The economic wide impacts of Grand Ethiopian Renaissance Dam on Ethiopian Economy: A CGE modeling approach

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Abstract

The study examine the economic wide impacts of the Grand Ethiopian Renaissance Dam on the Ethiopian economy by using a Computable General Equilibrium Modelling framework. To do so, the study used a secondary data which sourced from an updated social accounting matrix of Ethiopia for the year 2019/20. By outlined a recursive dynamic computable general equilibrium approach, the model run a policy simulation in which the additional 5,150 MW that scheduled to come online near the future form Grand Ethiopian Renaissance Dam. In opting for policy shock, the results of the study suggest that Ethiopian economy accumulated GDP gains from the steady-state operation of the Grand Ethiopian Renaissance Dam compared to a baseline. Specifically, the results of the study shows a spreading out effect in real GDP (on average Ethiopian GDP grows by 2.29 from the year 2020 to 2027 compared to the baseline scenario), sectors production, real investment, household income and household's consumption expenditure relative to the baseline scenario compared to a baseline without the dam. Relative to the baseline scenario, the results of the study also showed an improvement in the welfare for all the household categories. However, the shift in relative income across the household categories favors high income households. Overall, this paper suggests that Ethiopian economy will enjoy the largest improvement with additional power supply resulting from Ethiopian renaissance dam, therefore; all Ethiopian citizens shows their unity to finalize the projects on time and resolve the age-long problems of the people so that the economy maintains its tremendous progress.

Keywords: Dynamic Computable General Equilibrium, GAMS, CGE modeling, Ethiopian Renaissance Dam

1. Introduction

Noticeably, now a day electricity industry becomes a robust industry that enthusiastically contributes to the progress, prosperity and healthy development of a nation. In one hand, electricity has an exceptional 'energy currency' that underpins the economic development mode of the country (Coupal& Holland, 2002); on the other hand, the level and speed of economic development plays a decisive role in determining the demand for electricity (Khandker et al., 2009). Therefore, when the economy has experienced in power failures even an hour, means that a lot of activity is forced to go on a standstill and, hence, directly thwart the fulfillment of the Sustainable Development Goals by fading the society's reaction to economic changes (Vera, 2016).

Like other third world nations, in Ethiopia a severely restricted, inefficient and unreliable supply of electricity has historically recorded as a limiting factor for its economic development (Woldesenbet, 2005). Moreover, with its fast economic growth; electrifying of million households, remote communities and small-scale entrepreneurs remains a challenge in Ethiopia though pleasingly Ethiopia has endowed with abundant water resources and enormous hydropower potential to put her out of poverty trap.

Consequently, after a wake up, to cover an imminent shortfall in electricity, Ethiopian government launched a plan to exploit the electricity generation potentials in the country. A major step in this regard was the notice in 2011 to construct the largest reservoir in Africa near the border to Sudan, the Grand Ethiopian Renaissance Dam with a storage capacity of 74 billion cubic meters and a power generating capacity of above 5150 Mw. In this milieu, the GERD is central to Ethiopia's development vision of becoming a middle-income country by 2025 and to be Africa's energy hub (Block and Strzepek, 2010).

Notwithstanding to these increment in public investments in energy sector, the current utilization of hydropower resources of the country are limited to 2,000 MW which is less than 5percent of the estimated hydropower potentials of the country (Ferrari et al., 2013). Currently, only 27 percent of all households in Ethiopia have access to electricity and the remaining part of the population still relying on traditional biomass. On average, the electricity wastage in Ethiopia is about 20 percent, which is much higher than the international average, 12-13 percent. As Woldesenbet (2005) have investigated, power outages caused firms without backup generators to lose approximately 15 percent to 30

percent of their potential production. Even when the power shortages were less severe, losses could reach up to 10 percent. Their preliminary results also indicate that the economy may have lost 10 percent to 15 percent of total yearly gross value of production that could have contributed from the sector and 1 percent to 3 percent of total yearly government revenue because of power outages.

In view of this, as the completion of the dam construction is getting closer and closer, more and more studies are being published and controversially discuss the likely consequences of the GERD on its environmental, social, economical, and political blueprints. However, the only other preliminary study that I know of had by Ferrari et al., (2012) and Tewodros et al., (2015) which tried to examine the economic wide effect of the dam. The study presented here employs a Computable General Equilibrium (CGE) modeling framework, but contrary to previous studies this study evaluates the direct and indirect economic effect of GERD on Ethiopian economy: First by employing a dynamic recursive multi-sectoralcomputable general equilibrium model via modeling the issue of hydropower to a single-country approach, and Secondly; by substituted the original SAM of Ethiopian with a new one where electricity is produced by two activities: i.e. fossil and hydroelectric sources.

Therefore, by filling the above knowledge gap, this study attempts to answer the following research questions:

- What are the presumable effects of GERD on factors income, household's income and consumption expenditure?
- What are the likely effects of GERD on Ethiopian export and import volumes (i.e. on the external sector)?
- What are the potential effects of GERD on sectoral productions, real government spending and real investment?
- Will the construction of Ethiopian renaissance dam contribute toward its economic growth?

The rest of the paper is organized as follows. First, the type and source of data, modeling methods, and simulation scenarios are described. Then, the results on macroeconomic variables, real output by sector, factor income, households income and expenditure, and household welfare are presented. Lastly, conclusions and reccomendation are provided.

2. Methodology

2.1. Type and Source of Data

To capture the economic wide effect of Ethiopian renaissance dam to Ethiopian economy, this study used secondary data sourced from updated 2019/20 SAM of Ethiopia which represents the economy by activities, factors, commodities, and institutions including an aggregate savings-investment account.

2.2. Social accounting matrix

In a narrower sense, a social accounting matrix (SAM) represents flows of all economic transactions that take place within an economy. It is at the core, a matrix representation of the national accounts for a given country, which provides a static picture of the economy (Pyatt and Thorbecke, 1976). As a data framework, the SAM is a snapshot, which explicitly incorporates various crucial transaction links among variables, such as the mapping of factorial income distribution from the structure of production and the mapping of the household income distribution from the factorial income distribution, among others. In other saying, it is a comprehensive accounting framework within which the full circular flow of income from production to factor incomes, household income to household consumption, and back to production is captured.

