<u>Technical Paper</u>
Trade-offs of economic activity, climate change and job creation in Uganda: An Economy-wide Analysis

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Abstract

The macroeconomic stability Uganda has enjoyed in the last two decades, is at risk of being eroded by climate related extreme weather events. In the recent past, floods and lands slides have devastated Uganda leaving behind fatalities and damaged public infrastructure like roads and bridges. This has mounted fiscal policy pressures to reconstruct damaged public infrastructure and also finance additional social spending like relief to the affected households. The FY 2024/25 fiscal risk statement identifies, these climate related expenditures as a major source of fiscal risks through increasing unplanned fiscal deficit and debt. To relieve government of climate related fiscal pressures, government is strategizing to again access to climate finance; which is has conditionality of adoption of greenhouse gas (GHG) emission reducing policies. A similar conditionality follows the European Union's (EU) decision to roll-out the Carbon Border Adjustment Mechanism (CBAM), which might compromise agricultural and industrial exports to the EU market. In addition, the Ministry of Health has linked the increase of the prevalence of respiratory diseases and mortalities to high emissions or air pollution in urban areas; where most air pollutant concentration is higher than WHO thresholds. In spite of these, fiscal policies designed to accelerate economic growth sequentially also increase GHG emissions. To curb down emissions, Uganda adopted a ban on charcoal burning, and imposed taxes on fossil fuel and older cars. However, emissions have continued to increase relative to economic output. This has raised key policy questions; first on how the trade-off between emission reduction policies and economic growth can be untangled; and also whether constraining charcoal production is an efficient policy in reducing emissions. We used an economy-wide multiplier model to examine policy options to untangle the trade-off between climate mitigation policies, economic growth and job creation. The results show that clean energy (electricity) and fuel energy are used by sectors that contribute less to economic output; and the labour force is largely employed in emitting sectors. In addition, constraining production of emitting commodities like charcoal deteriorates economic growth and jobs creation; if such a policy is not accompanied with investing in transitioning to clean energy. We thus recommend government to adopt a holistic policy package that complements the ban on emitting commodities with investments to make green energy cheap and available; promote the use of electricity in productive sectors; and also to extend the mitigation beyond energy emissions to cover emissions from production process, waste management and also adoption of energy saving tools like energy saving cooking stoves.

JEL: Q54, Q58, R51, and C67

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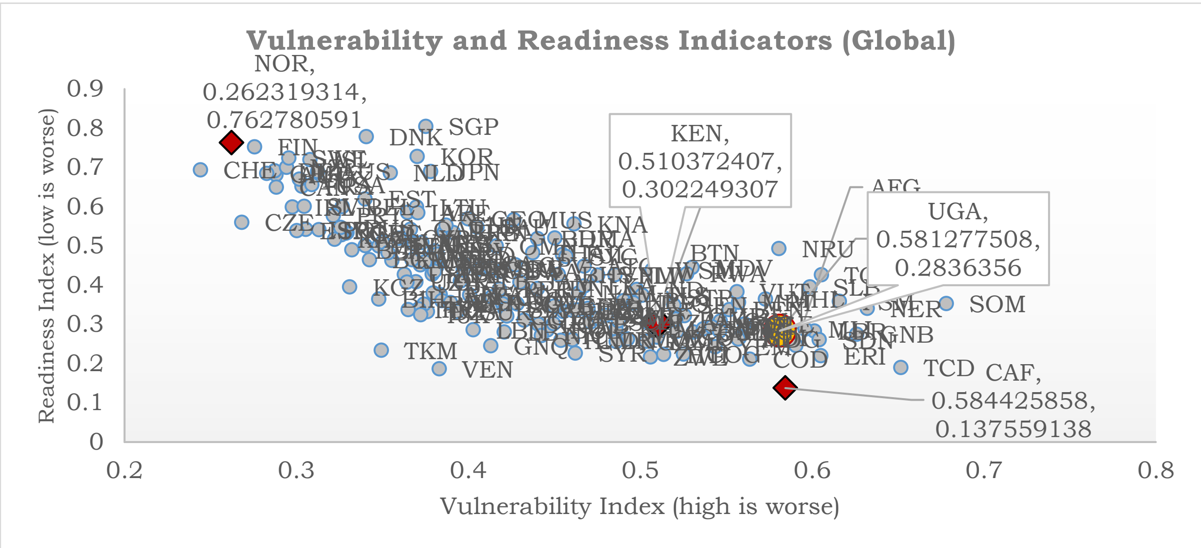
1.0 Introduction

Economic growth and employment are both instrumental components of a stable macroeconomic environment. Economies design fiscal and monetary policies to accelerate these two macroeconomic outcomes; however, since there is no free-lunch, these come at a cost to the environment as well as climate change. In addition to the risk of depleting the stock of natural capital, emissions of greenhouse gases (GHG) from economic activities increase the concentration of carbon dioxide in the atmosphere which forms a *cumulo dome* like a blanket that captures heat in the atmosphere; thus increasing temperatures (global warming) and the related climate change effects.

As a result, the incidence of climate-related disasters have increased in the global economy; with increasing disastrous effects in African economies due to their low levels of readiness and high vulnerabilities. The most recent is the cyclone *Idai* and *Kenneth* that devastated Mozambique, Malawi and Zimbabwe; and in Mozambique alone 1.85 million people were affected and caused 603 deaths (MoH (2019). Similarly, in 2024, heavy rains caused floods in Kenya which affected 380,573 people, 267 deaths and destroyed 41,562 acres of cropland. In Uganda, floods devastated the economy in 2019 displacing 65,250 persons and affecting 248,210 people (UNCERT, 2020). Similarly, in 2020, floods and landslides in eastern Uganda caused 24 deaths and loss of 4,907 livestock; and about 3,748 lives were affected (IFRC, 2022). In 2023, floods and landslides led to the loss of six people and also destroyed homesteads and public infrastructure like roads and bridges (Floodlist, 2023; and MoWE, 2023). The disastrous effects of floods in developing countries, particularly in Uganda show high vulnerability and low readiness to respond; and these have fiscal impacts in form of fiscal risks through increasing fiscal deficit and debt (MOFPED, 2024).

The Notre-Dame Global Initiative (ND-GAIN) under the University of Notre-Dame publishes annual data for countries on the vulnerability and readiness to respond to climate change shocks. Figure 1 shows the global comparisons of Uganda's readiness and vulnerability indices using the ND-GAIN database for 2021. Figure 1 shows that Uganda is among countries with the highest vulnerability indices (0.58) and the lowest readiness to respond (0.28). This justifies the need and urgency for Uganda to incorporate climate change policy analysis in their planning and policy frameworks.

Figure 1: Global comparison of Uganda's vulnerability and readiness Indecies for 2021



Source: MEFMI staff calculations, using data from Notre Dame Global Initiative (ND-GAIN)[2]

[2] ND-GAIN data accessed on 5th October 2023.

In addition to the above, scholars have found climate change events to also have distorting impact pathways to economic growth, job creation, and productivity of labour and capital (Batten et. al., 2020; Eboli et. al., 2008; and Hepworth and Goulden, 2008). Climate change has also been found to strain fiscal policy through reducing revenues, increase spending pressures and escalating debt indicators. This has created a *trio-dilemma* for fiscal policy on how to increase economic growth and job creation without distorting the climate change outcomes. This discussion paper envisages to focus the policy discussion on the *trio-dilemma* and the options for unlocking this trade-off between economic growth, employment and climate change in Uganda.

1.1 Climate change and macroeconomic development in Uganda

In the last two decades, the government of Uganda has enjoyed dividends of macroeconomic stability but these achievements have been underpinned by increasing unemployment, poverty and increased frequency of climate-related disasters like floods, droughts, landslides, and unpredictable rain seasons. Consequently, labour productivity has stalled as more than a half of Uganda's labour force has remained trapped in the agriculture sector producing a quarter of GDP (World Bank, 2022 and Asiimwe, 2022). As a mitigation measure, the government has adopted micro-economic policies; for instance, rolling out programmes like provision of seed capital to village-based saving groups (SACCOs); provision of cheap credits to small enterprises and the adoption of green fiscal budgeting with an intention to sustain and strengthen the economy's capacity to generate jobs. In addition, government has increased expenditures on social transfers to support households affected by climate-related disasters and also on the reconstruction of infrastructures washed away by floods and mudslides.

