Modelling of Covid-19 Impact on the Tanzanian Economy and Female Labour

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Abstract

This study used a computable general equilibrium model to investigate the likely economic impact of the COVID-19 pandemic in Tanzania focusing on gender. The study relied heavily on the official data for modelling the short-term impacts of the COVID-19 magnitude of the shock for the economic sectors, gendered labour market, and the whole economy. The analysis was carried out across different socioeconomic groups - across the country in particular, gender and rural/urban regions, in order to identify the most affected and vulnerable labour categories. The COVID-19 induced shock leads to a decline in real gross domestic product (GDP) of 5.4 % compared to the non-pandemic period. The pandemic lowered revenues from taxes and fees that led to the deterioration in the fiscal deficit. Wage rates declined more for female labour than they did for male labour in both rural and urban areas. Since the wage rate for women is normally lower than that for men, the negative impact of COVID-19 on women was more or less similar in both rural and urban areas and the demand for male labour dropped further than that for women. Moreover, many women work in export-oriented sectors, where output and export demands decreased sharply.

Keywords: COVID-19, Computable General Equilibrium Model, Gender, Tanzania

JEL code: I15, C68, J16, O55

1 Introduction

The Coronavirus disease, known as COVID-19 pandemic has caused social-economic shocks globally, with varying consequences between men and women. Indeed, evidence from past zoonotic disease[1]-driven economic crises often points to a more drastic impact on women. Past experience with epidemics (e.g. Ebola virus, Zika virus) in African countries suggests that women were more affected. There are two reasons for this. First, because women form the majority of all the caregivers resulting in higher infections rates for them (Menéndez et al., 2015; Strong and Schwartz, 2019). Second, many women are working in the sectors (e.g., trade, hospitality, tourism, and health), which were hit harder by the economic downturn resulting to a decrease of their incomes (African Development Bank, 2015).

In Tanzania, women tend to be concentrated at the lower levels of the employment ladder, and where there are lay-offs, people working in these posts (lower- level) are the first to lose jobs. Even where both men and women have the same educational qualifications, women earn less than is the case with men who also tend to get early promotions and secure top management jobs with higher salaries. Moreover, many women (52%) are employed in the informal sector and are more engaged in household activities than is the case with men. Thus, women have less job security and earnings than is the case with men. In the urban areas, 20.3 % of women-headed households are poor (Household Budget Survey, 2019).

As other African countries, Tanzania has been affected by the adverse effects of COVID-19 with the first case being confirmed on 16th March 2020. The index case involved a Tanzanian citizen who had entered Arusha from Belgium the day before. Since March 2020, the Tanzanian Government has adopted key steps of curbing the COVID-19 outbreak. These measures include closing of schools, the introduction of a fourteen days mandatory quarantine for international arrivals at their own costs, restrictions on international travels, social distancing, and restrictions of non-essential movements and public gatherings (Bank of Tanzania, 2021). In response to the effects of COVID-19, the Tanzanian government implemented a variety of economic measures to support the most affected sectors. Notable ones include granting of Value-Added Tax (VAT) and customs duties exemptions to imported medical equipment and supplies, public subsidies for tourism-related businesses to cover their operational and development expenditure and the reduction of the discount rate from 7 to 5 % by the Bank of Tanzania (United Republic of Tanzania, 2020).

From the population of more than 57.6 million (National Bureau of Statistics, 2018), the Tanzanian Government reported 509 COVID-19 infection cases, with 21 deaths by the end of May 2020 (World Health Organization, 2020). In May 2020, the Tanzanian Government stopped the reporting of statistical updates on COVID-19 infection cases (United Republic of Tanzania, 2020). This was followed by the lifting of all restrictions related to the COVID-19 in July 2020, which led to the reopening of the suspended international flights in and out of Tanzania, reopening of all educational institutions, and the resumption of sports and other social events and activities.

For the first time in its sixty-year history, Tanzania lost a sitting head of state, the late President John Pombe Magufuli, on March 17, 2021. Her Excellency President Samia Suluhu Hassan, the former Vice President was appointed as the first female President to assume this top leadership position in the land as provided for in the Constitution of the United Republic of Tanzania. The new President put particular emphasis on the economic empowerment of women and other aspects pertaining to gender equality and gender parity. In this regard, the President provided a scientific approach towards the reduction of adverse effects of the COVID-19 pandemic on the Tanzanian economy, including allowing vaccines from COVAX into the country (Rao, 2021) and championing vaccination campaigns.

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[1] This type of disease passes from an animal or insect to a human. Some don't make the animal sick but will sicken a human.

COVID-19 has had serious economic consequences in Sub-Saharan Africa, Tanzania inclusive. According to the Government assessment, the real GDP growth rate for 2020 declined from the initial projection of 6.9 to 5.5 % (United Republic of Tanzania, 2020). One of the reasons for this reduction is the effects of COVID-19 on the economy. There are many dimensions of the effects of COVID-19 outbreak on the economy including:

-    a sharp but temporary decline in domestic consumption;
-    a decline in private investment due to a decrease in the demand for loans by some sectors affected by COVID-19 pandemic.
-    spill overs of weaker demand to other sectors and economies through trade and production linkages (e.g. a decline in transit goods due to shutdown of borders;
-    a decline in the exports of crops such as cotton, cashew nuts, coffee due to the fall in demand; a decline in wholesale and retail businesses especially the importation from China, India and some European Countries;
-    a decline in tourism, hospitality services, and passenger travels.

This study investigated the economic impacts of COVID-19 on female labour and on the Tanzanian economy as a whole. A static Computable General Equilibrium (CGE) model was used to simulate the economic impacts resulting from the COVID-19 pandemic.

The study considered the following research questions:

- What is the impact of COVID-19 on the Tanzanian economy?
- What is the impact of COVID-19 on women and men?
- How has COVID-19 impacted women's employment in Tanzania?
- How can the government supports women in Tanzania during the COVID-19 era?
- What is the gender-forward recovery trajectory of the Tanzanian economy?

This study differs from other studies on COVID-19 in Tanzania because it focused on women's participation in the labour market during the pandemic outbreak. Moreover, Tanzania is one of the countries in the world, which has not been under lockdown (United Nation, 2021).

This study provides light on some of the key challenges, which women faced during the COVID-19 era and proposes measures, which could assist policymakers make informed decisions in mitigating negative impacts of COVID-19 on women and on the economy as a whole. The results of this study could be considered in the Government's efforts to ensure the gender-forward recovery trajectory of the Tanzanian economy.

The rest of the paper is structured as follows. Section 2 presents empirical evidence of gender and economic development in Tanzania. Section 3 reviews literature to situate the study, followed by the presentation of the model and data in Section 4. Section 5 presents the scenario assumptions. Section 6 describes simulation scenarios, conclusion and recommendations on policy implication.

2 Background: Gender and Economic Development in Tanzania

In recent years, Tanzania has been and still is one of the best performing economies in East Africa. This is reflected in the improvement of its Human Development Index (HDI) (Idris, 2018). Between 1990 and 2019, the score of HDI value for Tanzania increased from 0.368 to 0.529, which is above the average of 0.513 for countries in the low human development group (United Nation Development Programme, 2020; United Republic of Tanzania, 2018). For example, in Burundi, the average rate of HDI accounts for 0.431, in South Sudan, the HDI score accounts for 501 (United Nation Development Programme, 2020a; United Nation Development Programme, 2020b). On the economic front, Tanzania is transitioning from a lower income country to a middle-income country, the status she achieved in July 2020. Economic growth over the last decade averaged 6-7 %. Construction, mining, tourism, transport, and communications have been key growth drivers of the economy in Tanzania.

However, the country faces inequalities – including gender inequalities. Based on the official statistical report (Ministry of Finance and Planning - Poverty Eradication Division, 2019; Integrated Labour Force Survey, 2015), there is a gender gap in both economic participation and

in income. Tanzania, like other developing countries, has a large population and over 65 % of the population depends on agriculture and agriculture-related activities as the primary source of employment and food. The majority of women work in agriculture, but mostly as unpaid labourers, and earning less than what men earn and only a few of them hold land rights. Women in all areas (rural and urban) and at all education levels have lower labour participation rates than men have. Tanzania's gender development index (GDI) value is 0.948, while her gender inequality index (GII) value is 0.556, ranking her 140 out of 162 countries (United Nation Development Programme, 2020).

Women constitute a greater proportion of the working-age population but a smaller share of the economically active population: females account for 52.1 % of the working-age population (from 15 to 60 years old[2]), but labour force participation rate is higher among males (89.4%) than among females (84.2%). Across all educational categories, the rate share of the male is higher than that of the female (Table 1); and the gender gap is much larger for those with tertiary education than those in other categories.

Table 1. Labour force participation rate by level of education and Sex, Tanzania Mainland

Level of education	Male	Female	Total
Never attended	87.6	79.8	82.3
Primary	94.7	89.7	92.2
Secondary including vocational and non-university	81.3	78.5	80.1
Tertiary (University)	83.2	67.1	78.0
Total	**89.4**	**84.2**	**86.7**

Source: Computed by author from data on Integrated Labour Force Survey, 2015

There is also an income gap between women and men. Women receive salaries, which are on average 40.5 % lower than those received by men. This is particularly observed in agriculture where the mean monthly income for males is nearly two times (TZS 150,665/ USD 92.3) of that earned by females (TZS 92,882/ USD 56.9).

Agriculture accounts for the largest share of employment in Tanzania. A greater proportion of women than men (69% vs. 64% respectively) work in agriculture (see Figure 1). Unpaid family labourers constitute 34.5% of those employed in agriculture – there are more than twice as many females as males in this category. Significant gender gaps are frequent in ownership of farming land with far fewer women than men landholders, women owing smaller plot sizes than men do, and employing fewer workers than those employed by men and farming more for subsistence than for income generation as opposed to compared to male landholders who do otherwise.

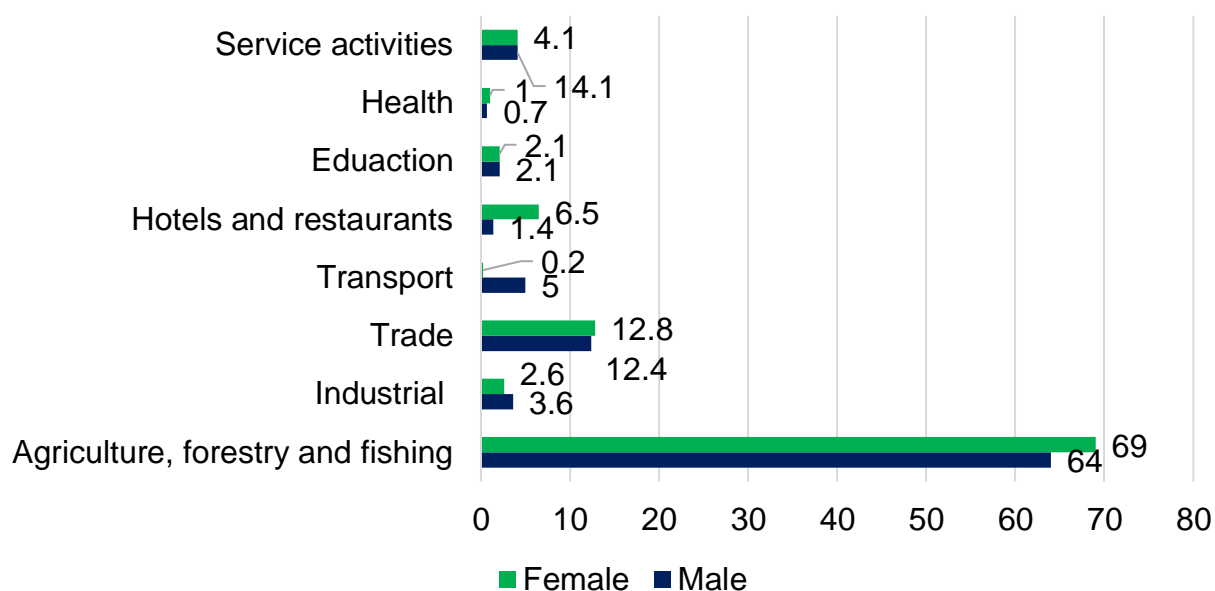[2] The retirement age in Tanzania Mainland is 60

Figure 1. Distribution of employment in different activities, by sex (in %)
Source: Computed by author from data on Integrated Labour Force Survey, 2015

Men are more likely than is the case with women to be employed in formal sectors, including government service. This implies that females are more likely to be engaged in employment with less income and less security. The share of men in the top and middle management positions is 82.6 % compared to 17.4 % for women.

Women make up a large share of employment in some of the industries, which are most directly affected by COVID-19 such as agricultural, accommodation and food services, trade, health and social work. As a result, women's income as well as consumer spending on certain foods are likely to decline. Moreover, women are traditionally responsible for taking care of the children and the sick, therefore, their domestic chores may increase the burden of responsibilities, leaving them with less time for paid activities.

