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The macroeconomic impact of COVID-19 in Mozambique: A social accounting matrix approach

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Abstract

This study assesses the economic costs of COVID-19 and the state of emergency implemented by the Government of Mozambique. We use a social accounting matrix multiplier analysis to estimate the effects of the pandemic on the economy. Our simulations suggest that the Mozambican economy lost 3.6 percentage points of GDP growth in 2020 and that employment was 1.9 percentage points down. These losses were primarily driven by export shocks, the most heavily affected sectors being trade and accommodation and mining. Mozambique faces a critical challenge of how to promote economic diversification and reduce vulnerability to foreign shocks.

KEYWORDS
COVID-19, Mozambique, multisector multiplier analysis, social accounting matrix

JEL CLASSIFICATION
E01; E16; E17; O21

1 | INTRODUCTION

The Government of Mozambique has done its utmost to contain the spread of the COVID-19 pandemic while simultaneously aiming to avoid a very costly (and possibly unrealistic[1]) lockdown. At the end of March 2020, President Filipe Nyusi announced the implementation of a state of emergency. It was initially in place for 120 days

and after a short interim period got renewed for another 30 days before new legislation addressing calamities took effect. The first 120 days were coined by the attempt to prevent the disease, while the later stage of the emergency/calamity seems to recognize both the existence of the virus, and the need for envisaging a "new normal" combined with a slow opening up of the economy.

While the government has so far managed to avoid the extreme of implementing a complete lockdown, the pandemic combined with the mitigation measures have come with a heavy cost to the economy. To come better to grips with the impact and the policy dilemmas involved, with a view to designing optimal policy responses, it is of the utmost importance to improve our understanding of the impact of the pandemic and its consequences across the economy.

This study relies on a social accounting matrix (SAM) for Mozambique (Cruz et al., 2018) to assess the impact of COVID-19 and the state of emergency on the Mozambican economy. The simulation suggests that Mozambique lost in total 3.6 percentage points growth in 2020 due to COVID-19 and that total employment is 1.9 percentage points down compared with a scenario without the pandemic.

The main part of the growth and employment losses results from a demand reduction for Mozambican products by the rest of the world. The most affected economic sectors are mining and trade and accommodation. Furthermore, the results indicate that the production factors capital and urban labour are more impacted than rural labour. Our simulation brings out Mozambique's high dependence on a few export items (including tourism).

The study proceeds as follows. Section 2 summarizes the development of COVID-19 and the government responses. Section 3 discusses how the pandemic affected the economy in 2020 through supply, demand, investment and export channels. Section 4 explains the methodology applied to address the key research question, while Section 5 presents results. Section 6 concludes.

2 | COVID-19 IN MOZAMBIQUE

In this section, we discuss the development of the COVID-19 pandemic and the government response as well as the existing literature related to the economic impact of the pandemic in Mozambique. The impact of COVID-19 began in Mozambique some time before the virus itself arrived. While Europe, Asia and America already reported increasing numbers of COVID-19 cases during the first quarter of 2020, Mozambique remained disease free and initially implemented a series of countermeasures in an attempt to prevent the virus from entering. The government also developed a four-stage plan to deploy mitigating measures conditional on how the COVID-19 situation would evolve.

The measures became gradually stricter and more restrictive with each stage. Level 1 was put in place during the beginning of March. The implemented measures included the screening of people entering the country from countries with high numbers of active cases, quarantining travellers arriving from high risk countries, training of technical health teams to detect and investigate suspicious cases, and the procurement of individual protection material (CoM, 2020b). Furthermore, state travel was banned as well as events with more than 300 participants (CoM, 2020c).

While these efforts managed to delay the pandemic, the first COVID-19 case was reported on 22 March 2020 (CoM, 2020e). As a response, the government introduced further measures to reduce the spread of COVID-19 such as the closure of all schools, the banning of gatherings with more than 50 people and the suspension of issuing entry visas. A Technical Committee was also created to analyse the trend of the pandemic (CoM, 2020h, 2020i).

Furthermore, the government revised the state budget, prioritizing the health sector and increasing the initial allocation to the sector by a further US$20 million to US$50 million (CoM, 2020g). The Bank of Mozambique (BdM) introduced a currency credit line of over US$500 million to provide liquidity to the economy, relaxed customer credit restructuring conditions and reduced the level of mandatory foreign and national currency reserves (CoM, 2020f). H.E. Adriano Maleiane, Minister of Economics and Finances, also requested US$700 million from Mozambique's external partners to help mitigate the impact of COVID-19 (CoM, 2020g).

At the end of March, President Filipe Nyusi moved the alert to level 3 of the government plan and declared for the first time in Mozambique's modern history that the country was in a state of emergency, which started on 1 April (CoM, 2020j). The state of emergency was announced in Decree 12/2020 and ratified by the Assembleia de República in Law 01/2020 on 31 March. The decree and the law include a set of measures to prevent the spread of COVID-19, and some of the measures affect economic activities. These measures are of particular interest for our analysis. They include, for example, quarantine regulations, suspension of entry visas, cancellation of public and private events, closure of commercial and public establishments, and mandatory social distancing. A summary is provided in Table A1.

Further articles of the Decree 12/2020 have indirect impacts on the economy. For example, the closure of all educational institutions and the prohibition of religious and cultural meetings reduce the need for transportation.

On 9 April, IMF and the World Bank injected 21 billion meticais into the State Budget (CoM, 2020m). The government extended the exemption of cooking oil and hygiene products from the 17% Value Added Tax (VAT) and discharged the payment of late tax payments fees. Furthermore, the use of masks became mandatory in all public and private passenger transport (CoM, 2020l). The government and INSS provided funds to small and medium enterprises (SMEs) through the National Bank of Investment (BNI) in the amount of 1600 million meticais to support affected sectors by the state of emergency (CoM, 2020n), and the electricity price was reduced by 10% as of June (CoM, 2020o).

Ever since the first implementation of the state of emergency on 1 April, some forms of mitigation measures affecting the economy have been in place. The severity of the mitigation measures depended on the development of the pandemic. As of 31 December 2020, Mozambique had tested 271,947 people for COVID-19, and 18,642 (7%) were tested positive (Figure 1). Among the positive cases, 18,326 were caused by local transmission, and the remaining 316 cases were imported from abroad. Mozambique had registered 166 deaths due to COVID-19. Among positive cases, 16,663 cases have recovered (Ministério da Saúde, 2020b). Figure 1 shows the development of COVID-19 since March 2020.

Compared with neighbouring countries, Mozambique was hit on a similar level except for South Africa. In all categories of cases and deaths, it was South Africa that suffered by far the most in southern Africa. Zambia, Zimbabwe and Malawi suffered from the pandemic on a similar level as Mozambique and in terms of deaths per 1 million Mozambique suffered the least (Table 1).

Within Mozambique, the spread of the virus was more severe in the south of the country. The capital Maputo Cidade and Maputo Province accounted for 69% of the cases at the end of 2020. The remaining nine provinces only accounted for 31% of COVID-19 cases (Figure 2). In terms of deaths, the picture is similar; however, this time, it is Maputo Cidade alone that carries the lion's share. Some 80% of COVID-19 deaths in 2020 occurred in Maputo Cidade, while the remaining 20% are spread out rather evenly over the remaining 10 provinces (Ministério da Saúde, 2020b).

While the Government of Mozambique puts a lot of effort into testing and tracing COVID-19 cases, it is very likely that the real number is significantly higher than officially reported numbers. Rigorous testing is complicated in Mozambique for several reasons. The country lacks infrastructure in rural areas, and the damages due to the recent cyclones Idai and Kenneth continue as barriers in reaching the whole population (CoM, 2020p, 2020r). The situation is exacerbated by the ongoing violent conflicts in the north and centre regions of the country, which have displaced many people from their homes, making COVID-19 less of a priority (RM, 2020; SAPO, 2020). As in other countries, COVID-19 also highlights social problems leading to increased trust issues between the population, the government and the police. Especially, reports about the misuse of power by the police in implementing the restriction measures seem to accumulate (Kyed, 2020). The government tries hard to avoid a full lockdown knowing very well that many Mozambicans are too poor and cannot simply remain at home (Egger et al., 2020a). For the poor, it has in many cases become a question between risking contracting COVID-19, penalization by the police or starvation (Kyed, 2020).

Related literature analysing the impact of COVID-19 in Mozambique is scarce but emerging. Most papers focus on microeconomic indictors such as poverty and inequality. For example, Mussagy and Mosca (2020) analysed the

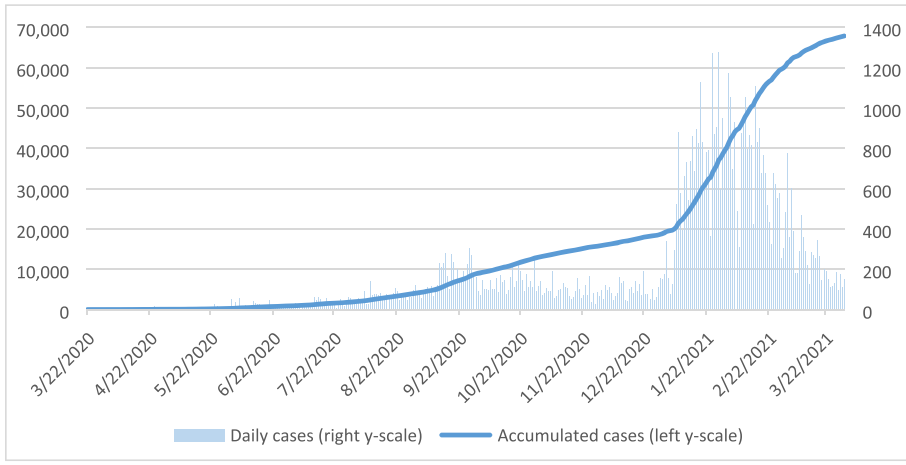

FIGURE 1 COVID-19 in Mozambique. *Source*: Ministério da Saúde (2020a)

TABLE 1 Total and relative COVID-19 cases and deaths in 2020

	Cases	Deaths	Cases per million	Deaths per million
Mozambique	18,642	166	579.6	5.2
Malawi	6583	189	335.1	9.6
South Africa	1,057,161	28,469	17,607.0	474.2
Zambia	20,725	388	1095.4	20.5
Zimbabwe	20,499	483	1358.3	32.0

Source: Ritchie et al. (2020).

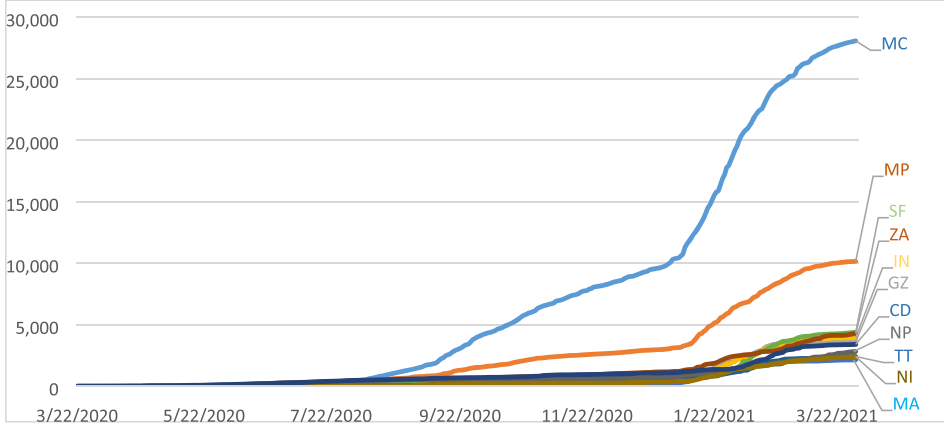

FIGURE 2 Total COVID-19 cases by province. Abbreviations: CD, Cabo Delgado; GZ, Gaza; IN, Inhambane; MA, Manica; MC, Maputo Cidade; MP, Maputo Province; NI, Niassa; NP, Nampula; SF, Sofal; TT, Tete; ZA, Zambezia. *Source*: Ministério da Saúde (2020a)

impact of COVID-19 on poverty and inequality. They apply a microsimulation to data from the *Inquérito sobre Orcamento Familiar* (IOF) 2014–2015 assuming a contraction of consumption by 5%, 10% and 20%. They found an increase in the national poverty rate by 9–18 percentage points depending on the scenario. Inequality measured by the Gini index was found to increase between 1 and 3 percentage points.

Mozambique Economic Update prepared by the World Bank showed economic trends and presented scenarios in terms of poverty incidence (World Bank, 2021b). The report associates the contraction of the economy in 2020 with a slowdown in Foreign Direct Investments (FDI) and capital inflows. Poverty scenarios are based on the assumption of consumption decline of 5%, 10%, 25% and 50%. The preferred scenario (consumption decline of 10%) would increase the poverty rate by more than 5 percentage points or push around 1.4 million Mozambicans into poverty (World Bank, 2021b).

Barletta et al. (2021) analysed the impact of COVID-19 and the implemented mitigation measures on household consumption poverty. They used estimates from the present paper regarding the macroeconomic impact of COVID-19 on production by sector, household income and employment as inputs and combined these inputs with the national representative IOF 2014–2015 data to simulate the impact of COVID-19 on poverty. They found that poverty increased between 4.3% and 9.9%, which corresponds to an additional 2 million Mozambican entering into poverty within a year.

All of these studies had to assume the size of the shock to the economy and except for Barletta et al. (2021) the studies used admittedly reasonable but to a certain degree random and rather rough assumptions. Barletta et al. (2021) used the detailed estimates from our study, which highlights one of our contributions to the literature because the results can reduce the need for arbitrary assumptions reducing uncertainty in other studies.

Further studies analysing and monitoring the Mozambican economy during the pandemic were provided by the World Bank and AfDB (AfDB, 2021; World Bank, 2021a). World Bank (2021a) is arguing that the contraction of the Mozambican economy was driven by the reduction in external demand and domestic activities triggered by the pandemic. Mozambique's existing growth model is based on large investments in the extractive industry and export of commodities. The extractive industry is one of the growth drivers hit especially hard by the pandemic, but also by the conflict in the North. Their model estimated a contraction of the economy by 1.3%, which is in line with official data from INE (2021a). AfDB (2021) basically provided a similar picture with GDP estimated to decrease by 0.5% in 2020, which is mainly because the pandemic hampered development in construction, tourism, transport and decreased demand for exported goods. Both institutions expect the economy to recover in 2021.

Both studies focus on the overall economy but do not try to disentangle the impact of COVID-19 from other events. They only show the final GDP values but do not consider what the counterfactual would be. This presents another contribution of our paper. The results can be interpreted as impact of COVID-19 disentangled from any other events and from this point we can calculate the counterfactual of a GDP in a World without pandemic.

The study closest to ours in terms of methodology and approach is Arndt et al. (2020). Basically, they conducted the same analysis as we do for South Africa by analysing the economic impact of COVID-19 and the mitigation measures using a SAM for South Africa. Their simulation predicted that COVID-19 declined South Africa's GDP by 5 percentage points.

3 | THE SHOCKS

In this section, we discuss how the COVID-19 pandemic and the mitigation measures taken in 2020 affected (i.e., "shocked") broad sectors of the Mozambican economy and outline our underlying assumptions that feed into the model simulation that helps us assess the economic impact. We differentiate between four channels of impact.