These new spending pressures have scaled-up fiscal deficit (excluding grants) to 6.1% of GDP in FY 2022/23 against the East African Community (EAC) commitment target of 3% (MoFPED, 2023) as shown in Figure 1. Consequently, debt-to-GDP has increased to 46.9% by FY 2022/23 (against a sustainability threshold of 50%). In the recent past, the combination of the effects of COVID-19 and climate change developments have synergistically contributed to having economic growth stagger below it potential of 6% as shown in Figure 2. In addition to the sluggish economic growth, the pressure of creating new jobs seems less yielding as the working population is increasing slower than the population growth rate as shown in Figure 3.

Figure 2: Trends of economic growth and fiscal deficit to GDP ratio

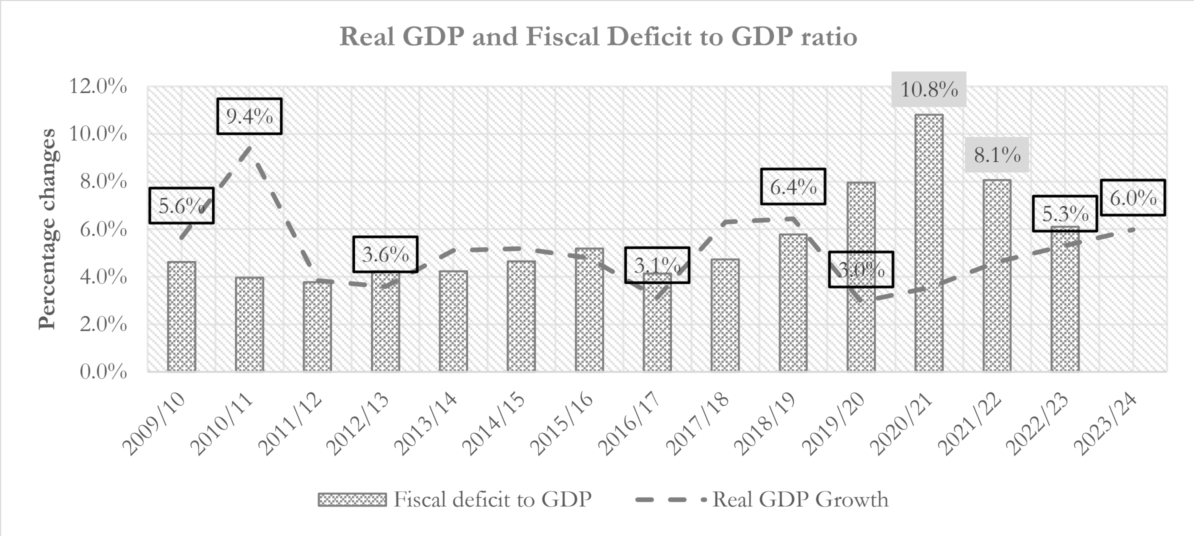
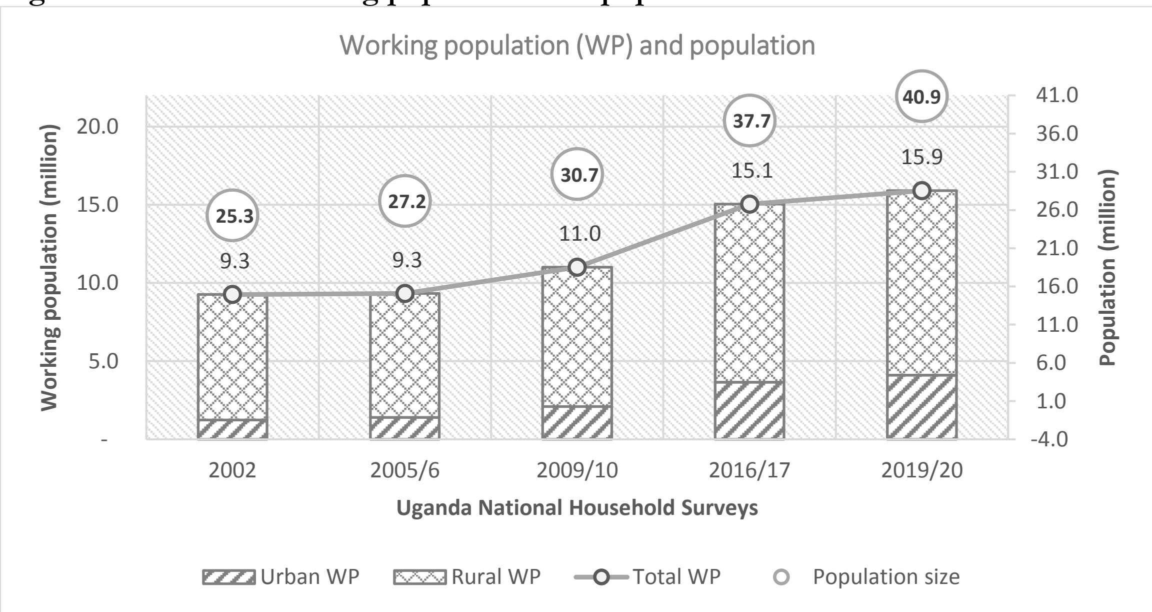


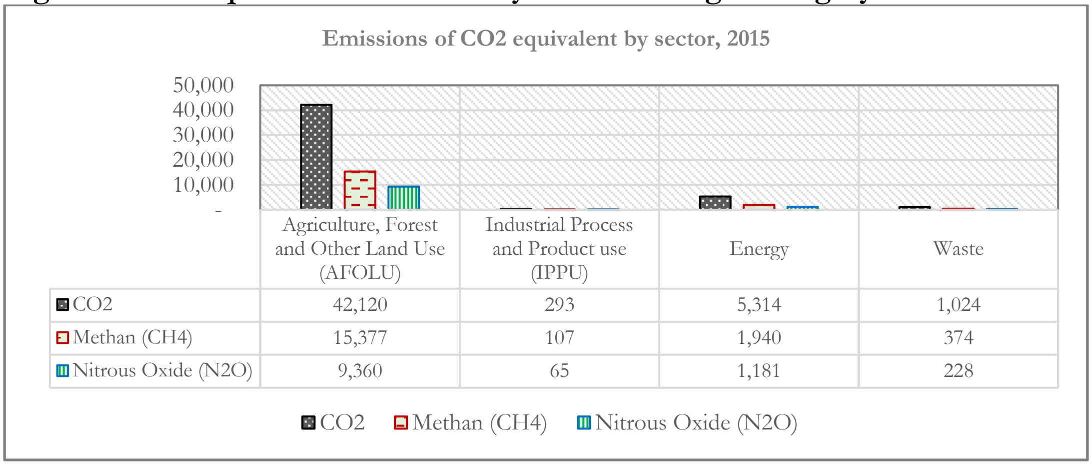
Figure 2: Trends of working population and population size



WP means working population

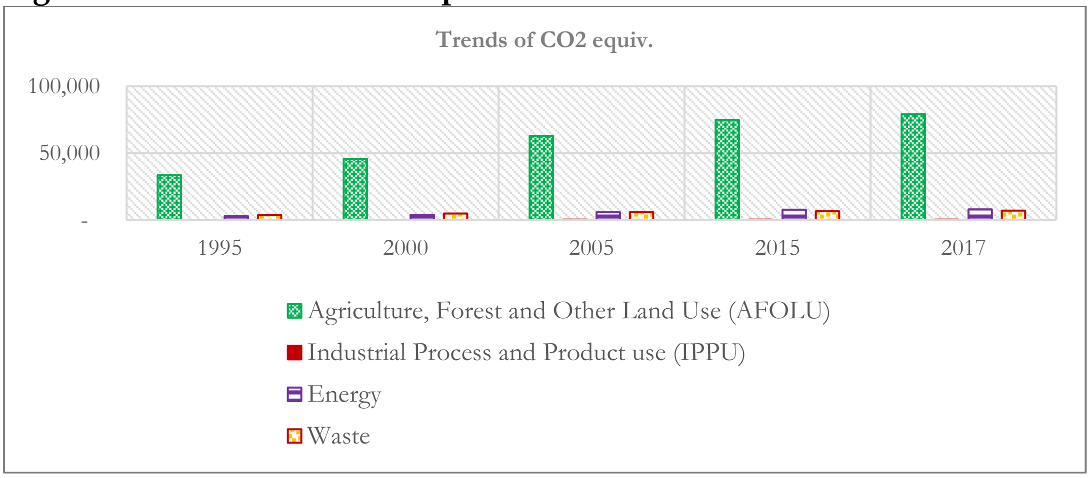
The slow economic growth and increasingly high debt to GDP have created a hedge-fence that has strained government's ability to provide adequate public services and create jobs for the rapidly growing population. This has left environmental resources, which are prone to climate change shocks as the default source of livelihood for majority of Ugandans; thus increasing natural capital depletion due to increased anthropogenic activities. Consequently, Uganda loses about 120,000 hectares of forest cover annually due to charcoal burning and firewood collection (NPA, 2020). In addition, the release of solid waste, waste water and emissions of greenhouse gases (GHGs) continue to rise in Uganda. The Ministry of Water and Environment in Uganda shows that, in 2015, about 77,381 Gg Carbon dioxide equivalent were emitted to the environment. This was followed by Methane (17,798 Gg) and Nitrous Oxide (10,833 Gg). The distribution of these emissions by sector is shown in Figure 3 whereas the emission trends are shown in Figure 4.

