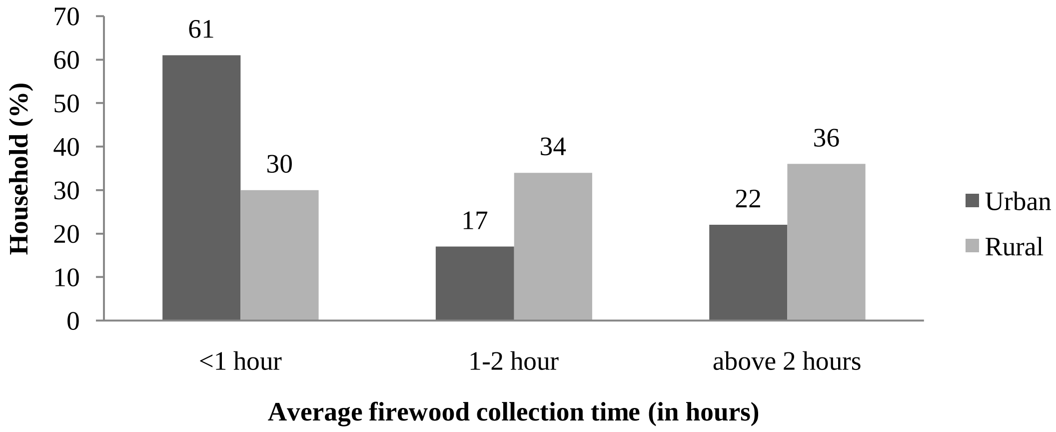

Figure 1.4: Classification of Ethiopian households by firewood collection time per round trip

Source: Author's compilation based on Central Statistical Agency (2014)

Water fetchers and firewood collectors are usually agricultural laborers in Ethiopia. Water fetching and firewood collection reduce labor time available for market related sectors including non-agricultural activities that adversely affect the development and productivity of these sectors. The time spent for water fetching and firewood collection can be reduced through better access to drinking water supply and improved energy technology (for example improved cooking stoves). If part of this time were to be freed and reallocated to income-generating agricultural or non-agricultural activities, this would facilitate non-agricultural activities and positively affect the economy.

Few studies, for example by Fontana & Wood (2000) and Fofana et al. (2003) incorporated home activities into a Computable General Equilibrium (CGE) framework. These studies explicitly considered leisure and home activities as sectors like any other economic sector. However, many of the earlier studies addressed all home activities in aggregate including care of children and the elderly, cooking, cleaning, fetching water and collecting firewood. Little or no attempts were made to distinguish between the varieties of home activities. Different types of home activities satisfy different objectives and are accomplished by different technologies. Therefore, an appropriate policy intervention is required to improve the efficiency of different home activities. For instance, a parent's time spent on childcare activity can be reduced by employing a babysitter. However, the time spent on water fetching and firewood collection can be reduced with improved access to water infrastructure and energy efficient technology (Fontana, 2014). The current study exclusively focuses on water fetching and firewood collection among the many home activities.

An existing 2005/06 Social Accounting Matrix (SAM) of Ethiopia (Tebekew et al., 2009) is modified to account for a detailed representation of water fetching, firewood collection and leisure. Corresponding to each household group in the SAM, separate water fetching, firewood collection and leisure activity and commodity accounts are included. The values of these activities and commodities are derived from the shadow wage of labor. This study applies a single-country CGE model, namely STAGE (McDonald, 2007) to the updated SAM of Ethiopia. This study carried out two major policy scenarios: the first scenario is an increase in the total factor productivity (TFP) of water fetching and firewood collection activities in response to improved access to drinking water infrastructure and energy efficient technology. The second scenario is a decrease in the trade and transport margins and an increase in TFP of activities that produce trade and transport services due to improved access to road transport infrastructure. Government savings and foreign savings in all policy scenarios finance the building of water facility and road infrastructure and the provision of energy efficient technologies.

1.2 Objectives of the study

This study has the following main objectives:

1) To identify the opportunities and major constraints of non-agricultural activities using a country representative household survey,
2) To investigate the economy-wide impact of improved access to water infrastructure and energy efficient technology and explore their effect for facilitating non-agricultural activities and
3) To study the economy-wide effect of better access to road transport infrastructure and identify its impact on enhancing non-agricultural activities.

A derived objective of this study is to update the 2005/06 SAM of Ethiopia with a detailed representation of water fetching, firewood collection and leisure.

1.3 Data sources and methods of the study

1.3.1 Data sources

This study uses secondary data sources including household surveys and an existing SAM. The household survey is used to address objective one of the study. On the other hand, the SAM is employed to achieve objectives two and three of the study.

1.3.1.1 Household surveys

The household surveys used in this study are the Ethiopian Rural Socio-Economic Survey (ERSS) and Rural Investment Climate Survey (RICS).

The World Bank (WB) in collaboration with the Central Statistical Agency of Ethiopia (CSA) conducted the RICS in 2006/07. The RICS covered the four main regions, namely: SNNPR, Oromia, Amhara and Tigray that represent more than 90% of the population of Ethiopia. In each of the four regions, representative households were selected; totaling 14,616 households (see section 2.2 for more details).

The ERSS was conducted by CSA in collaboration with WB in 2011-2012. This survey covered 3,969 households living in rural and small towns of the country. All regions of Ethiopia were covered by this survey and hence the sampled households represent rural and small towns of Ethiopia. The dataset incorporates household socio-economic characteristics including education, health status, asset ownership, time allocation, food security and non-agricultural activities (see section 3.4 for more details).

1.3.1.2 The social accounting matrix (SAM)

This study uses an updated 2005/06 SAM of Ethiopia. The Ethiopian Development Research Institute (EDRI) constructed the SAM based on 2005/06 data. The SAM has detailed accounts for activities, commodities, households, factors and taxes. The SAM also includes the accounts of saving-investment, trade and transport margins, government, enterprises and the rest of the world. The main sources of data for constructing the SAM were CSA, Ethiopian Revenue and Custom Authority (ERCA) and Ministry of Finance and Economic Development (MOFED). In this study, the 2005/06 SAM is modified to account for a detailed representation of water fetching, firewood collection and leisure activities and commodities. Separate accounts for water fetching, firewood collection and leisure activities are introduced. The households perform water fetching and firewood collection activities and consume leisure. Separate water fetching, firewood collection and leisure activities and commodities are created matching to each household group.

The updated SAM has 199 activities, 194 commodities, 34 household groups, 31 factors of production, 17 tax accounts and other core accounts such as government, enterprise, trade and transport margins, saving-investment, stock changes and the rest of the world. Therefore, the updated SAM has 481 rows and columns (see section 5.3, 5.4 and 5.5 for the technical documentation of the updated SAM of Ethiopia).

1.3.2 Methods of the study

Both econometrics and a CGE model are implemented to achieve the objective of this dissertation (Figure 1.5). Specifically, an econometric model is applied to estimate the determinants of non-agricultural activities (see section 2.6 for more details). An econometric model is also used to investigate the effect of water fetching and firewood collection on non-agricultural activities (see section 3.5 for more details). Household surveys such as RICS and ERSS (see section 1.3.1.1 for more details) were the main sources of data for estimating the econometric models.

A single-country CGE model, namely STAGE (McDonald, 2007) is implemented to investigate the economy-wide effect (hence its impact on non-agricultural activities) of improved access to drinking water, energy efficient technology and road transport infrastructure (see section 4.4 for a detailed technical documentation of the STAGE CGE model). The CGE model is calibrated using the updated 2005/06 SAM of Ethiopia (see section 1.3.1.2 for more details).

Although the CGE simulations are not based on the results from econometric models, the estimation of the latter model provides evidence and helps to understand the importance of the policy simulations carried out in this study. For instance, the econometric estimation reveals that water fetching, firewood collection and road infrastructure are real barriers to non-agricultural activities. Analyzing the economy-wide effects of reducing these barriers is the center of the policy simulations that are accomplished by the CGE model.

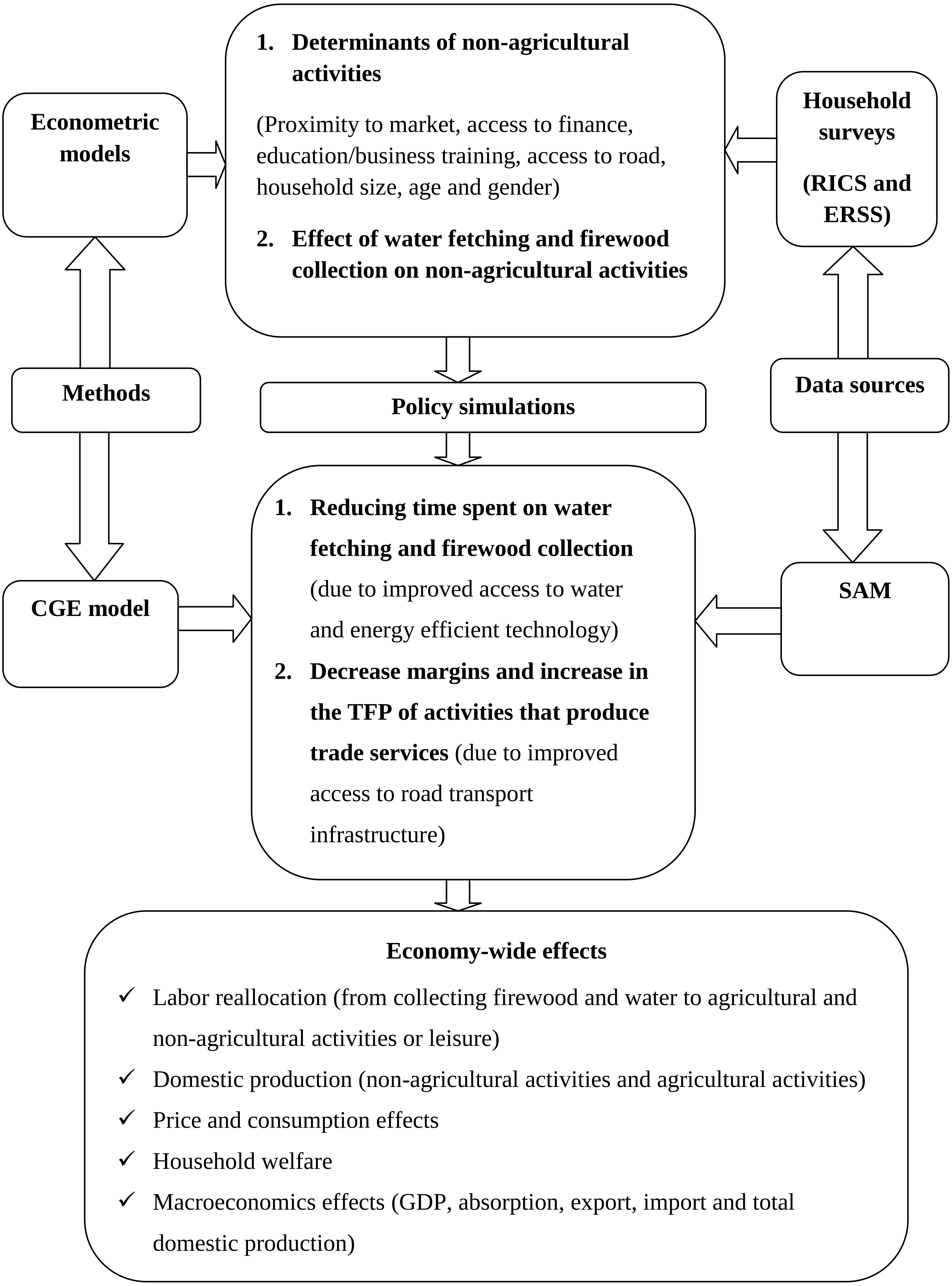

Figure 1.5: Methodological framework of the study

Source: Author's compilations

1.4 Thesis outline

The rest of this thesis is structured in eight chapters.

Chapter 2 explores the characteristics of non-agricultural activities in Ethiopia based on a country representative household survey. The main constraints of non-agricultural activities of Ethiopia are identified and analyzed.

In Chapter 3, an overview of water fetching and firewood collection in developing countries in general and in Ethiopia in particular is reported. Based on a household survey that represents rural and small towns of Ethiopia, the effect of water fetching and firewood collection on non-agricultural activities is also analyzed and discussed.

Chapter 4 introduces the CGE model and describes the basic structure of these models. The chapter also includes a review of literature on labor markets and time use in CGE models. Furthermore, the technical documentation of the STAGE model is given.

Chapter 5 presents the concept of a social accounting matrix, reviews the 2005/06 SAM of Ethiopia and provides the technical documentation of the updated and adjusted SAM of Ethiopia.

In Chapter 6, the economy-wide effect of improved access to water infrastructure and energy efficient technology is analyzed and discussed.

Chapter 7 analyzes and discusses the economy-wide impacts of improved access to road transport infrastructure.

Chapter 8 provides concluding remarks and policy implications of this study. Furthermore, it makes suggestions for the direction of future research.

Chapter 2: Opportunities and Determinants of Rural Non-agricultural Activities in Ethiopia

2.1 Introduction

Diversification of the source of household income is a common practice in many countries but factors influencing this decision differ. Households in developing economies are not an exception to this phenomenon (Lemi, 2006). Agricultural households expand the sources of their income due to pull and push factors. A common pull factor is that a non-agricultural activity generates extra income. On the other hand, a common push factor is to minimize risks and cope with shocks. Both types of diversification influence the well-being of rural households. Pull factors increase income and improve welfare of the households, whereas the push factors are expected to reduce poverty levels of the households (Nega et al., 2009).

Traditionally, it is assumed that the entire rural economy depends on agriculture with the non-agricultural sector contributing negligibly. However, this has changed recently and it is widely recognized that non-agricultural activities make considerable contributions to economic growth, reduce poverty and limit rural-urban migration (Lanjouw & Lanjouw, 2001). Empirical evidence indicates that non-agricultural activities on average constitute 40-45% of the total income for rural African households. Furthermore, non-agricultural activities are found to improve household income and wealth and hence contribute significantly to the survival strategies of households (Barrett et al., 2001).

Few attempts have been made to study non-agricultural activities in Ethiopia. The majority of earlier studies were conducted based on household surveys with limited coverage that hardly represent the whole country. Furthermore, the importance of non-agricultural activities in Ethiopia is not properly recognized and is rarely supported by the government. Evidence based policy intervention for promoting non-agricultural activities in Ethiopia requires studying the existing features and prospective of the sector. Therefore, this chapter uses a comprehensive household survey that represents the Ethiopian population to explore the characteristics and constraints of non-agricultural activities in Ethiopia.

More specifically, this chapter identifies the opportunities, characteristics and major constraints of non-agricultural activities. The chapter responds to the following research questions: What are the non-agricultural activities? What are the basic characteristics of these non-agricultural activities? What are the impediments of non-agricultural activities?

2.2 Data sources

The main dataset applied in this chapter is derived from the Ethiopian RICS. The World Bank (WB) in cooperation with the Central Statistical Agency of Ethiopia (CSA) conducted the RICS. The survey was carried out as part of the national Agricultural Sample Survey (AGSS). The AGSS is a country-level survey that is undertaken annually and covers all parts of the country. The aim of the AGSS is to assemble seasonal basic data about Ethiopia's agriculture. More specifically, it gathers data on total cultivated land, volume of production (by crop types) and farm management practices. Therefore, during the 2006/2007 agricultural season, the AGSS incorporated the RICS as part of the annual survey. In other words, the field survey of the RICS centered on the survey areas of the AGSS.

The RICS covers four main regions, namely Tigray, Amhara, Oromia and SNNPR, which together represent more than 90% of the population of Ethiopia. In each one of the four regions, representative agricultural households were selected. The sampling strategy of the RICS follows that of the AGSS and classifies regions based on Enumeration Area (EA). EA refers to the units of land demarcated for the aim of enumerating the population and housing units with no error and replication. Each EA comprised 150-200 households. The following steps were followed to select representative households. First, each region was divided into 5 to 19 zones depending on the size of the population. Second, each zone was divided into EAs and a zone could have between 2 to 48 EAs depending on the population size. Lastly, households were chosen from each EA using the simple random sampling method. Consequently, the RICS incorporates 14,616 agricultural households selected from four regions of Ethiopia. The data provided include: 1) Demographic characteristics such as age, education, gender and household size. 2) Main characteristics of the non-agricultural activities such as source of start-up capital, motives to start business, seasonality of non-agricultural activity, number of employees, average monthly sales and the major constraints facing the activity.

2.3 Non-agricultural activities across regions and major sectors in Ethiopia

2.3.1 Non-agricultural activities across main regions

Table 2.1 shows participation in non-agricultural activities across the four regions of the study based on the respondents' answer to the question of whether they participate or not. Households were asked whether they diversified into non-agricultural activities in the last three years and the responses were recorded as "no" or "yes." Rural households in all selected regions are engaged in non-agricultural activities. From the total sampled households, 22.5% diversify into non-agricultural activities. This is not an indication that these households are exclusively engaged in non-agricultural activities. Non-agricultural activity may be performed as a complement to agriculture on part time basis or during the agricultural off-seasons.

Participation in non-agricultural activities ranges from 17% to 37% in Amhara and SNNPR regions respectively (Table 2.1). It may not be appropriate to aggregate non-agricultural participation across different regions because the sampled households are not proportional to the population size of each region. The divergence of non-agricultural participation across regions can be partly explained by the disparity in the availability of rural infrastructure across the different regions.

Table 2.1: Non-agricultural activities by major regions of Ethiopia

	Number of rural households		Percentage of rural households
Regions	**No engagement in non-agricultural activities**	**Engagement in non-agricultural activities**	**Share of households engagement in non-agricultural activities**
Tigray	1,483	396	21.1
SNNPR	1,556	923	37.2
Amhara	6,422	1,377	17.7
Oromia	1,872	587	23.9
Total	11,333	3,283	22.5

Source: Author’s compilation from Central Statistical Agency and World Bank (2007)

2.3.2 Non-agricultural activities by sector

Ethiopian non-agricultural activities can be broadly categorized into manufacturing, trade and service sectors (Table 2.2). The manufacturing activities include food, beverages, brewing, distilling, grain milling and other manufacturing. Service activities include small restaurants, repair services, carpentry, transport, etc. whereas trade includes wholesale and retail trade. Table 2.2 indicates that 52%, 36% and 12% of rural households are engaged in trade, manufacturing and service sectors respectively (the percentages are not summing up to neither the columns nor rows in Table 2.2). The higher engagement of households in most regions in trade can be explained by the ease of entry in such activity.

Table 2.2: Non-agricultural activities by sectors (percentage)

Regions	Manufacturing	Trade	Services
Tigray	30	56	14
Amhara	43	41	16
SNNPR	32	57	11
Oromia	35	52	13
Total	36	52	12

Source: Author's compilation from Central Statistical Agency and World Bank (2007)

2.4 Pull-push factors influencing non-agricultural activities

Rural households of Ethiopia are either pulled into or pushed towards non-agricultural activities. The pull factors motivate the households to engage in non-agricultural activities. The main pull factors include the availability of non-agricultural opportunities and the favorable demand for non-agricultural commodities (Woldehanna & Oskam, 2001; Beyene, 2008). Obtaining additional income for supporting agriculture and for attaining social and economic independence are also reported as pull factors for diversification into non-agricultural activities (Gebre-egziabher, 2000; Tesfaye, 2008).

On the other hand, the main push factors triggering non-agricultural activities in rural Ethiopia include limited or lack of land holding, seasonality of agriculture and low income from farm and large family size (Woldehanna & Oskam, 2001; Beyene, 2008; Tesfaye, 2008). Rural households of Ethiopia are forced into non-agricultural diversification when they encounter failures in crop production as one of the household survival strategies (Shen, 2004; Lemi, 2006; Kune & Mberengwa, 2012). Table 2.3 depicts the finding of the RICS, in which sampled households were asked to indicate the main motives for non-agricultural participation. The main motives are to look for a means to invest in agriculture (42.6%), low or volatile earnings (30%), limited access to agricultural land (12%) and the presence of market opportunity for non-agricultural goods (6%).

Table 2.3: Motives to participate in non-agricultural activities

Motives	Percentage of households
1) Pull factors	
Means to invest in agriculture	42.6
Market opportunity	6.0
Social/economic independence	4.3
2) Push factors	
Low/volatile earnings	30.0
No access to agricultural land	12.0
3) Others	
Other motives	2.8
Advice from relatives/friends	2.0
Support from NGO/government	0.1

Source: Author's compilation from Central Statistical Agency and World Bank (2007)

2.5 Constraints of non-agricultural activities

In the RICS, households were asked to specify the major constraints they face in starting and operating non-agricultural activities. Table 2.4 indicates that the major constraints of non-agricultural activities are limited access to finance (48%), lack of market opportunities (24.5%), lack of business training (12.5%), limited access to road, transportation and telecommunication (7%), government administrative bureaucracy and related constraints (4%) and other constraints such as lack of time and lack of working place (4%).

Table 2.4: Self-reported constraints of non-agricultural activities

Constraints	Percentage of households
Access to finance (lack of capital and credit services)	48.0
Lack of market (lack of market information and low demand)	24.5
Lack of business training	12.5
Access to road, transportation and telecommunication	7.0
Government administrative bureaucracy and related constraints (license, high tax, among others)	4.0
Other constraints (lack of time, lack of working place, among others)	4.0

Source: Author's compilation from Central Statistical Agency and World Bank (2007)

2.6 Determinants of Ethiopian rural non-agricultural activities

2.6.1 Probit model estimations

The agricultural household model predicts that households allocate labor to agricultural and non-agricultural activities based on the marginal return of labor from these activities (Singh, et al., 1986). Rural households participate in non-agricultural activities by comparing the value of reservation wage and market wage. A reservation wage is defined as the marginal value of labor time that is not employed in non-agricultural activities, while the market wage in this specific case is the wage obtained from the non-agricultural activities. Households are employed in non-agricultural activities when wages from the market are higher than the reservation wage (Huffman & Lange, 1989).

The decision of households to diversify or not to diversify into non-agricultural activities is a binary outcome variable. The probit model is an appropriate non-linear regression model for estimating response or a dependent variable which has a binary outcome (Wooldridge, 2002). Thus, the probit model is estimated to identify the major constraints of non-agricultural participation of rural households in Ethiopia. The probit model for the household non-agricultural labor supply decision can be specified as follows:

$$P_r(P_i = 1) = P_r(W_m > W_r) = X_i\beta + \varepsilon$$

Where P_r is the probability to diversify into non-agricultural activities, P_i is the household participation decision. P_i=1 if the household diversifies into non-agricultural activities and P_i=0 if the household does not diversify into non-agricultural activities. W_m is the wage from non-agricultural activities, W_r is the reservation wage, ε is the random disturbances term of the model and X_i is the vector of the exogenous factors that influence the households' non-agricultural participation decisions. A summary of all variables in the estimated model is depicted in Table 2.5.

Table 2.5: Summary of descriptive statistics

Variables	Mean	Standard deviation
Distance to major market centers (minutes of walking)	79.8	63.5
Distance to all-weather road (minutes of walking)	111.8	136.7
Household size	6.0	10.0
Education (household head)	2.0	3.0
Age (household head)	43.0	16.0

Source: Author's compilation from Central Statistical Agency and World Bank (2007)

The probit model applied to the RICS data was estimated using STATA. The dependent variable is the probability of the non-agricultural participation decision of rural households that attains the value of "1" if the households engage in non-agricultural activities and "0" otherwise. The following factors that potentially influence the non-agricultural participation are included in the model: distance to the major market center, proximity to all-weather road, household size and demographic factors (the household's head education, gender and age). Distances to the major market center and all-weather road are measured by number of minutes to reach a market center and an all-weather road, respectively. Furthermore, the household head's education and age are measured in years. Gender is captured by a dummy variable in the model; it attains "1" if the head is male and "0" otherwise.

Table 2.6 reports the results of the probit model estimation of the determinants of non-agricultural activities based on the RICS. The model is estimated with robust standard error to avoid the problem of heteroscedasticity. The value of goodness-of-fit of the model as shown by McFadden pseudo R2 is 0.12 which is a small value, implying that other factors that potentially affect non-agricultural activities are not included in the model. There is no precise value of a typical pseudo R2, as a rule of thumb a pseudo R2 above 0.5 is good. For verifying the validity of the estimated model, statistical tests such as t-test, Wald Chi-square test and multicollinearity test are conducted.

The empirical results of these statistical tests demonstrated the robustness of the estimated model. Specifically, the t-test statistics indicate that every variable incorporated in the model is statistically significant at 5% level (the sign ** shows a 5% significance level). The Wald Chi-square test (Prob>chi2) confirmed that at least one of coefficients in the estimated model is different from zero. Furthermore, the variance inflation factor (vif) test for multicollinearity indicates that the explanatory variables in the models are free from multicollinearity; none of the independent variables is highly correlated to each other (see appendix A.I for the details of the vif test result).

Table 2.6: Determinants of non-agricultural activities

Variables	Coefficients	Robust standard error	P>/z/	Marginal effect
Access to market (walking distance in minutes)	-0.0015 **	0.0003	0.000	-0.0004
Access to road (distance to all-weather road)	-0.0004**	0.0001	0.002	-0.0001
Household size	0.0605 **	0.0066	0.000	0.0151
Education (household head)	0.0332 **	0.0054	0.000	0. 0083
Gender (household head)	-0.8429**	0.0329	0.000	-0.2503
Age (household head)	-0.1871**	0.0010	0.000	-0.0047

*Pseudo R2 = 0. 1230 Prob>chi2=0.0000 **5% statistically significant

Source: Author's computation from Central Statistical Agency and World Bank (2007)

2.6.2 Discussion of results

In this section, the interpretation of the influence of each explanatory variable in the estimated model on the dependent variable is presented. The explanatory variables include distance to the major market center, access to road, household size, household head's education, gender and age.

A) Proximity to market center

Distance to the major market center is incorporated to capture the impact of access to market for non-agricultural activities. Distance to the market center is integrated in the model by considering the walking time spent to arrive at the nearest major market center that is calculated in minutes. The estimation results indicate that distance to market has a negative sign and significantly affects non-agricultural diversification. The marginal effect indicates that households that are residing one more minute walking distance farther away from the main market center are 0.04% less likely to engage in non-agricultural activities relative to households residing closer to the market center. This outcome is consistent with other empirical evidence in Ethiopia (see for example, Block & Webb, 2001; Shen, 2004; Tesfaye, 2008; Rijkers & Söderbom, 2013).

B) Access to roads

Access to the closest all-weather road is included to examine the effect of road infrastructure on non-agricultural participation. Proximity to all-weather road is captured in the model by considering the travel time spent to reach the closest all-weather road that is observed by the walking distance in minutes. The outcome of the estimation indicates that distance to roads has a significant negative influence on the non-agricultural diversification of rural households of Ethiopia.

Thus, the marginal effect shows that households located one more minute walking distance further away from all-weather road are 0.01% less likely to engage in non-agricultural activities relative to households who reside closer to all-weather roads. This indicates that the road infrastructure slightly facilitates rural non-agricultural activities.

C) Household size

The size of household positively affects non-agricultural participation. The marginal effect indicates that the presence of one additional household member increases the chance to participate in non-agricultural activities by 1.5%. A larger size of households results in a higher supply of labor force at the household level. This additional labor supply is more probable to participate in the non-agricultural sector. This outcome is consistent with other empirical evidence in Ethiopia by Tesfaye (2008) and Beyene (2008).

D) Education

The education status of the head of the household can be a barrier to non-agricultural diversification. The maximum years of education was considered to approximate the household head's education. The estimation results indicate that the more years of education of the household head, the more positive the influence on non-agricultural participation of households. This is intuitive, as education can be considered important for business awareness of households. This is shown by the marginal effect of the model that indicates that every extra year of education results in a 0.83% higher probability of engaging in non-agricultural activities.

E) Household head's gender

The model results indicate that non-agricultural participation is significantly influenced by the household head's gender. A female-headed household has a larger chance of engaging in the non-agricultural sector relative to a male-headed household. Specifically, male-headed households are 25% less likely to engage in non-agricultural activities relative to female-headed households. This outcome is similar to other studies in the country (see Demeke, 1997; Carswell, 2002; Bhatta & Årethun, 2013). Women are more likely to engage in non-agricultural activities because they are constrained in accessing agricultural land and other resources (Demeke, 1997). This triggers more participation of female-headed households in non-agricultural activities relative to male-headed households.

F) Household head's age

The number of years is used to measure the age of the family head and model results indicate that it negatively and significantly affects non-agricultural activities. In other words, the younger the head, the higher is the possibility to participate in non-agricultural activities. This correlation between age and non-agricultural participation can be interpreted in two different ways: 1) older people have more experience in farming, therefore they prefer to stay in farming and are less enthusiastic to engage in non-agricultural activities. 2) The younger heads of households usually possess less land compared to the older household heads due to population growth and inheritance. Therefore, they utilize non-agricultural opportunities as a survival strategy (Woldehanna & Oskam, 2001). This outcome is consistent with other empirical evidence of Ethiopia (Lemi, 2006; Tesfaye, 2008; Beyene, 2008; Bhatta & Årethun, 2013).

2.7 Summary and conclusion

The aim of this chapter is to study the characteristics and major constraints of non-agricultural activities. The dataset for this chapter was sourced from the RICS that is the most comprehensive household survey. Considerable shares of households in rural areas engage in non-agricultural activities in Ethiopia. From the total sampled households, 22.5% diversify into non-agricultural activities. The non-agricultural activity is performed as a complement to agriculture on part time basis or during the agricultural off-seasons. The participation rate of non-agricultural activities varies across different regions. Non-agricultural participation ranges from 17% to 37% in Amhara and SNNPR regions respectively. The main non-agricultural activities are manufacturing, trade and service. The rate of non-agricultural participation varies in the different sectors such as trade (52%), manufacturing (36%) and service (12%). The higher engagement of households in most regions in trade can be justified by the ease of entry in such an activity.

Rural households participate in non-agricultural activities due to push factors (such as volatile earnings and lack of access to agricultural land), pull factors (such as to look for a means to invest in agriculture) and other factors (such as social/economic independence and advice from relatives). The major constraints of non-agricultural activities are poor access to road and transportation, little access to finance, lack of market opportunities and lack of education/training. Therefore, the presence of basic infrastructure such as roads, education and telecommunication are crucially important for facilitating non-agricultural activities of Ethiopia. In order to promote non-agricultural activities, the policy priority should focus on the development of rural road transport infrastructure, schools, telecommunication and credit facility.

The next chapter provides a general review of water fetching and firewood collection and identifies the effect of water fetching and firewood collection on non-agricultural activities of Ethiopia.

Chapter 3: Water Fetching and Firewood Collection in Ethiopia

3.1 Introduction

According to the 2008 international standard system of national accounts (SNA 2008), household activities can be categorized into: 1) domestic and personal services and 2) productive activities. Domestic and personal services include cleaning and decoration of homes, repair of durables or other goods in the household, preparing meals, caring of children, the sick and elderly people. An enormous amount of labor is devoted to domestic and personal services. However, these services are excluded from production boundaries by the system of national accounts and hence these household activities are not part of the estimation of gross domestic product (GDP) (European Commission et al., 2009).

On the other hand, household productive activities include agricultural activities (such as cultivation of crops), firewood collection, forestry, fishing and hunting. Other primary production such as water fetching and mining is also part of productive activities by households. Productive activities also cover agricultural product processing such as grain milling, fruits preservation by drying, dairy production and making of mats and baskets. Furthermore, other activities such as cloth weaving, making of dress and footwear, tailoring and pottery are also covered in the household productive activities. All these household activities are incorporated in the production boundary irrespective of whether the commodities are consumed at home or supplied to the market (European Commission et al., 2009). Empirical literature interchangeably uses different terminologies to describe household activities. These terminologies include non-market activities, household reproduction, social reproduction, reproduction sector, unpaid work and home activities and domestic work (Chadeau,1992; Fontana & Wood, 2000; Fontana,2001, 2002, 2004; Latigo & Neijwa,2005; Fofana et al., 2005; Fofana et al., 2006).

Households allocate time to market activities, non-market activities and personal care. Market sectors include all income-generating activities such as agriculture, manufacturing and services. Non-market sectors include home activities (for example, care of children and elderly, cleaning, cooking, fetching water and collecting firewood) and leisure. The focus of this study is on water fetching and firewood collection from among many household activities that are considered as productive by the system of national accounts. Water fetching and firewood collection are routine tasks of households in developing countries. Since the source of water and firewood is not easily accessible in most developing countries, households travel long distances to secure water and firewood. This chapter provides a general review of time spent on water fetching and firewood collection in developing countries and explores time use pattern for these activities in Ethiopia. The chapter also aims to investigate the effect of water fetching and firewood collection on non-agricultural activity participation of rural households in Ethiopia.

3.2 Overview of water fetching and firewood collection in developing countries

3.2.1 Access to drinking water supply and water fetching time

One of the components of the United Nation Millennium Development Goals (UNMDG) was a 50% reduction in the share of population that is unable to secure improved drinking water by 2015 using 1990 as the base period. Specifically, the UNMDG target was to attain 88% coverage of clean water supply by 2015 and it was already achieved in 2010. Global coverage of improved supply of water rose from 76% in 1990 to 91% in 2015. However, nearly 663 million peoples globally are unable to access improved drinking water, out of this 50% live in Sub-Saharan Africa. Furthermore, disparities persist in accessing improved drinking water between urban and rural areas. For example, 96% of the urban populations in the world have access to improved drinking water relative to 84% of the rural global populations (WHO and UNICEF, 2015).

The main sources of drinking water for most populations in developing countries are rivers, wells/springs, lakes and irrigation canals (WHO and UNICEF, 2015). However, these sources of water are often located far from the neighborhoods of households. Households spend a large amount of daily time for collecting water. Empirical evidence shows that globally women and children on average spend 200 million hours per day for collecting water. On average, people walk six kilometers every day for water fetching in Asia and Africa. Access to water is a serious challenge for most Sub-Saharan African countries. It is estimated that annually 40 billion working hours are spent for water fetching activities in Sub-Saharan Africa (Wilbur et al., 2016). Therefore, a large amount of working time that can be potentially used for income-generating activities is lost to water fetching activities. A large proportion of the population in several African countries spends significant time per day for water collection from a distant source. In many African countries more than a quarter of the population spends more than 30 minutes for collecting water (WHO and UNICEF, 2015).