In a broader sense, in addition to providing a consistent classification scheme, it can conceive as a modular analytical framework for a set of interconnected a subsystem, which specifies the major relationships among variables within and among these systems (Luppino et al., 2004). With regard to the structure of the standard SAM, it has a number of accounts such as activities, commodities, institutions, factors of production and saving-investment accounts. In addition to these accounts, SAM may have extra accounts like taxes, total margins (IFPRI, 2010).

In this context 2019/20 SAM of Ethiopia captures: the sources of income and expenditure destination of all accounts, breakdown of sectoral GDP (value addition) by labor and capital factors, income generation and distribution of the institutions in general and household groups in particular, patterns of expenditure by institutions including Household groups, the inter-dependence between activities and institutions with respect to income generation and final demand creation, the inter-dependence among institutions regarding transfer receipts

and transfer payments, the role of institutions in capital formation, and the relationship of the domestic economy with the Rest of the World / external sector.

2.3. Model formulation

This paper attempts to examine the economy-wide effects of Ethiopian renaissance dam to Ethiopian economy using a recursive dynamic computable general equilibrium (CGE) model. This is because, CGE models have features that make them suitable for such analysis (Janda et al., 2011), as it has sound micro-economic foundations and a complete description of the economy with both direct and indirect effects of a policy changes. More explicitly, in the CGE model the general equilibrium theories are transformed from an abstract form into a realistic and computable one by using a set of equations to characterize supply, demand and equilibrium conditions in the economic system. Therefore, in these equations there are both economic shocks or exogenous variables and endogenous variables or quantities and prices. Consequently, the impacts of exogenous economic shocks on any sector will spread to the whole system of the economy, which in turns lead to the changes in those endogenous variables. Therefore, the state of equilibrium changes from one point to another. Here, by solving the CGE model we can be obtained a new equilibrium quantities and prices whenever the exogenous variables are changed. This becomes the plus points of CGE model over partial equilibrium.

2.4. Simulation designs

Assessing the economic wide effect of Ethiopian renaissance dam to Ethiopian economy requires economic scenarios that can be simulated with the dynamic CGE model for Ethiopia economy to be defined. Unfortunately, the macro closure of the model imposes restrictions on the type of scenarios that willsimulate. Additionally, the simulation exercise by itself requires the definition of a baseline scenario that can be used as a benchmark to measure the impact of a given policy scenario's. Hence, this scenario is run and provides "what if" or counterfactual projections, rather than a forecast.

In a consequence, since the main objective of this paper is to assess the potential economic wide impacts of Ethiopian renaissance dam on Ethiopian economy and currently she has announced a national energy policy, it makes sense to assess the impact of policy prescriptions on Ethiopian's economy. For this sake, we have considered the economic scenario thatwillbe compared withthe result of the baseline run.

- Given the additional electricity generation capacity of Ethiopia, we run a policy simulation in which the additional 5,150 MW that scheduled to come online near the future form renaissance dam.
    - Specifically, given that there is no additional power generation capacity expected from Ethiopian renaissance dam between the years 2020 to 2022, the electricity supply growth is set to be zero. However; in 2022 there is additional power generation capacities which expected to come online from Ethiopian renaissance dam. Hence in this year,electricity supply growth is set to 13.5 percent.[1] This simulates the new generating capacity of GERD which come online over this period (i.e. as two turbines of GERD each with capacity 350 MW have already been installed and are waiting test electricity generation). From 2022 onward, electricity supply growth rate is set to 94.4 percent in this policy run.

3. Discussion and analysis

3.1. Policy Simulation Results

The main rationale of this paper is to provide an economy-wide examination of the contribution that additional power generation from Ethiopian renaissance dam will make to Ethiopian economy over the coming years. Unless and otherwise the researcher stated, intentionally in this section the policy simulation results are expressed as percentage deviations relative to the baseline. Moreover, although the researcher present results for all years of simulation, the discussion pay particular attention to analyzing results for the years 2022 and 2027, which respectively corresponds to the implementation period of Ethiopian renaissance dam and end of the simulation period. Now let us scrutinize the simulation results more plainly.

3.2. Macroeconomic effects

As a basic industry of the national economy, the electricity industry plays an irreplaceable role to support economic development. Thus, the impacts of Ethiopian renaissance dam on GDP should be put in the first place in order to know the power effect better. To do so, the

[1] *This growth rate electricity supply is computed by the following formula that* ***interpreted as the smoothed annualized growth rate achieved during the considered time horizon*** *where* n is number of periods

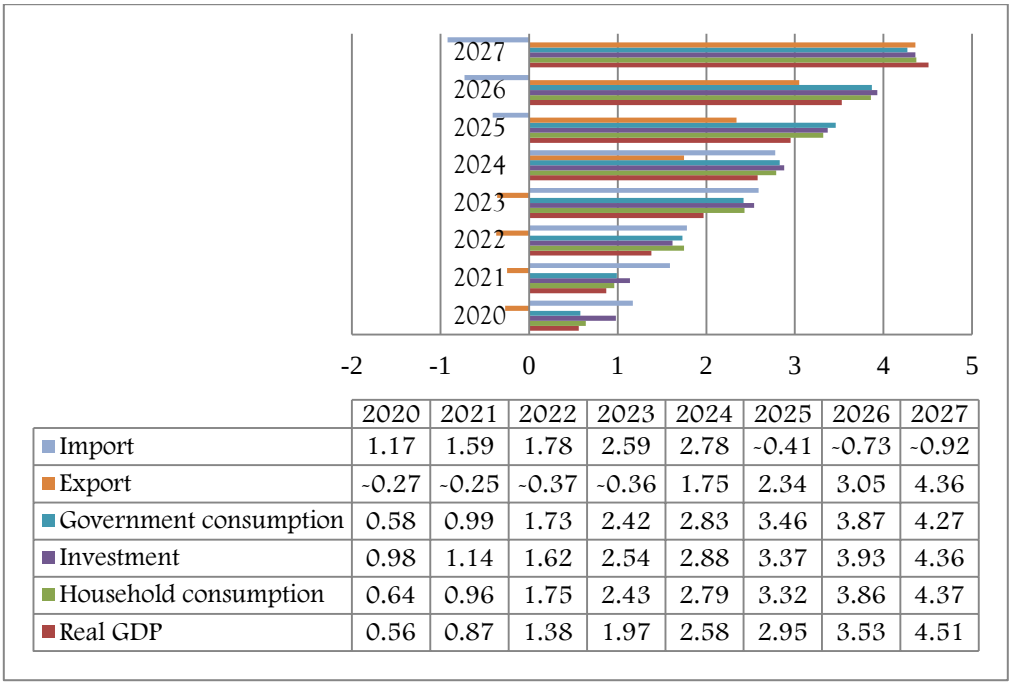
$$\sqrt[n]{\frac{\text{ending value}}{\text{beginning value}}} - 1$$

