Time use for Home Activities, Market Activities and Leisure in Ethiopia: Economy-wide effects of improved efficiency

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Table of Contents

ABSTRACT

Water fetching and firewood collection are among home activities which are part of the daily routine of many households in rural Ethiopia. Households spend large amounts of time for collecting water and firewood. Furthermore, water fetchers and firewood collectors are mostly agricultural laborers in Ethiopia. Fetching water and firewood reduce labor available for market related activities such as agriculture which affects productivity of these sectors negatively. Better access to water and energy services is expected to release labor for market related activities which can have economy wide impacts. This study investigates the economy wide effects of improved efficiency of water fetching and firewood collection activities. The study uses the 2004/05 Social Accounting Matrix (SAM) of Ethiopia which is updated and adjusted for the purpose of this study. The SAM is modified to account for a detailed representation of water fetching, firewood collection and leisure activities and commodities. Distinct water fetching, firewood collection and leisure activities are added to the SAM in accordance with household classification.

The simulation scenario is an increase in the Total Factor Productivity (TFP) of both water fetching and firewood collection activities due to better access to water and energy services. In the same scenario, government's deficit is increased to finance the cost of water and energy infrastructure. The simulation results indicate that employment of labour in agriculture, industry and service activities increased as a result of relocating the released labour from water fetching and firewood collection. This stimulates production in the destination sectors that leads to higher total domestic production and overall welfare is improved. Macro-economic indicators including GDP, total absorptions and export supply also increased as a result of better access to water and energy services.

1. Introduction

Access to water and household energy are among the development challenges of developing countries. Approximately, 663 million peoples around the world lack access to improved drinking water; out of this 50% live in Sub-Saharan Africa. The target of the millennium development goal (MDG) to reduce the proportion of population without sustainable access to drinking water by halve between 1990 and 2015 is unachievable by most of Sub-Saharan Africa countries but there are some ongoing positive changes. Ethiopia is among one of the countries that successfully achieved this target. During 1990 only 13% of Ethiopian populations has access to improved water but in 2015 half of the population is able to get improved water sources (WHO and UNICEF, 2015).

However, the majority of Ethiopian households are unable to access drinking water in their neighborhood. It is only 12% of Ethiopian populations have access to piped water (WHO and UNICEF, 2015). The main sources of drinking water for Ethiopian households are public standpipe, protected/unprotected dug well/spring, ponds, lakes, river, etc (WHO and UNICEF, 2010). These sources of water are usually located far from the neighborhood of the household. The majority of Ethiopian households often spend several hours on a daily basis for collecting drinking water from the remote sources. For instance, 16% and 34% of urban and rural household respectively on average travel between 1 to 2 hours per trip for water fetching. In rural areas of Ethiopia, household spend a longer hours for fetching water. For example, 10% of rural household on average travel more than 2 hours per trip for collecting water (see Figure 1).

