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Understanding Structural Effects of COVID-19 on the Global Economy: First Steps

Christine Arriola, Przemyslaw Kowalski and Frank van Tongeren

The COVID-19 pandemic and associated policy responses are likely to alter the global economy in a way that affects its ability to adjust to future shocks and changes. This paper develops a point of reference for thinking about developments which could be deemed long-term and which could in turn be incorporated into what we call a "post-COVID-19 baseline". Using the OECD's CGE model METRO, the paper finds that output declines observed in 2020 were driven primarily by reductions in labour productivity due to varying abilities to telework across countries. Negative economic impacts were largely mitigated by government support to firms and households. Border measures to control the spread of the virus also had less of an impact on total output, reflecting important government efforts to facilitate cross border flows of goods and services whilst managing cross border movements of people. Demand shifts had the smallest impact on global GDP, but had significant and heterogeneous impacts on consumption, output and trade changes across countries and sectors. This in turn contributed to pressures on some global supply chains.

Key words: Trade, shocks, general equilibrium model

JEL codes: F14, F17, C68

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Executive Summary

In a period of frequent and significant changes, it becomes increasingly difficult to make predictions on what the future brings. Yet, calls for policy initiatives targeting efficiency and security of supply, including those which are relevant for specific supply chains which can be deemed 'essential' or 'strategic' in the current context, such as pharmaceuticals and manufactured electronic products, call for medium to long-term assessments. This is also the case for policy considerations to ease restrictions on cross-border movement of people, which can facilitate post-pandemic structural adjustments. In order to conduct such assessments, it is necessary to adjust the modelling base line of standard quantitative frameworks like the OECD METRO Model.

This paper proposes to work towards a new baseline by using the outcome of an impact analysis of the COVID-19 pandemic and the associated policy responses on the global economy and international trade using the OECD METRO Model. For this purpose, the main COVID-19-related effects observed in 2020 in the following areas are assessed: (1) the impacts of containment measures on: (i) labour market changes; and (ii) consumer demand shifts; and (2) the impact of government policies affecting: (iii) trade costs for goods and services trade; and (iv) fiscal policy measures directed at supporting firms and households. The effects observed in 2020 and analysis of the broader policy context provide a point of reference for thinking about developments which could be deemed long-term and which would in turn be incorporated into what can be called a post-COVID-19 modelling baseline.

The baseline and the METRO model can also be used to build on work in Arriola et al. (2020[1]) and analyse further how different shocks can on the one hand reinforce and on the other abate each other in globally interlinked economic systems, and thus contribute to the identification of stress points in supply chains.

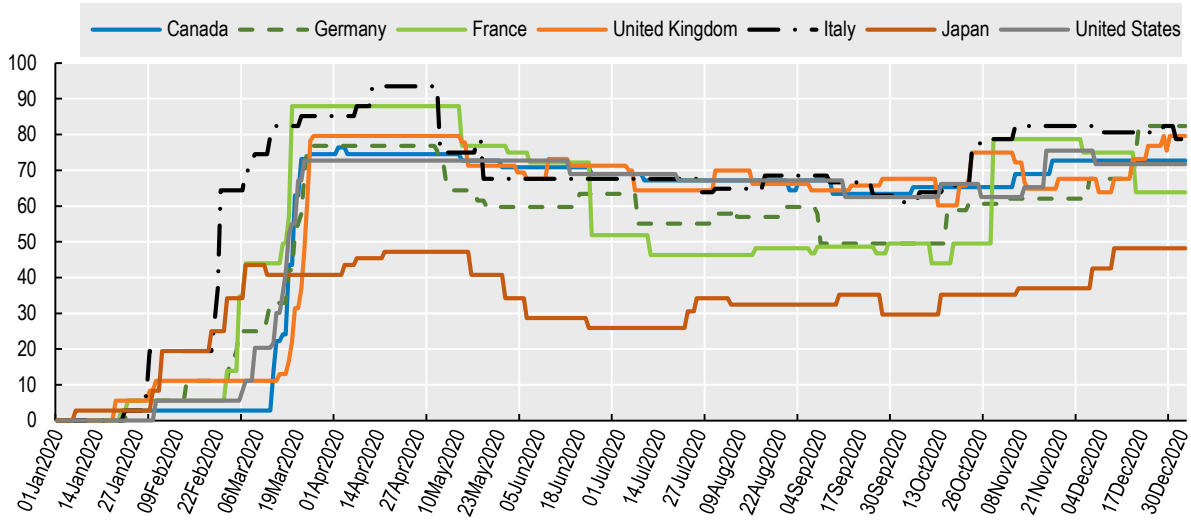
1. Introduction and objectives of the study