3 Literature review

There is a wide range of literature on CGE-based analysis of the economic benefits of closing gender gaps, particularly in developing countries. Starting with the pioneering work of Fontana and Wood (2000) and Fontana et al. (2001), there is increasing recognition in the CGE model-based studies on the need for considering gender issues in economic policymaking.

Previous studies (i.e., Arndt and Tarp 2006; Fofana et al. 2003 Fontana and Wood 2000; Fontana et al. 2004; Arora and Rada, 2020; Cockburn et al., 2007) focused on the impact of trade liberalization policies on female labour. For example, Arndt et al. (2006) developed a CGE model for Mozambique that distinguished factor markets by gender and skills and incorporated the links between trade reforms, product prices and wages by gender. The findings by Arndt et al. (2006) revealed that, trade policy has only a modest effect on gender wage differentials, and conclude that policy concerns with gender imbalances should focus on skill upgrading and sectoral mobility rather than on trade policy.

In another study, Cockburn et al. (2007) and Chitiga et al. (2010) analysed how trade liberalization has affected gender inequality in the labour market. The authors developed an integrated CGE microsimulation model with explicit incorporation of non-market activities and gender decomposition. The findings showed that trade liberalization is strongly gendered biased against women.

Chitiga-Mabugu and Kinyondo (2009) utilized a CGE model to examine the effects of economywide and partial productivity increase on the economy, gender employment, wages,

income and welfare in South Africa. The study introduced six types of labour identified by skills and gender, and utilized a CGE model, which has 49 sectors, 14 household categories and 2 factors of production - capital and labour.

Maisonnave et al. (2016) measured the impacts of positive discrimination policy on employment, poverty and income distribution for South Africa using a CGE top-down modelling, which has two production factors namely, capital and labour. The labour was split by race group and skill level implying they end up with twelve different labour categories. Also, they introduced an unemployment rate in each labour market. The results showed a sharp decline in unemployment and poverty for each population group.

Chitiga et al. (2013) examined the impact of employment and infrastructure investments on the South African economy. For the labour market modelling, the authors used several assumptions for a CGE model in order to take into account the South African economy. The labour was disaggregated into three broad types: unskilled, semi-skilled and skilled workers. Each type of broad labour was then disaggregated into occupations. Each activity used both production factors.

Many studies in Tanzania have used CGE models when analysing the impact of various economic policies on the economy focusing on gender issues. For example, Para et al. (2010) used a 2001 Tanzania Social Accounting Matrix (SAM) to illustrate the transmission channels through which sectoral growth patterns have different effects on the incomes of women and men.

Latorre (2016) analysed the impact of tariff reform on female and male workers and the reduction of regulatory barriers faced by domestic and foreign firms operating in business services in Tanzania. The main findings show that the increase in FDI in services benefits males more than it does females.

The current study focuses on economic consequences of disease outbreaks in the economic modelling literature. This is because modelling the economic consequences of epidemics and pandemics forms an important component of preparing contingency plans for possible new outbreaks (Geard et al., 2020). It should be noted, that the economic modelling of infectious diseases literature is still small and relatively recent. A good account of the modelling approach is available in Blake et al. (2003), who developed a CGE model for the UK to provide a comprehensive assessment of the economic impacts of Foot and Mouth Disease (FMD) on tourism-related activities and other sectors of the economy. Moreover, Blake et al. (2003) linked a CGE model to a micro-regional tourism simulation (MRTS) model to analyse the economy-wide impacts of FMD in the context of intersectoral and interregional linkages in the economy.

Geard et al. (2020) examined the likely economic effects of hypothetical Ebola outbreak scenarios for two illustrative examples of developing countries in the Asia-Pacific region namely, Fiji and Timor. The economic impact of the Ebola outbreak was estimated with two linked models: a stochastic disease transmission (SEIR) model and a quarterly version of the multi-country GTAP model. In another study, Dixon et al., (2010) examined the effects of a hypothetical influenza epidemic H1N1 in the U.S.

Over the last year, CGE models have been increasingly used to evaluate the impacts of COVID-19 on the economy under different policy choices. Accordingly, several studies (i.e., Chitiga-Mabugu et al., 2021; Yue &Yun, 2021: Jin & Weixian, 2021) have analysed the impact of fiscal policy reforms in the light of COVID-19 pandemic. In addition, some of the studies (e.g., Gopalakrishnan et. al., 2020; Ayadin & Ari, 2020 ; Yang at el., 2020) analysed the impacts of COVID-19 on the tourism sector.

It should be noted, that in just six months in 2020, scholars in tourism pointed out the importance of COVID-19 impacts on the tourism sector. Thus, from January to June 2020, over 23,600 published papers on COVID-19 topic were indexed on the Web of Science and Scopus (Teixeira da Silva, 2020). Haleem et al (2020) identified 18 areas of academic research including travel and tourism industry, which were affected by COVID-19. Thus, Haleem et al. (2020) concluded that multi-disciplinary research would help understanding further COVID-19 and its socio-economic consequences on the society. Despite the plethora of studies on the impact of

COVID-19 on the society, only a few of these focused on the gendered labour market related issues.

In a recent study, Chitiga et al. (2021a) conducted a study in South Africa and that women were more adversely affected by the COVID-19 than men were since they (women) comprise the majority of low-skilled workers which are more concentrated in sectors that are hurt the most by COVID-19. Moreover, the authors found that poverty rates among female-headed households have increased by a high magnitude than for male-headed households. The authors concluded, that COVID-19 could increase women's vulnerability.

Escalante and Maisonnave (2021) evaluated the impact of COVID-19 pandemic on women's welfare and domestic burden in Bolivia and revealed that, female-headed households in general and those headed by unskilled women, in particular, are the most affected, as they experience significant reductions in employment and the largest increase in household burden. They found that poverty outcomes increased for more women than men.

Maisonnave and Cabral (2020) and Mabugu et al. (2021) looked at gendered impacts of COVID-19 pandemic responses for Senegal and Zimbabwe respectively. The authors did a modelling analysis of the impact of alternative COVID-19 mitigation and recovery scenarios. The analysis was done nationwide and across diverse socioeconomic categories – particularly on gender and rural/urban regions with the aim of identifying the most affected and vulnerable populations and the manner in which the planned recovery policies affect them.

The current study therefore complements the recent literature with a CGE model-based COVID-19 impact analysis for the Tanzania's economy. Unlike most of the existing studies on the impacts of the pandemic on the developing countries, the current study considered recent shocks of the COVID-19 pandemic on gender employment in the Tanzanian economy.

4 Methodology: Data and Model
4.1 Data
4.1.1 Social Accounting Matrix

The benchmark data, which were used to calibrate the CGE model, were arranged in the form of a Social Accounting Matrix (SAM), which is a system of accounts recording all transactions between agents in the economy. The SAM developed in this section serves two purposes. Firstly, it helps in understanding the structure of the Tanzanian economy and its main labour market characteristics in the reference year 2015; secondly, it provides a database for the CGE model.

Tanzania's 2015 SAM, which was developed by International Food Policy Research Institute (IFPRI) was used for this study (Randriamamonjy & Thurlow, 2017). The SAM describes 55 sectors and 56 commodities. For the purpose of this study, two main adjustments were made to the labour factors of the original structure of the updated 2019 Tanzanian SAM.

First, the labour categories were reclassified into three categories based on education levels. The first group was unskilled low educated labour without school education from grade 1 to 6, the second group was semi-skilled workers with medium education from grades 7 to 10, the third group included the skilled workers with secondary education who completed grade 12 or with tertiary education with academic diplomas and degrees. Second, the labour categories were split into males and females using the Integrated Labour Force Survey report for 2014 (NBS, 2017) that gives the earnings by activities for both male and female workers in urban and rural areas. Consequently, there were twelve labour categories, namely urban male and female unskilled, semi-skilled and skilled workers; and rural male and female unskilled, semi-skilled and skilled workers. Capital is categorized into four subcategories: crops, livestock, mining and other capital.

Using the SAMBAL method by Lemelin et al (2013), the 2015 SAM for Tanzania was updated to 2019 (Table 2). Table 2 shows that the structure of the Tanzanian economy observed in the SAM is very similar to that resulting from World Bank data and national reports.

Table 2. Macroeconomic indicators

Indicators	SAM for Tanzania	
	2015	**2019**
GDP at market prices, bln TZS	85 816	103 029
Share of final private expenditure in GDP	0.603	0.606
Share of Government expenditures in GDP	0.145	0.088
Share of Exports in GDP	0.222	0.165
Share of Imports in GDP	0.271	0.211
Share of Gross fixed capital formation in GDP	0.299	0.352
GDP at basic prices, bln TZS	78 716	89 195
Share of Agricultural sector in GDP	0.303	0.295
Share of Industrial sector in GDP	0.253	0.282
Share of Service sector in GDP	0.444	0.423

Source: author's calculations based on the 2015 Tanzanian SAM (Randriamamonjy & Thurlow, 2017)

According to the structure of the Tanzanian economy, as shown in Tables 3 and 1A[3] in Appendix 1, the service sector contributes about 42.3% of the GDP, which is the highest of all the sectors, while the agricultural and industrial sectors contribute 29.5% and 28.2% respectively. The following sectors contribute the most to the Value-Added: Construction (13.6%), Trade (13.2%), Transport (4.9%), Business services (5.4%), Public Administration (5.6%), Mining (5.1%), Maize (3.2%), Fruits and Nuts (3.8%) and Forest (3.3%).

Table 3. Composition of the Tanzanian economy, by main sectors in %age

Sector	Domestic Production		Value added at factor cost		Imports (M)		Exports (X)	
	Value	Share (%)	Value	Share (%)	Value	Share (%)	Value	Share (%)
Agricultural	28950.7	19.5	26312.5	29.5	697.1	2.5	4387.4	20.5
Industrial	48171.1	32.5	25153.0	28.2	18285.5	66.7	11198.8	52.2
Services	71198.3	48.0	37729.5	42.3	8431.1	30.8	5851.1	27.3
Total	**148320.1**	**100**	**89195.0**	**100**	**27413.8**	**100**	**21437.3**	**100**

Source: author's calculations based on the updated 2019 Tanzanian SAM (Randriamamonjy & Thurlow, 2017)

In terms of international trade, imports are mainly for chemicals, including petroleum, fertilizer and pesticides (20.3%), machinery and equipment (16.6%), electricity, gas and steam (18.2%), transport (12.9%) and accommodation and food services (12.4%). Together these goods account for 80.4% of the total imports. For the following commodities, the imports exceed domestic production: wheat (682.9%), crops (170.7%), fats, oil, and vegetable processing (410.4%), chemicals (199.2%), non-metal minerals (660.8%), metal products (2476.3%), machinery and capital goods (3165.2%), electricity, gas, and steam (178.7%), accommodation and food (90.3%) and transport (34.8%) (see Table 1a, Appendix 1). Forest (12.1%), mining (21.2%), accommodation and food services (17.5%), and transport (6.9%) sectors represent 57.7% of the total exports; while the pulses (1.8%), oilseeds (1.3%), cotton (0.8%), fruits (1.9%), and cash crops (such as cocoa, coffee and tobacco) account for 6.8 % of the total exports. In terms of export propensity, almost all domestic production of cotton, flowers, cattle, fat, oil, and vegetable processing products and metal products are exported.

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[3] Table 1A provides detailed information for all sectors for the updated 2019 SAM of Tanzania

Figure 2 reflects the factors of production in the total value added of all sectors. Overall, the total service sector is the most intensive in the use of labour (65.7%) compared to Agricultural (41.3%) and Industrial (46.4%) sectors. Table 2A in Appendix 2 shows that, the Health sector is the most female-intensive labour activity, with 47.9 % of the total payments to labour going to female workers. Hotels and restaurants, education, and other services sectors follow with shares of labour income allocated to women of 41.5, 41 and 42.3% respectively. Other sectors with high intensities of female labour (exceeding 25%) include Trade and Fishing with a focus on Tuna Fisheries, Forestry, Tea Leaves and Roots.