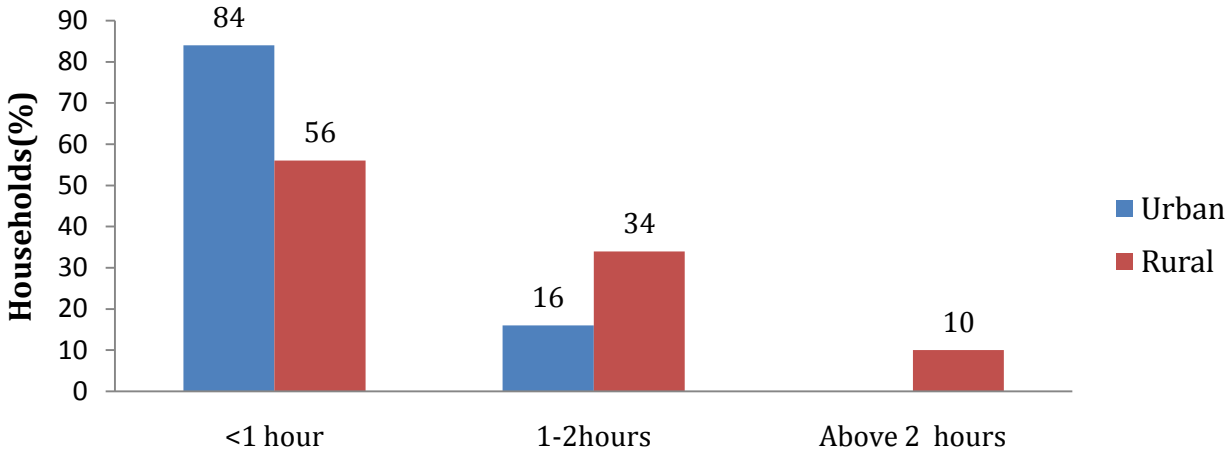

Figure 1: Ethiopian household by average water fetching time per trip

Source: Central Statistical Agency of Ethiopia (2014)

Ethiopia is also a country where the majority of populations have limited access to electricity. More than 75% of Ethiopian populations live without access to electricity. Nearly all rural households and 80% of urban households of Ethiopia depend on biomass fuel for cooking (OECD/IEA, 2014). Biomass fuel is sourced from firewood, animal dung and crop residue. The majority of households use traditional cooking stove which is less energy efficient. Furthermore, due to underdeveloped road infrastructure and deforestation, households 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 trip to collect firewood respectively (see Figure 2).

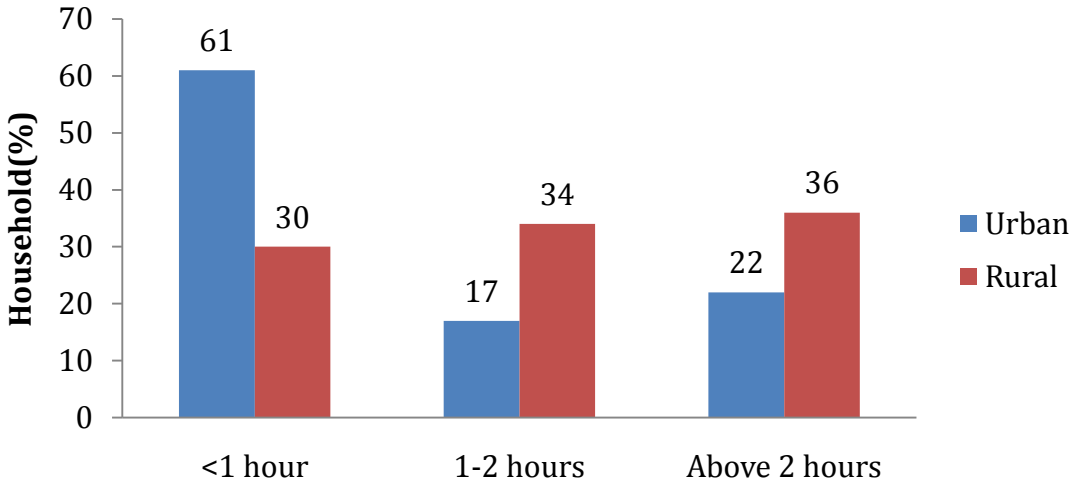

Figure 2: Ethiopian household by average firewood collection time per trip

Source: Central Statistical Agency of Ethiopia(2014)

Therefore, Ethiopian household allocates significant quantity of labor for water fetching and firewood collection activities. Furthermore, water fetchers and firewood collectors are usually agricultural laborers in Ethiopia. Particularly, fetching water and firewood reduces labor time available for marketed sectors which adversely affects productivity of these sectors. The times spend for fetching water and firewood can be significantly minimized through better access to water and household energy (e.g. improved stove). The released labor from water and firewood collection can be partly reallocated to marketed activities or partly reallocated to leisure. Labor reallocated to marketed activities would have tremendous economy wide implication. An improved efficiency of water fetching and firewood collection activities can be potentially attained via public expenditure on water infrastructure and household energy saving technologies. The objective of this study is to investigate and identify economy wide effects of improved efficiency of water fetching and firewood collection activities.