The COVID-19 pandemic and associated policy responses aimed at containing the virus are having far-reaching economic consequences. The pandemic has had an impact on human health and behaviour, and governments deployed considerable and diverse virus containment and economic support measures. In several countries citizens were required to work from home, social interactions were limited, schools, shops and restaurants had to be closed, and governments placed various restrictions on public transport and travel both within and across international borders. This has virtually shuttered economic activity in certain sectors of the economy, while other sectors were relatively unaffected (and some increased). At the same time, many governments have deployed unprecedented financial and other means to support incomes, employment and prevent pandemic-related bankruptcies. In most cases, these measures were decided by national governments in reaction to rapidly and unequally evolving health statistics, and there was relatively little co-ordination across countries. Together with significant unexpected changes in consumer demand, the diverse policy responses resulted in unprecedented heterogeneity in international trade across traded products and partners, and revealed hitherto undetected bottlenecks and vulnerabilities in terms of the ability to source materials, parts and components and other products, marking high uncertainty and adjustment costs (Arriola, Kowalski and van Tongeren, 2021[2]) Currently, it is unknown which of these effects will be short-lived and which might last longer.[1] The latest data on different containment measures and their stringency suggest that, at the end of 2021, several measures introduced in the second quarter of 2020 remain in place in several countries (Figure 1).

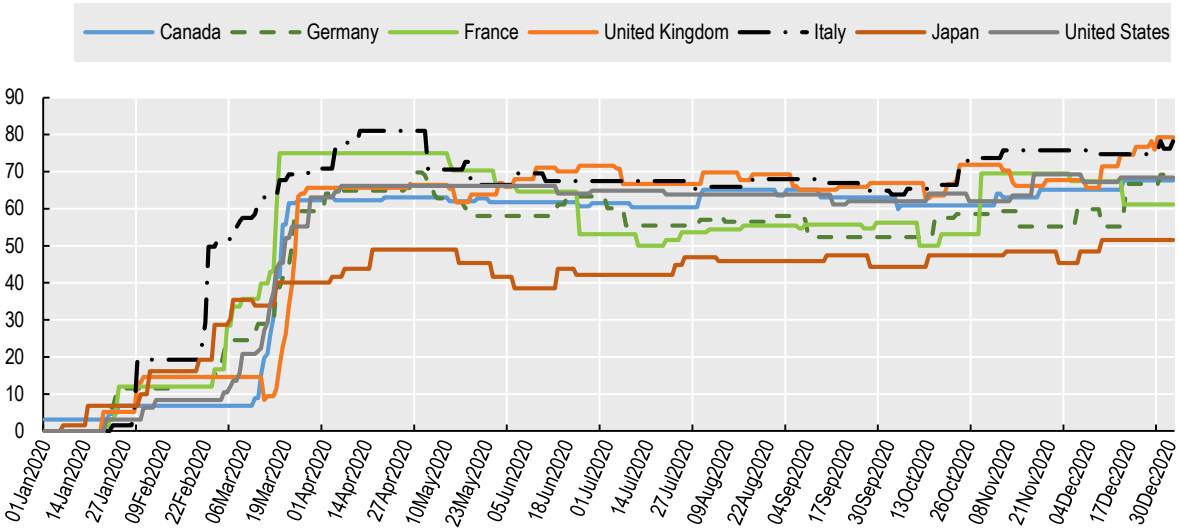
[1] Short-lived effects might not necessarily call for a policy response, or may call for a different type of responses or accompanying policies than long-term effects.

Figure 1. Stringency of COVID-19 related measures in selected OECD countries

Panel A. Stringency of containment measures



Panel B. Index of government response



Note: Panel A shows a composite measure capturing stringency of virus contained measures such as requirements to stay at home or bans on public gatherings while Panel B shows an index of government policies aimed at alleviating the negative economic effects of the pandemic. Both measures are rescaled to a value from 0 to 100 (100 = strictest / strongest).

Source: Oxford Coronavirus Government Response Tracker.[2]

[2] The Oxford Tracker is available at https://www.bsg.ox.ac.uk/research/research-projects/coronavirus-government-response-tracker.

