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The macroeconomic implications of disease pandemics in developing countries: An application of Covid-19 in Uganda

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Abstract

This study examines the economy-wide implications of infectious diseases, taking the case of the Covid-19 pandemic in Uganda. Covid-19 containment measures generated social and economic consequences. We employ a recursive dynamic computable general equilibrium model to evaluate the implications on the economy. We design scenarios to mimic the containment policies via labour supply, labour productivity, government healthcare spending and remittance inflows. Results indicate that growth in sector output declines when compared to the no-Covid-19 baseline. However, export growth rates are predicted to be higher. Increased government healthcare spending induces expansion in the healthcare output, but the sectors that produce the intermediate inputs for healthcare production do not grow in tandem. Household welfare declines, and the loss is largest among the top quintile households in both rural and urban areas. Policymakers should revisit Uganda's industrial policy towards domestic production of intermediate inputs to critical domestic sectors such as healthcare. Also, accelerate rural infrastructure development particularly the road network, to facilitate an integrated rural economy induced by the shift in labour and enterprise towards rural areas.

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computable general equilibrium modelling, Covid-19, developing countries, economic growth, infectious diseases, labour shocks, Uganda

JEL CLASSIFICATION
D580, I130, J210, 011

1 | INTRODUCTION

Infectious diseases have caused millions of deaths throughout history. Some infectious diseases can spread very rapidly among local, national or global populations. The coronavirus (Covid-19), first confirmed in China in December 2019, quickly spread to other parts of the world and was declared a Public Health Emergency of International Concern in January 2020. Data from China showed that human-to-human transmission is the main mode of Covid-19 transmission, in both community and hospital settings, and the transmitters may be asymptomatic or with mild symptoms (Wang et al., 2020). Countries moved quickly to contain the spread of Covid-19, and the mitigating strategies generated economic consequences, including impact on travel services, hospitality services, durables expenditure and the global supply chain.

To date, the African continent has had the least deaths from Covid-19—171 434 deaths compared to 2 012 067 in Europe or 2 742 377 in the Americas (World Health Organisation, 2022). However, several African countries have suffered huge economic downturns because of the pandemic containment policies, and the significance of the negative effect varies by the structure of the economy and the stringency of lockdown enforcement. For instance, whereas the people-oriented tourism sector was hit hard in top destination countries such as Tunisia, Morocco, Egypt and South Africa (Arezki et al., 2021), food security remained relatively stable in a survey of selected sub-Saharan countries (SSA), largely due to the subsistence agricultural practices in these countries (Adjognon et al., 2021; Furbush et al., 2021). In Uganda, stringent lockdown measures were instituted in March 2020 and later gradually eased although education institutions remained closed for face-to-face teaching for nearly 2 years, yet there was no planned online teaching as a mode of delivery for most of them.

Our study examines the economy-wide implications of the Covid-19 pandemic using a dynamic computable general equilibrium (CGE) model of Uganda. Specifically, we design scenarios to mimic the effect of containment policies on the economy, focussing on mechanisms via labour supply and labour productivity shocks, government healthcare expenditure and remittance inflows and evaluate the aggregate effect on sector production, international trade and household welfare. We find that Covid-19 containment policies lead to a decline in growth rates for most sectors, whereas exports' potential increases for agricultural products destined to neighbouring countries. Household welfare declines, and the effect is more profound among remittance recipients in the top quintile. Our study contributes to the literature on the economy-wide impact of infectious diseases. The dynamic CGE model is an economy-wide analytical approach that goes beyond the narrow internal focus on the health sector to examine wider macro effects. Existence of a large informal (unregulated) sector that is also a significant employer in Uganda, for example, has implications for the wages' structure, sector output composition and household income and poverty rates in the country. The CGE model captures these effects, and the application to Uganda confers lessons to other developing countries with similar economic structure, on the economy-wide effects of infectious disease pandemics.

2 | THEORETICAL AND EMPIRICAL UNDERPINNINGS OF THE MACROECONOMICS OF INFECTIOUS DISEASES

Infectious diseases affect the economy's productive capacity through mortality and morbidity and behavioural adjustments. The main channels of this effect have been widely studied, and they include education attainment, life

expectancy and human capital accumulation (Acemoglu & Johnson, 2007; Bleakley, 2007; Cervellati & Sunde, 2005), labour force participation and savings and investment (Bloom et al., 2007). The production function approach succinctly illustrates the pathways between infectious diseases and development (Bloom et al., 2021). Specifically, a country's aggregate output (Y_t) is generated by combining aggregate physical capital (K_t) and aggregate human capital (H_t):

$$Y_t = f(K_t, H_t),$$

where H_t is a product of aggregate labour supply, L_t, a disease-specific productivity parameter, $\varnothing_t$ and average human capital h_t, such that $H_t = L_t \varnothing_t h_t$. The average human capital is, in turn, determined by the average years of schooling (quantity and quality of education) and work experience of the labour force.

In a closed economy, capital accumulation, (K_{t+1}), is determined by aggregate private consumption, C_t, aggregate government expenditure on health or education, G_t, and the depreciation rate of physical capital, δ, as follows:

$$K_{t+1} = Y_t - C_t - G_t + (1 - \delta) K_t.$$

Consequently, the effect on aggregate output depends on the infectious disease-induced effects on human capital, private consumption and public expenditure.

Reduction in human capital occurs when labour supply and productivity decline because of sickness and death from the infectious disease. It may also be due to workplace reporting restrictions voluntarily for fear of being either infected or mandatory to reduce the risk of infection, as in the case of Covid-19 lockdowns (e.g., see Hosono, 2021) and when there is a disincentive to invest in human capital due to high infection risks over the life cycle. For instance, the perceived risk of being infected as a healthcare worker on duty during the Covid-19 pandemic may discourage learners from enrolling into education programmes to become healthcare professionals. Additionally, when the infectious disease and associated policies disrupt the schooling and learning, education outcomes and human capital accumulation decline in the long run. Yet the role of human capital as a key driver of economic growth is undisputable, although its measurement using years of schooling or enrolment rates is a subject of debate (Hanushek, 2015). Nevertheless, recent studies have developed techniques for measuring learning outcomes, which capture the quality of education reflected in the stock of basic cognitive skills, using standardised test scores, across developed and developing countries (Angrist et al., 2021; Patel & Sandefur, 2020). Higher levels of cognitive skills attract higher earnings and employment rates (Hampf et al., 2017).

Consumption is another variable in the growth equation that is affected by the infectious disease. Reduction in consumption arises when people forego consumption due to illness or aversion behaviour to avoid infection or mandatory restriction to prevent infection (e.g., see Hosono, 2021). The immediate short-term impact is a stockpile of consumer goods. Eventually, firms are forced to cut back on production hours, which could result in worker redundancies and create unemployment in the short to medium term. Additionally, consumption could decline due to a reallocation of expenditure towards measures for disease prevention and/or treatment, for instance, in the case of private out-of-pocket payments for services or the case of an increase in public healthcare budget while reducing resources available to other sectors.

The interaction between the consumption, savings and investment channels is quite complex, and the relationship with growth in aggregate output is not linear. For example, the forgone consumption expenditure could potentially result in increased savings for future investment. Similarly, public expenditure in prevention measures, such as research and development (R&D), could result in more and better treatments in the long run, thus mitigating the negative impact on labour participation rates and productivity. Additionally, there will be ensuing expenditure multiplier effects through the sectors that supply inputs for R&D. The interaction involves backward and forward linkages, and some effects are lagged such that the relationship with aggregate output is likely to be non-linear and bidirectional. The suggestion is to estimate the economy-wide effects of the infectious disease in a dynamic general equilibrium model set-up, as we do in this study.

Studies that have investigated the economic impact of infectious disease pandemics tend to focus on the direct effects of the pandemic, such as illnesses, deaths and hospitalisations, and direct effects of mitigation strategies, such

as cost-effectiveness analyses of vaccinations, business losses from reduced consumption and workforce absenteeism, among others. In this regard, several recent studies have employed the canonical SIR—susceptible (S), infected (I) and recovered (R) epidemiology model (Kermack & McKendrick, 1927), integrated with key economic variables, to study the evolution of Covid-19 and its interaction with economic activity (Acemoglu et al., 2021; Botha et al., 2021; Firano & Fatine, 2020) among others. They have shown that both the disease fatality and the containment policies of social distancing generate negative consequences on social and economic conditions. These studies are premised on the fact that, in addition to mortality and morbidity, the pandemic containment policy measures lead to a reduction in consumption, in number of working hours and in production and consequently slow down economic growth. The main transmission channels have been widely studied, as alluded to in the opening paragraph of Section 2.

In adopting containment measures, however, policymakers face the dilemma of a trade-off between the health and the wellbeing of the people and the economy. For instance, the Morocco study demonstrated that containment measures also result in an overall gain in wellbeing from maximising the utility of the infected and uninfected people (Firano & Fatine, 2020). In this regard, some studies have sought to assess the optimal policy for social distancing, which balances the benefits in health outcomes and the detrimental effects on macroeconomic effects (Caulkins et al., 2021; Torre et al., 2021), and showed that the balance varies, depending on the structure of the economy. For example, calibration of the optimal containment policy response yields a reduction of 3.4 deaths per percentage point in GDP loss in Uganda compared to USA's 7.9 deaths per point of GDP loss (von Carnap et al., 2020). This suggests that developing countries should be cautious when adopting lockdown policies from economies that have established systems of better handling the pandemic. We thus undertake to evaluate the impact of Covid-19 on Uganda's economy given its unique characteristics of a young population and a large informal sector, in addition to being a low-income country.

Overall, the foregone studies adopt a typical partial equilibrium analysis, which is ill-equipped to estimate the cascade effects resulting from the pandemic containment policies. The suggestion is to combine the information from estimated cost-effectiveness of healthcare interventions with macroeconomic data, such as social accounting matrices in a CGE model, to estimate the shocks to the whole economy of various policy interventions. I undertake the CGE approach in this study. Some early studies that evaluated the economic impact of infectious disease pandemics employed the static CGE country models (Keogh-Brown et al., 2010) and more recently, the impact of Covid-19 (Keogh-Brown et al., 2020) in developed countries setting. They show that the major loss to the economy arises from the courses taken to mitigate the disease, including business closures, school closures, home quarantine and aversion behaviour, all of which result in reduction in consumption and a decline in labour supply to the economy. One of the few studies evaluating developing country economies applied a static CGE model to Thailand, South Africa and Uganda and showed sectoral impacts that differed across countries, depicting the differences in the structure of the economies under study (Smith & Keogh-Brown, 2013).

However, the static CGE model applications only highlight the short-term effects; they do not capture the long-term effects of the pandemic and mitigating factors on the economy. I employ a dynamic recursive CGE model as a more suitable alternative because health effects and associated policies in the wider economy may have long-term lags. The dynamic model generates an evolution path of the economic system from the initial to the final state, thus capturing the costs associated with the adjustment to changes in the public health policies.