Figure 3: CO2 equivalent emissions by Greenhouse gas category and sector



	Agriculture, Forest and Other Land Use (AFOLU)	Industrial Process and Product use (IPPU)	Energy	Waste
CO2	42,120	293	5,314	1,024
Methan (CH4)	15,377	107	1,940	374
Nitrous Oxide (N2O)	9,360	65	1,181	228

Figure 4: Trends of emissions per sector



1.2 Problem Statement

As Uganda's fiscal policy aims at harnessing economic growth potential and job creation; raising economic output also has consequential implications on environment and climate change as discussed in section 1.1 above. Scholars like Everett *et. al.*, (2010) lists the environmental resources that form intermediate inputs for productive sectors to include; wood, water, and minerals which can lead to depletion of natural capital. This anthropogenic depletion of natural capital retrospectively forms a potential risk to the effectiveness of fiscal and monetary policies (Eboli et. al., 2008 and Batten et. al., 2020). Other scholars like Asici (2011) show that economic output can be degrading to the environment in form of emissions like release of waste water and Greenhouse gases (GHS). In regard to environmental degradation, Asici's findings dispute the environmental Kuznets curve that as income increases, degradation of the environment improves in the initial phases and later deteriorates as income increases. This argument is confirmed by the increasing emissions trends in Uganda as shown in Figure 4 above. This explicitly shows an existence of a policy dilemma on increasing economic growth and employment without deteriorating the state of the environment/climate outcomes.

To mitigate emissions, Uganda committed in the Nationally Determined Contribution (NDC) to reduce by 24.7 percent (about 36.75 million tons of CO2 equivalent) by 2030 (MoWE, 2022). The fiscal tools proposed include taxing emitting fossil fuels and supporting the new of cleaner energy sources like electricity, Liquefied Petroleum Gas (LPG) and Biofuels. Uganda adopted policies like increasing excise taxes on petrol and diesel (0.42 and 0.33 USD per litre) and also a 50 percent environmental levy on imported cars whose year of manufacture is above 10 years. In addition, in 2023 the president issued an executive order (No. 3 of 2023) that bans the burning and trade of charcoal in northern and eastern Uganda to curb down emission and environmental degradation. Contrary to these policy measures, the importation of older cars has continuously increased faster than the population growth rate (3.1 percent). In 2020 and 2021 the newly imported cars increased by 10.7 and 24.4 percent respectively (UBOS, 2023). MoWE (2022) shows that the current number of motorised vehicles is at 1,355,090 with an average age of more than 15 years old. In addition, the demand for fossil fuel by the transport sector has increased from 13,310 Terajoules (TJ) in 2005 to 43,360 TJ in 2017 (MoWE, 2022). As a result, GHG emissions has increased in the transport sector and by 2017, it was at 3,168 Gg[3] of carbon dioxide (CO2) Equivalent. In addition, the production and trade of charcoal has continued illegally in the northern and eastern parts of the country; and legally in other parts of the economy. The policy question at stance is whether these policies are *pareto optimal,* in the case of Uganda.

In addition to increasing GHG emissions and the re-occurrences of extreme weather events (like floods and landslides), Uganda's fiscal policy is increasingly strained with climate related expenditure pressures like relocation and social transfers to the affected households, and reconstruction of public infrastructure washed away by floods. Within fiscal policy discussions, government is devising options of raising finances like gaining access to climate

[3] This covers Carbon Dioxide (CO2), Methane (CH4) and Nitrous Oxide (N2O).

financing and also to shield the economy against the potential negative effects of European Union (EU) policy to roll-out the Carbon Border Adjustment Mechanism (CBAM). This is likely to affect some of Uganda's main agricultural exports like coffee which is mainly exported to the EU. Climate financing and CBAMS requirements are hinged on the partner country's policies for climate change mitigation especially in the reduction of GHG emissions. Uganda's drive to access climate financing and comply to the CBAM has inclined fiscal policy discussions on how to devise the best policy package that would mitigate GHG emission with minimal effects on economic growth and job creation.

It is on this background that this paper seeks to provide a policy discussion on the trade-off between climate change, economic activity and job creation in Uganda. The discussion focuses on the possible policy options that would untangle the trade-off between climate change policy, economic growth and employment.

1.3 Objectives

The main objective of this discussion paper is to provide a policy discussion on the trade-offs of economic activity, climate change and job creation. The specific objectives include;

i. To assess the effects of output enhancing policies on climate change and environmental variables like GHG emissions, release of waste water, and the use of environmental resources.
ii. Quantify the trade-off between economic activity, job creation and climate change mitigation
iii. Provide a policy discussion on climate change mitigations options that would untangle the trade-off between climate change policy, economic growth and employment. The discussion focuses on the comparison of energy transition and constraining economic output for the largest emitting sectors as a measure to attain the Nationally Determined Conditions (NDCs) in Uganda.

The policy discussion in this paper is envisaged to contribute to the attainment of Article 2 of the Paris Agreement which calls for "*making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development*" (UNFCCC, 2016).

2.0 Discussion of Literature

Governments frequently design policies to accelerate economic growth and create jobs especially for the youths. This role of Government is key for ensuring macroeconomic stability; and forms a conducive environment required by the private sector to thrive. However, academic and empirical studies show that, although macroeconomic stability is key for sustainable development, this is not sufficient if it does not create jobs and/or provide resilience to climate related shocks (ILO et. al., 2012). However, generating output comes along with release of waste and emissions to the environment as shown by scholars like Eboli et. al. (2008) and this makes growth enhancing policies damaging to the environment. Although, developing economies like Uganda have for decades designed growth enhancing policies with less focus on effects on climate change, scholars like Batten et. al. (2020) and Eboli et. al. (2008) have found existence of reverse pathways through which climate related disasters reduce economic growth, job creation, capital returns and productivity. In the recent past, floods and landslides have washed away public infrastructure like roads and bridges; increased unplanned fiscal deficits and debt to meet social expenditures to affected households (Floodlist, 2023; and MoWE, 2023).

Scholars like Hepworth and Goulden, (2008) found existence of impact pathways through which climate change disasters affects outputs of all productive sectors in Uganda. Quantitative official statistics show that, with exception of the post-COVID-19 period, climate change partly explain the low economic growth for Uganda in the past decade. This is confirmed by the adjusted macroeconomic indicators published annually by Government of Uganda which shows a decline in national savings due to climate change disasters. MOFPED (2023) shows that the national savings reduces from 22.6 percent of GNI to 15.7 percent of GNI when climate effects are considered. The drop is largely caused by the accelerated consumption of fixed capital due to climate disasters, carbon dioxide damage, air pollution damage, and the net forest depletion. MOFPED also shows that the decline of national savings due to climate change has been sustained more than half a decade in the past. In addition, Uganda's Ministry of Water and Environment quantified the effects of climate change effects on agriculture, infrastructure and energy. They found out that it would cost the economy in form of reduction in economic growth by about 40 years (2010 – 2050) and if nothing is done to reverse this, it would increase temperature between 1.5 and 2 degrees Celsius in the same period (MoWE, 2015). Such effects would increase the cost of borrowing for government due to the deteriorating effects on credit ratings (Cevik and Jalles, 2020). This discussion shows that climate change has strong impact pathways to economic growth and debt in Uganda.

The pathways of climate effects to the monetary sector is less mentioned in literature. But scholars like Batten et. al. (2020) have shown that climate change effects extend beyond fiscal policy to monetary sector through depletion of the central bank's ability to maintain stability of the monetary sector. The paper argues that climate effects increase uncertainties in the private sector investments and also damage the existing stock of private and public infrastructure instalments. These generate demand and supply shocks which distort precision of monetary policies and the respective outcomes.