The study uses the 2004/05 Social Accounting Matrix (SAM) of Ethiopia which is updated and adjusted for the purpose of this study. The 2004/05 SAM is modified to account for a detailed representation of water fetching, firewood collection and leisure activities and commodities. This study applies a single country Computable General Equilibrium (CGE) model, namely STAGE (Mcdonald, 2007) to the updated SAM of Ethiopia. The simulation scenario run is 50% increase in the Total Factor Productivity (TFP) of both water fetching and firewood collection activities in response to better access to water and energy services. In the same scenario, government deficit is increased by 10% to finance the cost of expanding water and energy infrastructure.

The rest of the paper is organized as follows; the second section presents data and model, the third section reports simulation results and discussion and the last section presents the conclusion.

2. Data and Model

2.1 Data

This study uses the 2004/05 Social Accounting Matrix (SAM) of Ethiopia (Tebekew et al., 2009). For the purpose of this study, the SAM is updated and adjusted to account for a detailed representation of water fetching, firewood collection and leisure activities and commodities. Since water fetching and firewood collection are performed by households, distinct water fetching and firewood collection activities are added to the SAM in accordance with household classification. Following the approach developed by Fontana & Wood (2000), a separate activity and commodity accounts are created for leisure. Since leisure is consumed by households, leisure activities are added to the SAM in accordance with household classification. Furthermore, distinct commodity accounts are also created for water fetching, firewood collection and leisure. Transactions for water fetching, firewood collection and leisure in the SAM are computed based on the value of labor time allocated to these activities. The values of labor time spend for water fetching, firewood collection and leisure activities are computed based on the shadow wage of labor. The updated micro-SAM has the following typical features. First, the SAM distinguishes 199 activities and 95 commodities. Second, there are 34 representative household groups which are categorized by agro-ecological zones, poverty status and source of non-agricultural income. Third, there are 10 labor categories which are classified by gender and occupations and 21 other factors of production such as capital and land which are differentiated by agro-ecological zones. Fourth, the SAM also has 17

tax accounts and other core accounts such as government, investment and the rest of the world.

2.2 Model

This study applies STAGE Computable General Equilibrium (CGE) model (Mcdonald, 2007) to the updated SAM of Ethiopia. STAGE is a single country CGE model. It is a social accounting matrix (SAM) based CGE model which has linear and non-linear relationships that govern the behavior of agents in the model.
It was intended to modify the final demand system of the household and introduce labor-leisure trade off in the model. The basic idea was to introduce two levels nesting in the final demand system of the household. In the upper nest, household consume aggregate commodities and leisure which are aggregated by CES function. On the other hand, in the lower nest, household consume aggregate commodities which are also CES combination of water fetching and firewood collection and all other commodities. Unfortunately, due to time constraints during paper submission, we can't able to include the modified household demand system in this paper. Therefore, this paper sticks to the linear expenditure system (LES) of the standard model for modeling the final demand system of the household.

For the purpose of this study, domestic production is modified to accommodate the four level production process (see Figure 3). In the first level of production nesting, aggregate intermediate inputs and aggregate value added are combined using CES technology to produce total output. In the second level of production nesting, leontief technology combines aggregate intermediate inputs while aggregate value added (land, labor and capital) are aggregated by CES function which is depicted in Figure 3. In the third level of production nesting, aggregate skilled and unskilled labors are combined by CES technology to form aggregate labor which allows substitution possibility between skilled and unskilled labor. In the fourth level, skilled female and male labors are combined by CES technology to form aggregate skilled labors which allows substitution possibility between female and male in the skilled labor categories. In the same level of production nesting, unskilled female and male labors are combined by CES technology to form aggregate unskilled labor which also allows substitution of male and female in the unskilled labor categories. The model is solved using General Algebraic Modeling System (GAMS) and adapted to use an updated SAM of Ethiopia.