3.2.2 Firewood collection

Nearly half of the populations in developing countries depend on traditional biomass for satisfying their energy demand. Furthermore, 68% of the populations in Africa depend on traditional biomass energy for cooking. Traditional biomass includes wood, tree leaves, charcoal, animal dung and crop residues (International Energy Agency, 2015). Firewood is the major source of fuel for the larger share of households in developing countries. However, households travel long distances or spend long time per day for collecting firewood. Figure 3.1 depicts the average time spent for firewood collection per household per day in selected African countries. On average, households spend between 0.8 hours in Zimbabwe and 5 hours in Sierra Leone per day for firewood collection (World Bank, 2014). The regional average of time spent on firewood collection is 2.1 hours per household per day.

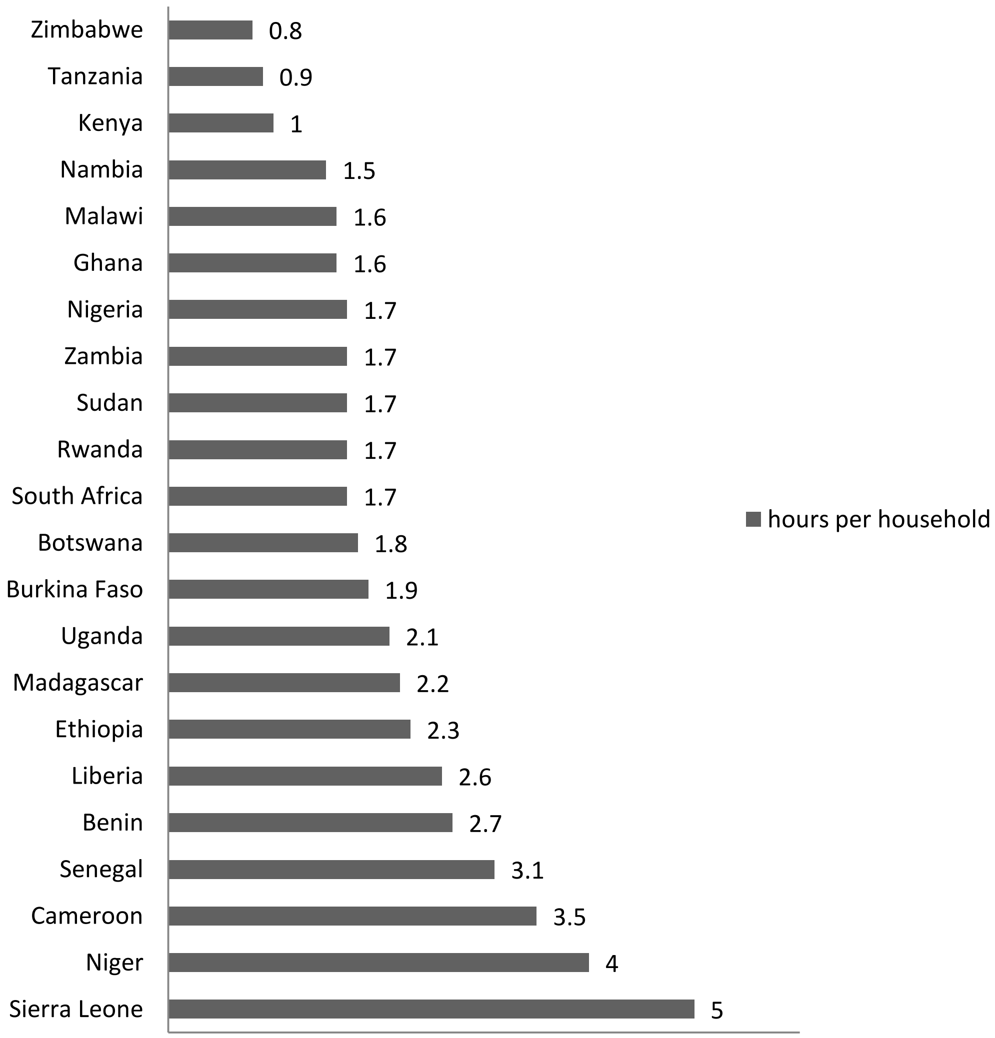

Figure 3.1: Time spent for firewood collection in selected African countries

Source: Author's computation from World Bank (2014)

3.3 Benefit-cost ratio (BCR) of improved access to drinking water infrastructure and household energy

3.3.1 BCR of improved access to drinking water supply

WHO and UNICEF define drinking water supply as improved and unimproved based on the safety of the water, technology type and travel time to access the water (Table 3.1). An improved water source refers to the water supply that is connected to the household/piped water, public tap/stand pipe and protected well/spring. On the other hand, unimproved water supply has the following features: requires some travel and waiting time, is sourced from unprotected wells/springs, surface water (for example, river, lake, ponds and irrigation canals) and unreliable sources (such as tanker truck and bottled water).

Table 3.1: Improved and unimproved drinking water supply

Improved	Unimproved
Piped water/household connection	Unprotected dug well/spring
Public tap/stand pipe	Surface water (for example, river and pond)
Protected well/spring	Water provided by tanker truck
Collected rain water	Vender provided water

Source: UNICEF and WHO (2000)

Unimproved access to drinking water supply has both health and non-health related effects (Figure 3.2). The health effects of unimproved drinking water include waterborne diseases (for example, cholera and typhoid), expenditure for the treatment of the patient who is sick by the waterborne disease, labor lost by the sick person and labor lost by person who cares for the sick person. On the other hand, non-health related costs of unimproved access to water supply comprised labor time lost for collecting water from the distant sources. Therefore, unimproved access to water supply directly and indirectly linked to labor availability and/or productivity of labor in the household. In other words, unimproved access to water supply affects the quantity and quality of labor in the household (Rosen & Vincent, 1999; Hutton & Haller, 2004; Hutton et al., 2007; World Health Organization, 2012).

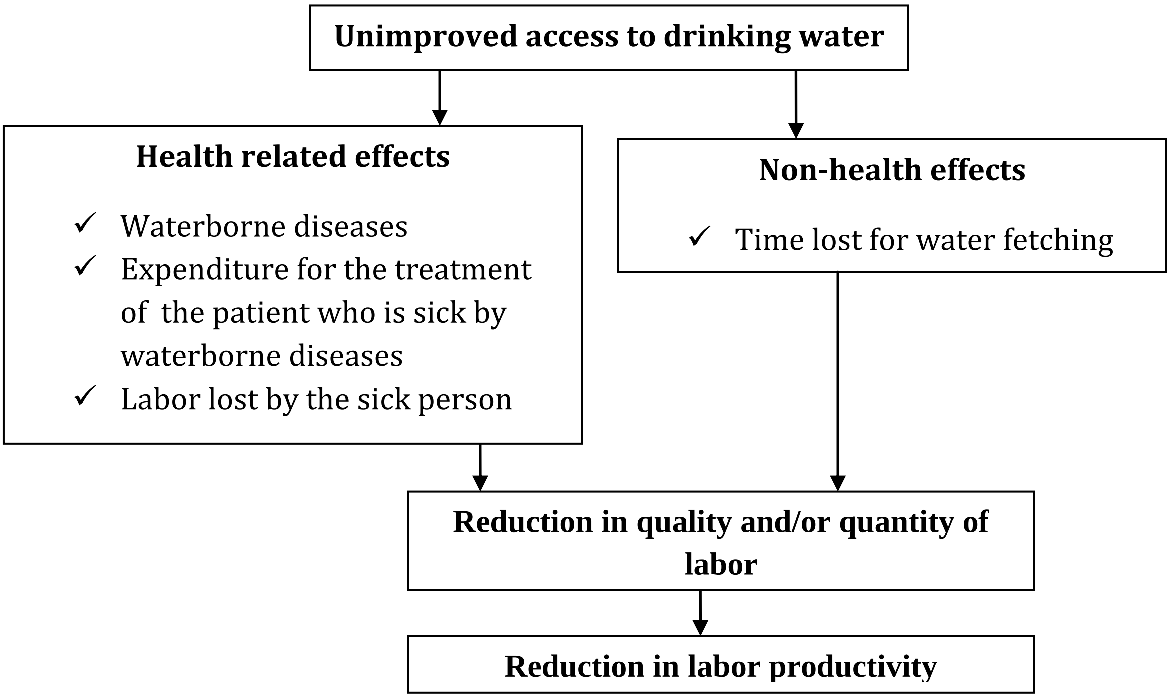

Figure 3.2: Impacts of unimproved access to drinking water supply on labor availability and labor productivity

Source: Author's compilation based on Rosen & Vincent (1999)

The expansion of improved drinking water infrastructure has both costs and economic benefits. Some of the costs include investment cost (for example, cost associated with the initial construction of the water facility) and recurrent cost (for example, maintenance cost). The benefits of improved access to drinking water supply include health related benefits (for example, reduction of waterborne diseases, less mortality, avoidance of the loss of productive time due to diseases and saved health care expenditure) and the opportunity cost of travel and waiting time saved from fetching water.

The WHO estimates the BCR of universal access to improved drinking water for 136 low and middle-income countries in 2012 (World Health Organization, 2012). These countries are grouped into nine sub-regions: South-Eastern Asia (S.E.Asia), Sub-Saharan Africa (SSA), Latin America and Caribbean (LAC), Southern Asia (S.Asia), Eastern Asia (E.Asia), North Africa (N.Africa), Western Asia (W.Asia), Caucasus and Central Asia (CCA) and Oceania. The BCR was estimated for individual countries initially and then it was aggregated to a region weighted by the respective country's population.

According to the WHO's study, the benefits of universal access to drinking water outweigh the costs for most of the countries (Table 3.2). Table 3.2 depicts the BCR of universal access to improved drinking water across countries ranging from 0.6 in Oceania to 3.7 in S.Asia. Each additional dollar of investment provided for improved drinking water results in 0.6 to

3.7 dollar worth of benefits. The bigger proportions of these benefits are derived from the opportunity cost of labor time saved due to improved access to water supply.

Table 3.2: BCR of improved access to water supply (US$ return per US$ invested)

Regions	BCR
S.Asia	3.7
SSA	2.5
LAC	2.4
N.Africa	2.4
W.Asia	2.3
E.Asia	1.6
CCA	1.0
S.E.Asia	0.9
Oceania	0.6
World	2.0

Source: Author's compilation based on World Health Organization (2012)

3.3.2 BCR of improved access to household energy

More than half of the world population depends on traditional biomass such as wood, dung and crop residue for satisfying their energy demand (Bloom et al., 2005). These biomass fuels are usually used for cooking in traditional stoves. Traditional cooking stoves result in indoor air pollution (IAP) that causes respiratory diseases (Rehfuess et al., 2006; Hutton et al., 2007). Furthermore, open fire or traditional stoves are less energy efficient. Because of inefficiency of open fire or traditional stoves, the longer cooking time and hence larger amounts of wood, dung and crop residues are required for cooking. Therefore, households spend a large amount of time for cooking and collecting biomass fuel on a daily basis.

Improved access to household energy (for example, improved cooking stove) has costs and economic benefits. The costs include the purchase of stoves and installation cost among others. On the other hand, the benefits include health related benefits (reduction of diseases caused by IAP), less expenditure on health care services linked to IAP, productivity gain due to better health, time saved from cooking and fuel collection, environmental benefits (for example, fewer trees cut down). Table 3.3 shows the BCR of reducing the share of the population without access to improved cooking stove by 50% across WHO sub-regions. The WHO regions are South-East Asia Region (SEAR), Western Pacific Region (WPR), Eastern Mediterranean Region (EMR), Region of the Americas (AMR), African Region (AFR) and European Region (EUR).

The estimated BCR of access to improved cooking stove varies across different sub-regions; it ranges from 37.4 to 137.4 in AFR and WPR respectively. Each additional dollar of investments to provide improved stoves results in 37.4 to 137.4 worth of US dollar benefits. The largest share of benefits is derived from the saved time that would have been used for cooking and collecting firewood (Hutton et al., 2006).

Table 3.3: BCR of access to improved stove (US$ return per US$ invested)

WHO regions	BCR
WPR	137.4
EUR	90.6
EMR	55.7
AMR	51.2
SEAR	42.3
AFR	37.4

Source: Author's compilation based on Hutton et al. (2006)

3.4 Time spent on water fetching and firewood collection in Ethiopia

3.4.1 Water fetching in Ethiopia

Most rural households in Ethiopia have inadequate access to drinking water. Young boys and girls or adult women usually fetch water. Often, rural households collect water for own consumption but in urban areas, water can also be sold in the market.

3.4.1.1 Sources of drinking water supply

The main sources of drinking water supply are tap, protected or unprotected well/spring, river/lake/pond and rainwater during rainy seasons. Table 3.4 depicts the proportion of households by the sources of drinking water supply in small towns and rural areas. For example, the main sources of drinking water for rural households include protected well/spring (30.2%), river/lake/pond (23.7%) and unprotected well/spring (23.1%). On the other hand, the main sources of drinking water for households in small towns include taps such as private tap (14.5%), shared tap (14.5%) and communal tap (16.8%) and water from kiosk/retailers (29.2%).

Table 3.4: Sources of drinking water supply in rural and small towns (percentage of households)

Sources of drinking water	Rural	Small towns
Protected well/spring	30.21	9.81
River/lake/pond	23.69	5.32
Unprotected well/spring	23.05	4.29
Communal tap outside compound	8.82	16.77
Water from kiosk/retailer	8.12	29.24
Shared tap in compound	1.23	14.52
Rain water	1.99	1.64
Private tap in compound	0.56	14.52
Tap connected to the house	0.26	2.66
Other	2.07	1.23
Total	100.00	100.00

Source: Author's computation based on Central Statistical Agency and World Bank (2013)

3.4.1.2 Water fetching time

Water sources are not located in the nearest vicinity of the households in most parts of the country. Households spend much time per day for collecting water. For instance, rural households on average spend 0.64 hours and urban household on average spend 0.15 hours per day for water fetching (Table 3.5). Gender disparity persists in collecting water in rural parts of Ethiopia; female household members spend more time than male household members do. In urban areas, male household members on average spend 0.05 hours per day and female household members spend 0.1 hours for fetching water.

Table 3.5: **Average time spent per day (in hours) for water fetching in Ethiopia**

Location	Male	Female	Total
Rural	0.12	0.52	0.64
Urban	0.05	0.10	0.15

Source: Author's computation based on Central Statistical Agency (2014)

3.4.2 Firewood collection in Ethiopia

Firewood collection is one of the routine household activities in Ethiopia. Firewood is used for cooking food and lighting for the household. In addition to firewood, households also use charcoal, electricity, animal dung cakes and crop residues for satisfying their energy demand. Most of the collected firewood is used for own consumption. However, firewood can be sold in the market both in rural and urban areas of Ethiopia.

3.4.2.1 Sources of cooking fuel

The main sources of cooking fuel are firewood, charcoal, dung/manure, kerosene, butane/gas, electricity and solar energy. Table 3.6 describes the main sources of cooking fuel. Firewood is the major source of fuel for households in rural areas (88.8%) and small towns (79.6%).

Table 3.6: Sources of cooking fuel in Ethiopia (percentage of households)

Sources of cooking fuel	Rural	Small towns
Firewood (collected)	84.48	27.20
Dung/manure	5.42	1.43
Firewood (purchased)	4.36	52.35
Charcoal	0.44	11.45
Crop residue/leaves	3.37	1.43
Other (electricity, solar energy, kerosene, butane/gas)	1.94	6.13
Total	100.00	100.00

Source: Author's computation from Central Statistical Agency and World Bank (2013)

3.4.2.2 Firewood collection time

Women and girls from poor households predominantly sell firewood, which they carry on their back and transport to small rural towns and/or big urban markets. It is a norm to collect firewood from nearby forest areas. However, forests are not easily accessible in the nearest vicinity of the household due to deforestation. Household members therefore spend much time for collecting firewood. For example, rural and urban households on average spend 0.58 hours and 0.1 hours per day for firewood collection respectively. Gender disparities persist in collecting firewood in rural areas. For example, males on average spend 0.2 hours but females on average spend 0.38 hours per day for firewood collection (Table 3.7).

Table 3.7: Average time spent per day (in hours) for firewood collection in Ethiopia

Location	Male	Female	Total
Rural	0.20	0.38	0.58
Urban	0.05	0.05	0.10

Source: Author's computation based on Central Statistical Agency (2014)

3.5 The effect of water fetching and firewood collection on non-agricultural activities in Ethiopia

3.5.1 Introduction

Water fetchers and firewood collectors are agricultural and non-agricultural laborers in Ethiopia. Water fetching and firewood collection therefore affect production and productivity of income-generating activities. In this section of the chapter, the impact of water fetching and firewood collection on household participation in non-agricultural activities is estimated using household surveys collected from small towns and rural areas of Ethiopia.

3.5.2 Description of the data

The data was sourced from the ERSS. The CSA in cooperation with the WB conducted the ERSS in 2011-2012. This survey covers 3,969 households living in small towns and rural areas of the country. All regions of Ethiopia are covered and hence sampled households represent rural areas and small towns of Ethiopia. The data incorporates household socio-economic characteristic including education, health status, asset ownership, time allocation, food security and non-agricultural activities (Central Statistical Agency and World Bank, 2013).

3.5.3 Model specification and estimation

3.5.3.1 Econometric model specification

Similar to chapter two, the probit model is applied to estimate the effect of water fetching and firewood collection on non-agricultural activities. Since this chapter uses a different data source, it is treated separately from the model in Chapter 2.

The bivariate probit model for the household non-agricultural labor supply decision is specified as follows:

$$P_r\,(P_i\!=\!1) = P_r\,(W_m\!>\!W_r) = X_iB + \epsilon$$

Where P_r is the probability to diversify into non-agricultural activities, P_i is the household participation decisions, P_i=1 if the household diversifies into non-agricultural activities and P_i=0 if the household does not diversify into non-agricultural activities. W_m is the wage from non-agricultural activities, W_r is the reservation wage and ϵ is random disturbance term. X is a vector of factors that influence household's non-agricultural participation decisions. The summary of all variables in the estimated model are depicted in Table 3.8.

Table 3.8: Summary of descriptive statistics

Variables	Mean	Standard deviations
Time spent on non-agricultural activities in hours	5.07	11.46
Time spent on agricultural activities in hours	11.30	15.29
Time spent on water fetching in hours	0.39	0.99
Time spent on firewood collection in hours	0.41	1.12
Age of the household head	48.00	17.00

Source: Author's computation based on Central Statistical Agency and World Bank (2013)

3.5.3.2 Estimation of econometric model

The binary probit model specified above is estimated. The dependent variable is the probability of non-agricultural participation decision of rural households that attains the value of "1" if the household diversify into non-agricultural activities and "0" otherwise. The independent variables are factors that influence non-agricultural participation. The identified non-agricultural determinants include time spent on agricultural activities, time spent on water fetching, time spent on firewood collection, access to credit and possession of non-agricultural equipment (such as sewing machine, weaving equipment, hand drawn cart and animal drawn cart). The quantitatively estimated empirical results are reported in Table 3.9.

In order to control for the heteroscedasticity, the model is estimated using robust standard error. The value of goodness-of-fit of the model as shown by R2 is 0.11. The statistical tests such as t-test, Wald Chi-square test and multicollinearity test validate the robustness of the estimated model. The t-test statistics indicates that all independent variables incorporated in the model are significant at 5% level (the sign ** shows the significance of the variable at 5% level). The Wald Chi-square test confirmed that at least one of the coefficients in the estimated model is far from zero. Furthermore, the variance inflation factor (vif) test for multicollinearity indicates that the model is free from multicollinearity (see appendix A.II for the details of vif test results).

Table 3.9: Determinants of non-agricultural activities in Ethiopia

Variables	Coefficients	Robust standard error	P>/z/	Marginal effect
Time spent on water fetching	-0.1914**	0.0133	0.000	-0.0658
Time spent on firewood collection	-0.1559**	0.0129	0.000	-0.0536
Time spent on agricultural activities	-0.0184**	0.0009	0.000	-0.0063
Access to credit	0.4471**	0.0216	0.000	0.1537
Ownership of non-agricultural asset	0.0229**	0.0089	0.011	0.0079

*Pseudo R2 = 0.1102 Prob>chi2=0.0000 **statistically significant at 5% level

Source: Author's computation based on Central Statistical Agency and World Bank (2013)

3.5.4 Discussion of results

The empirical results are discussed in the following paragraphs:

A) Time spent on water fetching

Rural households of Ethiopia usually spent a high number of labor hours for water fetching. To estimate the effect of water fetching time on the participation of households in the non-agricultural activity, the number of daily labor hours spent on the activity was incorporated as an independent variable. The labor hours spent for water fetching as expected has a negative significant influence on non-agricultural participation. Specifically, each additional labor hours spend on water fetching results 6.6% less chance to participate in non-agricultural activities.

B) Time spent on firewood collection

Rural households also spend more labor time for collecting firewood. Labor hours spent on firewood collection negatively influence non-agricultural activities. Households that spend larger share of their labor hours for collecting firewood would have a lesser probability to engage in non-agricultural activities. In other words, each extra labor hours spend on firewood collection results 5.4% less probability to engage in non-agricultural activities.

C) Time spent on agricultural activities

Rural households usually spend a large proportion of labor hours on agricultural activities, which is the mainstay of the rural households of Ethiopia. The estimation results indicate that labor hours allocated to agricultural activities negatively and significantly affect non-agricultural activities. The marginal effect indicates each additional labor hours spend on agricultural activities results 0.63% less chance to participate into non-agricultural activities.

D) Access to credit

Access to credit constrains rural non-agricultural diversification. Credit access is labeled as a dummy variable that attains "1" if credit facility is accessible by the household and "0" otherwise. The estimation results indicate that credit access has a positive significant influence on non-agricultural participation. The marginal effect shows that households with credit access are 15.4% more likely to participate in non-agricultural activities relative to households that lack credit facility. In other words, financial capital is a critical bottleneck that inhibits rural households of Ethiopia to diversify into non-agricultural activities.

E) Ownership of non-agricultural asset

Non-agricultural assets are equipment that enables rural households to engage in non-agricultural activities. Some of the non-agricultural assets are hand driven carts, animal driven carts, weaving and sewing machines. A dummy variable is generated to capture non-agricultural equipment in the model. Specifically, if households have any of these assets it is assigned a value of "1" and "0" otherwise. The marginal effect indicates that households that own non-agricultural equipment are 0.79% more likely to engage in non-agricultural activity relative to households that do not own this equipment and it is statistically significant. Therefore, the possession of non-agricultural assets increases the chance of non-agricultural participation.

3.6 Summary and conclusion

In most developing regions such as Sub-Saharan African and Asian countries, households spend relatively long time per day for accessing drinking water and firewood. For instance, more than a quarter of the populations in several African countries spend more than 30 minutes per day for collecting water. Furthermore, the African average time spent on firewood collection is 2.1 hours per household per day. Similarly, water sources are not located in the nearest vicinity of the household in most parts of Ethiopia. Households spend long periods per day for collecting water. For instance, in rural area, male household members spent on average 0.12 hours and female household members spend 0.52 hours per day for water fetching. Ethiopian households also spend much time for collecting firewood. For example, male household members spend on average 0.2 hours and female household members spend 0.38 hours per day for firewood collection in rural Ethiopia.

The effect of water fetching and firewood collection on non-agricultural activities is estimated based on a household survey collected from rural areas and small towns of Ethiopia. Non-agricultural activities are also influenced by other factors such as time spent on agricultural activities, ownership of non-agricultural assets and access to credit. Labor hours spent on water fetching and firewood collection negatively and significantly affects non-agricultural activities. Therefore, non-agricultural activities can be promoted by reducing time spent on water fetching and firewood collection. Improved access to drinking water supply and energy saving technology potentially reduces water fetching and firewood collection time. The next chapter presents an overview of labor markets and time use in CGE models and provides an overview on their depiction in the STAGE model used for this study.

Chapter 4: Labor Markets and Time Use in CGE Models and Description of Their Depiction in the STAGE CGE Model

The aim of this chapter is to introduce CGE models and describe their basic structure and to review the depiction of labor markets and time use in CGE models. The technical documentation of the STAGE CGE model applied for this study is briefly presented.

4.1 Introduction to CGE models

4.1.1 Defining CGE models

CGE models can be defined in several ways. Burfisher (2011) defined CGE models as systems of equations that depict the whole economy and the linkage among its parts. The equations in CGE models are directly derived from economic theory. The three terms constituting CGE describe the distinguishing features of the model: 'Computable', 'General' and 'Equilibrium'. 'Computable' refers to that the model is solvable and able to generate numerical results. 'General' implies that the model incorporates the behavior of all agents in the economy (economy-wide). Agents in the economy include households, government, producers, saving-investment and the rest of the world. 'Equilibrium' means agents in the economy are optimizing their objectives given budget, time and other resource constraints. For example, firms maximize profit and households maximize utility given the price of goods and budget constraints (Dixon & Parmenter, 1996; Burfisher, 2011).

Thissen (1998) defined CGE models as the basic general equilibrium macroeconomic interaction among the pattern of demand, incomes of various groups, the balance of payment and structure of production in multi-sectors. CGE models are applied to study a broader range of economic problems at national and international levels. For example, the impact of trade liberalization (Araujo & Flaig, 2016), the effect of climate change (Döll, 2009) and the role of road infrastructure (Schürenberg-Frosch, 2014) among others. CGE models can be constructed in varieties of shapes and size including single-country or multi-country CGE models. Single-country CGE models describe economic activities in one country in detail, for example, the STAGE model (McDonald, 2007). Multi-country CGE models are employed to study economic activities in two or more countries or regions. These models describe each country's production activities, consumption, trade activities and so on. In multi-country models, economies are linked through trade or flows of capital, for example in the GTAP model (Hertel & Tsigas, 1997).

4.1.2 Basic structure of CGE models

The basic structures of CGE models include functional relationships related to production, commodity prices, production factors, households, enterprises, government, international trade, saving-investment and the rest of the world.

4.1.2.1 Production block equations

Production blocks of equations represent the supply side of CGE models. The level of inputs and the technology of production determine production or output. Therefore, production block equations control the decisions of producers about the quantities of inputs and outputs. It is assumed that producers are either minimizing cost or maximizing profit subject to prices of inputs and outputs and production technology. Furthermore, in standard CGE models, the market structures are perfectly competitive; producers cannot influence prices in the market and make zero profit. The production technology is described by nested production functions in most CGE models. The technology can e.g. be specified by a constant elasticity of substitution (CES) function or by a Leontief function (Lofgren et al., 2002).

4.1.2.2 Commodity price block equations

Commodity price blocks in CGE models consist of producer and consumer price equations. Due to the quality difference among commodities of different origin and destinations (export, import and domestic output for domestic use), commodity prices in the system of CGE models are diverse (Lofgren et al., 2002).

Prices in CGE models are endogenously determined. All the demand and supply equations are homogeneous of degree zero in prices and income in CGE models. In other words, doubling of all prices does not affect the equilibrium production and demand. Only relative prices are determined in CGE models. A price index is often used as numeraire for all prices. The consumer price index (CPI) or producer price index (PPI) can be chosen as a numeraire in CGE models (Robinson, 2006).

4.1.2.3 Factor block equations

The factor block of equations accommodates the payments and receipts by production factors. These factors include labor, capital, land and other primary resources. Factors receive wages from activities and these wages are paid to institutions such as households, enterprises and the government (Burfisher, 2011).

4.1.2.4 Household block equations

Households are modeled to optimize utility given their budget constraints. The household block represents the different sources of income and the expenditures incurred by households. Households collect wages from factors and transfers from government, other households, enterprises and the rest of the world. Household expenditure consists of purchase of commodities, tax payments, transfers and savings.

4.1.2.5 Enterprise block equations

The enterprise block of equations contains the income and expenditure by enterprise. Enterprises receive payments from factors of production and other institutions. The expenditure of enterprises goes to taxes, transfers to other institutions such as government and savings. Furthermore, enterprise expenditure and income are modeled similar to income and expenditure by households (Lofgren et al., 2002).

4.1.2.6 Government block equations

The government blocks of equations control the revenue and expenditure by the government. Government collects revenue from taxes, receives transfers from abroad and receives income from factors. Government uses this income for consumption, other expenditure and saving. The expenditure by the government includes purchases of goods and services, subsidies to households and enterprise and transfer to the rest of the world (Teh & Piermartini, 2005).

4.1.2.7 Trade block equations

The trade blocks equations are composed of domestic commodities and foreign commodities. Specifically, exports and imports of goods and services between the domestic economy and the rest of the world are covered. Imports are modeled using the Armington assumption that domestically produced goods and imported goods are not perfectly substitutable. A constant elasticity of transformation (CET) function is applied for the optimal allocation of domestically produced commodities for the domestic market and exports.

4.1.2.8 Saving-investment block equations

The saving-investment blocks of equations control the flow of saving and investment. Savings include the aggregate savings by all domestic institutions such as households, government, enterprises and foreign savings. These savings are allocated to domestic or international investment.

4.1.2.9 The rest of the world block equations

The rest of the world equations control the transfer of payments and receipts between institutions in the domestic economy and the rest of the world.

4.1.2.10 Model closure and market-clearing block

Model closure refers to the decision by the modeler to determine and distinguish exogenous and endogenous variables. In other words, the model closure defines the line of causality in CGE models. The choice of closure rules significantly affects the behavioral relationships and simulation results. Furthermore, closure rules chosen should represent and describe the economy of the particular country under study (Thissen, 1998; Burfisher, 2011).

For example, the external account closure is achieved by fixing either the exchange rate or the external balance. Fixing the exchange rate is appropriate for countries with a fixed exchange rate regime whereas a fixed external balance is appropriate for countries with a restricted external balance (McDonald, 2007). For example, a flexible exchange rate that clears the external balance for obtaining the required level of foreign savings may reflect a given amount of foreign capital import.

For the saving-investment balance, the closure is either saving-driven (the value of investment adjusts) or investment-driven (the value of savings adjusts). Investment driven closures can be chosen to finance a given cost of investment; the flexible savings adjust to finance the fixed investment. For the government balance, the closure choices are fixing either the savings and consumption of the government or the tax rates. If government savings and consumption are fixed, the tax rates are endogenously adjusted to achieve the required level of government savings and consumption. Similarly, the factor market closure is achieved by either fixing factor supply or the wage rate. If the factor supply is fixed, flexible wages equilibrate the factor market.

The market-clearing block ensures that all markets are cleared in the model simultaneously (McDonald, 2007). Market-clearing conditions include factor supply equaling factor demand, the demand for commodities being satisfied by the corresponding supply of commodities and expenditure and income by households, enterprises and government being equivalent.

4.2 Labor market in CGE models

4.2.1 Introduction

Production activities require different production factors such as land, labor and capital. These factors of production are combined with intermediate inputs to produce outputs. Factor markets are one of the macroeconomic components in the framework of CGE models. Different assumptions are made to incorporate factor markets in CGE models. For example, factor supply may be fixed but remuneration to the factor (such as wage or rent) is assumed to vary. This brings equality of factor supply and demand; this is the situation of full employment of factors. Alternatively, it can be assumed that remuneration to the factors is fixed but factor supply is flexible. In this case, it is assumed that the factor can be unemployed (Lofgren et al., 2002).

This section discusses the depiction of labor markets in the CGE framework. Labor markets in the structure of CGE models comprise the supply and demand of labor. Modeling labor may not only cover the marketed labor that is allocated to market sectors but also labor allocated to non-marketed activities (for example, leisure and home production). Based on the topic of interest, labor can be categorized based on the level of skill (e.g. high-skilled labor, medium-skilled labor and low-skilled labor). It can be classified by sector of employment (for example, agricultural labor and non-agricultural labor), gender status (for example, male labor and female labor), location (for example, rural labor and urban labor) and age (for example, adult labor and child labor) (Boeters & Savard, 2011).

4.2.2 Labor demand

In CGE models, labor demand is endogenously determined and it is obtained from the sectoral production functions (Boeters & Savard, 2011). Specifically, labor demand is derived from the profit maximization behavior of productive sector subject to production technology, wage and price of output (Kurzweil, 2002).

4.2.3 Labor supply

Labor supply is introduced into CGE models based on the following two assumptions: it is exogenous or it is endogenous to the model.

4.2.3.1 Exogenous labor supply

In most standard CGE models, labor supply is modeled with the assumption that it is exogenous to the system. When the supply of labor is fixed (exogenous), the wage rate is flexible and clears the labor market. In other words, labor demand and supply are equalized by a market-clearing wage. The assumption of fixed labor supply reflects the situation of full employment; the labor supply curve is vertical (Figure 4.1). The wage rate can decrease or increase at the given employment level. For example, Figure 4.1 shows the wage rate increasing from W_0 to W_1 but labor supply (L^s) remaining the same (Lofgren et al., 2002; Banse et al., 2013).

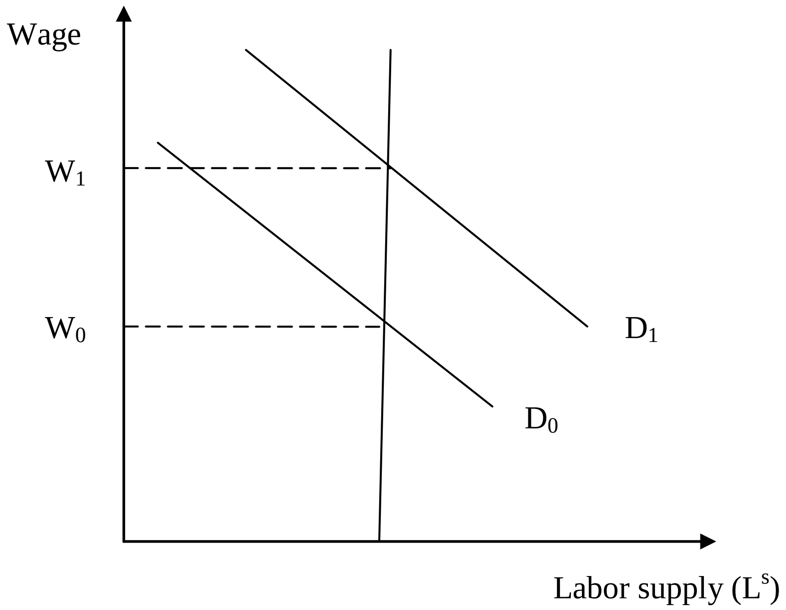

Figure 4.1: Labor supply in standard CGE models

Source: Adapted from Banse et al. (2013)

4.2.3.2 Endogenous labor supply

Labor supply may be endogenously integrated into a CGE framework based on the depiction of the labor-leisure choice, an upward sloping labor supply curve or the explicit modeling of unemployment.

4.2.3.2.1 Labor-leisure choice

Labor supply can be endogenously introduced into CGE models based on the labor-leisure choice. According to this approach, households obtain utility from the consumption of goods and leisure time. Leisure is integrated into the household utility function with the assumption that it is similar to any other normal good and has opportunity cost which is equivalent to the level of wage. The rise in the wage rate has both substitution and income effects (Figure 4.2).