Most of the industrial subsectors are relatively intensive in the use of unskilled and semi-skilled male workers. However, compared to female workers, males are relatively more intensive in all industrial sectors. Thus, it can expected that a simulated reform, which targets women, will impact the labour market.
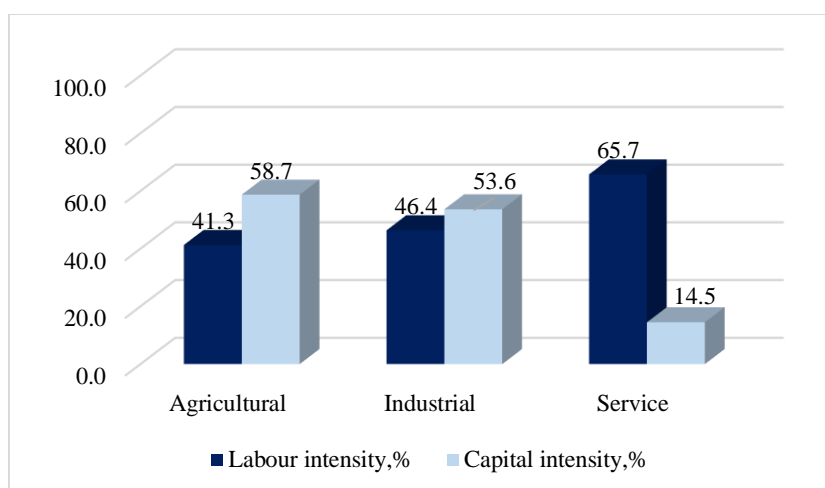
Figure 2. Production factors' contribution to main sectoral value added, %
Source: author's calculations based on the updated 2019 Tanzanian SAM (Randriamamonjy and Thurlow, 2017)

In terms of profits and returns on capital, the total agricultural sector is intensive in the use of capital (58.7%) instead of the industrial and services sectors. The industrial sector is more intensive in the use of capital too (53.6%) than in the use of labour (46.4%).

Tables 4 and 3A[4] present the sectoral composition of factor earnings, including labour by gender, skill and sectors. From Tables 4 and 2A, the preponderance of the service sector in factor returns mirrors the above observations on the distribution of employment. Most female income is from unskilled services labour, particularly, from sectors such as Trade, Business services, Public administration, Education, Health and Other services. The Service sectors are a major employer of semi-skilled and skilled women. Most of the value-added income accruing to the service sectors are accounted for by wages of semi-skilled and skilled women which represent 65.7% and 71.9% respectively of the total value added at factor cost. After the service sector, the next most important sector for unskilled female income is agriculture, which represents 41.8% of their aggregate wage bill. In terms of the use of labour, Tables 4 and 3A show that the industrial sector is extremely intensive in use of male labour.

Table 4. Sectoral composition of factor earnings (%)

Sector	Labour categories						Capital
	Unskilled		Semi-skilled		Skilled		
	Male	Female	Male	Female	Male	Female	
Agricultural	22.6	41.8	12.9	26.8	9.0	19.9	36.9

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[4] Table 3A in Appendix 1 reflects composition of factor earnings across 56 industries

Industrial	29.7	6.2	33.7	7.6	35.3	8.2	32.2
Service	47.7	51.9	53.4	65.7	55.7	71.9	30.9
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: author's calculations based on the updated 2019 Tanzanian SAM (Randriamamonjy & Thurlow, 2017)

4.2 Model
4.2.1 Description of the CGE Model

The Partnership for Economic Policy (PEP) static computable general equilibrium (CGE) model was used for the modelling of the impact of COVID-19 on the Tanzanian economy and female labour. A detailed description of the model's behavioural relationships can be found in Decaluwé et al. (2013).

4.2.2 Model specifications

In the model, there are three factors of production, land, capital and labour. According to our SAM, labour is disaggregated by areas (urban and rural), gender and skills. The domestic production function is assumed to be of constant returns to scale and presented in a two-level production process.

At the first level, the output is a Leontief function of value added and intermediate consumption. At the second level, it is assumed that the composite labour and composite capital are substitutes following a constant elasticity of substitution (CES) function.

Agents in the model include households, firms, government and the rest of the world (ROW). The household receives income from capital and labour as well as transfers from institutions. The firms' income is derived from capital owned and transfers from other institutions, while they spend on dividends and direct taxes and make savings.

The government collects taxes (direct, indirect taxes and import duties) and provides subsidies (negative tax) on commodities and activities. On the other hand, the government spends on commodities, makes transfers and saves. The ROW obtains its income from capital, labour, imports and transfers from firms and government. The ROW spending consists of commodities purchases (from exports) and transfers to the households (remittance). Current account balance represents the difference between ROW spending and income.

Regarding world trade, the world prices were assumed as fixed and Tanzania is a small country (price taker). Depending on the variations in the foreign savings account, the real exchange rate was assumed to be flexible, in other words, it may appreciate or depreciate and the current account balance is exogenous. Finally, when it comes to the factor markets, it was assumed that capital is fully employed and mobile across sectors, implying that, capital can be employed in different activities. Labour supply is endogenous. Labour demand, employment and wages can vary after a shock, but wage differentials are fixed at their initial level.

5 Scenario assumptions

The impact of COVID-19 on the Tanzanian economy simulated by the model considered two categories of transmission channels: (1) channels related to international shocks, and (2) channels related to domestic shocks. A key challenge for this exercise is to determine the magnitude of the shocks for each transmission channel. Based on government records and official statistics, the following assumptions for the international channels were made:
- *Increase in prices of world crude oil*

This is a simulation of a 17 % increase in the world oil price[5] and then we considered the transmission channels on the whole economy. This scenario assumes that the increase of the prices of crude oil and petroleum commodities imported by Tanzania is fully transmitted to end-users through an increase in the purchasing prices.

The average world price of crude oil has been fluctuating for the past decade. A record price collapse was in the year 2020 where prices declined sharply from USD 50.7 (March 2020) to USD 43.8 (December 2020) per barrel (approximately 35.7% decline). This was due to a huge decline in demand following the outbreak of the COVID-19 pandemic. However, oil prices started to recover in the first quarter of 2021 with prospects for further recovery of an average of USD 59.5 per barrel in March 2021 (World Bank, 2021; BOT, 2021). The price increase has been due to the unexpected higher production cuts by OPEC and its partners. The global economic recovery to pre-pandemic levels and improved growth prospects are the factors supporting the recovery (Word Bank, 2021b).

- *Decrease in exports*

Between May 2020 and 2021, Tanzania faced a decline in the global demand for its products, in particular for 42% of traditional exports (all cash crops except coffee and sisal). Minerals (tanzanite and diamond) export decreased at an annual rate of 37.4%; fish product exports decreased by 7.4%; and travel receipts from international tourism declined by 62%, due to preventive measures adopted by various countries fighting the pandemic. In this scenario, export-oriented sectors with a high rate of female employment were selected such as - pulses, oilseeds, cotton and fibber, fruits and nuts, cash crops (cocoa, and tobacco), and forest.

- *Transportation costs*

As was mentioned earlier, Tanzania was not under lockdown, therefore, only transportation costs (domestic logistic costs) were identified as the shock of the domestic transmission channel. It was assumed that logistic transaction costs increased for goods and services inside the country. The size of the shock was estimated based on the related literature (e.g., Mabugu et al., 2021).

The magnitudes of the COVID-19 shocks were computed using the Monthly Economic Review (BOT, 2021) from the Bank of Tanzania. Table 5 summarizes both international and domestic transmission channels, which were designed for scenarios reflecting the pandemic in Tanzania.

Table 5. Description of the COVID-19 shocks

Transmission channel	Shock description (period: May 2021)
International channels	
Increase in prices of world crude oil	- 17% for import prices of petroleum products
Decrease in exports	- 42% for traditional exports (pulses, oil seeds, cotton and fibre, fruits and nuts, cash crops (cocoa and tobacco), and forest) - 37.4% for minerals (tanzanite and diamond) - 7.4% for fish and fish products (tuna and other fisheries) - 62% for travel receipts from international tourism (hotel and transportation)
Local channel	
Increase in transportation costs	- 2%

Source: Author's observation based on the Bank of Tanzania (2020; 2021)

6 Results and Discussion

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[5] The period under review from March 2020 to March 2021

This section presents the simulation results with a focus on the macroeconomic, sectoral, factor market and institutional levels. The research findings were analysed in terms of the impacts of COVID-19 on economic growth, sectoral production and prices, male and female labour in urban and rural areas, and economic agents' behaviour (such as government, households, firms and the rest of the world). The model ran from 2019 (updated year of the SAM) and the simulated results were compared to the business as usual path of the economy to determine the COVID-19 impacts.

6.1 Impact on the macro-economic indicators
6.1.1 Impact on GDP and other economic variables

Table 6 illustrates the scale of the pandemic scenarios on reducing GDP and other major macroeconomic variables in the Tanzanian economy. The rest of this section discusses these results at greater length. We can clearly see that the pandemic has had negative effects on the Tanzanian economy. This is because, the real GDP declined by 5.4% due to the reduction in private investment (-6.1%) and the real consumption budget (-4.9%).

Table 6. Main Macroeconomic variables after COVID-19 (in % changes)

Macroeconomic variable	Simulation result
Real GDP at market prices	-5.4
Real consumption budget of households	-4.9
Private investment (GFCF real)	-6.1
Overall exports	+15.7
Overall imports	-20.2
Consumer Price Index	-13.9
Total investment	-23.8
Households savings	-18.1
Firms Savings	-16.6

Source: Simulation results

Tanzania faces a decrease in the demand for the exports of some of its commodities such as restaurants and accommodation (-34.4%), transport (-31%), mining (-4.9%), pulse (5.5%), cotton (-21.1%), fruits (-5.8%), tobacco (-11.4%) and forest (-14.9%) but overall, the total exports increased by 15.7%. This may seem surprising, but several reasons are attributed to this. First, is because an increase of international market prices stimulated export-oriented sales abroad. Second, in response to the COVID-19 outbreak and to support the private sector, the Tanzanian government did not implement lockdown measures without ignoring the guidelines from health professionals (URT, 2020). In summary, the results show that some export-oriented sectors (in particular 33 sectors out of 41) have not been affected. Given a fixed current account balance, the decrease in total imports (-20.2%) led to a real exchange rate depreciation (13.9%) and a corresponding increase in the overall exports. Exports increased in most of the export-intensive sectors, in other words, sectors with high export ratios (Exports/Output).

The domestic prices fell significantly. The decrease in the domestic price implies that consumers substitute for relatively cheaper domestic commodities than imports, leading to an overall decrease of imports by 20.2 %. The decrease in the total investment (23.8%) is explained by the decrease in government savings, household savings (18.1%) and firms' savings (16.6%). Household savings is a linear function of disposable income with the marginal propensity to save of 10.2 %. The households' consumption expenditure is above savings in the Tanzanian economy.

Total government revenue decrease by 15.7 % due to the reduction in the receipts from taxes and transfer payments (Appendix 4, Table 4A). The government income from transfers was reduced by 14.2 %. Because of the reduction in imports, revenues from import duties decreased

by 10.1 %. The decline in public revenue and fixed government expenditures led to an increase in the current public deficit, which was already a matter of concern before the pandemic.

6.2 Impact on sectors
6.2.1 Impact on production

The simulation scenarios related to COVID-19 had various effects on the sectors (Appendix 5, Table 5A). Due to the decrease in imports, Tanzania is facing disruption in the supply of capital goods (i.e., decrease in machinery, vehicles and transport equipment equals 16.4%) from abroad. This has affected industries which are capital intensive and source their inputs from abroad such as rice (-4.4%), pulses (-2.6%), cassava (-2.2%), root (-2.9%), vegetable (-1.8%), cotton (-20.2%), fruits (-2.4%), tobacco (-3.7%), poultry (-7.5%), livestock (-6.3%) and forest (-10.3%). Others include fish (-2.8%), mining (-3.3%), meat processing (-1.7%), food processing (9.1%), water (-2.1%), construction (-4.1%), trade (-1.3%), transportation (-3.2%), hotel (19.4%), communication (-7.8%), real estate (-4.5%) and financial service (-1.1%).

In 24 out of 56 sectors had their total outputs and the price of value-added of each sector dropping at different rates. The decline of production in these sectors can be explained by two factors. First, the construction, which represents approximately 68.5 % of the total investment, fell in the investment budget leading to the reduction of output. Indeed, this decline in investment was due to a drop in the income and savings in all institutions. Second, other sectors, which are female labour-intensive were heavily affected by the pandemic thus, women were expected to suffer much more than was the case with men.

Consequently, the level of employment follows the pattern in the total output at various rates reflecting the labour intensity of each sector. Moreover, due to the drop in the exports demand for the selected commodities, the total production in the export-oriented sectors declined. As a result, the overall demand for labour in these sectors decreased with the highest degree in mining (-14.2%), cotton (-21%) and accommodation (-19.5%).

6.2.2 Impact on Factor Market

The COVID-19 pandemic had negative impacts on both wage rates and returns to capital in the industries. Most of the industries, which experienced a reduction of output are export-oriented (Appendix 6, Tables 6A).

It is noted that industries (32 sectors out of 56) that experience output expansion saw an increase in unit profits, which is the same as saying that they experienced higher returns to capital. For some sectors, their expansion was significant and these included wheat (35.4%), Oils (13.6%) and Crops (44.3%) (Appendix 7, Figure 1A)

Due to the negative effects of the pandemic, wage rates and returns to capital were negatively affected. These decreased in each industry even in the sectors in which production was expanding.