The pandemic and the associated policy responses are estimated to have had major macroeconomic impacts, with world GDP and international trade estimated to have contracted in 2020 by, respectively, 3.5% and 8.5% (OECD, 2021[3]). The impacts were heterogeneous across countries and regions, with the Euro area, for example, recording a more pronounced GDP decline than the United States or Japan, and the People's Republic of China (hereafter "China") recording a positive growth rate.[3] Effects were also heterogeneous in terms of their structure[4] due to, among others: different degrees to which consumption and production of different products relies on personal contacts; changing consumer preferences; and differences across sectors in productivity effects associated with new working arrangements (e.g. teleworking), as well as disruptions in supply chains. These suggest significant impacts on product and factor markets, the distribution of incomes, savings, prices, consumption, production, employment, as well as directions and product composition of trade flows across the world economy, which have been recently documented in Arriola, Kowalski and van Tongeren (2021[2]).

Data on the structure of economies, such as the data on output, consumption or trade by product or sector, or distribution of income are often provided at different levels of sectoral aggregation and are published with considerable time lags which vary by country. This impedes a timely analysis of structural changes at major turning points such as the COVID-19 pandemic. It is for this reason that economic models, computable general equilibrium (CGE) models in particular (Section 2), are often used in order to fill in the missing information and to provide insights into the effects of shocks and possible policy responses.

This paper draws on different comparative sources of data describing the economic impact of the COVID-19 pandemic and government measures. The analysis incorporates changes in sectoral and aggregate output, changes in consumption demand as well as government support to households and the corporate sector; estimates of changes to labour productivity; and the effects of virus containment measures on the cost of trading goods and services. One consistent modelling framework, the OECD CGE METRO Model, is then used to assess the impact of the COVID-19 pandemic and the associated policy responses on the global economy and international trade. METRO is a unique analytical tool which can shed empirical light on structural changes to world production and trade due to the COVID-19 pandemic which cannot yet be seen in statistical data or which are not consistently reported in macroeconomic projections. It can be used to empirically disentangle and decompose the various channels through which COVID-19 measures are impacting the economy. It can also be used to assess broader trade policy options which can support economic recovery going forward (e.g. reforms of non-tariff measures, NTMs), or the possible effects of specific trade and trade-related policies considered in some countries in the context of the COVID-19 pandemic (such as, for example, those regarding supply chains; see, for example, Arriola et al. (2020[1]).

There are some limitations on using a CGE model to model the short-term effects of the pandemic. The impact on sectors have been both uneven and at unprecedented levels, as certain sectors where shut down as way to contain the virus. CGE modelling is about making small incremental changes and allowing the model to find the next equilibrium state based on behavioural parameters estimated in a period of normal functioning of markets. The economic effects experienced during the COVID-19 pandemic have been neither small nor incremental, and at times there was no market where supply could meet demand. Even one and a half years after the pandemic broke out, there are doubts that the world economy is functioning normally. Because of the size and complexity of the shocks that simultaneously hit the various parts of world economy, it is necessary to readjust the model's global database before it can be used for further forward-looking analysis. This readjustment means finding data describing economic changes during the early part of the pandemic and to modify the model's mechanisms to obtain a simulated picture of 2020 that matches the empirical realities of that year. This readjusted model and database (that takes into account the turning point the global economy has just gone through) can represent the starting point for future assessments regarding the expected shape of recovery. Because the general equilibrium-modelling framework ensures that all the accounts balance, what is spent is earned and what is earned is

[3] China's GDP is projected to have increased by 2.3% in 2020, while that of the Euro area, United States and Japan have declined by 6.7, 3.5 and 4.7% (OECD, 2021[3]).

[4] For example, there are considerable differences in changes to main macroeconomic aggregates such as consumption, investment or governments' fiscal stances. In some OECD countries, arts, recreational and personal as well as accommodation and food services registered declines of more than 20% between February and September 2020 while manufacturing and construction registered declines of 5 to 8%, and some sectors, such as wholesale and retail trade, recorded positive growth rates (OECD, 2020[28]).

spent or saved, it imposes a strong structure that helps to trace the direct and indirect effects of the various COVID-19 related factors. Such indirect effects may not be seen readily in statistics.

This paper is the first instalment of OECD work on the impact of the COVID-19 pandemic on the global economy and international trade, and the role of trade policy in economic recovery. It is divided into five sections: Section 1 describes the paper's objective; Section 2 situates this paper in the literature; Section 3 presents the model, documents data used, and adjustments made; Section 4 discusses the assumptions and implementation of the COVID-19 related factors; Section 5 presents selected results; and Section 6 concludes.