Amidst this mist of climate scares, some scholars have shown the existence of economic growth dividends that follow a prudent management of climate related effects. Boehm (2020) and Stavros (2021) shows that managing climate change effects would improve the economy's sovereign credit rating which would taint the country with a good investment climate; and this would attract foreign direct investment that spur economic growth. However, other scholars like Averchekova et. al., (2019) show that these dividends would only emerge through implementation of climate change policies and strategies.

The discussion of literature above show the existence of economic impact pathways between climate change, economic growth and job creation in Uganda and beyond. The links within these pathways suggest a trade-off between climate policies and economic growth that need to be untangled through designing of supportive economic policy package. It is on this background that this paper proposes to address this policy knowledge gap through providing a policy discussion on how to unlock the *pareto optimality* trade-off between climate change policies and economic growth, job creation.

3.0 Methodology

To address the objectives of this discussion paper, we used the an economy-wide approach to link economic activity, climate change, and job creation. This assessment makes use of the backward and forward linkages across the sectors which are embedded in the multipliers of the input-output framework of the productive sectors. To capture the backward and forward effects across productive economic sectors, we use the multiplier model proposed by Pyatt and Round (2006). This approach has been widely used by scholars like Llop (2005) and Bandara and

Kelegama (2008). To demonstrate this model, let X_{ij} be output for sector j and a_{ij} are Leontief coefficients and F_i is the exogenous demand. To address the objectives of this discussion paper, we use both constrained and unconstrained multipliers. The unconstrained multipliers are used to generate sectoral interlinkages as well as linkages with institutional economic agents. Then the constrained multipliers provide scenarios that would support policy discussions on the impact of constraining the output of emitting sectors on the economy. These two approaches are discussed below.

3.1 The Unconstrained Multiplier Model

The multiplier model is derived as follows.

$$X_i = \sum_{j=1}^{n} X_{ij} + F_i, \quad \ldots (1)$$

$$\Delta X_i = \sum_{j=1}^{n} a_{ij} \Delta X_j + \Delta F_i, \quad \ldots (2)$$

$$(I - A)X = F \rightarrow X = (I - A)^{-1} F \quad \ldots (3)$$

Where, $(I - A)^{-1}$ is the multiplier matrix

We use the above multiplier model to compute the backward and forward linkages following the approach proposed by Parra and Wodon (2009).

$$BL_j = \frac{\sum_i nB_{i,j}}{\sum_i \sum_j B_{i,j}} \quad \ldots (4)$$

$$FL_i = \frac{\sum_j nB_{i,j}}{\sum_i \sum_j B_{i,j}} \quad \ldots (5)$$

Where; BL_j is backward linkages; FL_i is forward linkages; n is the number of accounts involved in the multiplier computations; and Σ is the summation notation.

3.2 The Constrained Multiplier Model

The constrained multiplier model supports the quantitative discussion on the policy options for mitigating climate. The use of this model allows us to constrain economic output of the emitting sectors to provide a comparison with the unconstrained scenario for discussion. The difference between the constrained and the unconstrained multiplier models provide the extent to which constraining the emitting sectors impacts the ability of other sectors of the economy to generate growth and jobs. The constrained multiplier model used in this paper follows; Breisinger *et. al.* (2010). To impose a constraint; the model is developed in such a way that for any sector where output cannot change, imports clears the increased demand of the respective commodities. Thus the constraint would have minimal impacts for commodities that are largely imported and larger effects for commodities that are purely supplied domestically. Thus, the exogenous and endogenous accounts for the emitting sectors are swapped to activate the constrained model. Eqn. (6) shows the constrained Multiplier model.

$$\begin{bmatrix} X_1 \\ F_2 \end{bmatrix} = (1 - M^*)^{-1} * N * \begin{bmatrix} F1_1 \\ X_2 \end{bmatrix} \quad \ldots\ldots (6)$$

Where; $\begin{bmatrix} X_1 \\ F_2 \end{bmatrix}$ is the new endogenous account and $\{(1 - M^*)^{-1} * N\}$ is the multiplier matrix. In the $(1 - M^*)^{-1}$ matrix, the constrained sector is replaced with the respective values in the identity matrix. Then the N Matrix, is the identity matrix where for the constrained sector is replaced with the respective values in the $(1 - M^*)$ matrix. Then, $\begin{bmatrix} F1_1 \\ X_2 \end{bmatrix}$ is the new vector of exogenous variables.

3.3. Appending Environment Vectors and Employment to Multiplier Model

To link employment and climate change to the economy-wide model, we use output intensities for energy, environmental and employment. We compute the energy, environment and emission intensities are follows.

$$\text{Energ\_int}_j = \frac{Energ_j}{[(I-A)^{-1}F]} \quad \ldots\ldots (7)$$

$$\text{Forest\_int}_j = \frac{\text{Forest}_j}{[(I-A)^{-1}F]} \quad \ldots\ldots (8)$$

$$\text{Wateruse\_int}_j = \frac{\text{Wateruse}_j}{[(I-A)^{-1}F]} \quad \ldots\ldots (9)$$

$$\text{Wastedisp\_int}_j = \frac{\text{Wastedisp}_j}{[(I-A)^{-1}F]} \quad \ldots\ldots (10)$$

$$\text{GHGemission\_int}_j = \frac{\text{GHGemission}_j}{[(I-A)^{-1}F]} \quad \ldots\ldots (11)$$

$$\text{Employ\_int}_j = \frac{\text{Employ}_j}{[(I-A)^{-1}F]} \quad \ldots\ldots (12)$$

Thus changes in demand for energy and environmental resources as well as the emission disposals would be modelled as;

$$\Delta\text{Energ} = \left[\frac{Energ_j}{[(I-A)^{-1}F]}\right][(I - A)^{-1}\Delta F] \quad \ldots\ldots (13)$$

$$\Delta\text{Forest} = \left[\frac{Forest_j}{(I-A)^{-1}F}\right][(I - A)^{-1}\Delta F] \quad \ldots\ldots (14)$$

$$\Delta\text{Wateruse} = \left[\frac{Wateruse_j}{(I-A)^{-1}F}\right][(I - A)^{-1}\Delta F] \quad \ldots\ldots (15)$$

$$\Delta\text{Wastedisp} = \left[\frac{Wastedisp_j}{(I-A)^{-1}F}\right][(I - A)^{-1}\Delta F] \quad \ldots\ldots (16)$$

$$\Delta\text{GHGemission} = \left[\frac{GHGemission_j}{(I-A)^{-1}F}\right][(I - A)^{-1}\Delta F] \quad \ldots\ldots (17)$$

$$\Delta\text{Employ} = \left[\frac{Employ_j}{(I-A)^{-1}F}\right][(I-A)^{-1}\Delta F] \quad \ldots\ldots (18)$$

Where; Energ is energy use, forest refers to the use of forest resources, wateruse is the use of water resources, wastedisp is the waste water disposal to the environment, GHGemission is the Greenhouse Gas emissions, and Employ refers to the number of jobs created.

3.4 The data

The discussion paper uses three types of data sets. First, the 2016/17 Social Accounting Matrix (SAM) which has the input-output structure of the Ugandan economy. The structure of the SAM follows Josee and Thurlow (2016) and Bellu, L. G. (2012). The second data type is the secondary data on GHG emissions, use of water, and release of solid waste and water water to the environment as a result of production and final consumption. This data was sourced from the Ministry of Water and Environment. The third category of data include macroeconomic datasets and empirical studies on Uganda to support the shocks for the model. For this policy discussion, we use the 2016/17 Social Accounting Matrix (SAM) for Uganda. The SAM naming system follows Tran et. al., (2020).

3.5 Simulation design

We simulate three scenarios. The first scenario adopts a balanced growth of aggregate demand by 5 percent and assess the impact on economic growth, employment, energy demand, emissions and the use of environmental resources. The second scenario extends the first scenario by transitioning 50 percent of biomass energy to Liquefied Petroleum Gas (LPG) as a form of clean energy. The third scenario extends the first scenario by constraining the production of emitting commodities specifically charcoal production. The second and third scenarios compare with the results of the first scenario in terms of the impacts on emissions and economics aggregates. The focus assesses on the efficiency of each of the climate mitigation polices of transitioning to clean energy and constraining production of emitting commodities. The results are discussed in section 4.0.

4.0 Results

In this section we discuss the results in two sub-sections. Section 4.1 discusses the correlation analysis of economic activity, emissions, employment and environmental resources. Then, section 4.2 presents the impact of enhanced economic activity on emissions, job creation and the use of environmental resources. Lastly, section 4.3 quantifies the policy options that can untangle the trade-off between climate policies, economic output and job creation.