Wage rates declined more for female labour than it did for male labour in both rural and urban areas (Appendix 7, Figure 2A). Since the wage rate for women is normally lower than that for men, the negative impact of COVID-19 on women was even harder.

Despite the wage reduction in all sectors of the economy, in rural areas, the demand for all labour categories (skilled, semi-skilled, and unskilled) was declining for sectors, which were affected by the pandemic (see Appendix 9, figure 3A). However, the overall demand for unskilled males increased by 5 % while that for unskilled females increased by 6.5 %. This mainly occurs in labour-intensive sectors, which were not hit by COVID-19. There is a similar pattern with the overall demand for medium and skilled labour. In urban areas, the overall demand for all-female labour categories grew higher than that for males. But the growth rate of urban labour was lower than was the case in rural areas.

As was mentioned in Section 2, more females than males were working in the sectors heavily affected by COVID-19. These sectors are labour intensive. However, in both rural and urban areas, the demand for male labour dropped more significantly than was the case with female labour

(Appendix 8, figure 3A and 3B). The capital rental rate decreased in all sectors. This led to an increase in the demand for capital for selected sectors. The sectors that reduced their domestic production also reduced the capital use.

6.3 Impact on agents
6.3.1 Impact on households, firms and ROW's income

The impacts of COVID-19 negatively affected the income of all economic agents in the economy (Appendix 9, Table 7A). Due to the reduction of the wage rate (Figure 4), households' labour income and total income declined by 18.5 and 18.1 % respectively. As a result, the average household consumption decreased (-8.4%). Firms' income decreased given the reduction in income from the capital rent (-18.3%) and transfer income (-13.8). The total income of ROW reduced by 14.5 %.

The study findings are in line with the Tanzanian economic update (World Bank, 2020), which showed that during the pandemic era, the growth in private consumption, accounting for roughly two-thirds of GDP, declined as a result of higher consumer risk aversion, higher precautionary savings and loss of disposable income due to unemployment or the fewer hours worked for.

6.3.2 Impact on households' consumption

Despite a significant decline in CPI (see Table 5), the real consumption budget of the households declined by 4.9%. On average, the private consumption declined by 8.4 %. Specifically, the households' consumption of agricultural commodities dropped by an average of 3.7% followed by commodities from the manufacturing sector (metal, machinery, electricity) and service sector (e.g., communication, accommodation and restaurants) (see Appendix 10, Table 7B).

7 Conclusions and policy recommendations

Tanzanian's economic fortunes are currently closely tied to the COVID-19 pandemic brought about by the coronavirus. The lockdown measures, which most of the countries around the world adopted to contain the virus, had profound economic implications for the Tanzanian economy.

The COVID-19 pandemic has had negative impacts on both women's and men's employment. The analysis in this study shows that measures of curbing the spread of the COVID-19 virus first affected the jobs predominantly held by women, such as food and accommodation services. However, as the pandemic worsened and disrupted cross-border value chains, the impact on men's employment increased because men tend to work in the sectors and jobs that are more dependent on international trade. Unskilled labour was especially hit the hardest. These findings rely however on the assumption that the pandemic would be under control by the end of 2021 and would not cause harm beyond this time threshold. The hysteresis effects might be deeper and more prolonged if the pandemic is more drawn out.

There are no mitigation measures (e.g., fiscal package) analysed in this paper. However, the results of this study are important in helping guide the Tanzanian Government towards taking informed decision of the appropriate measures when containing situations similar to COVID-19 pandemic with a focus on gender inequality.

The Government can recover from the negative impact of COVID-19 pandemic by generating additional revenue in 2021-2022 Fiscal Year through:
-   more efficient tax collection system (e.g., VAT);
-   additional revenue creation through enhanced regional trade (e.g., East African Community and Southern African Development Community).

The COVID-19 magnified the existing gender disparities and inequalities faced by vulnerable groups – primarily women. To reduce the gender inequalities and to address the long-term impacts of COVID-19 on women in the labour market, the following policy measures are suggested:
-   Supporting the digital schooling that can narrow the gender gap in education.
-   Providing subsidies to the most female intensive sectors such as trade, hotel and restaurant, health, and education.
-   Stepping up measures to increase the role and numbers of women in decision-making processes, including the prevention and response to COVID-19. It should be noted, that this policy measure is a part of Tanzanian Government Leadership and Sectors Leadership our recommendations are intended for.

8 References

African Development Bank (2015). African Economic Outlook 2015: Regional Development and Spatial Inclusion, OECD Publishing, Paris, https://doi.org/10.1787/aeo-2015-en

Arora D, Rada C (2020). Gender norms and intrahousehold allocation of labor in Mozambique: A CGE application to household and agricultural economics. *Agricultural Economics* 51, 259–272. https://doi.org/10.1111/agec.12553

Arndt, C., Robinson, S. and Tarp, F. (2006), "Trade Reform and Gender in Mozambique", *Nordic Journal of Political Economy*, vol. 32, pp. 73-89.

Aydin L. and Ari I. (2020). The impact of Covid-19 on Turkey's non-recoverable economic sectors compensating with falling crude oil prices: A computable general equilibrium analysis. *Energy Exploration & Exploitation* 0(0) 1–21.DOI: 10.1177/0144598720934007

Bank of Tanzania (BOT) (2020). Monthly Economic Review. March 2020: Bank of Tanzania. Dodoma

Bank of Tanzania (BOT) (2021). Monthly Economic Review. June 2021: Bank of Tanzania. Dodoma

Blake A., Sinclair T., and Sugiyarto G. (2003). Quantifying the impact of foot and mouth disease on tourism and the UK economy. *Tourism Economics* 9(4):449-465. DOI: 10.5367/000000003322663221

Chitiga M., Mabugu R. & Maisonnave H. (2016). Analysing job creation effects of scaling up infrastructure spending in South Africa. *Development Southern Africa*, 33:2, 186-202, DOI: 10.1080/0376835X.2015.1120650

Chitiga-Mabugu, M and Kinyondo, G. (2009). The general equilibrium effects of a productivity increase on the economy and gender in South Africa. *South African Journal of Economics and Management Sciences (SAJEMS),* Vol 12 no 3, 307-324, JUTA and CO Publishers (ISI)

Chitiga-Mabugu, M., Henseler, M., Mabugu, R., & Maisonnave, H. (2021). The impact of the COVID-19 enforced lockdown and fiscal package on the South African economy and environment: A preliminary analysis. *Environment and Development Economics,* 1-14. doi:10.1017/S1355770X21000243

Chitiga, M., Cockburn J., Decaluwé B., Fofana, I., Mabugu, R. (2010). Case study: A gender-focused macro-micro analysis of the poverty impacts of trade liberalization in South Africa. *International Journal of Microsimulation*, International Microsimulation Association, vol. 3(1), pages 104-108.

Chitiga, M., Henseler, M., Mabugu, R., Maisonnave, H (2021a). How COVID-19 Pandemic Worsens the Economic Situation of Women in South Africa. *Eur J Dev Res.* 2021 Aug 16 : 1–18
https://doi.org/10.1057/s41287-021-00441-w

Cockburn J., Fofana I., Decaluwe B., Mabugu R., Chitiga M. (2007). A Gender-Focused Macro-Micro Analysis of the Poverty Impacts of Trade Liberalization in South Africa, in: J. Lambert, P. (Ed.), *Equity*. Emerald Group Publishing Limited, pp. 269–305. https://doi.org/10.1016/S1049-2585(07)15011-0

Decaluwé, B., Lemelin, A., Robichaud, V., Maisonnave, H. (2013). Pep-1-1: the PEP standard single-country, static CGE model. Partnership for Economic Policy

Dixon, P. B., Lee, B., Muehlenbeck, T., Rimmer, M. T., Rose, A., & Verikios, G. (2010). Effects on the U.S. of an H1N1 Epidemic: Analysis with a Quarterly CGE Model. *Journal of Homeland Security and Emergency Management*, 7(1)

Escalante, L. & Maissonave, H. (2021). Gender and Covid-19: Are women bearing the brunt? A case study for Bolivia. *Journal of International Development*. DOI: 10.1002/jid.3603

Fofana I, Cockburn J, Décaluwé B (2003). Modeling male and female work in a computable general equilibrium model applied to Nepal. Université Laval. 54.

Fontana M (2004). Modelling the effects of trade on women, at work and at home: comparative perspectives. *Economie internationale* no 99, 49–80.

Fontana M, Wood A (2000). Modeling the Effects of Trade on Women, at Work and at Home. *World Development* 28, 1173–1190. https://doi.org/10.1016/S0305-750X(00)00033-4

Geard N., Giesecke J.A., Madden J.R., McBryde E.S., Moss R., Tran N.H. (2020) Modelling the Economic Impacts of Epidemics in Developing Countries Under Alternative Intervention Strategies. In: Madden J., Shibusawa H., Higano Y. (eds) Environmental Economics and Computable General Equilibrium Analysis. New Frontiers in Regional Science: Asian Perspectives, vol 41. Springer, Singapore. https://doi.org/10.1007/978-981-15-3970-1_9

Haleem A., M. Javaid, R. Vaishya. 2020. Areas of academic research with the impact of COVID-19. American Journal of Emergency Medicine, April 2020. doi.org/10.1016/j.ajem.2020.04.022

Household Budget Survey (HBS) (2019). Household Budget Survey 2017-2018: Key Indicators. National Bureau of Statistics. Dodoma

Idris, I. (2018) Mapping Women's Economic Exclusion in Tanzania. K4D Helpdesk Report. Brighton, UK: Institute of Development Studies

Integrated Labour Force Survey (ILFS) (2015). Integrated labour force survey 2014: provisional tables. National Bureau of Statistics. Ministry of Finance. Dar-es-Salaam

Jin Xu & Weixian Wei (2021) The effects of tax and fee reduction policy on mitigating shock of the COVID-19 epidemic in China, Applied Economics, DOI: 10.1080/00036846.2021.1904119

Latorre, M. (2016), A CGE Analysis of the Impact of Foreign Direct Investment and Tariff Reform on Female and Male Workers in Tanzania, World Development, 77, (C), 346-366

Lemelin, A, Fofana, I and Cockburn, J (2013) Balancing a Social Accounting Matrix: Theory and Application, available of the PEP website (https://www.pep-net.org/sambal-gpcema)

Mabugu R., Maisonnave H., Makochekanwa A. (2021): MPIA-20586 Simulations of policy responses and interventions to promote inclusive adaptation to and recovery from the COVID-19 crisis in Zimbabwe. PEP project MPIA-20586 Final Report: URL: https://portal.pep-net.org/public/project/20586

Maisonnave H, and Cabral FJ (2020): MPIA-20591 Analyzing the macro-economic impacts of COVID-19 in Senegal through the gender lens. PEP project MPIA-20591 Final Report: URL: https://portal.pep-net.org/public/project/20591

Maisonnave, Decaluwe, B., Chitiga, M. (2016). Does South African Affirmative Action Policy Reduce Poverty? A CGE Analysis. Poverty&Public Policy, 8:3. https://doi.org/10.1002/pop4.145

Menéndez C., Lucas A., Munguambe K., Langer A. (2015), *Ebola crisis: The unequal impact on women and children health*, Elsevier Ltd, http://dx.doi.org/10.1016/S2214-109X(15)70009-4.

Ministry of Finance and Planning - Poverty Eradication Division (MoFP- PED) [Tanzania Mainland] and National Bureau of Statistics (NBS), 2019. Tanzania Mainland Household Budget Survey 2017-18, Key Indicators Report. Dodoma, Tanzania.

National Bureau of Statistics NBS (2018). National Population Projections. Office of the Chief Government Statistician. Ministry of Finance and Planning. Zanzibar. National Bureau of Statistics. Ministry of Finance and Planning. Dar es Salaam.

National Bureau of Statistics NBS (2014). Foreign Trade Statistics. Ministry of Finance, National Bureau of Statistics. Dar-es-Salaam

OECD (2020). Women at the core of the fight against COVID-19 crisis, *OECD Policy Responses to Coronavirus (COVID-19)*, OECD Publishing, Paris, https://doi.org/10.1787/553a8269-en.

Parra, J. and Wodon, Q. (2010). How does grow affect labour income by gender? A Structural Path Analysis for Tanzannia. MPRA Paper. 27735, University Library of Munich, Germany.