For instance, a rise in the wage rate results in higher opportunity cost of leisure that makes the person to consume less leisure and spend more time for work; this is the substitution effect. Additionally, an increasing wage rate results in an increase in real income and raises consumption of goods inclusive of leisure that is an income effect. The labor-leisure interaction results in a backward-bending labor supply curve. Initially, an increase in the wage rate causes labor supply to increase and a further increase in the wage rate reduces labor supply (Annabi, 2003; Decaluwé et al., 2010).

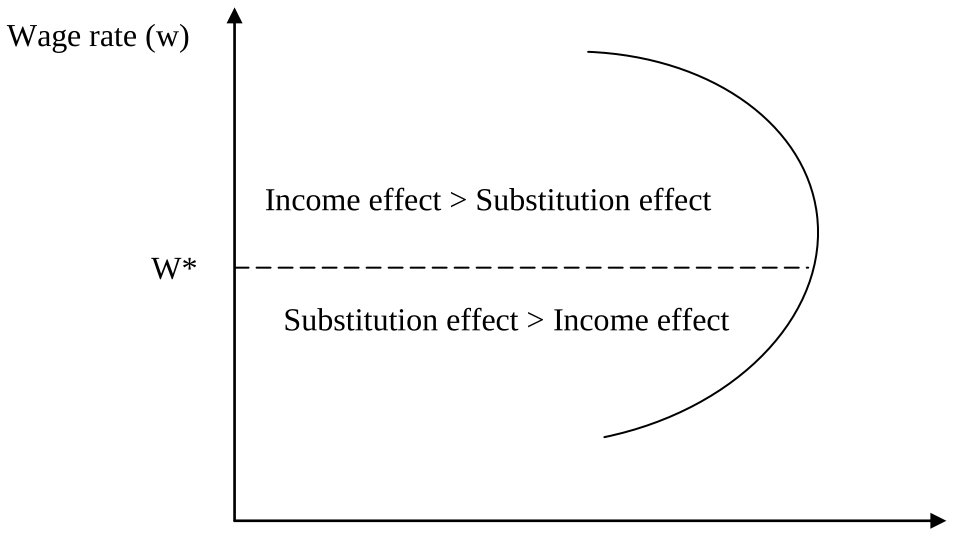

Figure 4.2: Backward-bending labor supply

Source: Adapted from Annabi (2003)

Annabi (2003) describes the mechanism through which the supply of labor is endogenously determined by utility maximization of the household. The household utility function is described according to the linear expenditure system where the household maximizes utility (U) which is defined by the aggregate consumption good (C) with consideration of the minimum level of consumption (C^{min}) and leisure time (L_t) given the time and budget constraints. This can be expressed mathematically as:

$$\mathrm{Max}U = \alpha \ln\left(C - C^{min}\right) + \beta \ln L_t \text{ ………….. (1)}$$

Subject to

$$PC = wTL + y = w(T - L_t) + y = Y - wL_t \text{ …………. (2)}$$

Where TL is labor time, P is price of commodities, C is amount of consumption, w is wage rate, y is non-labor income, L_t is leisure time, T is the total available time of the household (T= TL + L_t). This can be rewritten as wT= wTL + wL_t. This implies that time endowment (total time: labor time and leisure time) which is evaluated by the wage rate (w) and Y is full income. This can be defined as Y= wT + y. The consumption function is aggregated by the Cobb-Douglas function where $\alpha + \beta = 1$.

The optimal function of consumption and demand for leisure is derived using the Lagrangian multipliers approach. The Lagrangian multipliers (L) for the above consumption function can be specified as:

$$L = U + \lambda(P * C - Y + wL_t) \text{ …………… (3)}$$

The partial differentiation of L with respect to consumption (dL/dC) and leisure (dL/dLt) yields the optimal level of consumption and demand for leisure. After some rearrangement of the first order condition, the consumption and leisure demand functions are:

$$C = C^{min} + \frac{\alpha}{P}\left(Y - P * C^{min}\right) \text{……………… (4)}$$

$$L_t = \frac{\beta}{w}\left(Y - P * C^{min}\right) \text{………………. (5)}$$

The labor supply function can be derived from the total labor time and leisure demand function: total available time (T) = labor time (TL) + leisure time (L_t). The labor supply is equivalent to amount of labor time (TL), so that $TL=T-L_t$

After some substitution, the labor supply function (TL) can be obtained:

$$TL = T - L_t = T - \frac{\beta}{w}\left(Y - P * C^{min}\right) = \alpha T - \frac{\beta}{w}\left(y - P * C^{min}\right) \text{…... (6)}$$

Where all variables are defined as above. The labor supply function depends on the wage rate, the total available labor time, non-labor income and the minimum level of consumption.

Numerous CGE analyses incorporate the endogenous supply of labor using the labor-leisure approach. For example, Fox (2002) illustrates how labor supply can be endogenously determined by incorporating the labor-leisure choice into the US International Trade Commission's CGE model of the US economy. Other studies such as Fofana et al. (2005) also integrate the labor-leisure choice into a CGE model in studying the effect of liberalizing trade policy on women work and leisure for the Nepalese economy. In the study of Fofana et al. (2005), labor supply is endogenously determined using utility function which is defined over home produced and marketed goods and leisure subject to constraints of production technology, budget and time.

4.2.3.2.2 Upward sloping labor supply curve

In most standard CGE models, the two extreme assumptions about the operation of labor markets are, labor supply is perfectly elastic or it is perfectly inelastic. When it is perfectly inelastic, flexible wage rate clears the market. Alternatively, when it is perfectly elastic, the wage rate is fixed and flexible labor supply equilibrates the market. The upward sloping labor supply curve provides an intermediate option for these two extreme labor market assumptions in CGE modeling. Under an upward sloping labor supply curve, both labor supply and wage can change simultaneously. In other words, the wage rate endogenously determines labor supply. Mathematically, the upward sloping labor supply function can e.g. be specified as:

$$LS_i = \beta_i W_i^{\varepsilon i}$$

Where LS_i is labor supply of labor type i (labor can be categorized as skilled or unskilled, male or female, etc.), β_i is a slope parameters, W is the rate of wage and ε is the labor supply elasticity (Watson et al., 2013). Figure 4.3 presents an upward sloping labor supply curve. The figure indicates a positive relationship between wage rate and labor supply. LS* refers to the maximum available amount of labor. An increase in the wage rate from W_0 to W_1 results in labor supply rising from LS_1 to LS_2.

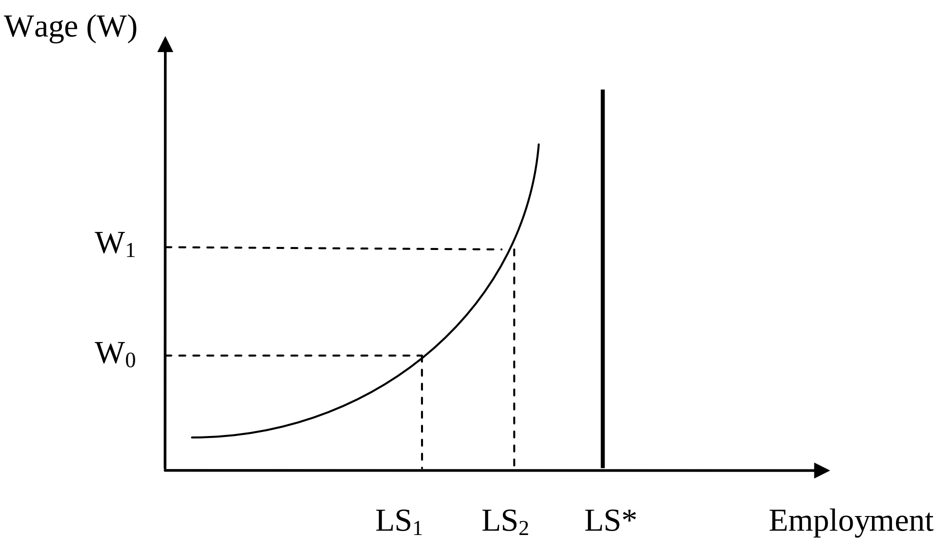

Figure 4.3: Upward sloping labor supply curve

Source: Adapted and modified from Shutes (2012)

4.2.3.2.3 Unemployment in CGE models

Unemployment is the difference between labor supply and labor demand. Specifically, if labor supply exceeds labor demand, the situation of unemployment appears. On the other hand, if the labor supply is exactly equivalent to labor demand, unemployment does not exist. Unemployment is introduced into CGE models exogenously or endogenously.

4.2.3.2.3.1 Exogenous unemployment

It is assumed that factors outside the system determine unemployment in most CGE models. This implies that there is no situation of unemployment in the model. This assumption does not imply that zero unemployment is prevailing in a given economy but it is merely assumed that unemployment is exogenous to the CGE model (Estache et al., 2007; Shutes et al., 2012).

4.2.3.2.3.2 Endogenous unemployment

Unemployment can be introduced into CGE models with the assumption that it is endogenously determined within the system. Since unemployment is the difference between labor demand and supply, the rate of unemployment in each labor market can be defined as:

$$U^k = \frac{\sum_h LS_h{}^k - \sum_h LD_h{}^k}{\sum_h LS_h{}^k}$$

Where, U^k refers to the rate of unemployment, k refers to the different labor types that can be classified in different ways, for example, by gender (male and female), location (rural and urban) and education (skilled and unskilled). On the other hand, h refers to household's labor, $\sum_h LS_h{}^k$ is the aggregate labor supply, $\sum_h LD_h{}^k$ is aggregate labor demand and both labor supply and demand are endogenously determined (Fofana et al., 2005).

4.2.3.3 Labor mobility

Factor mobility refers to movement of a factor across different sectors or regions. The assumptions on factor mobility in a CGE model reflect the degree to and the speed at which a given factor of production is capable of switching between economic sectors due to changes in relative returns (Shutes et al., 2012). The following assumptions may be made about labor mobility in CGE model: a) labor is perfectly mobile and b) labor is imperfectly mobile.

4.2.3.3.1 Perfect labor mobility

Perfect mobility of labor refers to the movement of labor between the different sectors or regions without any restrictions. In other words, labor freely moves between sectors because of differences in relative returns between the origin sector and destination sectors. The mobility of labor is continued until the difference in returns between the origin and the destination sectors disappears. Perfect mobility of labor is assumed in most standard global CGE models such as GTAP, MIRAGE, GLOBE and WORLDSCAN (Banse et al., 2013).

4.2.3.3.2 Imperfect labor mobility

In the context of real world situations, labor may not easily switch across sectors without any restrictions or labor may be immobile across sectors. The movement of labor between the different sectors involves adjustment costs (searching cost) and non-transferability of skill or loss of skills (Tapp, 2008). These situations make the smooth flow of labor across different sectors more sluggish or imperfect or fully immobile. The imperfect mobility of labor in the framework of CGE models may be controlled by the following functions: Constant Elasticity of Transformation (CET) and migration functions.

4.2.3.3.2.1 Imperfect labor mobility with CET function

Imperfect labor mobility across different sectors may be governed by CET functions. This refers to the degree of labor reallocation between sectors in response to relative returns that depend on the value of the elasticity of transformation. The larger the elasticity of transformation, the stronger the mobility of labor whereas the lower elasticity of transformation, the lower the mobility of labor between different sectors (Banse et al., 2013).

4.2.3.3.2.2 Imperfect labor mobility with migration function

The imperfect mobility of labor across different sectors can also be depicted by a migration function. Flaig et al. (2013) developed imperfect labor mobility governed by migration functions based on the work of McDonald & Thierfelder (2009). According to Flaig et al. (2013), specific labor types (for example, industrial skilled labor) can migrate between segmented blocks of sectors (for example, industry) in which perfect mobility of labor is assumed. The changes in relative wages determine the migration of labor. Labor migration also depends on the amount of labor supplied in the base situation.

The migration function can be specified as:

$$\mathrm{M_f} = \mathrm{LS_f} * \left[\frac{\text{relative wage}_\mathrm{f}}{\text{relative wage in the base}_\mathrm{f}}\right]^{\mathrm{etmig\ f}} - \mathrm{LS_f}$$

Where, f refers to labor, M_f is the amount of labor migrated, LS_f is supply of labor in the base and $etmig_f$ is elasticity of migration. The response of labor migration to the difference in the relative wage is determined by the elasticity of migration. When the value of $etmig_f$ is zero, no labor migrates while if it is high, labor moves strongly between sectors.

4.3 Time use in CGE models

Households distribute daily time to marketed activities, home activities, leisure and personal care. Marketed activities cover all income-generating activities such as agriculture, manufacturing and services. On the other hand, home activities consist of cleaning, cooking, fetching water and collecting firewood among others. This section highlights the depiction of time use spend on home activities in the CGE model.

4.3.1 Integrating home production into CGE models

Home production refers to non-marketed or household reproduction activities such as cooking and cleaning, personal care, childcare, water fetching and firewood collection among others. Households spend a larger portion of their labor time on home production activities in developing countries. Accordingly, the time spent on home activities negatively affects participation of households in market activities. Therefore, it is economically interesting to look at household labor allocation between market activities and home activities. Some studies integrate home production into CGE models. For example, Fontana & Wood (2000) built a CGE model that explicitly identifies home production and leisure as separate activities in addition to the usual marketed activities. Home activity and leisure are recognized as independent activities that behave like any market activities. According to Fontana & Wood (2000), home activities are assumed to be produced by using female and male labor and without any other primary inputs (for example, capital) or intermediate inputs. In other words, home production is the CES function of the aggregates of the composite of female and male labor where male and female labor is imperfectly substituted.

Fontana & Wood (2000) estimated the value of labor supplied to home activities based on setting the opportunity cost of labor equal to market wage rate. Specifically, labor time spend on these activities is translated to a monetary value to derive the value of home commodities. Consequently, the opportunity cost of labor depends on specific household characteristics such as gender, age and education. Furthermore, it is also assumed that all home production is used for home consumption. Home produced goods are not supplied to the market. The composition of female and male labor for home production depends on the substitution elasticity, the share parameter and the relative opportunity cost of labor (Fontana & Wood 2000; Fofana et al. 2005).

This section provides the depiction of labor in a CGE model as developed by Fontana & Wood (2000) and further elaborated and extended by Fofana et al. (2003). In these frameworks, male and female household members allocate their time to market activities, home activities and leisure. The household's utility optimization problem determines the amount of labor devoted to each of these activities. It is assumed that household utility is derived from the consumption of marketed goods, home commodities and leisure time subject to the time and budget constraints. The utility function (U_h) is mathematically specified as:

$$U_h = F\left(M_h, H_h, Le^m, Le^f\right) \ldots\ldots\ldots.. (1)$$

Where U_h refers to household utility, h refers to household, M_h is marketed goods, H_h is home goods, Le^m is male time and Le^f female time allocated to leisure.

This function can be defined as an extended Stone-Geary utility function:

$$U_h = \left(Le_h^m - \overline{Le^m{}_h}\right)^{\beta_h{}^{mal}} \left(Le_h^f - \overline{Le_h^f}\right)^{\beta_h^{fem}} \left(H_h - \overline{H_h}\right)^{\beta_h^H} \prod_i \left(M^i{}_h - \overline{M^i}_h\right)^{\beta_h^i} \ldots\ldots\ldots (2)$$

With $\beta_h{}^{mal} + \beta_h^{fem} + \beta_h^H + \sum \beta_h^i = 1$

Where $\overline{Le^m{}_h}$ and $\overline{Le^f{}_h}$ are the minimum leisure time of males and females, $\overline{H_h}$ and $\overline{M_h}$ is the minimum consumption of home and marketed goods respectively, β refers to the marginal budget share that determines the distribution of household income between marketed goods and leisure.

The above utility function of the household is constrained by the following functions:

Home production technology:

$$Z_h = A_h * \left[\alpha_h * LHfem_h^{\rho} + (1 - \alpha_h) * LHmal_h^{-\rho}\right]^{\frac{-1}{\rho}} \ldots\ldots. (3)$$

Budget constraints:

$$\sum_i P_{i,h} M_{i,h} = NY_h + w_{mal} LMmal_h + w_{fem} LMfem_h = Y_h \ldots\ldots (4)$$

Time constraints:

$$Tmal_h = LMmal_h + LHmal_h + le_h{}^m \ldots\ldots. (5)$$

$$Tfem_h = LMfem_h + LHfem_h + le_h{}^f \ldots\ldots. (6)$$

Where Z_h is the production of the home good, A_h is a scale parameter, α_h is a labor share parameter and ρ is an elasticity parameter. P_h is the marketed good price, NY_h is non-labor income of the household, w_{mal} is the wage rate of males and w_{fem} is females' wage rate. $LMfem_h$ and $LMmal_h$ are female and male household labor devoted to marketed sector respectively. $LHmal_h$ and $LHfem_h$ are the amount of males' and females' labor allotted to the production of home goods, Y_h is real income, Tmalh and $Tfem_h$ is the total available male and female household labor respectively.

The combined budget and time constraints would be:

$$\sum_i P_{i,h} M_{i,h} + P_h^H H_h + w_{mal} Le_h^m + w_{fem} Le_h^f = FY_h \quad \ldots\ldots\ldots\ldots (7)$$

Where P_h^H represent the price of home goods, H_h is the volume of a home good and FY_h is full income.

In order to determine the consumption and labor supply decision of the household, the extended utility function of Stone-Geary (equation 2) is solved given the combined constraints of time and budget (equation 7). The utility maximization problem can be solved based on the Lagrangian multipliers (L) approach that can be defined as:

$$L = \left(Le_h^m - \overline{Le^m{}_h}\right)^{\beta_h{}^{mal}} \left(Le_h^f - \overline{Le_h^f}\right)^{\beta_h^{fem}} \left(H_h - \overline{H_h}\right)^{\beta_h^H} \prod_i \left(M_h - \overline{M_h}\right)^{\beta_h^i} + \lambda \left(FY_h -\right.$$

$$\text{iPi,hMi,h} - \text{PhH Hh} - \text{wmaleLehm} - \text{wmaleLehf} \quad \ldots\ldots\ldots\ldots\ldots (8)$$

After partially differentiating the Lagrangian multiplier with respect to marketed goods ($\frac{dL}{dM_h}$), home goods ($\frac{dL}{dH_h}$) and leisure ($\frac{dL}{dLe_h^m}$ and $\frac{dL}{dLe_h^f}$) and manipulation of intermediate results, the following demand functions for market and home produced goods and labor supply to home production is obtained:

$$M_{i,h} = \overline{M_{i,h}} + \frac{\beta_h^i \left[Y_h - \sum_i P_i \overline{M}_{i,h}\right]}{P_i\left(1 - \beta_h{}^{mal} - \beta_h^{fem} - \beta_h^H\right)} \quad \ldots\ldots\ldots (9)$$

$$H_h = \overline{H_h} + \frac{\beta_h^i \left[Y_h - \sum_i P_i \overline{M_{i,h}}\right]}{P_i^{NM}\left(1 - \beta_h{}^{mal} - \beta_h^{fem} - \beta_h^H\right)} \quad \ldots\ldots\ldots (10)$$

$$LHmal_h = Tmal_h - LMmal_h - \left[\overline{Le^m{}_h} + \frac{\beta_h^{mal} \left[Y_h - \sum_i P_i \overline{M_{i,h}}\right]}{w_{mal}\left(1 - \beta_h{}^{mal} - \beta_h^{fem} - \beta_h^H\right)}\right] \quad \ldots\ldots\ldots (11)$$

$$LHfem_h = Tfem_h - LMfem_h - \left[\overline{Le^f{}_h} + \frac{\beta_h^{fem} \left[Y_h - \sum_i P_i \overline{M_{i,h}}\right]}{w_{fem}\left(1 - \beta_h{}^{mal} - \beta_h^{fem} - \beta_h^H\right)}\right] \quad \ldots\ldots\ldots (12)$$

Where M_h and H_h are the demand functions of market and home goods, $LHmal_h$ is the male labor supply function and $LHfem_h$ is the female labor supply function for home production. The observation from these equations is that the household's decision to allocate labor into marketed activities, home production and leisure depends on the demand for marketed goods, home goods and leisure.

4.3.2 Examples of policy experiments considering time use in CGE models

The mechanism through which home production is blended into the system of CGE models is presented in the previous section. Several types of policy experiments can be made by incorporating home production in the structure of CGE models. For example, Fontana (2004) built a CGE model which incorporates leisure and home production and applied it to Bangladesh and Zambia to address the impact of trade policies. The main policy experiment of the study was to evaluate the impact of full elimination of import tariffs. The outcome of the simulation indicates that the full elimination of tariffs increases male and female employment in market activities such as the manufacturing and service sectors. The higher need of labor in the marketed sector results in a reallocation of labor from home activity and leisure to marketed activities.

Mitik & Decaluwé (2009) analyzed impact of trade on the labor allocation decision of household members in South Africa. Household members include adult males, adult females and children such as boys and girls. These household members allocate their time to education, home activities and leisure. Specifically, adult members of the household allocate their time to market work, home production and leisure whereas boys and girls spend their time on home activity, education and leisure. This study addressed the time allocation decision of adult females and males as well as girls and boys in the household in response to change in the trade policy. It is assumed that adult and child labor is perfectly substitutable for home production. This is an important assumption because when adult household members increase their labor time to market activities, girls and boys become more involved in the home activity. Following the perfect substitutability assumption of adults and children in home activities, any macroeconomic policies that affect market activities have an impact on children schooling. For example, if trade liberalization increases adult female and male labor allocated to export oriented sectors, their involvement in home production declines (labor would be reallocated from home activity to market activity). This would make children to undertake their parents' role in the home activity and reduce their time allocated to education. Due to the engagement in the home activities, children might not necessarily dropout from schooling but rather face time constraints to conduct homework and study and would allocate less time to leisure.

4.4 STAGE CGE model

4.4.1 Introduction

This section describes the STAGE CGE model. This study uses the STAGE CGE model developed by McDonald (2007). STAGE is a single-country CGE model and it is implemented in General Algebraic Modeling System (GAMS). It is a SAM based model. The SAM helps to distinguish economic actors and it provides the database for calibration of the model. Most part of the STAGE model description in this section is based on the STAGE base version model documentation by McDonald (2007). This section aims to provide a general review of the structure of the STAGE model, for a detailed documentation of the model refer to McDonald (2007).

4.4.2 Behavioral relationships in the STAGE model

Behavioral relationships in the STAGE model comprise linear and non-linear relationships. Households choose a bundle of commodities to consume in order to maximize a Stone-Geary utility function. The commodities consumed by households are a composite of domestically produced and imported commodities. The CES functional form is used to combine the imported and locally produced commodities by assuming that both these commodities are imperfect substitutes. Following Armington (1969), the relative price of imported and local commodities determines the optimal ratio of imported and domestically produced goods. A two-level production nesting is implemented for modeling domestic production. At the top level of production, the value added and intermediate inputs are aggregated by a CES or a Leontief technology. At the lower level of production, Leontief technologies are used to aggregate intermediate inputs, while CES technologies are used to aggregate primary inputs.

In the STAGE model, a single activity can produce multiple commodities and commodities can be produced by multiple activities by assuming that the proportionate composition of each activity's production of commodity outputs remains the same. Domestically produced commodities are provided to the domestic market or to export. Domestically produced and exported commodities are aggregated by a CET function. The relative prices control the optimal supply of domestically produced commodities for local and export markets.

The STAGE model is flexible for modeling small countries (i.e., being a price taker) or large countries (i.e., being a price maker). In addition to these behavioral relationships, the model also includes various tax instruments and adjustment/scaling factors. A variety of adjustable closure and market-clearing conditions are also incorporated in the model.

4.4.3 Quantity relationships in the STAGE model

The quantity relationships in the STAGE model are described in Figure 4.4. Locally produced commodities (QXC_c) by several of activities ($QXAC_{a2}$) are aggregated by CES technology. On the other hand, Leontief technology is used to aggregate each activity's output (QX_{a2}).

Domestically produced commodities (QXC_c) are supplied to the domestic (QD_c) and export (QE_c) markets. Domestically produced commodities delivered to the domestic market (QD_c) and imported commodities (QM_c) are aggregated to constitute composite commodities (QQ_c). Therefore, QQ_c is the total supply of commodities to the domestic market. The demand for QQ_c is composed of intermediate input demand ($QINTD_c$), households demand (QCD_c), enterprise demand ($QENTD_c$), demand by government (QGD_c), stock changes ($dstocconst_c$) and gross fixed capital formation ($QINVD_c$).

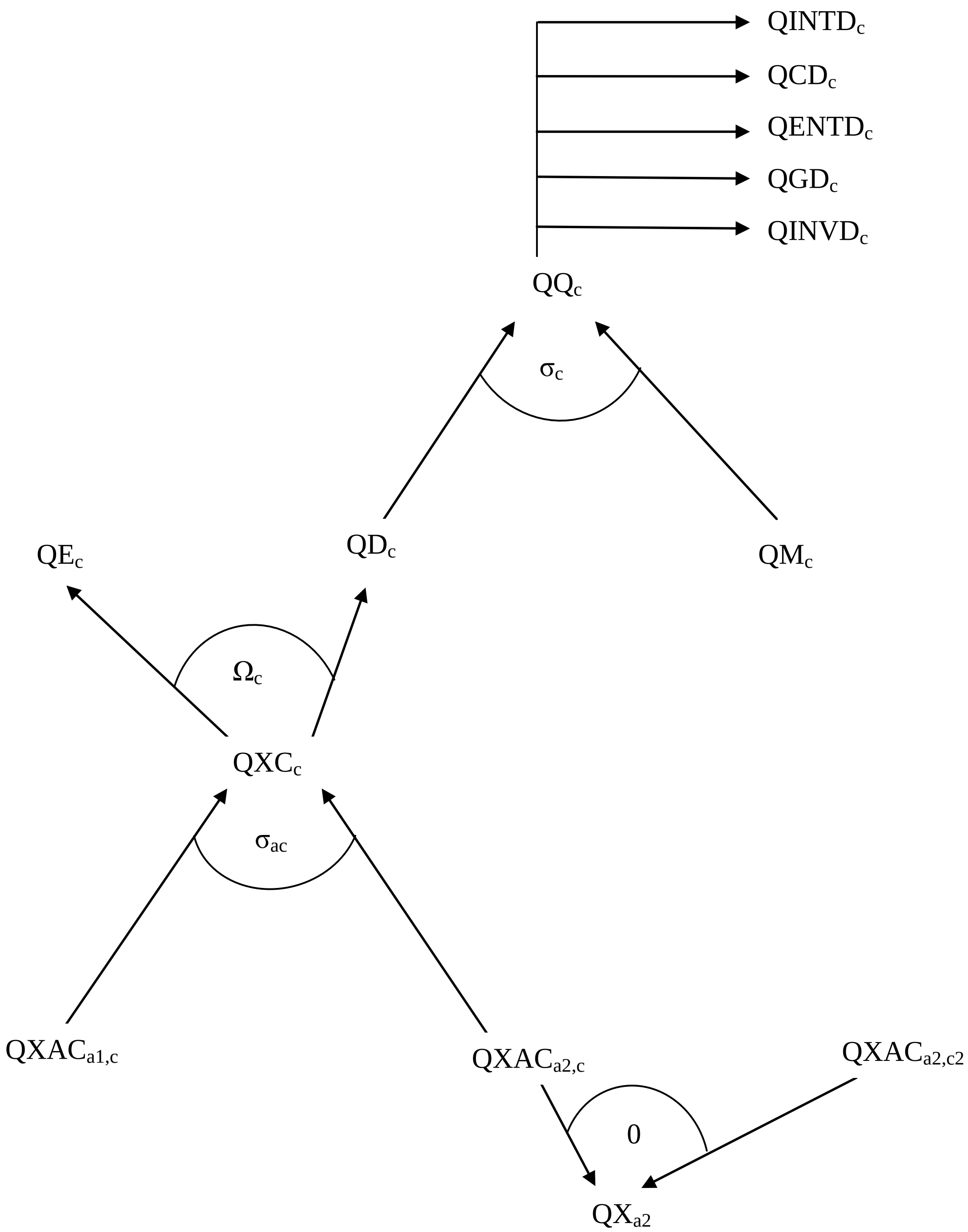

Figure 4.4: Quantity relationships in the STAGE model

Source: Taken from McDonald (2007:16)

4.4.4 Price relationships in the STAGE model

Price relationships in the STAGE model are depicted in Figure 4.5. Each set of commodities/activities in the STAGE model has its own corresponding set of price levels. The structure of prices in the STAGE model follows that of the quantity relationships in the model. The composite consumer price (PQD_c) is defined as supply price of composite commodities (PQS_c) uplifted by excise taxes (TEX_c) and sales taxes (TS_c). PQS_c is the weighted mean of price of domestically produced and consumed commodities (PD_c) and the imported commodities' prices (PM_c) that are determined by the product of the world market price (PWM_c) and the exchange rate (ER) elevated by import duties (TM_c).

Similarly, producer prices (PXC_c) are the weighted mean of the commodities' price of produced and domestically sold (PDS_c) and exported (PE_c) products. The domestic price of exported commodities is determined by the product of export price in the world market (PWE_c) and the ER reduced by a potential export tax (TE_c). The mean price per unit of output obtained by activity (PX_a) is defined as the weighted mean of the prices of domestic producers. After deducting the output taxes (TX_a), the remainders are paid to value added (PVA_a) and intermediate inputs ($PINT_a$).

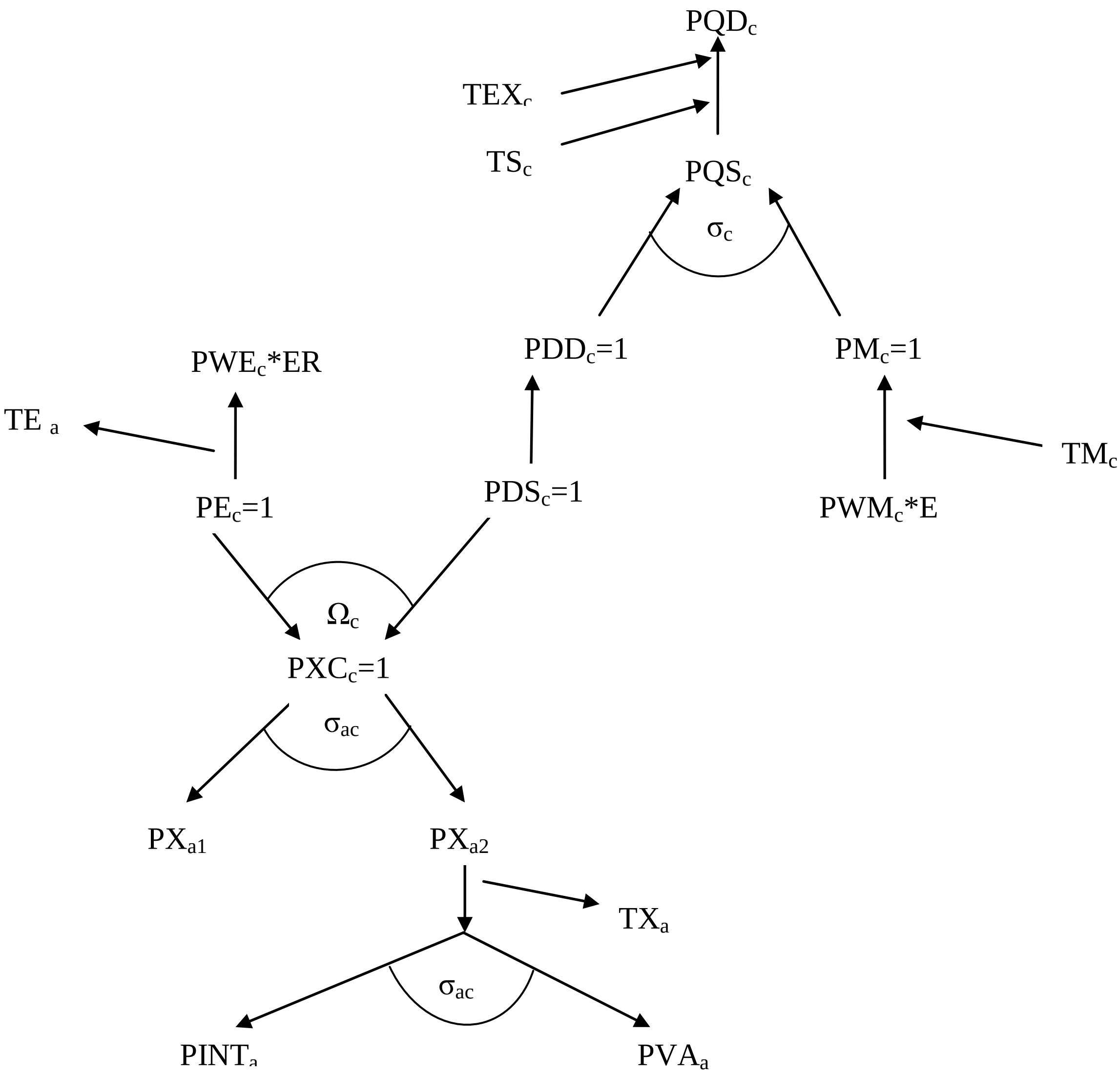

Figure 4.5: Price relationships in the STAGE model

Source: Taken from McDonald (2007:15)

4.5 The model extensions of this study

This study modified the STAGE model. Most of the basic features of the STAGE model are applied except some extensions in the domestic production structure. The domestic production structure is extended to capture different labor types (such as female and male) in the process of fetching water and firewood. The basic version of the STAGE model uses a two-stage production process for modeling domestic production. In this study, domestic production is modified to accommodate a four level production process (Figure 4.6). In the first level, intermediate inputs and value added are combined using CES technology to produce total output. In the second level, Leontief technology combines intermediate inputs, while the value added composite (land, labor and capital) is aggregated by a CES function. In the third level, aggregate skilled and unskilled labor are combined by CES technology to form aggregate labor that allows substitution between skilled and unskilled labor. In the fourth level, female and male labor is combined by CES technology to form aggregate skilled/unskilled labor that allows for substitution between female and male in the labor categories. The modified STAGE model is calibrated using the updated SAM of Ethiopia.