4.1 Correlation analysis of economic activity, GHG emission, energy and employment

This section discusses the correlation between economic activity, emissions, energy and employment. The correlation analysis depicted in Figure 5 shows that sectors with higher multipliers for GDP, employment and output are associated with low intensities for fuel energy, electricity and emission. However, despite the existence of negative correlation between emission intensities and activity multipliers; there exist weakly positive correlation with total GHG emissions. From this, we deduce that a larger portion of emissions are generated in non-energy sources like AFOLU[4], waste and industrial processes (IPPU) as shown by the positive correlation.

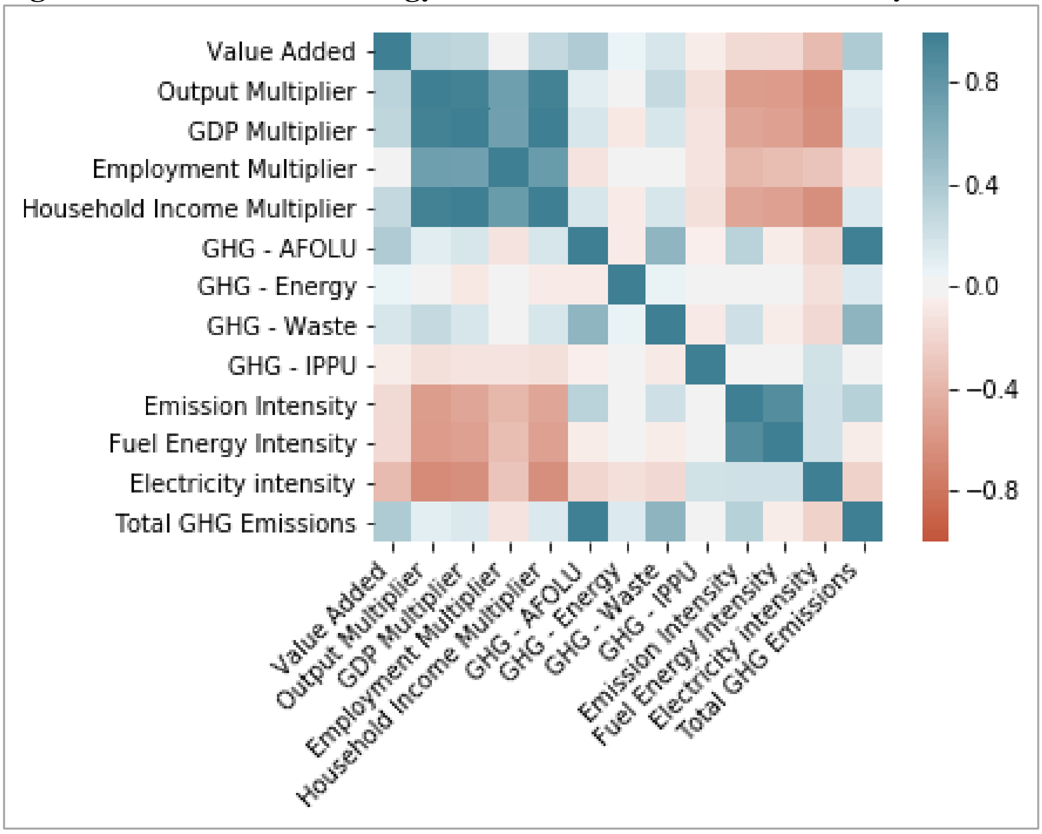
Sectors that use clean energy (hydro and solar electricity) are associated with low total GHG emission intensities; as shown by the negative correlations. In addition, sectors that use a larger portion of clean energy (hydro and solar electricity) and dirty energy (fossil and biomass) contribute less to economic output, employment and growth. In addition, sectors with the highest emission of GHG are associated with less potential of creating job creation. This highlights two policy implications. First, it justifies the existence of a trade-off between economic activity, energy use and emissions. Secondly, shows that energy use in Uganda is more consumptive and not effectively contributing to economic growth. This inclines to policy options like limiting the production of commodities with higher emission intensities. However, constraining the use of fossil and biomass could potentially constrain economic growth amplified by their backward and forward linkages with other sectors. Thus, there is need to quantify the impact of the policy option of limiting production of emitting commodities.

[4] Agriculture, Forestry and other Land Use (AFOLU)

Figure 5 also that household income multipliers are less in sectors with higher electricity and energy intensities and higher in emitting sectors especially in agriculture and sectors with higher waste emissions. The negative correlation between household incomes and energy (electricity and fuel energy) intensities is dictated by the fact that energy is mainly used by sectors that contribute less to economic output and growth. Thus, both clean energy (hydro and solar electricity) and fuel energy (fossil and biomass) are not effectively utilised to spur economic growth in Uganda. We deduce two policy implications of this finding. First, there is need for government to design policies that would promote the use of electricity and fuel energy in the productive sectors. Such policies would focus on value addition which would embrace the use of modern climate-smart technologies that would put the energy to productive use. This would accelerate economic growth and employment; with minimal harm to climate and environment. The second policy implication is to design policies that would decarbonize the sectors where majority of Ugandans are employed without limiting production. This require analysis of the potential effects of options of climate mitigations discussed in section 4.3.

Figure 5 shows a strong positive correlation between sectors with higher fuel energy intensities and higher emission intensities. This shows that fuel energy (like fossil and biomass) is key in defining the trends of GHG emissions in the production process in Uganda. Total GHG emissions are mainly driven by emissions from Agriculture, Forest and other Land Use (AFOLU) followed by Waste emissions, energy and lastly the Industrial Processes and Product Use (IPPU). However, AFOLU and waste emissions are positively correlated to economic activity (value added and output) whereas the energy emissions are weakly associated with economic activity. This implies that a large portion of GHG emission in Uganda are from non-energy sources. Thus, mitigation policies should not only focus on curbing the use of fossil and biomass fuel but also cover the non-energy sources of emissions like biomass burning, waste management and process emissions.

Figure 5: Correlations of Energy, Emissions, and economic activity



4.2 Impact of enhanced economic activity on GHG emissions, employment and use of environment resources

To address the first objective, we assess and quantify the impact of economic activity enhancing policies on emissions, employment and the use of energy and environmental resources. This provides a baseline quantification of the impact of output enhancing policies on energy demand, Greenhouse gas (GHG) emissions, job creation, and use of environmental resources. It is upon these baseline results that the trade-offs and mitigation analysis is made as discussed in the subsequent sections.

In the baseline impact analysis, we simulate the impact of a policy that increase aggregate demand by 5 percent. The results depicted in Table 1 show that this policy increases economic growth (GDP) by 3.5 percentage points and household incomes by 3.2 percent. Growth is largely driven by the industrial sector (4.0 percent) followed by agricultural sector (3.5 percent) and service sector (3.1 percent). Box 1 (Fig (a)) shows the key sub-sectors driving this growth and these are largely; food crops followed by trade, construction, agro-processing real estate and cash crops. In regards to employment, 508,758 new jobs are created mainly from the agricultural sector (294,957) followed by service sector (171,114) and lastly industry sector (42,688) as shown in Table 1. Box 1(Fig (c)) shows that the new jobs are largely in the food crop sector, followed by trade and cash crop sectors.

Table 1 also shows an increase in energy demand to the tune of 11,812 Terajoules (TJ) of fuel energy [5]; 153.1 GWh of green electricity [6] and 1.5 GWh of thermal electricity. The increase in electricity energy is mainly in the industry sector followed by services sector, household final consumption and lastly agriculture sector. The increase in energy demand drives up fuel energy GHG emissions by 256 Gg of CO2 Eq, mainly in the service sector (117.6 Gg), followed by the household final consumption (68.9 Gg), industry sector (52.9 Gg) and lastly agricultural sector (16.7 Gg). However, aggregate emissions (AFOLU, Energy, Waste and IPPU emissions sources) increases by 1,303.7 Gg CO2 Eq. Box 1 (Fig (b)) shows that from AFOLU emissions amount to 714.3 Gg, followed by Energy emissions (256.0 Gg), Waste emissions (222.2 Gg) and IPPU (11.2 Gg). Box 1 (Fig (b)) shows that the agriculture sector is the main driver of emissions increases (entire AFOLU emissions) followed by household final demand (waste emissions); whereas services and industry are the main source of energy emissions.

Table 1 also shows that, 77 percent of the aggregate GHG emissions from the industry and 95 percent of GHG emissions from the service are a result of the use of *dirty fuels'* (fossil and biomass energy). And emissions from agriculture are non-energy emissions; only 2 percent of agricultural emissions are from energy. This is justifies the findings in the correlation analysis in section 4.1 where agricultural emission were found to have a weakly negative correlation with fuel energy. This implies that the choice of mitigation policy measures for GHG emissions from the agricultural sector should focus on policies related to production processes and waste emissions whereas mitigations policies for industry and service sectors should focus transitioning to cleaner sources of energy.