2. Relation to existing work

CGE modelling featured prominently among the recent studies used to assess the economic impacts of COVID-19. This is because the CGE approach allows consistent accounting for complex economic interactions and general equilibrium effects, which is particularly useful for understanding developments in recent periods when much of the statistical data is not yet available as well as for projections of different scenarios. Arriola et al. (2020[1]) used the OECD METRO model to first construct a COVID-19 base simulation and second to develop a set of scenarios on top of that base to explore risks and vulnerabilities in global value chains. The COVID-19 baseline featured changes in labour supply- and productivity as well as demand shocks and trade cost changes estimated to have occurred in the first half of 2020 only and did not include government support measures.

Within a just a few short months from the start of the pandemic, several studies were produced to estimate the impact of the health crisis on the global economy. One of the first CGE analysis[5] of the economic effects of COVID-19, published in early March 2020, was McKibbin and Fernando (2020[4]). The study explored macroeconomic and financial market effects of different scenarios of geographical spread of the virus and illustrated what economic costs could be avoided by greater investment in public health infrastructure. In April 2020, a Bank of International Settlements note on macroeconomic effects of COVID-19 provided a review of CGE (and other) studies on the economic costs of earlier pandemics, drawing possible lessons for the COVID-19 pandemic (Boissay and Rungcharoenkitkul, 2020[5]). The early April WTO's trade forecast was produced, amongst others, using the WTO's CGE model for predicting GDP and trade effects on the basis of assumptions regarding the effects of the COVID-19 pandemic on costs, labour supply, falling demand in sectors affected by social distancing, and supply chain frictions, among others (WTO, 2020[6]). The April 2020 World Bank analysis also examined the potential impact of COVID-19 on GDP and trade using a CGE model (Maliszewksa, Mattoo and van der Mensbrugghe, 2020[7]). The study focused on short-term impacts on GDP and trade of an illustrative scenario incorporating assumptions on the underutilisation on labour and capital, increase trade costs, reduced demand for international travel services, and shift in demand from sectors with close human interaction (like hospitality, restaurants, domestic transportation) towards goods and other services sectors. A European Commission's analysis of the impact of the COVID-19 pandemic on trade, published first in April 2020 and updated in May 2020, used a combination of two CGE models, which were used to derive predictions about the effects on global and EU trade on the basis of the IMFs' April 2020 GDP forecasts (European Commission, 2020[8]). In May 2020, the Asian Development Bank used the GTAP CGE model to update their initial assessment of the potential effects of the COVID-19 pandemic, with a particular focus on the Asia and Pacific Region by incorporating three main channels: trade costs, negative supply-side productivity, and fiscal stimuli (Asian Development Bank, 2020[9]).

Several recent country and sector-specific CGE-based studies of COVID-19 effects are also available. A New Zealand Institute of Economic Research study used a CGE model to investigate the potential local and regional impacts of COVID-19 in New Zealand with a focus on tourism (Leroy de Morel, 2020[10]). An academic study published in July 2020, used a CGE model to examines the macroeconomic and greenhouse gas emission impact of the COVID-19 crisis focusing on Belgium (Lahcen, 2020[11]). Another academic study, published in October 2020, used a CGE model linked to a population-wide

[5] The study combined a dynamic stochastic general equilibrium (DSGE) and a CGE model.

epidemiological demographic model to estimate the potential impact of COVID-19 on the United Kingdom economy, distinguishing between direct disease effects, preventive public actions and associated policies (Keogh-Brown, 2020[12]). UNDP (2020[13]) conducted a CGE analysis of potential economic and social impacts of COVID-19 in Cambodia. Researchers at the United States Department of Agriculture and the Colorado State University linked a CGE model to simulate the economic effects of COVID-19 with a model that analyses the gap between food consumption and nutrition targets to add a food security dimension to the set of available COVID-19 analyses (Beckman, Baquedano and Countryman, 2021[14]). In addition, a study by UNCTAD used CGE analysis to assessed the economic consequences of COVID-19 for the global tourism sector (UNCTAD, 2020[15]). The Economic Research Institute for ASEAN and East Asia used a CGE model for the Indonesian Economy to analyses the impact of the pandemic along with the measures the government has taken to support the travel and tourism sector in the country (Rum, 2021[16]).

While a fully-fledged review of all relevant studies is beyond the scope of this paper, this section shows that within only a few months of the start of the pandemic, several CGE-based studies of the possible economic and other effects of COVID-19 were prepared (see Annex Table A A.1 for a summary of the related studies referenced in this section). While this literature provides some insights into the possible short- and long-term effects of the pandemic on economic activity and international trade, each study has a specific focus and few focused specifically on the global implications for sectoral trade, regional trade effects, or long-term implications for trade policy. Moreover, as argued by for example in Perdana (2020[17]), given the rapid epidemiological, policy and economic developments, some of the studies prepared only a few months ago are now outdated in terms of their assumptions. The analysis in this paper benefits from concrete, real-world data as the basis for its assumptions and model inputs.

