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COVID-19 impact study: assessing the consequences of the pandemic on economic output in developing countries for targeted sectors

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Abstract: *This paper presents a model for how the impact of the COVID-19 pandemic on economic output in developing countries can be assessed with a new approach. Existing models lack sectoral granularity in developing countries, which can, however, be obtained through input-output modelling by changing the social accounting matrix to simulate a COVID-19 economy. Results have been estimated for 65 sectors and 141 regions which correspond to the Global Trade Analysis Project's data. The analyses showed that the average impact in Africa and Asia on industry output is –2.6 per cent and –2.9 per cent, respectively. It is estimated that tourism and services are the most heavily impacted sectors, between –15 per cent and –19 per cent for hospitality, recreation, and other service activities, and between –4 per cent and –7 per cent for transport services. The model is a first attempt at estimating impact at this level of granularity per country and sector, which by triangulation with empirical data can be used to make substantiated management or policy decisions.*

Keywords: COVID-19, economic impact, Joint Impact Model, sector impact, DFI

Introduction

More than a year after the first signs of the COVID-19 virus it has become clear that the world is dealing with a pandemic which will leave large scars on the global economy. As the virus has spread through the world, the economy has slowed down as a result of lockdown measures imposed to limit transmission. The impact of similar diseases has shown that economic costs are largely due to behavioural changes of individuals aimed at preventing further spread, as well as government policies with the same intent (Brahmbhatt and Datta, 2008). These preventive actions have considerable effects on economies through altered supply chains, trade, and private consumption.

The Joint Impact Model (JIM) was developed by development finance institutions (DFIs) and Steward Redqueen (SRQ) to assess the indirect impact of DFIs on the Sustainable Development Goals (SDGs) (JIM, 2021). After a year

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of testing, it is obvious that DFI impact is largely indirect rather than resulting directly from investments (for example, see Cogito Consulting, forthcoming). The relative importance of indirect effects and the significance of SDG impact of DFIs (Jouanjean et al., 2013) has led to increased interest in modelling.

The JIM is based on input-output (IO) modelling, which was in large part developed by economist Wassily Leontief (1936). Through IO modelling, different types of indirect impact can be estimated such as the number of jobs supported or level of greenhouse gases (GHG) emitted. Moreover, worldwide effects such as those of the COVID-19 crisis can also be estimated.

The aim of this paper is to demonstrate how the IO model assesses the impact on revenue (or output) per sector due to the COVID-19 pandemic, with illustrative examples of 'shocks' in tourism, services (especially transport), import, and labour. With this information, combined with empirical data, decisions can be made to help clients in sectors where sales decreased most strongly due to the COVID-19 crisis or where most jobs or value added can be preserved. Due to the COVID-19 crisis, the SDG impact data as calculated by models which were calibrated to pre-COVID-19 statistic data is no longer up to date as the economy has changed. Sophisticated economic models (such as computable general equilibrium (CGE) models) have been used to estimate this economic impact (see Maliszewska et al., 2020). However, these do not have a sufficiently granular breakdown per country and sector to accurately estimate the change in the impact attributable to DFIs. Therefore, an IO model, adapted from JIM, was used to estimate the impact of the COVID-19 pandemic to assess the changed revenues per sector. These changes in revenue can in turn be used to approximate other impacts, such as changes in employment or GHG emitted. The decision was made to follow the methodology by Maliszewska et al. (2020) as closely as possible, and to utilize them as the 'comparison model' for the IO approach utilized here.

The JIM IO model takes into account the following types of impact.