- The first channel is an industry-level supply shock, which captures COVID-19 encumbered situations that hinder production. Examples are government mitigation measures reducing the on-site workforce or closure of certain establishments.

- The second channel is the COVID-19 induced macro-level demand shock. Households that were laid off or mandated not to work lost income and reduced consumption, and others reduced consumption by shopping less to mitigate the risk of infection.
- The third channel is concerned with the increased uncertainty created by the pandemic, which put investment decisions on hold.
- Finally, the fourth channel covers the rest of the world. COVID-19 affected all of the world and in turn influenced Mozambique's export markets and import conditions as well as the amount of remittances received.

The impact of each channel is assumed for each economic sector. As will be explained in the methodology section, only the largest shock (supply, demand, investment or export) enters the model as a direct impact for each sector. This procedure is used to avoid double counting (see Section 4). The model will then compute the indirect effects trickling down to other sectors. Therefore, we discuss in this section and the appendix each broad sector under the channel in which the sector suffered from the biggest shock.

As a start date for the shocks, we chose the second quarter of 2020. The state of emergency took effect on 1 April, and some form of it (emergency or calamity) has been in place since. For our analysis, this makes it easy to identify the timing of the shock. We restrict our analysis to the calendar year 2020 and therefore only show the impact of the pandemic for the first three quarters. We do this because we aim to make the estimates comparable with official GDP data and GDP forecasts, which are usually reported/aggregated on an annual basis.

The main data used are preliminary national account data, published by the Instituto Nacional de Estatística, export data from the Banco de Moçambique and commodity price data from the World Bank. We stress that the data show the overall situation of the Mozambican economy, including the outcome of all four identified COVID-19 channels of impact plus all other non-COVID-19 related changes in the economy during 2020.

In other words, the data for 2020 cannot be used in any simple way to measure the impact of COVID-19 and the government mediation measures. Yet, they can help guide our modelling assumptions and can be used as a feedback on how well the model is calibrated. We based our assumptions regarding each quarter in 2020 on the best estimates available to us. Table 2 shows a summary of the assumptions made for each sector for each quarter of 2020.

3.1 | Industry level supply shocks

COVID-19 and the resulting state of emergency affect the supply side of all sectors in Mozambique. Company production has been influenced by the state of emergency mainly through Article 17 and 22 of the Decree 12/2020. They must ensure the protection of personnel (Article 17) and reduce on-site employees to 1/3 and/or ensure 1.5 m distance between workers and promote shift work (Article 22). These measures complicated production; however, the impact is likely to be smaller in many sectors compared with a full lockdown as observed in South Africa.

The industry level supply shock dominated three economic sectors in particular: Other Mining (Graphite and Rubies), other Manufactured Products (Clothing, Machines and Equipment), and Transportation and Storage. For the assumed size of the impact in each quarter, see Table 2, and for an in-depth discussion and underlying data for the assumption for each of the three sectors, see Appendix B.

3.2 | Macro level demand shocks

3.2.1 | Household consumption (urban/rural)

Household consumption in rural and urban areas has been affected by COVID-19 mainly through a reduction in disposable income. Lower production reduced the need for employment and therefore income. This effect is assumed

TABLE 2 Assumptions

	Quarters 2, 3, and 4	Impact due to emergency/distancing rules compared with pre-crisis		
	Industry level supply shocks	**Q2**	**Q3**	**Q4**
1	Other mining (graphite and rubies)	−20% to −30%	−30% to −40%	−20% to −30%
2	other manufacturing products (clothing, machines and equipment, etc.)	−1 to −10%	0%	0%
3	Transport	−1 to −10%	0%	−1 to −10%
	Macro level demand shocks			
	Household consumption	−1 to −10%	−1 to −10%	0%
4	Agriculture[a]	−1 to −10%	−1 to −10%	0%
5	Processed foods	−1 to −10%	−1 to −10%	0%
6	Utilities (electricity and water)	−1 to −10%	−1 to −10%	0%
7	Trade	−1 to −10%	−1 to −10%	0%
8	Telecommunication and information technology	−1 to −10%	−1 to −10%	0%
9	Financial and insurance services	−1 to −10%	−1 to −10%	0%
10	Business and real estate services	−1 to −10%	−1 to −10%	0%
11	Public administration, health and Education	−1 to −10%	−1 to −10%	0%
	Investment			
12	Construction	−1 to −10%	−1 to −10%	−1 to −10%
13	Machinery and transport equipment	−10% to −20%	−10% to −20%	−10% to −20%
	Export			
14	Coal	−20% to −30%	−20% to −30%	−10% to −20%
15	Aluminium	−10% to −20%	−1 to −10%	−1 to −10%
16	Tourism	−90%	−90%	−75%
17	Natural gas (to South Africa)	−1 to −10%	−10% to −20%	−1 to −10%
18	Sugar	−10% to −20%	−1 to −10%	0%
19	Tobacco	−1 to −10%	−20% to −30%	−10% to −20%
20	Cotton	−30% to −50%	−20% to −30%	−10% to −20%
21	Labour remittances	−30% to −50%	−20% to −30%	−10% to −20%

[a]Excluding sugar, tobacco and cotton, which are included in the export channel.
Source: Authors' assumptions based on best available evidence.

stronger in urban areas where the density of people restricts movement proportionally more under social distancing rules than in spacious rural areas.

The Indice de Confiança e de Clima Económico (ICCE) reports the employment index shown in Figure 3. Employment was down by 10% and 8% in Q2 and Q3, respectively, compared with Q1. Based on the ICCE, we assume a mild impact (−1% to −10%) of COVID-19 on household consumption in Q2 and Q3. Considering the ongoing state of emergency and the slow opening of the economy towards the end of Q3, we assume an improvement to zero change in Q4 compared with Q1. This assumption is also in line with the ICCE index, which is only 2.5% lower in Q4 compared with Q1.

It should be noted that this assumed mild impact (−1% to −10%) in Q2 and Q3 is applied to all sectors. However, due to the model properties, only the largest impact by channel will feed into the model directly. This means, for example, that if we assume zero impact for supply, investment and export for the financial sector, then the

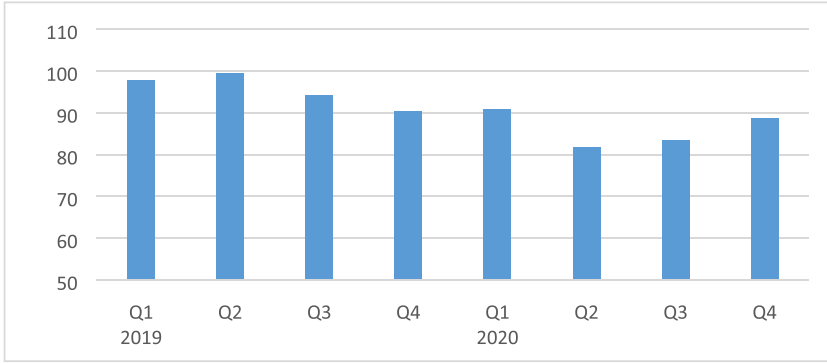

FIGURE 3 ICCE employment. *Note*: The Indice de Confiança e de Clima Económico (ICCE) is a survey based index measuring the economic activities by sector. Base year (=100) is 2014. *Source*: INE (2021b)

assumed impact will come through the demand household channel in the magnitude discussed above. This is the case for the following sectors: agriculture,[2] processed foods, utilities, trade, financial and insurance services, business and real estate services, public administration, education and health. For all these sectors, the supply shock was considered to be less relevant than the demand shock.

Furthermore, subsistence demand has been excluded from the demand shocks. This is because production used by households in subsistence farming should not be affected by the state of emergency. Therefore, only marketed (as opposed to non-marketed) demand for unprocessed agricultural products is accounted for.

3.3 | Investment

The pandemic creates uncertainty. The size of the pandemic is for many people and countries unprecedented and the mere idea of locking down whole nations was alien not long ago. Not knowing how the pandemic will develop means that any investment decision has to take into consideration the new situation. In most cases, this means that uncertainty and therefore the risk of an investment increases. Higher risk typically leads to a reduction in investments.

One major event impacting Mozambique's level of investments has certainly been the postponement of the Final Investment Decision (FID) of the Exxon led 30 billion US-$ LNG project in Cabo Delgado (CoM, 2020d). The project was set to become one of the biggest projects in Africa and due to the missing FID, which was initially expected in the first half of 2020, construction has been delayed considerably. As of mid-2021, Exxon has delayed the FID three times and a final decision is becoming less likely as time passes (CoM, 2021).

It could also be argued that speculative investors would use a pandemic to profit and therefore assuming a negative shock could result in an overestimation of the negative impact of the pandemic. However, the probability that this bias occurs in our analysis is low. With the exception of two sectors, the SAM will actually account for potential speculative investments, because the investment shock is endogenized for them. We recall that only the greatest initial shock, which can be supply or demand or investment or export, is assumed. The remaining shocks are calculated endogenously within the SAM. Our model endogenized the investment shock (positive or negative) for all sectors except for construction and machinery and equipment.

The two sectors identified, where a primary shock goes through the investment channel and therefore could eventually be affected by the failure of incorporating speculative investments, are construction and machinery and equipment. Quarterly production of the construction sector as well as imported capital goods (a proxy for machinery

and equipment) declined during the pandemic (see Figures A5 and A6). Therefore, we feel confident that speculative investment does not represent a problem in our analysis and to confirm this we conduct a robustness check in Section 6.

3.4 | Exports

The pandemic spread worldwide and therefore affected not only Mozambique's domestic economy but also the markets to which Mozambique sells its products abroad. Comparing the spread of COVID-19 and the implemented mitigation measures between Mozambique and other countries like South Africa shows that the impact abroad has been severe. Therefore, the way COVID-19 influences the rest of the world is affecting the external sector of Mozambique. The negative impact through the export channel in comparison to the other channels (supply, demand, and investment) seems to be more persistent. The IMF predicted for 2020 a growth rate of −4.9% for the world economy before recovering in 2021 to 5.4% growth (IMF, 2020).

To calibrate our model, we used export data for 2020 from BdM. As with the national account data used above, it should be noted that the data show the impact of all four COVID-19 channels without distinguishing among them. As guidance for our assumptions for 2020, we combine the export data with commodity price data from the World Bank. World demand for Mozambican products is determined by the international price of the commodity because Mozambique is a price taker in all markets. This makes price data a viable option in our context. Finally, we consider only activities/industries where the export channel dominates over the other three channels and feed into the model.

The export shock is in particular important for eight economic sectors: Coal, Aluminium, Tourism, Natural Gas (to South Africa), Tobacco, Cotton, Sugar and Labour Remittances. For the size of the impact in each quarter, see Table 2, and for an in-depth discussion and underlying data for the assumptions, see Appendix B.

4 | METHODOLOGY

The previous section discussed how broad sectors of the Mozambican economy were affected directly by COVID-19 and the mitigation measures implemented by the government. However, knock-on effects of these direct impacts spread through the entire economy, upstream as well as downstream. In this study, we focus on the former. If one sector was impacted negatively, suppliers of intermediate inputs to that sector faced lower demand while the users of the output of the sector faced supply disruptions. The latter may not be relevant since final demand could be constrained.

The method used to capture the economy-wide effects is similar to the one discussed in Arndt et al. (2020). An economy-wide simulation model is employed that produces empirical results from reasonable scenarios that represent the direct impact or "shocks" to the economy associated with the pandemic. The model provides "what-if" projections of a variety of economic indicators given the specified scenario. The indicators are based on detailed industry level observations that effect supply of goods and services or their demand. In addition, it is possible to specify macro constraints. Results of scenario analysis are not forecasts of the future. Rather, they represent possible outcomes given the shocks assumed which are then forced to be internally consistent. As such, this is meant to provide a disciplined framework for engaging in coherent policy debates.

4.1 | SAM multiplier model

There are several methods for exploring the economy-wide effects of shocks to the economy (for a more detailed discussion, see Arndt et al., 2020). In this study, we use multisector multiplier analysis. This approach focusses on

inter-industry linkages as measured by input–output (I-O) tables and expands the I-O approach to incorporate other economic actors than just industries, like the government and households.

A SAM is an accounting framework: a matrix or table that maps out the income and expenditure accounts of industries and single accounts for enterprises, households, government, savings/investment and the rest of the world (exports, imports and various transfers). The SAM integrates these accounts with the national income and product accounts in accordance with the UN System of National Accounts (SNA). We use a SAM for Mozambique that describes its economy for the year 2015. For further details, see Cruz et al. (2018).

SAMs show the full circular flow of income in the economy, including the generation of income by production activities (value added), and how that income is distributed to households, providing them with income to buy the goods and services produced or imported by the economy. Although a SAM offers a somewhat disaggregated picture of the economy, it is not as detailed as the micro-level survey data it is partly based on.

The SAM for this study identifies 51 productive activities (industries), which employ capital of various kinds (physical capital stock, land and livestock) as well as four different types of labour in rural as well as urban areas, to produce 52 homogenous commodities. The primary income generated by the productive activities is distributed to 10 different household types, which are distinguished by urban and rural location and income quintiles. The income they receive is used for private consumption expenditure of 52 commodities, saving, transfers and taxes. Taxes are received by the government to make expenditures, including transfers to households. There are also corporate taxes and indirect taxes on commodities. The economy is open such that imports of goods and services add to domestic supplies and exports and other international transfers add to demand.

The SAM is combined with linear behavioural assumptions for households, firms and other agents, along with other assumptions, to build not only a descriptive model of the Mozambican economy but also one that shows how it may respond to short-term demand shocks. In standard multiplier analysis, there are two key assumptions:

- Activities use intermediate inputs in fixed proportions to their total costs (or output). In other words, production technology is fixed and linear.
- The model assumes that prices are fixed. Instead, adjustments to shocks bring about changes in quantities (gross output).

The COVID-19 shock has an immediate impact on the economy, and it is unlikely that in a short time perspective production technologies and prices change significantly. This includes wage rates (the price of labour). While profit seeking price increases may be observed in the real world, they are not considered as incentives to stimulate production. As such, a SAM multiplier analysis is a reasonable tool to use in the short term. We apply for each quarter the same SAM with different inputs, which makes our approach static. Our research interest is the immediate impact of COVID-19 on the economy, and we are not addressing at this point how the structure of the economy changes over time. For these reasons—that is, short time horizon and our research focus—a static SAM approach is arguably a reasonable approach to provide timely results. Future research focusing on the structure of the economy and a longer time horizon should consider using Computable General Equilibrium (CGE) models or dynamic SAMs, which allow for adjustments in both prices and quantities.

The COVID-19 shocks impact on the economy in months or quarters, not multiple years. It is unlikely that in such a short period, production technologies and prices change significantly. This includes wage rates (the price of labour). While profit seeking price increases may be observed in the real world, they are not considered as incentives to stimulate production. As such, a SAM multiplier analysis is a reasonable tool to use in the short term. We apply for each quarter the same SAM with different inputs, which makes our approach static. The research topic in this study is the immediate impact of COVID-19 on the economy and not on how the structure of the economy changes over time. For these reasons—short time period and research focus—a static SAM approach is a reasonable tool to provide timely results. Future research focusing on the structure of the economy and a longer time horizon should consider

using Computable General Equilibrium (CGE) models or dynamic SAMs, which allow for adjustments in both price and quantity.