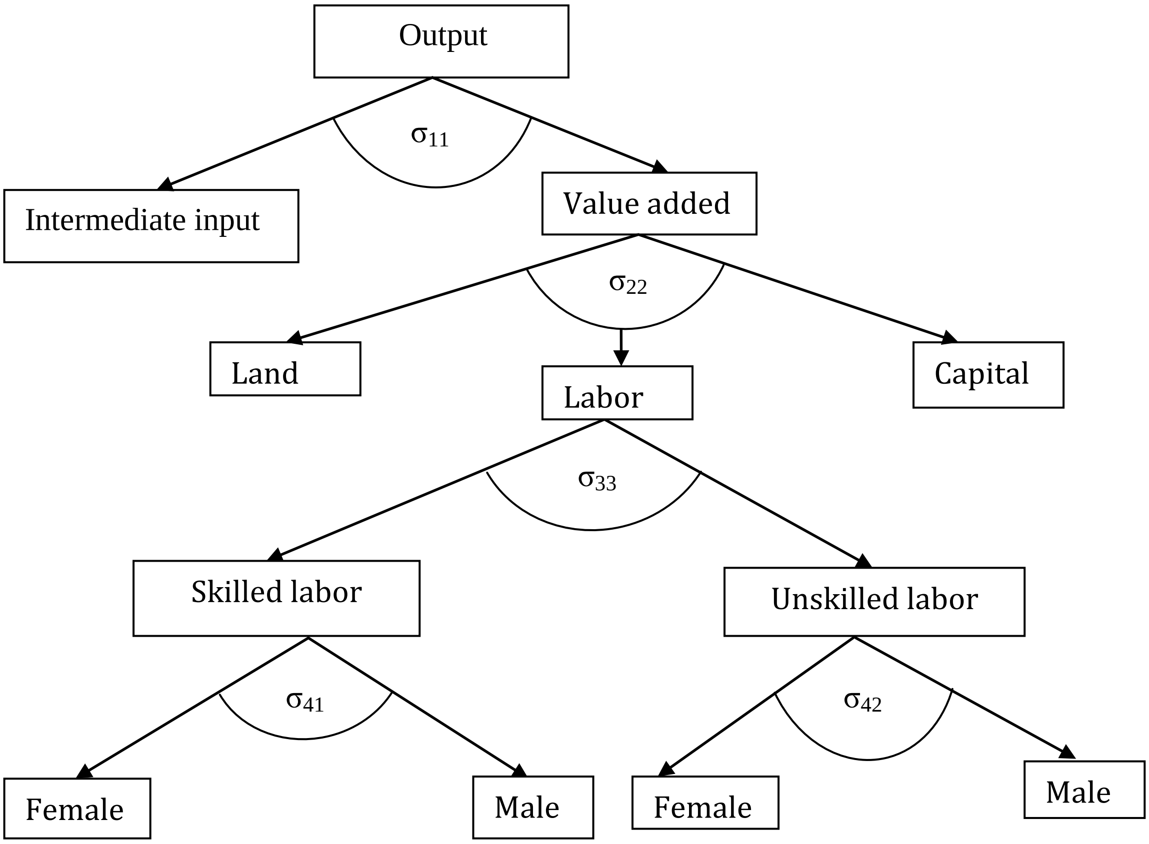

Figure 4.6: Production nesting

Source: Own compilations

The study models home produced and home consumed commodities (HPHC). HPHC commodities include any type of commodities that are produced and consumed by households. HPHC commodities constitute a large share of household consumption in developing economies (Arndt, Jensen, Robinson, & Tarp, 1999). Most commodities produced by households are composed of HPHC commodities and marketed commodities. In other words, these household make production for supplying all or some part of their own output into the market and/or for their own consumption.

This study adopted the approach developed by Lofgren et al. (2002) to model HPHC commodities. Based on this approach the consumption of pure marketed and HPHC commodities is differentiated through market price and producer price. Specifically, the consumption of marketed commodities is valued at market prices whereas the consumption of HPHC is valued at producer prices (i.e. without taxes and trade and transport margins). Therefore, household consumption is modified to distinguish between the consumption of marketed commodities and HPHC commodities.

4.6 Elasticities

Several types of model specific elasticities are used in the calibration of the CGE model applied for this study. Elasticities in the model include commodity, activity and income elasticities. Commodity elasticities involve Armington's substitution elasticities between imported and domestically produced commodities and the elasticities of transformation between local commodities and export commodities. The commodity elasticities also include export demand elasticities and substitution elasticities for aggregation of commodity output. Activity elasticities cover elasticities of substitution between intermediate inputs and value added input and the substitution between different primary factors such as labor, capital and land in the nested production function. Income elasticities are elasticities for the consumption of different commodities by households. In this study, commodity, activity and Frisch elasticities are adopted from Flaig (2014). On the other hand, most of the income elasticities are adapted from Tafere, Taffesse, & Tamru (2010) and some of the income elasticities are obtained by educated guess given the structure of the Ethiopian economy. All the elasticity values are reported in appendix C.

4.7 Summary

CGE models are defined as a system of equations that depicts the interdependence of all sectors or actors in the economy. The basic structure of CGE models include functional relationships related to production, commodity prices, production factors, households, enterprises, government, international trade and saving-investment and the rest of the world. This chapter discusses the depiction of the labor market in CGE models. Labor markets consist of labor demand and supply. Different assumptions are adopted to integrate labor demand and supply into the structure of CGE models. For example, in most standard CGE models, labor demand is endogenously determined. On the other hand, labor supply can also be endogenously determined or it can be exogenous to the system. Assumptions also need to be made about labor mobility: it can be assumed that labor is immobile, partially mobile or perfectly mobile across different sectors. Furthermore, modeling labor may not only cover the marketed labor but also cover labor allocated to non-marketed activities including water fetching and firewood collection.

STAGE is a single-country SAM based CGE model. Behavioral relationships in the STAGE model comprise linear and non-linear relationships. Households choose a bundle of commodities to consume in order to maximize Stone-Geary utility function. The commodities consumed by households are a composite of imported and locally produced commodities. The CES is used to combine imported and locally produced commodities by assuming that these commodities are imperfect substitutes using the Armington assumption. For the purpose of this study, the structure of domestic production is modified to include several labor types used for fetching water and firewood. Therefore, domestic production is extended to include four level production processes. Intermediate inputs and value added are combined using CES technology to produce total output in the top level. In the second level, intermediate inputs and value added are aggregated by a Leontief technology. In the third level, CES technology is used to aggregate unskilled and skilled labor to form aggregate labor. In the fourth level, female and male labor is combined by CES technology to form aggregate skilled/unskilled labors.

In the STAGE model, a single activity can produce multiple commodities and the same commodities can be produced by multiple activities. Relative prices control the optimal supply of domestically produced commodities for the local market and for the export market. The next chapter discusses the technical documentation of the updated and adjusted 2005/06 SAM of Ethiopia that is used in the STAGE model applied for conducting policy experiment in the subsequent chapters.

Chapter 5: An Updated 2005/06 SAM of Ethiopia

The objective of this chapter is to introduce the concept of a SAM, review the 2005/06 SAM of Ethiopia, briefly provide the technical documentation of the updated SAM of Ethiopia and highlight the basic structure of the 2005/06 Ethiopian economy based on the SAM.

5.1 What is a SAM?

A SAM is a comprehensive and consistent data framework that describes the interdependence that prevails within a socio-economic system. A SAM represents the circular flow of the economy that captures transactions and transfers between all economic agents in the system for a particular period, usually for a year. The data for the SAM is obtained from various sources including national accounts, input-output tables and socio-economic surveys. SAMs are organized in a matrix format. Mathematically, a SAM consists of a square matrix with corresponding rows and columns. Each account in the SAM is represented by a row and a column (Pyatt & Round, 1985; Round, 2003).

Every transaction in the SAM is shown in a cell. Each cell in the SAM describes the flow of funds from the column to the row account. The receipts (income) are recorded in the row whereas the payments (expenditures) are recorded in the column. The SAM contains an identical number of rows and columns: every incoming and outgoing transaction has a corresponding row and column. The double-entry accounting principles require that the column total (total expenditure) is equal to the corresponding row total (total revenue) for each account in the SAM. In other words, all expenditure which is incurred by the column account is fully absorbed by the corresponding row account and hence the SAM is balanced (Thorbecke, 2000; Breisinger et al., 2010).

In principle, there is no standardized SAM detail. The size of the SAM (number of rows and columns) depends on availability of data and the motivation of the researcher to construct it (Pyatt & Round, 1985). SAMs are generally built by incorporating the following account groups: activities, commodities, factors, institutions (household, enterprise and government), savings and investment and the rest of the world. Each account can have numerous sub-accounts (McDonald et al., 1997).

5.2 The SAM of Ethiopia

In Ethiopia, two comprehensive SAMs were constructed based on the economic flow of the country at the different years. The first comprehensive SAM for Ethiopia was built based on the economic flow for 2001/02 and it was finalized in 2007 (Tebekew et al., 2009). The SAM comprised 61 commodities, 42 activities, 5 factors, 2 households and 17 tax accounts. This SAM also includes the following accounts: trade and transport margins, government, the rest of the world and saving-investment. Subsequently, the detailed and disaggregated SAM of Ethiopia was built based on the economic flow of 2005/06 years. The construction of the 2005/06 SAM was completed and became available to the public in 2009 (Tebekew et al., 2009).

The 2005/06 SAM of Ethiopia was built by EDRI in cooperation with the University of Sussex. The SAM consists of 99 activity accounts, 90 commodity accounts, 25 factor accounts, 17 tax accounts, 14 household groups and it includes an account of marketing margins, saving-investment account, an enterprise account, a government and a rest of the world account. The SAM is composed of 255 columns and rows. In this SAM, agricultural activities, rural households, land and livestock capital are disaggregated geographically across the five agro-ecological zones. These zones are distinguished by temperature and moisture. The agro-ecological zones include humid reliable moisture lowlands (zone 1), highlands with sufficient moisture that are cereals based (zone 2), highlands with sufficient moisture that are 'enset' based (zone 3), drought prone highlands (zone 4) and arid pastoralist lowland plains (zone 5). The main sources of data for constructing the 2005/06 SAM were MOFED, CSA and ERCA.

A more recent SAM of Ethiopia was built in 2010/11. This SAM comprises 63 activity accounts, 67 commodity accounts, 15 household groups, 13 factor accounts, 3 tax accounts, an account of transaction cost, a saving-investment account, an enterprise account, a government and a rest of the world account. The SAM has 167 column and row accounts (Ahmed, et al., 2017).

5.3 Own modifications of the 2005/06 SAM of Ethiopia

Since the 2010/11 SAM of Ethiopia was published only during the final stage of this thesis, the 2005/06 SAM was used instead. In order to address the desired aims of the thesis, some accounts of the 2005/06 SAM of Ethiopia were modified. Specifically, the household, factor, activity and commodity accounts in the SAM are updated.

5.3.1 Household accounts

The 2005/06 SAM has disaggregated household accounts. Households in the SAM are grouped by place of residence, income level and agro-ecological zones. Households are broadly grouped into rural and urban households. Rural households are regrouped by level of income (poor and non-poor) across the five agro-ecological zones. Households located in urban areas are also grouped by income level (poor and non-poor) and regrouped by the size of settlement (small and large urban settlement). For the aim of this study, the groupings of rural households are modified while urban households remained unaltered. Rural households are regrouped based on the source of income. Accordingly, rural households are categorized into agricultural households, mixed households and non-agricultural households. Households are regrouped based on the 2004 household income, consumption and expenditure survey (HICES) of Ethiopia from which the household accounts of the 2005/06 SAM of Ethiopia were initially constructed.

In this survey, households were asked to specify the income sources per major expenditure item. According to HICES, the sources of household income include own agricultural enterprise, household enterprise other than agriculture, gifts and remittances received from government organizations. Furthermore, also included are gifts and remittances received from non-government organizations (NGO), collected free goods (for example, firewood and water), wages and salaries, bonuses, overtime remuneration and allowances, pension and other social security benefits received, savings, interest and royalties received and dividends (profit share). Households also receive income from house rent, rent other than house rent, sales of household fixed assets and personal care goods and other current transfers (Central Statistical Agency, 2007). Thus, by combining the information of income sources for major expenditure items with information on the expenditure shares, it was possible to approximate the shares of income sources. Although the validity of this approach is questionable, it was used because of a lack of alternatives.

Based on the value of households' six-month consumption expenditures, the average percentage share of households' income from different sources was derived. In order to derive the average percentage share of each income source, the following steps were conducted. In the first step, a household identity (ID) was generated which enabled us to identify each household by its corresponding unique household ID. In the second step, the monetary amount of each income source was derived for each household based on the respective monetary amount of expenditure and considering rural residence and household ID. Since the focus of this study is on rural households, the analysis refers to this type of household. In the third step, the total household income was generated by aggregating each income source. In the last step, the percentage share of income from each source was derived.

This was done by dividing each income sources by the total household income derived in step three.

The average rural household's six-month income shares are depicted in Table 5.1. The largest percentage of household income is derived from households' own agricultural enterprise (58.8%). This confirms that a large proportion of rural households in Ethiopia depend on agriculture for their livelihoods. The second and third largest share of income is received from non-agricultural enterprises (8.53%) and collected free wood and water (8.52%), respectively. Other sources of income include pensions, remittances from abroad, remittances from households and sales of household assets that all together contributed 24% to household income.

Table 5.1: The average percentage share of the sources of income

Major sources of income	Percentage share
Household own agricultural enterprise	58.80
Household own non-agricultural enterprise	8.53
Collected free goods (firewood and water)	8.52
Gifts and remittances received from households	7.70
House rent	6.90
Wages and salaries	5.00
Gifts and remittances received from government organizations	0.80
Gifts and remittances received from NGOs	0.80
Gifts and remittances received from abroad	0.10
Pension and other social security benefits	0.10
Savings	0.10
Interest and royalties received	0.02
Dividends (profit share)	0.001
Income from rent other than house rent	0.30
Sale of household fixed assets and personal care goods	0.03
Other current transfers	2.29
Total	100.00

Sources: Author's computation based on Central Statistical Agency (2007)

The percentage shares of household income depicted in Table 5.1 are the basis for grouping rural households in the SAM. Since households on average receive the largest share of their income from agriculture, households are grouped according to the percentage share of agricultural income. Specifically, based on the percentage share of income from “own agricultural enterprise,” rural households are grouped into three categories:

1) Agricultural household: households who receive 70% or more of their income from ‘‘own agricultural enterprise.’’
2) Mixed household: households who receive between 40% and 70% of their income from ‘‘own agricultural enterprise.’’
3) Non-agricultural household: households who receive less than 40% of their earnings from ‘‘own agricultural enterprise.’’

Therefore, 45%, 31% and 24% of the households are agricultural households, mixed households and non-agricultural households, respectively (Table 5.2). As expected, the majority of rural households are agricultural households reflecting the fact that Ethiopia is an agrarian economy. On the other hand, one-fourth of the households are non-agricultural households.

Table 5.2: The percentage distribution of household groups

Household groups	Number of households	Percentage of households
Agricultural household	4268	45
Mixed household	2952	31
Non-agricultural household	2275	24
Total households	9495	100

Source: Author’s computation based on Central Statistical Agency (2007)

Agricultural households, mixed households and non-agricultural households are further grouped into poor and non-poor by agro-ecological zones. Finally, 34 groups of households (30 rural households and 4 urban households) are obtained (Figure 5.1).

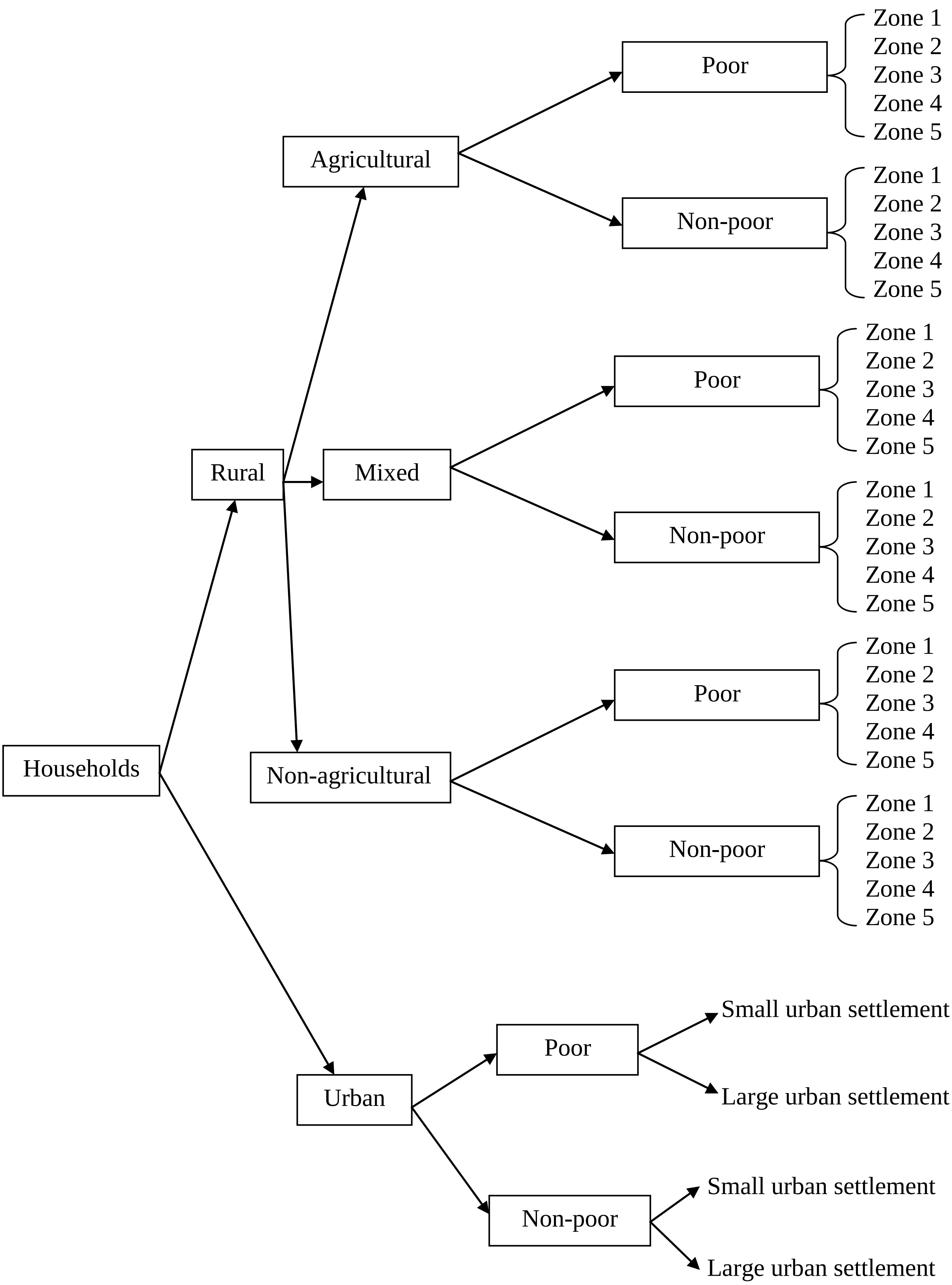

Figure 5.1: Household categories

Source: Author's compilation

5.3.2 Factor accounts

In the 2005/06 SAM of Ethiopia, factor accounts are classified into labor, land and capital. The labor account in the original SAM was disaggregated by five occupational categories. These include agricultural labor, professional labor, administrative labor, skilled labor and unskilled labor (Tebekew et al., 2009). In the updated SAM, each category of labor from the original SAM is disaggregated by gender. Gender division of labor is persistent in Ethiopia. For instance, male labor is predominately employed in most of the market related activities. In contrast, household activities such as water fetching and firewood collection are mostly performed by female members of the household (Figure 5.2)

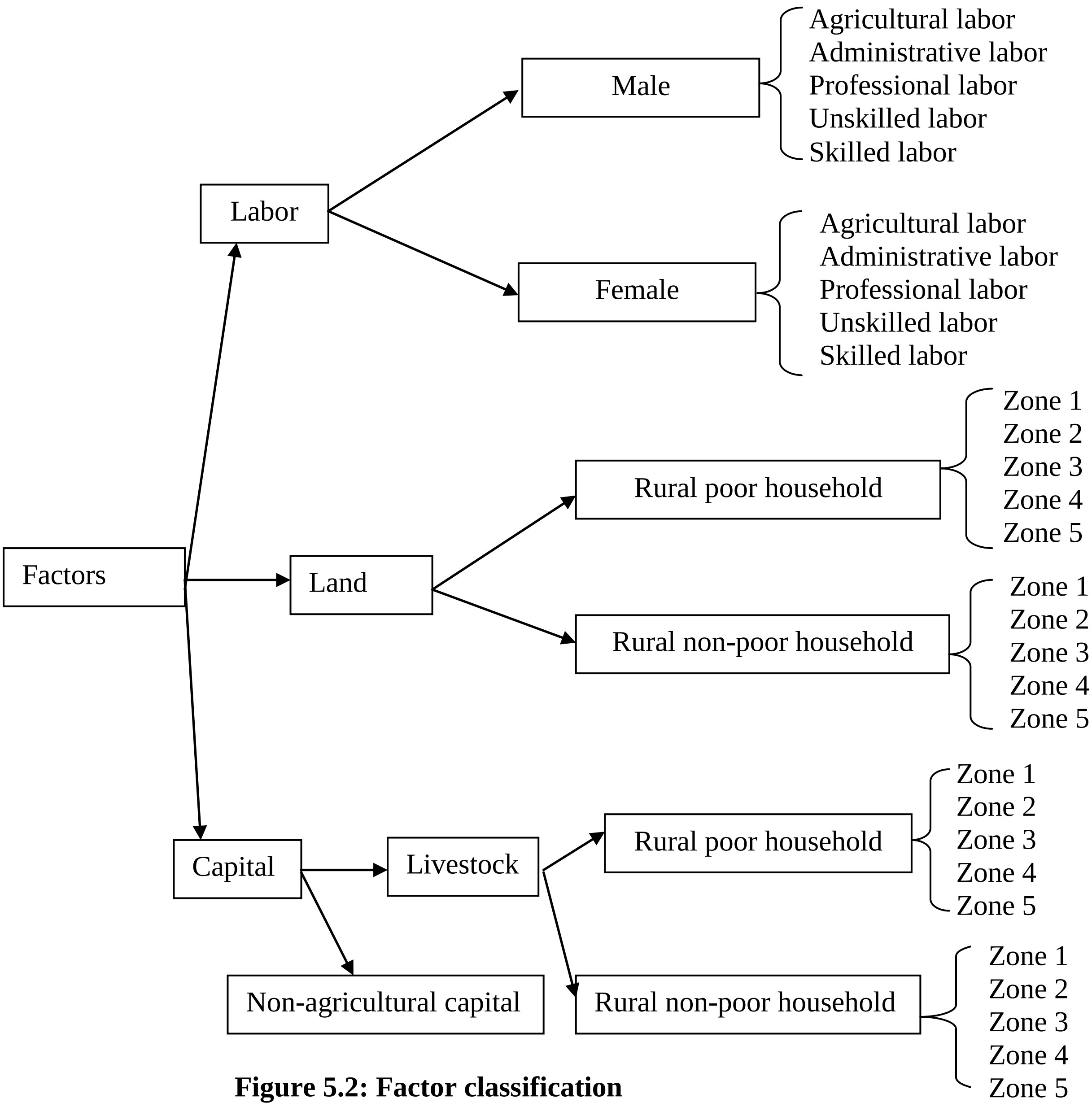

Figure 5.2: Factor classification

Source: Author's compilation based on Tebekew et al. (2009)

5.3.3 Activity and commodity accounts

5.3.3.1 Activity accounts

The 2005/06 SAM distinguishes activity and commodity accounts. It incorporates multiple agricultural, industrial and service activities. For the purpose of this study, water fetching, firewood collection and leisure activities are added to the SAM. Since water fetching and firewood collection are performed by households, separate water fetching and firewood collection activities are created corresponding to each household group presented in the SAM. Furthermore, following the approach developed by Fontana & Wood (2000), a separate account for leisure activities is generated corresponding to each household group in the SAM. Therefore, the updated SAM incorporates 199 activities: 65 agriculture, 20 industry, 12 services, 34 water fetching, 34 firewood collection and 34 leisure activities (see appendix B.1 for the details).

5.3.3.2 Commodity accounts

Compared to the 2005/06 SAM of Ethiopia, the commodity accounts are further disaggregated into marketed commodities and home consumed commodities. Like any other normal commodity, leisure is also consumed by households. In other words, leisure is assumed a normal commodity. Since households consume their own production of water, firewood and leisure, separate water fetching, firewood collection and leisure commodities are added corresponding to each household group in the updated SAM. There are 34 household groups in the SAM and hence, 34 water fetching, 34 firewood collection and 34 leisure commodity accounts are created. On aggregate, 102 additional commodity accounts are integrated into the updated SAM. Therefore, the updated SAM has 194 commodity accounts (see appendix B.2 for the details).

In summary, the updated SAM comprises 199 activities and 194 commodities, 34 household groups, 31 factors of production (10 labor categories and 21 other factors), 17 tax accounts, trade and transport margins, savings and investment, stock changes, enterprises, government and rest of the world. Therefore, the updated SAM comprises 481 row and column accounts; 226 extra rows and columns are generated compared to the original SAM that has 255 rows and columns. After all data modification, the cross entropy method is used for balancing the SAM (Robinson et al., 2001). The balanced macro SAM of Ethiopia is depicted in Table 5.3. The accounts of the disaggregated SAM of Ethiopia are listed in appendix B.

Table 5.3: Macro SAM of Ethiopia (in billions Ethiopian birr)

Accounts	Commodity	Margin	Activity	Factor	Household	Gov	Tax	Enterprise	Investment	Row	Total
Commodity		23.09	64.99		162.79	15.91			31.89	16.77	315.45
Margin	23.09										23.09
Activity	235.25										235.25
Factor			170.26							0.45	170.7
Household				163.80		1.55				15.79	181.14
Gov							14.15	5.37		3.73	23.26
Tax	10.10				2.73			1.32			14.15
Enterprise				6.69							6.69
Investment					15.53	5.37			3.72	10.99	35.61
Row	47.01			0.21	0.09	0.43					47.74
Total	315.45	23.09	235.25	170.7	181.14	23.26	14.15	6.69	35.61	47.74	

Source: Tebekew et al. (2009); Author's computation

5.4 Schematic structure of the SAM with water fetching, firewood collection and leisure

Table 5.4 shows the typical structure of a SAM with water fetching, firewood collection and leisure. For illustrative purposes, only the following accounts are incorporated:

1) One household group (hh1),
2) Four activities such as teff production (atef), water fetching performed by hh1 (awfhh1), firewood collection performed by hh1 (afwhh1) and leisure produced by hh1 (alhh1),
3) Four commodities such as teff (ctef), water fetching consumed by hh1 (cwfhh1), firewood collection consumed by hh1 (cfwhh1) and leisure consumed by hh1 (cleishh1),
4) Two factors of production such as agricultural labor (fagrlab) and capital (kap),
5) Other accounts such as trade and transport margins (margin), government (gov), tax, saving and investment (s-i) and the rest of the world (row),

Water fetching and firewood collection activities employ only primary factors (labor and capital). More specifically, water fetching and firewood collection activities are conducted by agricultural labor and hence agricultural labor receives wage from awfhh1 and afwhh1. Other factors such as capital (for example, donkey) can also be used for fetching water and firewood, so that awfhh1 and afwhh1 also pay to capital. It is assumed that leisure is a normal good. Like any other normal commodity, leisure is consumed by the households while the leisure activity employs only labor. Leisure activities can be undertaken by agricultural and non-agricultural labor and hence alhh1 pays to agricultural labor and non-agricultural labor as a compensation or wage. Activities such as afwhh1, afwhh1 and alhh1 receive payments from commodities such as cwfhh1, cfwhh1 and cleishh1 respectively for supplying outputs.

Households consume their own production of water, firewood and leisure; one commodity account per household group is incorporated in the updated SAM. For example, hh1 consumes water fetched by hh1 (cwfhh1), firewood collected by hh1 (cfwhh1) and leisure produced by hh1 (cleishh1). Therefore, households consume marketed commodities (such as ctef) and non-marketed commodities (such as cwfhh1, cfwhh1 and cleishh1) and hence payments go from households to commodities as consumption expenditure. Marketed commodities pay taxes and transportation cost whereas non-marketed commodities (such as water fetching, firewood collection and leisure) do not pay any taxes and transportation cost.

Table 5.4: Typical structure of SAM with water fetching, firewood collection and leisure

		ACTIVITIES				COMMODITIES				MARGINS	FACTORS		HOUSEHOLDS	GOV	TAX	INVT	ROW
		atef	awfhh1	afwhh1	alhh1	ctef	cwfhh1	cfwhh1	cleishh1	margin	fagrlab	kap	hh1	gov	tax	s-i	row
	atef					X											
	awfhh1						X										
ACTIVITIES	afwhh1							X									
	alhh1								X								
	ctef	X								X			X			X	X
	cwfhh1												X				
COMMODITIES	cfwhh1												X				
	cleishh1												X				
MARGINS	margin					X											
	fagrlab	X	X	X	X												
FACTORS	kap	X	X	X													
HOUSEHOLDS	hh1										X	X		X			X
GOVT	gov														X		X
TAX	tax					X							X				
INVT	s-i												X	X			X
ROW	row	X											X	X		X	

Source: Author’s compilation

5.5 Estimating the value of water fetching, firewood collection and leisure

In order to incorporate water fetching, firewood collection and leisure as activities and commodities in the structure of the SAM, it is necessary to obtain the transaction values of these accounts. The values of labor time spent on these activities are derived with the assumption that labor allocated to these activities has an opportunity cost of time. The laborer would receive remuneration if he/she would spend this time on market related activities. Therefore, the labor time is converted into monetary value based on the shadow wage of labor. In order to be consistent with other transaction values in the SAM, the annual shadow wage of labor is obtained. This section presents the procedures adopted to estimate the value of water fetching, firewood collection and leisure.

5.5.1 Estimation of the value of water fetching

In order to translate labor time spent on water fetching into monetary value, the average labor time spent on water fetching is obtained from the 2014 Ethiopian time use survey (ETUS). In this survey, every household with members over the age of seven was asked to specify how much time they spent for water fetching before the immediate day of the survey. The assumption is that family members with the specified age are capable of providing water fetching service to the household. According to the ETUS, rural households on average spend 0.64 hours and urban households spend 0.15 hours per day for water fetching. The annual average of labor time allocated to water fetching is derived from the daily average labor time spent on this activity in rural and urban areas.

An individual rural household spends on average about 19.2 hours per month (0.64 hours per day *30 days) and 230.4 hours per year (19.2 hours per month*12 months) for water fetching. On the other hand, urban households on average spend 4.5 hours per month (0.15 hours per day*30 days per month) and 54 hours per year (4.5 hours per month*12 months) for water fetching. After deriving, the average annual labor hours spent on water fetching by each household, these labor hours are converted into monetary value.

Conceptually, the value of water fetching time could be approximated based on the wage per hour paid to water fetchers. However, in Ethiopia water fetching is frequently performed by household members who do not earn direct wages as compensation. Furthermore, reliable wage data for water fetching in the country is not easily accessible. Alternatively, the value of water fetching time could be estimated using the minimum wage of labor per hour (Malloy-Good & Smith, 2008). However, in Ethiopia there is no minimum wage of labor per hour. Therefore, the shadow wage of labor is used to determine the value of labor time committed to water fetching. The shadow wage of water fetching labor is the opportunity cost of labor time, the returns that would have been gained by working on the farm or other activities. In other words, the shadow wage of water fetching labor is the amount of forgone returns due to the labor allocated to water fetching.

Theoretically, the shadow wage of labor for farm households is estimated as marginal productivity of labor via the agricultural production function of the household, for example, the Cob-Douglas production function (Jacoby, 1993). The estimation of household level agricultural production functions and associated marginal productivity of labor requires detailed data related to household production decisions. Due to limited data access, this study does not estimate the shadow wage of labor. This study relies on the shadow wage of labor from empirical literature conducted in Ethiopia. The econometrically estimated household level shadow wage of farm labor is adopted from Bedemo et al. (2013). They estimated the shadow wage of farm labor based on a household survey collected from Oromia region of Ethiopia. Bedemo et al. (2013) estimated average real shadow wage of labor at household level to be 2.2 birr[1] per hour (adjusted for inflation). In other words, an individual household on average gains 2.2 birr per hour working on the agricultural activities and this would be a loss if labor were diverted into water fetching activity.

However, their shadow wage rate was approximated at the household level that was a rough estimation and it did not consider the composition of household members. Household members have different levels of shadow wage that depend on education status (unskilled and skilled labor), gender (female and male labor) and age (adult and child labor). Furthermore, the shadow wage rate estimated by Bedemo et al. (2013) was based on the data from a single region with a small number of sampled household surveys. This indicates that their estimated shadow wage of labor might not adequately represent the shadow wage for all household in the country. Therefore, the shadow wage rate obtained from Bedemo et al. (2013) needs careful interpretation as it was used to compute the value of water fetching labor. The value of water fetching can be

[1] 1 Ethiopian birr was equivalent to 0.05 US $ in 2013

defined as the products of average labor time spent on water fetching and the shadow wage of labor.

Although the shadow wage rate obtained from Bedemo et al. (2013) needs careful interpretation, it is plausible as compared to the minimum wage of labor per hour from the marketed sector. For example, in Ethiopia, as to the author's knowledge, there is no officially standardized minimum wage of labor per hour but there is a standardized minimum salary per month for public servants. The minimum wage of labor per hour can be derived from the minimum monthly salary. Public workers were paid the minimum salary of 420 birr per month in 2005/06. Public servants are expected to work for 8 hours per day, 5 days per week and 4 weeks per month, totally they are supposed to work for 160 hours per month (8 hours per day*5 days per week*4 weeks per month). The minimum wage rate per hour can be derived by dividing the minimum monthly salary (420 birr) to monthly working hours (160 hours). After some manipulation and adjustment for inflation, the minimum real wage of labor would be 2.4 birr per hour which is not significantly different from the shadow wage of labor from Bedemo et al. (2013) i.e. 2.2 birr per hour.

From the above paragraph, the average labor hours spent on water fetching by the rural household is 230.4 hours per year. Accordingly, the average value of water fetching labor would be 507 birr (230.4 hours*2.2 birr) per year for rural households. Rural and urban households have diverse levels of shadow wages. However, for this study due to limited data availability, it is assumed that both rural and urban households have a similar level of shadow wage. The level of shadow wage that was estimated by Bedemo et al. (2013) represents only rural households but this shadow wage is applied to urban households for reasons of scarce data sources in this study. Hence, from the above paragraph, the average annual labor times spent on water fetching by urban households is calculated at 54 hours and the adopted shadow wage put at 2.2 birr per hour. Thus, the average value of water fetching labor would be 119 birr (54 hours*2.2 birr) per year for urban households of Ethiopia.