In regard to environmental resources, the demand for water increases by 8.04 cubic hectometres (hm^3) with most increases in agriculture as shown in Table 1 and Box 1 (Fig (d)). Since most of the water supply to agriculture is precipitation (rain water); any slackness in this supply would require investment in irrigation to avoid constraining output and economic growth potential. Similarly, the release of waste water to the environment increases 0.019 hm^3, thus

[5] Fuel energy refers to fossil fuel (petrol, diesel, kerosene and LPG) and biomass (charcoal, firewood and agricultural waste).
[6] Green electricity means hydro and solar electricity.

requiring simultaneous investment in waste management to avoid the increase in waste emissions. The demand for forest products in form of wood (firewood, charcoal and other wood) increases by 1,725,000 metric tons; with most increases among households, followed by industry, services and lastly agriculture sector.

Table 1: Impact on economic activity, energy demand, emissions and demand of environment resources

	Agriculture	Industry	Services	Households	Total
Real GDP	3.5%	4.0%	3.1%		3.5%
Jobs - FTE	294,957	42,688	171,114		508,758
Waste Water (hm3)	0.000	0.019	0.000	0.000	0.019
Fuel Energy (TJ)	1,819	3,510	1,816	11,812	18,957
Electricity - Green (GWh)	0.5	65.7	53.3	33.6	153.1
Electricity -Thermal (GWh)	0.0	0.7	0.5	0.3	1.5
Forestry -wood (000' mt)	55.0	729.6	126.3	814.4	1,725.4
Water Use (hm3)	8.00	0.04	0.00	0.00	8.04
Energy GHG Emissions (Gg)	16.7	52.9	117.6	68.9	256.0
National GHG Emissions (Gg)	836.2	68.8	124.4	274.4	1,303.7
Household Income					3.2%

Box 1: Policy impact on economic growth, employment and use of environmental resources

Figure (a): Impact economic growth

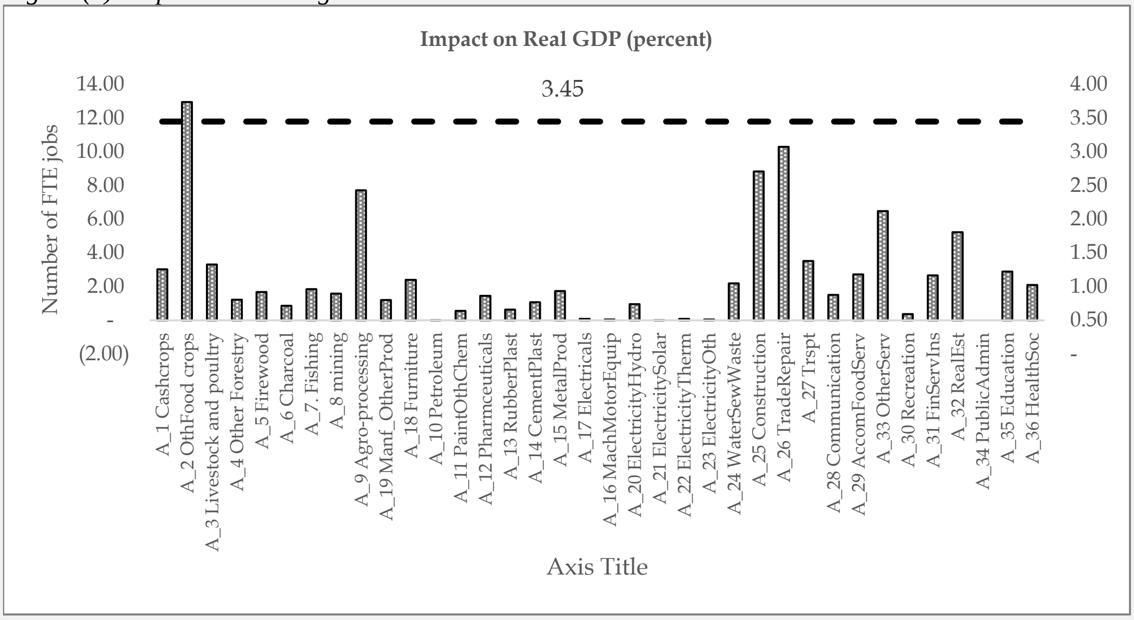


Figure (b): Impact GHG emissions

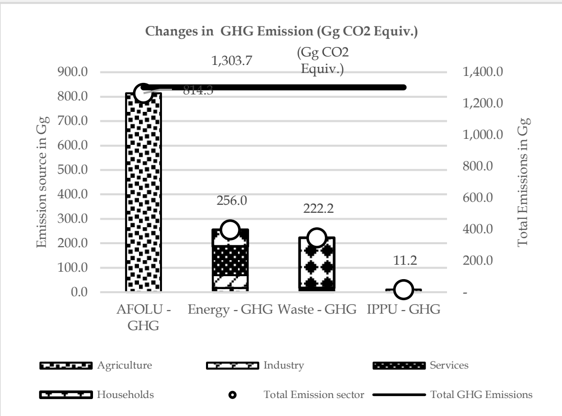


Figure (c): Impact job creation

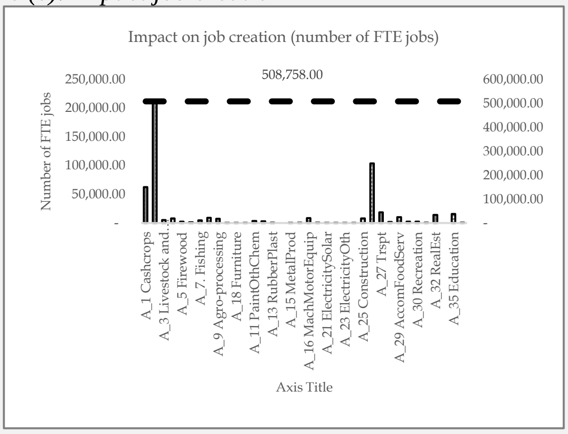
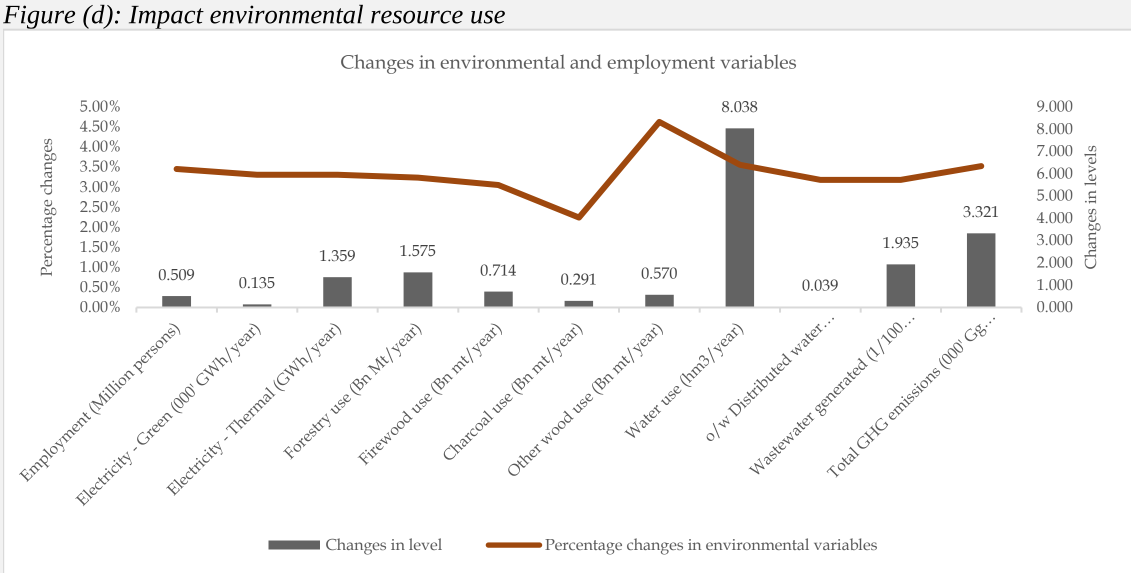


Figure (d): Impact environmental resource use



4.3 Quantify the options to untangle the trade-off between economic activity, job creation and climate change mitigation

In this section we assess the existence of a trade-off of climate change policies, economic growth, and job creation. We also compare the effectiveness of two climate mitigation policy measures including; transitioning to clean energy and constraining production of emitting commodities. The first scenario transition 50 percent of biomass use for energy to the use of LPG; whereas the latter scenario limits the production of charcoal which is one of the key sources of emissions. The results in Figure 6 show that a policy increase of aggregate demand by 5 percent would yield a benefit of 3.5 percent of GDP and 500,088 jobs; at a cost of increasing Greenhouse gases (GHG) emissions by 1,304 gigagram (Gg) which is about 3.9 percent of the emission reduction commitment in the Nationally Determined Contribution (NDC). This shows that expansion of economic activity increases emissions; and if not mitigated, it makes economic policy inconsistent with the NDC commitment of reducing emissions by 24.7 percent (about 36.75 million tons of CO_2 equivalent) by 2030 (MoWE, 2022).