4.2 | Setting up scenarios

Lockdown measures typically impact the economy in two broad ways:

i. Preventing households from spending their income since most are not allowed to leave their homes. Unless employed in an essential sector, they cannot go to work, so their income is negatively impacted.
ii. Making non-essential industries close down with declines in production and possibly large numbers of workers being laid off, temporarily at least.

The SAM multiplier model is a demand driven framework, so the driver of the scenarios is a change in exogenous final demand (by households, government, investors and exports). While point (i) above makes intuitive sense, point (ii) appears to be a "supply" shock. But here, it is assumed that the lockdown of activities is effectively the same as a decline for the demand of the goods and services they produce. To capture the impact on supply of a strict lockdown of industries, all final demand for the commodities produced by the industry would hypothetically be eliminated. This essentially cuts production in those industries (for a more detailed discussion, see Arndt et al., 2020, in particular, Figure A1). The other reason for doing this is that the SAM's final demand is expressed in terms of goods and services and not as outputs of activities.

Given the above, scenarios can be constructed from the bottom up. In addition, industries will be facing an uncertain future and the bottom-up impacts may have macroeconomic ramifications. Industries may be hesitant to engage in investment projects, resulting in a decline in aggregate investment. Moreover, the pandemic is not limited to Mozambique. It is a global pandemic that has resulted in a major decline in world trade. To accommodate this, macro investment and exports are assumed to decline and this could serve as a benchmark to the bottom-up commodity level changes.

In doing so and unlike typical macro top-down recessions, what is developed here derives from shocks in demand and supply at the sectoral level: the lockdown scenario. However, this "bottom-up" recession, leads to "top-down" effects on macros aggregates that may or may not exacerbate the effects of the bottom-up shock. To avoid possible double counting the larger of the supply and demand shock is taken to be the final one submitted to the model and imposed on the modelled economy.

5 | RESULTS

When examining the results of the assumptions described above (and in the appendix), it may be useful to make a distinction between domestic and foreign shocks. In what follows, domestic shocks are those associated with the supply/demand shock as well as gross domestic investment, while those associated with exports are considered foreign shocks. Given the linear nature of the SAM model, the impacts of each subshock are additive. Note that the foreign shock will have domestic consequences, as will be seen later. With that in mind, we start by considering GDP in Figure 4.

It can be seen that during the second quarter (Q2), the domestic shock pushed GDP down, directly and indirectly, below the start of the pandemic by 2.5 percentage points while the foreign impact was −3.1 percentage points so that the total impact in Q2 was a reduction in GDP by 5.6 percentage points, based on the combined assumptions. In Q3 the model suggests that the domestic impact was slightly smaller and the foreign impact stronger, which resulted in a combined impact on GDP in Q3 of −5.9 percentage points. The Q4 assumptions result in a

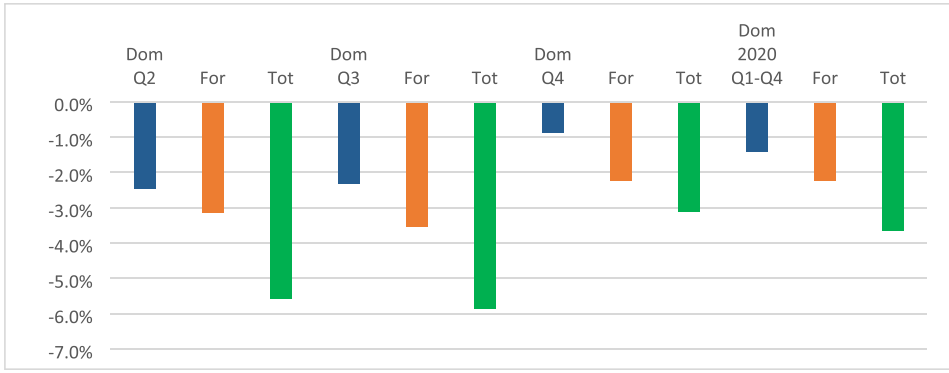

FIGURE 4 Total impact on GDP. *Source*: Authors' calculations based on the multiplier model

small domestic impact but the foreign drivers remains a bit more persistent so that the total impact is calculated to be −3.1 percentage points in Q4.

The interpretation of these results is as follows. In a world free of COVID-19, the Mozambican economy would have grown by 5.6 percentage points more than it actually did in Q2. Put differently, because of COVID-19 and the state of emergency, the economy lost 5.6 percentage points of growth in Q2. According to the national accounts data Mozambique's economy measured in terms of value added[3] did grow by 5.8% in Q2 compared with Q1 (INE, 2020). Our result for Q2 therefore implies that growth without COVID-19 would have been 5.8% + 5.6% = 11.4% in Q2. The 11.4% may seem high but is in line with pre-crisis growth rates. Variation of GDP (value added) between Q1 and Q2 were 10.5%, 9.6% and 8.5% in 2019, 2018 and 2017, respectively.

Dividing the sum of the Q2-Q4 impacts by 4 (assuming zero impact in Q1), the average over the calendar year can be calculated to be −3.6 percentage points in total, with −1.4 percentage points due to the domestic shock and −2.2 percentage points to the foreign shock.

A slightly different view on GDP is shown in Figure 5 by presenting the results for their components. Here, consumption (C), investment (I) and exports (E) are derived by assumption (exogenous) while imports and GDP are determined by the model (endogenous).

The strongest component in Q2 and Q3 are exports, confirming that the impact is more foreign than domestic driven. In Q4, consumption is according to the scenario no longer negatively impacted and exports are also less negative. The main driver of this quarter was the negative impulses from the investment component. Note that the combined impacts on GDP are not simply the sum of these components, since there is also the matter of what happens to imports. Still, as in Figure 4, the downturn in Mozambique is mainly a foreign impact story, with domestic drivers playing a lesser role.

Which industries were specifically impacted by the downturn is examined in Figure 6.[4] Production GDP is reported here for seven broad activities. Even with this limited number of industries, the figure becomes rather cluttered, so we only present broad patterns. In general, it would appear that mining and accommodation (the latter combined with trade) are mainly impacted through the foreign channel. Through the domestic channel, construction and trade and accommodation and manufacturing are the main victims, although the latter also suffers from the foreign driver via the metal products (aluminium) activity (Table 3).

The negative impact on mining is strongest in Q3 and abated somewhat as the calendar year closed out. Trade and accommodation remained persistently negative and is still the most severely impacted sector during Q4 and on average for the whole year. As this played out in the model simulation, agriculture is one of the least affected

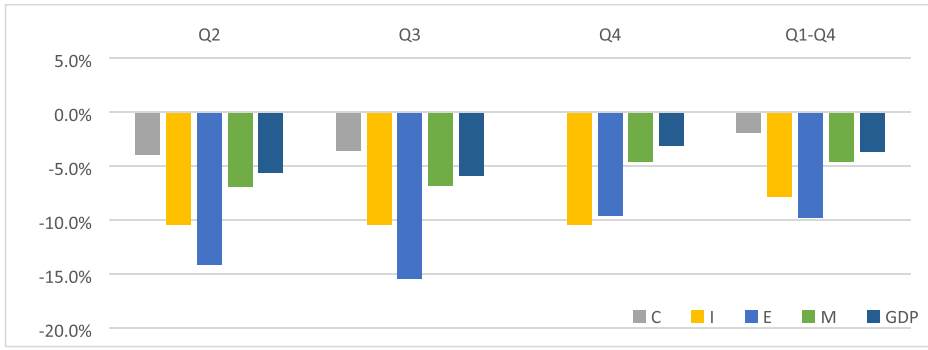

FIGURE 5 Total impact on expenditure GDP components. Abbreviations: C, private consumption expenditure; E, exports; GDP, GDP @ market prices; I, gross domestic fixed investment; M, imports. *Source*: Authors' calculations based on the multiplier model

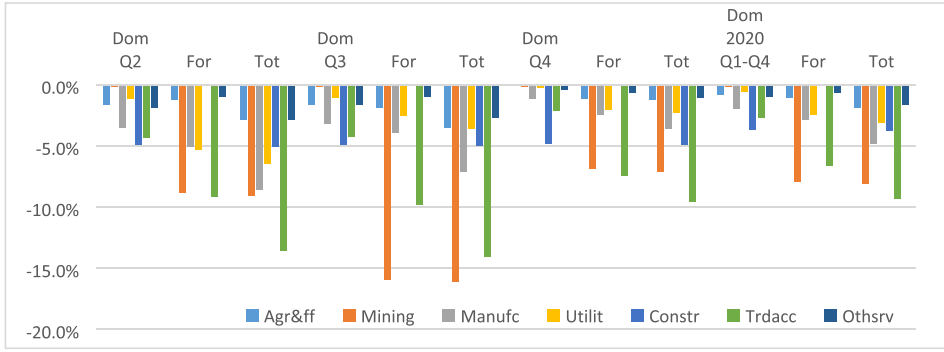

FIGURE 6 Total impact on production GDP by industry. Abbreviations: Agr&ff, agriculture, forestry and fishing; Constr, construction; Manufc, manufacturing; Mining, mining and quarrying; Othsrv, other services; Trdacc, trade and accommodation; Utilit, electricity, gas and water. *Source*: Authors' calculations based on the multiplier model

together with other services (transportation, finance, business, health, education, public administration, etc.). On the far right hand side, it can be seen that the most negative total impact for the year is shared by trade and accommodation and mining, followed by manufacturing, construction and electricity with agriculture and other services affected less negatively.

One of the key features of the SAM multiplier analysis is that it accounts for direct and indirect impacts. Thus, the above results are based on the sum of direct and indirect effects. But how important were each of these two effects in relation to the total impact? Figure 7 offers an indication for Q2. As explained in the methodology section, the exogenous drivers of the shocks are expressed in terms of commodities. We determine first round impacts on activities by modelling the question who is making or supplying these products directly from a local source, that is, before the knock-on indirect effects come into play. Such first round impacts are pretty much as close as we can get to the direct impact on activities.

In the first group of bars, it can be seen that agriculture is impacted negatively in spite of there not being any lockdown supply-side constraints imposed on it. Moreover, we have been careful to exclude from the demand shock

TABLE 3 Detailed direct and indirect impacts on GDP and employment as % of the total impact on GDP and employment for 2020 (calendar year)

	GDP Total Shock (Av. Q1–Q4)	% of impact		Employment Total Shock (Av. Q1–Q4)	% of impact
1	Accommodation and food serv.	15.9%	1	Wholesale and retail trade	35.4%
2	Wholesale and retail trade	14.2%	2	Accommodation and food serv.	18.8%
3	Transportation and storage	10.1%	3	Other services	7.5%
4	Natural gas	8.6%	4	Tobacco	4.2%
5	Coal and lignite	5.6%	5	Maize	3.4%
6	Metals and metal products	3.7%	6	Transportation and storage	3.3%
7	Information and communication	3.6%	7	Sugar cane	3.3%
8	Electricity, gas and steam	3.3%	8	Information and communication	2.5%
9	Other foods	3.0%	9	Vegetables	2.0%
10	Construction	2.8%	10	Other mining	1.8%
11	Education	2.3%	11	Other foods	1.6%
12	Tobacco	2.1%	12	Education	1.5%
13	Cereal and vegetable processing	2.0%	13	Other crops	1.5%
14	Sugar cane	1.9%	14	Construction	1.4%
15	Non-metal minerals	1.7%	15	Cassava	1.2%
16	Maize	1.7%	16	Poultry	1.2%
17	Other mining	1.5%	17	Other livestock	1.0%
18	Business services	1.3%	18	Business services	1.0%
19	Machinery and equipment	1.2%	19	Other oilseeds	0.8%
20	Finance and insurance	1.2%	20	Groundnuts	0.8%
21	Poultry	1.1%	21	Rice	0.6%
22	Fishing	1.0%	22	Electricity, gas and steam	0.6%
23	Other livestock	0.9%	23	Finance and insurance	0.6%
24	Vegetables	0.9%	24	Forestry	0.6%
25	Other crops	0.7%	25	Pulses	0.4%

Note: Total impact is due to the combined domestic and foreign shock, averaged out over the four quarters with zero impact on Q1.
Source: Authors' calculations based on the multiplier model.

the subsistence demand. Thus, only marketed (as opposed to non-marketed subsistence) demand for unprocessed agricultural products is accounted for. This explains the 1.7 percentage points' direct decline for agricultural production. Therefore, while harvesting and other agricultural activities are assumed to have continued as normal, as noted earlier in our discussion, demand for (unprocessed) agricultural products still declines, not only directly but also more importantly, indirectly.

The latter adds another 1.4 percentage points to the total decline in agriculture of 3.1 percentage points. Indirect impacts clearly matter as they account for almost 50% of the total negative impact on agriculture. These indirect effects emanate from lower demand for processed food, which in turn results in further downward pressure on agricultural products. This relatively high share of indirect effects is even more noticeable for industries such as utilities

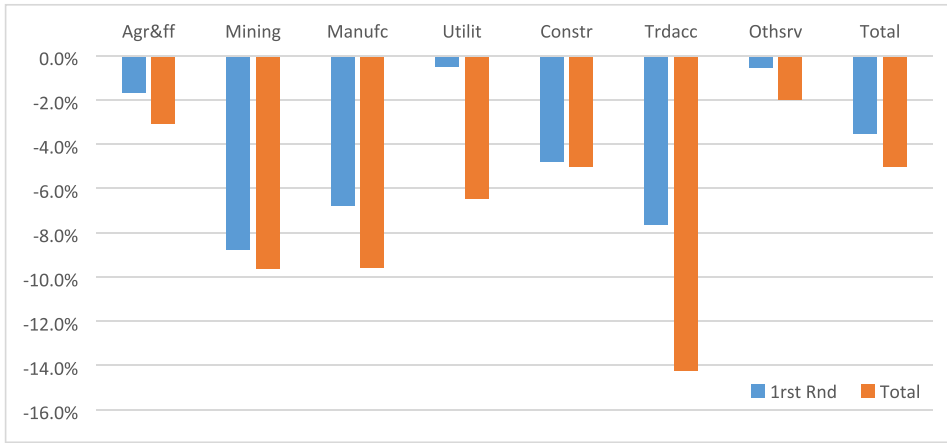

FIGURE 7 Direct (first round) and indirect impact on production GDP by industry for Q2. *Source*: Authors' calculations based on the multiplier model

and other services, which are hardly impacted directly. Indeed, the total impact on utilities is estimated at −6.5 percentage points while the first round only accounts for −0.5 percentage points in this modelled economy.

Clearly, the opposite is the case for mining and construction. The first round impact pretty much explains the total impact. To these activities, indirect effects matter little. This is understandable and related to the nature of their activity. However, manufacturing also seems to suffer from low indirect effects, which may be kind of a blessing in disguise during a downturn but masks the feature of very limited integration into the Mozambican economy.

The trade and accommodation story is somewhat different in that the latter drives the first round direct impact while the trade sector suffers mainly indirectly from lower trading margins. Note that no specific direct supply-side lockdown assumptions were imposed on trade since the economy-wide negative demand assumptions will result in effectively the same thing in that customers do not show up at the shops whether they are locked out or not. The lower trade margins only become noticeable as an indirect impact in the model. The overall picture is that the direct impact accounts for more than two thirds of the negative rate of change in GDP (at basic prices) while only one third can be attributed to the indirect effects. The spreading of the negative economic impact of the pandemic through the Mozambique economy is limited mainly because of the lack of integration amongst production activities.