5.5.2 Estimation of the value of firewood collection

Following a similar approach to that followed for water fetching, the value of labor allocated to firewood collection is derived. The daily labor time spent on firewood collection is obtained from the 2014 ETUS. Similar to the case of water fetching, households with members over the age of seven were asked to specify how much time they spent for firewood collection. According to this survey, rural households on average spend 0.58 hours and urban households spend 0.1 hours per day for collecting firewood.

The annual averages of labor time allocated to firewood collection are derived from the daily average labor time spent on this activity in rural and urban areas. An individual rural household spends on average about 17.4 hours per month (0.58 hours per day*30 days) and 208.8 hours per year (17.4 hours per month*12 months) on firewood collection. On the other hand, urban households on average spend 3 hours per month (0.1 hours per day*30 days) and 36 hours per year (3 hours per month*12 months).

Similar to water fetching, the same shadow wage of labor is applied to evaluate the value of time spent on firewood collection. The average real shadow wage of labor as estimated by Bedemo et al. (2013) was 2.2 birr per hour at household level. Based on the above paragraph, the average annual labor time spent on firewood collection is 208.8 hours for rural households. The value of firewood collection labor would be the product of average labor time spent on firewood collection and the shadow wage of labor. The average shadow wage of firewood collectors would be 459 birr (208.8 hours*2.2 birr) per year for rural households. Furthermore, the average shadow wage of firewood collectors would be 79 birr (36 hours*2.2 birr shadow wage) per year for urban households of Ethiopia. The estimated shadow wage is also adjusted for inflation.

5.5.3 Estimation of the value of leisure

Similar to the case of water fetching and firewood collection, the shadow wage approach is used for the estimation of the value of leisure activities. The household level shadow wage estimated by Bedemo et al. (2013) is also adopted. The value of leisure activities is determined based on the average time spent on leisure activities and the shadow wage of labor. Based on the 2014 ETUS, the average time spent on leisure activities was 1.6 hours for urban areas and 0.6 hours per day per person in rural areas of Ethiopia. However, these figures do not represent leisure of the whole households. All members of the household can enjoy leisure. For the purpose of this study, leisure enjoyed by the working age members of the household (those over the age of ten) is considered. These household members are capable to deliver water fetching and firewood collection services.

The average number of working age persons in each household in rural and urban areas is obtained from the 2005/06 HICES. According to the 2005/06 HICES, on average there are five working age persons per household in rural areas and four persons in urban areas. Therefore, the average leisure time for the working age household members is 3 hours per day (0.6 hours*5 persons) for rural household and 6.4 hours per day (1.6 hours*4 persons) for urban households. Rural households on average spend 90 hours per month (3 hours*30 days) and 1,080 hours per year (90 hours per month*12 months) for leisure activities. On the other hand, urban households on average spend 192 hours per month (6.4 hours per day*30 days) and 2,304 hours per year (192 hours*12 months) for leisure activities. Hence, the average value of leisure per year per household would be 2,376 birr (2.2 birr*1,080 hours) for rural households and 5,069 birr (2.2 birr*2,304 hours) for urban households. The estimated shadow wage is also adjusted for inflation. A summary of the value of aggregated shadow wages of labor for water fetching, firewood collection and leisure per year is given in Table 5.5.

Table 5.5: Aggregate value of shadow wages per year per household (in birr)

Activities	Rural households	Urban households
Water fetching	507	119
Firewood collection	459	79
Leisure	2,376	5,069

Source: Author's computation

5.6 An overview of the 2005/06 Ethiopian economy

This section gives a general review of the Ethiopian economy based on the structure of the 2005/06 updated SAM. The following sections discuss production and supply of commodities, the structure of demand, household income and consumption, GDP at factor cost and trade shares.

5.6.1 Production and commodity supply

The production and supply of commodities is depicted in Table 5.6. Services account for 45%, agriculture for 27.1% and industry for 27.9% of the total commodity supply in the economy.

Table 5.6: Sectoral share of commodity supply (percentage)

	Agriculture	Industry	Services	All commodities
Domestic production	33.38	9.61	57.00	100.00
Trade and transport margin	31.25	68.75	0.00	100.00
Tax	1.11	86.97	11.92	100.00
Import	4.72	70.97	24.31	100.00
Total commodity supply	27.12	27.91	44.97	100.00

Source: Author's computation based on the updated 2005/06 SAM

The value of total commodity supply consists of the value of domestic production, imports, taxes and margins. The domestic production was 70.8% and imported commodity was 17.1% of the total commodity supply (Table 5.7). Marketed commodities pay trade and transport margin and tax. Trade and transport margins were 8.4% and taxes were 3.7% of the total commodity supply value.

Table 5.7: Components of commodity supply (percentage)

	Agriculture	Industry	Services	Total
Domestic production	33.38	9.61	57.00	70.83
Trade and transport margin	31.25	68.75	0.00	8.40
Tax	1.11	86.97	11.92	3.67
Import	4.72	70.97	24.31	17.09
Total commodity supply	27.12	27.91	44.97	100.00

Source: Author's computation based on the updated 2005/06 SAM

5.6.2 Structure of demand

Demand consists of intermediate demand and final demand (Table 5.8). Intermediate demand includes demand for commodities that serve as an input in the production process. On the other hand, consumption demand by government, households, investment and the rest of the world constitute final demand. Based on the 2005/06 economy, intermediate demand was 25.9% and final demand was 74.2% of total demand.

Table 5.8: The structure of demand (percentage)

	Intermediate demand	Final demand
Intermediate demand	25.85	
Household demand		48.52
Government demand		6.32
Investment demand		12.66
Rest of the world demand		6.66
Total	25.85	74.15

Source: Author's computation based on the updated 2005/06 SAM

5.6.3 Household income and expenditure

The shares of household income are depicted in Table 5.9. The sources of household income are factor payments, government transfers and remittances from abroad. The major source of income for all households is factor income, predominantly from labor. Aggregate factor income constitutes 87.63% of total household income. The share of government transfers was 1.14% and remittances from abroad accounted for 11.23% of total households' income.

Table 5.9: Sources of household income (percentage)

	Factor income					
Households	Labor income	Land income	Capital income	Government transfer	Remittances from abroad	Total
Rural poor	70.11	3.21	19.98	1.04	5.66	100.00
Rural non-poor	43.74	9.77	40.89	0.41	5.19	100.00
Urban poor	61.97	0.00	8.22	3.95	25.86	100.00
Urban non-poor	37.04	0.00	30.80	2.66	29.50	100.00
Total	48.18	6.02	33.43	1.14	11.23	100.00

Source: Author's computation based on the updated 2005/06 SAM

Percentage shares of household expenditures are depicted in Table 5.10. The expenditure by households includes consumption of commodities, taxes, savings and transfer payments. The largest share of total household expenditure is the consumption of aggregate commodities (87%). Household savings account for 11.1%, taxes for 1.94% and transfers 0.1% of total expenditures by households.

Table 5.10: Household expenditure (percentage)

	Households				
Expenditures	Rural poor	Rural non-poor	Urban Poor	Urban non-poor	Total
Food consumption	51.44	51.04	48.91	26.95	45.87
Non-food consumption	34.97	39.31	37.78	51.78	41.08
Tax	0.16	0.13	0.00	8.57	1.94
Saving	13.43	9.51	13.31	12.40	11.05
Transfers	0.00	0.00	0.00	0.29	0.06
Total	100.00	100.00	100.00	100.00	100.00

Source: Author's computation based on the updated 2005/06 SAM

5.6.4 Gross domestic product (GDP) at factor cost

GDP at factor cost includes payments from activities to value added inputs such as labor and capital. For this overview, the sectoral activities are aggregated into agriculture, industry and services. Based on the updated 2005/06 SAM, agriculture contributes 45.4%, industry 4.9% and services 49.7% of total GDP at factor cost (Table 5.11).

Table 5.11: The sectoral shares of GDP at factor cost (percentage)

	Agriculture	**Industry**	**Services**	**Total**
Sectoral shares	45.36	4.97	49.67	100.00

Source: Author's computation based on the updated 2005/06 SAM

Labor contributes 52.24% and capital 41% to total GDP (Table 5.12). Furthermore, labor and capital differently contribute to the GDP of each sector in the economy. Labor contributes 75.4% of agriculture, 40% of industry and 32.3% of services GDP. On the other hand, capital contributes 10% of agriculture, 60% of industry and 67.8% of services GDP. Thus, agriculture is labor-intensive whereas industry and services are capital-intensive sectors.

Table 5.12: Value added share (percentage)

	Agriculture	Industry	Services	Total
Labor	75.40	40.01	32.31	52.24
Land	14.40	0.00	0.00	6.52
Capital	10.20	59.99	67.78	41.31
Total	100.00	100.00	100.00	100.00

Source: Author's computation based on the updated 2005/06 SAM

5.6.5 Trade share

Trade shares highlight the composition of imports and exports (Breisinger et al., 2010). The shares of agricultural, industrial and services imported or exported goods in the total volume of imports or exports is depicted in Table 5.13. Most of the imported commodities are industrial products such as machinery and other manufacturing commodities (71%). On the other hand, primary agricultural (40.9%) and services (40.4%) commodities dominate the exports of the Ethiopian economy.

Table 5.13: Trade share (percentage)

Trade	Agriculture	Industry	Service	All commodities
Import	4.72	70.97	24.31	100
Export	40.88	18.70	40.43	100

Source: Author's computation based on the updated 2005/06 SAM

5.7 Summary

This chapter reviews the 2005/06 SAM of Ethiopia and presents the technical documentation of the updated SAM. The activity, commodity, household and factor accounts of the SAM are updated for the current study. The rural households are regrouped based on the proportion of agricultural income. Labor is disaggregated based on gender. Since water fetching, firewood collection and leisure are performed by households, separate water fetching, firewood collection and leisure activities and commodities are added in accordance to household groups in the updated SAM. The values of water fetching, firewood collection and leisure are estimated based on the shadow wages of labor.

The updated SAM has 199 activities, 194 commodities, 34 household groups, 10 labor categories and 21 other primary factors, 17 tax accounts and other accounts such as trade and transport margins, saving and investment, enterprise, stock change, government and the rest of the world. Therefore, the updated SAM has 481 rows and columns: 226 extra rows and columns are generated as compared to the original SAM that has 255 rows and columns. Furthermore, the chapter also highlights the structure of the Ethiopian economy based on the updated SAM.

The next chapter analyzes and discusses the economy-wide effect of improved access to drinking water supply and energy efficient technology based on the updated 2005/06 SAM of Ethiopia implemented in the STAGE CGE model.

Chapter 6: Economy-Wide Effects of Improved Access to Water Fetching and Firewood Collection in Ethiopia

6.1 Introduction

Ethiopian households allocate significant quantities of labor for water fetching and firewood collection. Furthermore, water fetchers and firewood collectors are predominantly agricultural laborers in Ethiopia. Specifically, fetching water and firewood reduces labor time available for marketed sectors including non-agricultural activities that adversely affects production and productivity of these sectors. The time spent on fetching water and firewood can be significantly reduced through improved access to water infrastructure and energy efficient technology (such as improved cooking stoves). The freed labor from water fetching and firewood collection can be partly reallocated to marketed activities or to leisure. Labor reallocated to market related activities would have positive economy-wide implications. The objective of this Chapter is to investigate economy-wide effects of improved access to water supply and energy efficient technology.

This study applied the modified STAGE CGE model (Chapter 4) based on the updated 2005/06 SAM of Ethiopia (Chapter 5). The rest of the chapter is structured as follows: Section 6.2 highlights the policy simulations, Section 6.3 presents and discusses the results, Section 6.4 presents a sensitivity analysis and the last Section provides a summary and conclusions.

6.2 Policy simulations and model closure rules

6.2.1 Simulation scenarios

The construction of drinking water infrastructure around the vicinity of households and providing access to energy technology (such as improved cooking stoves) potentially reduce the time spent on water fetching and firewood collection. This would improve the efficiency of collecting water and firewood as less labor would be required to collect the same amount of water and firewood. Therefore, this study analyzes the scenario of an increase in the total factor productivity (TFP) of water fetching and firewood collection activities due to improved access to drinking water and energy technology.

The quantity of labor time freed in response to better access to drinking water supply depends on agro-ecological zone and place of residence (rural vs. urban). This complicates the estimation of the exact amount of time saved due to improved access to water infrastructure. However, the amount of time released from water fetching can be approximated based on the literature. For instance, Cook et al. (2013) reported that improved access to water supply can successfully reduce water fetching time by 35% to over 90% per day in the Oromia region of Ethiopia. Accordingly, in this study, it is assumed that improved access to drinking water supply can reduce the time spent on water fetching on average by 50%.

Similarly, the amount of time saved due to improved access to energy technology relies on access to modern cooking technology and availability of sources of energy. Empirical evidence by Gaia Consulting Oy and Ethio Resource Group (2012) in Ethiopia indicates that access to improved cooking stoves reduces household's firewood consumption by more than 50%. This would lead to approximately 50% less firewood collection time. This study assumes that in response to improved access to energy technology, firewood collection time could be reduced on average by 50%.

Therefore, the simulation scenario is a 50% increase in the TFP of both water fetching and firewood collection activities in response to improved access to water and energy technology.

The cost of financing water and energy infrastructure are obtained from domestic sources or international donors (loans and grants). Specifically, the main sources of financing water and energy infrastructure in Ethiopia are government treasury, user contributions and support from international donors. Indeed, approximately three-fourth of the total national water supply budget is sourced from the treasury of government and the remaining share is covered by international donors and user contribution (World Bank, 2016).

In the policy scenario, the funds for constructing drinking water and energy facilities are sourced from government savings and foreign savings (loans and grants). In other words, in order to finance the construction of water infrastructure and energy efficient technology, government savings and foreign savings are exogenously increased in the model. Since government treasury is the largest source of funds in the national water supply budget, the larger share of funds is obtained from the government savings relative to foreign savings. The total government savings are 5.4 billion birr and foreign savings are 10.9 billion birr in the updated SAM.

For approximating the effect of government expenditure on reducing water fetching and firewood collection time, expert opinions and estimates of the budget required for achieving universal water access as defined by the UNMDG are used in this study. According to experts'opinion, 0.5 to 1.5 hours per day per household from water fetching can be saved in Sub-Saharan African countries by achieving universal access to water i.e. a 50% reduction in the share of population that is unable to secure improved drinking water (World Health Organization, 2012). Therefore, for this study it is assumed that if Ethiopia achieved universal water access, the average water fetching time will be reduced by 50%.

According to World Bank (2016), the aggregate budget required for achieving universal access to water in Ethiopia is 16.7 billion birr. The country already spent 13.6 billion birr in the year 2012. Therefore, it is assumed that an extra 3.1 (16.7-13.6) billion birr investment is needed for achieving universal water access (World Bank, 2016). It is also assumed that the required fund (3.1 billion) is generated through a 37% increase in government savings (i.e. 2 billion birr) and a 10% increase in foreign savings (i.e. 1.1 billion birr). Therefore, for financing water and energy infrastructure, government savings exogenously increase by 37% and foreign savings increase by 10%. Since the government and foreign savings are not channeled to investments, the multiplier effects are not accounted for in this simulation.

6.2.2 Model closure rules

The exchange rate is flexible while the external balance is fixed in the model. The exchange rate is flexible to produce the fixed level of foreign savings for funding water infrastructure and energy efficient technology. Investment driven savings is chosen where investment is fixed and savings are flexible in the model such that savings adjust for the saving-investment balance. Alternatively, savings driven investment closure can be chosen where savings are fixed but investment is flexible to adjust the saving-investment balance to generate the required level of funds for the construction of water and energy infrastructure.

Government raises funds through income tax replacement. Government savings are fixed and income tax rates are endogenously adjusted to produce a fixed level of government savings for financing the construction of water infrastructure and energy efficient technology. Alternatively, government investment (expenditure) is fixed and income tax rates are endogenously adjusted to produce a fixed level of public expenditure for financing water and energy infrastructure. The CPI is chosen as a numeraire. Furthermore, factor supplies are fixed in the model and in order to enable the mobility of water fetcher and firewood collectors across different sectors, perfect factor mobility is assumed in the model.

The study examines the impact on labor reallocation across sectors, domestic production, domestic prices and household consumption, household welfare and major macroeconomic indicators.

6.3 Results and discussions

6.3.1 Effect on labor demand

In rural Ethiopia, water fetching and firewood collection is commonly accomplished by reducing the daily agricultural labor time. On the other hand, in urban parts of the country, unskilled workers commonly collect water and firewood. Water fetching and firewood collection are labor-intensive household activities. An improved TFP of water fetching and firewood collection results in reduction of labor required to perform these activities. Table 6.1 describes the change in labor demand across sectors in response to improved TFP of water fetching and firewood collection activities.

The simulation result indicates that because of a 50% rise in TFP, labor demand declines on average (weighted) by 22.3% for firewood collection and by 21.7% for water fetching activities. Because of better access to water facility, households consume additional water and relatively more labor is required to fetch the extra drinking water. Therefore, the labor demand for water fetching does not decline by the full 50%. On the other hand, employment of labor in agriculture, industry and service activities increases on average by 1.6%, 0.9% and 0.5% respectively because of absorbing the released labor from water fetching and firewood collection. The agricultural sector absorbs a larger percentage of labor relative to industry and service sectors. This happens because large shares of water fetchers and firewood collectors are agricultural laborers in Ethiopia. Thus, when water fetching and firewood collection activities are effectively accomplished, agriculture absorbs a relatively larger proportion of freed laborers relative to other sectors (such as industry and service). Furthermore, most of the freed laborers prefer to enjoy extra leisure and hence labor is reallocated to leisure (4.6%).

Table 6.1: Simulated changes (percentage) in labor demand across sectors

Labor demand by sectors	Base	Simulation	Absolute change	%Change (weighted)
Agriculture	4436.54	4508.15	71.61	1.61
Industry	258.33	260.60	2.27	0.88
Service	1305.81	1312.92	7.11	0.54
Water fetching	603.32	472.73	-130.59	-21.65
Firewood collection	537.75	417.61	-120.15	-22.34
Leisure	3675.43	3845.35	169.92	4.62

Source: Author's computation based on model results

6.3.2 Effect on domestic production

Table 6.2 depicts the change (weighted) in domestic production because of increased TFP of water fetching and firewood collection activities. Production of water fetching on average increases by 17.5% and firewood collection on average increases by 16.5% due to enhanced TFP. Furthermore, labor released from water fetching and firewood collection is transferred into other sectors and stimulates agricultural and non-agricultural (such as industry and services) production in the destination sector. Production of agriculture, industry and services on average increases by 1.2%, 0.6% and 0.4%, respectively, due to employment of extra labor which is attracted from water fetching and firewood collection. Production in the agricultural sector increases by a higher proportion relative to other sectors (industry and services).

Higher TFP in water fetching and firewood collection activities provides larger proportions of released labor for agriculture relative to industry or services and hence production in this sector increases more. Furthermore, the production of leisure increases by 4.6%, which is relatively greater than other sectors such as agriculture, industry and services. This happens because there was less or no time left for leisure activities when household collects water and firewood from the distant sources and therefore, the freed labor prefers to enjoy leisure and hence more labors are reallocated to leisure. Additionally, the larger production of leisure can be explained by the fact that the consumption of leisure is more sensitive to the income changes relative to other commodities. Therefore, an increase in household income (due to reallocation of labor to income generating activities) raises the demand for leisure that leads to a more production of leisure.

Table 6.2: Simulated changes (percentage) in domestic production by sectors

Sector	Base	Simulation	Absolute change	%Change (weighted)
Agriculture	7243.98	7331.41	87.43	1.21
Industry	3396.94	3416.97	20.03	0.59
Service	10366.24	10409.66	43.41	0.42
Water fetching	606.85	713.22	106.37	17.53
Firewood collection	543.93	633.55	89.62	16.48
Leisure	3675.43	3845.35	169.92	4.62

Source: Author's computation based on model results

6.3.3 Effect on domestic price and household consumption demand

In response to higher TFP in water fetching and firewood collection activities, a large amount of labor is released and reallocated to other activities. The labor reallocated to other sectors enhances domestic production (Table 6.2) and at the same time results in higher income for households through increased factor payments. The simultaneous rise in both domestic production and household income differently affects domestic prices and household consumption. Conceptually, increased domestic production results in higher commodity supply in the market and this can potentially reduce domestic supply prices of commodities (PQS) and purchaser prices (PQD). On the other hand, the freed labor from fetching water and firewood and subsequently reallocated to marketed sectors brings extra income to the households which increases household consumption demand (QCD). This potentially increases domestic prices.

Table 6.3 describes the percentage change (weighted) in domestic prices and household demand in response to higher TFP in water fetching and firewood collection (refer to appendix B.2 for the full list of commodities). The simulation results indicate that because of higher TFP in water fetching and firewood collection, QCD increases for all commodities: agricultural by 1.7%, industrial by 1.3%, services by 0.6%, water fetching by 17.5%, firewood collection by 16.5% and leisure by 4.6%. Domestic prices for agricultural, industrial and service commodities on average increase by 2.1% and for leisure commodities on average increase by 2.3%. This implies that the effect of increasing income dominates the price effect. The extra income results in upward shift in households' consumption demand and hence increases domestic prices.

On the other hand, household demand for water fetching and firewood collection commodities increases but domestic prices for these commodities decrease on average by 32.2% and 32.1%, respectively. Household demand for water fetching and firewood collection increases by 17.5% and 16.5% respectively. This can be explained by the fact that because of efficiency gains in water fetching and firewood collection, large quantities of water and firewood are produced and supplied to the market. Water and firewood become relatively cheaper and hence consumption demand for these commodities increases (due to income and substitution effects).

Table 6.3: Simulated changes (percentage) in domestic price and household demand

Commodities	PQD+PQS	QCD
Agriculture	2.10	1.69
Industry	2.05	1.32
Service	2.10	0.57
Water fetching	-32.19	17.53
Firewood collection	-32.10	16.48
Leisure	2.25	4.62

Source: Author's computation based on model results

6.3.4 Effect on household welfare

Increased TFP of water fetching and firewood collection also affects household welfare. Table 6.4 shows the equivalent variation (EV) in percent of base income to examine the actual welfare changes across household groups. Welfare improvement happens to all groups of rural households but the amount of welfare gains varies among households. Different household groups allocate divergent quantities of labor for water fetching and firewood collection. Accordingly, welfare gains depend on household endowment of labor that can be potentially allocated to water fetching and firewood collection. In other words, households that allocate a relatively larger proportion of labor to water fetching and firewood collection obtain high welfare gains. For instance, non-poor and poor rural households in agro-ecology zones 1 and 5 allocate the highest proportion of labor to water fetching and firewood collection relative to other groups of households. Because of increase in the TFP of water fetching and firewood collection, welfare gains by these household groups are higher than to other household groups.

On the other hand, the divergent share of water and energy consumption expenditure also results in different welfare gains across household groups. The share of consumption expenditure to water and energy commodities differs by household groups. Better access to water and energy infrastructure increases the supply of water and energy and these commodities become relatively cheaper. Households that spend a larger share of their consumption expenditure on water and energy commodities gain more welfare relative to others. For example, poor rural households located in agro-ecology zones 1 and 5 spend a larger proportion of consumption expenditure on water and energy commodities. Because of better access to water and energy facility, the welfare gains to these household groups are higher than to other household groups.

Similarly, the welfare of poor urban households is also positively affected by increasing TFP of water fetching and firewood collection. Since urban households allocate less labor for collecting water and firewood, their welfare gain is lesser than for rural households. However, the welfare of urban non-poor households is negatively affected. This can be explained by the fact that some portions of financing the construction of water and energy facility are obtained from government savings that are raised through income tax. Since urban non-poor households contribute, a larger share of tax to the government, their consumption expenditure decreases and hence welfare declines. Table 6.5 shows changes in taxes expressed as percentage of income.

Table 6.4: Simulated changes (percentage) in household welfare (EV/base income)

Households	EV/base income
Household rural zone 1 poor agricultural	6.88
Household rural zone 1 poor mixed	6.88
Household rural zone 1 poor non-agricultural	6.88
Household rural zone 2 poor agricultural	4.88
Household rural zone 2 poor mixed	4.88
Household rural zone 2 poor non-agricultural	4.88
Household rural zone 3 poor agricultural	5.35
Household rural zone 3 poor mixed	5.35
Household rural zone 3 poor non-agricultural	5.35
Household rural zone 4 poor agricultural	4.84
Household rural zone 4 poor mixed	4.98
Household rural zone 4 poor non-agricultural	4.98
Household rural zone 5 poor agricultural	6.94
Household rural zone 5 poor mixed	6.94
Household rural zone 5 poor non-agricultural	6.94
Household rural zone 1 non-poor agricultural	5.16
Household rural zone 1 non-poor mixed	5.16
Household rural zone 1 non-poor non-agricultural	5.16
Household rural zone 2 non-poor agricultural	3.19
Household rural zone 2 non-poor mixed	3.19
Household rural zone 2 non-poor non-agricultural	3.19
Household rural zone 3 non-poor agricultural	3.86
Household rural zone 3 non-poor mixed	3.86
Household rural zone 3 non-poor non-agricultural	3.76
Household rural zone 4 non-poor agricultural	3.46
Household rural zone 4 non-poor mixed	3.46
Household rural zone 4 non-poor non-agricultural	3.46
Household rural zone 5 non-poor agricultural	5.69
Household rural zone 5 non-poor mixed	5.69
Household rural zone 5 non-poor non-agricultural	5.69
Household small urban poor	1.50
Household big urban poor	1.91
Household small urban non-poor	-3.75
Household big urban non-poor	-1.54

Source: Author’s computation based on model results

Table 6.5: Change in taxes expressed as percentage of income

Households	Changes in taxes as % of income
Household rural zone 1 poor agricultural	0.15
Household rural zone 1 poor mixed	0.11
Household rural zone 1 poor non-agricultural	0.12
Household rural zone 2 poor agricultural	0.02
Household rural zone 2 poor mixed	0.02
Household rural zone 2 poor non-agricultural	0.02
Household rural zone 3 poor agricultural	0.04
Household rural zone 3 poor mixed	0.03
Household rural zone 3 poor non-agricultural	0.03
Household rural zone 4 poor agricultural	0.02
Household rural zone 4 poor mixed	0.01
Household rural zone 4 poor non-agricultural	0.02
Household rural zone 5 poor agricultural	0.01
Household rural zone 5 poor mixed	0.01
Household rural zone 5 poor non-agricultural	0.01
Household rural zone 1 non-poor agricultural	0.07
Household rural zone 1 non-poor mixed	0.15
Household rural zone 1 non-poor non-agricultural	0.22
Household rural zone 2 non-poor agricultural	0.00
Household rural zone 2 non-poor mixed	0.01
Household rural zone 2 non-poor non-agricultural	0.01
Household rural zone 3 non-poor agricultural	0.01
Household rural zone 3 non-poor mixed	0.02
Household rural zone 3 non-poor non-agricultural	0.02
Household rural zone 4 non-poor agricultural	0.00
Household rural zone 4 non-poor mixed	0.01
Household rural zone 4 non-poor non-agricultural	0.01
Household rural zone 5 non-poor agricultural	0.00
Household rural zone 5 non-poor mixed	0.00
Household rural zone 5 non-poor non-agricultural	0.01
Household small urban poor	0.17
Household big urban poor	0.19
Household small urban non-poor	0.96
Household big urban non-poor	0.78

Source: Author’s computation based on model results

6.3.5 Macroeconomic effects

Reallocation of released labor from water fetching and firewood collection to other sectors creates economy-wide linkages and positively affects the macroeconomic indicators such as GDP, total domestic production, absorption, import, export and exchange rate.

Table 6.6 depicts the macroeconomic effect of higher TFP in water fetching and firewood collection. Total domestic production increases by 2%, GDP by 2.6%, absorption by 2.8%, imports by 1.5% and the exchange rate by 1.3%. The released labor from water fetching and firewood collection is reallocated to productive sectors that accelerate domestic production. This leads to an increase in domestic consumption (absorption) and import. Furthermore, reallocated labor promotes the growth of the economy and hence the GDP increases.

Table 6.6: Macroeconomic impact (percentage changes)

Real macroeconomic indicators	Change (%)
Absorption	2.76
Import	1.50
Export	-2.43
Exchange rate	1.30
GDP	2.62
Total domestic production	2.00

Source: Author’s computation based on model results

6.4 Sensitivity analysis

The sensitivity of model results due to the change in the core model parameters such as the income elasticity of leisure is discussed in this section. Specifically, this section discusses the sensitivity of labor demand, domestic production, household welfare and major macroeconomic effects due to the change in the income elasticity of leisure. Sensitivity analysis is carried out by changing the income elasticity of leisure from 2 to 3 (50% increase) and 4 (100% increase). The sensitivity of model results in response to the change in income elasticity of leisure is provided in appendix E. The percentage change in labor demand and domestic production varies when the income elasticity of leisure increases from 2 to 3 and 4. When the income elasticity of leisure is higher, a larger share of the freed labor gets into leisure and a smaller proportion is reallocated to other sectors (agriculture, industry and services) (see appendix E.1 for details).

Household welfare is not very sensitive to the change in the income elasticity of leisure. All groups of households except urban non-poor households have less welfare gains when the income elasticity of leisure increases from 2 to 3 and 4 (see appendix E.2 for the details). The reason is that leisure does not create multiplier effects via commodity demand. The macroeconomic indicators such as absorption, import demand, GDP from expenditure and total domestic production also slightly vary due to the change in the income elasticity of leisure. Specifically, absorption, import demand, GDP and total domestic production increase by a lesser percentage when the income elasticity of leisure is higher (see appendix E.3 for the details).

Therefore, the change in the income elasticity of leisure leads to some changes in labor demand, domestic production, household welfare and major macroeconomic indicators. Although the changes in the income elasticity of leisure result in slight disparities in the magnitude of simulation outcome, the direction of changes remains the same as well as the order of size.

6.5 Summary and conclusion

The majority of Ethiopian household has limited access to drinking water supply and energy efficient technology. Households spend a large amount of time for water fetching and firewood collection. Water fetching and firewood collection reduces labor available for other activities such as agriculture and non-agricultural activities, which negatively affects the production of these sectors. Better access to water and energy services improves the TFP of water fetching and firewood collection activities and releases labor for other activities, which has positive economy-wide implications. This chapter estimates the economy-wide effects of improved TFP of water fetching and firewood collection activities. The simulation scenario is a 50% increase in the TFP of both water fetching and firewood collection activities because of improved access to water infrastructure and energy efficient technology. The funds for financing the construction of water and energy infrastructure are sourced from government savings (through income tax replacement) and foreign savings.

The simulation results indicate that due to increased TFP of water fetching and firewood collection, labor demand by firewood collection and water fetching activities decline. On the other hand, employment of labor in agriculture, industry and in services increases because of absorbing the released labor from water fetching and firewood collection. The reallocated labor to agricultural and non-agricultural activities stimulates domestic production. Households also enjoy extra leisure because of better access to water and energy services and overall welfare increases. Furthermore, the released labor facilitates aggregate domestic production, consumption and imports and hence growth of the economy. Although simulation results are sensitive to the change in the income elasticity of leisure, the direction and order of magnitude of results are unaltered in all scenarios.

The study results show that better access to drinking water supply and improved energy technology leads to the reallocation of labor towards other sectors including non-agricultural activities and enhances domestic production, employment, overall welfare and economic growth. Therefore, it is helpful to recognize the economic significance of labor released from water fetching and firewood collection. The next chapter analyzes and discusses the economy-wide effect of improved access to road transport infrastructure.

Chapter 7: Road Infrastructure in Rural Ethiopia: Economy-Wide Effects of Reducing Transport Margins

7.1 Introduction

Road transport infrastructure provides a fertile ground for the promotion of rural non-agricultural activities. Poor road transport is a major constraint of market access in Ethiopia. Long travel time and high transportation costs are caused by poorly developed road infrastructure. This adversely affects non-agricultural activities and market access of rural households. For example, empirical evidence reported in Chapter 2 indicates that poor access to road transport infrastructure is among the major impediments of rural non-agricultural activities in Ethiopia. Households located far away from all-weather roads are less likely to participate in non-agricultural activities as compared to households residing closer to all-weather roads.

Trade and transport margins can be reduced through public investments on road infrastructure. The objective of this chapter is to investigate and discuss the economy-wide effect of reducing trade and transport margins in response to better road infrastructure. The analysis applies a modified version of the STAGE CGE model (Chapter 4) based on an updated 2005/06 SAM of Ethiopia (Chapter 5). The rest of this chapter is structured as follows: Section 7.2 highlights the policy simulations, Section 7.3 presents and discusses the results, Section 7.4 presents a sensitivity analysis and the last section provides a summary and conclusions.

7.2 Policy simulations and model closure rules

7.2.1 Policy scenarios

This section discusses the following three policy scenarios: i) reducing trade and transport margins, ii) increasing TFP of activities that produce trade and transport services and iii) a combination of (i) and (ii).

Scenario one: Reducing trade and transport margins

Investment in road infrastructure expands the size of the road transport network and increases road density in the country. Road density is defined as the ratio of aggregate length of road transport in the country to the total size of the country. It is also described as road length per 1000 square km of land area or length of road per 1000 person. Increased road density facilitates transportation services that reduce the costs of transportation and hence transport margins. The effect of road density on transport margins can be obtained through the estimation of the elasticity of the transport margin with respect to road density. The elasticity of the transport margin with respect to road density is estimated by Schürenberg-Frosch (2014) and adopted for the purpose of this study. Based on data from African countries, Schürenberg-Frosch (2014) estimated the elasticity of transport margins with respect to road density to be 0.19 and 0.16 for agricultural and non-agricultural commodities, respectively. In other words, 1% increases in road density results in a transport margin decline by 0.19% for agricultural commodities and by 0.16% for non-agricultural commodities.

The first scenario is carried out based on the road budget and the growth rate of road network density during the period of the Growth and Transformation Plan of Ethiopia (GTP) (2010-2015). During the GTP period, 7.4 billion birr was invested for road construction annually and on average the road density annually expanded by 22% (Ministry of Finance and Economic Development, 2014). Since the Ethiopian government made huge investments in the road sector in the past two decades, only a small increase in road investment is assumed for the future. In this scenario, we assumed only half of the GTP period's annual road budget (i.e. 3.7 billion birr) is invested for road infrastructure that would expand road density by 11% $\left[\frac{22\% * 3.7 \text{ billion birr}}{7.4 \text{ billion birr}}\right]$(based on the GTP period's road density growth and road budget). Based on the above mentioned elasticity of transport margins with respect to road density, this is equivalent to a 2.1% (11%*0.19) reduction of trade and transport margins for agricultural commodities and a 1.8% (11%*0.16) reduction for non-agricultural commodities. Therefore, this scenario is a 2.1% reduction of trade and transport margins for agricultural commodities and 1.8% reduction of trade and transport margins for non-agricultural commodities.