3. Methodology and data

3.1. The main features of the METRO model

The METRO model (OECD, 2020[18]) is a computable general equilibrium (CGE) model, and it has been calibrated for this analysis to 29 regions, 26 sectors, and 8 production factors. Like many CGE models, METRO relies on a comprehensive specification of all economic activity within and sometimes between countries (and therefore the different inter-linkages that tie these together). The model builds on the GLOBE model developed by (McDonald and Thierfelder, 2013[19]). The novelty and strength of METRO lies in the detailed trade structure and the differentiation of commodities by end use. Specifically, commodities and thus trade flows are distinguished by whether they are destined for intermediate use, for use by households, for government consumption, or as investment commodities.

The database of the model relies on the GTAP v10 database reference year 2014 (Aguiar et al., 2019[20]) in combination with the OECD Inter-Country Input-Output Tables, which are the main source of the OECD Trade in Value Added Indicators and allows the model to distinguish trade for use in intermediate production or final demand. Available policy information includes tariff and tax information from GTAP as well as OECD estimates of non-tariff measures on goods (Cadot, Gourdon and van Tongeren, 2018[21]), services ((Benz and Gonzales, 2019[22]); (Benz and Jaax, 2020[23])), trade facilitation (OECD, 2018[24]) and export restricting measures. The METRO database contains 65 countries and regional aggregates and 65 commodities.

The model is firmly rooted in microeconomic theory, with firms maximising profits and creating output from primary inputs (i.e. land, natural resources, labour and capital), which are combined using constant elasticity of substitution (CES) technology, and intermediate inputs in fixed shares (Leontief technology). Households are assumed to maximise utility subject to a Stone-Geary utility function, which allows for the inclusion of a subsistence level of consumption. All commodity and activity taxes are expressed as *ad valorem* tax rates, and taxes are the only income source to the government.

This analysis was implemented with a version of METRO configured for short-term analysis, featuring, among others, immobile land and capital. The trade balance is assumed to be flexible and wages are assumed downwardly rigid. The government is assumed to maintain its expenditure in real terms, while taxes remain unchanged and the government balance is allowed to adjust. Investment demand is assumed to be fixed as a share of domestic absorption while private domestic savings are free to adjust.

3.2. Pre-COVID-19 adjustments to the model base data

The METRO database relies heavily on the GTAP database, which in some cases deviates from official statistics due to the necessary adjustments to construct a consistent and balanced database for global modelling purposes. One area where the GATP v10 database diverges is the implied savings rate of private households, which is a key parameter in METRO. This contrasts with the GTAP model (and its database), which combines private households and government into one institution, with one savings rate.

As the household savings rate adjusts to maintain the balance between investment and savings, the size and sign of a region's savings rate influences how the model behaves. Accordingly, the model database is modified such that the implied 2014 savings rates reflects the information found in secondary sources (OECD or United Nations Data).[6] The model database is adjusted by running a model simulation using the target rates as shock parameters along with a closure set up designed to minimize changes to a region's GDP.[7]

4. Modelling of the effects of the COVID-19 pandemic in METRO

To assess the economic impact of the COVID-19 pandemic and the associated policy responses on the global economy and international trade, four types of economic shocks related to the COVID-19 containment measures as well as other economic policy responses were incorporated into the model. These include: 1) changes in labour productivity; 2) changes in demand; 3) border measures that affected the cost of trading goods and services; and 4) governments financial support to households, workers, and firms negatively impacted by the COVID-19 containment measures.[8] The next section provides more detail of each assumption and describes their implementation into the model.

4.1. General assumptions

Modelling the impact of COVID-19 pandemic relies on several underlying assumptions about the nature and duration of the government containment and support measures and their impact productivity, the associated demand changes in the sectors directly impacted by the policies, and the extent of that impact. These assumptions, which are elaborated briefly below, are computed on the basis of the latest available data, the existing CGE analyses of COVID's economic impact and the growing economic literature on the pandemic.

[6] The social account matrix (SAM) of regions that are net savers according to the alternative sources but have a negative savings rate in the GTAP database is calibrated by targeting both the savings rates and the net surplus or deficit of the government account. The latter is included as a target on the share of the government balance to prevent the adjustment to be fully carried by the change in government savings. The adjustment also includes updating the income tax rate in these regions.