So far, we have considered the expenditure and the production side of GDP. The third method of GDP accounting is from the income side. In Figure 8, income earned by the two broad factors of production labour and capital is shown. In addition, labour is broken down by urban and rural. Across all quarters and for domestic as well as foreign drivers it would appear that urban labour was more negatively impacted than rural labour while capital was more negatively impacted than labour.

The reason for capital being impacted more than labour has to do with the functional distribution of income within the industries that are mostly impacted. In Figure 6, it was shown that apart from trade and accommodation, mining, utilities and manufacturing are the most negatively impacted sectors by the shocks. These sectors are typically more capital intensive thereby biasing total factor payments towards capital. The production factor capital is therefore likely to earn relatively less in this type of downturn. This is notwithstanding the high negative impacts on trade and accommodation as well as construction.

The relatively low impact on agriculture and other services, which are typically more labour intensive, may explain the relatively lower impact on labour as a whole. Similarly, the large weight of agriculture in the Mozambique economy may do the same for the relatively low impact on rural labour.

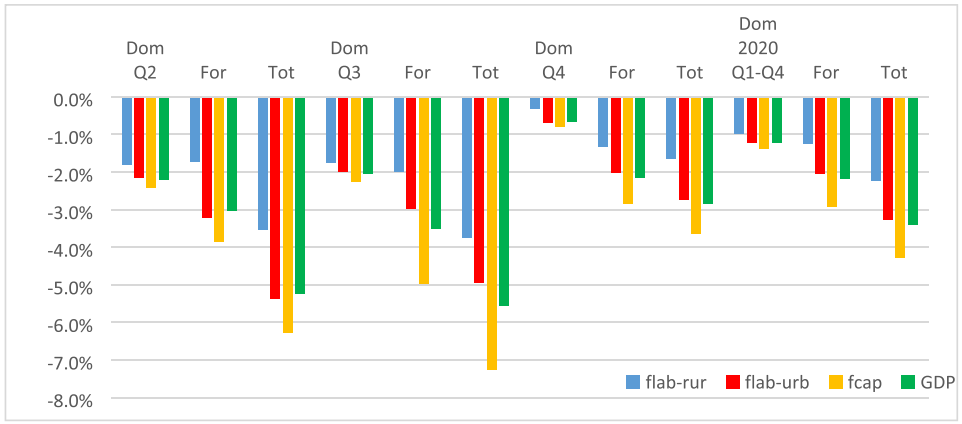

FIGURE 8 Impact on income GDP by production factor with labour by rural/urban. Abbreviations: fcap, factor capital; flab-rur, factor labour-rural; flab-urb, factor labour-urban. *Source*: Authors' calculations based on the multiplier model

During Q4, the negative shock on coal becomes less persistent while the shock on tourism remains relatively high. The result is that rural labour is impacted much more negatively from the foreign shock than from the domestic shock.

The patterns of results for labour earnings according to the rural and urban distinction in Figure 8 above is more or less the same as for low (primary and unfinished secondary) and high (secondary and tertiary) educated labour, as can be seen in Figure 9.

It can also be seen from both figures that capital and urban as well as highly educated labour suffered relatively more from the foreign shock compared with the domestic shock. The reason is the heavy reliance of the Mozambican economy on agriculture and the relatively low negative shock assumed for this activity.

One would expect that the impacts on the functional distribution have implications for the impact on income distribution and possibly follows the same patterns. In Figure 10, household income is distinguished by urban and rural while the income distinction of the bottom 80% (low-income households) and top 20% (high-income households) is shown in Figure 11.

This appears indeed to be the case when considering the urban/rural distinction, with rural households suffering relatively less throughout all periods.

In terms of household income groups, the rather crude distinction in Figure 10 between low- and high-income households suggests a more egalitarian negative outcome. This implies that the impact on urban low-income households is disproportionally worse as was shown in Figure 10 where urban households suffered more.

Of particular concern to policy makers is the impact of the pandemic on Mozambique's employment situation. Figure 12 shows the industry-level employment effects. We estimated the employment impact by using employment–output elasticities, which consider long-term relationships between GDP and employment. A 1% drop in GDP equates more or less to a 0.5% decline in employment.[5]

What stands out in particular is the large impact on trade and accommodation. This is the result of relatively higher direct employment/output ratios and relatively higher employment–output elasticities for the services activities in general. The employment impact on mining is for similar reasons relatively small. Further, trade and accommodation are strongly impacted through the domestic and the foreign channel, while most other sectors only suffer through one channel.

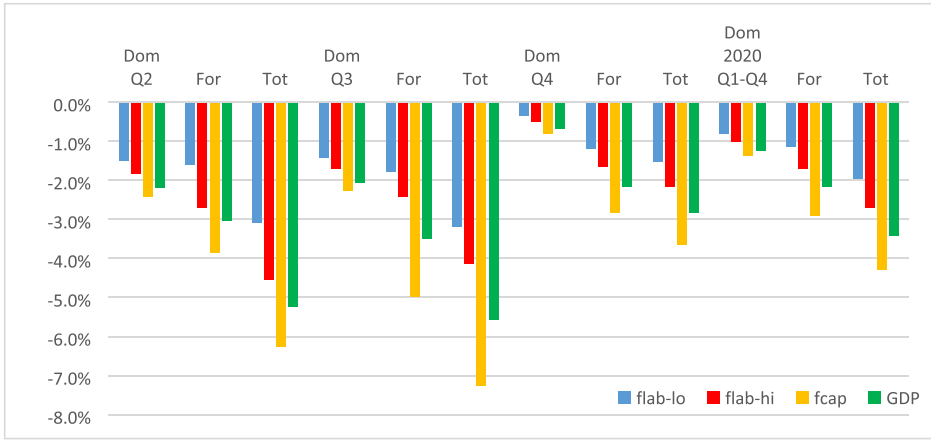

FIGURE 9 Impact on income GDP by production factor with labour by educational attainment. Abbreviations: facp, factor capital; flab-hi, labour with secondary and tertiary education as highest education attained; flab-lo, labour with primary and unfinished secondary education as highest education attained. *Source*: Authors' calculations based on the multiplier model

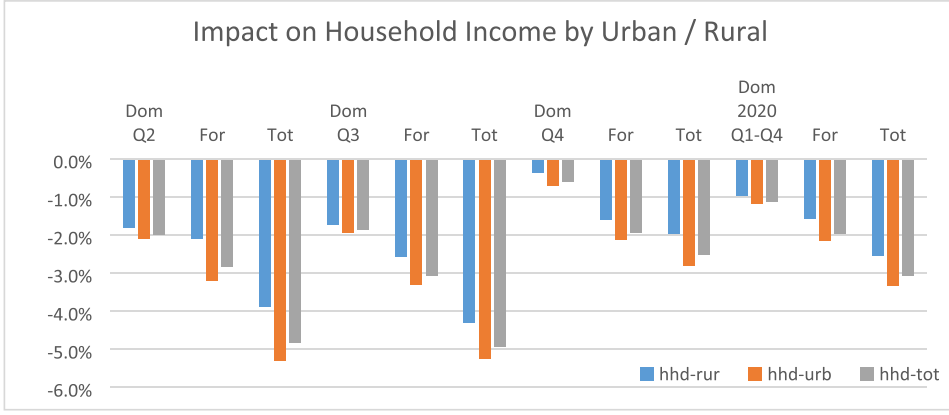

FIGURE 10 Impact on household income by urban/rural population. Abbreviations: hhd-rur, rural household; hhd-tot, total households; hhd-urb, urban households. *Source*: Authors' calculations based on the multiplier model

Impacts on employment by level of education attained are shown in Figure 13. The results could be compared with the impacts on wage earnings shown in Figure 9.

Overall, employment was according to the model 1.9 percentage points down on average over the full calendar year compared with a COVID-free world.

The final Figure 14 features the urban/rural distinction and displays similar patterns to those in Figure 13. Over the full year, employment in urban areas reached levels that in this scenario are almost 4 percentage points down compared with a COVID-free world. Again, in rural areas this impact is more muted.

Detailed results for the 25 most impacted activities for the calendar year 2020 are shown in Table 3 for GDP and employment. It can be seen that accommodation and trade services share most of the burden. In terms of GDP, gas, coal, metals and electricity feature high but they do not feature in the top 25 of employment. On the other hand,

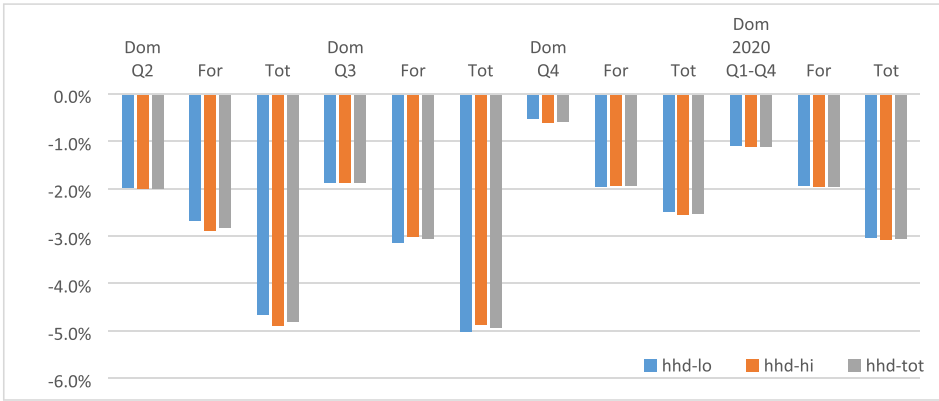

FIGURE 11 Impact on household income by low and high income groups. Abbreviations: hhd-hi, household income quintile 5; hhd-lo, household income quintiles 1–4; hhd-tot, household income total. *Source*: Authors' calculations based on the multiplier model

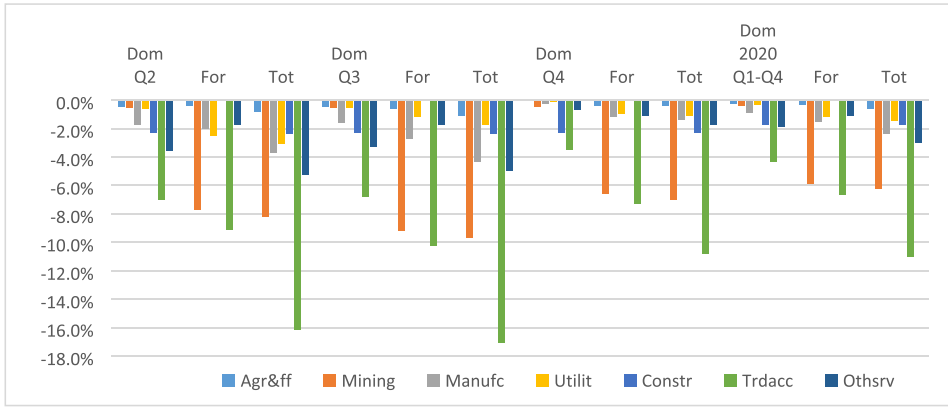

FIGURE 12 Total impact on employment by broad industry. Abbreviations: Agr&ff, agriculture, forestry and fishing; Constr, construction; Mining, mining and quarrying; Manufc, manufacturing; Othsrv, other services; Trdacc, trade and accommodation; Utilit, electricity, gas and water. *Source*: Authors' calculations based on the multiplier model

other services can expect rather large employment impacts although the impact on GDP is so low it is not even shown. Such apparent outliers are the results of the marginal employment intensities of these activities. In broad terms, various mining and manufacturing subsectors are impacted severely in terms of GDP and a number of agricultural and other services subsectors are so in terms of employment.

6 | ROBUSTNESS CHECKS

In this section we discuss the results of five robustness checks dealing with the sensitivity of the results with respect to the input assumptions, the level of subsistence consumption, employment-output elasticities, speculative investments, and labour remittances.[6]

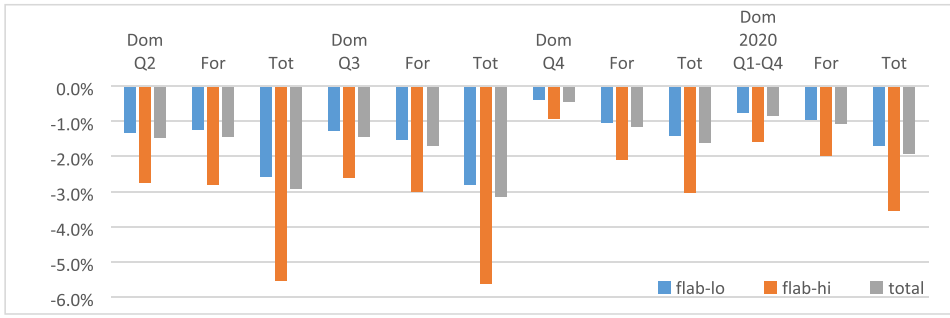

FIGURE 13 Impact on employment by educational attainment. Abbreviations: flab-hi, labour with secondary and tertiary education as highest attained education level; flab-lo, labour with primary and unfinished secondary education as highest attained education level. *Source*: Authors' calculations based on the multiplier model

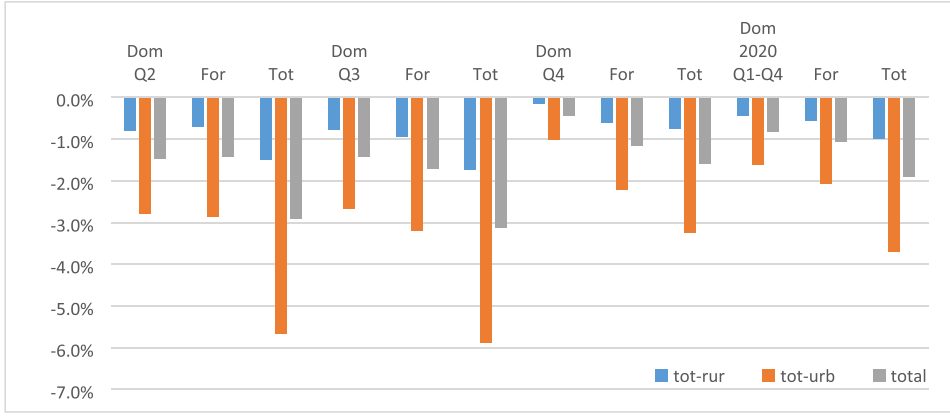

FIGURE 14 Impact on employment by urban/rural population. Abbreviations: tot-rur, total rural; tot-urb, total urban. *Source*: Authors' calculations based on the multiplier model

6.1 | Assumption sensitivity

The first robustness check deals with the sensitivity of our results with respect to the input assumptions. So far we showed point estimates of the results, which means that the results are based on the mid-point of the assumption ranges shown in Table 2. Using an example for clarification, the assumed shock of −20% to −30% in Q2 for the sector Other Mining (Graphite and Rubies) translates in the model to a shock of the mid-point of that range, that is, −25%.

Figure 15 shows the results including the lower and upper bounds for the impact of the COVID-19 shock on GDP. The point estimate of −3.6 percentage points for the whole year 2020 (right bar Figure 15) shows a variation of around ±1.5 percentage points. Assuming the lower bound shocks results in an estimate of −2.2 percentage points while the upper bound shocks results in an estimate of −5.2 percentage points.