Randriamamonjy J. and Thurlow J. (2017). *2015 Social Accounting Matrix for Tanzania a Nexus Project SAM*. Washington, DC: IFPRI

Rao, P. (2021). Tanzania's first female President Samia Suluhu addresses UN General Assembly, calls for global vaccine equity. UN Affairs https://www.un.org/africarenewal/news/tanzania%E2%80%99s-first-female-president-samia-suluhu-addresses-un-general-assembly-calls-global

Strong A.E., Schwartz D.A. (2019). Effects of the West African Ebola Epidemic on Health Care of Pregnant Women: Stigmatization With and Without Infection. In: Schwartz D., Anoko J., Abramowitz S. (eds) Pregnant in the Time of Ebola. Global Maternal and Child Health (Medical, Anthropological, and Public Health Perspectives). Springer, Cham. https://doi.org/10.1007/978-3-319-97637-2_2

Teixeira da Silva, J.A., Tsigaris, P. & Erfanmanesh, M. Publishing volumes in major databases related to Covid-19. *Scientometrics* (2020). https://doi.org/10.1007/s11192-020-03675-3

United Nation Development Programme (2020). Next Frontier: Human Development and the Anthropocene. Briefing note for countries on the 2020 Human Development Report http://hdr.undp.org/sites/default/files/Country-Profiles/TZA.pdf

United Nation Development Programme (2020a). Next Frontier: Human Development and the Anthropocene. Briefing note for countries on the 2020 Human Development Report http://hdr.undp.org/sites/default/files/Country-Profiles/BDI.pdf

United Nation Development Programme (2020b). Next Frontier: Human Development and the Anthropocene. Briefing note for countries on the 2020 Human Development Report http://hdr.undp.org/sites/default/files/Country-Profiles/SDN.pdf

United Nation Development Programme (2020c) United Nations Socio-Economic Recovery Framework for the United Republic of Tanzania. United Nations Tanzania country office

United Nations. (UN). (2021). Economic Commission for Africa; United Nations. Economic Commission for Africa (2021-02). Waving or Drowning? The Impact of Covid-19 Pandemic on East African Trade. Addis Ababa. UN.ECA. https://hdl.handle.net/10855/43923

United Republic of Tanzania (URT) (2020). National Budget Speech – 2020/21 fiscal year

United Republic of Tanzania (URT) (2018). Implementing Partner. Tanzania Human Development Report 2017. Social Policy in the Context of Economic Transformation. Economic and Social Research Foundation

World Bank. (WB). (2020). Tanzania Economic Updated: Addressing the Impact of COVID-19 with a Special Section on the Role of ICT. The World Bank Group Macroeconomics, Trade and Investment Global Practice, Africa Region
http://www.worldbank.org/tanzania/economicupdate

World Bank (2021a), World Bank Commodities Price Forecast (Constant US Dollars), April 2021. https://www.worldbank.org/en/research/commodity-markets

World Health Organisation (WHO). (2021). Coronavirus disease (COVID-19) Situation Report – 133. https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200601-covid-19-sitrep-133.pdf?sfvrsn=9a56f2ac_4

Yanga Y., Zhangb H., Chen X. (2020). Coronavirus pandemic and tourism: Dynamic stochastic general equilibrium modeling of infectious disease outbreak. Annals of Tourism Research, Volume 83, July 2020, 102913.

Guo Y., Shi, Y. (2021). Impact of the VAT reduction policy on local fiscal pressure in China in light of the COVID-19 pandemic: a measurement based on a computable general equilibrium model. *Economic Analysis and Policy*, Elsevier, vol. 69(C), pp. 253-264.

9 Appendix

Appendix 1

Table 1A. Detailed sectoral production structure of updated 2019 SAM for Tanzania

Activities	Domestic Production		Value added at factor cost		Imports (M)		Exports (X)		M/Q (%)	X/Q (%)
	Value	Share (%)	Value	Share (%)	Value	Share (%)	Value	Share (%)		
Maize	3515.8	2.4	2872.4	3.2	65.6	0.2	16.9	0.1	1.9	0.5
Sorghum and millet	492.5	0.3	386.4	0.4		0.0		0.0	0.0	0.0
Rice	1778.3	1.2	1230.7	1.4	3.3	0.0	1.7	0.0	0.2	0.1
Wheat and burley	75.3	0.1	64.5	0.1	513.9	1.9	23.8	0.1	682.9	31.6
Other cereals	24.9	0.0	23.7	0.0		0.0	8.9	0.0	0.0	35.8
Pulses	1859.1	1.3	1922.3	2.2	6.3	0.0	375.5	1.8	0.3	20.2
Groundnuts	752.9	0.5	629.1	0.7	2.3	0.0		0.0	0.3	0.0
Oil seeds	581.7	0.4	676.0	0.8	5.1	0.0	282.3	1.3	0.9	48.5
Cassava	1167.0	0.8	1119.3	1.3		0.0		0.0	0.0	0.0
Other roots	1304.7	0.9	1210.4	1.4		0.0	5.4	0.0	0.0	0.4
Vegetables	1459.3	1.0	1334.4	1.5	2.8	0.0	1.6	0.0	0.2	0.1
Sugar cane	314.1	0.2	223.7	0.3		0.0		0.0	0.0	0.0
Cotton and fibre	5.9	0.0	78.9	0.1		0.0	173.5	0.8	0.0	2945.4
Fruits and nuts	3380.6	2.3	3389.4	3.8	13.8	0.1	407.6	1.9	0.4	12.1
Cash crops (Aggregated: Cocoa. coffee and tobacco)	234.8	0.2	244.7	0.3	19.6	0.1	222.1	1.0	8.3	94.6
Tea leaves	11.3	0.0	34.4	0.0	2.3	0.0	62.0	0.3	20.5	546.9
Cut flowers	24.3	0.0	59.4	0.1	2.2	0.0	40.7	0.2	9.3	167.9
Other crops	10.0	0.0	54.9	0.1	17.1	0.1	53.1	0.2	170.7	530.0
Cattle	2819.8	1.9	2357.1	2.6	3.5	0.0	13.1	0.1	0.1	0.5
Raw milk	2420.2	1.6	2251.9	2.5		0.0		0.0	0.0	0.0
Small ruminants	416.0	0.3	385.6	0.4		0.0		0.0	0.0	0.0
Poultry	480.7	0.3	366.3	0.4	3.9	0.0		0.0	0.8	0.0
Other livestock	292.2	0.2	177.0	0.2		0.0	11.4	0.1	0.0	3.9
Forestry	2668.9	1.8	2912.5	3.3	35.3	0.1	2591.0	12.1	1.3	97.1
Fishing	2721.5	1.8	2154.5	2.4		0.0	76.0	0.4	0.0	2.8
Tuna fishing	139.2	0.1	152.9	0.2		0.0	20.7	0.1	0.0	14.9
Crude oil	0.0	0.0	0.0	0.0	3.4	0.01		0.0	0.0	0.0
Natural gas	0.0	0.0	0.0	0.0	4.8	0.02		0.0	0.0	0.0
Mining	3472.6	2.3	4548.9	5.1	12.3	0.0	4545.4	21.2	0.4	130.9
Meat processing	229.0	0.2	93.9	0.1	7.3	0.0	14.5	0.1	3.2	6.3

Fish and seafood processing	121.0	0.1	58.0	0.1	17.6	0.1	184.1	0.9	14.6	152.2
Fats and vegetable processing	92.4	0.1	395.5	0.4	379.1	1.4	1121.1	5.2	410.4	1213.5
Dairy	185.0	0.1	62.1	0.1	19.0	0.1	2.8	0.0	10.3	1.5
Grain milling	2585.1	1.7	1692.5	1.9	10.7	0.0	893.9	4.2	0.4	34.6
Sugar refining	1900.7	1.3	1149.5	1.3	77.5	0.3		0.0	4.1	0.0
Other foods	1007.4	0.7	479.9	0.5	41.6	0.2	27.7	0.1	4.1	2.8
Animal feed	46.6	0.0	15.2	0.0	1.4	0.0	7.4	0.0	3.0	15.9
Luxury foodstuff (Beverage and tobacco processing)	1524.1	1.0	2132.7	2.4	25.6	0.1	1566.8	7.3	1.7	102.8
Paper, fiber and leather products	390.6	0.3	553.0	0.6	778.0	2.8	924.0	4.3	199.2	236.6
Chemicals including petroleum, fertilizer and pesticides)	840.6	0.6	491.7	0.6	5555.2	20.3	794.0	3.7	660.8	94.5
Non metal minerals	693.1	0.5	439.1	0.5	168.5	0.6	356.2	1.7	24.3	51.4
Metal and metal products	54.7	0.0	128.7	0.1	1354.7	4.9	359.8	1.7	2476.3	657.6
Other manufacturing	778.0	0.5	356.5	0.4	136.5	0.5	139.7	0.7	17.5	18.0
Machinery	143.4	0.1	68.7	0.1	4537.5	16.6	60.6	0.3	3165.2	42.2
Electrisity, gas, and steam	280.0	0.2	274.1	0.3	4986.1	18.2	201.0	0.9	1780.7	71.8
Water supply and sewage	188.3	0.1	120.0	0.1		0.0		0.0	0.0	0.0
Construction	33638.6	22.7	12093.2	13.6	168.7	0.6		0.0	0.5	0.0
Wholesale and retail trade	20769.8	14.0	11750.9	13.2		0.0		0.0	0.0	0.0
Transport and storage	10205.0	6.9	4329.5	4.9	3547.0	12.9	1481.2	6.9	34.8	14.5
Hotel and Restaurants	3775.9	2.5	1092.8	1.2	3409.0	12.4	3752.8	17.5	90.3	99.4
Information and communication	3512.8	2.4	1907.2	2.1		0.0		0.0	0.0	0.0
Finance and insurance	3765.5	2.5	2255.3	2.5	221.3	0.8	73.2	0.3	5.9	1.9
Real estate activities	2379.5	1.6	2035.2	2.3		0.0		0.0	0.0	0.0
Business services	11331.8	7.6	4807.1	5.4	1043.4	3.8	481.2	2.2	9.2	4.2
Public administration	8353.8	5.6	5012.9	5.6	200.2	0.7	53.0	0.2	2.4	0.6
Education	3190.0	2.2	2165.3	2.4		0.0		0.0	0.0	0.0

Health and social work	2167.8	1.5	1287.6	1.4		0.0		0.0	0.0	0.0
Other services	1746.3	1.2	1085.8	1.2	10.3	0.0	9.7	0.0	0.6	0.6
Total	**148320.1**	**100.0**	**89195.0**	**100.0**	**27413.8**	**100.0**	**21437.3**	**100.0**	**18.5**	**14.5**

Note: * Imports as a share of domestic production

** Exports as a share of domestic production

Source: author's calculations based on the updated 2019 Tanzanian SAM (Randriamamonjy and Thurlow , 2017)

Appendix 2

Table 2A. Labour and capital income share in Tanzania SAM

Activity	Labour intensity,%	Female labour income intensity,%	Male labour intensity,%	Capital intensity,%	Activity	Labour intensity,%	Female labour income intensity,%	Male labour intensity,%	Capital intensity,%
Maize	17.2	7.7	9.5	82.8	Fats and vegetable processing	7.5	2.5	5.0	92.5
Sorghum and millet	13.3	6.0	7.3	86.7	Fish processing	29.9	10.1	19.8	70.1
Rice	16.8	7.5	9.2	83.2	Dairy	20.8	7.0	13.8	79.2
Wheat and burley	21.6	9.7	11.9	78.4	Grain milling	19.4	6.5	12.9	80.6
Other cereals	27.3	12.2	15.1	72.7	Sugar refining	9.4	3.2	6.3	90.6
Pulses	37.1	16.6	20.4	62.9	Other foods	17.8	6.0	11.8	82.2
Groundnuts	36.3	16.3	20.0	63.7	Animal feed	41.0	13.8	27.2	59.0
Oil seeds	34.5	15.5	19.0	65.5	Luxury foodstuff	17.7	6.0	11.8	82.3
Cassava	48.9	21.9	27.0	51.1	Paper and leather products	33.8	11.4	22.4	66.2
Other roots	63.6	28.5	35.0	36.4	Chemicals	16.1	5.4	10.7	83.9
Vegetables	32.3	14.5	17.8	67.7	Non metal minerals	19.4	6.5	12.9	80.6
Sugar cane	41.9	18.8	23.1	58.1	Metal	29.0	9.7	19.2	71.0
Cotton and fibre	49.9	22.4	27.5	50.1	Manufacturing	20.4	6.9	13.6	79.6
Fruits and nuts	36.0	16.1	19.8	64.0	Machinery	40.3	13.5	26.7	59.7