source: Barbara et.al.(2018)

simulation results in this study are presented in a series of real GDP growth, consumption, real investment, export and import deviation from baseline scenarios.

As shown in Figure 1 below, the positive impacts of Ethiopian renaissance dam on GDP are very significant. This change in the GDP is attributed to the change in the GDP distribution due to the reallocation of the factors of production, intermediate inputs among all domestic production sectors, change in the level of consumption and net trade. In opting of the policy shock, GDP gain accelerates with an additional power supplies resulted from Ethiopian renaissance dam, i.e. on average Ethiopian GDP grows by 2.29 from the year 2020 to 2027 compared to the baseline scenario.

Figure 1: The effect of GERD on macroeconomic variables (year on year deviation from its baseline scenario)



	2020	2021	2022	2023	2024	2025	2026	2027
Import	1.17	1.59	1.78	2.59	2.78	-0.41	-0.73	-0.92
Export	-0.27	-0.25	-0.37	-0.36	1.75	2.34	3.05	4.36
Government consumption	0.58	0.99	1.73	2.42	2.83	3.46	3.87	4.27
Investment	0.98	1.14	1.62	2.54	2.88	3.37	3.93	4.36
Household consumption	0.64	0.96	1.75	2.43	2.79	3.32	3.86	4.37
Real GDP	0.56	0.87	1.38	1.97	2.58	2.95	3.53	4.51

Source: GMAS result and authors' own calculation

On the external sector, in opting of the policy shock,the result of the exercise showed that total export of the country has reduce in the first four simulation periods (i.e. reduced by 0.27 percent in 2020, by 0.25 percent in 2021, by 0.37 percent in 2022 and by 0.36 percent in 2023). This finding is in line withthe finding of Bohlmann et al. (2015), but contrary with the result by Levent (2016). This partly might be explained bythe appreciation of real exchange rate (i.e. on average by 0.75 percent) which resulted from the increment in electricity export to neighboring countries.

In the viewpoint of domestic producers, appreciation of real exchange rate effect per se reduces in tendency of the price of exports relative to the price in the domestic market, and thus producers shift their optimal profit-maximizing output mix between export and home market production in favor of the latter. As well, an appreciation of real exchange rate makes import cheaper and export expensive in world market this induce firms to import more and export less; and hence, reduce the competitiveness of trade sectorsin Ethiopia. Therefore; in opting of the policy shock, an appreciation or overvaluation of real exchange rate become inimical to export performance.

However; in the last four simulation periods the real export grew at a positive rate even if the real exchange rate is continued to appreciate until 2025. This part of the result is in line with the finding by Levent (2016), where doubling of electricity increases export on average by 0.31 percent in turkey. This might be presented as the total factor productivity effect of GERD on sectors which have highly linked with electricity (i.e. industry and manufacturing sectors) coupled with the reduction in production costsexists with the additional power supply from renaissance dam.

Moreover; the possible combined effect of increase in total factor productivity and lower appreciation of the real exchange rate in later periods result in positive growth of real export in the last simulation periods. Therefore; these upbeat supply side effects of Ethiopian renaissance dam on the productivity of different sectorssurmount the possible negative effect of the appreciation of the real exchange rate.

Conversely to export,in this policy experiment import volumes rise in line with an increment in factor income and consumption in the first five shock periods. Imports rise by 1.17 percent in 2020, by 1.59 percent in 2021, by 1.78 percent in 2022, by 2.59 percent in 2023 and by 2.78 in 2023 relative to the baseline scenario. These estimates confirm most of the empirical results found in the literature which examine the economic-wide effect of electric powergeneration plants (For instance; Bohlmann, et al., 2015; Robinson &Gueneau, 2014; and Kenneth et al., 2007). This result can be explained bythe incrementin factor income and the appreciation of domestic currency as a result ofthe additional power supply via the construction ofrenaissance dam.

The intuition is that, in the perspective of domestic residents, an appreciation of real exchange rate reduces the price of imported product relative to domestically produced goods.This induces a substitution effect towards imports for commodities in cases where the exchange rate effect dominates the simultaneous drop in the prices of domestic output due to the electricity price reduction in the new equilibrium. This substitution effect affects both imports of final goods and intermediate inputs. Factor income distribution as well shapes the import demand patterns in important ways and implies the orthodox conclusion that – ceteris paribus – the rise in factor income increases the volume of domestic imports. Consequently, consuming a narrow range of importedproduct may simply reflect a narrow range of factor income, with no particular welfare loss.

However; in the last three post-shock periods, real imports volume do decline (i.e.reduced by 0.41 percent in 2025, by 0.73 percent in 2026 and by 0.92 percent in 2027). This result highlighted a significant shift in the consumption pattern of domestic consumers from the imported to domestic products, and the increment in the competitiveness of domestic production capabilities to match its counterparts due to the improvement in the ease of doing business with additional power supply from renaissance dam.

On investment level, as it is part GDP components, the construction of Ethiopian renaissance dam induce the capital stocks to rise over the medium and long term in line with the rise in factor income and real GDP growth rate. This result is in line with the finding by Levent (2016), Bohlmann et al. (2015) and Guntilake H. and RolandHolst D. (2013) who documents a positive effect of additional power supply and real investment. This could be illuminated with the fact that, as the accelerator theory states, when businesses see an improvement in factor income andeconomic forecasts, they will increase their investment to meet future increment in demand.