Most of this variation comes from the domestic shocks, while the intervals from the foreign shocks are much smaller (Figure 15). Considering that the foreign shocks contribute most to the total shock we feel confident that this robustness shows that the sensitivity of our results towards the input assumption is within an acceptable range.

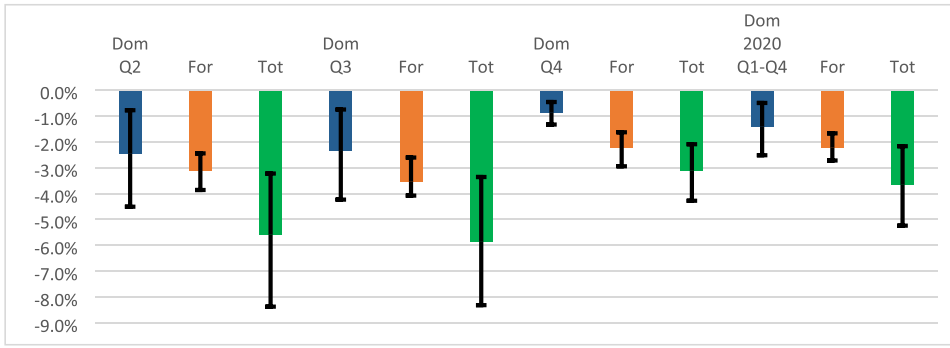

FIGURE 15 Impact on GDP with lower and upper bounds of input assumptions. *Source*: Authors' calculations based on the multiplier model

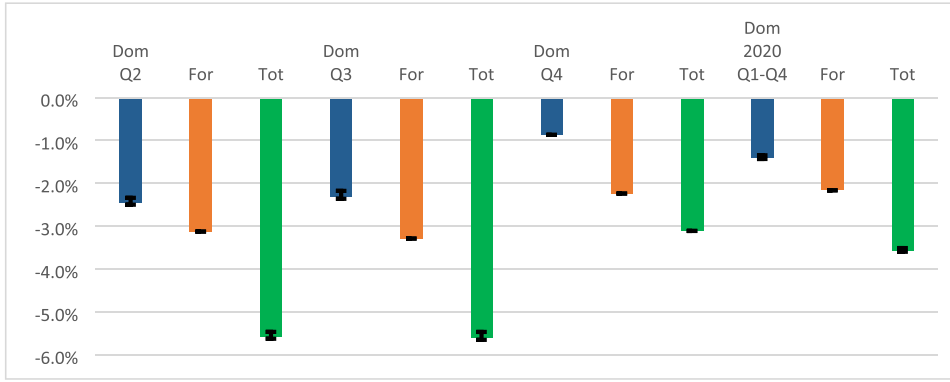

FIGURE 16 Impact on GDP with different levels of subsistence consumption. *Source*: Authors' calculations based on the multiplier model

6.2 | Subsistence consumption

The results from our SAM account for subsistence consumption, for example, farmers consuming their produce instead of selling it in the market. The level of subsistence consumption is based on data from the SAM itself, which implies that we assume that the subsistence consumption level was not affected by the pandemic.

In this robustness check, we test how sensitive our results are to this assumption by estimating two opposite scenarios and compare it with our initial results. In the first scenario, we assume that through the pandemic and the implemented mitigation measures, it became more difficult to sell products in the market and as a response producers increased subsistence consumption. The second scenario assumes the opposite; that is, the pandemic resulted in less competition from abroad, which increased the share producers sold in the market and as a result subsistence consumption decreased. For both scenarios, we assume a 10% positive or negative change in subsistence consumption depending on the scenario.

Figure 16 shows the results of this robustness check. The small size of the results intervals show that the impact of subsistence consumption on the results is minimal. In scenario 1, in which subsistence consumption increases due to worse market conditions, the total impact in 2020 increased by 0.02 percentage points. For scenario 2, in which

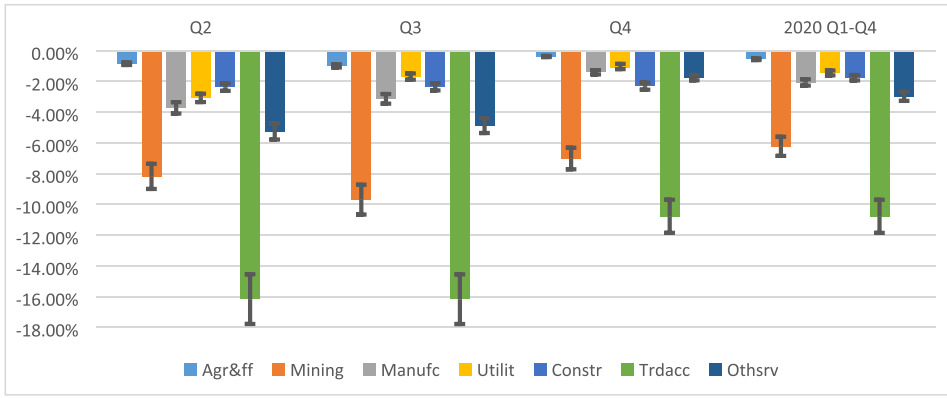

FIGURE 17 Total impact on employment by broad industry with different output-employment elasticities. Abbreviations: Agr&ff, agriculture, forestry and fishing; Constr, construction; Mining, mining and quarrying; Manufc, manufacturing; Trdacc, trade and accommodation; Othsrv, other services; Utilit, electricity, gas and water. *Source*: Authors' calculations based on the multiplier model

subsistence consumption decreased, the impact on GDP decreased by 0.07 percentage points. These changes are trivial so we conclude that the results are robust regarding subsistence consumption.

6.3 | Employment-output elasticities

Our employment results depend on the employment-output elasticities estimated by Kapsos (2005). These elasticities are estimated based on data covering 1991–2003, and it could be argued that they are somehow outdated; however, at the same time, they represent the most up-to-date estimates available for Mozambique.

In this robustness check, we test the sensitivity of our employment results with regard to our choice of employment-output elasticities by increasing and decreasing the elasticities by 10%. Figure 17 shows the results by industry with intervals to indicate the level of variations. The greatest variation can be observed for trade and accommodation, which is not surprising because the service sector has the biggest elasticity. The maximum observed variation occurs in the trade and accommodation sector in Q2 when the results vary up to ±1.6 percentage points. The variation in the remaining sectors is always lower.

We consider the observed level of variation as minor and conclude that the results are robust with respect to our choice of output-employment elasticities.

6.4 | Speculative investments

The next robustness check is concerned with speculative investments. So far, we assumed that the investment channel is affected negatively by COVID-19; however, it could also be that some economic agents use the opportunity of a pandemic for speculative investments, which could result in an increase in investments or a positive shock to the economy. As already explained in Section 3.3, we think that the possibility of speculative investments is a small concern for our approach because almost all sectors endogenized the impact of the investment channel.

However, two sectors in which the investment channel is assumed to be the primary shock and therefore not endogenized in the model are construction and machinery and equipment. For these two sectors, we conduct a robustness check in which we decrease the assumed negative investment shock gradually up to the point in which

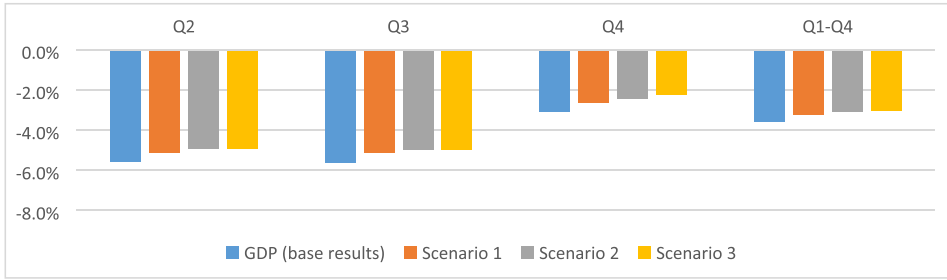

FIGURE 18 Impact on total GDP for different levels of investment shock. *Note*: GDP (base results) assumed a construction shock of −5% and machinery and equipment shock of −15%. Scenario 1 assumed a construction shock of 0% and machinery and equipment shock of −10%. Scenario 2 assumed a construction shock of 0% and machinery and equipment shock of −5%. Scenario 3 assumed a construction shock of 0% and machinery and equipment shock of 0%. *Source*: Authors' calculations based on the multiplier model

we assume a zero effect. The final scenario in which we assume zero impact on these sectors through the investment channel can be understood as a scenario in which the negative impact of COVID-19 on investment has been cancelled out by an increase in speculative investment because of COVID-19. We refrain from going further and do not analyse situations in which speculative investments are greater than the negative impact of COVID-19, because as the data show in Figures A5 and A6, the overall impact in both sectors is negative.

Figure 18 shows the results for this robustness check for total GDP. As expected, the impact of COVID-19 on GDP decreased with lower assumed investment shocks. The initial estimated shock of COVID-19 on GDP in 2020 (right bars of Figure 18) was −3.6 percentage points and reduced to −3 percentage points in scenario 3 (the scenario with zero investment shock). Considering that the overall change in construction and machinery and equipment was negative in 2020, it is very unlikely that scenario 3 holds and even so the variation is small enough to not challenge our overall findings.

6.5 | Labour remittances

Our input assumptions regarding the impact of COVID-19 on labour remittances could be seen as arbitrary, because we assume a negative impact while data provided by the World Bank actually show that remittances to Mozambique increased from 2% to 2.5% of GDP in 2020 (World Bank, 2021c). However, these data have to be interpreted with caution because border closures due to COVID-19 in some countries blocked some forms of remittances, especially remittances carried physically over the border. As a response, many remittance senders moved to formal ways such as bank transfers or mobile money (Ratha, 2021). Formal remittances show up more easily in statistical data; therefore, some part of the increase in remittances could be a move from informal uncaptured transmissions to more formal remittance transmissions.

The main driver for Mozambique's remittances is development in neighbouring South Africa and due to the proximity of Mozambique to mines in the east of South Africa a big part of remittances is carried physically over the border and therefore difficult to register. However, to ascertain that our decision of a negative impact of COVID-19 does not entail the risk of driving our results we conduct a robustness check in which we decrease the negative impact assumed to zero.

We do not present a figure for the results of this robustness check because as it turns out the change in total GDP in 2020 changes by a mere 0.00046 percentage points, which is not detectable in a figure. We further conclude that our results are not influenced by our decision to assume a negative impact on labour remittances.

7 | CONCLUSION

This study offered an analysis of the macroeconomic impact of COVID-19 on the performance of the Mozambican economy in 2020. We used a SAM-based multiplier analysis, which allows us to estimate the total impact of COVID-19 on the economy and distinguish between the contributions of foreign and domestic shocks to changes in production and employment across a range of economic sectors.

Our estimates indicate that economic growth in 2020 was 3.6 percentage points lower because of COVID-19 than it would have been otherwise. Accordingly, and given the overall contraction of the Mozambican economy of −1.3%, as reported by INE (2021a), we estimate growth would have been 2.3% in 2020 without the COVID-19 shock. Furthermore, the results show that employment was 1.9 percentage points lower due to COVID-19 in 2020 and that the two sectors hit the hardest by the pandemic were the mining and trade & accommodation sector.

This study has not analysed in detail the impact of COVID-19 on monetary poverty in Mozambique.[7] However, adopting the growth-poverty elasticity in the period 2008/2009–2014/2015 of 0.68 estimated by the World Bank,[8] a 3.6 percentage point loss in GDP is associated with an increase in poverty of 2.45 percentage points. Put differently, the equivalent of more than half the progress in terms of poverty reduction realised between 2008/2009–2014/2015 is likely to have been wiped out in 2020 due to the COVID-19 shock alone. This is particularly serious because Egger et al. (2020b) have already suggested that the impact of cyclones Idai and Kenneth, as well as an ongoing debt crisis, may have left Mozambique in 2019 with a poverty rate not that different from that of 2015. The implication is that Mozambique may have ended 2020 with a national poverty rate markedly higher than that of 2015.

In conclusion, we note, first, that most of the COVID-19 impact on the economy came in 2020 through the export channel. This vividly illustrates Mozambique's dependence on a small number of export items and its corresponding vulnerability to trade shocks. Following World Bank (2020), upgrading of export value chains and diversification of the export basket represent key policy challenges.

Second, the economic impact was stronger for the urban population and for capital income. This is related to the first point, especially with the mining sector identified as impact driver, which is a capital-intensive industry. The agricultural sector, on the other hand, seems to have been impacted less negatively which contributes to the result that the impact in rural areas was lower. Considering the high importance of the agricultural sector in the Mozambican economy this might be interpreted as a blessing in disguise for many low-income families. However, this blessing is fragile. Mozambique already has very high poverty rates and the situation could quickly degrade if COVID-19 spreads into rural areas, where the impact on health could be more severe due to a lack of proper health care facilities. Even if households may find themselves above the poverty line right now, many are close to being pushed below the line due to the dynamics of the COVID-19. Accordingly, it should be kept in mind that even small absolute losses for poor households may matter a lot for their welfare.

Last, the results in this study reflect the implications of a consistent simulation of the impact of COVID-19 on the Mozambican economy in 2020. We stress that our results are conditional on the assumptions made and incorporate the effects of mitigation measures adopted over that period. In hindsight, these assumptions may prove imprecise. In a forward-looking perspective, it is critical to keep in mind that the future impact of COVID-19 will depend on how the pandemic develops, both locally and globally. The analytical platform developed here can easily be updated and adjusted as and when new information becomes available.

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DATA AVAILABILITY STATEMENT

The SAM that support the findings of this study is available at https://www.wider.unu.edu/database/2015-social-accounting-matrix-mozambique.

The remaining data were derived from the following resources available in the public domain: INE (https://www.ine.gov.mz/), Banco do Mozambique (https://www.bancomoc.mz//) and The World Bank (https://www.worldbank.org/en/research/commodity-markets).

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ENDNOTES

[1] See https://www.wider.unu.edu/publication/mozambique-prepared-lockdown-during-covid-19-pandemic and Egger et al. (2020).

[2] Except for the agricultural sub-sectors sugar, tobacco and raw cotton, which have been impacted by the export channel.

[3] Value added growth excludes product taxes and was chosen in this context to make the results comparable. The SAM does not include product taxes (Cruz et al., 2018).

[4] For a definition of the activities included in each industry/sector, see Table A2.

[5] The exact employment–output elasticities are 0.32 for the agricultural sector, 0.47 for the manufacturing sector (including the extractive industry) and 1.54 for the service sector. The values are retrieved from Kapsos (2005).

[6] For space reasons, we report only results on the impact on GDP and some other relevant dimensions. The remaining results can be requested from the authors.

[7] This is the topic of a separate study forthcoming shortly (Barletta et al., 2021).