Cash crops	45.9	*20.6*	*25.3*	54.1	Electricity, gas, and steam	56.5	*2.4*	*54.1*	43.5
Tea leaves	51.2	*23.0*	*28.2*	48.8	Water supply	45.3	*12.8*	*32.5*	54.7
Cut flowers	28.0	*12.6*	*15.4*	72.0	Construction	74.1	*1.8*	*72.3*	25.9
Other crops	29.8	*13.4*	*16.4*	70.2	Trade	63.1	*26.7*	*36.4*	36.9
Cattle	34.0	*15.2*	*18.7*	66.0	Transport	41.6	*1.0*	*40.5*	58.4
Raw milk	39.6	*17.8*	*21.9*	60.4	Hotel and Restaurants	53.9	*41.5*	*12.4*	46.1
Small ruminants	42.5	*19.0*	*23.4*	57.5	Communication	23.9	*5.1*	*18.8*	76.1
Poultry	32.2	*14.5*	*17.8*	67.8	Finance and insurance	39.6	*18.6*	*21.0*	60.4
Other livestock	41.2	*18.5*	*22.7*	58.8	Real estate	7.6	*1.9*	*5.7*	92.4
Forestry	80.6	*36.2*	*44.4*	19.4	Business services	94.4	*15.2*	*79.3*	5.6
Fishing	54.4	*24.4*	*30.0*	45.6	Public administration	96.6	*15.3*	*81.3*	3.4
Tuna fishing	57.6	*25.8*	*31.7*	42.4	Education	97.2	*41.0*	*56.2*	2.8
Mining	22.5	*3.9*	*18.7*	77.5	Health	97.2	*47.9*	*49.3*	2.8
Meat processing	8.7	*2.9*	*5.8*	91.3	Other services	69.8	*42.3*	*27.5*	30.2

Source: author's calculations based on the updated 2019 Tanzanian SAM (Randriamamonjy and Thurlow , 2017)

Appendix 3
Table 3A. Sectoral composition of factor earnings (%)

Activity	Male			Female			Capital
	Unskilled	Semi-skilled	Skilled	Unskilled	Semi-skilled	Skilled	
Maize	1.0	0.6	0.4	1.9	1.2	0.9	5.7
Sorghum and millet	0.1	0.1	0.0	0.2	0.1	0.1	0.8
Rice	0.4	0.2	0.2	0.8	0.5	0.4	2.4
Wheat and burley	0.0	0.0	0.0	0.1	0.0	0.0	0.1
Other cereals	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pulses	1.5	0.8	0.6	2.7	1.8	1.3	2.9
Groundnuts	0.5	0.3	0.2	0.9	0.6	0.4	1.0
Oil seeds	0.5	0.3	0.2	0.9	0.6	0.4	1.1
Cassava	1.1	0.6	0.5	2.1	1.3	1.0	1.4
Roots	1.6	0.9	0.6	3.0	1.9	1.4	1.1
Vegetables	0.9	0.5	0.4	1.7	1.1	0.8	2.2
Sugar cane	0.2	0.1	0.1	0.4	0.2	0.2	0.3
Cotton and fibre	0.1	0.0	0.0	0.2	0.1	0.1	0.1
Fruits and nuts	2.5	1.4	1.0	4.7	3.0	2.2	5.2
Cash crops	0.2	0.1	0.1	0.4	0.3	0.2	0.3
Tea leaves	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Cut flowers	0.0	0.0	0.0	0.1	0.0	0.0	0.1
Other crops	0.0	0.0	0.0	0.1	0.0	0.0	0.1
Cattle	1.7	0.9	0.7	3.1	2.0	1.5	3.7
Raw milk	1.9	1.1	0.7	3.4	2.2	1.6	3.2
Small ruminants	0.3	0.2	0.1	0.6	0.4	0.3	0.5
Poultry	0.2	0.1	0.1	0.5	0.3	0.2	0.6
Other livestock	0.2	0.1	0.1	0.3	0.2	0.1	0.2
Forestry	4.9	2.8	1.9	9.0	5.8	4.3	1.3
Fishing	2.4	1.4	1.0	4.5	2.9	2.1	2.3
Tuna fishing	0.2	0.1	0.1	0.3	0.2	0.2	0.2
Mining	3.1	1.9	1.5	1.3	1.4	1.4	8.4
Meat processing	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Fish and seafood processing	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Fats and vegetable processing	0.1	0.1	0.1	0.1	0.1	0.1	0.9
Dairy	0.0	0.0	0.0	0.0	0.0	0.0	0.1

Grain milling	0.6	0.7	0.7	0.8	0.9	1.0	3.3
Sugar refining	0.2	0.2	0.2	0.3	0.3	0.3	2.5
Other foods	0.2	0.2	0.2	0.2	0.2	0.3	0.9
Animal feed	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Luxury foodstuff	0.7	0.8	0.8	0.9	1.1	1.1	4.2
Paper. fiber and leather products	0.3	0.4	0.4	0.4	0.5	0.6	0.9
Chemicals	0.1	0.2	0.2	0.2	0.2	0.2	1.0
Non metal minerals	0.2	0.2	0.2	0.2	0.2	0.3	0.8
Metal	0.1	0.1	0.1	0.1	0.1	0.1	0.2
Manufacturing	0.1	0.2	0.2	0.2	0.2	0.2	0.7
Machinery	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Electrisity. gas. and steam	0.4	0.5	0.6	0.0	0.1	0.1	0.3
Water supply and sewage	0.1	0.1	0.1	0.1	0.1	0.2	0.2
Construction	23.5	28.1	29.9	1.4	1.9	2.0	7.5
Wholesale and retail trade	11.7	13.5	14.2	21.4	26.7	29.1	10.4
Transport and storage	4.7	5.7	6.1	0.3	0.4	0.4	6.0
Accommodation and food services	0.4	0.4	0.5	3.1	3.9	4.3	1.2
Information and communication	0.9	1.2	1.4	0.6	0.9	1.1	3.5
Finance and insurance	1.2	1.6	1.7	2.7	3.9	4.4	3.3
Real estate activities	0.4	0.3	0.3	0.2	0.4	0.4	4.5
Business services	11.0	11.5	11.7	4.9	6.4	7.0	0.6
Public administration	11.2	12.8	13.5	5.0	7.0	7.9	0.4
Education	3.7	3.5	3.4	6.3	7.1	7.5	0.1
Health and social work	1.8	1.9	2.0	4.4	5.0	5.2	0.1
Other services	0.9	0.9	0.9	3.0	4.1	4.6	0.8
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: author's calculations based on the updated 2019 Tanzanian SAM (Randriamamonjy and Thurlow , 2017)

Appendix 4

Table 4A. Public Finance variables after COVID-19 (in % changes)

Macroeconomic variable	Simulation result
Total Government revenue	-15.7
Government Income from transfers	-14.2
Revenue from business taxes income	-18.43
Revenue from Indirect taxes	-14.03
Revenue from Import duties	-10.1

Source: Simulation results

Appendix 5

Table 5A. Impact of COVID-19 on domestic production (in % changes)

Industry	Total output	Demand for Labour	Price of value added
Rice	-4.4	-6.1	-20.8
Pulse	-2.6	-4.1	-20.7
Cassava	-2.2	-3.9	-20.6
Root	-2.9	-2.6	-20.5
Vegetable	-1.8	-5.5	-20.7
Cotton	-20.2	-21.0	-20.6
Fruits	-2.4	-3.8	-20.7
Tobacco	-3.7	-4.8	-20.6
Poultry	-7.5	-8.6	-20.7
Livestock	-6.3	-7.2	-20.7
Forest	-10.4	-9.7	-19.5
Fish	-2.8	-1.1	-25.3
Mining	-3.3	-14.2	-18.4
Meat processing	-1.7	-2.3	-18.4
Food processing	-9.1	-9.5	-17.9
Water	-2.1	-3.2	-17.9
Construction	-4.0	-4.4	-18.3
Trade	-1.4	-1.6	-18.1
Transport	-3.2	-4.1	-18.5
Accommodation and restaurants	-19.5	-19.5	-18.2
Communication	-7.8	-9.4	-18.2
Financial service	-1.2	-2.0	-18.5
Real estate	-4.6	-4.7	-18.3
Other service	-4.2	-4.3	-18.4

Source: Simulation results

Appendix 6

Table 6A. Impact of COVID-19 on factor market

Sectors	Value-added	Wage	Capital rent
Rice	-4.4	-20.5	-21.7
Pulses	-2.8	-20.5	-21.7
Cassava	-2.9	-20.5	-21.7
Root	-1.8	-20.5	-21.7
Vegetable	-4.1	-20.5	-21.7
Cotton	-20.2	-20.5	-21.7
Fruits	-2.4	-20.5	-21.7
Tobacco	-3.7	-20.5	-21.7
Poultry	-7.5	-20.5	-21.4
Livestock	-6.3	-20.5	-21.4
Forest	-10.4	-20.5	-18.4
Fish	-2.8	-20.5	-18.4
Mining	-3.3	-19.6	-27.3
Meat processing	-1.7	-18.1	-18.4
Food processing	-9.1	18.1	-18.4
Water	-2.1	-17.2	-18.4
Construction	-4.0	-17.6	-18.4
Trade	-1.4	-18.1	-18.4
Transport	-3.2	-17.5	-18.4
Accommodation and restaurants	-19.5	-18.4	-18.4
Communication	-7.8	-17.2	-18.4
Financial service	-1.2	-17.6	-18.4
Real estate	-4.6	-18.3	-18.4
Other service	-4.1	-18.1	-18.4

Source: Simulation results

Appendix 7
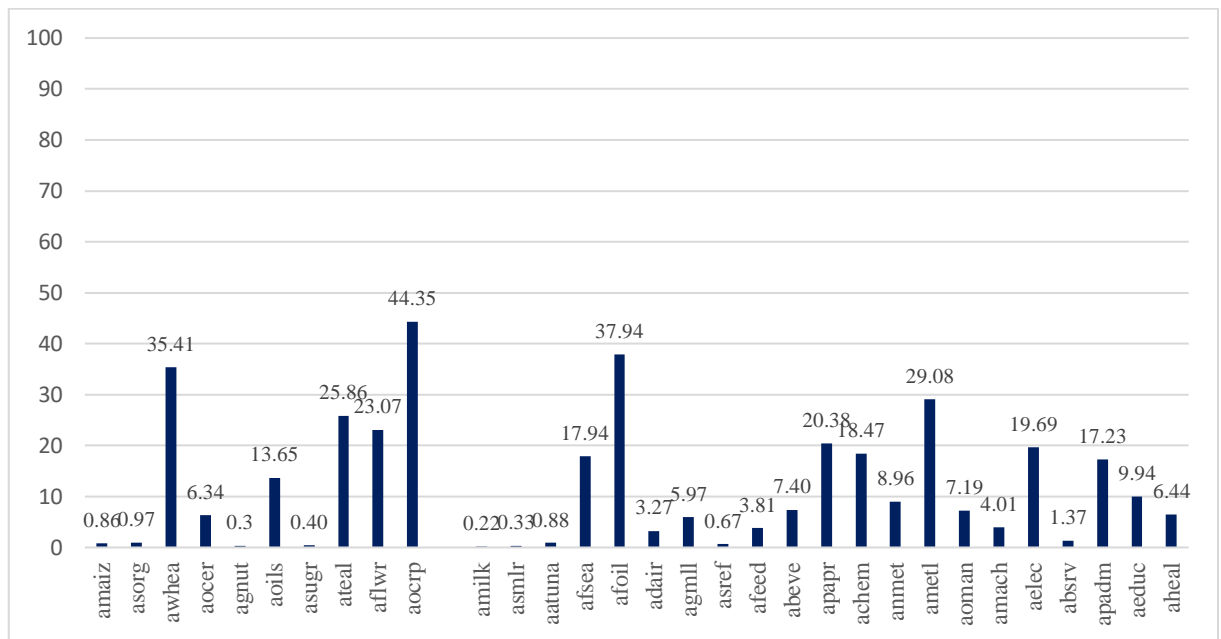
Figure 1A. Impact of COVID-19 on domestic production
Source: Simulation results
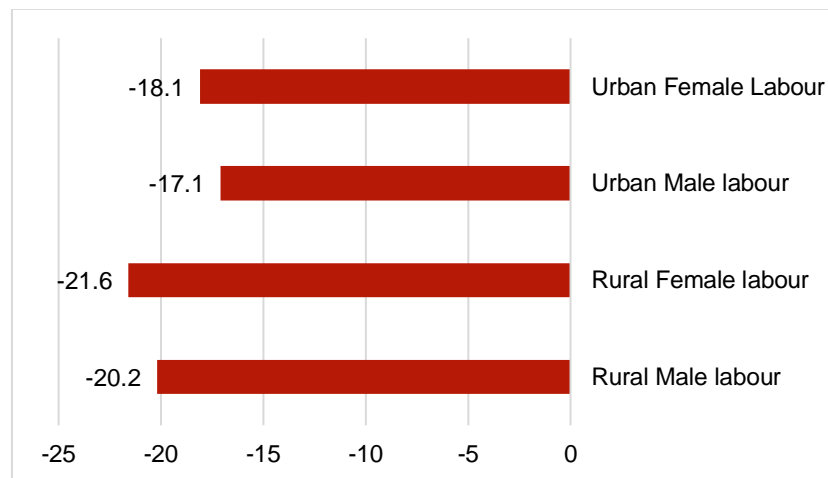
Figure 2A. Impact of COVID-19 on the wage rate of male and female labour in rural and urban areas
Source: Simulation results