2.1 | Uganda: Socioeconomic characteristics

Uganda presents an interesting case study for the economic implications of Covid-19 because it is in the top five on the ranking of countries with the youngest population and in the bottom three (at 1.9% of total population) on the list of countries with a population share above 65% (United Nations, 2019). The country's age structure suggests that it is likely to have a low case fatality rate from Covid-19; case fatality rate is highest among older people—65 years and above (Yanez et al., 2020).

Uganda's economic structure is characterised by primary sector activities of agriculture, forestry and fishing that are the major employers in the economy—employing approximately 65% of the total population, although they contribute less than a third of total GDP: 24% compared to 26.2% for industry, 43% for services and 6.8% in taxes on products in 2019/2020 (Uganda Bureau of Statistics, 2020). Persons in paid employment (wage and salaried workers) constitute 38.1% of total persons in employment compared to 49.9% in 'own account workers', 6.9% in 'contributing family worker', 4.4% in 'employer' and 0.7% in 'other' categories (Uganda Bureau of Statistics, 2020). Half of the employment in the primary sector is 'own account worker', and only 35.7% is 'paid employment' compared to 56.6% in services and 7.9% in industry. According to the National Labour Survey 2016/2017, the informal sector employs 84.9% of the population, and 90% of whom are youth (10–30 years). Like many developing countries, Uganda's economic structure implies that many households leave on hand-to-mouth, rendering prolonged lockdowns economically untenable, whereas enforcing lockdowns in the large informal sector is also a big challenge to government.

3 | METHODOLOGY

This study examines the economic impact of Covid-19 using a single country recursive dynamic CGE model (Thurlow, 2004). This approach was chosen because it considers the interdependencies between different sectors, agents and markets in the economy and captures the direct and indirect effects of a policy shock. The dynamic model analyses the path of a transitional dynamic towards a new steady state after an initial shock, thus allowing a comparison of the impact of various policy shocks.

3.1 | Model description

A CGE model is a set of mathematical equations specifying the economy in terms of agents—households, firms/producers, the government and the rest of the world. Each agent has different resources and behaves differently from the other agents. For example, households are the consumers in the economy; they work for firms and receive wages in return for their labour; and they spend their wages on purchasing goods and services and save any remainder. In deciding which goods to buy or saving to make, households choose those combinations that give them the most satisfaction (utility) within the constraints of their budget (income). In the model, each household allocates their disposable income to consumption by maximising a Stone–Geary utility function under a linear expenditure system.

The firms (producers) purchase labour from the households and combine it with capital and land (which they also buy) to produce goods and services. Firms choose how much of a good they produce by minimising the cost of production while maximising their sales because they want the biggest possible profit. The model assumes perfectly competitive markets and constant returns to scale production functions. In the factor markets, quantity of labour is exogenously supplied, whereas capital is endogenously determined. Labour supply is fixed, and the real wage adjusts to equate demand and supply. Thus, labour supply adjusts exogenously from a linked Ugandan demographic model for the baseline and according to the policy shock assumptions for the counterfactual. Capital accumulation is modelled endogenously; current period investments build on the new capital stock for the next period.

The government collects taxes from wages by households and sales by firms and then spends the money on public services such as healthcare. The macroeconomic closures are defined as follows. For the government balance, we assume flexible government savings, whereas all taxes and real government consumption are fixed. Additionally, within the government expenditure equation, we fix the government function (commodity consumption) demand scaling factor, whereas the government function shares and transfers are endogenously determined to allow for modelling the increase in the health sector budget due to Covid-19 induced demand. To align with this government function closure, we assume a savings-driven savings-investment balance so that the households' and enterprises' marginal propensities to save are fixed and real investment expenditure adjusts to equal the volume of savings

available to finance it. For the external balance, foreign savings are kept constant, whereas the real exchange rate is flexible to clear foreign exchange markets.

The CGE modelling finds a solution where all these behaviours are satisfied (and optimised) simultaneously. The solution of the model represents an economy in equilibrium. The recursive dynamic feature implies that the within-period equilibrium for a given period forms the baseline for the next period model run, and the process continues for the entire model horizon. In each iteration, investment of the current period is turned into capital stock of the next period, and exogenously provided factor supply and productivity growth rates determine the overall growth of the economy. The model is solved using the Generalised Algebraic Modelling System (GAMS) computer software (General Algebraic Modelling System, 2014).

3.2 | Data: Social accounting matrix (SAM)

A CGE model is calibrated from a SAM as the benchmark performance of an economy. A SAM is a comprehensive, economy-wide data framework representing the economy by capturing the financial value of transactions and transfers between all economic agents in the system, for a given period. The latest Uganda SAM for the baseline calibration is readily available (International Food Policy Research Institute, 2017; Randriamamonjy & Thurlow, 2016). It is a Nexus SAM with 58 sectors in a 122 by 122 matrix, representing activities (entities that carry out production) and commodities (markets for goods and nonfactor services), factors of production, the government, domestic nongovernment institutions (households and enterprises) and the rest of the world (external sector). The matrix columns represent payments, and rows are receipts, as in the accounting double-entry format.

The Nexus SAM is a one-to-one mapping of activities and commodities. Our value addition is in transforming it into a SAM suitable for calibrating the dynamic CGE model to achieve the study objectives. We aggregate the N58 micro-SAM into a Macro-SAM as follows. The sector/commodity mapping in the micro-SAM is aggregated into three main sectors of agriculture, industry and services, as shown in Table 1, purposefully done to aid the analysis of targeted policy simulations. Agriculture includes food and cash crops and livestock farming; industry includes food processing and other manufacturing and in services; 'Other private services' include accommodation and food services, information and communication, finance and insurance, real estate activities and business services, whereas 'Other services' include both public and private services not listed elsewhere.

For factors of production, we maintain the disaggregation in the micro-SAM: labour disaggregated by residence (rural/urban) and by level of education (uneducated, primary, secondary and tertiary). This classification is important because different policies will affect dissimilar categories of labour differently. For example, the closure of universities is likely to affect the urban tertiary level workers more than the urban uneducated workers. Similarly, we maintain the household categories in the micro-SAM—by residence (urban/rural) and by income quintile, again for identifying the extent to which each household category is affected by the different containment policies. We balance the SAM using the PEP SAMBAL SAM balancing program solved in GAMS (Lemelin et al., 2013). The SAM coefficients in the Nexus SAM (the benchmark dataset) approximate the functioning of the economy as of 2019, the first year of Covid-19.

3.3 | The pathways of the Covid-19 effect for simulation

Given Uganda's young population and the disease dynamics, we consider the fact that the greatest impact of the Covid-19 pandemic arises from the containment policies rather than death or illness from the disease. For instance, according to the data record on 3rd March 2021 by Johns Hopkins University, Uganda had only 40 395 confirmed cases and 334 deaths, with a case fatality ratio of 0.8% translating to 0.78 deaths per 100 000 population. Similarly, a study predicted Uganda to have a low disease burden (mortality and morbidity) from Covid-19, based on the country's

TABLE 1 Classification and aggregations from the Uganda SAM2013

Sectors/commodities	Factors	Households
Agriculture	Labour	Rural farm—Quintile 1
Agriculture	Labour—rural uneducated	Rural farm—Quintile 2
Forestry	Labour—rural primary	Rural farm—Quintile 3
Fishing	Labour—rural secondary	Rural farm—Quintile 4
Industry	Labour—rural tertiary	Rural farm—Quintile 5
Other mining	Labour—urban uneducated	Rural nonfarm—Quintile 1
Meat, fish and dairy	Labour—urban primary	Rural nonfarm—Quintile 2
Fruit and vegetable processing	Labour—urban secondary	Rural nonfarm—Quintile 3
Fats and oils	Labour—urban tertiary	Rural nonfarm—Quintile 4
Grain milling	Land	Rural nonfarm—Quintile 5
Sugar refining	Land—agricultural crops	Urban—Quintile 1
Other foods	Capital	Urban—Quintile 2
Beverages	Capital—crops	Urban—Quintile 3
Other manufacturing	Capital—livestock	Urban—Quintile 4
Chemicals	Capital—mining	Urban—Quintile 5
Machinery and equipment	Capital—other	
Utilities		
Construction		
Services		
Wholesale and retail trade		
Transport and storage		
Other private services		
Public administration		
Education		
Health and social work		
Other services		

Source: Authors' derivations from the Uganda SAM2013.

population age structure, but warned of an elevated risk of an increase in non-Covid-19 disease burden because of prolonged lockdown and other restrictions (Bell et al., 2020). Therefore, we concentrate on designing scenarios for the pandemic containment strategies and predict the impact on the economy over the period 2020–2030. At the domestic level, we consider the presidential directives on containment of Covid-19 and their effect via labour supply, labour productivity and government spending on healthcare. At the global level, we consider the impact on remittance inflows.

3.3.1 | The dynamic baseline growth path: No-Covid-19 scenario

The baseline scenario depicts how the economy would perform in the absence of Covid-19 effects, for the period 2020 to 2030. The beginning of the model horizon is selected to coincide with the onset of the pandemic. Similarly, 2030 is selected because the International Monetary Fund (IMF) Outlook predicts that low-income countries will continue to struggle for at least a decade before they can fully return to pre-pandemic per capita income rates.

Capital accumulation is calibrated at 5% per annum, to generate a GDP growth rate of 5.6% that is consistent with the IMF Economic Outlook for Uganda. This baseline GDP growth rate is achieved with a 1% annual growth rate in labour productivity and total factor productivity.

Aggregate government consumption expenditure and foreign savings are each set to grow at 3% per annum, based on the average growth in the trend depicted in the national accounts for the past decade (Uganda Bureau of Statistics, 2020). The government consumption shares by function take the average values derived from the trend in actual expenditure shares for fiscal years 2015/2016 to 2019/2020 (Uganda Bureau of Statistics, 2020). Annual change in labour supply is set at 4%, in line with the United Nations demographic model for Uganda. Growth in remittance inflows is set at 10% per annum, in accordance with the average annual increase for the past 20 years (Cooper et al., 2018).

3.3.2 | Labour supply with Covid-19

Total labour includes formal and informal employees of varying skill levels, and they are affected differently by the lockdown policies. Whereas remote working became quite attractive during the lockdown, it poses serious challenges to employers and is hardly feasible for informal sector workers[1] who are the majority in Uganda. Even for the 17.9% formal sector workers with access to technology and capable of applying the digital tools, the proportion that can work from home varies by sector and occupation. Many workers in retail, leisure, construction and manufacturing can hardly work from home. Additionally, the concept of remote working is relatively new in Uganda; it poses challenges for worker productivity because workers are accustomed to working in proximity of their employers/supervisors, let alone the lack of required Information Technology equipment, slow or no internet access and intermittent electricity supply.