[8] See https://documents.worldbank.org/en/publication/documents-reports/documentdetail/377881540320229995/

REFERENCES

AfDB. (2021). "African economic outlook 2021. From debt resolution to growth: The road ahead for Africa." https://www.afdb.org/en/knowledge/publications/african-economic-outlook

Arndt, C., Davies, R., Gabriel, S., Harris, L., Makrelov, K., Robinson, S., Simbanegavi, W., Van Seventer, D., & Anderson, L. (2020). "Impact of Covid-19 on the South African economy—An initial analysis." SA-TIED Work. Pap. 111. *SA-TIED Working Paper 111*. SA-TIED Working Paper. https://sa-tied.wider.unu.edu/sites/default/files/pdf/SA-TIED-WP-111.pdf

Barletta, G., Castigo, F., Egger, E. M., Keller, M., Salvucci, V., & Tarp, F. (2021). "The impact of COVID-19 on consumpiton poverty in Mozambique." 2021/94. WIDER Working Paper. https://doi.org/10.35188/UNU-WIDER/2021/034-4

BdM. (2021). "Balança de Pagamentos." http://www.bancomoc.mz/fm_pgLink.aspx?id=222

Bulmer-Thomas, V. (1982). *Input-output analysis in developing countries: Sources, methods and applications*. John Wiley & Sons, Australia Limited.

CoM. (2020a). "Mozambican miners return to South Africa as COVID-19 blockade lifts." Club of Mozambique, 1–4. https://clubofmozambique.com/news/mozambican-miners-return-to-south-africa-as-covid-19-blockade-lifts-166332/

CoM. (2020b, March 12). "MISAU Communique: Government reinforces Covid-19 prevention measures—Unabridged." *Club of Mozambique*.

CoM. (2020c, March 14). "Mozambique reinforces COVID-19 prevention measures." *Club of Mozambique*. https://clubofmozambique.com/news/just-in-mozambique-reinforces-covid-19-prevention-measures-155170/

CoM. (2020d, March 21). "Exclusive: Coronavirus, gas slump put brakes on Exxon's giant Mozambique LNG plan." *Club of Mozambique*. https://clubofmozambique.com/news/exclusive-coronavirus-gas-slump-put-brakes-on-exxons-giant-mozambique-lng-plan-reuters-155825/

CoM. (2020e, March 22). "Mozambique reports first case of Covid-19." *Club of Mozambique*. https://clubofmozambique.com/news/mozambique-reports-first-case-of-covid-19-155872/

CoM. (2020f, March 23). "Covid-19: Bank of Mozambique announces measures to support companies and families." *Club of Mozambique*. https://clubofmozambique.com/news/covid-19-bank-of-mozambique-announces-measures-to-support-companies-and-families-155956/

CoM. (2020g, March 23). "Covid-19: Government asks for US $ 700 Million – Nmin." *Club of Mozambique*. https://clubofmozambique.com/news/covid-19-government-asks-for-us700-million-finmin-155955/

CoM. (2020h, March 23). "Mozambique: Government cuts 2020 GDP forecast to 2. 2% -3. 8% due to Covid-19." *Club of Mozambique*. https://clubofmozambique.com/news/mozambique-government-cuts-2020-gdp-forecast-to-2-2-3-8-due-to-covid-19-155963/

CoM. (2020i, March 30). "Mozambique: Nyusi declares state of emergency." *Club of Mozambique*. https://clubofmozambique.com/news/mozambique-nyusi-declares-state-of-emergency-156530/

CoM. (2020j, April 1). "Nyusi declares state of emergency—AIM report." *Club of Mozambique*. https://clubofmozambique.com/news/nyusi-declares-state-of-emergency-aim-report-156729/

CoM. (2020k, April 6). "Gemfields warns extended COVID-19 travel restrictions could wipe out $ 25m cash pile." *Club of Mozambique*. https://clubofmozambique.com/news/gemfields-warns-extended-covid-19-travel-restrictions-could-wipe-out-25m-cash-pile-157093/

CoM. (2020l, April 9). "Covid-19: Government decrees VAT exemption on cooking oil, hygiene products, extends exemption of tax late payment charges." *Club of Mozambique*. https://clubofmozambique.com/news/covid-19-government-decrees-vat-exemption-on-cooking-oil-hygiene-products-extends-exemption-of-tax-late-payment-charges-157300/

CoM. (2020m, April 9). "Covid-19: World Bank and IMF inject 21 billion Meticais into the 2020 state budget." *Club of Mozambique*. https://clubofmozambique.com/news/covid-19-world-bank-and-imf-inject-21-billion-meticais-into-the-2020-state-budget-157299/

CoM. (2020n, May 19). "Mozambique: INSS to fund 600 million credit line for SMEs affected by." *Club of Mozambique*. https://clubofmozambique.com/news/mozambique-inss-to-fund-600-million-credit-line-for-smes-affected-by-covid-19-160621/

CoM. (2020o, May 22). "Covid-19: Electricity price to drop 10% as of June, parliament aproves VAT exemptions—Mozambique." *Club of Mozambique*. https://clubofmozambique.com/news/covid-19-electricity-price-to-drop-10-as-of-june-parliament-aproves-vat-exemptions-mozambique-161075/

CoM. (2020p, July 17). "Mozambique: Housing survey starts in September for post-cyclone Idai reconstruction." *Club of Mozambique*. https://clubofmozambique.com/news/mozambique-housing-survey-starts-in-september-for-post-cyclone-idai-reconstruction-166106/

CoM. (2020q, July 20). "Mozambican miners return to South Africa as COVID-19 blockade lifts." *Club of Mozambique*. https://clubofmozambique.com/news/mozambican-miners-return-to-south-africa-as-covid-19-blockade-lifts-166332/

CoM. (2020r, July 22). "Mozambique: US $ 20 million available for post-cyclone Kenneth recovery in Cabo Delgado." *Club of Mozambique*. https://clubofmozambique.com/news/mozambique-us20-million-available-for-post-cyclone-kenneth-recovery-in-cabo-delgado-166160/

CoM. (2020s, August 3). "Covid-19: Emergency measures end as cases jump—By Joseph." *Club of Mozambique*. https://clubofmozambique.com/news/covid-19-emergency-measures-end-as-cases-jump-by-joseph-hanlon-167616/

CoM. (2021, March 4). "Mozambique: ExxonMobil again postpones final decision on Rovuma." *Club of Mozambique*. https://clubofmozambique.com/news/mozambique-exxonmobil-again-postpones-final-decision-on-rovuma-lng-185917/

Cruz, A. S., Mafambissa, F. J., Magaua, M., Salvucci, V., & van Seventer, D. (2018). "A 2015 Social Accounting Matrix (SAM) for Mozambique." 2018/20. WIDER Working Paper. https://www.wider.unu.edu/publication/2015-social-accounting-matrix-sam-mozambique

Egger, E. M., Jones, S., Justino, P., Manhique, I. & Santos, R. (2020a). "Africa's lockdown dilemma: High poverty and low trust." WIDER Working Paper 2020/76. WIDER Working Paper. https://www.wider.unu.edu/sites/default/files/Publications/Working-paper/PDF/wp2020-76.pdf

Egger, E.-M., Salvucci, V., & Tarp, F. (2020b). Evolution of multidimensional poverty in crisis-ridden Mozambique. WIDER Working Paper 2020/69. Helsinki: UNU-WIDER. Available at: https://www.wider.unu.edu/publication/evolution-multidimensional-poverty-crisis-ridden-mozambique

FAO. (2020). "Biannual report on global food markets: June 2020." https://doi.org/10.4060/ca9509en

IMF. (2020). *World economic outlook update June 2020*. World Eonomic Outlook. https://www.imf.org/en/Publications/WEO/Issues/2020/06/24/WEOUpdateJune2020

INE. (2020). "Contas Nacionais, 2nd Trimestre 2020." http://www.ine.gov.mz/estatisticas/estatisticas-economicas/contas-nacionais

INE. (2021a). "Contas Nacionais 4th Trimestre." http://www.ine.gov.mz/estatisticas/estatisticas-economicas/contas-nacionais

INE. (2021b). "Indicadores de Confiança e de Clima Económico de Dezembro 2020." http://www.ine.gov.mz/estatisticas/estatisticas-economicas/icce/public_-icce-dezembro-2020.pdf/view

Kapsos, S. (2005). "The employment intensity of growth: Trends and macroeconomic determinants." No. 2005/12. Employment Strategy Papers. https://doi.org/10.1057/9780230627383

Kapsos, S. (2006). The Employment Intensity of Growth: Trends and Macroeconomic Determinants. In J. Felipe & R. Hasan (Eds.), *Labor Markets in Asia*. Palgrave Macmillan, London. https://doi.org/10.1057/9780230627383_4

Kyed, H. M. (2020). "COVID-19 in Mozambique: Police violence, mistrust of government and the fear of hunger." https://www.diis.dk/node/24080

Ministério da Saúde. (2020a). "Boletim Diario Covid-19." 2020. https://www.misau.gov.mz/index.php/covid-19-boletins-diarios

Ministério da Saúde. (2020b). "Boletím Diário Covid-19 No 289 (31 de Dezembro de 2020)." https://www.misau.gov.mz/index.php/covid-19-boletins-diarios

Mussagy, I. H., & Mosca, J. (2020). "MICRO-SIMULAÇÕES DOS IMPACTOS DA COVID-19 NA POBREZA E RURAL." No 96. *Observador Rural*. Observador Rural. https://omrmz.org/omrweb/wp-content/uploads/Observador-Rural-96-Micro-simulações-dos-Impactos-da-Covid-19-na-Pobreza.pdf

Ratha, D. (2021). "Remittances during the COVID-19 crisis: Resilient and no longer small change." People Move. 2021. https://blogs.worldbank.org/peoplemove/remittances-during-covid-19-crisis-resilient-and-no-longer-small-change

Ritchie, H., Mathieu, E., Rodés-Guirao, L., Appel, C., Giattino, C., Ortiz-Ospina, E., Hasell, J., Macdonald, B., Beltekian, D., & Roser, M. (2020). "Coronavirus pandemic (Covid-19)." OurWorldInData.Org. 2020. https://ourworldindata.org/coronavirus

RM. (2020, July 21). "C. DELGADO: CHEGADA MASSIVA DE DESLOCADOS À PEMBA DESAFIA IMPLEMENTAÇÃO DE MEDIDAS DE PREVENÇÃO DA COVID-19." *Rádio Moçambique*. https://www.rm.co.mz/rm.co.mz/index.php/component/k2/item/12109-c-delgado-chegada-massiva-de-deslocados-a-pemba-desafia-implementacao-de-medidas-de-prevencao-da-covid-19.html

SAPO. (2020, July 17). "Deslocados Vivem Com Medo de Ataques No Centro de Moçambique." *SAPO Noiticias*. https://noticias.sapo.mz/actualidade/artigos/deslocados-vivem-com-medo-de-ataques-no-centro-de-mocambique

The World Bank. (2020). "Pink sheet data." Commodity Markets. 2020. https://www.worldbank.org/en/research/commodity-markets

World Bank. (2020). "Economic diversification: Lessons from practice." In *Aid for Trade at a Glance 2019*. OECD, WTO. https://www.oecd-ilibrary.org/docserver/f61d8ce8-en.pdf?expires=1633527020&id=id&accname=guest&checksum=B8A9A62F4A050F391D881ECC71FDA021

World Bank. (2021a). "Macro poverty outlook—Sub-Saharan Africa: Country-by-country analysis and projections for the developing world." https://thedocs.worldbank.org/en/doc/bcbb8499f7037137142af9a4af52326c-0350082021/original/mpo-ssa.pdf

World Bank. (2021b). "Mozambique economic update, setting the stage for recovery, February 2021."

World Bank. (2021c). "World Bank Data—Personal remittances, received (% of GDP)—Mozambique." 2021. https://data.worldbank.org/indicator/BX.TRF.PWKR.DT.GD.ZS?locations=MZ

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APPENDIX A: TABLES

TABLE A1 State of emergency measures affecting economic activities

Art.	Description	Impact
Art. 3	Quarantine: Mandatory 14 days quarantine for everyone entering the country.	Prevents most forms of business travel
Ar. 8	Official documents: During the state of emergency the issuing of documents such as passports, ID, driver license, company registration are suspended.	Prevents most forms of business travel and hinders new companies to start a business.
Art. 9	Entry visa: The issuing of entry visas to the country is suspended	Prevents any form of international tourism and business.
Art. 14	Public and private events: All events are cancelled. Amusement and similar commercial establishments such as discos, casinos, gyms, museums, or libraries have to close.	Reduces directly the production of goods and services needed for events and forbids the work of commercial establishments.
Art. 17	Public and private institutions: The mandatory measures in Art. 17 mainly promote social distancing in public entities and private companies. They include the reduction of the on-site workforce to 1/3, promote rotation systems and home office, minimum of 1.5 m distance, and additional hygiene measures.	Businesses operate on lower capacity. Increase of organizational burden to implement the measures.
Art. 20	Markets: Reduced opening time for markets (6 am to 5 pm), mandatory distance and hygiene rules for sellers.	Lower business activity due to reduced opening hours. Higher operational costs.
Art. 26	Transportation: Passenger transport can only use 1/3 of the vehicle capacity (this measure has been suspended), motorcycle taxis are forbidden to operate, and hygiene and sanitary measures must be implemented.	Temporarily passenger transport capacity was reduced by over 2/3. Additional costs through hygiene measures.

Source: Presidential decree 12/2020 and Law 01/2020 from 31 March, Republic of Mozambique.

APPENDIX B: THE SHOCKS BY SECTOR

In this appendix, we discuss the assumption (shock) for each economic sector which fed into the model. We determine for each sector the size of the shock through each of the four identified channels (supply, demand, investment and export) for each quarter in 2020. Note that only the biggest shock enters the model as first round shock and the remaining trickle down effects are calculated by the model. For this reason we focus and arrange the sectors with the dominant channel in mind. For a more detailed discussion about the channels and methodology, see Section 4.

B.1 | Supply side channel

B.1.1 | Other mining

The main mining activities other than coal and gas in Mozambique include ruby mining (Montepuez Ruby Mine [MRM]), graphite (Syrah Resources) and heavy sands.

Ruby mine operators have been affected on the supply side by COVID-19 mainly through the imposed travel restrictions. Article 9 of Decree 12/2020 suspends visa issuing. This restriction made it impossible for the ruby

companies to hold auctions and therefore to sell their products. These auctions are usually responsible for over 90% of the revenues and influenced business significantly in 2020 (CoM, 2020k). The mining companies are also directly affected on the supply side by COVID-19. MRM and Syrah Resources reported cases of COVID-19 in their mines, and production had to be shut down (CoM, 2020s).

Export data for 2020 show an initial large impact in Q2 followed by an even stronger negative impact in Q3 and a backdrop into a large impact in Q4 again (see Figure A1). Other mining export contracted by 35%, 65% and 32% in Q2, Q3 and Q4 compared the values in 2019 (BdM, 2021). Based on the export data, we assumed that due to the direct impact of COVID-19 (cases) and mitigation measures (suspension of visas), the other mining sector was affected with a large impact (−20% to −30%) in Q2, followed by a severe impact (−30% to −40%) in Q3 and a backdrop to a large impact (−20% to −30%) in Q4.

B.1.2 | Other manufactured products (clothing, machines and equipment)

The supply side of the manufacturing sector was affected during the state of emergency mainly through the mandatory reduction in on-site employees, social distancing and hygiene measures. National account data show that the whole industry sector contracted by around 9%, 40% and 0% in Q2, Q3 and Q4 compared with Q1, respectively. However, in a year-on-year comparison the industry sector contracted by only 5.3%, 0.9% and 1.1% in Q2, Q3 and Q4 in 2020 (Figure A2). It should be noted that the data show the overall industry values and not only other manufacturing production. Furthermore, the data show the overall effect and not the direct impact of COVID-19 for industry supply.