In other saying, if factor income increases via the construction of Ethiopian renaissance dam, as the economy is on an up-turn,this inducesinvestment spending in the economy to rise. Our results also confirm this and show that investment expenditure will rise by 0.98 percent in 2020, by 2.54 percent in 2022 and 4.36 percent in 2027, compared with the baseline scenario.

In sequence of events, we have also scrutinizing the question how does the construction of Ethiopian renaissance dam affect consumption pattern? This question is crucial for understanding consumers' behaviour and to evaluate our policy changes impacts on households' resources. Indeed, in virtually consumption represents more than two thirds of GDP, thus knowledge of how consumers respond to income change with additional power supply from Ethiopian renaissance dam is also crucial for evaluating the macroeconomic impact thoroughly.Consequently, in opting of the policy simulation, it is obvious that the construction of Ethiopian renaissance dam increases factor income through backward and forward linkages (we will discuss this situations in the later sub-section).

> *Symmetrically, the result of the exercise showed that an additional power supply from Ethiopian renaissance dam increases household's consumption in line with increased factor income, but the short-term increases in income affect consumption less than long-term increases. Household's consumption rise by 0.64 percent in 2020, by 2.43 percent in 2025 and by 4.37 percent in 2027 relative to the baseline scenario. The empirical results obtained in this study are consistent with the finding by Bohlmann et al. (2015) who find a positive relationship between expansions of power supply and household's consumption.*

Moreover, through power exports Ethiopian renaissance dam have also contributed significantly to a rise in government revenues via increases in the corporate tax revenue and surplus transfers. Accordingly, the government expenditure rise in line with increases in government revenue. The result also confirms this generalization (i.e. government spending increase by 0.58 percent in 2020, by 2.42 percent in 2025 and by 4.27 percent in 2027). This finding could also be presented as a result of rising in tax revenues in line with increase in economic activityfrom additional power supplies. In a consequence, the budget deficit slightly becomes narrow and narrow in the long term relative to the baseline scenario.

In a nutshell, from this evaluation the researcher can confidently conclude that Ethiopian renaissance dam should be brought online as expected in the simulation design, since its contribution on GDP components has shown as being unambiguously good for the economy.

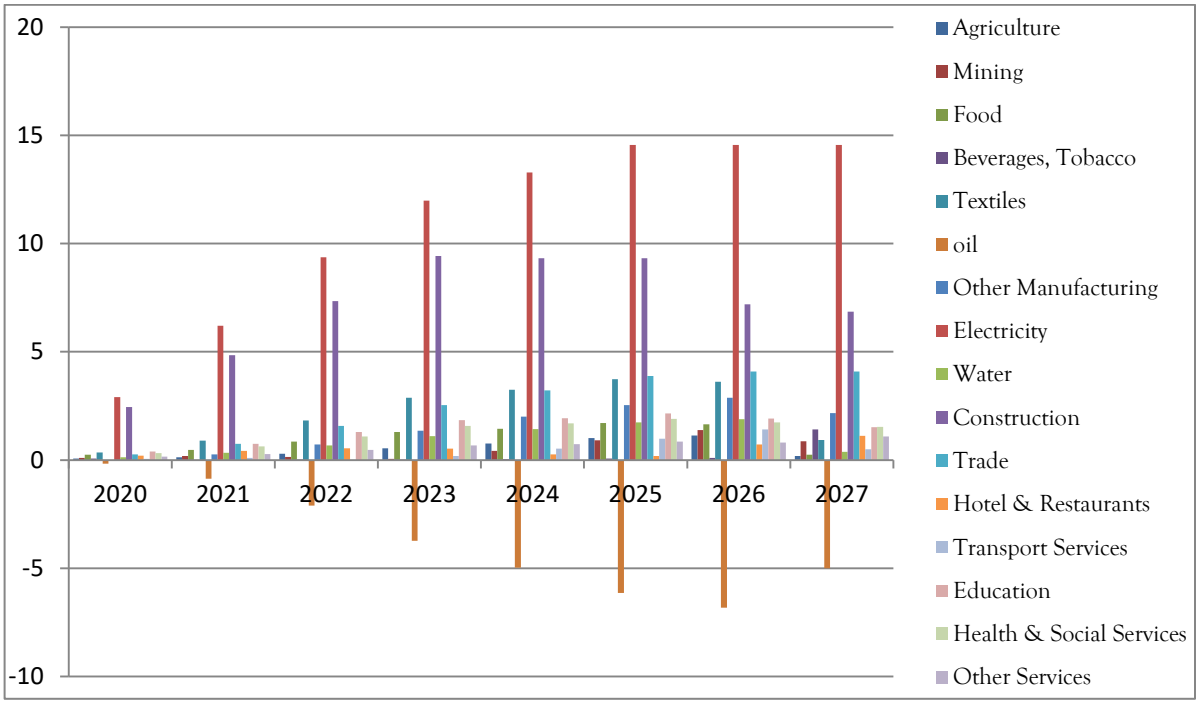
3.3. Impact on real output by sector

Macroeconomic effects that we have seen before, however; represent aggregate impacts. We further need to investigate these effects on different activities of the economy. The impacts of Ethiopian renaissance dam on the output of various sectors have shown in figure 2 below. As can be seen, the impacts of additional power supply from renaissance dam on various sectors are different. The impacts of Ethiopian renaissance dam on real output are fairly positive for almost all the sectors because the construction of Ethiopian renaissance dam benefits all sectors through a reduction in margin costs. This result is in line with the finding by Robinson, S. & Gueneau, A. (2013), and Guntilake H. and RolandHolst D. (2013) who were documents a positive effect of additional power supply and real output by sector.