Using data from the Uganda High-frequency Phone Survey on Covid-19, conducted in June 2020, a study found that 45% of adult men and 49% of adult women did not work in the week preceding the survey, due to Covid-19 restrictions (James et al., 2020). Additionally, a research team that was studying the economic status of households in 21 parishes from two rural districts in Western Uganda, prior to the Covid-19 lockdown, conducted a follow-up survey in May 2020 to establish the impact of the lockdown on economic outcomes and wellbeing (Mahmuda & Riley, 2021). They found a 50% decline in wage and salaried labour supplied by households, and household labour supplied to their enterprises. However, they also found a reallocation of labour towards crop and livestock farming and an overall increase in the time allocated to these activities by nearly 100% on the baseline mean. This suggests the lockdown could have induced households to devote time to farm activities both for subsistence and for income, because income-generating opportunities outside the homesteads had drastically reduced. The farming labour dynamics revealed in this survey are a typical representation of rural communities throughout the country because these areas experience similar weather patterns and seasonality of crop and livestock farming. These labour supply dynamics inform the labour force growth parameter values for simulation.

First, we assume an increase in the labour supply in the rural-based primary activities of agriculture, forestry and fishing. Thus, we increase the initial rural non-tertiary labour by 50% in the first year. This increase is then reverted to 20% in the subsequent year and finally remains at 10% above the initial level, up to 2030 (subject to the 4% annual labour growth rate in the baseline). This scenario assumes that some workers will be returning to their former occupations in the aftermath of Covid-19 restrictions, whereas some will remain in the newfound activities of farming. Second, we assume a decline in labour supply for predominantly urban-based enterprise sector activities, including wholesale and retail, transport and storage and other private services, largely in the informal sector. Thus, we reduce the initial stock of urban non-tertiary labour by 80%. This reduction is then reverted to 50% in the subsequent year

[1]Persons in informal sector employment are normally in precarious employment situations not entitled to basic benefits such as pension/retirement fund, paid leave and medical benefits, and often their employment agreement is verbal.

and then to 20% in next year and then remains at 10% below the initial level up to 2030 (subject to the baseline annual labour growth rate). These labour adjustments assume that some workers will not return to their jobs as some businesses downsized, whereas others went bust due to Covid-19 restrictions.[2]

3.3.3 | Labour productivity with Covid-19

The physical and mental wellbeing of workers is pertinent to their performance at work. Wellbeing and worker productivity are inextricably linked. Mahmuda and Riley (2021) found an increase in depression and low wellbeing among the respondents in the Western districts of Uganda. Additionally, disruptions in teaching and learning programmes due to closure of schools and training institutions imply that acquisition of skills is negatively impacted. This will potentially affect progress in human capital accumulation, both in the short and medium term (World Bank, 2021). Consequently, labour productivity levels will decline in tandem. We therefore model a labour productivity shock in all sectors of the economy by assuming a gradual decline, with the largest shock in the first year, which reduces in subsequent years as people become accustomed to the new normal of living and working, thereby making necessary adjustments. Consequently, we apply the following values for the labour productivity growth parameter. We assume that the initial labour productivity declines by 10%, and then this decline reverts to 5% in the subsequent year and finally to 2.5% per year until 2030. The decline is attributed to a combination of factors, including reduced population wellbeing and reassignment of tasks from those usually performed, e.g., the reallocation of labour to farm activities as discussed above, as well as inadequate skills acquisition due to Covid-19 disruptions in the school system.

3.3.4 | Remittance inflows with Covid-19

This scenario accounts for reduced remittance inflows to Uganda due to Covid-19 effects in source countries. Uganda is in the top 10 recipients of remittances in Africa; remittance inflows increased steadily for the past 20 years, reaching 4% of GDP as of 2019 (World Bank, 2020b). According to the Annual Personal Transfers Survey 2018 by the Bank of Uganda, a third of the remittances come from Europe led by the UK and about a quarter each from the Middle East and North America (Bank of Uganda, 2018). The survey also revealed that recipient households used 68.5% of funds received on consumption-related expenses, including general household goods, such as food, clothing, rent and utilities and education. The bulk of 29.2% spent on nonconsumption items went to business-related activities, building works and land purchase. The World Bank predicted remittances to sub-Saharan Africa to fall in 2020 and that the declining trend would continue in subsequent years (World Bank, 2020a).

Given that the main sources of remittances were adversely affected by the Covid-19 pandemic and some of them went into recession, we assume a drastic decline of remittance inflows in the first year and that the trend would gradually level off by 2030, following the anticipated economic recovery in migrant host countries. Thus, the transfer growth parameter (from rest of the world to households) takes on the following values. We shock the model with a reduction in remittances by 80% from the initial year, and then this reduction is reverted to 50% in the subsequent year and finally to 10% for all years up to 2030.

3.3.5 | Increase in the health sector spending (fixed resource envelope) with Covid-19

On healthcare expenditure, the government actions included an increase in capacity of some government hospitals to cater for critical care, setting up case isolation centres in different parts of the country and later, setting up

[2]The Economic Policy Research Centre rapid survey of businesses revealed that business activity reduced by more than 50% and 75% of the surveyed businesses laid off workers due to Covid-19 pandemic risks and associated restrictions (Lakuma et al 2020).

vaccination centres. This scenario assumes that the government has a fixed resource envelope from which to fund additional healthcare expenditure arising from Covid-19. There is no taxation increase earmarked for this additional healthcare spending, but rather the general tax revenue follows the same path as in the baseline. With a fixed budget, such additional spending in the health sector is drawn from other government functions, such as the public administration sector.[3] Parameter values for the government expenditure growth (by function) are as follows. We assume that the health sector budget share doubles in the first year, and then this increase is reverted to 50% in 2022 and finally to 30% for the years up to 2030.

3.3.6 | Increase in health sector spending (external resources) with Covid-19

This scenario assumes the same health sector-spending pattern as the previous scenario, but the government can also mobilise additional resources from external sources for funding healthcare activities in the wake of Covid-19. Therefore, the health sector budget share increases with additional resources in the form of transfers from the rest of the world to government, specifically directed to the health sector. We assume that the foreign aid flows beyond the baseline rate are deployed in the health sector according to the Covid-19-induced priorities. Although part of the foreign aid inflow may be in the form of concessional loans, such that they carry an implication for interest payments, the current model does not distinguish between foreign aid inflows that are concessional loans or grants. Our analysis is limited to assessing the Covid-19-induced healthcare spending with increased external resources, assuming that a positive impact could outweigh the cost of interest payments on the economy. We thus define a health-aid multiplier while maintaining the same pattern of increase in health spending as in the preceding simulation (i.e., where the health spending increases in a fixed government budget).

4 | RESULTS

In CGE modelling, the emphasis of the simulation results is on the direction (sign) of the effect of a shock in the economy, as opposed to the magnitude of the effect. We thus present results as deviations from the baseline (i.e., the predicted counterfactual path compared to the no-Covid-19 scenario). Values in each simulation scenario column represent the contribution of each Covid-19 pathway.

4.1 | Sector performance

The country experiences some growth under each of the scenarios, as seen in Figure 1, which illustrates the trend in growth in GDP at factor cost, from 2020 to 2030. However, we are interested in understanding whether Covid-19 had an impact on the growth rates when compared to the baseline growth path. Thus, Table 2 reports the deviation from the baseline for annual sectoral GDP growth rates under the different scenarios.

From Table 2, we observe that the Covid-19 channel scenarios modelled generate slower growth rates in output for majority of the sectors, when compared to the baseline. However, the labour supply shock, which increases rural non-tertiary labour, predicts higher growth rates. This is because economic activity shifted to rural areas during the Covid-19 lockdowns, which induced an increase in demand for labour to work on farms and other rural-based activities (see Appendix Table A4). At the same time, people flock to rural areas where the cost of living is relatively cheaper when compared to life in urban centres during Covid-19 lockdown. Majority of those flocking rural areas are

[3]The public administration sector in the SAM comprises of all those government functions in the national accounts, other than health, i.e., public administration = general public services, defence, public order, economic affairs, environment, housing and community affairs and social protection.

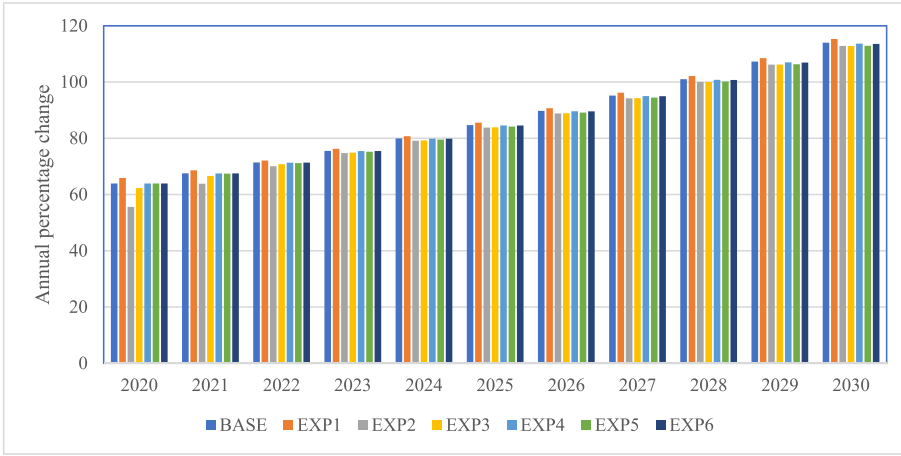

FIGURE 1 Growth in GDP at factor cost: 2020 to 2030 (% change). *Data source*: CGE modelling results [Color figure can be viewed at wileyonlinelibrary.com]

informal sector workers with non-tertiary education. They thus drive down wage rates for the non-tertiary category of labour despite the increase in demand. The labour supply and demand dynamics generate lower growth rates in wage rates for non-tertiary rural labour when compared to the baseline, as shown in Table 3. Consequently, this category of labour supply shock generates faster growth rates in output of all sectors compared to the baseline, as shown in Table 2 Column 3.

The growth rate in the economy-wide wage rate for majority of the labour categories is predicted to be lower when compared to the baseline (Table 3). However, when combined with the other shocks, the lower sector output growth rates shown in Table 2 suggest that availability of cheap labour alone is not sufficient to spur growth in all sectors beyond the baseline rates. The lack of commensurate growth rates in sector output is partly due to the underdeveloped physical infrastructure networks, needed to facilitate easy movement of goods to markets. Poor rural road networks, lack of processing and storage facilities that could preserve the abundant seasonal harvest to be sold in times of scarcity and limited rural electrification to facilitate business activities, including agricultural processing, among others, hinder development of an integrated economy. For example, up to 90% of the transport sector is dependent on the road network, yet only 3.2% of the total road network is paved, mainly in cities and urban centres (Ministry of Works and Transport (Uganda), 2018). Yet evidence shows that the stock of infrastructure assets is positively associated with economic growth (Calderón & Servén, 2004), and the productivity effects of transport infrastructure tend to be higher for roads (Melo et al., 2013). It is therefore important to augment the growth in production factors, such as labour, with accelerated investment in rural infrastructure, so that producers and consumers are better integrated into national and international markets and hence generate faster economic growth.