We assumed the COVID-19 impact to be in proportion to the whole industry and that supply was impacted mildly (−1% to −10%) in Q2 and zero for Q3 and Q4.

B.1.3 | Transportation and storage

Domestic passenger transport was severely affected on the supply side for a short period by the state of emergency. Article 26 of Decree 12/2020 regulates that the transport sector is only allowed to use 1/3 of their vehicle capacity,

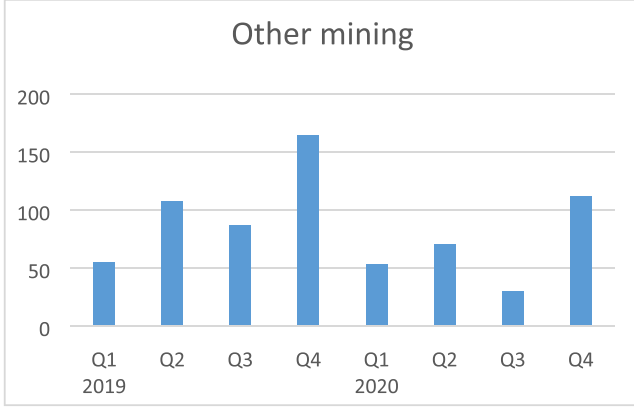

FIGURE A1 Other mining export. *Note*: In million US$, other mining includes rubies, sapphires, emeralds and heavy sand. *Source*: BdM (2021)

banns motorcycle taxis, and makes travel business owners accountable to implement hygiene and sanitary measures creating additional costs. However, the initial strict rule to reduce capacity by 2/3 was lifted shortly after its implementation, reducing the impact on supply considerably.

International passenger transport was affected severely through the state of emergency. The suspension of visa issuing and cancellation of almost all international flights reduced activity significantly. Cargo transport reduced because of lower demand and international cargo mainly because of new complicated boarder procedures. However, other transport of goods was only minimally affected on the supply side by the state of emergency measures.

Indirect effects of the state of emergency on the trade sector such as the discouragement of movement by the government, closure of schools, and promotion of home office reduces the demand for transportation. These indirect effects are part of the demand side and are picked up by the model through other channels.

National account data show a contraction of the sector in Q2, a recovery in Q3 followed by a new contraction in Q4 (Figure A3). Production in the transport, storage and IT sector was 5%, 1% and 8% down in Q2, Q3 and Q4 compared with 2019 levels. For Q2, we assume the supply impact to be mild (−1% to −10%), and for Q3, we assume that the situation moved back to pre-crisis levels (0%), while Q4 again is assumed to be mildly impacted (−1% to −10%).

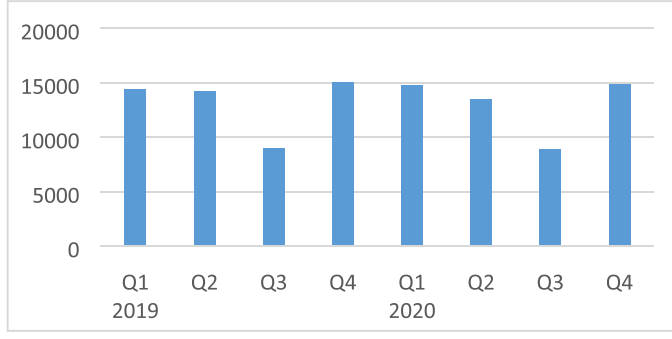

FIGURE A2 Quarterly industry production. *Note*: National account data, values in constant 2014 10^6MT. *Source*: INE (2021a)

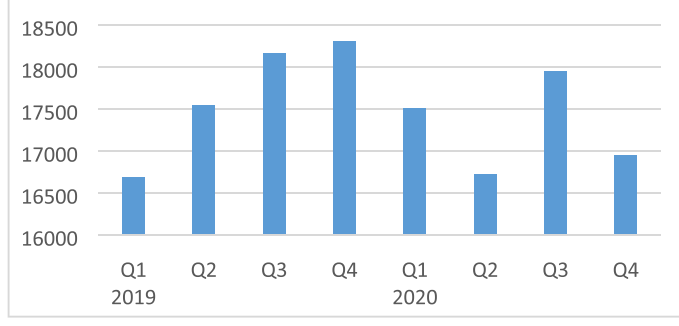

FIGURE A3 Quarterly transport, storage and IT production. *Note*: National account data, values in constant 2014 10^6MT. *Source*: INE (2021a)

B.2 | Demand side channel

The assumption regarding the size of the effect through the demand channel was already discussed in Section 3.2, and we assumed that the demand changed accordingly throughout the whole economy, that is, for each sector. The assumed impact is mild (−1% to −10%) in Q2 and Q3 and 0% in Q4. Remember that only the biggest sectorial effect from the four channels (supply, demand, investment and export) enters the model as first round impact. The impacts through the remaining three channels were then calculated in the model. This means that for sectors where we assumed zero impact in Q2 and Q3 for the supply, investment and export channels the applied first round impact in the model work through the demand channel.

This is the case for the following economic sectors: Agriculture, Processed Foods, Utilities (Electricity and Water), Trade, Telecommunication and Information Technology, Financial and Insurance Services, Business and Real Estate Services, Public Administration, Health and Education.

Most of these sectors are part of the service sector industry (Financial and Insurance Services, Business and Real Estate Services), and many of their jobs are desk based which minimized the disruption from a supply side perspective. Many of these services could still be offered during the pandemic in 2020 via online, phone or adjusted office services. Telecommunication and Information Technology might even have benefitted from the pandemic. Home offices should have created an incentive to invest more in IT solutions. A similar positive effect could have occurred for the utility sector. Public administration and education faced a disruption in supply (school closure and home office/rota systems). However, government employees were still paid, and therefore, the supply side was not disrupted in terms of monetary values.

Agriculture activities take place in rural areas, and the low population density there makes it easy to conform to social distance rules. Further, the government recognises the importance of the sector in terms of employment and livelihood and minimized any possible disruptions. Taking the seasonality of the agriculture sector into account and comparing only on a year-on-year basis, national account data show a 3.5%, 3% and 1% increase in activities in Q2, Q3 and Q4 compared with 2019 (Figure A4). Therefore, the supply does not seem to have been interrupted due to COVID-19. It could still be argued that some of the agriculture production is mainly exported and therefore the export channel should be dominant. This is a valid point, and we took care of it in our analysis by treating the main agricultural export items in which we found a disruption through a change in world demand separately. This was the case for sugar, tobacco and cotton, and we discuss each of these sub-sectors below in the export channel section.

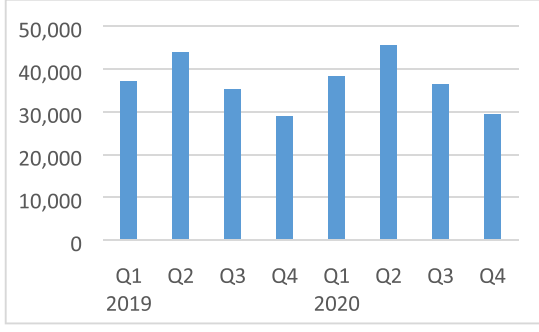

FIGURE A4 Quarterly agriculture production. *Note:* National account data, values in constant 2014 10^6MT. Source: INE (2021a)

B.3 | Investment channel

B.3.1 | Construction

The impact of COVID-19 on the construction sector will take time to materialize. The ongoing crisis will make people hesitant to invest in new buildings, the government has not announced any form of investment programme in infrastructure and companies will hold back investments.

However, data show that the construction sector was only mildly impacted in 2020. National account data actually revealed an increase in activities by 4%, 5% and 15% in Q2, Q3 and Q4 compared with Q1 (Figure A5). Nevertheless, on a year-on-year comparison, the growth was negative, −0.9%, −0.2% and −4%.

Considering that the construction sector normally operates under a positive trend and in combination with the stagnation or mildly negative growth in 2020, we assume a mild impact (−1% to −10%) in Q2, Q3 and Q4.

B.3.2 | Machinery and transport equipment

As guidance to determine the impact of COVID-19 and the mitigation measures on investments for machines and transport equipment, we used the value of imported capital goods (machines, tractors and semi-robotic machines) from BdM. Overall, the imported values decreased in Q2 by 34% compared with Q1 and by 30% compared with Q2-2019 (Figure A6). This would indicate a large impact of around 30%. It could be that some machines were not delivered because of supply chain problems abroad. However, we assume the impact on investment to be somewhat smaller at a moderate level (−10% to −20%) in Q2. This is because other political events such as the conflicts in the north and centre of the country also increased uncertainty with negative consequences for investment decisions. In Q3 and Q4 the value of imported capital goods decreased by 23% and 17% compared with Q1 and is around 33% and 26% less compared with Q3/Q4-2019 (Figure A6). Therefore, it seems that the negative impact continued for the rest of the year and therefore we assumed for Q3 and Q4 a moderate impact (−10% to −20%) as well.

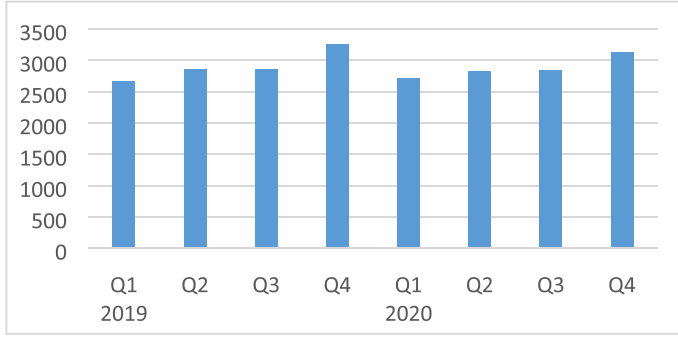

FIGURE A5 Quarterly construction production. *Note*: National account data, values in constant 2014 10^6MT. *Source*: INE (2021a)

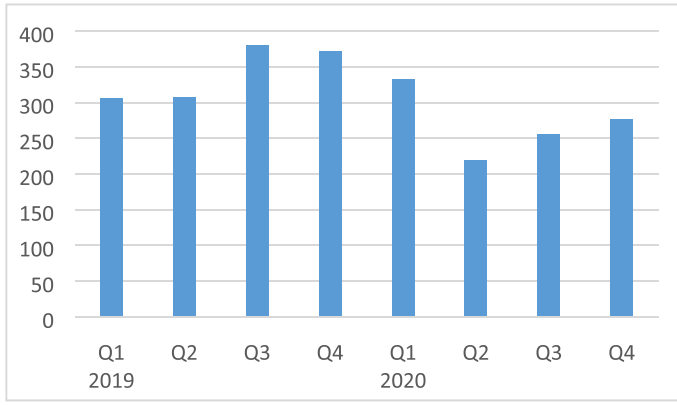

FIGURE A6 Imported capital goods. *Note*: In million US$. *Source*: BdM (2021)

B.4 | Export channel

B.4.1 | Coal

The coal sector has been severely affected by the pandemic. On the supply side, Article 17 and 22 of the Decree 12/2020, the state of emergency obliges companies to ensure the protection of personal and reduce on-side employees to 1/3 and/or ensure 1.5 m distance between workers. Considering that coalmines in Mozambique are open pitch, it would be feasible to implement such measures at some costs and still produce some coal. Therefore, the supply side effect should be small. However, the impact on the supply side is clearly overshadowed by the impact on the demand side. World demand and prices for coal decreased significantly because of the economic slowdown worldwide due to COVID-19. Vale—the biggest coal producer in Mozambique—stopped extracting coal due to low world demand in June and announced to keep the production stop in place until the end of the year (CoM, 2020s).

Total coal export declined in Q2 by 28% compared with Q1 (Figure A7, left) and the international coal price by 26% (Figure A7, right). The export reduction of 28% would indicate an almost severe impact (−30% to −50%); however, this is again the total effect. The export effect should be lower because not everything can be attributed to COVID-19. Some of the effect could also be because of other factors such as continued global development in renewable energy and the climate change debate. The export shock for coal was set to be large (−20% to −30%) in Q2.

Coal exports in Q3 were also below pre-pandemic levels but already improved somewhat compared with the initial shock in Q2 even though the coal price continued to stay low. Therefore, we assume that the large initial shock in Q2 continued in Q3. For Q4, we assume an improvement of the situation based on the fact that the international coal price increased by 26% in the last quarter of the year and reached almost pre-pandemic levels. Even if the price reached pre-pandemic levels the export data show that complete recovery in terms of volume will take a bit longer, therefore, we assume for Q4 an improvement but still no complete recovery to pre-pandemic levels, that is, a moderate impact (−10% to −20%).

B.4.2 | Aluminium

The international aluminium price decreased by 11% in Q2 (Figure A8, right), and at the same time, total aluminium exports declined by 11% in Q2 (Figure A8, left). Therefore, the reduction in aluminium export seems to be driven

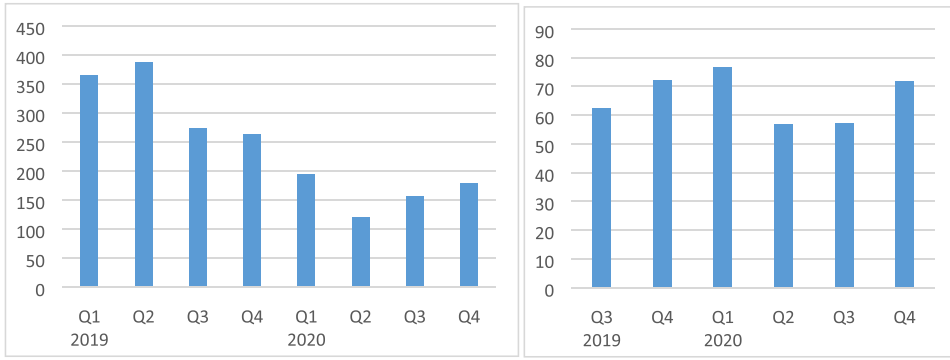

FIGURE A7 Coal export (left) and coal price (right). *Note*: Left figure shows the coal export of Mozambique in million US$. The right figure shows the international coal price (South Africa). *Source*: BdM (2021) and The World Bank (2020)

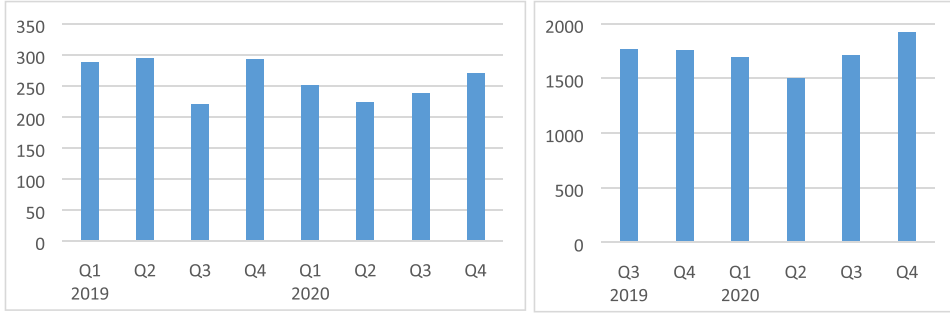

FIGURE A8 Aluminium export (left) and Aluminium price (right). *Note*: The left figure shows the export values of aluminium (bars and cables) in million US$. The right figure shows the international aluminium price in US$/mt. *Source*: BdM (2021) and The World Bank (2020b)

mainly by the price decline. Because most Mozambican aluminium is exported, this implies that the sector has been mainly influenced by the export channel. The export shock is therefore classified as the main channel and the impact is quantified at as moderate (−10% to −20%) in Q2.