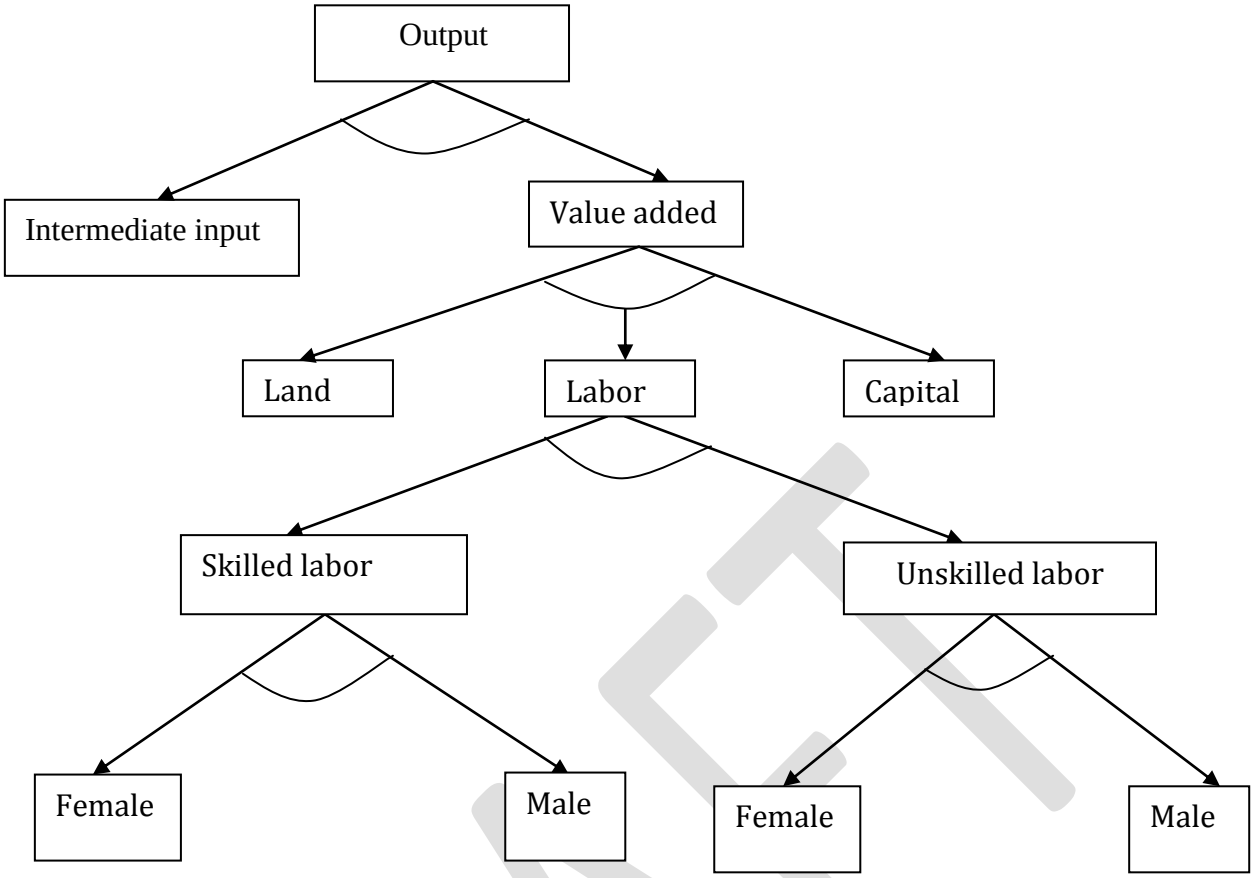

Figure 3: Production nesting

Source: Own compilations

3. Simulations and Results

3.1 Simulation scenarios

This study analyses the scenario of increase TFP of water fetching and firewood collection activities due to better access to water and energy services. In the same scenario, deficit of the government is increased to finance the cost of constructing water and energy infrastructure. The study examines the impact on labor reallocation and domestic production in response to higher TFP of fetching water and firewood. Furthermore, the effects on household's welfare and macroeconomic indicators are also investigated.