[7] Specifically, government income and expenditure are assumed to be fixed and the internal balance remains flexible. The regional savings rates, which is the combination of government and household savings, and income are fixed. Lastly, exchange rates are assumed to be fixed and a region's trade balance is allowed to vary.

[8] The focus of this paper is the impact of COVID-19 on the global economy and international trade. Other trade policy changes that occurred in 2020 were not included in the present analysis.

4.2. Labour markets

The COVID-19 illness itself can have a direct effect on a person's ability to participate in the labour market if that person falls ill and is required to stay at home or, in the worst case, dies from the illness. A healthy person may be required to stay at home to be a caregiver, either to a sick relative or to a child whose school has been closed as a preventative measure or because of a lockdown. As part of the containment measures, many governments have also required or recommended teleworking from home whenever possible. For a variety of reasons – such as "lack of coordination, shirking, and a lack of interaction between people decreasing creativity" – a negative effect on productivity of certain professionals who can work, but must work from home, has been posited in the literature (WTO, 2020[6]).[9]

Labour markets were therefore affected by the pandemic directly and indirectly, and in complex ways. Early policy responses focused primarily on limiting social interactions, including between workers and between workers and customers. Some workers could not tend to their duties, some could only do so via means of teleworking, and some could provide their services as before but demand for these was reduced due to customer absence or order cuts. Many governments implemented pandemic-related support policies aimed at sustaining financial stability of businesses and employment (e.g. through worker furlough schemes). In labour markets, the restrictions thus resulted in a mixture of reduced labour supply, reduced productivity, and reduced demand for labour.

In the short-term closure assumptions for this modelling exercise, factors are allowed to be unemployed and wages are fixed. Labour supply is infinitely elastic and employment depends entirely on final demand for products and labour productivity. Accordingly, the assumption applied in the model to reflect the impact of the pandemic on labour is to reduce labour productivity, thereby reducing the demand for labour which becomes relatively more expensive as wages are fixed, and allow the model to determine the level of employment due to the health crisis.[10]

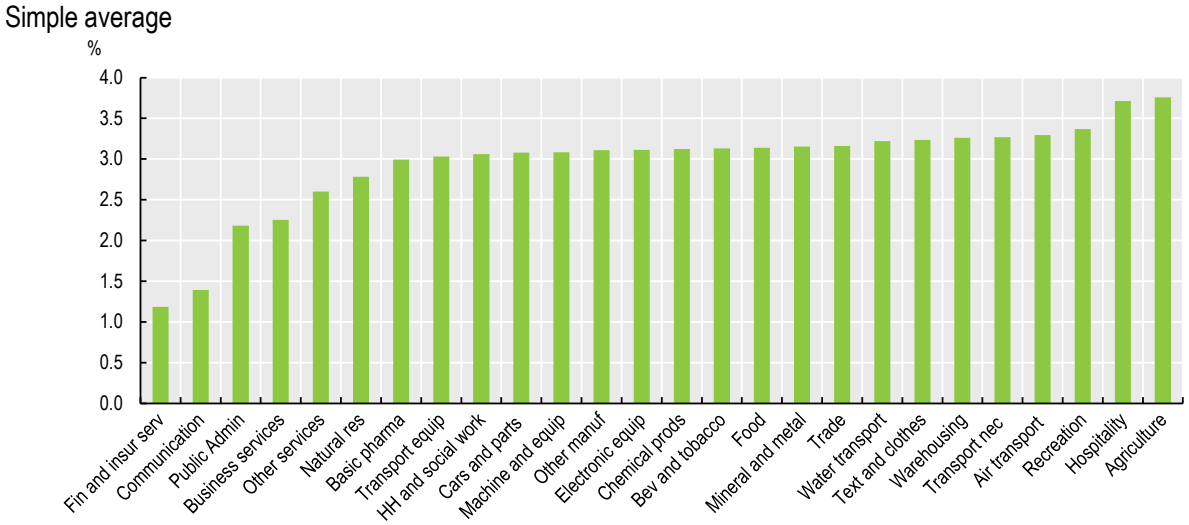
To calibrate the labour market shock, a base 4% of labour productivity loss is assumed based on estimates for the United Kingdom by Bloom et al. (2020[25]) which was the only study that attempted a quantification of labour impacts early in the pandemic. The actual impacts were likely highly sector and country-specific, because they depended on large differences in policy responses (i.e. on restrictions in place and on whether, when and where furlough schemes or other labour-related measures were in place). The assumption of a 4% productivity loss in 2020 is indicative, and it has been derived as a simple average of the estimated quarterly per hour and per job percentage changes in 2020. It is important to bear in mind, however, that the study found that labour productivity per job in 2020 declined by 11% on average in the four quarters of 2020, while labour productivity per hour worked increased by 3% in the same period, reflecting the complexity of the impact of the pandemic on labour.