- First, there are the direct impacts. These occur at the DFI client level and include the GHG emitted by the firm, the number of employees, and the taxes paid and profits made. The wages are not included as a form of direct impact, but instead are used to calculate the 'induced' impact. Including these as a form of direct and induced impact simultaneously would lead to double-counting.
- Second, there are the supply chain impacts. If a client has expenditures to other firms (the suppliers) the turnover of these firms will indirectly be supported. These will in turn also have impact at their suppliers (the suppliers' suppliers, or the second 'cycle'), and so on indefinitely through the supply chain. This will lead to supply chain jobs supported, GHG emitted, and value-added taxes and profits. The wages at the suppliers, suppliers' suppliers, etc. are again used for the 'induced' impact only.
- Third, there are the so-called induced effects. The client's employees will spend money in the economy, thereby supporting turnover of other firms. Also, the employees of the suppliers of the client (and the suppliers' suppliers, etc.) will support turnover of firms, leading to induced jobs supported, GHG emitted, and value-added.

- Fourth is the finance-enabling impact. By assuming a constant capital-to-output ratio of 1:0.35, the impact of the investments of financial intermediaries (such as banks and funds) can be estimated. If a DFI invests in a bank, and this bank in turn invests US$1 m in other firms, the attributable revenues and corresponding impact of these firms is estimated to be $350,000. This figure is subsequently used to find the estimated direct impact (at the client), the supply chain, and induced impacts.
- Fifth is the power-enabling impact. Stable and affordable power is a key for firms to increase turnover. SRQ has researched the relationship between investments in power-generating infrastructure and turnover. Based on the research in 11 case studies, a fixed power-to-output ratio is used to estimate the extra output of firms due to the production of power (SRQ, 2020). This additional output is not a direct nor a supply chain impact, but one 'made possible' due to a more stable power supply. To avoid over-counting, since this impact can be regional or even nationwide, the impact is not traced through the economy using the JIM – instead, the estimated increase in output is multiplied with the employment and GHG intensities to find the impact. The value-added impact is found with the coefficients of the IO table.

In this paper, the changes to the economy are applied through four 'shocks' in targeted sectors: 1) a drop in international tourism, 2) a change in the expenditure pattern of households, away from services requiring proximity, 3) an increase in the cost of trade, and 4) a decline in employment. While these shocks are of a dynamic form for a CGE model, they have been translated to static changes in the IO model's social accounting matrix (SAM) to assess the effect of the COVID-19 pandemic. This research provides preliminary data on the relative size of the sectoral impact of COVID-19. As more data becomes available, more accurate estimates can be made and will be shared by the researchers upon request.

Background

A literature study was performed to learn which observed economic data or modelled economic data is already available. The most notable source of data is from the Global Trade Analysis Project (GTAP, 2021). GTAP is a global network of researchers and policy makers conducting quantitative analysis of international policy issues. The GTAP database provides geographic and sectoral granularity but is only updated every four years. It is a key source of information for models in developing countries. Models and forecasts of the following institutions were also investigated: International Monetary Fund (IMF), Organisation for Economic Co-operation and Development (OECD), World Bank (WB), the World Trade Organization (WTO), the United Nations Conference on Trade and Development (UNCTAD), and the Asian Development Bank (ADB). There are certainly more institutions and databases available; however, those that have been researched are generally seen as leading institutions and provide much of their data without cost. As can be observed, the data can help in refining the IO model, but there is no

single dataset with up-to-date information that has a sufficiently granular sectoral or regional breakdown.

- IMF: The most recent dataset (January 2021) contains GDP information for a selected number of countries (30, of which most are advanced economies). The more elaborate dataset (October 2020) contains GDP information for each country. No sectoral breakdown is available (IMF, 2021).
- OECD: Data contains many different datasets with some granularity with respect to country and sectoral breakdown. However, data is only available for OECD countries and very minimally for non-OECD countries (OECD, 2021).
- WB: The most recent dataset (January 2021) contains GDP information for 137 countries, including many developing countries and small island developing states. It contains real data for 2018–19, estimates 2020, and forecasts 2021–22. No sectoral breakdown is available (World Bank, 2021).
- WTO: Data on international trade for 285 countries and regions is available. Disaggregation between 10 and 20 product groups is also available up to 2019. Total trade data is available up to third quarter 2020 (WTO, 2021).