3.1.1 Increase TFP of water fetching and firewood collection activities

The quantity of labour times saved in response to better access to water supply depends on agro-ecology zone and place of residence (rural vs. urban). This complicates the estimation of the exact amount of time released as a result of improved water infrastructure. However, the value of times saved from water fetching can be

approximated in a certain range of intervals. For instance, Cook, Masuda, Fortmann, Gugety, & Smith-Nilson (2013) based on village level household survey in Oromia region of Ethiopia find out that improved access to water supply can successfully reduce water fetching time on average by 35% to over 90% per day. Accordingly, in this study, it is assumed that better access to drinking water supply can reduce time spend for fetching water on average by 50%.

Similarly, the amount of time saved due to improved access to household energy relies on access to modern cooking technology and availability of traditional source of energy. Empirical evidence in Ethiopia indicates that access to improved stove reduces household's fuel consumption by more than 50 percent. This led to approximately 50 percent less firewood collection's time (Gaia Consulting Oy and Ethio Resource Group, 2012). Accordingly, in this study, it is also assumed that in response to improved access to energy services (e.g. improved stove), efficiency of firewood collection activities can be increased on average by 50%.

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

Construction of water and energy infrastructures can be financed from domestic and/or foreign sources but the main source of finance is derived from domestic sources. Thus, the cost of constructing water and energy infrastructure is financed by the saving of government. It is assumed that 10% increase in government's deficit is sufficient to cover costs of expanding water and energy infrastructures. Therefore, government deficit is increased by 10% to meet the target of 50% increase in the TFP of water fetching and firewood collection activities.

3.1.2 Model closure rule

The main macro closures include; flexible exchange rate which is used to clear the market for foreign exchange, investment driven saving, consumer price index(CPI) chosen as a numeraire, flexible government saving, fixed factor supply and factors are perfectly mobile across sectors in the economy.

3.2 Results and Discussion

3.2.1 Effect on labor demand

In rural Ethiopia, fetching water and firewood are usually accomplished by reducing the daily agricultural labour time. On the other hand, in urban part of the country, unskilled workers are commonly collect water and firewood. Water fetching and firewood collection activities are labor intensive household activities. An improved TFP of water fetching and firewood collection results reduction of labour required to perform these activities. Figure 4 describes the percentage change in labour demand across sectors in response to improve TFP of water fetching and firewood collection activities.

The simulation result indicates that as a result of 50% rise in TFP, labour demand by firewood collection and water fetching activities is declined on average by 17.2% and 17.2% respectively. On the other hand, employment of labour in agriculture, industry and service activities is on average increased by 1.3%, 0.9% and 0.6% respectively as a result of absorbing the released labour from water fetching and firewood collection. Bigger percentage of labour is absorbed by agriculture sector, this happens due to the fact that larger proportion of water fetcher and firewood collectors are also agricultural labourer in Ethiopia. In other words, labours that collect water and firewood are also responsible for performing agricultural activities. Thus, when water fetching and firewood collection activities are effectively accomplished, most of the freed labours are reallocated to agricultural sectors than other sectors.

Furthermore, parts of the freed labours prefer to enjoy extra leisure and hence relatively bigger proportions of released labours are also reallocated to leisure (1%).