To address the emission trade-off with economic activity, we introduce two climate mitigation policies and assess the response of the trade-off between emission reduction policies and economic outcomes. We compare the results of the impacts of energy transition and constraining the production of key emitting commodities. Since charcoal is the main source of biomass GHG emissions in Uganda; we simulate a constrained production of charcoal. On transitioning to clean energy; of the 505,440 TJ of biomass energy, half of this energy is transferred to the use of Liquefied Petroleum Gas (LPG). The results of these two scenario options are shown in Figure 6.

Figure 6: Scenario analysis of trade-off of emission reduction, job creation and growth

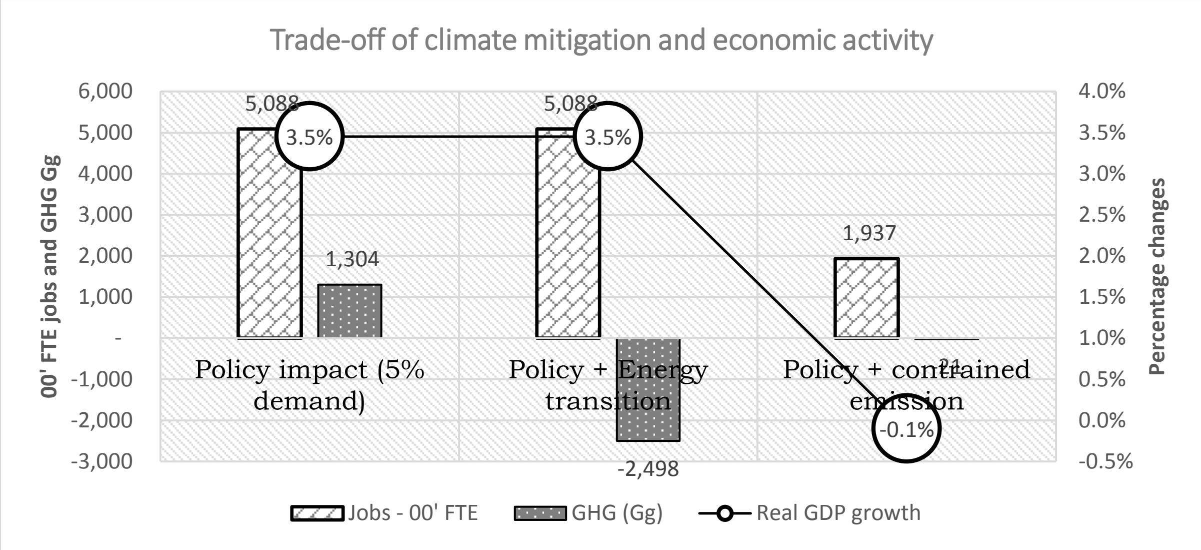


Figure 6 shows that limiting the production of charcoal given the policy increase of aggregate demand; reduces GHG emissions by 1,324 Gg (from 1,304 Gg to -21 Gg below the baseline). Box 2 (Table (a)) shows that, the emission reduction is distributed among all emission types (Energy, AFOLU, Waste and IPPU). However, this emission reduction comes at a cost of reducing economic growth gains of output expansion from 3.5 percent to -0.1 percent. In addition, household incomes gains reduce from 3.2 percent to 0.9 percent; as new jobs created reduce from 508,758 FTE[7] jobs to 193,706 FTE jobs. Box 2 (Table (b)) shows that, energy demand for fuel reduces from an increase of 7,145 TJ to a drop of -105,730 TJ (below the baseline); mainly due to direct and indirect constraints to economic output. Electricity demand reduces from 153 GWh to 76 GWh; as the demand for environmental resources also decline. These results show that, constraining the production of the emitting commodity (charcoal) as a mitigation measure for climate change; reduces GHG emissions at a cost of deteriorating economic growth, job creation, and household incomes as well as constraining the use of electricity, fuel energy and environmental resources. This amplifies the findings in the correlation analysis where energy is used in sectors that contribute less to economic growth. This requires policies that instead promote the use of energy in productive sectors to spur growth and employment. Such policies would focus on complementing the curb on charcoal production with provision of greener and cheaper source of energy like hydroelectricity, Liquefied Petroleum Gas (LPG), biofuels and energy saving cooking stoves.

[7] FTE jobs means Full Time Equivalent.

However, when we adopt the policy of transitioning to cleaner energy (50 percent from charcoal to LPG); the gains of economic growth (GDP) and new jobs remain unchanged as GHG emissions reduce by 3,802 Gg (from an increase of 1,304 Gg above the baseline to -2,498 Gg below the baseline). Box 2 (Table (a)) shows that, the emission reduction is mainly driven by change in energy emission which halves from 7,369 Gg to 3,567 Gg; and this reduces the share of energy emissions to total emissions from 19.2 percent to 10.3 percent. The reduction in GHG emissions due to energy transitioning is about 11.4 percent of the target emission reduction in the Nationally Determined Contribution (NDC) as by 2030 (MoWE, 2022).

The above discussion shows that constraining the production of emitting commodity; reduces emissions at a cost of deteriorating the potential gains of policies designed to spur economic growth and job creation. However, transitioning to cleaner energy untangles the trade-off of policy enhancement of economic output and climate change mitigation. In addition, transitioning to cleaner energy curbs down more GHG emission compared to limiting the production of emitting commodity. However, the simultaneous adoption of both policies would yield more returns to economic growth, employment and energy use while reducing emissions; towards attaining Government’s commitment in the Nationally Determined Conditions (NDC) to reduce GHG emissions by 36.75 million metric tonnes of Carbon dioxide equivalent by 2030.

Box 2: Impact of climate mitigation policy options on emissions reduction, economic growth, employment and use of environmental resources

Table (a): *Climate change mitigation measures and emissions*

	AFOLU - GHG	Energy - GHG	Waste - GHG	IPPU - GHG	TOTAL
Base case scenario					
Base - GHG	22,587	7112.54	6991.51	349.78	37,041
Shares	61.0%	19.2%	18.9%	0.9%	100%
Policy: 5% increase in aggregate demand					
Policy - GHG	23401.72	7368.55	7213.76	360.93	38,345
Shares	61.0%	19.2%	18.8%	0.9%	100%
Policy: Transition 50% towards clean energy (LPG)					
Policy - GHG	23401.72	3566.84	7213.76	360.93	34,543
New shares	67.7%	10.3%	20.9%	1.0%	100%
Policy +Constraining output for emitting sectors - Charcoal					
Policy - GHG	22,998	6,610	7,059	354	37,020

Table (b): Economic expansion and climate mitigation measures

	Agriculture	Industry	Services	Households	TOTAL
Policy: 5% increase in aggregate demand					
Real GDP	3.5%	4.0%	3.1%		3.5%
Household income					3.2%
Jobs - FTE	294,957	42,688	171,114		508,758
Waste Water (hm3)	0.000	0.019	0.000	0.00	0.019
Fuel Energy (TJ)	1,819	3,510	1,816	11,812	7,145
Electricity–green (GWh)	0.5	65.7	53.3	33.6	153.1
Electricity –Thermal (GWh	0.0	0.7	0.5	0.3	1.5
Energy GHG emission(Gg)	16	58	118	69	186
National GHG emission (Gg)	836.2	68.8	124.4	274.4	1,303.7
Forestry -wood (000' mt)	55	730	126	814	911
Water Use (hm3)	8.00	0.04	0.00	0.00	8.04
Policy + constrain output of emitting sectors - Charcoal					
Real GDP	-6.4%	2.9%	1.7%		-0.1%
Household income					0.9%
Jobs - FTE	66,802	33,533	93,371		193,706
Waste Water (hm3)	0.000	0.006	0.000		0.006
Energy (TJ)	-112,803	2,619	1,104	3,351	-105,730
Electricity–green (GWh)	0.3	36.8	29.5	9.4	76.0
Electricity –Thermal (GWh	0.0	0.4	0.3	0.1	0.8
Energy GHG (Gg)	-638	42	74	19.5	-502.8
National GHG emission (Gg)	-224	49	76	77	21
Forestry -wood (000' mt)	-848	670	54	230	106.7
Water Use (hm3)	-9.37	0.01	0.00		-9.35