The cost of financing road infrastructure can be acquired from domestic sources and international donors. During the GTP period (2010-2015), 79% of the funds for the road investment came from domestic sources and the remaining 21% were collected from international sources (Ethiopian Roads Authority, 2015). Based on these figures, the government savings and foreign savings are considered the sources of finance for building road infrastructure in all scenarios. Since government treasury is the largest source of funds for road investment, the larger share of funds is obtained from the government savings relative to foreign savings. In the SAM updated for this dissertation, the total government savings are 5.4 billion birr and foreign savings are 10.9 billion birr in the updated SAM. Thus, the required fund (3.7 billion birr) is generated through a 38% increase in government savings (i.e. 2.1 billion birr) and a 15% increase in foreign savings (i.e. 1.6 billion birr). This funding leads to the road network density expanding by 11%.

Scenario two: **Increasing TFP of activities that produce trade and transport services**

Improved access to road infrastructure facilitates transportation of commodities to the market. Better access to road transport potentially increases the efficiency of activities that produce trade and transport services such as trade, transport and communication. The TFP effect of better access to road infrastructure is obtained through the elasticity of the TFP of activities that produce trade and transport services with respect to public expenditure on road infrastructure that is adopted from Lofgren & Robinson (2004). According to Lofgren & Robinson (2004), the elasticity of TFP of trade and transport services with respect to public expenditure on road infrastructure is 0.021 for Sub-Saharan African countries i.e. a 1% increases in public expenditure for road infrastructure results in a 0.021% increases in the TFP of activities that produce trade and transport services.

The increased government savings and foreign savings for building road infrastructure from scenario one is applied to this scenario. Thus, a 38% increase in government savings and a 15% increase in foreign savings results in a 0.79% (38%*0.021) and 0.32% (15%*0.021) increase in the TFP of activities that produce trade and transport services respectively. Therefore, in this scenario TFP of activities that produce trade and transport services increase by 1.1% (0.79 + 0.32).

Scenario three: **Combination of scenario one and two**

Since improved access to road infrastructure reduces trade and transport margins and simultaneously increases TFP of activities that produce trade and transport services, it is expected that the combined scenarios would have larger economy-wide effects relative to the separate effects. Therefore, scenario one and scenario two are combined to constitute scenario three; a reduction of the trade and transport margin by 2.1% for agricultural commodities and by 1.8% for non-agricultural commodities and in the same scenario, the TFP of trade, communication and transport activities increasing by 1.1%. For financing road infrastructure, government savings exogenously increase by 38% and foreign savings increase by 15% in all scenarios. The policy scenarios are summarized in Table 7.1

Table 7.1: Summaries of policy scenarios

Scenarios	Policy shocks
Scenario one	2.1% decrease in trade and transport margins for agricultural commodities
	1.8% decrease in trade and transport margins for non-agricultural commodities
Scenario two	1.1% increase in TFP of trade, transport and communication activities
Scenario three	Combination of scenario one and two

Source: Author's compilations

7.2.2 Model closure rules

The external balance is fixed and the exchange rate is flexible to clear the external balance. The exchange rate is flexible to produce the required level of foreign savings for funding road infrastructure. Investment driven saving is assumed where investment is fixed and saving adjusted for the change in the investment demand. Government raises funds through income tax replacement. Government savings are fixed and income tax rates endogenously adjusted to produce a fixed level of government savings for financing the building of road infrastructure. The CPI is chosen as a numeraire. Furthermore, factor supply is fixed and in order to enable the mobility of water fetchers and firewood collectors across different sectors, perfect factor mobility is assumed in the model.

The next section reports the policy impact on domestic commodity prices, household consumption, domestic production, welfare and major macroeconomic indicators.

7.3 Trade and transport margin across sectors

Trade and transport margins across sectors are depicted in Table 7.2. Trade and transport margins are relatively higher in non-agriculture sectors than in agriculture. Aggregate agricultural commodities pay 7.2 billion birr for trade and transport margins service. On the other hand, aggregate non-agricultural commodities pay 15.9 billion birr for trade and transport services.

Table 7.2: Trade and transport margins by sector

Sectors	Trade and transport margins in billions birr	Margin expressed as percentage of production values
Agriculture	7.2	11.1
Non-agriculture	15.9	12.5
Total	23.1	12.0

Source: Author’s compilations from the updated 2005/06 SAM

7.4 Results and discussion

7.4.1 Changes in commodity prices

The effect of a decline in trade and transport margins and increase in TFP of activities that produce trade and transport services are injected in the economy through the purchaser price of composite commodities (PQD), which is defined as follows:

$$PQD_c = PQS_c * (1 + TS_c + TEX_c) + \sum_m (ioqttqq_{m,c} * PTT_m)$$

Where PQS_c is the supply price of commodity c, TS_c is the sales tax rate, TEX_c is the excise tax rate, $ioqttqq_{m,c}$ is the quantity of transport margin ‘m’ used per unit of domestic demand and PTT_m is the price of the trade and transport margins.

Better access to road transport infrastructure mainly affects prices of marketed commodities. This is because these groups of commodities use the services of trade and transport. The decrease in trade and transport margins and increase in TFP of activities that produce trade and transport services reduce the gap between consumer price and producer price. Table 7.3 depicts the implication of lower trade and transport margins and increase in TFP of activities that produce trade and transport services on consumer price (PQD) and producer price (PXAC) (refer to appendix D for the full list of commodities). In response to less trade and transport margins and higher TFP, the consumer price for marketed commodities declines in all scenarios. In scenario one, the consumer price decreases by 0.8% for both market food and market non-food. In the second scenario, PQD decreases by 0.4% for market food and by 0.9% for market non-food commodities. Furthermore, the PQD for market food and market non-food decreases by 0.9% and 1%, respectively, in the third scenario.

Table 7.3: Simulated changes (percentage) in PQD and PXAC

Simulated changes (percentage) in PQD			
Commodities	**Scenario one**	**Scenario two**	**Scenario three**
Market food	-0.81	-0.40	-0.89
Market non-food	-0.83	-0.86	-0.96
Simulated changes (percentage) in PXAC			
Commodities	**Scenario one**	**Scenario two**	**Scenario three**
HPHC food commodities	0.76	0.32	0.88
HPHC non-food commodities	0.82	0.70	0.87

Source: Author's computation based on model results

The producer price for own consumed commodities increases in all scenarios. Specifically, it increases by 0.8% for both HPHC food and HPHC non-food commodities in the first scenario and by 0.3% for HPHC food commodities and by 0.7% for HPHC non-food commodities in the second scenario. In the third scenario, the producer price increases by 0.9% for both HPHC food and HPHC non-food commodities. Even though HPHC commodities are not directly affected by the policy scenarios, the producer price of these commodities is influenced indirectly through the income effect. Specifically, improved road transport infrastructures facilitate market supply of commodities that enhances domestic production and increases income of households. This leads to increases in the demand for own consumed commodities and hence the PXAC for these commodities rises in all scenarios.

Furthermore, due to the price linkages in the economy, all commodity prices are affected by the policy simulations; including supply prices of commodities (PQS), domestic prices of imported commodities (PM) and domestic prices of exports (PE). Because of lower margins and increases in TFP of trade and transport services, the quantity of commodities supplied to the market increases. Therefore, PQS, PM and PE for marketed food and non-food commodities declines in all scenarios (see appendix F for the details). For convenience, water fetching, firewood collection and leisure commodities are incorporated under the category of HPHC commodities in this chapter.

7.4.2 Changes in household consumption

The policy scenarios also affect household consumption. Table 7.4 describes the impact of improved road transport on the consumption of commodities. Consumption of marketed and HPHC commodities increases in all scenarios. Lower trade and transport margins result in lower PQD for marketed commodities that make these commodities relatively cheaper and hence household consumption increases. Furthermore, increased TFP of activities that produce trade and transport services facilitates the transportation of commodities. This results in extra commodity supply in the market and lower PQD and enhances consumption.

Accordingly, household demand for marketed commodities increases in the first scenario: by 0.3% for both market food and market non-food commodities. In the second scenario, the consumption of marketed commodities also increases: by 0.2% for both market food and market non-food commodities. Similarly, the consumption of marketed commodities also increases in the third scenario: by 0.4% for market food and by 0.5% market non-food commodities. Trade and transport margins constitute a higher share of the cost of marketed non-food commodities in comparison to marketed food commodities. Therefore, due to less trade and transport margins, consumption of marketed non-food commodities increases more compared to marketed food commodities.

Table 7.4: Simulated changes (percentage) in household consumption

Commodities	Scenario one	Scenario two	Scenario three
HPHC food commodities	0.26	0.19	0.34
HPHC non-food commodities	0.31	0.15	0.51
Market food	0.29	0.21	0.36
Market non-food	0.33	0.24	0.52

Source: Author’s computation based on model results

The policy simulations also influence household consumption of HPHC commodities. Consumption of HPHC food commodities increases in all scenarios: by 0.3% in scenario one, by 0.2% in scenario two and by 0.3% in the third scenario. Likewise, the consumption of HPHC non-food commodities also increases in all scenarios: by 0.3% in the first scenario, by 0.2% in the second scenario and by 0.5% in the third scenario. Although trade and transport margins do not directly affect HPHC commodities, the consumption of these commodities increase due to the income effect. Particularly, domestic production is enhanced by improved road infrastructure (Table 7.5) that led to increased household income and hence increased consumption of HPHC commodities.

7.4.3 Changes in domestic production

Development of road infrastructure potentially reduces transportation margins in all sectors of the economy. In other words, less trade and transport margins and higher efficiency facilitate trade activities, encourage larger supply of commodities to the market and enhance domestic production. Table 7.5 depicts the implication of lower per unit margin requirements and improved TFP on domestic production. The simulation results indicate that production increases in agricultural and non-agricultural sectors (industry and services) in each scenario. Agricultural production increases in all scenarios: by 0.1% in scenario one and scenario two and by 0.2% in the third scenario. Service production also increases: by 0.6% in the first scenario, by 0.8% in the second scenario and third scenario. Similarly, industrial production increases: by 1.1% in the first scenario, by 0.8% in the second scenario and by 1.4% in the last scenario.

Since trade and transport margins are higher for non-agricultural commodities relative to agricultural commodities, the reduction of margins provides bigger incentives for non-agricultural production. For instance, industrial production increases by a larger proportion relative to other sectors in all scenarios. Furthermore, domestic production increases by larger proportions in the third scenario relative to scenarios one and two; this is because the combined effects of lower trade and transport margins and increased efficiency have a stronger effect on domestic production relative to the separate effects.

Table 7.5: Simulated changes (percentage) in domestic production

Economic sectors	Scenario one	Scenario two	Scenario three
Agriculture	0.07	0.08	0.15
Service	0.57	0.77	0.83
Industry	1.06	0.79	1.36

Source: Author's computation based on model results

7.4.4 Changes in household welfare

Table 7.6 describes the welfare implication of lower trade and transport margins and improved TFP of activities that produce trade and transport services. Simulation results indicate that expansion of road infrastructure results in welfare improvement among all household groups except non-poor households located in urban areas. However, the amount of welfare gain varies across households. Welfare gains are driven by the increase in the consumption of households in response to lower prices. Households that consume a larger proportion of market non-food commodities are relatively better off than other households are. This is because the cost of margin services accounts for a relatively high proportion of the total expenditure of market non-food commodities. Accordingly, lower trade and transport margins and improved efficiency strongly increase the consumption of market non-food commodities and hence contribute to the well-being of households.

Furthermore, lower transport margins and improved efficiency decrease the cost of production and facilitate domestic production (Table 7.5), leading to increased factor income to households (Table 7.7) and hence positive welfare effects. Only the welfare of non-poor urban households declines in all scenarios because those households pay the largest share of taxes. The change in taxes as percentage of income is reported in appendix G.1. Therefore, the increase in income taxes for financing road infrastructure negatively affects the consumption expenditure for non-poor urban households (see appendix G.2 for the details).

Table 7.6: Simulated changes (percentage) in household welfare (EV/base income)

Households	Scenario one	Scenario two	Scenario three
Household rural zone 1 poor agricultural	0.82	0.73	0.83
Household rural zone 1 poor mixed	0.82	0.73	0.83
Household rural zone 1 poor non-agricultural	0.82	0.73	0.83
Household rural zone 2 poor agricultural	1.31	1.19	1.34
Household rural zone 2 poor mixed	1.31	1.19	1.34
Household rural zone 2 poor non-agricultural	1.31	1.19	1.34
Household rural zone 3 poor agricultural	1.30	1.19	1.32
Household rural zone 3 poor mixed	1.30	1.19	1.32
Household rural zone 3 poor non-agricultural	1.30	1.19	1.32
Household rural zone 4 poor agricultural	1.21	1.12	1.25
Household rural zone 4 poor mixed	1.21	1.12	1.25
Household rural zone 4 poor non-agricultural	1.21	1.12	1.25
Household rural zone 5 poor agricultural	0.74	0.68	0.78
Household rural zone 5 poor mixed	0.74	0.68	0.78
Household rural zone 5 poor non-agricultural	0.74	0.68	0.78
Household rural zone 1 non-poor agricultural	0.96	0.89	1.02
Household rural zone 1 non-poor mixed	0.96	0.89	1.02
Household rural zone 1 non-poor non-agricultural	0.96	0.89	1.02
Household rural zone 2 non-poor agricultural	1.01	0.93	1.10
Household rural zone 2 non-poor mixed	1.01	0.93	1.10
Household rural zone 2 non-poor non-agricultural	1.01	0.93	1.10
Household rural zone 3 non-poor agricultural	1.15	1.09	1.24
Household rural zone 3 non-poor mixed	1.15	1.09	1.24
Household rural zone 3 non-poor non-agricultural	1.15	1.09	1.24
Household rural zone 4 non-poor agricultural	1.07	1.01	1.16
Household rural zone 4 non-poor mixed	1.07	1.01	1.16
Household rural zone 4 non-poor non-agricultural	1.07	1.01	1.16
Household rural zone 5 non-poor agricultural	0.69	0.65	0.77
Household rural zone 5 non-poor mixed	0.69	0.65	0.77
Household rural zone 5 non-poor non-agricultural	0.69	0.65	0.77
Household small urban poor	0.85	0.86	0.90
Household big urban poor	0.42	0.47	0.49
Household small urban non-poor	-3.04	-3.16	-2.83
Household big urban non-poor	-1.23	-1.38	-1.11

Source: Author’s computation based on model results

Table 7.7: Simulated changes (percentage) in factor income

Factors of production	Scenario one	Scenario two	Scenario three
Agricultural labor male	0.95	0.63	1.12
Agricultural labor female	0.95	0.63	1.12
Administrative labor male	0.23	0.16	0.42
Administrative labor female	0.48	0.35	0.67
Professional labor male	0.27	0.19	0.46
Professional labor female	0.41	0.29	0.59
Unskilled labor male	1.00	0.68	1.17
Unskilled labor female	0.83	0.55	1.01
Skilled labor male	0.28	0.22	0.48
Skilled labor female	0.40	0.30	0.59
Capital land for rural poor in zone 1	1.41	1.13	1.61
Capital land for rural non-poor in zone 1	1.55	1.30	1.78
Capital land for rural poor in zone 2	0.78	0.42	0.92
Capital land for rural non-poor in zone 2	0.48	0.06	0.58
Capital land for rural poor in zone 3	0.78	0.45	0.91
Capital land for rural non-poor in zone 3	0.59	0.21	0.72
Capital land for rural poor in zone 4	0.75	0.42	0.88
Capital land for rural non-poor in zone 4	0.49	0.10	0.59
Capital land for rural poor in zone 5	1.10	0.77	1.24
Capital land for rural non-poor in zone 5	0.96	0.59	1.11
Capital livestock for rural poor in zone 1	1.06	0.72	1.23
Capital livestock for rural non-poor in zone 1	1.06	0.72	1.23
Capital livestock for rural poor in zone 2	0.95	0.60	1.13
Capital livestock for rural non-poor in zone 2	0.95	0.60	1.13
Capital livestock for rural poor in zone 3	0.99	0.65	1.17
Capital livestock for rural non poor in zone 3	0.99	0.65	1.17
Capital livestock for rural poor in zone 4	1.01	0.67	1.19
Capital livestock for rural non-poor in zone 4	1.01	0.67	1.19
Capital livestock for rural poor in zone 5	0.97	0.62	1.15
Capital livestock for rural non-poor in zone 5	0.97	0.62	1.15
Non-agricultural capital	0.13	0.18	0.25

Source: Author’s computation based on model results

7.4.5 Macroeconomic effects

Reducing trade and transport margins and increasing the TFP of activities that produce trade and transport services create economy-wide effects and positively affect the entire macroeconomic indicators such as GDP, private consumption, investment consumption, absorption, total domestic production and import demand. Table 7.8 depicts macroeconomic implications of reducing trade and transport margins and improved efficiency.

For instance, in the first scenario GDP increases by 0.3%, private consumption by 0.6%, investment consumption by 1.9%, absorption by 0.7%, total domestic production by 0.5% and import demand by 1.6%. In the second scenario, total domestic production increases by 0.5%, GDP by 0.1%, private consumption by 0.5%, investment consumption by 1.7%, absorption by 0.6% and import demand by 1.5%. Similarly, in the third scenario GDP increases by 0.4%, total domestic production by 0.7%, private consumption by 0.7%, investment consumption by 2.3%, absorption by 0.8% and import demand by 1.8%.

Improved road infrastructure facilitates trade and transport activities in the economy that enhance transportation of commodities into the market and results in lower prices of commodities. This leads to an increase in domestic demand and hence more domestic production, which accelerates the growth of the economy and increases GDP.

Table 7.8: Real macroeconomic effects (percentage changes)

Macroeconomic indicators	Scenario one	Scenario two	Scenario three
GDP	0.25	0.14	0.37
Private consumption	0.58	0.49	0.67
Investment consumption	1.96	1.74	2.26
Absorption	0.71	0.61	0.82
Total domestic production	0.45	0.47	0.65
Import demand	1.55	1.47	1.82

Source: Author’s computation based on model results

7.5 Sensitivity analysis

Sensitivity analysis is conducted to ensure the stability of model results in response to changes in behavioral parameters. Since better access to road infrastructure mostly affects marketed commodities, sensitivity analysis is carried out by changing the income elasticity of demand for these commodities. In other words, because the reduction in margin and increase in TFP of activities that produce trade and transport services is injected to the economy through purchaser prices of marketed commodities, the income elasticity of demand for these commodities is selected for sensitivity analysis. Specifically, the income elasticity of demand for marketed commodities increases and decreases by 50%. The details of the sensitivity of demand for marketed commodities, domestic production, household welfare and macroeconomic effects in response to a 50% increase and decrease in the income elasticity of demand are reported in appendix H.

Household consumption of market commodities is sensitive to the change in the income elasticity of demand for marketed commodities. The higher the income elasticity of demand, the larger the change in consumption of marketed commodities across all scenarios.

Similarly, domestic production is sensitive to the change in the income elasticity of demand for marketed commodities. The higher the income elasticity of demand, the larger the increase of domestic production in all scenarios. Household welfare is also sensitive to the change in income elasticity of demand. The magnitude of welfare gain varies by a small margin in response to the change in the income elasticity of demand. The biggest welfare gain (or the smallest loss) is achieved at the higher income elasticity. Furthermore, macroeconomic indicators such as GDP, absorption, total domestic production and import demand are sensitive to the change in the income elasticity of demand. A lower income elasticity of demand leads to smaller macroeconomic effects across all scenarios.

In conclusion, the sensitivity analysis indicates that changes in income elasticity of demand for marketed commodities cause a change in the magnitude of the consumption of commodities, domestic production, household welfare and real macroeconomic indicators. Although changes in the income elasticity of demand for marketed commodities lead to changes in the size of simulation results, the directions as well as the order of magnitude of changes remain the same in all scenarios.

7.6 Summary and conclusion

Ethiopia is heavily dependent on road infrastructure for transportation services. However, access to rural roads is still very low in Ethiopia. Poor road transport is a major constraint of market access and non-agricultural activities in the country. The aim of this chapter is to investigate the economy-wide effect of reducing trade and transport margins in response to better road transport infrastructures. Better access to road infrastructure potentially reduces per unit trade and transport margins and increases efficiency of transporting commodities into the market. Three policy scenarios are conducted in this chapter. Based on the growth rate of road network density during the GTP period, trade and transport margins are reduced by 1.8% to 2.1% in the first scenario. The TFP of activities that produce trade and transport services is increased by 1.1% in the second scenario. Scenario one and two are combined to form the third scenario with the expectation it might produce a larger effect. The cost of financing road infrastructure is sourced from government savings (government raises funds through income tax replacement) and foreign savings (international aids/loans).

The policy simulations indicate that lower margins and increasing TFP result in a reduction of PQD for marketed commodities across all scenarios. Household consumption and domestic production of agricultural and non-agricultural sectors are positively affected by the policy simulation. Furthermore, the simulation scenarios also indicate that expansion of road infrastructure results in welfare improvement among rural and urban households. The policy simulation also affects real macroeconomic indicators including GDP, investment consumption, private consumption, absorption, total domestic production and import demand. All the policy scenarios depict the expected outcome. There is no huge difference between scenario one and two for most simulation results. As expected the third policy scenario produced a larger effect relative to the separate effects of scenario one and two. In conclusion, because scenario one is carried out based on empirical literature, it seems to be the most realistic policy simulation.

Even though the simulation results are sensitive to the change in the income elasticity of demand for marketed commodities, the direction of changes is unaltered in all scenarios. Improved access to road transport is tremendously important for the promotion of both agricultural and non-agricultural activities. Therefore, improvement of road transport infrastructure should be considered as one of the policy pillars in the design of development policy and strategies of Ethiopia.

Chapter 8: Conclusion, Policy Implications and Outlook for Future Research

8.1 Main findings

This study identified the major determinants of non-agricultural activities in rural Ethiopia using a country representative household survey. The study also investigated the economy-wide impact (hence implications for non-agricultural activities) of improved access to water supply, energy efficient technology and road transport infrastructure. The methodologies applied are probit models and a single-country CGE model. Descriptive statistics and a probit model are implemented to study the characteristics and major constraints of non-agricultural activities. A CGE model is used to examine the economy-wide effects of improved access to water supply, energy efficient technology and road transport infrastructure. A 2005/06 Ethiopian SAM is updated to account for a detailed representation of water fetching, firewood collection and leisure activities. Water fetching, firewood collection and leisure were introduced as a separate sector in the SAM. The values for water fetching, firewood collection and leisure are estimated based on the shadow wages of labor.

The study indicates that the major constraints of non-agricultural activities are low access to finance (lack of credit access), poor access to market centers, lack of market opportunities (absence of market information and low demand), limited education/business training and poor access to roads, transportation and communication. For example, households residing one minute walking distance farther away from the main market center are 0.04% less likely to engage in non-agricultural activities relative to households residing closer to the market center. Similarly, households residing one more minute walking distance closer to all-weather roads are 0.01% more likely to engage in non-agricultural activities compared to households who reside farther away from all-weather roads. These findings indicate that proximity to market centers and road infrastructure facilitates rural non-agricultural activities. The main non-agricultural activities are services (including transport, carpentry and repair services), trade (including wholesale and retail trade) and manufacturing (including grain milling and brewing). Rural households engage in non-agricultural activities due to push factors (such as volatile earnings and lack of access to agricultural land), pull factors (such as search for means to invest in agriculture) and other factors (such as social/economic independence).

Other impediments of non-agricultural activities are time use for water fetching and firewood collection. Since the sources of water and firewood are often not easily accessible in Ethiopia, households spend much time per day for collecting water and firewood. For instance, rural households on average spend 0.64 hours per day for fetching water and 0.58 hours per day for firewood collection. This study estimates the effect of water fetching and firewood collection on non-agricultural activities using household survey data collected from rural areas and small towns of Ethiopia. The study reveals that water fetching and firewood collection significantly affect non-agricultural activities in Ethiopia. Households that spend one more hour for water fetching are 6.6% less likely to participate in non-agricultural activities relative to households that spend less time for the same activities. Similarly, households that spend one more hours on firewood collection are 5.4% less likely to engage in non-agricultural activities relative to household that spend less time for the same activities. Female household members spend longer hours relative to their male counterpart for both water fetching and firewood collection. For example, in rural areas, male household members on average spend 0.12 hours and female household members spend 0.52 hours per day for water fetching. Similarly, male household members on average spend 0.2 hours and female members spend 0.38 hours per day for firewood collection in rural Ethiopia.

The current study also analyzed and discussed the effect of two policy options for promoting non-agricultural activities in Ethiopia. The policy options are: i) freeing labor time from labor-intensive home activities such as water fetching and firewood collection and ii) improved access to road transport infrastructure.

The first policy option discussed in this study is facilitating non-agricultural activities by freeing labor from water fetching and firewood collection. Improved access to water infrastructure and energy efficient technology (for example, improved stoves) significantly reduces the time spent on water fetching and firewood collection. The freed labor can be partly reallocated to marketed activities such as agricultural and non-agricultural activities or partly reallocated to leisure. Labor reallocated to market related activities has positive economy-wide implications. This study examined a scenario of a 50% increase in the TFP of water fetching and firewood collection activities due to improved access to water and energy efficient technology. Government savings and foreign savings are the sources of finance for building water infrastructure and distributing energy efficient technology.

Simulation results indicate that due to increased TFP of water fetching and firewood collection activities, labor demand declines on average by 22.3% for firewood collection and 21.7% for water fetching. On the other hand, employment of labor in agriculture, industry and service activities increases on average by 1.6%, 0.9% and 0.5%, respectively, because of absorbing the released labor from water fetching and firewood collection. Agriculture absorbs a larger percentage of labor relative to industry and services. Most of the freed laborers prefer to enjoy extra leisure and hence labor reallocated to leisure increases by 4.6%. Furthermore, labor released from water fetching and firewood collection is transferred into the market sector and stimulates agricultural and non-agricultural (industry and services) production in the destination sector. Production of agriculture, industry and services increases on average by 1.2%, 0.6% and 0.4%, respectively, due to employment of extra labor released from water fetching and firewood collection.

Moreover, a reduction of the time spent for water fetching and firewood collection enhances the welfare of households. Welfare gains are higher for households who allocate a relatively large proportion of their labor to water fetching and firewood collection. Macroeconomic indicators such as GDP, total domestic production and absorption are positively affected. Improved access to water supply and household energy service ensures reallocation of labor towards market related sectors including non-agricultural activities enhances domestic production and improves overall welfare and economic growth. Although simulation results are sensitive to the change in the income elasticity of leisure, the directions of changes remain the same. Hence, it is helpful to recognize the economic significance of labor freed from water fetching and firewood collection in promoting income-generating activities such as non-agricultural activities and its economy-wide implication in Ethiopia.

The second policy analyzed in this study is the role of improved access to road transport infrastructure for enhancing non-agricultural activities. Ethiopia is heavily dependent on road infrastructure for transportation services. Access to better road transport infrastructure creates a favorable environment for the promotion of agricultural and non-agricultural activities and stimulates the growth of all sectors in the economy. Therefore, this study investigates the economy-wide effect of reducing trade and transport margins and increasing TFP of activities that produce trade and transport services in response to better road transport infrastructures. The policy scenario includes a 1.8% to 2.1% reduction of trade and transport margin, a 1.1%

increases in the TFP of activities that produce trade and transport services due to an improved road transport network.

The financing of road infrastructure is acquired from government savings and foreign savings. The study reveals that improved access to road transport infrastructure reduces consumer prices of marketed commodities by 0.4% to 0.9%. It enhances domestic production in agricultural and non-agricultural sectors by 0.1% to 1.4% and it results in welfare improvements among rural and urban households and facilitates economic growth. Even if the model results are sensitive to the change in the income elasticity of demand for marketed commodities, the direction of changes are unaltered. Therefore, improved access to road transport infrastructure is important for the development of non-agricultural activities.

8.2 Policy implications

In accordance with the findings of this study, the policy suggestions focus on the process of improving access to roads, drinking water supply and energy efficient technology as an instrument for successfully promoting rural non-agricultural activities in Ethiopia. Absence of improved road infrastructure is an impediment to the development of rural non-agricultural activities in Ethiopia. The development of road networks that connect rural areas and small rural towns potentially enhances access to market centers. Access to improved roads reduces transportation cost and makes an easy transportation of non-agricultural commodities from rural areas to small towns. This facilitates market activities and promotes agricultural and non-agricultural activities while stimulating the entire economic activities in the country. Therefore, the Ethiopian Government may expand road infrastructure in the country.

Non-agricultural activities are potentially promoted by improved access to drinking water supply and energy efficient technologies that reduce time spent for water fetching and firewood collection. Household access to improved water supply can be achieved through the construction of water infrastructure close to their neighborhood. As compared to other pro-poor sectors (agriculture, education and health), the water sector receives the lowest public budget. For example, the water sector annual average budget was 0.6% of GDP and 3% of the total national budget between 2008 to 2012 (World Bank, 2016). Therefore, increasing the public budget and mobilizing more external sources of finance (grants and loans) potentially reduce the funding gap in the water sector. Furthermore, there may also be a focus for the regular maintenance of the existing rural water infrastructure such as public water taps and hand pump water facilities. District offices working on water sectors should be strengthened in terms of skilled labor and adequate budget for their operations.

Improved access to energy technology can be attained through the dissemination of energy efficient improved cooking stoves. Adequate support should be provided for the production, adoption and dissemination of energy efficient improved stoves. Policy makers should integrate rural water supply, improved energy technology and road infrastructure as components in the rural development strategies in the country. The Ethiopian Government, local communities, non-governmental organizations and donor agencies should cooperate in the successful expansion of drinking water infrastructure, dissemination of improved cooking stoves and the building of road infrastructure. In general, this study shows that the policy interventions targeting the facilitation of non-agricultural activities result in noticeable economy-wide effects and stimulate economic growth. In other words, the current study highlighted the economy-wide benefits acquired through the development of non-agricultural activities in Ethiopia. Therefore, the potential gain derived from promoting non-agricultural activities should neither be neglected nor underestimated.

8.3 Limitations of the study

This study is not free from limitations. In this study, the transactions for water fetching, firewood collections and leisure activities and commodities in the updated SAM are estimated based on the shadow wage of labor. Because of data limitation, this study adopted the shadow wage of labor from other empirical literature conducted in Ethiopia, which was estimated based on a small household survey that might not adequately represent the shadow wage for all households in the country. Therefore, the transactions linked to water fetching, firewood collection and leisure accounts in the updated SAM might not fully reflect the true picture of the Ethiopian economy. Furthermore, the SAM used for this study represents the 2005/06 economy flows of the country. The current Ethiopian economy may not be fully represented by the transaction of the SAM, hence model results might be different if simulated using a more recent SAM. Accordingly, there might be some discrepancies in the size of simulation results but no major differences in the order of magnitude as well as the direction of changes are expected as the basic structure of the economy has not changed dramatically.

Improved access to drinking water and energy efficient technology has health and non-health related benefits such as reduction of waterborne diseases and indoor air pollution, saved health care expenditure, productivity gain due to better health and the time saved from water fetching and firewood collection. However, this study analyzes only the benefits of freed labor from water fetching and firewood collection due to improved access to water infrastructure and energy efficient technology. Therefore, the economic gains of better access to water and energy technology are only partially captured by this study.

The current study applies a static or single-period model due to limited time availability. However, it would be interesting if a dynamic model were implemented for this study. This is mainly because the benefits harvested from improved access to water facility, energy technology and road infrastructure might not be fully achieved in a single-period and can be distributed to several periods. A dynamic model is more appropriate for capturing the time path of benefits derived from improved access to water facility and household energy.

Most of the behavioral parameters such as elasticities are adopted from other studies and/or assumed by educated guess. The value of these elasticities might not be precise and their potential effect on model results might not be sufficiently considered. Therefore, sensitivity analyses were carried out in order to see how far the models results change due to changes in certain elasticity parameters. These sensitivity analyses could be extended. Generally, the simulation results reported in this study should not be considered as predictions of the future. The model results are the effect of the model’s reaction to an isolated exogenous shock. Other factors that can change in the real world are held constant in the model.

8.4 Outlook for future research

Outlooks for the directions to future research are provided on SAM development, CGE modeling and alternative policy experiments.

8.4.1 Suggestions for SAM development

The detailed representation of rural non-agricultural activities in the SAM is crucially helpful for adequately studying non-agricultural activities using economy-wide models. The main rural non-agricultural activities practiced in Ethiopia should be exhaustively identified and incorporated in the SAM. For example, a separate activity account can be created for each of the traditional handcrafts such as cloth or shoe making, pottery, basket weaving and woodcarving. Since these activities are differently distributed across the country, each activity account can be further re-categorized by regions or agro-ecological zones. Country representative rural labor force surveys, small manufacturing surveys or micro and small enterprise surveys can provide relevant inputs for effectively representing rural non-agricultural activities in the SAM.

8.4.2 Alternative CGE models

Non-agricultural activities can be analyzed and studied using village-level SAM and CGE models. This is helpful for comprehensively studying the non-agricultural activities in a particular village economy. Furthermore, a dynamic model can be applied for analyzing the time path of benefits derived from investment in water supply, energy technology and road infrastructure. The precision of behavioral parameters such as elasticities in the model can be improved by estimating the value of these elasticities using econometrics.

8.4.3 Alternative policy experiments

Alternative policy simulations include the effect of improved access to credit services, education and markets for promoting rural non-agricultural activities. Furthermore, studying women market work and access to water and household energy is another potential research topic that can be studied using the Ethiopian SAM updated for this study.