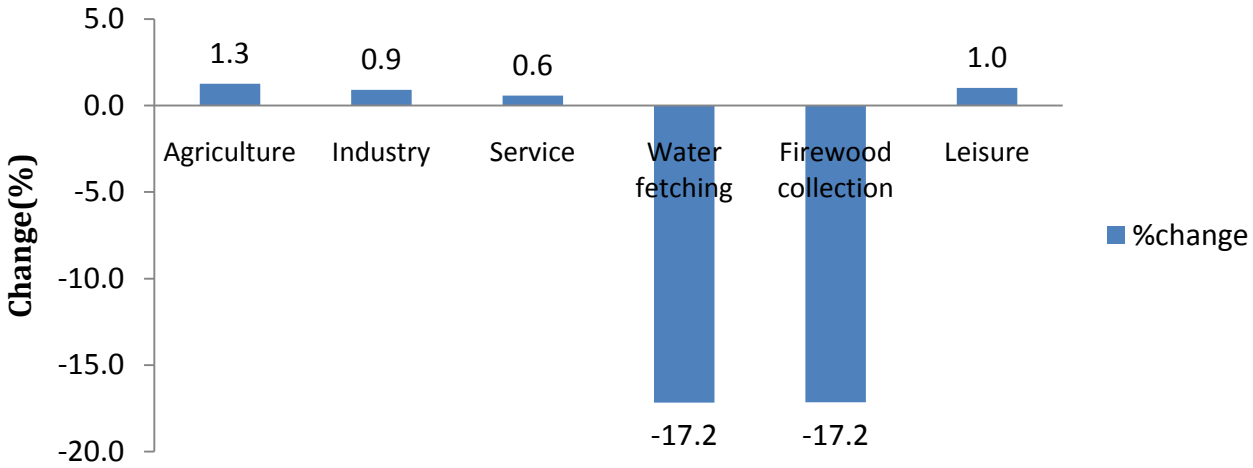

Figure 4: Labour demand across sectors (weighted average % change)

Source: Own computation based on model results

3.2.2 Impact on domestic production

Table 1 depicts the percentage change in domestic production as a result of increased TFP of water and firewood collection activity. Production of water fetching and firewood collection on average is increased by 24.2% and 24.2% respectively due to enhanced TFP. Furthermore, labors which are released from water fetching and firewood collection are transferred into marketed sector and leisure activities stimulate production in the destination sector. Production of agriculture, industry and service on average is raised by 0.9%, 0.4% and 0.2% respectively due to employment of extra labor which is taken from water fetching and firewood collection. Production in agriculture sector is increased by higher proportions relative to other marketed sectors (industry and service). This is because most of the labors employed in water fetching and firewood collection are at the same time engaged in agricultural activities.

Therefore, higher TFP in water fetching and firewood collection activities provides larger proportions of released labor for agricultural activities relative to industry or service and hence production in this sector is tremendously improved. The increase in domestic production can also be justified as labors are reallocated from less productive sectors (water fetching and firewood collection) to relatively better productive sectors (agriculture, industry or service). Furthermore, the production of leisure is increased by 1% which is relatively greater than other marketed sectors such as agriculture, industry and service. This is partly because household was overburden by water fetching and firewood collection activity when part of this labor is getting freed, they prefer to enjoy leisure.

Table 1: Change in domestic production

	Base	Simulation	Absolute change	Weighted %change
Agriculture	7242.29	7308.94	66.64	0.9
Industry	3395.42	3407.94	12.52	0.4
Service	10361.41	10377.99	16.58	0.2
Water fetching	607.74	755.09	147.35	24.2
Firewood collection	186.56	231.79	45.23	24.2
Leisure	6792.94	6862.05	69.11	1.0

Source: Own computation based on model results

3.2.3 Impact on household welfare

Increased TFP of water fetching and firewood collection also affects household's welfare. Table 2 describes weighted percentage change in equivalent variation (EV) in response to higher TFP in water fetching and firewood collection. EV of each household group is weighted by the base income so as to examine the actual welfare changes across household groups. Welfare improvement happens to all group of household but the amount of welfare gain varies among household. Different household groups allocate divergent quantity of labor for water fetching and firewood collection activities. Accordingly, welfare gain depends on household's endowment of labor that can be potentially allocated to fetching water and firewood. In other words, relatively better welfare gain is obtained by household who allocate relatively larger proportion of labor for water fetching and firewood collection activity.