Appendix 8
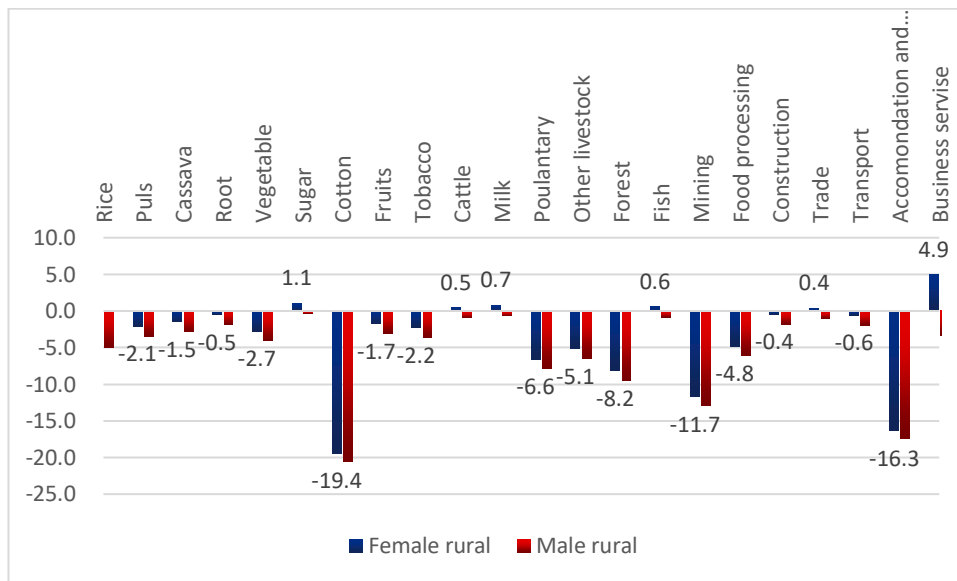
Figure 3A. Impact of COVID-19 on rural male and female employment (in % changes)
Source: Simulation results
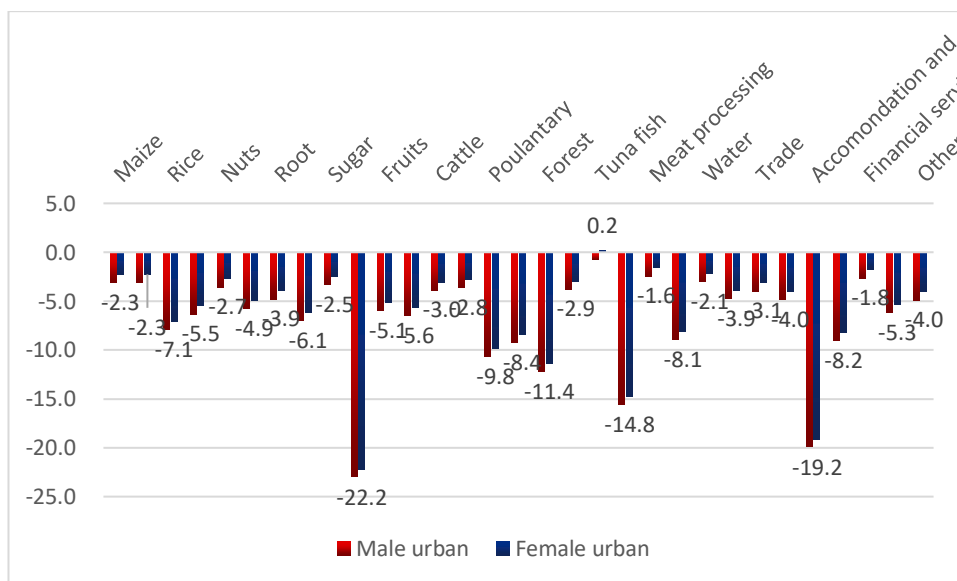
Figure 3B. Impact of COVID-19 on urban male and female employment (in % changes)
Source: Simulation results

Appendix 9

Table 7A. Impacts on households' and firms' and ROW's income (in %age change)

Agent	Type of income change
Households	
Total income	-18.1
Income from labour	-18.5
Income from capital	-21.6
Income from transfers	-16
Firms	
Total income	-16.8
Income from capital	-18.3
Income from transfers	-13.8
ROW	
Total Income	-14.5

Source: Simulation results

Table 7B. Average households' consumption on selected commodities (in %age change)

Commodities	Average households consumption
Agricultural commodities	-3.7
Food	-10.9
Nonmetal minerals	-11.8
Metal	-25.3
Mining	-11.2
Machinery	-24.5
Electricity	-23.3
Trade	-10.2
Transportation	-17.8
Accommodation and restaurants	-20.9
Communication	-10.7
Business services	-11.6
Education	-5.9
Health and social work	-7.7

Source: Simulation results

Appendix 10
Equations in Model
Production

1. $\quad VA_j = v_j XST_j$

2. $\quad CI_j = io_j XST_j$

3. $\quad VA_j = B_j^{VA}[\beta_j^{VA} LDC_j^{-\rho_j^{VA}} + (1-\beta_j^{VA})KDC_j^{-\rho_j^{VA}}]^{-\frac{1}{\rho_j^{VA}}}$

4. $\quad LDC_j = \left[\dfrac{\beta_j^{VA}}{1-\beta_j^{VA}}\dfrac{RC_j}{WC_j}\right]^{\sigma_j^{VA}} KDC_j$

5. $\quad LDC_j = B_j^{LD}\left[\sum_l \beta_{l,j}^{LD} LD_{l,j}^{-\rho_j^{LD}}\right]^{-\frac{1}{\rho_j^{LD}}}$

6. $\quad LD_{l,j} = \left[\dfrac{\beta_{l,j}^{LD}WC_j}{WTI_{l,j}}\right]^{\sigma_j^{LD}} \left(B_j^{LD}\right)^{\sigma_j^{LD}-1} LDC_j$

7. $\quad KDC_j = B_j^{KD}\left[\sum_k \beta_{k,j}^{KD} KD_{k,j}^{-\rho_j^{KD}}\right]^{-\frac{1}{\rho_j^{KD}}}$

8. $\quad KD_{k,j} = \left[\dfrac{\beta_{k,j}^{KD}RC}{RTI_{k,j}}\right]^{\sigma_j^{KD}} \left(B_j^{KD}\right)^{\sigma_j^{KD}-1} KDC_j$

9. $\quad DI_{i,j} = aij_{i,j}CI_j$

Income and Savings
Households

10. $\quad YH_h = YHL_h + YHK_h + YHTR_h$

11. $\quad YHL_h = \sum_l \lambda_{h,l}^{WL}\left(W_l \sum_j LD_{l,j}\right)$

12. $\quad YHK_h = \sum_k \lambda_{h,k}^{RK}\left(\sum_j R_{k,j}KD_{k,j}\right)$

13. $\quad YHTR_h = \sum_{ag} TR_{h,ag}$

14. $\quad YDH_h = YH_h - TDH_h - TR_{gvt,h}$

15. $\quad CTH_h = YDH_h - SH_h - \sum_{agng} TR_{agng,h}$

16. $\quad SH_h = PIXCON^{\eta} sh0_h + sh1_h YDH_h$

Businesses

17. $\quad YF_f = YFK_f + YFTR_f$

18. $\quad YFK_f = \sum_k \lambda_{f,k}^{RK}\left(\sum_j R_{k,j}KD_{k,j}\right)$

19. $\quad YFTR_f = \sum_{ag} TR_{f,ag}$

20. $\quad YDF_f = YF_f - TDF_f$

21. $\quad SF_f = YDF_f - \sum_{ag} TR_{ag,f}$

Government

22. $\quad YG = YGK + TDHT + TDFT + TPRODN + TPRCTS + YGTR$

23. $\quad YGK = \sum_k \lambda_{gvt,k}^{RK}\left(\sum_j R_{k,j}KD_{k,j}\right)$

24. $\quad TDHT = \sum_h TDH_h$

25. $\quad TDFT = \sum_f TDF_f$

26. $\quad TPRODN = TIWT + TIKT + TIPT$

27. $\quad TIWT = \sum_{l,j} TIW_{l,j}$

28. $\quad TIKT = \sum_{k,j} TIK_{k,j}$

29. $\quad TIPT = \sum_j TIP_j$

30. $\quad TPRCTS = TICT + TIMT + TIXT$

31. $\quad TIEDCT = \sum_i TIEDC_i$

32. $\quad TIVATCT = \sum_i TIVATC_i$

33. $\quad TIOTCT = \sum_i TIOTC_i$

34. $\quad TICT = TIEDCT + TIVATCT + TIOTCT$

35. $\quad TIMT = \sum_i TIM_i$

36. $\quad TIMT = \sum_i TIM_i$

37. $\quad TIXT = \sum_i TIX_i$

38. $\quad YGTR = \sum_{agng} TR_{gvt,agng}$

39. $\quad TDH_h = PIXCON^{\,n}ttdh0_h + ttdh1_h YH_h$

40. $\quad TDF_f = PIXCON^{\,n}ttdf0_f + ttdf1_1 YFK_f$

41. $\quad TIW_{l,j} = ttiw_{l,j}W_l LD_{l,j}$

42. $\quad TIK_{k,j} = ttik_{k,j}R_{k,j}KD_{k,j}$

43. $\quad TIP_j = ttip_j PP_j XST_j$

44. $\quad TIEDC_i = tedc_i\left[\left(PL_i + \sum_{ij} PC_{ij}tmrg_{ij,i}\right)DD_i + \left((1+ttim_i)PWM_i e + \sum_{ij} PC_{ij}tmrg_{ij,i}\right)IM_i\right]$

45. $\quad TIVATC_i = tvatc_i\left[\left(PL_i + \sum_{ij} PC_{ij}tmrg_{ij,i}\right)DD_i + \left((1+ttim_i)PWM_i e + \sum_{ij} PC_{ij}tmrg_{ij,i}\right)IM_i\right]$

46. $\quad TIOTC_i = totc_i\left[\left(PL_i + \sum_{ij} PC_{ij}tmrg_{ij,i}\right)DD_i + \left((1+ttim_i)PWM_i e + \sum_{ij} PC_{ij}tmrg_{ij,i}\right)IM_i\right]$

47. $\quad TIM_i = ttim_i PWM_i eIM_i$

48. $\quad TIX_i = ttix_i\left(PE_i + \sum_{ij} PC_{ij} tmrg_{ij,i}^X \right) EXD_i$

49. $\quad SG = YG - \sum_{agng} TR_{agng,gvt} - G$

Rest of the World

50. $\quad YROW = e\sum_i PWM_i IM_i + \sum_k \lambda_{row,k}^{RK}\left(\sum_j R_{k,j} KD_{k,j} \right) + \sum_{agd} TR_{row,agd}$

51. $\quad SROW = YROW - \sum_i PE_i^{FOB} EXD_i - \sum_{agd} TR_{agd,row}$

52. $\quad SROW = -CAB$

Transfers

53. $\quad TR_{agng,h} = \lambda_{agng}^{TR} YDH_h$

54. $\quad TR_{gvt,h} = PIXCON^{\eta} tr0_{gvt,h} + tr1_{gvt,h} YH_h$

55. $\quad TR_{ag,f} = \lambda_{ag,f}^{TR} TDF_f$

56. $\quad TR_{agng,gvt} = PIXCON^{\eta} TR_{agng,gvt}^0$

57. $\quad TR_{agd,row} = PIXCON^{\eta} TR_{agd,row}^0$

DEMAND

58. $\quad PC_i C_{i,h} = PC_i C_{i,h}^{MIN} + \gamma_{i,h}^{LES}\left(CTH_h - \sum_{ij} PC_{ij} C_{ij,h}^{MIN} \right)$

59. $\quad GFCF = IT - \sum_i PC_i VSTK_i$

60. $\quad PC_i INV_i = \gamma_i^{INV} GFCF$

61. $\quad PC_i CG_i = \gamma_i^{GVT} G$

62. $\quad DIT_i = \sum_j DI_{i,j}$

63. $\quad MRGN_i = \sum_{ij} tmrg_{i,ij} DD_{ij} + \sum_{ij} tmrg_{i,ij} IM_{ij} + \sum_{ij} tmrg_{i,ij}^X EXD_{ij}$

Producer Supplies of Products and International Trade

64. $\quad XST_j = B_j^{XT}\left[\sum_i \beta_{j,i}^{XT} XS_{j,i}^{\rho_j^{XT}} \right]^{\frac{1}{\rho_j^{XT}}}$

65. $\quad XS_{j,i} = \dfrac{XST_j}{\left(B_j^{XT} \right)^{1+\sigma_j^{XT}}}\left[\dfrac{P_{j,i}}{\beta_{j,i}^{XT} PT_j} \right]^{\sigma_j^{XT}}$