The immediate impact of the construction of Ethiopian renaissance dam is therefore; a significant expansion in output of electricity sector itself. This output expansion in electricity therefore; results in a higher demand for intermediate inputs thereby creating a spillover effect to the rest of the economy (i.e. as other sectors also increase their production to meet higher demand of their products). As a result, employment and returns to factors of production increases as well. Consequently, this higher in return to factors creates a snowball effect, as greater profitability in the electric sectors attract further investments. This is true especially for the sectors which have the strongest forward linkages with electricity. Thus, from our exercise one can ardently conclude that almost all sectors increase production relative to the baseline scenario due to the fact that the reduction in margin costs contributes to the reduction in the cost of production in post shock periods.

> *All at all, as a basic input for the national economy, additional power supply from Ethiopian renaissance dam makes the output of almost every sector increases.Secondly; the increments in the production of sectors indicating that under the background of a long-term power supply from the renaissance dam, industries transfer to high power-consuming sectors from low power consuming one.*

Figure1: The effect of GERD on real output by sector (Cumulative Percentage Difference Relative to Baseline).

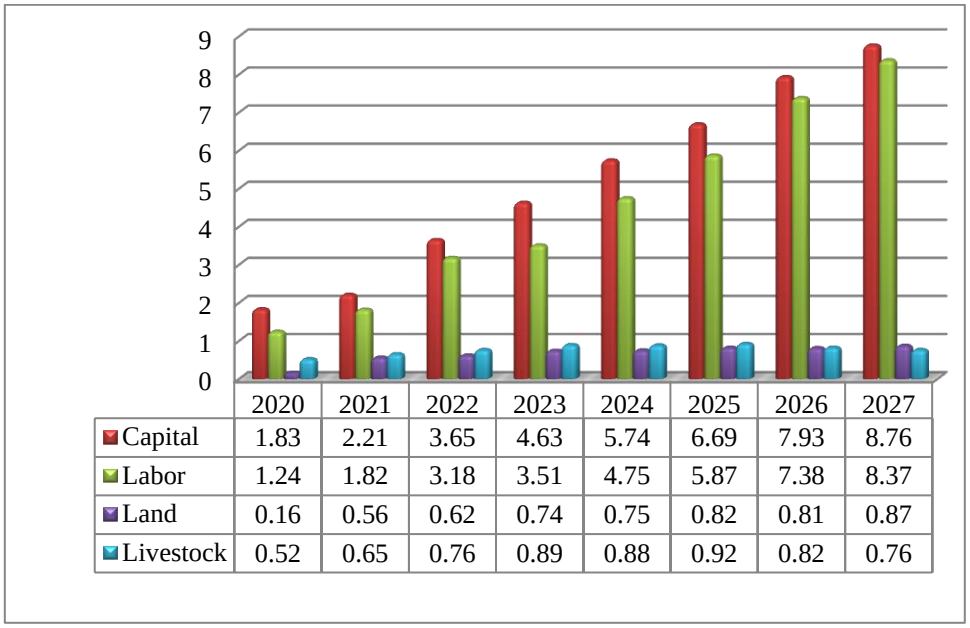


Source: GAMS result and Author's Own Calculations

3.4. Impacts on factor income

Regarding to the effects of GERD on the functional income distribution – that is the distribution of primary income by type of factors – Figure 3 displays the impacts on real factor returns relative to the baseline scenario in the corresponding years. Turning to returns of factors of production, the simulation result of the exercise found that aggregate income of factors of production in all simulation periods are slightly higher than the baseline. On balance, in our simulation periods we have observed that higher-growing sectors are relatively skill- and capital-intensive and thus their additional factor input demand drives up capital returns and skilled wages more than unskilled wages. Consequently, among the factors of production in our model, the return of capital grows at the fastest rate. It grew by 1.83 percent in 2020, by 4.63 percent in 2023 and by 8.76 percent in 2027 compared to the baseline scenario. This result is in line with the finding by Tewodros, N., Onno, K., Roy B. & Pieter v. (2015) and Levent (2016) who were documented a positive effect of additional power supply and income of factors.

Figure3: The effect of GERD on factor income (percentage change from the reference scenario)



	2020	2021	2022	2023	2024	2025	2026	2027
Capital	1.83	2.21	3.65	4.63	5.74	6.69	7.93	8.76
Labor	1.24	1.82	3.18	3.51	4.75	5.87	7.38	8.37
Land	0.16	0.56	0.62	0.74	0.75	0.82	0.81	0.87
Livestock	0.52	0.65	0.76	0.89	0.88	0.92	0.82	0.76

Source: GAMS result and Author's Own Calculations

As it can be seen from figure 3 above, in opting of our policy shock the aggregate income of labor has recorded positive growth compared with the baseline scenario. It has increased by 1.24 percent in 2020, by 3.51 percent in 2023 and by 8.37 percent in 2027 compared to base line simulation. The reason is emanates from fact that the higher-growing sectors what we have observed in our simulation are relatively skill and capital intensive and thus their additional factor input demand drives up skilled and semi-skilled returns more than the reference scenario.Consequently, the increment in returns of semi skilled and skilled labor offsets the reduction in returns of unskilled labor. Pronouncedly, the increment in income of skilled and semi-skilled labor is may be due to expansion in the output of tradable sector in our simulation. On the contrary, almost in all simulation periods the result of our exercise showed that in opting of our policy shock the returns of land and livestock are slightly risesbut ata lower rates. The reason for the reversal of the effect on agricultural land rents and livestock is related to the fact that electricity use in agriculture sector is very low. Thus, in our policy shock agriculture benefits very little from additional electricity supply via the construction of Ethiopian renaissance dam and electricity price reductions.