For instance, non-poor and poor rural household in agro-ecology zone 1 and 5 allocate bigger proportion of labor for water fetching and firewood collection relative to other groups of households. As a result of increase in the TFP of water fetching and firewood collection, welfare gain by these household groups is relatively better than other group of household. This happens because better access to water and energy services reduces the quantity of labor employed in collecting water and firewood. The released labors are reallocated to marketed sectors and generate additional income to the household and hence household's welfare is getting better off.

Table 2: Household welfare (EV/base income)

Households	% change
Household rural zone 1 poor Agricultural	2.83
Household rural zone 1 poor Mixed	2.83
Household rural zone 1 poor Non-Agricultural	2.91
Household rural zone 2 poor Agricultural	1.75
Household rural zone 2 poor Mixed	1.77
Household rural zone 2 poor Non-Agricultural	1.83
Household rural zone 3 poor Agricultural	1.99
Household rural zone 3 poor Mixed	2.10
Household rural zone 3 poor Non-Agricultural	2.09
Household rural zone 4 poor Agricultural	2.20
Household rural zone 4 poor Mixed	1.91
Household rural zone 4 poor Non-Agricultural	2.02
Household rural zone 5 poor Agricultural	3.21
Household rural zone 5 Poor Mixed	3.47
Household rural zone 5 poor Non-Agricultural	3.04
Household rural zone 1 non-poor Agricultural	2.12
Household rural zone 1 non-poor Mixed	2.18
Household rural zone1 non-poor Non-Agricultural	2.13
Household rural zone 2 non-poor Agricultural	1.29
Household rural zone 2 non-poor Mixed	1.33
Household rural zone 2 non-poor Non-Agricultural	1.29
Household rural zone 3 non-poor Agricultural	1.56
Household rural zone 3 non-poor Mixed	1.56
Household rural zone 3 non-poor Non-Agricultural	1.69
Household rural zone 4 non-poor Agricultural	1.41
Household rural zone 4 non-poor Mixed	1.48
Household rural zone 4 non-poor Non-Agricultural	1.47
Household rural zone 5 non-poor Agricultural	3.02
Household rural zone 5 non-poor Mixed	2.64
Household rural zone 5 non-poor Non-Agricultural	2.65
Household small urban poor	0.40
Household big urban poor	0.78
Household small urban non- poor	0.82
Household big urban non-poor	0.63

Source: Own computation based on model results

3.2.4 Macroeconomic effects

Increase TFP of water fetching and firewood collection activities affect labor reallocation, domestic production and overall welfare (see Figure 4, Table 1 and Table 2). This would create economic wide linkages and positively affects the entire macroeconomic indicators such as GDP, total domestic production, absorption and export supply. Figure 5 depicts macroeconomic effect of higher TFP in water fetching and firewood collection.

More specifically, as a result of increase TFP in water fetching and firewood collection and the accompanying interaction effect results increase in total domestic production, GDP from expenditure, absorption and export supply by 1.3%, 1.6%, 1.4% and 0.9% respectively.