As empirical data was insufficient to build an adequate COVID-19 impact assessment model, some of the institutions which have aimed at assessing the impact of COVID-19 through modelling were also investigated. As one will observe, this data is also inadequate for assessing the impact at a granular level for the portfolio compositions of DFIs. However, the models and the input assumptions *can* be used to adjust a model based on JIM methodology (see 'COVID-19 impact modelling and findings', below). The findings that informed this study include:

- WB: This model includes the following for shocks: 1) a 3 per cent drop in employment due to factory closures and social distancing; 2) a 25 per cent rise in the costs of all imports and exports due to additional inspections and border closures, among other factors; 3) a drop in international tourism of approximately 25 per cent; and 4) a 15 per cent switch in household demand away from services requiring proximity. Results were simulated for eight developing countries in Southeast Asia and are shown for six sectors (Maliszewska et al., 2020).
- ADB: The following shocks were included in this model: 1) a drop of 8.9 per cent in tourism receipts; 2) productivity shifts calibrated to cut consumption and investment by 5 per cent and 6.25 per cent, respectively; 3) productivity shift calibrated to raise health sector output by $10,000 per COVID-19 case in developing countries; and 4) fiscal stimulus and liquidity injections as subsidy to labour and capital (50/50) + 10 per cent injected as subsidy to consumers and producers. Results are shown for aggregate regions (Global, Southeast Asia, South Asia, etc.). There is no sectoral breakdown (Narayanan and Villafuerte, 2020).
- UNCTAD: The following shocks were applied: 1) a drop of 30–100 per cent of tourism income applied to sectors 'Accommodation, food and services' and 'Recreation and other services' in GTAP; 2) if demand for labour drops,

low-skilled workers in all countries and sectors can become unemployed but can look for a new post in a different sector; and the same goes for 3) high-skilled employees, although their wage will change upon switching sectors (UNCTAD, 2020).

COVID-19 impact modelling and findings

The fundamental idea behind IO modelling is to use empirical economic data to find the average expenditure and income pattern of firms per sector and country or region. The statistical data thus represents the average activity of firms per sector per country that both produce goods (outputs) and consume goods (inputs). The outputs are either sold to other industries as a form of inter-industry product, such as building materials or unprocessed food products, or can be sold to, for instance, households which are a form of 'final demand'. Outputs sold as inter-industry products by firms in one sector are the inter-industry inputs to firms in another (or the same) sector. These can then be shown in a two-dimensional table where the rows represent sales (outputs) and the columns expenditures (inputs). Based on the application of IO and other modelling, the following summarizes the findings of the study with specific reference to the COVID-19 impact on targeted shocks and sectors.

In this model, both the direct and indirect effects of four different shocks due to COVID-19 have been captured. In general, the combination of shocks to international tourism and to services requiring proximity are the strongest and most specific shocks impacting several sectors in particular. These are approximately analogous to the assumptions of the comparison model and are applied using various assumptions: shocks imposed as a change in final demand and multiplied with the Leontief inverse on an unchanged IO matrix, and shocks imposed both on the IO table and on final demand using a round-by-round approach (Miller and Blair 2009) with assumption of 12 rounds per year and 4 rounds per year. The results of the IO COVID-19 impact estimation study are largely consistent with the results obtained by the comparison model.

Shock 1: tourism

The first shock is a reduction in international tourism. In the comparison model this is reached by imposing a 50 per cent increase in consumption tax on export tourism services. This increasing consumption tax on tourism-related services is rebated to households and leads to a reduction in the private consumption of services relating to tourism by between 32 per cent and 16 per cent. In this IO model this shock is imposed by reducing the private consumption of services relating to tourism by between 32 per cent and 16 per cent (see van Leeuwen and McDougall, 2016). The money was not rebated in this model since it is expected that developing countries will not save much money on lower international tourism. To impose the shock, first, the international tourism receipts were obtained from WB (World Bank, 2020). The maximum shock noted by the comparison model of 32 per cent

was applied directly to the amounts on the international tourism receipts obtained, and the decline was spread out two-thirds over the private consumption of selected service sectors, and one-third to selected transport sectors. The shocks to the transport sectors were only half the size, since it is expected that a greater share is domestic travelling (commuting, domestic tourism, etc.).