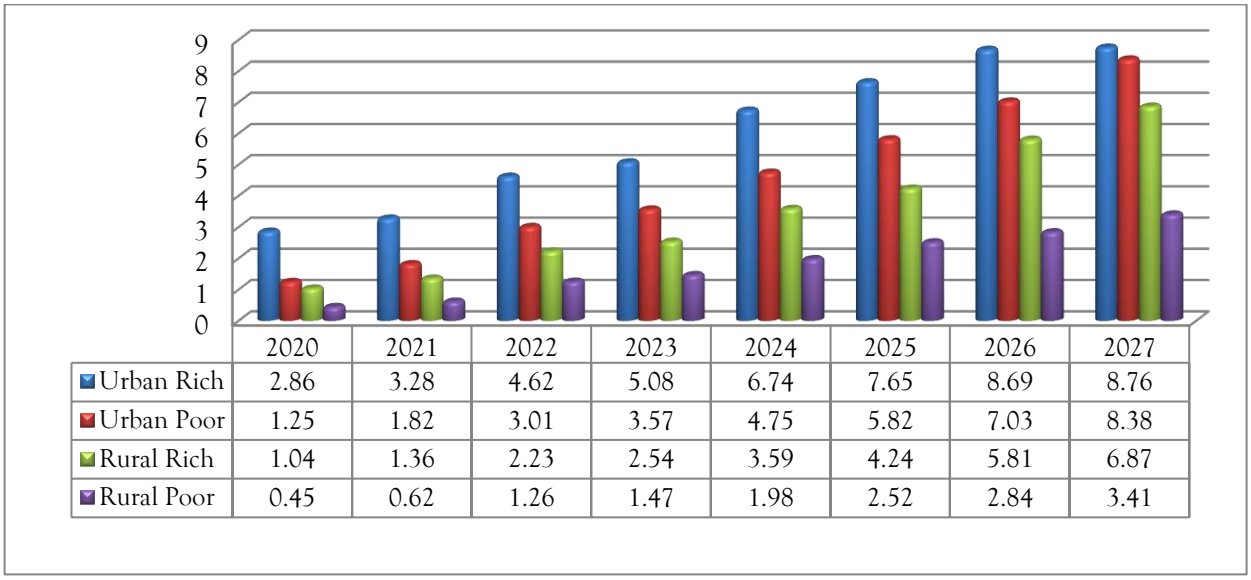
3.5. The effect of GERD on Household's Income

The income effect of the construction of Ethiopian renaissance dam via supplying additional power supply on household is captured through its impact on factor income and income

from transfers. This is due to the fact that the primary sources of income for households are emanates from factor payments and transfers from other institutions. In our policy shock, with the rise in the production and productivity ofalmost in all sectorsthroughadditional power supplies, workers will see their nominal returns to rise (see figure 4 below).In consequence the nominal income of both poor and non poor households in both urban and rural areas has improved. *This result is in line with the finding by* Ferrari, E., McDonald, S. & Osman, R *(2013) who documents a positive effect of additional power supply on nomial income by different catagories of the household.* However, since the urban and rural high-income groups have higher shares of capital and skilled labor in their total income mix than the low-income groups, the former groups gain disproportionally.

> *Differently speaking, in a policy targeting power supply increment from renaissance dam, theincrements in the income of poor and non poor households in rural and urban areas are different. For instance, in our policy shocks, the nominal income is slightly lower for rural households particularly for rural poor households than urban ones. For rural households, labor income is lower due to lower agricultural labor returnsin rural area while capital income is lower as it is affected by a lower return to agricultural land in rural area. As share however; agricultural labor income is an important source of income for the rural low income households representing 86 percent of total income and 45 percent of the total income for the rural rich ones. Conversely, in opting of our policy shock urban households see their income risescompared with the baseline scenario. Thiscan be illuminated with the fact that non-agricultural labor and capital, in which they are highly endowed, have higher returns in urban area compared rural one in all simulation periods as we have seen in section above.*

Figure4: The effect of GERD on household income (%change with respect to baseline scenario)



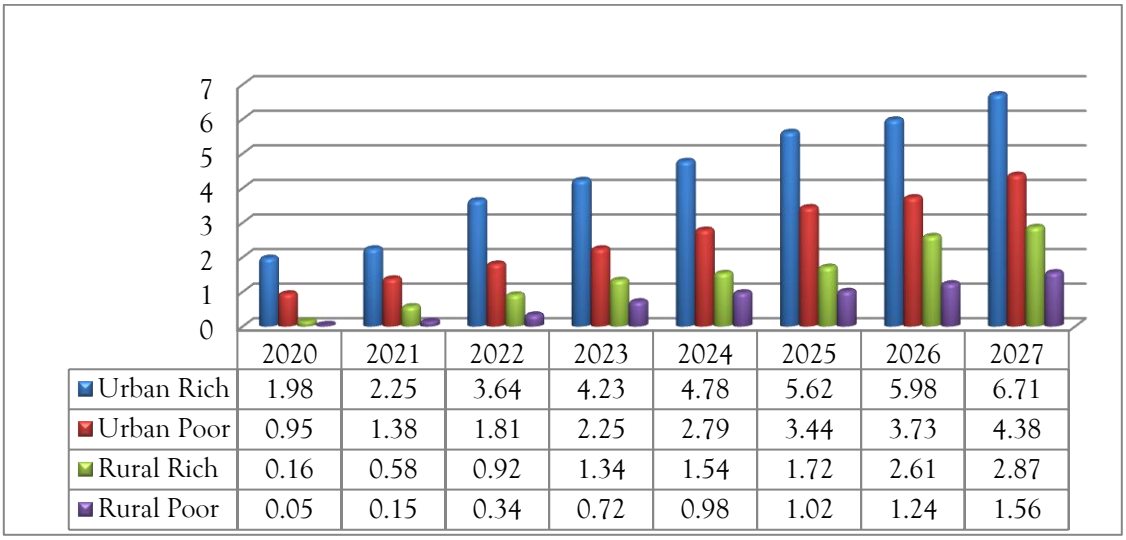
	2020	2021	2022	2023	2024	2025	2026	2027
Urban Rich	2.86	3.28	4.62	5.08	6.74	7.65	8.69	8.76
Urban Poor	1.25	1.82	3.01	3.57	4.75	5.82	7.03	8.38
Rural Rich	1.04	1.36	2.23	2.54	3.59	4.24	5.81	6.87
Rural Poor	0.45	0.62	1.26	1.47	1.98	2.52	2.84	3.41