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Appendices

Appendix A: Test of multicollinearity

Appendix A.I: Variance inflation factor (VIF) test of multicollinearity (for econometric model estimated in Chapter 2)

Variables	VIF	1/VIF
Access to market (walking distance in minutes)	2.79	0.358319
Access to road (distance to all-weather road)	1.82	0.549280
Volatilities of agricultural income	3.13	0.319261
Household size	5.68	0.176030
Age (household head)	5.06	0.197548
Gender (household head)	4.25	0.235447
Education (household head)	1.69	0.592220
Mean VIF	3.49	

Source: Own computation based on Central Statistical Agency and World Bank (2007)

Appendix A.II: VIF test of multicollinearity (for econometric model estimated in Chapter 3)

Variables	VIF	1/VIF
Water fetching time	1.29	0.777404
Firewood collection time	1.25	0.797032
Time spend for agricultural activities	1.43	0.701455
Access to credit	8.34	0.119966
Region	2.82	0.354114
Ownership of non-agricultural asset	1.00	0.997110
Mean VIF	3.12	

Source: Own computation based on Central Statistical Agency and World Bank (2013)

Appendix B: Structure of the updated 2005/06 SAM of Ethiopia

Appendix B.1: Activity accounts

Appendix B.1.1: Agricultural activities

Abbreviations	Descriptions
atef1	Growing teff in zone 1
atef2	Growing teff in zone 2
atef3	Growing teff in zone 3
atef4	Growing teff in zone 4
atef5	Growing teff in zone 5
abar1	Growing barley in zone 1
abar2	Growing barley in zone 2
abar3	Growing barley in zone 3
abar4	Growing barley in zone 4
abar5	Growing barley in zone 5
awhea1	Growing wheat in zone 1
awhea2	Growing wheat in zone 2
awhea3	Growing wheat in zone 3
awhea4	Growing wheat in zone 4
awhea5	Growing wheat in zone 5
amaiz1	Growing maize in zone 1
amaiz2	Growing maize in zone 2
amaiz3	Growing maize in zone 3
amaiz4	Growing maize in zone 4
amaiz5	Growing maize in zone 5
asorg1	Growing sorghum in zone 1
asorg2	Growing sorghum in zone 2
asorg3	Growing sorghum in zone 3
asorg4	Growing sorghum in zone 4
asorg5	Growing sorghum in zone 5
apul1	Growing pulses in zone 1

Appendix B.1.1: Agricultural activities (continued)

Abbreviations	Descriptions
apul2	Growing pulses in zone 2
apul3	Growing pulses in zone 3
apul4	Growing pulses in zone 4
apul5	Growing pulses in zone 5
avegfr1	Growing vegetable and nec in zone 1
avegfr2	Growing vegetable and nec in zone 2
avegfr3	Growing vegetable and nec in zone 3
avegfr4	Growing vegetable and nec in zone 4
avegfr5	Growing vegetable and nec in zone 5
aoils1	Growing oil seeds in zone 1
aoils2	Growing oil seeds in zone 2
aoils3	Growing oil seeds in zone 3
aoils4	Growing oil seeds in zone 4
aoils5	Growing oil seeds in zone 5
acash1	Growing cash crops nec in zone 1
acash2	Growing cash crops nec in zone 2
acash3	Growing cash crops nec in zone 3
acash4	Growing cash crops nec in zone 4
acash5	Growing cash crops nec in zone 5
aenset1	Growing enset in zone 1
aenset2	Growing enset in zone 2
aenset3	Growing enset in zone 3
aenset4	Growing enset in zone 4
aenset5	Growing enset in zone 5
acrop1	Growing crop nec in zone 1
acrop2	Growing crop nec in zone 2
acrop3	Growing crop nec in zone 3
acrop4	Growing crop nec in zone 4

Appendix B.1.1: Agricultural activities (continued)

Abbreviations	Descriptions
acrop5	Growing crop nec in zone 5
acoff1	Growing coffee in zone 1
acoff2	Growing coffee in zone 2
acoff3	Growing coffee in zone 3
acoff4	Growing coffee in zone 4
alivst1	Livestock farming in zone 1
alivst2	Livestock farming in zone 2
alivst3	Livestock farming in zone 3
alivst4	Livestock farming in zone 4
alivst5	Livestock farming in zone 5
afisfor	Forestry and fishing

Appendix B.1.2: Industrial activities

Abbreviations	Descriptions
amining	Mining
aofood	Production, processing of food and related products
adairy	Manufacturing of dairy products
agmill	Manufacturing of grain mill products
agmillserv	Manufacturing of grain mill services
asug	Manufacture of sugar
abev	Manufacturing of beverage products
amtob	Manufacturing of tobacco products
atext	Manufacturing of textile products
aapar	Manufacturing of wearing apparels
aleath	Manufacturing of leather products
awood	Manufacturing of wood and products of wood
apaperp	Manufacture of paper and paper products
achem	Chemicals products manufacturing
aminprod	Mineral products manufacturing

Appendix B.1.2: Industrial activities (continued)

Abbreviations	Descriptions
abmetalp	Manufacturing metal products
amach	Machinery manufacturing
aelecq	Electronic equipments manufacturing
aveh	Motor vehicles manufacturing
aomanu	Furniture and related products manufacturing

Appendix B.1.3: Service activities

Abbreviations	Descriptions
aelect	Electricity
awater	Collection purification and distribution of water
acons	Service of construction
atrad	Trade
ahotel	Hotel
atrncom	Transport, communication and storage
afserv	Financial intermediation
arest	Real estate, business activities and renting
apadmin	Public administration
aeduc	Education
aheal	Health
aoserv	Business activities and related social services

Appendix B.1.4: Water fetching activities

Abbreviations	Descriptions
awfHH-Rural_EZ1Pagr	Water fetching by HH-Rural_EZ1Pagr
awfHH-Rural_EZ1Pmix	Water fetching by HH-Rural_EZ1Pmix
awfHH-Rural_EZ1Pnagr	Water fetching by HH-Rural_EZ1Pnagr
awfHH-Rural_EZ2Pagr	Water fetching by HH-Rural_EZ2Pagr
awfHH-Rural_EZ2Pmix	Water fetching by HH-Rural_EZ2Pmix
awfHH-Rural_EZ2nagr	Water fetching by HH-Rural_EZ2nagr

Appendix B.1.4: Water fetching activities (continued)

Abbreviations	Descriptions
awfHH-Rural_EZ3Pagr	Water fetching by HH-Rural_EZ3Pagr
awfHH-Rural_EZ3Pmix	Water fetching by HH-Rural_EZ3Pmix
awfHH-Rural_EZ3Pnagr	Water fetching by HH-Rural_EZ3Pnagr
awfHH-Rural_EZ4Pagr	Water fetching by HH-Rural_EZ4PPagr
awfHH-Rural_EZ4Pmix	Water fetching by HH-Rural_EZ4Pmix
awfHH-Rural_EZ4Pnagr	Water fetching by HH-Rural_EZ4Pnagr
awfHH-Rural_EZ5Pagr	Water fetching by HH-Rural_EZ5Pagr
awfHH-Rural_EZ5Pmix	Water fetching by HH-Rural_EZ5Pmix
awfHH-Rural_EZ5Pnagr	Water fetching by HH-Rural_EZ5Pnagr
awfHH-Rural_EZ1NPagr	Water fetching by HH-Rural_EZ1NPagr
awfHH-Rural_EZ1NPmix	Water fetching by HH-Rural_EZ1NPmix
awfHH-Rural_EZ1NPnagr	Water fetching by HH-Rural_EZ1NPnagr
awfHH-Rural_EZ2NPagr	Water fetching by HH-Rural_EZ2NPagr
awfHH-Rural_EZ2NPmix	Water fetching by HH-Rural_EZ2NPmix
awfHH-Rural_EZ2NPnagr	Water fetching by HH-Rural_EZ2NPnagr
awfHH-Rural_EZ3NPagr	Water fetching by HH-Rural_EZ3NPagr
awfHH-Rural_EZ3NPmix	Water fetching by HH-Rural_EZ3NPmix
awfHH-Rural_EZ3NPnagr	Water fetching by HH-Rural_EZ3NPnagr
awfHH-Rural_EZ4NPagr	Water fetching by HH-Rural_EZ4NPagr
awfHH-Rural_EZ4NPmix	Water fetching by HH-Rural_EZ4NPmix
awfHH-Rural_EZ4NPnagr	Water fetching by HH-Rural_EZ4NPnagr
awfHH-Rural_EZ5NPagr	Water fetching by HH-Rural_EZ5NPagr
awfHH-Rural_EZ5NPmix	Water fetching by HH-Rural_EZ5NPmix
awfHH-Rural_EZ5NPnagr	Water fetching by HH-Rural_EZ5NPnagr
awfHH-SmallurbanP	Water fetching by HH-SmallurbanP
awfHH-BigurbanP	Water fetching by HH-BigurbanP
awfHH-SmallurbanNP	Water fetching by HH-SmallurbanNP
awfHH-BigurbanNP	Water fetching by HH-BigurbanNP

Appendix B.1.5: Firewood collection activities

Abbreviations	Descriptions
afwHH-Rural_EZ1Pagr	Firewood collection by HH-Rural_EZ1Pagr
afwHH-Rural_EZ1Pmix	Firewood collection by HH-Rural_EZ1Pmix
afwHH-Rural_EZ1Pnagr	Firewood collection by HH-Rural_EZ1Pnagr
afwHH-Rural_EZ2Pagr	Firewood collection by HH-Rural_EZ2Pagr
afwHH-Rural_EZ2Pmix	Firewood collection by HH-Rural_EZ2Pmix
afwHH-Rural_EZ2nagr	Firewood collection by HH-Rural_EZ2nagr
afwHH-Rural_EZ3Pagr	Firewood collection by HH-Rural_EZ3Pagr
afwHH-Rural_EZ3Pmix	Firewood collection by HH-Rural_EZ3Pmix
afwHH-Rural_EZ3Pnagr	Firewood collection by HH-Rural_EZ3Pnagr
afwHH-Rural_EZ4PPagr	Firewood collection by HH-Rural_EZ4PPagr
afwHH-Rural_EZ4Pmix	Firewood collection by HH-Rural_EZ4Pmix
afwHH-Rural_EZ4Pnagr	Firewood collection by HH-Rural_EZ4Pnagr
afwHH-Rural_EZ5Pagr	Firewood collection by HH-Rural_EZ5Pagr
afwHH-Rural_EZ5Pmix	Firewood collection by HH-Rural_EZ5Pmix
afwHH-Rural_EZ5Pnagr	Firewood collection by HH-Rural_EZ5Pnagr
afwHH-Rural_EZ1NPagr	Firewood collection by HH-Rural_EZ1NPagr
afwHH-Rural_EZ1NPmix	Firewood collection by HH-Rural_EZ1NPmix
afwHH-Rural_EZ1NPnagr	Firewood collection by HH-Rural_EZ1NPnagr
afwHH-Rural_EZ2NPagr	Firewood collection by HH-Rural_EZ2NPagr
afwHH-Rural_EZ2NPmix	Firewood collection by HH-Rural_EZ2NPmix
afwHH-Rural_EZ2NPnagr	Firewood collection by HH-Rural_EZ2NPnagr
afwHH-Rural_EZ3NPagr	Firewood collection by HH-Rural_EZ3NPagr
afwHH-Rural_EZ3NPmix	Firewood collection by HH-Rural_EZ3NPmix
afwHH-Rural_EZ3NPnagr	Firewood collection by HH-Rural_EZ3NPnagr
afwHH-Rural_EZ4NPagr	Firewood collection by HH-Rural_EZ4NPagr
afwHH-Rural_EZ4NPmix	Firewood collection by HH-Rural_EZ4NPmix
afwHH-Rural_EZ4NPnagr	Firewood collection by HH-Rural_EZ4NPnagr
afwHH-Rural_EZ5NPagr	Firewood collection by HH-Rural_EZ5NPagr

Appendix B.1.5: Firewood collection activities (continued)

Abbreviations	Descriptions
afwHH-Rural_EZ5NPmix	Firewood collection by HH-Rural_EZ5NPmix
afwHH-Rural_EZ5NPnagr	Firewood collection by HH-Rural_EZ5NPnagr
afwHH-SmallurbanP	Firewood collection by HH-SmallurbanP
afwHH-BigurbanP	Firewood collection by HH-BigurbanP
afwHH-SmallurbanNP	Firewood collection by HH-SmallurbanNP
afwHH-BigurbanNP	Firewood collection by HH-BigurbanNP

Appendix B.1.6: Leisure activities

Abbreviations	Descriptions
aLHH-Rural_EZ1Pagr	Leisure enjoyed by HH-Rural_EZ1Pagr
aLHH-Rural_EZ1Pmix	Leisure enjoyed by HH-Rural_EZ1Pmix
aLHH-Rural_EZ1Pnagr	Leisure enjoyed by HH-Rural_EZ1Pnagr
aLHH-Rural_EZ2Pagr	Leisure enjoyed by HH-Rural_EZ2Pagr
aLHH-Rural_EZ2Pmix	Leisure enjoyed by HH-Rural_EZ2Pmix
aLHH-Rural_EZ2nagr	Leisure enjoyed by HH-Rural_EZ2nagr
aLHH-Rural_EZ3Pagr	Leisure enjoyed by HH-Rural_EZ3Pagr
aLHH-Rural_EZ3Pmix	Leisure enjoyed by HH-Rural_EZ3Pmix
aLHH-Rural_EZ3Pnagr	Leisure enjoyed by HH-Rural_EZ3Pnagr
aLHH-Rural_EZ4Pagr	Leisure enjoyed by HH-Rural_EZ4Pagr
aLHH-Rural_EZ4Pmix	Leisure enjoyed by HH-Rural_EZ4Pmix
aLHH-Rural_EZ4Pnagr	Leisure enjoyed by HH-Rural_EZ4Pnagr
aLHH-Rural_EZ5Pagr	Leisure enjoyed by HH-Rural_EZ5Pagr
aLHH-Rural_EZ5Pmix	Leisure enjoyed by HH-Rural_EZ5Pmix
aLHH-Rural_EZ5Pnagr	Leisure enjoyed by HH-Rural_EZ5Pnagr
aLHH-Rural_EZ1NPagr	Leisure enjoyed by LHH-Rural_EZ1NPagr
aLHH-Rural_EZ1NPmix	Leisure enjoyed by HH-Rural_EZ1NPmix
aLHH-Rural_EZ1NPnagr	Leisure enjoyed by HH-Rural_EZ1NPnagr
aLHH-Rural_EZ2NPagr	Leisure enjoyed by HH-Rural_EZ2NPagr

Appendix B.1.6: Leisure activities (continued)

Abbreviations	Descriptions
aLHH-Rural_EZ2NPmix	Leisure enjoyed by HH-Rural_EZ2NPmix
aLHH-Rural_EZ2NPnagr	Leisure enjoyed by HH-Rural_EZ2NPnagr
aLHH-Rural_EZ3NPagr	Leisure enjoyed by HH-Rural_EZ3NPagr
aLHH-Rural_EZ3NPmix	Leisure enjoyed by HH-Rural_EZ3NPmix
aLHH-Rural_EZ3NPnagr	Leisure enjoyed by HH-Rural_EZ3NPnagr
aLHH-Rural_EZ4NPagr	Leisure enjoyed by HH-Rural_EZ4NPagr
aLHH-Rural_EZ4NPmix	Leisure enjoyed by HH-Rural_EZ4NPmix
aLHH-Rural_EZ4NPnagr	Leisure enjoyed by HH-Rural_EZ4NPnagr
aLHH-Rural_EZ5NPagr	Leisure enjoyed by HH-Rural_EZ5NPagr
aLHH-Rural_EZ5NPmix	Leisure enjoyed by HH-Rural_EZ5NPmix
aLHH-Rural_EZ5NPnagr	Leisure enjoyed by HH-Rural_EZ5NPnagr
aLHH-SmallurbanP	Leisure enjoyed by HH-SmallurbanP
aLHH-BigurbanP	Leisure enjoyed by HH-BigurbanP
aLHH-SmallurbanNP	Leisure enjoyed by HH-SmallurbanNP
aLHH-BigurbanNP	Leisure enjoyed by HH-BigurbanNP

Appendix B.2: Commodity accounts

Appendix B.2.1: Agricultural marketed commodities

Abbreviations	Descriptions
ctef	Teff
cbar	Barley
cwhea	Wheat
cmaiz	Maize
csorg	Sorghum
cpul	Pulse
cveg	Vegetable
coils	Oil seed
ccotts	Cotton seed
ccane	Sugar cane
cfruit	Fruit crops
ctea	Tea
cchat	Chat
ccoff	Coffee
censet	Enset
ccrop	Cereal grain and other crop
cfiber	Plant based fiber
ccatt	Cattle
cpoul	Poultry and other small livestock
cmilk	Raw milk
ccott	Raw cotton
caprod	Animal product
cfors	Forestry products
cflower	Flowers
cfish	Fish

Appendix B.2.2: Industrial marketed commodities

Abbreviations	Descriptions
ccoal	Coal
cngas	Gas
cmin	Minerals
cmeat	Meat
cvprod	Vegetable
cdairy	Dairy products
csug	Sugar
cgmill	Grain mill
cgmillserv	Grain mill services
cfood	Food
cbev	Beverages
ctob	Tobacco
cmtea	Tea manufacturing
cmtob	Tobacco manufacturing
clcott	Cotton
ctext	Textiles
capar	Wearing apparels
cleath	Leather
cwood	Wood
cpaper	Paper product
coilptrl	Petroleum coal
cfert	Fertilizers
cchem	Chemicals
cminprod	Mineral
cmetal	Metals
cmprod	Products of metal
cveh	Motor vehicles
celecq	Electronic equipment
cmach	Machinery

Appendix B.2.2: Industrial marketed commodities (continued)

Abbreviations	Descriptions
comanu	Products of manufacturing

Appendix B.2.3: Marketed services

Abbreviations	Descriptions
celect	Electricity
cwater	Water
ccons	Construction
ctrad	Trade
chotel	Hotel
ctrans	Transport service
ccomm	Communication
cfserv	Financial service
cbserv	Business service
cpadmin	Public administration
ceduc	Education
cheal	Health
coserv	Recreation and others
crest	Real estate and renting services

Appendix B.2.4: Home consumed agricultural commodities

Abbreviations	Descriptions
cmaizo	Maize
coilso	Oil seed
cvego	Vegetable
cwheao	Wheat
cbaro	Barley
cfruito	Fruit crops
csorgo	Sorghum
ctefo	Teff
cpulo	Pulses
ccaneo	Sugar cane
cchato	Chat
ccoffo	Coffee
censeto	Enset
ccropo	Grains
cpoulo	Poultry
cmilko	Raw milk
ccotto	Raw cotton

Appendix B.2.5: Home consumed processed (industrial) commodities

Abbreviations	Descriptions
caprodo	Animal products
cforso	Products of forestry
cfisho	Fish
cmeato	Meat
cdairyo	Dairy products

Appendix B.2.6: Home consumed service commodities

Abbreviations	Descriptions
cresto	Housing

Appendix B.2.7: Water fetching commodities

Abbreviations	Descriptions
cwfHH-Rural_EZ1Pagr	Water consumed by HH-Rural_EZ1Pagr
cwfHH-Rural_EZ1Pmix	Water consumed by HH-Rural_EZ1Pmix
cwfHH-Rural_EZ1Pnagr	Water consumed by HH-Rural_EZ1Pnagr
cwfHH-Rural_EZ2Pagr	Water consumed by HH-Rural_EZ2Pagr
cwfHH-Rural_EZ2Pmix	Water consumed by HH-Rural_EZ2Pmix
cwfHH-Rural_EZ2nagr	Water consumed by HH-Rural_EZ2nagr
cwfHH-Rural_EZ3Pagr	Water consumed by HH-Rural_EZ3Pagr
cwfHH-Rural_EZ3Pmix	Water consumed by HH-Rural_EZ3Pmix
cwfHH-Rural_EZ3Pnagr	Water consumed by HH-Rural_EZ3Pnagr
cwfHH-Rural_EZ4Pagr	Water consumed by HH-Rural_EZ4Pagr
cwfHH-Rural_EZ4Pmix	Water consumed by HH-Rural_EZ4Pmix
cwfHH-Rural_EZ4Pnagr	Water consumed by HH-Rural_EZ4Pnagr
cwfHH-Rural_EZ5Pagr	Water consumed by HH-Rural_EZ5Pagr
cwfHH-Rural_EZ5Pmix	Water consumed by HH-Rural_EZ5Pmix
cwfHH-Rural_EZ5Pnagr	Water consumed by HH-Rural_EZ5Pnagr
cwfHH-Rural_EZ1NPagr	Water consumed by HH-Rural_EZ1NPagr
cwfHH-Rural_EZ1NPmix	Water consumed by HH-Rural_EZ1NPmix
cwfHH-Rural_EZ1NPnagr	Water consumed by HH-Rural_EZ1NPnagr
cwfHH-Rural_EZ2NPagr	Water consumed by HH-Rural_EZ2NPagr
cwfHH-Rural_EZ2NPmix	Water consumed by HH-Rural_EZ2NPmix
cwfHH-Rural_EZ2NPnagr	Water consumed by HH-Rural_EZ2NPnagr
cwfHH-Rural_EZ3NPagr	Water consumed by HH-Rural_EZ3NPagr
cwfHH-Rural_EZ3NPmix	Water consumed by HH-Rural_EZ3NPmix
cwfHH-Rural_EZ3NPnagr	Water consumed by HH-Rural_EZ3NPnagr
cwfHH-Rural_EZ4NPagr	Water consumed by HH-Rural_EZ4NPagr
cwfHH-Rural_EZ4NPmix	Water consumed by HH-Rural_EZ4NPmix
cwfHH-Rural_EZ4NPnagr	Water consumed by HH-Rural_EZ4NPnagr
cwfHH-Rural_EZ5NPagr	Water consumed by HH-Rural_EZ5NPagr
cwfHH-Rural_EZ5NPmix	Water consumed by HH-Rural_EZ5NPmix
cwfHH-Rural_EZ5NPnagr	Water consumed by HH-Rural_EZ5NPnagr
cwfHH-SmallurbanP	Water consumed by HH-SmallurbanP
cwfHH-BigurbanP	Water consumed by HH-BigurbanP
cwfHH-SmallurbanNP	Water consumed by HH-SmallurbanNP
cwfHH-BigurbanNP	Water consumed by HH-BigurbanNP

Appendix B.2.8: Firewood collection commodities

Abbreviations	Descriptions
cfwHH-Rural_EZ1Pagr	Firewood consumed by HH-Rural_EZ1Pagr
cfwHH-Rural_EZ1Pmix	Firewood consumed by HH-Rural_EZ1Pmix
cfwHH-Rural_EZ1Pnagr	Firewood consumed by HH-Rural_EZ1Pnagr
cfwHH-Rural_EZ2Pagr	Firewood consumed by HH-Rural_EZ2Pagr
cfwHH-Rural_EZ2Pmix	Firewood consumed by HH-Rural_EZ2Pmix
cfwHH-Rural_EZ2nagr	Firewood consumed by HH-Rural_EZ2nagr
cfwHH-Rural_EZ3Pagr	Firewood consumed by HH-Rural_EZ3Pagr
cfwHH-Rural_EZ3Pmix	Firewood consumed by HH-Rural_EZ3Pmix
cfwHH-Rural_EZ3Pnagr	Firewood consumed by HH-Rural_EZ3Pnagr
cfwHH-Rural_EZ4Pagr	Firewood consumed by HH-Rural_EZ4Pagr
cfwHH-Rural_EZ4Pmix	Firewood consumed by HH-Rural_EZ4Pmix
cfwHH-Rural_EZ4Pnagr	Firewood consumed by HH-Rural_EZ4Pnagr
cfwHH-Rural_EZ5Pagr	Firewood consumed by HH-Rural_EZ5Pagr
cfwHH-Rural_EZ5Pmix	Firewood consumed by HH-Rural_EZ5Pmix
cfwHH-Rural_EZ5Pnagr	Firewood consumed by HH-Rural_EZ5Pnagr
cfwHH-Rural_EZ1NPagr	Firewood consumed by HH-Rural_EZ1NPagr
cfwHH-Rural_EZ1NPmix	Firewood consumed by HH-Rural_EZ1NPmix
cfwHH-Rural_EZ1NPnagr	Firewood consumed by HH-Rural_EZ1NPnagr
cfwHH-Rural_EZ2NPagr	Firewood consumed by HH-Rural_EZ2NPagr
cfwHH-Rural_EZ2NPmix	Firewood consumed by HH-Rural_EZ2NPmix
cfwHH-Rural_EZ2NPnagr	Firewood consumed by HH-Rural_EZ2NPnagr
cfwHH-Rural_EZ3NPagr	Firewood consumed by HH-Rural_EZ3NPagr
cfwHH-Rural_EZ3NPmix	Firewood consumed by HH-Rural_EZ3NPmix
cfwHH-Rural_EZ3NPnagr	Firewood consumed by HH-Rural_EZ3NPnagr
cfwHH-Rural_EZ4NPagr	Firewood consumed by HH-Rural_EZ4NPagr
cfwHH-Rural_EZ4NPmix	Firewood consumed by HH-Rural_EZ4NPmix
cfwHH-Rural_EZ4NPnagr	Firewood consumed by HH-Rural_EZ4NPnagr
cfwHH-Rural_EZ5NPagr	Firewood consumed by HH-Rural_EZ5NPagr
cfwHH-Rural_EZ5NPmix	Firewood consumed by HH-Rural_EZ5NPmix
cfwHH-RuralE_Z5NPnagr	Firewood consumed by HH-Rural_EZ5NPnagr
cfwHH-SmallurbanP	Firewood consumed by HH-SmallurbanP
cfwHH-BigurbanP	Firewood consumed by HH-BigurbanP
cfwHH-SmallurbanNP	Firewood consumed by HH-SmallurbanNP
cfwHH-BigurbanNP	Firewood consumed by HH-BigurbanNP

Appendix B.2.9: Leisure commodities

Abbreviations	Descriptions
cLHH-Rural_EZ1Pagr	Leisure enjoyed by HH-Rural_EZ1Pagr
cLHH-Rural_EZ1Pmix	Leisure enjoyed by HH-Rural_EZ1Pmix
cLHH-Rural_EZ1Pnagr	Leisure enjoyed by HH-Rural_EZ1Pnagr
cLHH-Rural_EZ2Pagr	Leisure enjoyed by HH-Rural_EZ2Pagr
cLHH-Rural_EZ2Pmix	Leisure enjoyed by HH-Rural_EZ2Pmix
cLHH-Rural_EZ2nagr	Leisure enjoyed by HH-Rural_EZ2nagr
cLHH-Rural_EZ3Pagr	Leisure enjoyed by HH-Rural_EZ3Pagr
cLHH-Rural_EZ3Pmix	Leisure enjoyed by HH-Rural_EZ3Pmix
cLHH-Rural_EZ3Pnagr	Leisure enjoyed by HH-Rural_EZ3Pnagr
cLHH-Rural_EZ4Pagr	Leisure enjoyed by HH-Rural_EZ4Pagr
cLHH-Rural_EZ4Pmix	Leisure enjoyed by HH-Rural_EZ4Pmix
cLHH-Rural_EZ4Pnagr	Leisure enjoyed by HH-Rural_EZ4Pnagr
cLHH-Rural_EZ5Pagr	Leisure enjoyed by HH-Rural_EZ5Pagr
cLHH-Rural_EZ5Pmix	Leisure enjoyed by HH-Rural_EZ5Pmix
cLHH-Rural_EZ5Pnagr	Leisure enjoyed by HH-Rural_EZ5Pnagr
cLHH-Rural_EZ1NPagr	Leisure enjoyed by HH-Rural_EZ1NPagr
cLHH-Rural_EZ1NPmix	Leisure enjoyed by HH-Rural_EZ1NPmix
cLHH-Rural_EZ1NPnagr	Leisure enjoyed by HH-Rural_EZ1NPnagr
cLHH-Rural_EZ2NPagr	Leisure enjoyed by HH-Rural_EZ2NPagr
cLHH-Rural_EZ2NPmix	Leisure enjoyed by HH-Rural_EZ2NPmix
cLHH-Rural_EZ2NPnagr	Leisure enjoyed by HH-Rural_EZ2NPnagr
cLHH-Rural_EZ3NPagr	Leisure enjoyed by HH-Rural_EZ3NPagr
cLHH-Rural_EZ3NPmix	Leisure enjoyed by HH-Rural_EZ3NPmix
cLHH-Rural_EZ3NPnagr	Leisure enjoyed by HH-Rural_EZ3NPnagr
cLHH-Rural_EZ4NPagr	Leisure enjoyed by HH-Rural_EZ4NPagr
cLHH-Rural_EZ4NPmix	Leisure enjoyed by HH-Rural_EZ4NPmix
cLHH-Rural_EZ4NPnagr	Leisure enjoyed by HH-Rural_EZ4NPnagr
cLHH-Rural_EZ5NPagr	Leisure enjoyed by HH-Rural_EZ5NPagr
cLHH-Rural_EZ5NPmix	Leisure enjoyed by HH-Rural_EZ5NPmix
cLHH-Rural_EZ5NPnagr	Leisure enjoyed by HH-Rural_EZ5NPnagr
cLHH-SmallurbanP	Leisure enjoyed by HH-SmallurbanP
cLHH-BigurbanP	Leisure enjoyed by HH-BigurbanP
cLHH-SmallurbanNP	Leisure enjoyed by HH-SmallurbanNP
cLHH-BigurbanNP	Leisure enjoyed by HH-BigurbanNP

Appendix B.3: Household accounts

Abbreviations	Descriptions
HH-Rural_EZ1Pagr	Household rural zone 1 poor agricultural
HH-Rural_EZ1Pmix	Household rural zone 1 poor mixed
HH-Rural_EZ1Pnagr	Household rural zone 1 poor non-agricultural
HH-Rural_EZ2Pagr	Household rural zone 2 poor agricultural
HH-Rural_EZ2Pmix	Household rural zone 2 poor mixed
HH-Rural_EZ2nagr	Household rural zone 2 poor non-agricultural
HH-Rural_EZ3Pagr	Household rural zone 3 poor agricultural
HH-Rural_EZ3Pmix	Household rural zone 3 poor mixed
HH-Rural_EZ3Pnagr	Household rural zone 3 poor non-agricultural
HH-Rural_EZ4Pagr	Household rural zone 4 poor agricultural
HH-Rural_EZ4Pmix	Household rural zone 4 poor mixed
HH-Rural_EZ4Pnagr	Household rural zone 4 poor non-agricultural
HH-Rural_EZ5Pagr	Household rural zone 5 poor agricultural
HH-Rural_EZ5Pmix	Household rural zone 5 poor mixed
HH-Rural_EZ5Pnagr	Household rural zone 5 poor non-agricultural
HH-Rural_EZ1NPagr	Household rural zone 1 non-poor agricultural
HH-Rural_EZ1NPmix	Household rural zone 1 non-poor mixed
HH-Rural_EZ1NPnagr	Household rural zone 1 non-poor non-agricultural
HH-Rural_EZ2NPagr	Household rural zone 2 non-poor agricultural
HH-Rural_EZ2NPmix	Household rural zone 2 non-poor mixed
HH-Rural_EZ2NPnagr	Household rural zone 2 non-poor non-agricultural
HH-Rural_EZ3NPagr	Household rural zone 3 non-poor agricultural
HH-Rural_EZ3NPmix	Household rural zone 3 non-poor mixed
HH-Rural_EZ3NPnagr	Household rural zone 3 non-poor non-agricultural
HH-Rural_EZ4NPagr	Household rural zone 4 non-poor agricultural
HH-Rural_EZ4NPmix	Household rural zone 4 non-poor mixed
HH-Rural_EZ4NPnagr	Household rural zone 4 non-poor non-agricultural
HH-Rural_EZ5NPagr	Household rural zone 5 non-poor agricultural
HH-Rural_EZ5NPmix	Household rural zone 5 non-poor mixed

Appendix B.3: Household accounts (continued)

Abbreviations	Descriptions
HH-Rural_EZ5NPnagr	Household rural zone 5 non-poor non-agricultural
HH-SmallurbanP	Household small urban poor
HH-BigurbanP	Household big urban poor
HH-SmallurbanNP	Household small urban non-poor
HH-BigurbanNP	Household big urban non-poor

Appendix B.4: Factor accounts

Appendix B.4.1: Labor accounts

Abbreviations	Descriptions
Agrm	Agricultural labor male
Agrf	Agricultural labor female
Admm	Administrative labor male
Admf	Administrative labor female
Profm	Professional labor male
Proff	Professional labor female
Unskm	Unskilled labor male
Unskf	Unskilled labor female
Skm	Skilled labor male
Skf	Skilled labor female

Appendix B.4.2: Non-labor factors

Abbreviations	Descriptions
Capital_Land_RuralEZ1P	Capital land for rural poor in zone 1
Capital_Land_RuralEZ1NP	Capital land for rural non-poor in zone 1
Capital_Land_RuralEZ2P	Capital land for rural poor in zone 2
Capital_Land_RuralEZ2NP	Capital land for rural non-poor in zone 2
Capital_Land_RuralEZ3P	Capital land for rural poor in zone 3
Capital_Land_RuralEZ3NP	Capital land for rural non-poor in zone 3
Capital_Land_RuralEZ4P	Capital land for rural poor in zone 4
Capital_Land_RuralEZ4NP	Capital land for rural non-poor in zone 4
Capital_Land_RuralEZ5P	Capital land for rural poor in zone 5
Capital_Land_RuralEZ5NP	Capital land for rural non-poor in zone 5
Capital_Livst_RuralEZ1P	Capital livestock for rural poor in zone 1
Capital_Livst_RuralEZ1NP	Capital livestock for rural non-poor in zone 1
Capital_Livst_RuralEZ2P	Capital livestock for rural poor in zone 2
Capital_Livst_RuralEZ2NP	Capital livestock for rural non-poor in zone 2
Capital_Livst_RuralEZ3P	Capital livestock for rural poor in zone 3
Capital_Livst_RuralEZ3NP	Capital livestock for rural non-poor in zone 3
Capital_Livst_RuralEZ4P	Capital livestock for rural poor in zone 4
Capital_Livst_RuralEZ4NP	Capital livestock for rural non-poor in zone 4
Capital_Livst_RuralEZ5P	Capital livestock for rural poor in zone 5
Capital_Livst_RuralEZ5NP	Capital livestock for rural non-poor in zone 5
Non_Agg_capital	Non-agricultural capital

Appendix B.5: Other accounts

Abbreviations	Descriptions
ENT	Enterprises
GOVT	Government
TotalMargin	Transport margins
DSTOC	Stock changes
KAP	Savings
ROW	Rest of the world

Appendix B.6: Tax accounts

Abbreviations	Descriptions
LandTx	Land use tax
CapGainTx	Capital gains tax
IntIncTax	Interest income tax
RentIncTx	Rental income tax
DivTx	Dividend tax
ProfitTx	Profit tax
AgIncTx	Income tax (agricultural)
HHIncTx	Income tax (personal)
OEntTx	Other direct taxes
Impsur	Surtax from import
ImpVAT	Value added tax from import
ImpEcsTx	Excise tax from import
ImpWTx	Import withholding tax
ImpDuty	Import tax
ServTx	Service tax
LocEcsTx	Domestic excise tax
LocalVAT	Domestic value added tax

Appendix C: Commodity, activity and income elasticities

Appendix C.1: Commodity elasticities (see appendix B.2 for the detailed list of commodities)

Commodities	Armington CES elasticity (sigma)	CET elasticity (omega)
Agricultural	2	2
Industrial	2	2
Services	2	2

Source: Author's compilation and adapted from Flaig (2014)

Appendix C.2: Activity elasticities (see appendix B.1 for the detailed list of activities)

Commodities	CES elasticities for output (sigmax)	CES Elasticities for value added (omega)
Agricultural	0.5	0.8
Industrial	0.5	0.8
Service	0.5	0.8

Source: Author's compilation and adapted from Flaig (2014)

Appendix C.3: Activity elasticities for the production nest

Labor	Elasticities
Aggregate labor	1.5
Skilled labor	4.0
Unskilled labor	4.0
Unskilled female	4.0
Unskilled male	6.0
Skilled female	6.0
Skilled male	6.0

Source: Author's compilation and adapted from Flaig (2014)

Appendix C.4: Income elasticities

Appendix C.4.1: Income elasticities for poor rural households' consumption of agricultural commodities

Commodities	HH-Rural_EZ1Pagr	HH-Rural_EZ1Pmix	HH-Rural_EZ1Pnagr	HH-Rural_EZ2Pagr	HH-Rural_EZ2Pmix	HH-Rural_EZ2nagr	HH-Rural-EZ3Pagr	HH-Rural_EZ3Pmix	HH-Rural_EZ3Pnagr	HH-Rural_EZ4Pagr	HH-Rural_EZ4Pmix	HH-Rural_EZ4Pnagr	HH-Rural_EZ5Pagr	HH-Rural_EZ5Pmix	HH-Rural_EZ5Pnagr
ctef	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
cbar	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
cwhea	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
cmaiz	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
csorg	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
cpul	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
cveg	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
coils	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
ccotts	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
ccane	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
cfruit	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
ctea	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
cchat	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
ccoff	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
censet	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
ccrop	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
cfiber	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
ccatt	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
cpoul	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
cmilk	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
ccott	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
caprod	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
cfors	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
cflower	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
cfish	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5

Source: Author's compilation based on Tafere et al. (2010)

Appendix C.4.2: Income elasticities for poor rural households' consumption of industrial commodities

Commodities	HH-Rural_EZ1Pagr	HH-Rural_EZ1Pmix	HH-Rural_EZ1Pnagr	HH-Rural_EZ2Pagr	HH-Rural_EZ2Pmix	HH-Rural_EZ2nagr	HH-Rural_EZ3Pagr	HH-Rural_EZ3Pmix	HH-Rural_EZ3Pnagr	HH-Rural_EZ4Pagr	HH-Rural_EZ4Pmix	HH-Rural_EZ4Pnagr	HH-Rural_EZ5Pagr	HH-Rural_EZ5Pmix	HH-Rural_EZ5Pnagr
ccoal	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
cngas	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
cmin	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
cmeat	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
cvprod	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
cdairy	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
csug	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
cgmill	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
cgmillserv	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
cfood	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
cbev	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
ctob	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
cmtea	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
cmtob	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
clcott	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
ctext	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
capar	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
cleath	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
cwood	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
cpaper	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
coilptrl	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
cfert	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
cchem	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
cminprod	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
cmetal	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3

Source: Author's compilation based on Tafere et al. (2010)

Appendix C.4.2: Income elasticities for poor rural households' consumption of industrial commodities (continued)

Commodities	HH-Rural_EZ1Pagr	HH-Rural_EZ1Pmix	HH-Rural_EZ1Pnagr	HH-Rural_EZ2Pagr	HH-Rural_EZ2Pmix	HH-Rural_EZ2nagr	HH-Rural_EZ3Pagr	HH-Rural_EZ3Pmix	HH-Rural_EZ3Pnagr	HH-Rural_EZ4Pagr	HH-Rural_EZ4Pmix	HH-Rural_EZ4Pnagr	HH-Rural_EZ5Pagr	HH-Rural_EZ5Pmix	HH-Rural_EZ5Pnagr
cmprod	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
cveh	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
celecq	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
cmach	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
comanu	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3

Source: Author's compilation based on Tafere et al. (2010)

Appendix C.4.3: Income elasticities for poor rural households' consumption of service commodities

Commodities	HH-Rural_EZ1Pagr	HH-Rural_E_Z1Pmix	HH-Rural_EZ1Pnagr	HH-Rural_EZ2Pagr	HH-Rural_EZ2Pmix	HH-Rural_EZ2nagr	HH-Rural_EZ3Pagr	HH-Rural_EZ3Pmix	HH-Rural_EZ3Pnagr	HH-Rural_EZ4Pagr	HH-Rural_EZ4Pmix	HH-Rural_EZ4Pnagr	HH-Rural_EZ5Pagr	HH-Rural_EZ5Pmix	HH-Rural_EZ5Pnagr
celect	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
cwater	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
ccons	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
ctrad	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
chotel	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
ctrans	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
ccomm	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
cfserv	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
cbserv	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
cpadmin	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
ceduc	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
cheal	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
coserv	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
crest	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
cwaterfet*	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
cfirewood*	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
cleisure*	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0

Source: Author's compilation based on Tafere et al. (2010)

***** Because of limited space, water fetching, firewood collection and leisure commodities per household group is not reported.