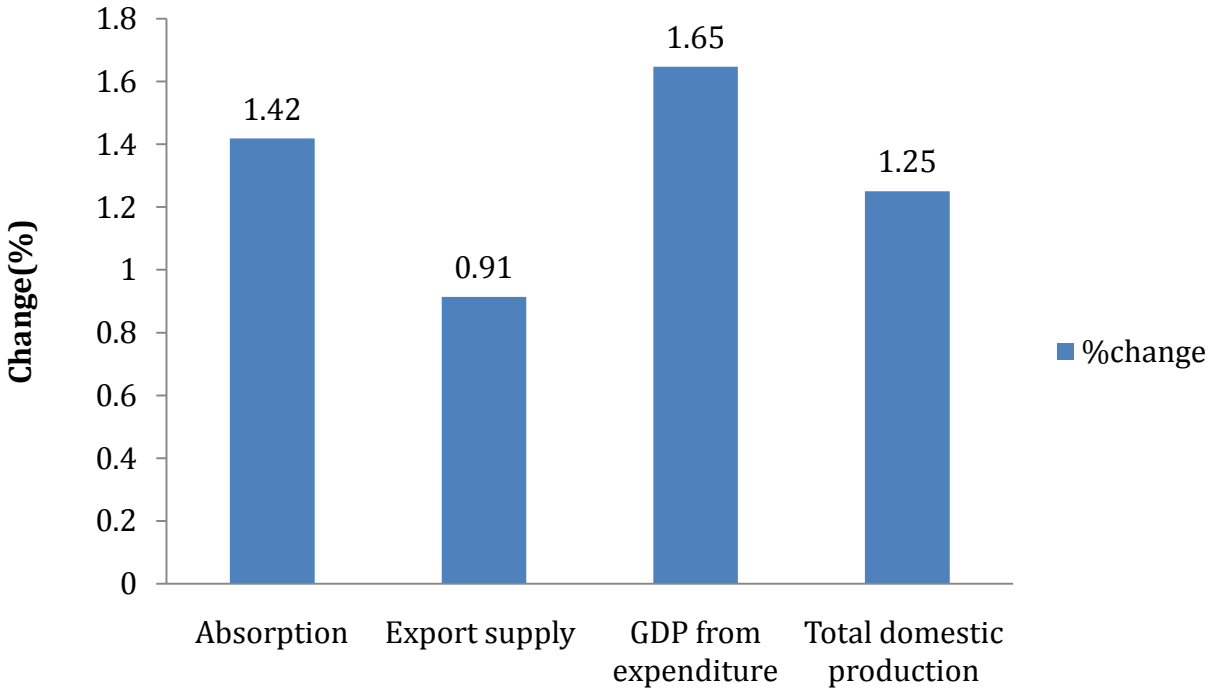

Figure 5: Macroeconomic impact (% change)

Source: Own computation based on model results

4. Conclusion

The majority of Ethiopian households have limited access to water and energy service. Water fetchers and firewood collectors are mostly agricultural laborers. Fetching drinking water and firewood reduces labor available for market activities such as agriculture which negatively affects the productivity of these sectors. Better access to water and energy service improves the TFP of water fetching and firewood collection activities and release labor for marketed activities which has economy wide implications. This study aims to estimate the economy wide effects of improved TFP of water fetching and firewood collection activities. The simulation scenario is 50% increase in the TFP of both water fetching and firewood collection activities due to better access to water and energy infrastructure. In the same scenario, the government deficit is increased by 10% to finance the cost of expanding water and energy service.

The simulation result indicates that due to increase TFP of water fetching and firewood collection, labour demand by firewood collection and water fetching activities is declined on average by 17.2% and 17.2% respectively. Additionally, employment of labour in agriculture, industry and service sector is on average increased by 1.3%, 0.9% and 0.6% respectively as a result of absorbing released labour from water fetching and firewood collection. Labors which are freed from fetching water and firewood are reallocated to marketed activities stimulate domestic production. Therefore, production of agriculture, industry and service on average rises by 0.9%, 0.4% and 0.2% respectively. Households also enjoy extra leisure due to better access to water and energy services and the overall welfare is better off. Furthermore, macro-economic indicators including GDP, export supply and absorption are also increased by 1.6%, 0.9%, and 1.4% respectively.

The study results show that expanding water and energy infrastructure and hence increase TFP of water fetching and firewood collection activities has enormous economy-wide effects. Better access to water and energy service ensures reallocation of labour towards market related activities and enhances domestic production, employment, overall welfare and economic growth. Therefore, it is absolutely helpful to recognize the economic significance of labours released from fetching water and firewood. Policy makers should consider investing in water and energy infrastructure as one of the core policy components of rural development policies and strategies of Ethiopia.

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