Source: GAMS result and Author's Own Calculations

3.6. Effect on Households Consumption Expenditure

On household's consumption expenditure side, in our model we have assumed that households spend their income on consumption after they pay taxes, save and transfer to other institutions. Hence, additional power supplies from Ethiopian renaissance dam affect the consumption expenditure of households by altering household's consumption. In our policy shock, we have aggregated households in to poor and non poor both in urban and rural areas. In consequence, with additional power supplies from renaissance dam the growth rate of households consumption expenditure of both poor and non poor households in both urban and rural areas has recorded a positive growth rate compared to the base line simulation. However, as can be seen from figure 5 below the increments in growth rate of consumption expenditures of poor and non poor households in rural and urban areas are different. For instance, the consumption expenditure of urban poor and rich households has increased by 1.98 and 0.95 percent in 2020, by 4.23 and 2.25 percent in 2023 and by 6.71 and 4.38 percent in 2027 compared to the baseline scenario, respectively. The consumption expenditure of rural rich and poor households has also increased by 0.16 and 0.05 percent in 2020, by 1.34 and 0.72 percent in 2023 and by 2.87 and 1.56 percent in 2027 compared with the reference scenario, respectively. This result is in line with the finding by Bohlmann et al. (2015), Ferrari, E., McDonald, S. & Osman, R (2013), and Guntilake H. and RolandHolst D. (2013).

Figure 5 *The effect of GERD on household's consumption expenditure (% change with respect to baseline scenario)*



	2020	2021	2022	2023	2024	2025	2026	2027
Urban Rich	1.98	2.25	3.64	4.23	4.78	5.62	5.98	6.71
Urban Poor	0.95	1.38	1.81	2.25	2.79	3.44	3.73	4.38
Rural Rich	0.16	0.58	0.92	1.34	1.54	1.72	2.61	2.87
Rural Poor	0.05	0.15	0.34	0.72	0.98	1.02	1.24	1.56

Source: GAMS result and Author's Own Calculations

3.7. Welfare effect Of GERD

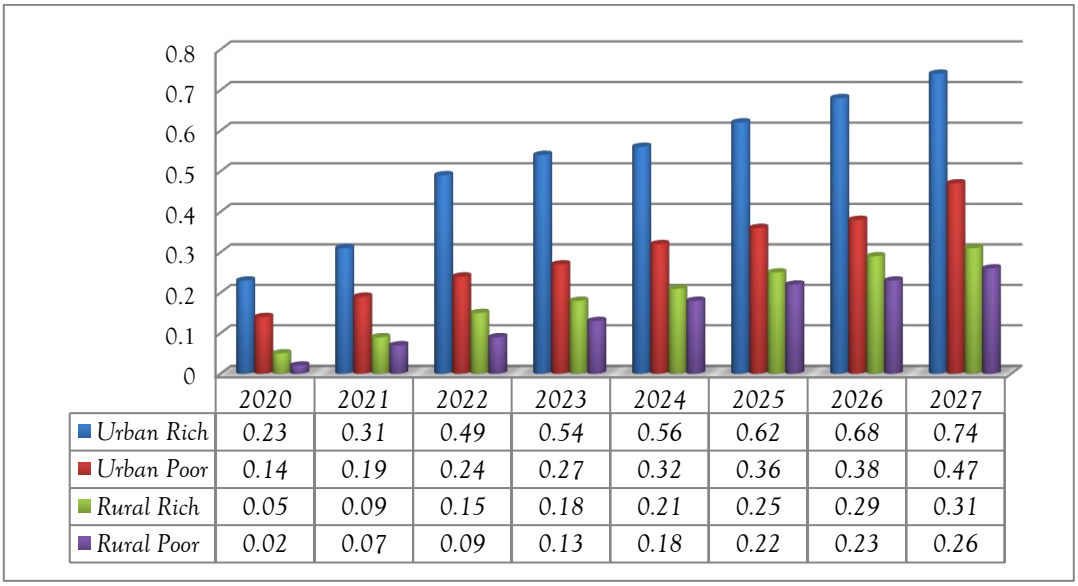
It is obvious that without changes in the electricity structure, economic and social transformation will lack motivation and the development foundation will be unsustainable. Therefore, its impacts on consumption and hence welfare are paramount. The construction of Ethiopian renaissance dam can affect household welfare through income via changes in factor incomes and through the expenditure via changes in commodity prices (Wiebelt et al., 2015).

> *To examine the impact of the policy simulation on the household's welfare we can use variables like household consumption expenditure and household real consumption. However, in most literature, to measure the welfare impact, equivalent variation (EV) is used as an important tool.EV compares "the costs of pre- and post-shock levels of consumer utility, both valued at base year prices'' (Burfisher, 2011). A positive EV implies a welfare gain due to the new policy/shock: a negative EV indicates welfare loss.*

In our experimental simulation the welfare effects of Ethiopian renaissance dam, as measured by the equivalent variation (EV), are substantial. Figure 6 below shows the improvements of welfare for all the households but much smaller compared to GDP gains. As we can see from the same diagramthe shift in relative income across the household categories favors high income households. This is due to the fact that these households derive most of their income from increased capital earnings and from increased earnings of

skilled labor. This result is in line with the finding by Ferrari, E., McDonald, S. & Osman, R *(2013)*, Block, P. &Strzepek, K. (2010) and Coupal, R.H. & Holland, D. (2002) who documents a positive effect of additional power supply on the welfare of the society.

Figure 6: GERD effect on household's welfare (Variation from its baseline scenario)



	2020	2021	2022	2023	2024	2025	2026	2027
Urban Rich	0.23	0.31	0.49	0.54	0.56	0.62	0.68	0.74
Urban Poor	0.14	0.19	0.24	0.27	0.32	0.36	0.38	0.47
Rural Rich	0.05	0.09	0.15	0.18	0.21	0.25	0.29	0.31
Rural Poor	0.02	0.07	0.09	0.13	0.18	0.22	0.23	0.26

Source: GAMS result and Author's Own Calculations

Moreover; a power supply increment causes prices to fall in the long run. This is due to the fact that with the rise in electricity supplies, the output of various sectors increase; hence, the supply of various goods increases more than what demand does. This will cause, ceteris paribus, a fall of final internal prices, which are a composite of prices of imports and domestically produced commodities. This reduction in price will in turn increase the purchasing of the households. Consequently, household's spending habits changed and Ethiopian economy experiences a positive welfare change in opting of our policy changes.