Shock 2: services

The second shock is a change in household expenditures, away from services requiring proximity towards other goods and services. In the comparison model this is reached by imposing a 15 per cent demand switch away from the services requiring proximity towards other goods and services. The examples they give are 'mass transport, domestic tourism, restaurants, and recreational activities'.

In the IO model, the total private consumption expenditures on targeted sectors were calculated and the receipts from international tourism were subtracted to find the *domestic* part of expenditures on these sectors. The drop of 15 per cent was applied directly to the domestic part of the private consumption amounts of sectors, and the 'savings' on these sectors were only redistributed for 50 per cent to other goods and services, in contrast with what is suggested by the comparison model. The rationale is that there is a maximum to the increase in output that firms can handle in a short period of time (due to production constraints) which is not captured by the static model.

Shock 3: import cost

The third shock is an increase in the cost of trade by 25 per cent. In the comparison model, this shock is imposed on all goods and services for both import and export. The shock is aimed at capturing the expected increase in costs of transportation and transactions. The researchers note that this can be due to additional inspections, reduced hours of operation, road closures, border closures, increases in transport costs, and so on. It was noted by Evans et al. (2014) that the Ebola outbreak could lead to trade costs rising by 10 per cent.

In the IO model this shock is imposed only on the cost of import. Raising these leads to a decline in all other expenditures for firms, households, and the government. In the current version of the IO model, only the impact on the import of goods was taken into account. First, the average trade costs per country per commodity were obtained from GTAP, such that subsequently the total trade costs per sector could be found. These trade costs on imports were increased by 25 per cent, while the total expenditures of firms were kept equal, leading to a decline in all other expenditures.

Shock 4: labour

The fourth shock is a reduction in labour. In the comparison model, the *availability* of labour was lowered by 3 per cent, leading to lower production and increased wages. With lower availability of labour due to factory closures and social distancing

measures the indirect effects they expect in the model are that wages will rise while return to capital will remain equal (due to their assumptions on elasticities). Also, this would lead to a drop in demand for capital, since labour and capital are needed in conjunction for the production of goods and services.

To translate this shock into static terms in this IO model, the shock is imposed on the expenditures of firms on wages by the percentage of working hours lost as found in ILOSTAT (2021), which should lead to lower private consumption (as these are endogenous in the model). The 3 per cent estimated by the comparison model was refined by taking the ILOSTAT data since the latter presents a more up-to-date and granular picture. Of the savings in labour costs, 25 per cent are used for extra procurement on goods and services in the same distribution as in GTAP before COVID-19 and another 25 per cent is included as savings which might lead to extra capital investments by other firms, while the last 50 per cent are not redistributed. The rationale is that due to containment measures, firms might try to buy more inputs or purchase capital to make up for the decline in labour.

Assumptions

The choice was made to endogenize firm expenditures and private consumption, which is a standard approach (Miller and Blair, 2009), and to also endogenize investments by firms as it is expected that due to the slowed-down economy, firms invest less in capital. The private consumption of food on the other hand was kept exogenous, as this is not expected to vary strongly with income. Government expenditures and exports were also kept exogenous. In general, national debt is expected to rise and export cannot be endogenized under the current model with the rest-of-world approach. That is, all trade was modelled bilaterally, for each country with the rest of the world. Endogenizing with the imbalance that exists under such an approach will not yield accurate results.