The productivity loss assumption is further reduced by the share of work in a sector in each region that can be done at home. For example, since 81% of jobs in the Canadian insurance and finance sector can be done remotely, the labour productivity assumption is thereby reduced by 81% and, as such, only a 0.8% reduction in labour productivity is applied in the model. The share of jobs that can be done remotely is based on the measure of feasibility of teleworking calculated by Espinoza and Reznikova (2020[26]), which is based on the OECD Survey of Adult Skills, and incorporates detailed information on 12 characteristics of workers' skills and tasks, including the intensity of the use of information and communications technology (ICT). Not surprisingly, services sectors like finance and insurance and information and communication have a high degree of teleworkability, while very little work can be done from home in sectors that require physical interaction, for example the hospitality or recreation sectors (Figure 2). Our assumptions imply that in the finance and insurance sector, the assumed loss of labour productivity is on average 1.2%, while labour productivity in the hospitality sector is assumed to decline by 3.7%.

[9] On the other hand, there is evidence that the net labour productivity impact of teleworking could actually be positive, especially for some jobs in the long term de Vries, Erumban and van Ark (2021[37]), Barrero, Bloom and Davis (2020[33]).

[10] Note that some governments have used job retention schemes to prevent a surge of unemployment resulting from the COVID-19 crisis (Scarpetta et al., 2020[38]).

Figure 2. Labour productivity decline



Source: Authors' calculations based on Espinoza and Reznikova (2020[26]) and OECD METRO model.

4.3. Trade costs for goods and services

The costs of transporting some goods and services increased during the COVID-19 pandemic. While some efforts were made to minimize border delays even with additional health and safety checks to reduce the spread of the virus across international borders, reinforced border controls, new protocols at the border, and additional documentation requirements for transporting goods and services across borders due to containment measure resulted in delays. While many measures were taken with the aim of controlling the spread of the virus and protecting the people handling and inspecting the goods, they have nevertheless translated into additional costs for traders.

The OECD Trade Facilitation Indicators and information on COVID-19-related policies were used to estimate *ad valorem* equivalents of the delays from the additional measures when trading goods across borders, following the approach in (OECD, 2017[27]). It aims to also take into account the length of periods in which these measures remained in place in 2020. The calculated rise in trade cost was implemented in METRO as an increase in the iceberg cost of goods imported into the region. The increase in cost was then adjusted by number of weeks border restrictions were in place. On average, the applied increase in trade costs related to additional border measures on goods in 2020 amounted to 2.2%.

Regulatory restrictions on the movement of people across international borders were also implemented as part of strategies to contain the spread of COVID-19. The simulations use the Services Trade Restrictiveness Indicator (STRI) and the OECD COVID-19 policy tracker to quantify the cost of the increase of restrictions on business travel, intra-corporate transfers, and mutual recognition of qualifications and licenses, along with other airport restrictions not related to the movement of people. The increase of restrictions on business travel and mobility is translated into *ad valorem* equivalents following Benz and Jaax (2020[23]) and adjusted to reflect the lengths of periods in which these measures remained in place in each country. Moreover, the increase in costs also takes into account the share of work in a sector that can be done remotely. Leveraging estimates from Espinoza and Reznikova (2020[26]), the increase in services trade cost is reduced by the share of work in the sector that can be done remotely as was done for the labour productivity assumption described in Section 4.2.

Table 1. Average increase in cost related to cross border restrictions on services trade

Percentage, simple average

	MFN	Intra-EEA
Communication	3.0	3.3
Business services	11.5	12.7
Financial services and insurance	7.4	5.6
Air transport	8.4	9.4
Water transport	6.6	8.3
Transport nec	4.7	6.1

Note: intra-EEA refers to trade within the European Economic Area.
Source: Author's calculation based on OECD STRI, Oxford Coronavirus Government Response Tracker, and Espinoza and Reznikova (2020[26]).

4.4. Government support

The model includes government support to households, workers, and firms negatively impacted by COVID-19 containment measures. This support comes in the form of reductions in household income tax and tax on labour and capital. Calibration of assumptions related to government support are based on OECD estimates wherever possible and IMF estimates for regions not covered by the OECD. The amount of total government support is the change in the underlying primary balance (in the case of OECD data) or general government structural balance (in the case of IMF data) expressed as percentage points change (in percentage of potential GDP where both the OECD and the IMF have their own estimates).[11] They thus aim to filter out cyclical changes in government balances and only leave what is 'discretionary', and taking changes means we are only taking what is supposed to be special to 2020.