Appendix C.4.4: Income elasticities for non-poor rural households' consumption of agricultural commodities

Commodities	HH-Rural_EZ1NPagr	HH-Rural_EZ1NPmix	HH-Rural_EZ1NPnagr	HH-Rural_EZ2NPagr	HH-Rural_EZ2NPmix	HH-Rural_EZ2NPnagr	HH-Rural_EZ3NPagr	HH-Rural_EZ3NPmix	HH-Rural_EZ3NPnagr	HH-Rural_EZ4NPagr	HH-Rural_EZ4NPmix	HH-Rural_EZ4NPnagr	HH-Rural_EZ5NPagr	HH-Rural_EZ5NPmix	HH-Rural_EZ5NPnagr
ctef	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
cbar	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
cwhea	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
cmaiz	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
csorg	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
cpul	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
cveg	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
coils	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
ccotts	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
ccane	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
cfruit	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
ctea	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
cchat	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
ccoff	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
censet	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
ccrop	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
cfiber	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
ccatt	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
cpoul	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
cmilk	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
ccott	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
caprod	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
cfors	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
cflower	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
cfish	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5

Source: Author's compilation based on Tafere et al. (2010)

Appendix C.4.5: Income elasticities for non-poor rural households' consumption of industrial commodities

Commodities	HH-Rural_EZ1NPagr	HH-Rural_EZ1NPmix	HH-Rural_EZ1NPnagr	HH-Rural_EZ2NPagr	HH-Rural_EZ2NPmix	HH-Rural_EZ2NPnagr	HH-Rural_EZ3NPagr	HH-Rural_EZ3NPmix	HH-Rural_EZ3NPnagr	HH-Rural_EZ4NPagr	HH-Rural_EZ4NPmix	HH-Rural_EZ4NPnagr	HH-Rural_EZ5NPagr	HH-Rural_EZ5NPmix	HH-Rural_EZ5NPnagr
ccoal	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
cngas	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
cmin	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
cmeat	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
cvprod	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
cdairy	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
csug	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
cgmill	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
cgmillserv	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
cfood	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
cbev	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
ctob	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
cmtea	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
cmtob	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
clcott	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
ctext	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
capar	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
cleath	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
cwood	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
cpaper	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
coilptrl	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
cfert	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
cchem	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
cminprod	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
cmetal	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
cmprod	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3

Source: Author's compilation based on Tafere et al. (2010)

Appendix C.4.5: Income elasticities for non-poor rural households' consumption of industrial commodities (continued)

Commodities	HH-Rural_EZ1NPagr	HH-Rural_EZ1NPmix	HH-Rural_EZ1NPnagr	HH-Rural_EZ2NPagr	HH-Rural_EZ2NPmix	HH-Rural_EZ2NPnagr	HH-Rural_EZ3NPagr	HH-Rural_EZ3NPmix	HH-Rural_EZ3NPnagr	HH-Rural_EZ4NPagr	HH-Rural_EZ4NPmix	HH-Rural_EZ4NPnagr	HH-Rural_EZ5NPagr	HH-Rural_EZ5NPmix	HH-Rural_EZ5NPnagr
cveh	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
celecq	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
cmach	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
comanu	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3

Source: Author's compilation based on Tafere et al. (2010)

Appendix C.4.6: Income elasticities for non-poor rural households' consumption of service commodities

Commodities	HH-Rural_EZ1NPagr	HH-Rural_EZ1NPmix	HH-Rural_EZ1NPnagr	HH-Rural_EZ2NPagr	HH-Rural_EZ2NPmix	HH-Rural_EZ2NPnagr	HH-Rural_EZ3NPagr	HH-Rural_EZ3NPmix	HH-Rural_EZ3NPnagr	HH-Rural_EZ4NPagr	HH-Rural_EZ4NPmix	HH-Rural_EZ4NPnagr	HH-Rural_EZ5NPagr	HH-Rural_EZ5NPmix	HH-Rural_EZ5NPnagr
celect	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
cwater	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
ccons	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
ctrad	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
chotel	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
ctrans	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
ccomm	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
cfserv	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
cbserv	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
cpadmin	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
ceduc	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
cheal	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
coserv	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
crest	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
cwaterfet*	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
cfirewood*	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
cleisure*	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0

Source: Author's compilation based on Tafere et al. (2010)

***** Because of limited space, each of water fetching, firewood collection and leisure commodities per household group is not reported.

Appendix C.4.7: Income elasticities for urban households' consumption of agricultural commodities

Commodities	HH-SmallurbanP	HH-BigurbanP	HH-SmallurbanNP	HH-BigurbanNP
ctef	1.1	1.1	1.1	1.1
cbar	0.3	0.3	0.3	0.3
cwhea	0.4	0.4	0.4	0.4
cmaiz	0.6	0.6	0.6	0.6
csorg	0.6	0.6	0.6	0.6
cpul	0.9	0.9	0.9	0.9
cveg	0.9	0.9	0.9	0.9
coils	0.9	0.9	0.9	0.9
ccotts	0.9	0.9	0.9	0.9
ccane	1.0	1.0	1.0	1.0
cfruit	0.9	0.9	0.9	0.9
ctea	0.9	0.9	0.9	0.9
cchat	0.9	0.9	0.9	0.9
ccoff	0.9	0.9	0.9	0.9
censet	0.9	0.9	0.9	0.9
ccrop	0.9	0.9	0.9	0.9
cfiber	1.2	1.2	1.2	1.2
ccatt	1.2	1.2	1.2	1.2
cpoul	1.2	1.2	1.2	1.2
cmilk	1.2	1.2	1.2	1.2
ccott	1.2	1.2	1.2	1.2
caprod	1.2	1.2	1.2	1.2
cfors	1.2	1.2	1.2	1.2
cflower	1.2	1.2	1.2	1.2
cfish	0.1	0.1	0.1	0.1

Source: Author's compilation based on Tafere et al. (2010)

Appendix C.4.8: Income elasticities for urban households' consumption of industrial commodities

Commodities	HH-SmallurbanP	HH-BigurbanP	HH-SmallurbanNP	HH-BigurbanNP
ccoal	1.3	1.3	1.3	1.3
cngas	1.3	1.3	1.3	1.3
cmin	1.3	1.3	1.3	1.3
cmeat	1.2	1.2	1.2	1.2
cvprod	0.9	0.9	0.9	0.9
cdairy	1.2	1.2	1.2	1.2
csug	1.0	1.0	1.0	1.0
cgmill	0.8	0.8	0.8	0.8
cgmillserv	0.8	0.8	0.8	0.8
cfood	0.5	0.5	0.5	0.5
cbev	0.1	0.1	0.1	0.1
ctob	1.2	1.2	1.2	1.2
cmtea	1.2	1.2	1.2	1.2
cmtob	1.2	1.2	1.2	1.2
clcott	0.8	0.8	0.8	0.8
ctext	0.7	0.7	0.7	0.7
capar	0.7	0.7	0.7	0.7
cleath	1.2	1.2	1.2	1.2
cwood	0.3	0.3	0.3	0.3
cpaper	0.3	0.3	0.3	0.3
coilptrl	1.3	1.3	1.3	1.3
cfert	1.3	1.3	1.3	1.3
cchem	1.3	1.3	1.3	1.3
cminprod	1.3	1.3	1.3	1.3
cmetal	1.3	1.3	1.3	1.3
cmprod	1.3	1.3	1.3	1.3
cveh	1.3	1.3	1.3	1.3

Source: Author's compilation based on Tafere et al. (2010)

Appendix C.4.8: Income elasticities for urban households' consumption of industrial commodities (continued)

Commodities	HH-SmallurbanP	HH-BigurbanP	HH-SmallurbanNP	HH-BigurbanNP
celecq	1.3	1.3	1.3	1.3
cmach	1.3	1.3	1.3	1.3
comanu	1.3	1.3	1.3	1.3

Source: Author's compilation based on Tafere et al. (2010)

Appendix C.4.9: Income elasticities for urban households' consumption of service commodities

Commodities	HH-SmallurbanP	HH-BigurbanP	HH-SmallurbanNP	HH-BigurbanNP
celect	1.4	1.4	1.4	1.4
cwater	1.4	1.4	1.4	1.4
ccons	1.4	1.4	1.4	1.4
ctrad	1.4	1.4	1.4	1.4
chotel	1.4	1.4	1.4	1.4
ctrans	1.4	1.4	1.4	1.4
ccomm	1.4	1.4	1.4	1.4
cfserv	1.4	1.4	1.4	1.4
cbserv	1.4	1.4	1.4	1.4
cpadmin	1.4	1.4	1.4	1.4
ceduc	1.4	1.4	1.4	1.4
cheal	1.4	1.4	1.4	1.4
coserv	1.4	1.4	1.4	1.4
crest	1.4	1.4	1.4	1.4
cwaterfet*	0.8	0.8	0.8	0.8
cfirewood*	0.8	0.8	0.8	0.8
cleisure*	2.0	2.0	2.0	2.0

Source: Author's compilation based on Tafere et al. (2010)

* Because of limited space, each of water fetching, firewood collection and leisure commodities per household group is not reported.

Appendix C.4.10: Frisch elasticities

Households	Frisch elasticities
HH-Rural_EZ1Pagr	-1.6
HH-Rural_EZ1Pmix	-1.6
HH-Rural_EZ1Pnagr	-1.6
HH-Rural_EZ2Pagr	-1.6
HH-Rural_EZ2Pmix	-1.6
HH-Rural_EZ2nagr	-1.6
HH-Rural_EZ3Pagr	-1.6
HH-Rural_EZ3Pmix	-1.6
HH-Rural_EZ3Pnagr	-1.6
HH-Rural_EZ4Pagr	-1.6
HH-Rural_EZ4Pmix	-1.6
HH-Rural_EZ4Pnagr	-1.6
HH-Rural_EZ5Pagr	-1.6
HH-Rural_EZ5Pmix	-1.6
HH-Rural_EZ5Pnagr	-1.6
HH-Rural_EZ1NPagr	-1.3
HH-Rural_EZ1NPmix	-1.3
HH-Rural_EZ1NPnagr	-1.3
HH-Rural_EZ2NPagr	-1.3
HH-Rural_EZ2NPmix	-1.3
HH-Rural_EZ2NPnagr	-1.3
HH-Rural_EZ3NPagr	-1.3
HH-Rural_EZ3NPmix	-1.3
HH-Rural_EZ3NPnagr	-1.3
HH-Rural_EZ4NPagr	-1.3
HH-Rural_EZ4NPmix	-1.3
HH-Rural_EZ4NPnagr	-1.3
HH-Rural_EZ5NPagr	-1.3
HH-Rural_EZ5NPmix	-1.3
HH-Rural_EZ5NPnagr	-1.3
HH-SmallurbanP	-1.6
HH-BigurbanP	-1.6
HH-SmallurbanNP	-1.3
HH-BigurbanNP	-1.3

Source: Author’s compilation and adapted from Flaig (2014)

Appendix D: Commodity mapping set

Aggregate commodities	Commodities
HPHC food commodities	ctefo
	cbaro
	cwheao
	cmaizo
	csorgo
	cpulo
	cvego
	coilso
	ccaneo
	cfruito
	cchato
	ccoffo
	censeto
	ccropo
	cpoulo
	cmilko
	ccotto
	caprodo
	cforso
	cfisho
	cmeato
	cdairyo
HPHC non-food commodities	cresto
Water fetching	cwaterfet*
Firewood collection	cfirewood*
Leisure	cleisure*
Market food	ctef
	cbar
	cwhea
	cmaiz
	csorg
	cpul
	cveg
	coils
	ccotts
	ccane
	cfruit

Source: Author's compilation

* Because of limited space, water fetching, firewood collection and leisure commodities per household group is not reported here.

Appendix D: Commodity mapping set (continued)

Aggregate commodities	Commodities
Market food	ctea
	cchat
	ccoff
	censet
	ccrop
	cfiber
	ccatt
	cpoul
	cmilk
	ccott
	caprod
	cfors
	cflower
	cfish
	cmeat
	cvprod
	cdairy
	csug
	cfood
	cbev
Market non-food	celect
	cwater
	ccons
	ctrad
	chotel
	ctrans
	ccomm
	cfserv
	cbserv
	cpadmin
	ceduc
	cheal
	coserv
	crest
	ccoal
	cngas
	cmin
	cgmill
	cgmillserv

Source: Author's compilation

Appendix D: Commodity mapping set (continued)

Aggregate commodities	Commodities
	capar
	ctext
	cpaper
	cwood
	cleath
Market non-food	coilptrl
	cfert
	cchem
	cminprod
	cmetal
	cmprod
	cveh
	celecq
	cmach

Source: Author’s compilation

Appendix E: Sensitivity of model results to changes in the income elasticities of leisure

Appendix E.1: Sensitivity of labor demand and production (percentage)

Labor demand by activities	Eyleisure*=2	Eyleisure=3	Eyleisure=4
Agriculture	1.61	1.16	0.82
Industry	0.88	1.07	1.28
Service	0.54	0.81	1.10
Water fetching	-21.65	-23.56	-24.91
Firewood collection	-22.35	-24.13	-25.39
Leisure	4.62	5.63	6.34
Production by activities	**Eyleisure=2**	**Eyleisure=3**	**Eyleisure=4**
Agriculture	1.21	0.89	0.65
Industry	0.59	0.61	0.63
Service	0.42	0.48	0.55
Water fetching	17.53	14.66	12.64
Firewood collection	16.48	13.81	11.91
Leisure	4.62	5.63	6.34

Source: Author’s computation based on model results

*Eyleisure: refers to the income elasticity of leisure

Appendix E.2: Sensitivity of welfare (EV/base income) to changes in the income elasticities of leisure

Households	Eyleisure=2	Eyleisure=3	Eyleisure=4
HH-Rural_EZ1Pagr	6.88	6.82	6.80
HH-Rural_EZ1Pmix	6.88	6.82	6.80
HH-Rural_EZ1Pnagr	6.88	6.82	6.80
HH-Rural_EZ2Pagr	4.88	4.89	4.91
HH-Rural_EZ2Pmix	4.88	4.89	4.91
HH-Rural_EZ2nagr	4.88	4.89	4.91
HH-Rural_EZ3Pagr	5.35	5.34	5.34
HH-Rural_EZ3Pmix	5.35	5.34	5.34
HH-Rural_EZ3Pnagr	5.35	5.34	5.34
HH-Rural_EZ4Pagr	4.84	4.85	4.86
HH-Rural_EZ4Pmix	4.98	4.96	4.95
HH-Rural_EZ4Pnagr	4.98	4.96	4.95
HH-Rural_EZ5Pagr	6.94	6.76	6.64
HH-Rural_EZ5Pmix	6.94	6.76	6.64
HH-Rural_EZ5Pnagr	6.94	6.76	6.64
HH-Rural_EZ1NPagr	5.16	5.12	5.10
HH-Rural_EZ1NPmix	5.16	5.12	5.10
HH-Rural_EZ1NPnagr	5.16	5.12	5.10
HH-Rural_EZ2NPagr	3.19	3.16	3.13
HH-Rural_EZ2NPmix	3.19	3.16	3.13
HH-Rural_EZ2NPnagr	3.19	3.16	3.13
HH-Rural_EZ3NPagr	3.86	3.83	3.82
HH-Rural_EZ3NPmix	3.86	3.83	3.82
HH-Rural_EZ3NPnagr	3.76	3.75	3.74
HH-Rural_EZ4NPagr	3.46	3.41	3.37
HH-Rural_EZ4NPmix	3.46	3.41	3.37
HH-Rural_EZ4NPnagr	3.46	3.41	3.37
HH-Rural_EZ5NPagr	5.69	5.52	5.40
HH-Rural_EZ5NPmix	5.69	5.52	5.40
HH-Rural_EZ5NPnagr	5.69	5.52	5.40
HH-SmallurbanP	1.50	1.31	1.12
HH-BigurbanP	1.91	1.85	1.80
HH-SmallurbanNP	-3.75	-4.03	-4.28
HH-BigurbanNP	-1.54	-1.72	-1.89

Source: Author's computation based on model results

Appendix E.3: Sensitivity of macroeconomic effects (percentage) to changes in the income elasticities of leisure

	Eyleisure=2	Eyleisure=3	Eyleisure=4
Absorption	2.76	2.64	2.67
Import	1.50	1.43	1.38
GDP from expenditure	2.62	2.56	2.52
Total domestic production	2.00	1.96	1.93

Source: Author's computation based on model results

Appendix F: Simulated changes (percentage) in the price of commodities

Scenario one	PQS	PM	PE
HPHC food	1.76		
HPHC non-food	0.76		
Market food	-0.12	-0.40	-0.31
Market non-food	-0.35	-0.39	-0.29
Scenario two	**PQS**	**PM**	**PE**
HPHC food	2.03		
HPHC non-food	0.54		
Market food	-0.28	-0.57	-0.86
Market non-food	-0.80	-0.67	-0.93
Scenario three	**PQS**	**PM**	**PE**
HPHC food	1.98		
HPHC non-food	0.92		
Market food	-0.42	-0.90	-1.10
Market non-food	-0.96	-0.90	-1.01

Source: Author's computation based on model results

Appendix G: Changes in taxes as percentage of income and changes in consumption expenditure

Appendix G.1: Change in taxes expressed as percentage of income

Households	Scenario one	Scenario two	Scenario three
HH-Rural_EZ1Pagr	0.07	0.07	0.06
HH-Rural_EZ1Pmix	0.05	0.05	0.05
HH-Rural_EZ1Pnagr	0.05	0.06	0.05
HH-Rural_EZ2Pagr	0.01	0.01	0.01
HH-Rural_EZ2Pmix	0.01	0.01	0.01
HH-Rural_EZ2Nagr	0.01	0.01	0.01
HH-Rural_EZ3Pagr	0.02	0.02	0.02
HH-Rural_EZ3Pmix	0.01	0.01	0.01
HH-Rural_EZ3Pnagr	0.02	0.02	0.02
HH-Rural_EZ4Pagr	0.01	0.01	0.01
HH-Rural_EZ4Pmix	0.01	0.01	0.01
HH-Rural_EZ4Pnagr	0.01	0.01	0.01
HH-Rural_EZ5Pagr	0.00	0.00	0.00
HH-Rural_EZ5Pmix	0.00	0.00	0.00
HH-Rural_EZ5Pnagr	0.00	0.00	0.00
HH-Rural_EZ1NPagr	0.04	0.04	0.04
HH-Rural_EZ1NPmix	0.08	0.08	0.08
HH-Rural_EZ1NPnagr	0.12	0.12	0.12
HH-Rural_EZ2NPagr	0.00	0.00	0.00
HH-Rural_EZ2NPmix	0.00	0.01	0.00
HH-Rural_EZ2NPnagr	0.01	0.01	0.01
HH-Rural_EZ3NPagr	0.00	0.00	0.00
HH-Rural_EZ3NPmix	0.01	0.01	0.01
HH-Rural_EZ3NPnagr	0.02	0.02	0.01
HH-Rural_EZ4NPagr	0.00	0.00	0.00
HH-Rural_EZ4NPmix	0.01	0.01	0.01
HH-Rural_EZ4NPnagr	0.01	0.01	0.01
HH-Rural_EZ5NPagr	0.00	0.00	0.00
HH-Rural_EZ5NPmix	0.00	0.00	0.00
HH-Rural_EZ5NPnagr	0.00	0.00	0.00
HH-SmallurbanP	0.07	0.07	0.06
HH-BigurbanP	0.05	0.05	0.05
HH-SmallurbanNP	0.82	0.84	0.80
HH-BigurbanNP	0.52	0.54	0.51

Source: Author’s computation based on model results

Appendix G.2: Changes (percentage) in household consumption expenditure

Households	Scenario one	Scenario two	Scenario three
HH-Rural_EZ1Pagr	1.59	1.28	1.75
HH-Rural_EZ1Pmix	1.59	1.28	1.75
HH-Rural_EZ1Pnagr	1.59	1.28	1.75
HH-Rural_EZ2Pagr	2.02	1.71	2.17
HH-Rural_EZ2Pmix	2.02	1.71	2.17
HH-Rural_EZ2nagr	2.02	1.71	2.17
HH-Rural_EZ3Pagr	2.02	1.71	2.16
HH-Rural_EZ3Pmix	2.02	1.71	2.16
HH-Rural_EZ3Pnagr	2.02	1.71	2.16
HH-Rural_EZ4Pagr	1.92	1.63	2.07
HH-Rural_EZ4Pmix	1.92	1.63	2.07
HH-Rural_EZ4Pnagr	1.92	1.63	2.07
HH-Rural_EZ5Pagr	1.41	1.13	1.57
HH-Rural_EZ5Pmix	1.41	1.13	1.57
HH-Rural_EZ5Pnagr	1.41	1.13	1.57
HH-Rural_EZ1NPagr	1.56	1.32	1.73
HH-Rural_EZ1NPmix	1.56	1.32	1.73
HH-Rural_EZ1NPnagr	1.56	1.32	1.73
HH-Rural_EZ2NPagr	1.50	1.27	1.67
HH-Rural_EZ2NPmix	1.50	1.27	1.67
HH-Rural_EZ2NPnagr	1.50	1.27	1.67
HH-Rural_EZ3NPagr	1.63	1.41	1.79
HH-Rural_EZ3NPmix	1.63	1.41	1.79
HH-Rural_EZ3NPnagr	1.63	1.41	1.79
HH-Rural_EZ4NPagr	1.52	1.31	1.68
HH-Rural_EZ4NPmix	1.52	1.31	1.68
HH-Rural_EZ4NPnagr	1.52	1.31	1.68
HH-Rural_EZ5NPagr	1.24	1.02	1.41
HH-Rural_EZ5NPmix	1.24	1.02	1.41
HH-Rural_EZ5NPnagr	1.24	1.02	1.41
HH-SmallurbanP	1.17	1.02	1.33
HH-BigurbanP	1.05	0.90	1.20
HH-SmallurbanNP	-3.93	-4.14	-3.67
HH-BigurbanNP	-1.87	-2.20	-1.74

Source: Author’s computation based on model results

Appendix H: Sensitivity of model results to changes in the income elasticities of demand for market commodities

Appendix H.1: Sensitivity of demand (percentage) to changes in the income elasticities of demand for market commodities

50% decreases in income elasticities			
Commodities	**Scenario one**	**Scenario two**	**Scenario three**
HPHC food	0.46	0.39	0.54
HPHC non-food	0.64	0.57	0.68
Market food	0.16	0.10	0.21
Market non-food	0.15	0.02	0.28
50% increases in income elasticities			
Commodities	**Scenario one**	**Scenario two**	**Scenario three**
HPHC food	0.19	0.16	0.24
HPHC non-food	0.25	0.13	0.46
Market food	0.38	0.29	0.45
Market non-food	0.47	0.29	0.68
Original results for comparison			
Commodities	**Scenario one**	**Scenario two**	**Scenario three**
HPHC food	0.26	0.19	0.34
HPHC non-food	0.31	0.15	0.51
Market food	0.29	0.21	0.36
Market non-food	0.33	0.24	0.52

Source: Author's computation based on model results

Appendix H.2: Sensitivity of production (percentage) to changes in the income elasticities of demand for market commodities

50% decreases in income elasticities			
Sectors	**Scenario one**	**Scenario two**	**Scenario three**
Agriculture	0.05	0.06	0.10
Service	0.54	0.70	0.80
Industry	0.90	0.15	1.12
50% increases in income elasticities			
Sectors	**Scenario one**	**Scenario two**	**Scenario three**
Agriculture	0.08	0.09	0.21
Service	0.59	0.79	0.88
Industry	1.18	0.81	1.45
Original results for comparison			
Economic sectors	**Scenario one**	**Scenario two**	**Scenario three**
Agriculture	0.07	0.08	0.15
Service	0.57	0.77	0.83
Industry	1.06	0.79	1.36

Source: Author’s computation based on model results

Appendix H.3: Sensitivity of welfare (EV/base income) to changes in the income elasticities of demand for market commodities

Appendix H.3.1: Sensitivity of welfare (50% decreases in income elasticities)

Households	Scenario one	Scenario two	Scenario three
HH-Rural_EZ1Pagr	0.82	0.73	0.82
HH-Rural_EZ1Pmix	0.82	0.73	0.82
HH-Rural_EZ1Pnagr	0.82	0.73	0.82
HH-Rural_EZ2Pagr	1.30	1.18	1.32
HH-Rural_EZ2Pmix	1.30	1.18	1.32
HH-Rural_EZ2nagr	1.30	1.18	1.32
HH-Rural_EZ3Pagr	1.29	1.19	1.30
HH-Rural_EZ3Pmix	1.29	1.19	1.30
HH-Rural_EZ3Pnagr	1.29	1.19	1.30
HH-Rural_EZ4Pagr	1.20	1.11	1.22
HH-Rural_EZ4Pmix	1.20	1.11	1.22
HH-Rural_EZ4Pnagr	1.20	1.11	1.22
HH-Rural_EZ5Pagr	0.73	0.67	0.76
HH-Rural_EZ5Pmix	0.73	0.67	0.76
HH-Rural_EZ5Pnagr	0.73	0.67	0.76
HH-Rural_EZ1NPagr	0.94	0.88	0.99
HH-Rural_EZ1NPmix	0.94	0.88	0.99
HH-Rural_EZ1NPnagr	0.94	0.88	0.99
HH-Rural_EZ2NPagr	0.98	0.91	1.06
HH-Rural_EZ2NPmix	0.98	0.91	1.06
HH-Rural_EZ2NPnagr	0.98	0.91	1.06
HH-Rural_EZ3NPagr	1.14	1.08	1.20
HH-Rural_EZ3NPmix	1.14	1.08	1.20
HH-Rural_EZ3NPnagr	1.14	1.08	1.20
HH-Rural_EZ4NPagr	1.05	0.99	1.12
HH-Rural_EZ4NPmix	1.05	0.99	1.12
HH-Rural_EZ4NPnagr	1.05	0.99	1.12
HH-Rural_EZ5NPagr	0.67	0.64	0.74
HH-Rural_EZ5NPmix	0.67	0.64	0.74
HH-Rural_EZ5NPnagr	0.67	0.64	0.74
HH-SmallurbanP	0.87	0.88	0.92
HH-BigurbanP	0.39	0.54	0.42
HH-SmallurbanNP	-3.06	-3.18	-2.87
HH-BigurbanNP	-1.26	-1.40	-1.16

Source: Author’s computation based on model results

Appendix H.3.2: Sensitivity of welfare (50% increases in income elasticities)

Households	Scenario one	Scenario two	Scenario three
HH-Rural_EZ1Pagr	0.82	0.74	0.83
HH-Rural_EZ1Pmix	0.82	0.74	0.83
HH-Rural_EZ1Pnagr	0.82	0.74	0.83
HH-Rural_EZ2Pagr	1.31	1.19	1.34
HH-Rural_EZ2Pmix	1.31	1.19	1.34
HH-Rural_EZ2nagr	1.31	1.19	1.34
HH-Rural_EZ3Pagr	1.30	1.19	1.32
HH-Rural_EZ3Pmix	1.30	1.19	1.32
HH-Rural_EZ3Pnagr	1.30	1.19	1.32
HH-Rural_EZ4Pagr	1.22	1.12	1.25
HH-Rural_EZ4Pmix	1.22	1.12	1.25
HH-Rural_EZ4Pnagr	1.22	1.12	1.25
HH-Rural_EZ5Pagr	0.75	0.69	0.79
HH-Rural_EZ5Pmix	0.75	0.69	0.79
HH-Rural_EZ5Pnagr	0.75	0.69	0.79
HH-Rural_EZ1NPagr	0.97	0.90	1.02
HH-Rural_EZ1NPmix	0.97	0.90	1.02
HH-Rural_EZ1NPnagr	0.97	0.90	1.02
HH-Rural_EZ2NPagr	1.03	0.95	1.11
HH-Rural_EZ2NPmix	1.03	0.95	1.11
HH-Rural_EZ2NPnagr	1.03	0.95	1.11
HH-Rural_EZ3NPagr	1.17	1.10	1.24
HH-Rural_EZ3NPmix	1.17	1.10	1.24
HH-Rural_EZ3NPnagr	1.17	1.10	1.24
HH-Rural_EZ4NPagr	1.09	1.02	1.17
HH-Rural_EZ4NPmix	1.09	1.02	1.17
HH-Rural_EZ4NPnagr	1.09	1.02	1.17
HH-Rural_EZ5NPagr	0.71	0.67	0.79
HH-Rural_EZ5NPmix	0.71	0.67	0.79
HH-Rural_EZ5NPnagr	0.71	0.67	0.79
HH-SmallurbanP	0.84	0.85	0.89
HH-BigurbanP	0.45	0.57	0.53
HH-SmallurbanNP	-3.03	-3.15	-2.82
HH-BigurbanNP	-1.21	-1.36	-1.10

Source: Author’s computation based on model results

Appendix H.4: Sensitivity of macroeconomic effects (percentage) to changes in the income elasticities of demand for market commodities

50% decreases in income elasticities			
Macroeconomic indicators	**Scenario one**	**Scenario two**	**Scenario three**
GDP	0.25	0.14	0.36
Absorption	0.70	0.60	0.80
Total domestic production	0.45	0.47	0.64
Import demand	1.47	1.39	1.70

50% increases in income elasticities			
Macroeconomic indicators	**Scenario one**	**Scenario two**	**Scenario three**
GDP	0.26	0.14	0.37
Absorption	0.71	0.61	0.81
Total domestic production	0.45	0.48	0.65
Import demand	1.62	1.54	1.88

Original results for comparisons			
Macroeconomic indicators	**Scenario one**	**Scenario two**	**Scenario three**
GDP	0.25	0.14	0.37
Absorption	0.71	0.61	0.82
Total domestic production	0.45	0.47	0.65
Import demand	1.55	1.47	1.82

Source: Author's computation based on model results