4. Conclusion and Recommendation

4.1. Conclusion

This paper examines the economy wide effect of Ethiopian renaissance dam on Ethiopian economy. The model is based on an updated Social Accounting Matrix for 2019/20 that takes into account the structural changes in the economy. Given the additional electricity generation capacity of Ethiopia, the model run a policy simulation in which the additional 5,150 MW that scheduled to come online near the future form renaissance dam. To analysis this policy option this paper outlined a recursive dynamic computable general equilibrium approach. In opting for the policy shock, the results of exercise showed that with an

increment in power supply from renaissance dam the country can optimize the beneficial impacts on its economy. Specifically, the simulation results show a spreading out effect in real GDP, sectors output, real investment, factor income, households income and households consumption expenditure. The result of the exercise also showed an improvement in the welfare for all the households' categories, however; the shift in relative income across the household categories favors high income households.

4.2. Recommendation

In the backstop of the above mentioned results, this study comes out with the following recommendations:

Under the background of a long-term power supply from the Ethiopian renaissance dam, industries transfer to high power-consuming sectors from low power consuming one. Hence; it is imperative to ensure adequate power supply to meet the industrial electricity demand and to avoid the adverse effects of electrical power shortages on industrial production. As production and productivity of industrial sector improves more following the construction of Ethiopian renaissance dam, it is imperative to speed up the adjustment of industrial structure. This is also necessary to increase the proportion of service industry to GDP and employment creation. At the same time, national policy makers should give special emphasis on the construction of Ethiopian renaissance dam as additional power supply from GERD makes the output of almost every sector increases and Ethiopian economy experiences a positive welfare change in opting of our policy changes. Overall, this paper suggests that Ethiopian economy enjoys the largest improvement with additional power supply resulting from Ethiopian renaissance dam, therefore; concerned bodies should exerted maximum efforts to finalize the projects on time and resolve the age-long problems of the people so that the economy maintains its tremendous progress.

4.3. Areas of Futre Research

This paper only considered the economic impact of the construction of Ethiopian renaissance dam; therefore, further research is required to get a more holistic view on the impact of Ethiopian renaissance dam on the environment and social considerations. Again, this research only creat one simulation scenario i.e. amount of electricity gernatated from GERD, hence further research can do a better job by creat additional policy scenarios' like saving rate. Consequently, alongside policy options that can spur

greater employment and economic growth by reducing the cost of adopting environment friendly energy strategies will append attention in the theme.

References

Barbara, I and Susan, D. (2018). Introductory Statistics. *Open Access Textbooks*. 6. https://commons.erau.edu/oer-textbook/6

Block, P. &Strzepek, K. (2010). Economic Analysis of Large-Scale Upstream River Basin Development on the Blue Nile in Ethiopia Considering Transient Conditions, Climate Variability, and Climate Change.J.Water Resource.Plan.Manag., 136, 156–166.

Bohlmann, J.A., Bohlmann, H.R. and Inglesi-Lotz, R. (2015).An Economy-Wide Evaluation of New Power Generation in South Africa: The Case of Kusile and Medupi.ERSA working paper, 524.

Coupal, R.H. & Holland, D. (2002, January).Economic Impact of Electric Power Industry Deregulation on the State of Washington: A General Equilibrium analysis. Journal of Agricultural and Resource Economics, 27(1), 244-260.

Ferrari, E., McDonald, S. & Osman, R. Grand Ethiopian renaissance dam: a global CGE model to assess the economic effects on the Ethiopian economy: Proceedings of the Paper Prepared for the 16th Annual Conference on Global Economic Analysis, 2013.

International Food Policy Research Institute (IFPRI), (2010). 2010 Annual Report. International Food Policy Research Institute, Washingeton D.C . DOI 10.2499/9780896297890

Janda, K., L. Kristoufek, & D. Zilberman. (2011). Modeling the Environmental and Socio-Economic Impacts of Biofuels. IES Working Paper: 33/2011.

Khandker, S. R. and Barnes, D. F. and Samad, H. A. (2009b): Welfare Impacts of Rural Electrification: A CaseStudy from Bangladesh. World Bank, Policy Research Working Paper 4859, Washington D.C.

Levent Aydin, 2016. "Potential Economic and Environmental Implications of Diesel Subsidy: A Computable General Equilibrium Analysis for Turkey," International Journal of Energy Economics and Policy, Econjournals, vol. 6(4), pages 771-781.

Luppino, M., G. Gajewski, S. Zohir, B. Khondker, & D. (2004). Estimating the impacts of the Jamuna Bridge on poverty levels in Bangladesh using SAM and CGE models: a

comparative study. Presented at the EcoMod Input-Output and General Equilibrium: Data, Modeling and Policy Analysis Conference.

Pyatt, G. & E. Thorbecke (1976). Planning Techniques for a Bette Future.International Labour Office, Geneva, Switzerland.

Robinson, S. &Gueneau, A. (2013).Economic Evaluation Of TheDiamer-Basha Dam: Analysis With An Integrated Economic/Water Simulation Model Of Pakistan. PSSP Working Paper 14.Washington, D.C.: International Food Policy Research Institute (IFPRI).

Tewodros, N., Onno, K., Roy B. & Pieter v. (2015).Estimation of the Trans-boundary Economic Impacts of the Grand Ethiopia Renaissance Dam: A Computable General Equilibrium analysis. Water Resources and Economics 10, 14–30.

Thurlow, J. (2008). A Dynamic Computable General Equilibrium (CGE) Model for South Africa: Extending the Static IFPRI Model. Working Paper 1-2004.

Woldesenbet, A. (2005). The Impact Of Electricity Shortages On The Large- And Medium-Scale Manufacturing Industry (LMSMI) In Ethiopia: using data obtained from a casestudy of 16 LMSMI firms that was undertaken in Addis Ababa. University of Cape Town (UCT).

Vera, S. (2016). Effects of Nation-wide Blackouts on the Economy.Soko Directory's in-house journalist