Additionally, when urban non-tertiary labour supply declines, the observed negative growth in most of the sectors is consistent with the effect of a reduction in aggregate demand. This is because the urban workers operate a more cash-based (monetised) economy, when compared to their rural counterparts who survive on subsistence from their gardens and hence are a source of regular demand for goods and services produced by all the sectors. A reduction in the growth rate of urban labour implies a decline in their labour income and potentially declining consumption expenditure. The cutback in consumption expenditure implies stockpiles of goods in retail and wholesale shops and ultimately in the manufacturers' warehouses. Consequently, firms will cut back on production of more goods.

Notable among the sector output performance is the machinery and equipment sector, whose growth rate rises by 1.02% points under the reduction in remittances' scenario. This suggests that the Covid-19-induced shift in how people live and work potentially generates increased demand for machinery and equipment, such as electrical

TABLE 2 Real sector GDP annual growth rate 2020–2030: deviation from baseline (%-point)

	Baseline	Non-tertiary rural labour increases	Non-tertiary urban labour declines	Decline in labour productivity: All sectors	Reduced remittance inflows	Increase in gov health spending (fixed budget)	Foreign aid for gov health spending
Agriculture	3.5	0.10	−0.03	−0.05	−0.06	−0.03	−0.01
Forestry	7.6	0.14	−0.11	−0.12	−0.23	−0.18	−0.09
Fishing	5.2	0.16	−0.07	−0.08	−0.19	−0.04	0.00
Other mining	8.1	0.22	−0.10	−0.17	−0.08	−0.27	−0.16
Meat, fish and dairy	1.9	0.11	0.02	−0.04	0.06	0.02	0.01
Fruit and vegetable processing	4.6	0.10	−0.05	−0.08	−0.13	−0.03	0.00
Fats and oils	4.0	0.11	−0.03	−0.08	−0.07	−0.01	0.01
Grain milling	4.1	0.10	−0.05	−0.06	−0.11	−0.05	−0.02
Sugar refining	3.2	0.26	0.02	−0.12	0.02	0.00	−0.02
Other foods	5.2	0.11	−0.07	−0.07	−0.20	−0.04	0.00
Beverages	6.3	0.24	−0.06	−0.13	−0.20	−0.05	−0.01
Other manufacturing	7.8	0.31	−0.08	−0.21	0.03	−0.17	−0.11
Chemicals	7.2	0.12	−0.07	−0.17	−0.18	−0.05	−0.02
Machinery and equipment	41.2	0.11	−0.64	−0.01	1.02	−0.64	−0.40
Utilities	6.9	0.12	−0.11	−0.11	−0.20	−0.10	−0.04
Construction	7.2	0.13	−0.11	−0.13	−0.16	−0.30	−0.18
Wholesale and retail trade	0.3	0.01	−0.01	−0.01	−0.01	−0.01	0.00
Transport and storage	5.6	0.20	−0.04	−0.18	−0.12	−0.02	−0.01
Other private services	5.8	0.10	−0.05	−0.16	−0.09	−0.07	−0.04
Public administration	3.2	0.01	0.02	−0.04	0.04	0.46	0.45
Education	6.0	0.11	−0.06	−0.13	−0.21	−0.02	0.02
Health and social work	5.8	0.06	−0.07	−0.10	−0.22	0.54	0.58
Other services	6.6	0.08	−0.10	−0.11	−0.24	−0.10	−0.04
Total	5.9	0.11	−0.10	−0.10	−0.03	−0.09	−0.04

Source: CGE modelling results.

and computer accessories, for example, for online learning and working from home, as well as farming tools and equipment to combine with the additional farming labour. Moreover, the biggest demanders of the machinery and equipment commodity are households with the highest household incomes (Q5), in both rural and urban areas (see Appendix Table A3 Household expenditure shares by commodity). These households are more likely to purchase equipment to suit the changes in lifestyles induced by Covid-19 restrictions. The contraction in other sectors under the same scenario is partly explained by the negative impact of reduced remittances on consumption expenditure. Majority of households that receive remittances deploy that nonlabour income to immediate expenditure demands, including out-of-pocket payments for healthcare, education and household consumption goods (Doyle, 2015; Medina & Cardona, 2010). This implies that a reduction in remittance income reduces consumption expenditure, which potentially leads to a decline in aggregate demand. This, in turn, feeds back to the sectors that supply the goods and services and limits growth in output produced.

TABLE 3 Annual growth rate in economy-wide wage (rent) for factors 2020–2030: deviation from baseline (%-points)

	Baseline	Non-tertiary rural labour increases	Non-tertiary urban labour declines	Decline in labour productivity: All sectors	Reduced remittance inflows	Increase in gov health spending (fixed budget)	Foreign aid for gov health spending
Labour—rural uneducated	1.9	−1.10	−0.12	−0.05	−0.12	−0.15	−0.08
Labour—rural primary	2.0	−1.10	−0.12	−0.05	−0.08	−0.16	−0.08
Labour—rural secondary	2.0	−1.11	−0.13	−0.03	−0.11	−0.10	−0.01
Labour—rural tertiary	1.2	0.14	−0.10	−0.02	−0.24	0.04	0.11
Labour—urban uneducated	2.9	0.16	−0.10	−0.05	0.03	−0.17	−0.08
Labour—urban primary	1.3	0.15	−0.04	−0.06	−0.10	−0.13	−0.06
Labour—urban secondary	1.4	0.15	−0.05	−0.04	−0.11	−0.04	0.03
Labour—urban tertiary	0.2	0.12	−0.08	0.00	−0.16	0.16	0.21
Land—agricultural crops	8.1	0.18	−0.11	−0.16	−0.28	−0.11	−0.04
Capital—crops	0.3	0.06	0.03	−0.05	−0.07	0.04	0.00
Capital—livestock	0.3	0.06	0.03	−0.05	−0.07	0.04	0.00
Capital—mining	1.4	0.05	0.09	−0.02	0.02	0.07	−0.03
Capital—other	0.7	0.08	0.04	−0.06	0.08	0.02	−0.01

Source: CGE modelling results.

Furthermore, increasing government health spending generates a decline in growth rates for most sectors, when compared to the baseline, although some of those sectors become better off when the source of government health funding is external resources. The decline in sector output growth is partly due to the expanding public healthcare expenditure, which reduces resources available to other government functions. A reduction in other government functional expenditures affects some of the sectors, which are more directly interlinked with the rest of the economy. For example, from the SAM, the public administration sector consumes 1.8% of the construction sector commodity compared to 0.25% consumption by the health sector, and the construction sector contributes 9.5% to GDP compared to 3.4% contribution by the health sector.

An increase in public health spending also implies an expansion in the production of healthcare services because the government is both the producer and the consumer of public healthcare. This expansion would require additional healthcare production inputs, such as healthcare workers, medicines and other healthcare commodities. It is interesting to note, however, that even for those commodities with large intermediate input shares in the production of a unit of healthcare, (i.e., SAM shares for other manufacturing: 0.17 and chemicals: 0.16), expanding the health sector production does not generate commensurate growth in the domestic sectors that could produce such commodities. This suggests that these commodities are largely imported, which is plausible because only a small proportion of medicines and medical commodities are produced locally in Uganda (UNIDO, 2010). The result demonstrates that the economy exhibits limited supply capacity by local manufacturing sectors; they are unable to meet the demand for critical healthcare production input commodities when the health sector expands. This calls for a reorientation of the country's industry policy towards manufacturing of products for which potential demand exists, such as medicines and medical commodities.

We also notice that expanding the skill-intensive health sector, through increased government health spending, generates increased demand for skilled labour, as shown by the results for the growth in quantity demanded of labour by sector (see Appendix Table A4). When compared to the baseline, the health sector demand for labour grows by 0.52% and 0.44% points for rural and urban tertiary labour, respectively. The increased demand also generates an

increase in the wage rate for this category of labour (see Table 3), partly because healthcare labour requires skills that take a long time to acquire, and therefore it is not likely to increase the pool of healthcare workers in the short run, yet there is growing demand. Overall, the health sector GDP grows by 0.54%–0.58% points, whereas other sectors shrink or remain at baseline levels, except for public administration. This result is consistent with the theoretical factor-bias effect of expanding a non-tradable sector in a Heckscher–Ohlin (H–O) model of production equilibrium, extended to incorporate health and healthcare (Kabajulizi, 2016). According to this theory, given a fixed endowment of skilled and unskilled labour, expanding the skill-intensive non-tradable health sector will draw more units of the available skilled labour and some unskilled labour into the production of healthcare, resulting into a decline in the skilled to unskilled labour ratio in the rest of the economy. Consequently, while the health sector output expands, the output of other skill-intensive tradable sectors, such as construction, manufacturing and machinery and equipment, will decline, whereas the tradable sectors intensive in unskilled labour will grow slowly. The theory suggests that in settings where skilled labour is scarce, such as Uganda, expanding the health sector may lead to a decline in overall output because the skill-intensive sectors' output declines, whereas that of unskilled intensity grows slowly.[4]

4.2 | International trade

The results for exports and imports' performance reflect the pattern of trade in Uganda. Coffee has been Uganda's leading export commodity accounting for over 15% share of total export value. However, nontraditional exports have been growing, including gold and gold compounds whose exports have drastically grown since 2015 and reached 35% share in 2019 (Uganda Bureau of Statistics, 2020). The major imports comprise of nonmonetary gold, petroleum products, motor vehicles, iron and steel products, medical products and pharmaceuticals, plastics in primary forms, machinery for industries and vegetable fats and oils. Uganda operates a trade deficit. As shown in Figure 2a and Figure 2b, the African region is the main destination of Uganda's exports with the top five being Kenya, Democratic Republic of Congo, South Sudan, Rwanda and Tanzania chronologically. Similarly, imports mainly originate from Asia, topped by China and India.