Macroeconomic impact

In the IO model, both the direct and indirect effects of four different shocks due to COVID-19 have been captured. In general, the combination of shocks to international tourism and to services requiring proximity are the strongest shocks impacting several sectors in particular.

The results of this COVID-19 impact estimation study on the output in Africa in the model are –2.6 per cent, and in Asia –2.9 per cent. It can be observed that the agricultural and natural resources sectors are impacted less heavily, at least partly due to the fact that the shock on trade cost was not included for export.

Figure 1 shows the impact for several sectors, disaggregated for the results obtained by the comparison study and in this IO model for the regions ‘Africa’ and ‘Asia’. As can be observed, the estimated impacts are broadly consistent.

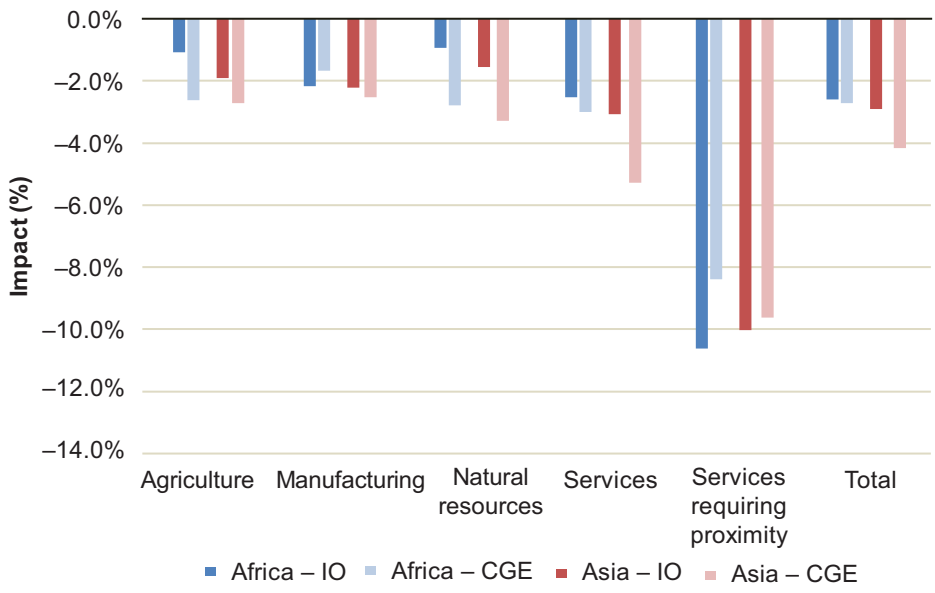

Figure 1 A side-by-side view of estimated impact per sector by the IO model and CGE model used by WB

Conclusion and recommendations

In this study, the effects of COVID-19 were modelled using an IO model. The changes were a translation of those shocks applied by Maliszewska et al. (2020) – the comparison model. It has been observed that by taking the average of different scenarios of the COVID-19 pandemic impact assessment, the average output is estimated to drop by 2.6 per cent in Africa and 2.9 per cent in Asia, with outputs decreasing most strongly in sectors relating to services requiring proximity. The JIM study presents a first attempt at estimating the changes in output for each of the 65 GTAP sectors and 141 countries and regions.

Due to the static nature of the IO model, which requires a lower number of input assumptions, more granular results were obtained in terms of country and sector breakdown. The model could be enhanced by including additional external data on the number of COVID-19 cases, vaccination numbers, mobility reports, and data from industries such as aviation (IATA) or restaurants (OpenTable, 2021). Also, the model would become more accurate by making the SAM inter-region available and including elasticities for the trade shocks. Despite the advantages gained by using a static model, there are limitations which make the results less accurate than more dynamic modelling. Therefore, it is suggested that the results are used in conjunction with information derived from other models or additional empirically collected data such as surveys. Through triangulation, the data obtained in this study can be used to substantiate support, management, policy, investment, and other decisions.

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