The aluminium export value recovered in Q3 as did the aluminium price. Therefore, we assume an improvement of the situation with only a mild impact (−1% to −10%) in Q3. Further, the positive price development of aluminium in Q4 continued but did not suffice to lift aluminium export to the same level as in the year before. Aluminium export was still 8% lower in Q4-2020 than it was in Q4-2019. Therefore, we assume that the mild impact (−1% to −10%) continued in Q4.

B.4.3 | Tourism

Activities in the tourism sector has been shocked through all four channels. Supply was hindered through the state of emergency, domestic demand reduced through fear of infections, and investments decisions for new hotels has

been delayed or cancelled. However, the biggest shock is assumed to have taken effect through the export channel. The cancellation of entry visas, border closure and cancellation of international flights made it impossible for any international tourist to enter the country.

National accounts data show that activities in the hotel and restaurant sector decreased by 36%, 19% and 12% in Q2, Q3 and Q4 compared with Q1, respectively. On a year-on-year comparison, the sector decreased 36%, 31% and 23% in Q2, Q3 and Q4 (Figure A9). The figure implies a huge impact and the high level of informality in the tourism sector makes it most likely that the real effect is even higher. Considering that tourism and related activities almost succumbed, we assumed that the impact of COVID-19 on the tourism export sector to be above 90% in Q2 and Q3. It was initially planned to start issuing visas again towards the end of Q3 but that did not materialise until the beginning of Q4. For Q4 we assume a small improvement to a severe shock (−75%) but still far away from Q1 levels.

B.4.4 | Natural gas (to South Africa)

Natural gas produced in Mozambique is exported to South Africa via a pipeline. This technology does not require much labour and therefore can operate during the state of emergency without interruptions on the supply side. The situation is different on the South African side of the border. The pandemic affected South Africa severely up to the point that the government implemented a full lockdown. South African demand is what determines the export volume and as can be seen in Figure A10 (left) natural gas export decreased in Q2 by 5% compared with Q1. The situation worsened in Q3 when natural gas export decreased 34% compared with Q1. Considering that the price index for natural gas increased in Q3 indicates that the Q3 decrease in natural gas export was mainly due to lower volumes delivered to South Africa. In Q4, the natural gas price further increased which should have had a positive impact on Mozambique's export earnings (Figure A10, right). However, in Q4, export values were still 3% lower than in the previous year and 22% lower than in Q1.

Based on the export and price data we assumed a mild impact (−1% to −10%) in Q2, a moderate impact (−10% to −20%) in Q3 and again a mild impact (−1% to −10%) in Q4.

B.4.5 | Sugar

FAO's food outlook of June 2020 estimates that Mozambique's sugar production and export does not change (FAO, 2020). Nevertheless, the international sugar price decreased in Q2 by 18% (Figure A11). Therefore, the impact

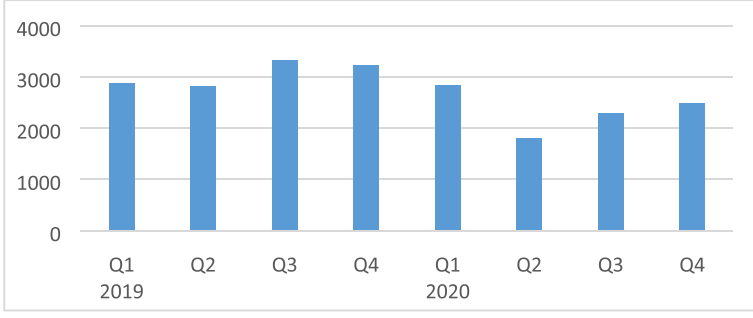

FIGURE A9 Quarterly production in the hotel and restaurant sector. *Note*: Values in constant 2014 10^6MT. *Source*: INE (2021a)

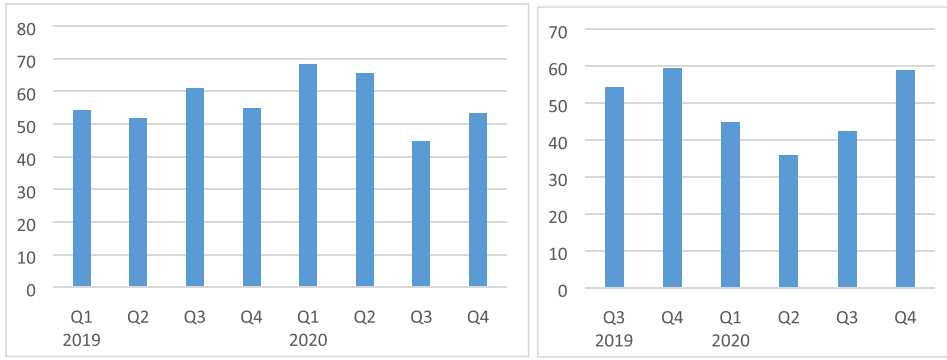

FIGURE A10 Natural gas export from Mozambique to South Africa (left) and Natural gas price index (right). *Note:* The left figure shows natural gas export in million US$. The right figure shows the natural gas price index from the World Bank (2010 = 100). *Source*: BdM (2021) and The World Bank (2020b)

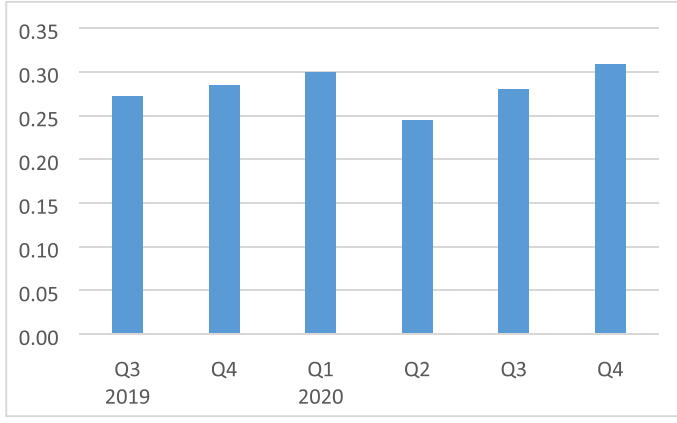

FIGURE A11 Sugar price. *Note*: World sugar price in US$/kg. *Source*: The World Bank (2020b)

in Q2 is assumed to be moderate (−10% to −20%) due to the price effect. In Q3 and Q4, the sugar price recovered gradually above pre-pandemic level. Based on the price development, we assumed a gradual improvement and set the impact to be mild (−1% to −10%) in Q3 and to zero in Q4.

B.4.6 | Tobacco

Harvesting and most export of tobacco happen in Q3 and Q4. Therefore, comparing Q2 with Q1 or the previous year does not really show the impact of COVID-19. Nevertheless, the annual change shows, that tobacco export is down by 78% in Q2-2020 compared with Q2-2019 and 64% down compared with Q2-2018 (Figure A12). We still assumed only a mild impact (−1% to −10%) in Q2 for tobacco due to the fact that Q2 is not a harvest period.

In Q3, tobacco export was down by 32% compared with Q3-2019 which in combination with a decreasing trend in the last 2 years amounts to a large impact (−20% to −30%). The situation improved slightly in Q4. Tobacco export was "only" 13% lower than a year before. Therefore, we assumed a moderate impact (−10% to −20%) in Q4 for the Tobacco industry.

B.4.7 | Cotton

The cotton price dropped in Q2 by 12% (Figure A13, left), and at the same time, cotton export (Figure A13, right) decreased by 75% in Q2 compared with Q1 and by 82% compared with Q2-2019. Considering the price and export value decline, we assume a severe impact (−30% to −50%) for Q2. In Q3, the export value of cotton slightly recovered but still remained below pre-pandemic levels. In Q4, the cotton price recovered even more and exceeded pre-pandemic levels. The price development in Q3 and Q4 and the export data indicate that the cotton sector did

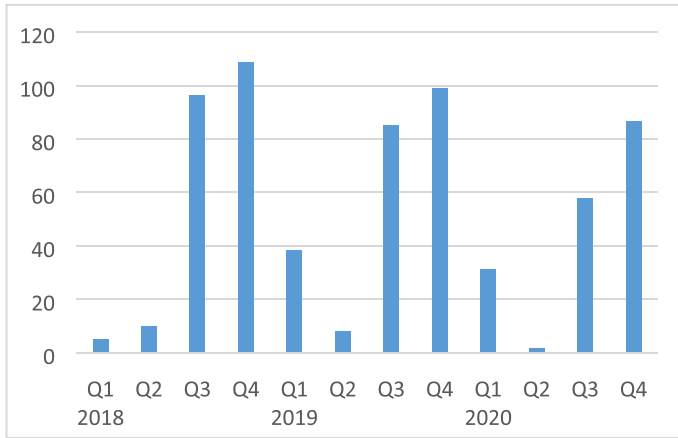

FIGURE A12 Tobacco export. *Note*: In million US$. *Source*: BdM (2021)

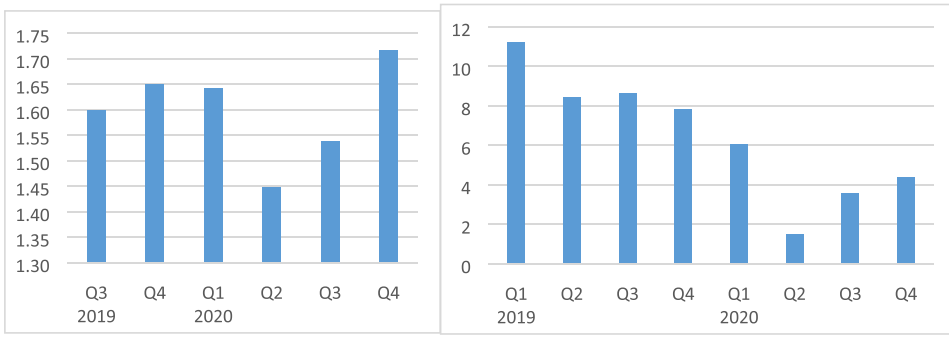

FIGURE A13 Cotton price (left) and cotton export (right). *Note*: Cotton price A Index in $/kg (left). Cotton export in million US$ (right). *Source*: The World Bank (2020b) and BdM (2021)

recover partly. Therefore, we assumed a large impact (−20% to −30%) in Q3 and a moderate impact (−10% to −20%) in Q4.

B.4.8 | Labour remittances

We assume a severe impact (−30% to −50%) on labour remittances in Q2 and that the situation gradually improved in Q3 (−20% to −30%) and Q4 (−10% to −20%). The main reason to assume a severe reduction in labour remittances is that COVID-19 is spreading worldwide and any Mozambican migrant could be affected abroad as much as in Mozambique or likely even more. For example, many Mozambicans are employed in South African mines. The lockdown in South Africa and the closed boarders between the two countries most likely reduced remittances significantly. It is estimated that due to the border closure between Mozambique and South Africa, families of an estimated 28,000 miners were affected (CoM, 2020q). The assumed improvement of the situation in Q3 and Q4 is because the governments in South Africa and Mozambique are implementing procedures for miners to return to their work place (CoM, 2020a).

APPENDIX C: SETTING UP A MULTIPLIER MODEL

A SAM multiplier model is an extended version of a basic IO model. A generic IO model can be written in the following way:

$$\mathbf{x} = \mathbf{Z}\mathbf{i} + \mathbf{f} \tag{A1}$$

$$\mathbf{x} = \mathbf{A}\mathbf{x} + \mathbf{f} \tag{A2}$$

$$\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{f} \Longleftrightarrow \mathbf{x} = \mathbf{L}\mathbf{f} \tag{A3}$$

$$\Delta\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\Delta\mathbf{f} \Longleftrightarrow \Delta\mathbf{x} = \mathbf{L}\Delta\mathbf{f} \tag{A4}$$

in which **x** is a column vector of industry outputs in an economy (**Δx** denotes a change in outputs). **Z** is a matrix of intermediate sales/demands in an economy. **f** is a column vector of final demand of goods and services supplied by industries in an economy (**Δf** denotes a change in final demands). **i** is a column vector of unit values, so that **Zi** is a column vector of intermediate demands summed over all industries. **A** is a matrix of intermediate demands per unit of industry output for an economy which is derived by dividing **Z** with the transpose of **x**, that is, the column totals. **L** is the Leontief matrix of direct and indirect impacts on each of the activities labelled in the row headings as a result of a one unit increase in final demand for goods and services produced by the activity in the column heading. The column totals of **L** are referred to as the "output multipliers." Comparison of output multipliers offers an indication which industry is more connected to the domestic economy.

Additional induced effects are captured by expanding the model by making a distinction between activities and commodities and by including detailed factor income and detailed household income and their expenditure. The generation and distribution of factor income to households depend on what happens to production, which is endogenous to the model. Household expenditure will generate an additional "induced" impact on output **x** in such an expanded version. The column totals (or sum over activities in case of a SAM) of **L** can be calculated for each activity as indicators of backward linkages.

APPENDIX D: EMPLOYMENT IMPACT ADJUSTMENT

Results of the base model include impacts on gross sectoral output. Using further linear relationships, the model generates results for value added, household income, imports, tax revenues and employment, amongst others. Impacts on value added (GDP at factor costs) are based on economy-wide industry level value added to gross output ratios. These ratios are assumed to hold at the margin and multiplied with the output impacts. The same applies to imports and taxes.

The typical assumption about the employment impacts is the same, in that the elasticity of employment with respect to output is equal to 1. In other words, if output goes down by 1%, employment will also go down by 1%. This may be considered as a more heroic assumption than the linearity of the base model itself (Bulmer-Thomas, 1982, p. 61). Firms may hold on to labour in downturns in order to avoid costly search and training and when there is an upturn, the demand for labour may not increase. Econometric analysis is required to estimate such elasticities. Broad estimates have been made for Mozambique by Kapsos (2006) and their results have been mapped to the industries (activities) and labour categories (by education).

APPENDIX E: SECTOR DEFINITION

TABLE A2 Sector definition

	Broad sectors	Included activities
1	Agriculture	Maize, sorghum and millet, rice, other cereals, pulses, groundnuts, other oilseeds, cassava, other roots, vegetables, sugar cane, tobacco, cotton and fibres, fruits and nuts, coffee and tea, other crops, cattle, poultry, other livestock, forestry and fishing
2	Mining	Coal and lignite, natural gas and other mining (rubies, graphite and heavy sands)
3	Manufacturing	Meat, cereal and vegetable processing, other foods, beverages and tobacco processing, textiles, clothing, leather and footwear, wood and paper, chemicals, non-metal minerals, metals and metal products, machinery and equipment and other manufacturing
4	Utility	Electricity (gas and steam), water supply and sewage
5	Construction	Construction
6	Trade and Accommodation	Wholesale and retail trade, accommodation, hotels, restaurants and alike and food services
7	Transportation	Transportation and storage and information and communication
8	Other services	Finance and insurance, real estate activities, business services, public administration, education, health and social work and other services

Note: Sector definition follows the social accounting matrix (SAM) created by Cruz et al. (2018) for a mapping of sector, SAM activities, INE activity description and INE commodity code, see appendix A of Cruz et al. (2018).