The impact of Covid-19 on imports and exports is presented in Table 4, which shows results for the annual growth rates in selected macro variables compared to the baseline. The predicted decline in growth rates is explained by the disruptions in trade flows brought about by border closures with trading partners, which slowed down the value chain. Although country borders have since opened with strict observance of Covid-19 standing operating procedures, it will take some countries quite a few years to recover to the pre-Covid-19 operating capacity. The predicted higher growth rates in exports under the scenario that increases non-tertiary rural labour could be explained by the composition of Uganda's exports and trading partners. Uganda exports a significant quantity of agricultural products to the neighbouring countries of Kenya, Rwanda, Democratic Republic of Congo, South Sudan and Tanzania, through informal trade routes at border posts and bus terminals, whereas imports of manufactures mainly come from Kenya through the same routes. Informal trade flows data are collected through Informal Cross-Border Trade surveys and included in the national accounts as informal imports and exports[5] (Uganda Bureau of Statistics, 2020). The informal trade routes continue to operate even when the border cargo-clearing offices are closed or restricted by Covid-19 regulations.

4.3 | Household welfare

The impact of Covid-19 restrictions on household welfare is mainly negative across all households although the magnitude varies by scenario, as shown by changes in consumption expenditure in Table 5 and equivalent variation

[4]This factor-bias outcome is, however, only part of the story of expanding the health sector. Expanding the health sector output also implies more services and treatments for the sick and unable to work labour. If these are cured and return to work, it may increase labour participation rates and labour productivity, i.e., the scale effect of increasing health sector output. The net impact on the economy will therefore depend on which outcome dominates. In developing countries, with a high disease burden, the scale effect tends to dominate because the marginal return of health output (treatments) is often high. The case varies for developed countries. See Chapter 2 in Kabajulizi (2016) for a detailed discussion of the theoretical outcomes of the model.

[5]These informal trade transactions do not go through official clearance and documentation processes required by the customs laws.

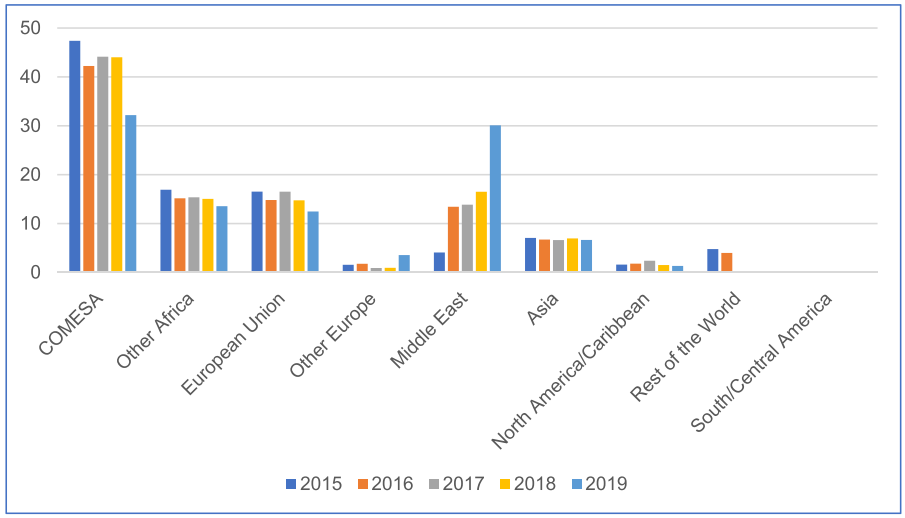

FIGURE 2A Exports by region of destination by percentage 2015–2019. *Data source*: Uganda Bureau of Statistics, Statistical Abstract 2020 [Color figure can be viewed at wileyonlinelibrary.com]

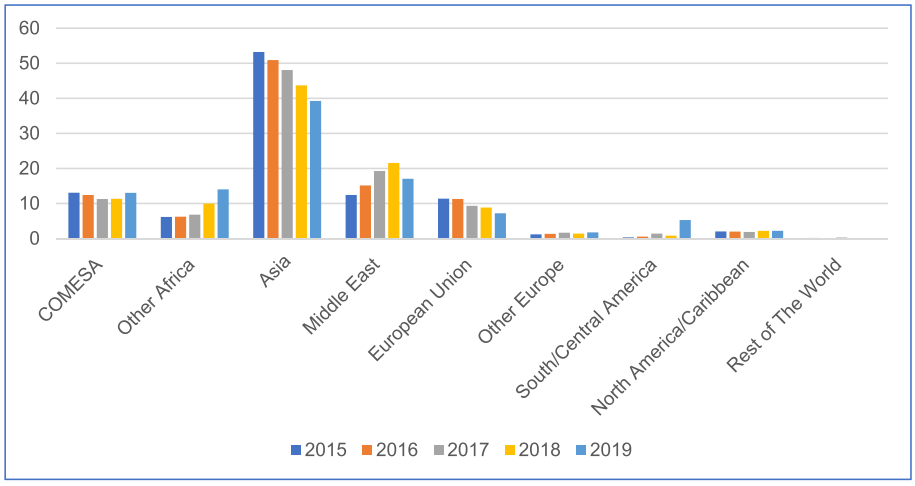

FIGURE 2B Imports by percentage share and region of origin, 2015–2019. *Data source*: Uganda Bureau of Statistics, Statistical Abstract 2020 [Color figure can be viewed at wileyonlinelibrary.com]

in Table 6. The equivalent variation is a consumption-based measure of welfare that controls for changes in prices. The baseline values are the percentage change in welfare by 2030. In subsequent columns, negative (positive) values denote welfare losses (gains) when compared to the baseline scenario. The positive values under the non-tertiary labour shock scenario suggest a degree of resilience amidst the Covid-19 shocks. This is possible because most households in Uganda earn more than half of their income from the ownership of land for agricultural crops and capital for crops and livestock (see shares in Appendix Table A1 and Table A2), for which activities carried out are mainly rural-based and continue to operate even during Covid-19 restrictions. Additionally, the agricultural sector, which employs more than 67% of Uganda's total labour force, acts as a cushion to the external shocks because individuals

TABLE 4 Annual growth rate for selected real macro variables' share in GDP: deviation from the baseline (%-age points)

	Baseline	Non-tertiary rural labour increases	Non-tertiary urban labour declines	Decline in labour productivity: All sectors	Reduced remittance inflows	Increase in gov health spending (fixed budget)	Foreign aid for gov health spending
Absorption	−0.02	−0.01	0.01	0.01	−0.17	0.01	0.02
Private consumption	−0.28	−0.01	0.01	0.02	−0.21	0.02	0.01
Investment	1.31	0.01	−0.01	−0.03	−0.12	−0.21	−0.14
Government consumption	−2.76	−0.10	0.09	0.09	0.03	0.96	0.91
Exports	3.35	0.03	−0.10	−0.02	0.40	−0.14	−0.12
Imports	2.24	−0.01	−0.05	0.01	−0.21	−0.08	−0.03
Net indirect taxes	0.07	0.01	0.01	0.00	−0.05	−0.05	−0.04

Source: CGE modelling results.

TABLE 5 Annual growth rate in household consumption expenditure 2020–2030: deviation from baseline (%-points)

	Baseline	Non-tertiary rural labour increases	Non-tertiary urban labour declines	Decline in labour productivity: All sectors	Reduced remittance inflows	Increase in gov health spending (fixed budget)	Foreign aid for gov health spending
Rural farm—Q1	6.9	0.10	−0.10	−0.11	−0.24	−0.11	−0.05
Rural farm—Q2	6.9	0.10	−0.10	−0.14	−0.26	−0.11	−0.05
Rural farm—Q3	6.8	0.10	−0.09	−0.15	−0.27	−0.10	−0.05
Rural farm—Q4	6.7	0.09	−0.10	−0.14	−0.26	−0.10	−0.05
Rural farm—Q5	6.7	0.10	−0.09	−0.23	−0.34	−0.10	−0.05
Rural nonfarm—Q1	6.3	0.05	−0.10	−0.09	−0.19	−0.12	−0.07
Rural nonfarm—Q2	6.3	0.06	−0.10	−0.08	−0.18	−0.12	−0.07
Rural nonfarm—Q3	6.2	0.06	−0.10	−0.06	−0.16	−0.12	−0.06
Rural nonfarm—Q4	6.3	0.07	−0.10	−0.08	−0.18	−0.12	−0.06
Rural nonfarm—Q5	6.3	0.08	−0.10	−0.21	−0.30	−0.10	−0.05
Urban—Q1	6.6	0.15	−0.09	−0.14	−0.26	−0.11	−0.05
Urban—Q2	6.5	0.15	−0.09	−0.15	−0.26	−0.11	−0.05
Urban—Q3	6.4	0.14	−0.09	−0.17	−0.27	−0.10	−0.04
Urban—Q4	6.2	0.14	−0.09	−0.19	−0.29	−0.09	−0.04
Urban—Q5	5.9	0.13	−0.09	−0.22	−0.31	−0.05	0.00

Source: CGE modelling results.

continue to engage in agricultural activities during the lockdown restrictions. This assertion is consistent with earlier studies, which found that, in Uganda, increased agriculture investment would lead to accelerated reduction in income poverty and at a higher speed among rural farming households compared to others (Kabajulizi et al., 2017).

Labour productivity growth is a key determinant of average living standards in the long run. The results in Table 5 Column 5 show that the decline in labour productivity growth shock affects the richer households' (Q5) consumption expenditure relatively more than other income quintiles, in both rural farming and non-farming households and urban households. This is because these households earn a relatively high proportion of their income from selling labour, as

TABLE 6 Disaggregated EV by household 2020–2030: deviation from baseline (%-age points)

	Baseline	Non-tertiary rural labour increases	Non-tertiary urban labour declines	Decline in labour productivity: All sectors	Reduced remittance inflows	Increase in gov health spending (fixed budget)	Foreign aid for gov health spending
Rural farm—Q1	7.4	0.15	−0.13	−0.15	−0.29	−0.14	−0.06
Rural farm—Q2	7.4	0.15	−0.13	−0.15	−0.33	−0.14	−0.06
Rural farm—Q3	7.4	0.14	−0.13	−0.15	−0.36	−0.14	−0.06
Rural farm—Q4	7.5	0.13	−0.13	−0.15	−0.35	−0.14	−0.06
Rural farm—Q5	8.2	0.15	−0.15	−0.17	−0.55	−0.16	−0.07
Rural nonfarm—Q1	6.3	0.07	−0.13	−0.10	−0.20	−0.16	−0.09
Rural nonfarm—Q2	6.4	0.08	−0.13	−0.11	−0.19	−0.16	−0.09
Rural nonfarm—Q3	6.5	0.08	−0.13	−0.11	−0.16	−0.16	−0.08
Rural nonfarm—Q4	7.0	0.11	−0.14	−0.13	−0.23	−0.17	−0.08
Rural nonfarm—Q5	7.7	0.12	−0.15	−0.14	−0.48	−0.16	−0.07
Urban—Q1	7.1	0.24	−0.13	−0.14	−0.34	−0.15	−0.07
Urban—Q2	6.9	0.23	−0.12	−0.13	−0.33	−0.14	−0.06
Urban—Q3	6.9	0.22	−0.12	−0.12	−0.36	−0.13	−0.05
Urban—Q4	7.2	0.22	−0.13	−0.13	−0.41	−0.13	−0.05
Urban—Q5	7.4	0.22	−0.14	−0.13	−0.50	−0.08	0.01

Abbreviation: EV, equivalent variation.