66. $\quad XS_{j,i} = B_{j,i}^X\left[\beta_{j,i}^X EX_{j,i}^{\rho_{j,i}^X} + \left(1 - \beta_{j,i}^X\right) DS_{j,i}^{\rho_{j,i}^X} \right]^{\frac{1}{\rho_{j,i}^X}}$

67. $\quad EX_{j,i} = \left[\dfrac{1-\beta_{j,i}^X}{\beta_{j,i}^X} \dfrac{PE_i}{PL_i} \right]^{\sigma_{j,i}^X} DS_{j,i}$

68. $\quad EXD_i = EXD_i^o\left(\dfrac{ePWX_i}{PE_i^{FOB}} \right)^{\sigma_i^{XD}}$

69. $$Q_i = B_i^M \left[\beta_i^M IM_i^{-\rho_i^M} + \left(1 - \beta_i^M\right) DD_i^{-\rho_i^M} \right]^{-\frac{1}{\rho_i^M}}$$

70. $$IM_i = \left[\frac{\beta_i^M}{1 - \beta_i^M} \frac{PD_i}{PM_i} \right]^{\sigma_i^M} DD_i$$

Prices

71. $$PP_j = \frac{PVA_j VA_j + PCI_j CI_j}{XST_j}$$

72. $$PT_j = \left(1 + ttip_j\right) PP_j$$

73. $$PCI_j = \frac{\sum_i PC_i DI_{i,j}}{CI_j}$$

74. $$PVA_j = \frac{WC_j LDC_j + RC_j KDC_j}{VA_j}$$

75. $$WC_j = \frac{\sum_l WTI_{l,j} LD_{l,j}}{LDC_j}$$

76. $$WTI_{l,j} = W_l \left(1 + ttiw_{l,j}\right)$$

77. $$RC_j = \frac{\sum_k RTI_{k,j} KD_{k,j}}{KDC_j}$$

78. $$RTI_{k,j} = R_{k,j} \left(1 + ttik_{k,j}\right)$$

79. $$R_{k,j} = RK_k$$

80. $$PT_j = \frac{\sum_i P_{j,i} XS_{j,i}}{XST_j}$$

81. $$P_{j,i} = \frac{PE_i EX_{j,i} + PL_i DS_{j,i}}{XS_{j,i}}$$

82. $$PE_i^{FOB} = \left(PE_i + \sum_{ij} PC_{ij} tmrg_{ij,i}^X \right) \left(1 + ttix_i\right)$$

83. $$PD_i = \left(1 + (tedc_i + tvatc_i + totc_i)\right) \left(PL_i + \sum_{ij} PC_i tmrg_{ij,i} \right)$$

84. $$PM_i = \left(1 + (tedc_i + tvatc_i + totc_i)\right) \left(\left(1 + ttim_i\right) ePWM + \sum_{ij} PC_{ij} tmrg_{ij,i} \right)$$

85. $$PC_i = \frac{PM_i IM_i + PD_i DD_i}{Q_i}$$

86. $$PIXGDP = \sqrt{ \frac{\sum_j \left(PVA_j + \frac{TIP_j}{VA_j} \right) VA_j^O}{\sum_j \left(PVA_j^O VA_j^O \right)} \frac{\sum_j \left(PVA_j VA_j + TIP_j \right)}{\sum_j \left(PVA_j^O + \frac{TIP_j^O}{VA_j^O} \right) VA_j} }$$

87. $PIXCON = \dfrac{\sum_i PC_i \sum_h C_{i,h}^O}{\sum_{ij} PC_{ij}^O \sum_h C_{ij,h}^O}$

88. $PIXINV = \prod_i \left(\dfrac{PC_i}{PC_i^O}\right)^{\gamma_i^{INV}}$

89. $PIXGVT = \prod_i \left(\dfrac{PC_i}{PC_i^O}\right)^{\gamma_i^{GVT}}$

Equilibrium

90. $Q_i = \sum_h C_{i,h} + CG_i + INV_i + VSTK_i + DIT_i + MRGN_i$

91. $\sum_j LD_{l,j} = LS_l$

92. $\sum_j KD_{k,j} = KS_k$

93. $IT = \sum_h SH_h + \sum_f SF_f + SG + SROW$

94. $\sum_j DS_{j,i} = DD_i$

95. $\sum_j EX_{j,i} = EXD_i$

Where;

CI_j : Total intermediate consumption of industry j

VA_j : Value added of industry j

XST_j : Total aggregate output of industry j

io_j : Coefficient (Leontief - intermediate consumption)

v_j : Coefficient (Leontief - value added)

KDC_j : Industry j demand for composite capital

LDC_j : Industry j demand for composite labour

B_j^{VA} : Scale parameter (CES - value added)

β_j^{VA} : Share parameter (CES- value added)

ρ_j^{VA} : Elasticity parameter (CES - value added); $-1 < \rho_j^{VA} < \infty$

RC_j : Rental rate of industry j composite capital

WC_j : Wage rate of industry j composite labour

σ_j^{VA} : Elasticity of transformation (CES - value added); $0 < \sigma_j^{VA} < \infty$

$KD_{k,j}$: Demand for type k capital by industry j

$LD_{l,j}$: Demand for type l labour by industry j

$RTI_{k,j}$: Rental rate paid by industry j for type k capital, including capital taxes

$WTI_{l,j}$: Wage rate paid by industry j for type l labour, including payroll taxes

B_j^{KD} : Scale parameter (CES - composite capital)

B_j^{LD} : Scale parameter (CES - composite labour)

$\beta_{k,j}^{KD}$: Share parameter (CES - composite capital)

$\beta_{l,j}^{LD}$: Share parameter (CES - composite labour)

ρ_j^{KD} : Elasticity parameter (CES - composite capital); $-1 < \rho_j^{KD} < \infty$

ρ_j^{LD} : Elasticity parameter (CES - composite labour); $-1 < \rho_j^{LD} < \infty$

σ_j^{KD} : Elasticity of substitution (CES - composite capital); $0 < \sigma_j^{KD} < \infty$

σ_j^{LD} : Elasticity of substitution (CES - composite labour); $0 < \sigma_j^{LD} < \infty$

$DI_{i,j}$: Intermediate consumption of commodity i by industry j

$aij_{i,j}$: Input- output coefficient

YH_h : Total income of type h households

YHK_h : Capital income of type h households

YHL_h : Labour income of type h households

$YHTR_h$: Transfer income of type h households

$R_{k,j}$: Rental rate of type k capital in industry j

$TR_{h,ag}$: Transfers from agent ag to type h households

W_l : Wage rate of type l labour

$\lambda_{h,k}^{RK}$: Share of type k capital income received by type h households

$\lambda_{h,l}^{WL}$: Share of type l labour income received by type h households

CTH_h : Consumption budget of type h households

$PIXCON$: Consumer price index

SH_h : Savings of type h households

TDH_h : Income taxes of type h households

YDH_h : Disposable income of type h households

η : Price elasticity of indexed transfers and parameters

$sh0_h$: Intercept (type h households savings)

$sh1_h$: Slope (type h households savings)

$agng$: Index of non-government agents

YF_f : Total income of type f businesses

YFK_f : Capital income of type f businesses

$YFTR_f$: Transfer income of type f businesses

SF_f : Savings of type f businesses

TDF_f : Income taxes of type f businesses

YDF_f : Disposable income of type f businesses

$TDFT$: Total government revenue from business income taxes

$TDHT$: Total government revenue from household income taxes

$TIEDC_i$: Government revenue from excise duties on product i

$TIVATC_i$: Government revenue from VAT on product i

$TIOTC_i$: Government revenue from other taxes on product i

$TICT$: Total government receipts if indirect taxes on commodities

$TIK_{k,j}$: Government revenue from taxes on type k capital used by industry j

$TIKT$: Total government revenue from taxes on capital

TIM_i : Government revenue from import duties on product i

$TIMT$: Total government revenue from import duties

TIP_j : Government revenue from taxes on industry j production

$TIPT$: Total government revenue from production taxes

$TIW_{l,j}$: Government revenue from payroll taxes on type l labour in industry j

$TIWT$: Total government revenue from payroll taxes

TIX_i : Government revenue from export taxes on product i

$TIXT$: Total government revenue from export taxes

$TPRCTS$: Total government revenue from taxes on products and imports

$TPRODN$: Total government revenue from other taxes on production

YG : Total government income

YGK : Government capital income

$YGTR$: Government transfer income

$ttdf0_f$: Intercept (income taxes of type f businesses)

$ttdf1_1$: Marginal income tax rate on type f businesses

$ttdh0_h$: Intercept (income taxes of type h households)

$ttdh1_h$: Marginal income tax rate of type h households

PP_j : Industry j unit cost, including taxes directly related to the use of capital and labour but excluding other taxes on production

$ttik_{k,j}$: Tax rate on type k capital used in industry j

$ttip_j$: Tax rate on the production of industry j

$ttiw_{l,j}$: Tax rate on type l worker compensation in industry j

DD_i : Domestic demand for commodity i produced locally

e : Exchange rate; price of foreign currency in terms of local currency

EX_i : Quantity of product i exported

IM_i : Quantity of product i imported

PE_i : Price received for exported commodity i (excluding export taxes)

PL_i : Price of local product i (excluding all taxes on products)

PWM_i : World price of imported product i (expressed in foreign currency)

$tedc_i$: Excise duty rate on commodity i

$tvatc_i$: VAT rate on commodity i

$totc_i$: Other tax rate on commodity i

$ttim_i$: Rate of taxes and duties on imports of commodity i

$ttix_i$: Export tax rate on exported commodity i

$tmrg_{ij,i}$: Rate of margin ij applied to commodity i

$tmrg_{ij,i}^X$: Rate of margin ij applied to export of commodity i

SG : Government savings

G : Current government expenditures on goods and services

CAB : Current account balance

PE_i^{FOB} : FOB price of exported product i

$SROW$: Rest of the world savings

$YROW$: Rest of the world income

$\lambda_{ag,agj}^{TR}$: Share parameter (transfer functions)

$tr0_{gvt,h}$: Intercept (transfers by type h households to government)

$tr1_{gvt,h}$: Marginal rate of transfers by type h households to government

$C_{i,h}$: Consumption of commodity i by type h households

$C_{i,h}^{MIN}$: Minimum consumption of commodity i by type h households

PC_i : Purchaser price of composite commodity i (including all taxes and margins)

$\gamma_{i,h}^{LES}$: Marginal share of commodity i in type h household consumption budget

$GFCF$: Gross fixed capital formation

INV_i : Final demand of commodity i for investment purposes

IT : Total investment expenditures

$VSTK_i$: Inventory change of commodity i

γ_i^{INV} : Share of commodity i in total investment expenditures

CG_i : Public consumption of commodity i (volume)

γ_i^{GVT} : Share of commodity i in total current public expenditures

DIT_i : Total intermediate demand for commodity i

$MRGN_i$: Demand for commodity i as a trade or transport margin

$XS_{j,i}$: Industry j production of commodity i

B_j^X : Scale parameter (CET-total output)

$\beta_{j,i}^{XT}$: Share parameter (CET-total output)

ρ_j^{XT} : Elasticity parameter (CET-total output); $1 < \rho_j^{XT} < \infty$

$P_{j,i}$: Basic price of industry j's production of commodity i

σ_j^{XT} : Elasticity of transformation (CET- total output); $0 < \sigma_j^{XT} < \infty$

$DS_{j,i}$: Supply of commodity i by sector j to the domestic market

$B_{j,i}^X$: Scale parameter (CET- exports and local sales)

$\beta_{j,i}^X$: Share parameter (CET- exports and local sales)

$\rho_{j,i}^X$: Elasticity parameter (CET- exports and local sales); $1 < \rho_{j,i}^X < \infty$

$\sigma_{j,i}^X$: Elasticity of transformation (CET- exports and local sales); $0 < \sigma_{j,i}^X < \infty$

EXD_i : World demand for exports of product i

PE_i^{FOB} : FOB price of exported commodity i (in local currency)

PWX_i : World price of exported product i (expressed in foreign currency)

σ_i^{XD} : Price- elasticity of the world demand for exports of product i

Q_i : Quantity demanded of composite commodity i

B_i^M : Scale parameter (CES- composite commodity)

β_i^M : Share parameter (CES- composite commodity)

ρ_i^M ; Elasticity parameter (CES- composite commodity); $-1 < \rho_i^M < \infty$

PD_i : Price of local product i sold on the domestic market (including all taxes and margins)

PM_i : Price of imported product i (including all taxes and margins)

σ_i^M : Elasticity of substitution (CES - composite commodity); $0 < \sigma_i^M < \infty$

PT_j : Basic price of industry j 's output

PCI_j : Intermediate consumption price index of industry j

RK_k : Rental rate of type k capital (if capital is mobile)

$PIXGDP$: GDP Deflator

$PIXGVT$: Public expenditures price index

$PIXINV$: Investment price index

LS_l : Supply of type l labour

KS_k : Supply of type k capital