5.0 Policy discussion

This paper addresses policy questions regarding whether there exist a trade-off between climate change mitigation policies and growth enhancing policies. The paper also compares the impacts of climate change mitigation policies on economic growth, employment, and the use of energy and environmental resources. Government has over time got concerned with the increase in emissions especially in the transport sector and the use of biomass as the traditional source of energy. In addition, government has observed an increase in respiratory diseases. Ministry of Health shows that in 2021, respiratory distress accounts for 1 percent of mortality and asthma accounts for 3.9 percent of mortality; Tuberculosis (TB) is responsible for 1.9 percent of mortalities and these are linked to emissions (MoH, 2021) [8]. In respect to the link of respiratory disease to emissions especially in urban areas; Government has noticed a deterioration of the air quality in cities like Kampala has deteriorated. The Uganda National Institute of Public Health published an epidemiological article in 2021 which showed that the air pollution in over 80 percent of the monitored cities was above the World Health Organisation (WHO) threshold of 25 micrograms per cubic meter; and this exposes over 90 percent of city dwellers to unhealthy air which is associated with non-communicable diseases in the cardiorespiratory system[9] (UNIPH, 2021). The concentration of pollutants with greatest health hazards was between 65 – 110 μ/m^3 higher that WHO threshold of 25 μ/m^3.

In addition to the above health risks of emissions, the country is faced with extreme weather events like floods an landslides which have caused mortalities and damaged public infrastructure; thus necessitating the reconstruction costs of damaged infrastructure making climate change a growing source of fiscal risk[10]. Also policy discussion of meeting conditions for climate financing and avoiding the negative effects of European Union (EU) roll-out of Carbon Border Adjustment Mechanism (CBAM); require Uganda to adopt GHG emission reduction policies. In relation to these calls for emission reduction, government had initially imposed a 50 percent environmental levy on imported cars that are older than 10 years; imposed tax on fuel (petrol and diesel) and also recently the president issued an executive order (No. 3

[8] Scholars like Weary *et. al.* (2024) show that the incidence rates respiratory symptoms before COVID-19 lockdown was at 254.2 cases per 1000 among the adult and 568.4 per 1000 children. The adult incidence rate for adults is 2.6 times higher than the 2019 global average for children. Thus, this risks increasing medical imports and also reducing the life expectancy and the quality of lives. In addition, Trishul *et. al.,* (2019) shows that the preference of respiratory disease like asthma are higher in urban areas where air pollution concentration is higher.

[9] UNIPH (2021) also shows that air pollution is the main global cause of respiratory disease like lung cancer, chronic obstructive pulmonary disease (COPD) and acute respiratory infections in children.

[10] MOFPED (2024) shows that climate change has potential to reduce economic growth and increase fiscal deficit and debt.

of 2023) that bans the burning and trade in northern and eastern Uganda. Contrary to the objectives of these measure, emissions have continued to increase in the transport sector, waste management sector and the use of biomass energy. The positive correlation between emission and fuel energy use has marred fiscal policy discussions with a dilemma of the choice of a policy package that can reduce emissions with minimal hurt on economic growth and job creation. Policy questions that arise include; how can the trade-off of emission reduction policies and economic growth be untangled? Is the constraining of charcoal production efficient in reducing emissions? How does this compare to transitioning to clean energy?

The results in this paper show that electricity and fuel energy are used in sectors that contribute less to economic growth and a large portion of emissions are non-energy emissions like waste management, and process emissions. Also majority if Ugandan are employed in sectors with higher emission intensities; thus limiting production in such sectors would deteriorate government's objective of job creation and growth enhancement. We deduce two policy implication from this finding. First, the emission reduction policies targeting fossil fuels and use of biomass energy may not effectively help in attaining Uganda's commitment in the Nationally Determined Contribution (NDC) of reducing emissions by 36.7 million tons of Carbon dioxide ($CO2$ eq.). Thus, the policy package should be extended to also curtail emissions from waste emissions and production processes like biomass burning and use of fertilisers in agriculture sector, process emissions in manufacturing and other sectors. Second, there is need of an additional policy package to re-align the use of electricity and fuel energy towards productive sectors so as to spur economic growth agenda. Such policy package could include promotion of value addition and adoption of modern green and energy saving technologies among productive sectors. These polices would green Uganda's development policy agenda.

In regard to environmental resources, increased economic activity raise the demand for water resources, forest products (wood) and also release of waste water to the environment. The increase in water demand is in agriculture. Since most of the water supply to agriculture is precipitation (rain water); any slackness in this supply of water would constrain agricultural output. Thus, in addition to emission mitigation measures, government need to expand the policy package to include investment in irrigation to avoid constraining economic growth potential. Similarly, the release of waste water to the environment increases 0.019 cubic hectometres (hm3), thus requiring simultaneous investment in waste management to avoid the increase in waste emissions.

Although government has adopted policies that constrain the production charcoal as per the executive order (GoU, 2023); the results of the economy-wide simulation shows that; the policy reduces emissions at the cost of deteriorating economic growth, household incomes and job creation, through the backward and forward linkages of charcoal with the rest of the productive sectors. This makes policy to ban charcoal production economically less efficient due to the trade-off of emission reduction and economic growth. On the other hand, adoption of transitioning to clean energy like electricity, LPG, biofuels and energy saving tools/equipment would reduce emissions and also retain the economic growth potential of the economy. This shows that the emission policy dilemma would be untangled by adoption of a holistic policy package that complements the ban on charcoal production with availing alternative cheap source of clean energy like hydroelectricity, Liquefied Petroleum Gas (LPG), and biofuels as well as adopting energy saving tools like cooking stoves. This would potentially reduce emissions by more than a 10^{th} of target emission reduction in the Nationally Determined Contribution (NDC).

6.0 Conclusion and recommendation

The study find the link between policies that enhance economic growth and Greenhouse gas (GHG) emissions in Uganda. Although Uganda's emission mitigation policies focus on curbing down energy emission (biomass and fossil fuel emissions); the results show that more than three quarters of the emissions are of non-energy sources like agricultural processes, waste management and biomass burning. We identify the need to twist the emission policy package to include measures that would promote the reduction of non-energy GHG emissions.

Since the ban on production of emitting commodities like charcoal comes along with a distortionary economic damage on economic growth; we recommend adoption of a holistic policy package. In summary, the government's emission reduction policy package should complement the ban on the production of emitting commodities like charcoal with the following complementary policies.

i) Adopt policies that would make clean energy cheaply available. Such energy sources include; hydroelectricity, Liquefied Petroleum Gas (LPG), biofuels and cleaner tools like energy saving cooking stoves.

ii) Since electricity and fuel energy are used in sectors that contribute less to economic output; there is need for government to adopt policies that promote the use of electricity and fuel energy in productive sectors. The effective approach would be to focus on value addition especially in agro-processing where improved technology like automated machinery would be used. In addition, since majority of Ugandans are employed in emitting sectors like agriculture; such a policy would accelerate economic growth and job creation; as well as curb down emissions.

iii) The policy package should also include focus on mitigating non-energy emissions given that a larger portion of aggregate national emissions are from non-energy sources like biomass burning, waste emissions and process emissions. Thus, inclusion of such policies in the package would effectively reduce emissions and enable government to attain the targets in the Nationally Determined Contribution (NDC).

iv) Since emissions from agriculture are largely process and waste emeissions whereas those from industry and service sector are more largely from the use of fuel energy; the choice of mitigation policy measures for agricultural sector should focus on policies related to production processes and waste emissions whereas mitigations policies for industry and service sectors should focus transitioning to cleaner sources of energy.

In conclusion, to adhere to the requirement of climate financing and avoiding the negative effects of the roll-out of the Carbon Border Adjustment Mechanism (CBAM) in the European Union (EU); government needs to adopt a comprehensive policy package that reduces emissions, complemented with investing in alternative cheap and clean energy, value addition in agriculture, waste emission management and also investment in water supply (irrigation) and forestry. Neglect of these complementary policy packages would reduce emissions but also deteriorate economic growth, employment and depletion of environmental resources.

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