Source: CGE modelling results.

shown in the SAM household shares per factor in Table A1 and factor shares per household in Table A2 in the appendix. For instance, the labour-rural-tertiary category forms 60.7% of total household factor ownership for the top quintile (Q5) rural non-farming households. This result resonates with findings from the distributional consequences of Covid-19 lockdown in Latin America and the Caribbean (Delaporte et al., 2021). In their study, they found that labour income distributions were affected differently in different countries, and informal workers were more likely to experience a lower drop of their pre-lockdown labour income under imperfect compliance. Moreover, in Uganda, members in the top quintile households are more likely to be in formal employment occupations and more likely to suffer from labour market shocks, such as reduction in salary and unemployment, yet these have been found to be negatively associated with financial wellbeing (Botha et al., 2021).

Additionally, the decline in remittances' scenario predicts the largest reduction in welfare among all households. This is plausible because remittance recipients often use the income to smooth out household consumption expenditure gaps (Ajaero et al., 2018) and act as insurance for households, tending to increase when the recipient income falls (Yang & Choi, 2007). Therefore, a reduction in remittance inflows means that the households are in a precarious position; recipient households' welfare declines as observed in our results. Again, the most affected households are those in the top quintile, in both rural and urban areas. This is consistent with the reality that relatively richer households are the ones most likely to afford and facilitate their kin to travel to migrant host countries in Europe, North America and the Middle East.

5 | DISCUSSION AND CONCLUSIONS

This study set out to evaluate the macroeconomic implications of infectious disease, the case of Covid-19 in Uganda. Although theory predicts that increased public expenditure on health generates growth in physical capital

accumulation, the result in the Ugandan case aligns with Bloom et al.'s (2021) view that the total net effect will depend on the strength of various forces at play in the economy and that a multisector analysis is most suited for such an analysis. The effect of expanding the healthcare budget also alludes to the debate that, although the healthcare sector contributes to economic growth by lowering mortality, increasing labour productivity and by individuals working longer in life, it also diverts resources from other economic activities such that there exists an optimal size of the health sector for economic growth; further expansion may not be beneficial for growth (Kuhn & Prettner, 2016). The welfare effects, where richer households experience relatively larger welfare losses, are contrary to findings from European countries where lower income groups were hit harder by lockdown measures (Palominoa et al., 2020). This demonstrates that heterogeneity across societies and economic structure will shape the susceptibility to and economic effects of infectious diseases.

These results have the following policy implications. On sector performance, policymakers need to revisit Uganda's industrial policy and reorient it towards domestic production of commodities that are intermediate inputs to critical domestic sectors, such as healthcare. Additionally, there is a need to accelerate rural infrastructure development particularly the road network, to facilitate an integrated rural economy induced by the shift in labour and enterprise towards rural areas. On welfare, the richer households need to be included in tailor-made Covid-19 relief initiatives. The Covid-19 relief food distribution during the first lockdown and the cash transfers ($28 per person) to vulnerable poor Ugandans following the second wave of Covid-19 lockdown were dodged with unenviable implementation hurdles: logistical challenges in the food distribution and lack of accurate identification data for the target cash beneficiaries. The government should integrate the national identification registration in all public service points to facilitate targeted service delivery.

Finally, the study findings suggest that, for developing countries, policies to contain infectious disease pandemics should be tailored to local conditions and not imported wholesome from well-established systems of the western world. The sector employment structure, a large informal sector and underdeveloped institutions that impede efficiency in government performance are unique attributes of developing countries, such as Uganda, which ought to be considered when adopting approaches to contain disease pandemics from other countries.

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I am grateful to Dr. Ole Boysen for some help with the modelling.

CONFLICT OF INTEREST

The author declares none.

ETHICS STATEMENT

Ethical approval for this type of study is not required by our university.

DATA AVAILABILITY STATEMENT

The Social Accounting Matrix data that support the findings of this study are available in 'Harvard Dataverse', V1 with the identifier: 10.7910/DVN/XDNIGO.

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APPENDIX A.

TABLE A1 Household shares per factor (%): distribution of household categories for each type of factor

Household category/factor type	Labour—rural uneducated	Labour—rural primary	Labour—rural secondary	Labour—rural tertiary	Labour—urban uneducated	Labour—urban primary	Labour—urban secondary	Labour—urban tertiary	Land—agricultural crops	Capital—crops	Capital—livestock
Rural farm—Q1	9.9	6.1	2.8	0.8	0.0	0.0	0.0	0.0	10.7	10.8	3.8
Rural farm—Q2	12.6	9.2	6.9	0.5	0.0	0.0	0.0	0.0	16.8	16.8	8.4
Rural farm—Q3	13.5	12.0	11.8	1.1	0.0	0.0	0.0	0.0	19.5	19.4	15.6
Rural farm—Q4	16.6	14.0	20.1	4.1	0.0	0.0	0.0	0.0	21.9	21.9	21.9
Rural farm—Q5	6.3	9.7	12.2	8.2	0.0	0.0	0.0	0.0	13.6	13.5	17.6
Rural nonfarm—Q1	8.8	5.3	1.6	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rural nonfarm—Q2	7.0	7.1	2.7	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rural nonfarm—Q3	8.2	10.0	6.5	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rural nonfarm—Q4	9.9	11.5	10.6	14.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rural nonfarm—Q5	7.2	15.1	24.8	60.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Urban—Q1	0.0	0.0	0.0	0.0	8.4	3.6	0.4	0.0	1.3	1.3	0.4
Urban—Q2	0.0	0.0	0.0	0.0	8.2	5.2	1.5	0.1	1.8	1.8	0.8
Urban—Q3	0.0	0.0	0.0	0.0	14.8	10.0	3.3	1.0	2.8	2.8	2.1
Urban—Q4	0.0	0.0	0.0	0.0	28.7	24.6	18.2	4.2	5.2	5.2	9.5
Urban—Q5	0.0	0.0	0.0	0.0	39.9	56.7	76.7	94.6	6.6	6.6	19.9
Total	100	100	100	100	100	100	100	100	100	100	100

Source: Author computation from the Uganda SAM2013.

TABLE A2 Factor shares per household type (%): distribution of factor types in each household categories

Household category/factor type	Labour—rural uneducated	Labour—rural primary	Labour—rural secondary	Labour—rural tertiary	Labour—urban uneducated	Labour—urban primary	Labour—urban secondary	Labour—urban tertiary	Land—agricultural crops	Capital—crops	Capital—livestock	Total
Rural farm—Q1	3.8	12.4	4.0	0.6	0.0	0.0	0.0	0.0	52.5	17.7	9.0	100
Rural farm—Q2	2.9	11.6	6.0	0.2	0.0	0.0	0.0	0.0	50.3	16.9	12.0	100
Rural farm—Q3	2.4	11.6	8.0	0.4	0.0	0.0	0.0	0.0	45.2	15.1	17.3	100
Rural farm—Q4	2.4	11.0	11.0	1.2	0.0	0.0	0.0	0.0	41.1	13.8	19.6	100
Rural farm—Q5	1.4	11.3	9.9	3.5	0.0	0.0	0.0	0.0	37.9	12.6	23.4	100
Rural nonfarm—Q1	20.0	64.8	13.2	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100
Rural nonfarm—Q2	11.7	64.7	17.4	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100
Rural nonfarm—Q3	8.0	52.7	24.1	15.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100
Rural nonfarm—Q4	7.1	44.5	28.6	19.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100
Rural nonfarm—Q5	2.4	27.2	31.0	39.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100
Urban—Q1	0.0	0.0	0.0	0.0	8.0	28.0	5.3	0.0	39.6	13.5	5.7	100
Urban—Q2	0.0	0.0	0.0	0.0	5.0	25.5	13.2	1.5	35.3	11.8	7.6	100
Urban—Q3	0.0	0.0	0.0	0.0	4.6	25.1	14.9	7.7	28.3	9.5	9.9	100
Urban—Q4	0.0	0.0	0.0	0.0	3.0	20.7	27.5	10.4	17.4	5.8	15.2	100
Urban—Q5	0.0	0.0	0.0	0.0	0.9	10.4	25.1	50.3	4.8	1.6	6.9	100

Source: Author computation from the Uganda SAM2013.

TABLE A3 Household expenditure shares by commodity

	Rural farm—Q1	Rural farm—Q2	Rural farm—Q3	Rural farm—Q4	Rural farm—Q5	Rural nonfarm—Q1	Rural nonfarm—Q2	Rural nonfarm—Q3
Agriculture	14.1	12.7	11.5	11.0	7.8	17.9	16.1	14.6
Forestry	2.3	2.6	2.7	2.0	1.5	2.1	3.9	4.0
Fishing	1.6	1.7	2.0	1.3	1.2	1.3	1.5	1.5
Meat, fish and dairy	10.2	9.1	7.8	6.1	3.3	8.2	8.9	8.8
Fruit and veg processing	2.8	2.5	1.8	1.8	0.9	1.8	1.8	2.0
Fats and oils	3.4	3.1	2.2	2.2	1.1	2.2	2.2	2.5
Grain milling	11.6	7.4	6.4	6.5	3.3	13.5	10.5	8.2
Sugar refining	3.2	4.6	3.8	3.0	1.7	3.1	4.0	4.1
Other foods	1.1	1.1	1.4	1.3	1.3	1.3	2.2	2.1
Beverages	3.4	4.7	4.5	4.4	6.0	8.6	4.5	3.8
Other manufacturing	12.5	12.3	11.6	12.8	11.0	11.0	11.1	10.0
Chemicals	12.8	12.2	10.9	9.2	6.8	10.8	10.1	9.8
Machinery and equipment	0.5	0.5	0.9	1.8	2.9	0.3	0.7	0.9
Utilities	1.8	0.7	1.3	1.0	0.8	1.5	1.0	1.9
Wholesale and retail trade	0.1	0.1	0.2	0.5	1.9	0.1	0.2	0.1
Transport and storage	2.6	3.8	4.6	5.2	5.0	2.1	4.2	5.3
Other private services	2.8	5.0	6.9	6.8	12.5	2.7	4.0	4.7
Education	7.9	8.5	10.1	10.9	8.1	5.1	6.8	7.5
Health and social work	5.0	6.2	7.4	8.2	7.5	6.4	6.0	7.1
Other services	0.3	1.2	2.0	3.9	15.6	0.0	0.4	0.9
Total	100	100	100	100	100	100	100	100

Source: Author computation from the Uganda SAM2013.

TABLE A3 (Continued)

	Rural nonfarm—Q4	Rural nonfarm—Q5	Urban—Q1	Urban—Q2	Urban—Q3	Urban—Q4	Urban—Q5
Agriculture	13.5	9.8	16.3	15.3	15.6	14.0	10.4
Forestry	3.8	2.4	3.5	4.4	7.4	6.2	3.5
Fishing	2.4	1.1	1.4	0.6	1.4	1.4	0.8
Meat, fish and dairy	7.3	5.1	6.5	11.1	8.4	6.3	3.6
Fruit and veg processing	1.5	0.9	2.8	2.1	2.1	1.6	0.8
Fats and oils	1.9	1.1	3.5	2.6	2.6	2.0	1.0
Grain milling	4.7	2.4	7.5	8.5	8.9	5.8	1.7
Sugar refining	3.3	1.8	3.2	3.7	4.4	3.1	1.6
Other foods	2.7	3.0	2.3	1.7	1.6	3.2	4.7
Beverages	4.4	4.8	3.8	2.9	2.3	2.9	3.8
Other manufacturing	9.3	11.1	10.3	10.4	8.5	8.3	10.1
Chemicals	8.1	7.7	12.3	8.3	7.7	6.0	6.4
Machinery and equipment	1.2	3.4	0.7	0.6	0.6	0.9	3.4
Utilities	3.7	3.0	3.2	4.1	5.4	5.9	6.0
Wholesale and retail trade	0.5	0.6	0.0	0.1	0.2	0.1	0.5
Transport and storage	5.4	5.9	3.2	3.8	4.0	4.8	6.4
Other private services	7.8	14.9	4.1	4.6	6.4	8.5	16.7
Education	9.0	9.1	8.8	9.7	6.8	12.0	10.1
Health and social work	7.2	7.3	6.6	5.6	5.2	5.6	5.6
Other services	2.4	4.5	0.0	0.0	0.7	1.6	2.9
Total	100	100	100	100	100	100	100

Source: Author computation from the Uganda SAM2013.

TABLE A4 Annual growth rate in quantity demanded of labour by sector 2020–2030: deviation from baseline (%-point)

		Baseline	Non-tertiary rural labour increases	Non-tertiary urban labour declines	Decline in labour productivity: All sectors	Reduced remittance inflows	Increase in gov health spending (fixed budget)	Foreign aid for gov health spending
Labour—rural uneducated	Agriculture	3.9	0.91	0.01	0.00	−0.10	0.04	0.03
	Forestry	5.3	0.94	−0.01	−0.03	−0.09	−0.07	−0.04
	Fishing	3.0	0.88	0.02	0.02	−0.06	0.06	0.04
	Other mining	6.3	0.83	0.00	−0.02	0.00	−0.15	−0.13
	Meat, fish and dairy	−0.3	0.80	0.09	0.08	0.16	0.11	0.06
	Fruit and vegetable processing	2.3	0.81	0.03	0.05	−0.03	0.06	0.05
	Fats and oils	1.7	0.81	0.05	0.05	0.03	0.08	0.06
	Grain milling	1.9	0.80	0.03	0.07	−0.01	0.05	0.03
	Sugar refining	0.9	0.86	0.07	0.05	0.08	0.07	0.03
	Other foods	2.9	0.89	0.03	0.03	−0.07	0.06	0.05
	Beverages	4.1	0.89	0.02	0.00	−0.09	0.04	0.03
	Other manufacturing	5.5	1.09	0.02	−0.10	0.16	−0.06	−0.06
	Chemicals	4.9	0.92	0.03	−0.06	−0.06	0.05	0.03
	Machinery and equipment	38.3	1.18	−0.49	0.10	1.18	−0.48	−0.33
	Construction	4.9	0.91	−0.01	−0.01	−0.04	−0.19	−0.12
	Wholesale and retail trade	−1.8	0.77	0.09	0.07	0.11	0.10	0.04
	Transport and storage	3.3	0.92	0.03	−0.03	−0.03	0.07	0.05
	Other private services	3.4	0.90	0.03	−0.03	0.01	0.05	0.03
	Public administration	0.4	0.77	0.05	0.19	0.03	0.61	0.58
	Education	3.6	0.88	0.00	0.04	−0.15	0.11	0.11
	Other services	4.3	0.91	−0.01	0.01	−0.12	0.01	0.02

TABLE A4 (Continued)

		Baseline	Non-tertiary rural labour increases	Non-tertiary urban labour declines	Decline in labour productivity: All sectors	Reduced remittance inflows	Increase in gov health spending (fixed budget)	Foreign aid for gov health spending
Labour—rural primary	Agriculture	3.8	0.91	0.02	0.00	−0.13	0.04	0.03
	Forestry	5.3	0.94	0.00	−0.03	−0.12	−0.06	−0.04
	Fishing	2.9	0.88	0.03	0.02	−0.10	0.06	0.04
	Other mining	6.2	0.82	0.00	−0.02	−0.04	−0.14	−0.13
	Meat, fish and dairy	−0.4	0.80	0.10	0.08	0.13	0.11	0.06
	Fruit and vegetable processing	2.3	0.81	0.03	0.05	−0.06	0.07	0.05
	Fats and oils	1.7	0.81	0.05	0.05	−0.01	0.09	0.06
	Grain milling	1.8	0.80	0.04	0.07	−0.04	0.05	0.03
	Sugar refining	0.9	0.85	0.08	0.05	0.05	0.08	0.03
	Other foods	2.9	0.89	0.03	0.03	−0.11	0.07	0.05
	Beverages	4.0	0.89	0.02	0.00	−0.12	0.04	0.03
	Other manufacturing	5.5	1.09	0.03	−0.10	0.12	−0.06	−0.06
	Chemicals	4.8	0.92	0.03	−0.06	−0.10	0.05	0.03
	Machinery and equipment	38.2	1.18	−0.49	0.10	1.14	−0.48	−0.33
	Construction	4.8	0.91	−0.01	−0.01	−0.07	−0.19	−0.12
	Wholesale and retail trade	−1.9	0.77	0.09	0.07	0.08	0.10	0.04
	Transport and storage	3.2	0.92	0.03	−0.03	−0.06	0.07	0.04
	Other private services	3.3	0.90	0.04	−0.03	−0.02	0.05	0.03
	Public administration	0.3	0.77	0.05	0.19	0.00	0.61	0.58
	Education	3.5	0.88	0.01	0.04	−0.18	0.11	0.11
	Health and social work	3.3	0.88	0.01	0.05	−0.17	0.66	0.65
	Other services	4.2	0.91	0.00	0.01	−0.16	0.02	0.02

(Continues)

TABLE A4 (Continued)

		Baseline	Non-tertiary rural labour increases	Non-tertiary urban labour declines	Decline in labour productivity: All sectors	Reduced remittance inflows	Increase in gov health spending (fixed budget)	Foreign aid for gov health spending
Labour—rural secondary	Agriculture	3.8	0.92	0.02	−0.01	−0.11	−0.01	−0.02
	Forestry	5.3	0.95	0.00	−0.05	−0.09	−0.11	−0.09
	Fishing	2.9	0.89	0.03	0.00	−0.07	0.02	−0.01
	Other mining	6.2	0.84	0.01	−0.04	−0.01	−0.19	−0.18
	Meat, fish and dairy	−0.4	0.81	0.10	0.07	0.15	0.07	0.01
	Fruit and vegetable processing	2.3	0.82	0.04	0.04	−0.03	0.02	0.00
	Fats and oils	1.7	0.82	0.05	0.03	0.02	0.04	0.01
	Grain milling	1.8	0.81	0.04	0.06	−0.02	0.01	−0.02
	Sugar refining	0.9	0.86	0.08	0.04	0.07	0.03	−0.01
	Other foods	2.9	0.90	0.04	0.01	−0.08	0.02	0.00
	Beverages	4.0	0.90	0.03	−0.02	−0.09	0.00	−0.02
	Other manufacturing	5.5	1.10	0.03	−0.12	0.15	−0.10	−0.11
	Chemicals	4.8	0.93	0.04	−0.07	−0.07	0.01	−0.02
	Machinery and equipment	38.2	1.19	−0.48	0.08	1.17	−0.54	−0.40
	Utilities	4.4	0.93	−0.01	0.00	−0.10	−0.02	−0.02
	Construction	4.9	0.92	−0.01	−0.03	−0.05	−0.23	−0.17
	Wholesale and retail trade	−1.8	0.78	0.10	0.06	0.11	0.06	0.00
	Transport and storage	3.3	0.93	0.04	−0.04	−0.04	0.03	0.00
	Other private services	3.4	0.91	0.04	−0.04	0.00	0.01	−0.02
	Public administration	0.3	0.78	0.05	0.18	0.03	0.57	0.54
	Education	3.5	0.89	0.01	0.02	−0.16	0.07	0.06
	Health and social work	3.3	0.89	0.01	0.03	−0.14	0.62	0.60
	Other services	4.2	0.92	0.00	−0.01	−0.13	−0.03	−0.03

TABLE A4 (Continued)

		Baseline	Non-tertiary rural labour increases	Non-tertiary urban labour declines	Decline in labour productivity: All sectors	Reduced remittance inflows	Increase in gov health spending (fixed budget)	Foreign aid for gov health spending
Labour—rural tertiary	Agriculture	4.4	0.02	0.00	−0.02	−0.01	−0.11	−0.11
	Fishing	3.4	0.00	0.02	0.00	0.02	−0.08	−0.10
	Other mining		0.00	0.00	0.00	0.00	0.00	0.00
	Meat, fish and dairy	0.1	−0.05	0.08	0.06	0.24	−0.03	−0.07
	Fruit and vegetable processing	2.8	−0.07	0.02	0.03	0.06	−0.08	−0.09
	Fats and oils	2.2	−0.06	0.04	0.03	0.11	−0.05	−0.08
	Grain milling	2.3	−0.07	0.02	0.05	0.07	−0.09	−0.11
	Sugar refining	1.4	−0.01	0.07	0.03	0.16	−0.06	−0.10
	Other foods	3.4	0.01	0.02	0.01	0.01	−0.08	−0.09
	Other manufacturing	6.0	0.19	0.01	−0.13	0.25	−0.21	−0.20
	Chemicals	5.4	0.02	0.02	−0.08	0.02	−0.09	−0.11
	Machinery and equipment	38.9	−0.01	−0.51	0.07	1.30	−0.67	−0.52
	Utilities	5.0	0.03	−0.03	−0.01	−0.01	−0.12	−0.11
	Construction	5.4	0.01	−0.02	−0.03	0.05	−0.33	−0.26
	Wholesale and retail trade	−1.3	−0.07	0.08	0.05	0.20	−0.03	−0.09
	Transport and storage	3.8	0.04	0.02	−0.05	0.06	−0.07	−0.09
	Other private services	3.9	0.02	0.02	−0.05	0.10	−0.09	−0.11
	Public administration	0.9	−0.09	0.04	0.17	0.12	0.47	0.45
	Education	4.1	−0.01	−0.01	0.02	−0.07	−0.03	−0.03
	Health and social work	3.8	0.00	0.00	0.02	−0.05	0.52	0.52
	Other services	4.8	0.02	−0.02	−0.01	−0.04	−0.13	−0.12

(Continues)

TABLE A4 (Continued)

		Baseline	Non-tertiary rural labour increases	Non-tertiary urban labour declines	Decline in labour productivity: all sectors	Reduced remittance inflows	Increase in gov health spending (fixed budget)	Foreign aid for gov health spending
Labour—urban uneducated	Agriculture	3.2	0.01	0.00	0.00	−0.20	0.04	0.03
	Forestry	4.6	0.03	−0.02	−0.03	−0.19	−0.06	−0.04
	Fishing	2.2	−0.02	0.01	0.02	−0.17	0.07	0.04
	Other mining	5.5	−0.10	−0.01	−0.02	−0.11	−0.14	−0.13
	Meat, fish and dairy	−1.0	−0.06	0.08	0.08	0.05	0.12	0.06
	Fruit and vegetable processing	1.6	−0.08	0.02	0.05	−0.13	0.07	0.05
	Fats and oils	1.0	−0.07	0.03	0.04	−0.08	0.09	0.06
	Grain milling	1.1	−0.08	0.02	0.07	−0.11	0.05	0.03
	Sugar refining	0.2	−0.02	0.06	0.05	−0.02	0.08	0.03
	Other foods	2.2	0.00	0.02	0.03	−0.18	0.07	0.05
	Beverages	3.3	−0.01	0.01	−0.01	−0.19	0.05	0.03
	Other manufacturing	4.8	0.17	0.01	−0.10	0.05	−0.05	−0.06
	Chemicals	4.1	0.01	0.02	−0.06	−0.17	0.06	0.03
	Machinery and equipment	37.3	−0.03	−0.50	0.10	1.03	−0.47	−0.33
	Utilities	3.7	0.01	−0.03	0.01	−0.20	0.03	0.03
	Construction	4.2	0.00	−0.03	−0.01	−0.15	−0.18	−0.12
	Wholesale and retail trade	−2.5	−0.08	0.08	0.07	0.01	0.11	0.04
	Transport and storage	2.6	0.02	0.02	−0.03	−0.13	0.08	0.04
	Other private services	2.7	0.00	0.02	−0.03	−0.10	0.06	0.03
	Education	2.9	−0.02	−0.01	0.04	−0.26	0.12	0.10
	Health and social work	2.6	−0.02	−0.01	0.04	−0.24	0.66	0.65
	Other services	3.5	0.00	−0.02	0.01	−0.23	0.02	0.02

TABLE A4 (Continued)

		Baseline	Non-tertiary rural labour increases	Non-tertiary urban labour declines	Decline in labour productivity: All sectors	Reduced remittance inflows	Increase in gov health spending (fixed budget)	Foreign aid for gov health spending
Labour—urban primary	Agriculture	4.3	0.01	−0.04	0.01	−0.12	0.02	0.01
	Forestry	5.8	0.03	−0.06	−0.03	−0.10	−0.08	−0.06
	Fishing	3.4	−0.01	−0.03	0.02	−0.08	0.04	0.02
	Other mining	6.7	−0.10	−0.05	−0.02	−0.02	−0.17	−0.14
	Meat, fish and dairy	0.1	−0.06	0.04	0.09	0.14	0.09	0.04
	Fruit and vegetable processing	2.8	−0.08	−0.02	0.06	−0.04	0.05	0.03
	Fats and oils	2.2	−0.07	−0.01	0.05	0.01	0.07	0.04
	Grain milling	2.3	−0.08	−0.02	0.08	−0.03	0.03	0.01
	Sugar refining	1.4	−0.02	0.02	0.06	0.06	0.06	0.02
	Other foods	3.4	0.00	−0.02	0.03	−0.09	0.05	0.03
	Beverages	4.5	−0.01	−0.03	0.00	−0.11	0.03	0.01
	Other manufacturing	6.0	0.18	−0.03	−0.10	0.14	−0.08	−0.08
	Chemicals	5.3	0.01	−0.02	−0.05	−0.08	0.03	0.01
	Machinery and equipment	38.8	−0.02	−0.56	0.11	1.17	−0.51	−0.36
	Utilities	4.9	0.02	−0.07	0.02	−0.11	0.01	0.01
	Construction	5.3	0.00	−0.07	−0.01	−0.06	−0.21	−0.14
	Wholesale and retail trade	−1.4	−0.08	0.04	0.08	0.10	0.08	0.03
	Transport and storage	3.7	0.03	−0.02	−0.02	−0.05	0.05	0.03
	Other private services	3.9	0.01	−0.02	−0.02	−0.01	0.03	0.01
	Public administration	0.8	−0.10	0.00	0.20	0.02	0.59	0.57

(Continues)

TABLE A4 (Continued)

		Baseline	Non-tertiary rural labour increases	Non-tertiary urban labour declines	Decline in labour productivity: All sectors	Reduced remittance inflows	Increase in gov health spending (fixed budget)	Foreign aid for gov health spending
	Education	4.0	−0.02	−0.05	0.04	−0.17	0.09	0.09
	Health and social work	3.8	−0.01	−0.05	0.05	−0.16	0.65	0.64
	Other services	4.7	0.01	−0.06	0.01	−0.14	0.00	0.00
		Baseline	**Non-tertiary rural labour increases**	**Non-tertiary urban labour declines**	**Decline in labour productivity: All sectors**	**Reduced remittance inflows**	**Increase in gov health spending (fixed budget)**	**Foreign aid for gov health spending**
Labour—urban secondary	Agriculture	4.3	0.01	−0.03	−0.01	−0.11	−0.04	−0.05
	Forestry	5.7	0.03	−0.05	−0.04	−0.10	−0.15	−0.12
	Fishing	3.3	−0.01	−0.02	0.01	−0.07	−0.02	−0.04
	Other mining	6.6	−0.09	−0.05	−0.03	−0.01	−0.23	−0.21
	Meat, fish and dairy	0.0	−0.06	0.05	0.07	0.15	0.03	−0.02
	Fruit and vegetable processing	2.7	−0.08	−0.02	0.04	−0.04	−0.01	−0.03
	Fats and oils	2.1	−0.07	0.00	0.04	0.02	0.01	−0.02
	Grain milling	2.2	−0.08	−0.01	0.06	−0.02	−0.03	−0.05
	Sugar refining	1.3	−0.02	0.03	0.04	0.07	0.00	−0.04
	Other foods	3.3	0.00	−0.01	0.02	−0.08	−0.01	−0.03
	Beverages	4.4	−0.01	−0.03	−0.01	−0.10	−0.04	−0.05
	Other manufacturing	5.9	0.18	−0.02	−0.11	0.15	−0.14	−0.14
	Chemicals	5.3	0.01	−0.02	−0.07	−0.07	−0.03	−0.05
	Machinery and equipment	38.8	−0.02	−0.55	0.09	1.18	−0.59	−0.44
	Utilities	4.9	0.02	−0.06	0.01	−0.10	−0.05	−0.05
	Construction	5.3	0.00	−0.06	−0.02	−0.05	−0.27	−0.20

TABLE A4 (Continued)

		Baseline	Non-tertiary rural labour increases	Non-tertiary urban labour declines	Decline in labour productivity: All sectors	Reduced remittance inflows	Increase in gov health spending (fixed budget)	Foreign aid for gov health spending
	Wholesale and retail trade	−1.4	−0.08	0.05	0.07	0.11	0.03	−0.03
	Transport and storage	3.7	0.03	−0.01	−0.04	−0.04	−0.01	−0.03
	Other private services	3.8	0.01	−0.01	−0.04	0.00	−0.03	−0.05
	Public administration	0.8	−0.10	0.00	0.18	0.03	0.54	0.51
	Education	4.0	−0.02	−0.04	0.03	−0.16	0.03	0.03
	Health and social work	3.7	−0.01	−0.04	0.04	−0.15	0.58	0.58
	Other services	4.7	0.01	−0.05	0.00	−0.13	−0.06	−0.06
		Baseline	**Non-tertiary rural labour increases**	**Non-tertiary urban labour declines**	**Decline in labour productivity: All sectors**	**Reduced remittance inflows**	**Increase in gov health spending (fixed budget)**	**Foreign aid for gov health spending**
Labour—urban tertiary	Agriculture	5.1	0.03	−0.01	−0.04	−0.07	−0.19	−0.19
	Forestry	6.5	0.05	−0.03	−0.07	−0.06	−0.30	−0.26
	Meat, fish and dairy	0.8	−0.04	0.07	0.04	0.19	−0.11	−0.15
	Fruit and vegetable processing	3.5	−0.06	0.01	0.01	0.00	−0.16	−0.16
	Fats and oils	2.9	−0.05	0.02	0.01	0.06	−0.14	−0.15
	Grain milling	3.0	−0.06	0.01	0.03	0.02	−0.18	−0.18
	Sugar refining	2.1	0.00	0.05	0.01	0.11	−0.15	−0.18
	Other foods	4.1	0.02	0.01	−0.01	−0.04	−0.16	−0.17
	Beverages	5.2	0.01	0.00	−0.04	−0.06	−0.18	−0.19
	Other manufacturing	6.8	0.20	0.00	−0.15	0.19	−0.29	−0.28

(Continues)

TABLE A4 (Continued)

		Baseline	Non-tertiary rural labour increases	Non-tertiary urban labour declines	Decline in labour productivity: All sectors	Reduced remittance inflows	Increase in gov health spending (fixed budget)	Foreign aid for gov health spending
	Chemicals	6.1	0.04	0.01	−0.10	−0.03	−0.18	−0.19
	Machinery and equipment	39.9	0.01	−0.53	0.05	1.24	−0.79	−0.62
	Utilities	5.7	0.04	−0.04	−0.02	−0.06	−0.20	−0.19
	Construction	6.1	0.02	−0.04	−0.05	−0.01	−0.42	−0.34
	Wholesale and retail trade	−0.7	−0.06	0.07	0.04	0.15	−0.11	−0.16
	Transport and storage	4.5	0.05	0.01	−0.07	0.00	−0.16	−0.17
	Other private services	4.6	0.03	0.01	−0.07	0.04	−0.18	−0.18
	Public administration	1.5	−0.08	0.02	0.16	0.07	0.39	0.38
	Education	4.8	0.00	−0.02	0.00	−0.12	−0.12	−0.11
	Health and social work	4.5	0.01	−0.02	0.01	−0.11	0.44	0.44
	Other services	5.5	0.03	−0.03	−0.03	−0.09	−0.21	−0.20

Source: CGE modelling results.