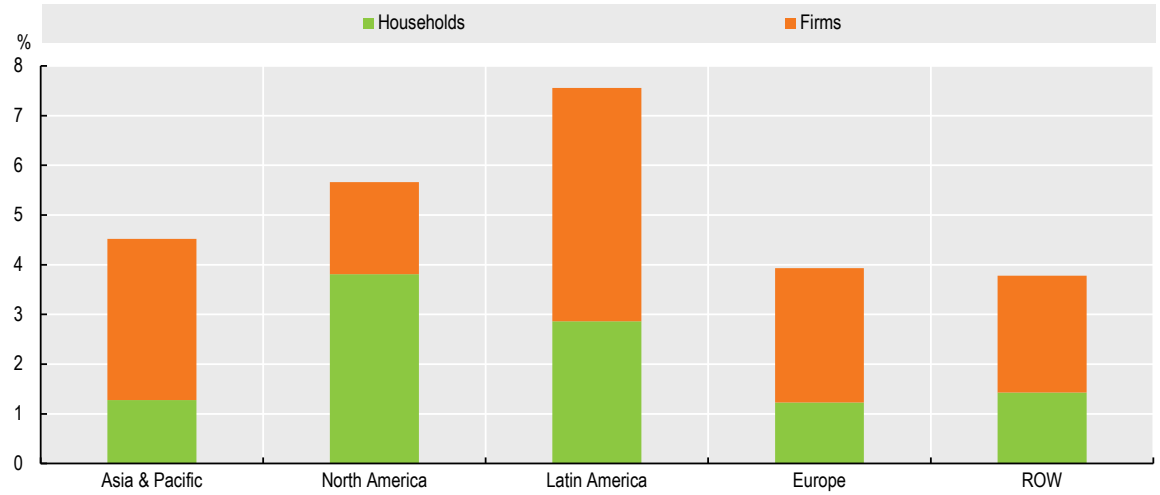
Estimates were also made on portions of support directed to households versus firms based on the December *Economic Outlook* (OECD, 2020[28]), which contained some information on contributions of social transfers to household disposable income growth in 2020.[12]

Overall, the simulation assumes that governments supports amounts to 4.7% of world GDP, though the amount of support varies across regions (Figure 3). More than half (57%) of the support is provided to firms as a decrease in factor use tax on labour and capital, and the remaining to households in the form of lower income tax. Without available data on the amount of government support by sector, all sectors receive the same decrease in factor use tax in a region. In reality, sectors most affected by the pandemic have been receiving more support. Since the positive effect on production of the government transfer is taken into account when calibrating the demand shocks, this assumption could lead to an underestimation of the output change attributed to the demand shift in sectors most negatively impacted by the pandemic, and an overestimation of the change in output in less affected sectors.

[11] The OECD estimates are slightly different on the level of methodology (OECD excludes interest payments on existing debt and the two institutions have their own estimates of potential output). However, they seem close enough for countries for which they can be compared and since these are estimates and uncertainty around these is considerable take up of programmes. These are probably as good as we can get at this stage.

[12] At present, information on sector-specificity of these measures is scarce although some monitoring exercises provide such information. See, for example, the World Bank's "Tracker of Subsidies and State Aid to mitigate COVID-19 Effects" available at www.worldbank.org/en/topic/competitiveness/coronavirus.

Figure 3. Government support to households and firms as a share of GDP, 2020



Source: Authors' calculation based on OECD December 2020 Economic Outlook, IMF WEO Database, METRO database.

4.5. Demand

Social distancing measures have also consisted of closures of restaurants, gyms, "non-essential" businesses and cancellation of travel, recreational and cultural activities. The resulting change in consumption behaviour as well as the containment measures put in place by governments translated into a decline in demand in many sectors. At the same time, spending more time at – and thus investing more in – homes, resulted in a surge in demand for 'home nesting' products, such as household appliances or home office equipment. There was a broad tendency to switch away from services towards goods and, within goods, and from durables (e.g. cars or machinery) towards consumption goods (e.g. food, electronics). The direction and extent of these changes were, however, highly sector specific and they depended on the nature of measures and the length of periods during which they were in place in different countries. For example, travel restrictions affected more directly the demand for air transport, while gathering restrictions directly affected the hospitality, recreation and wholesale trade sectors.

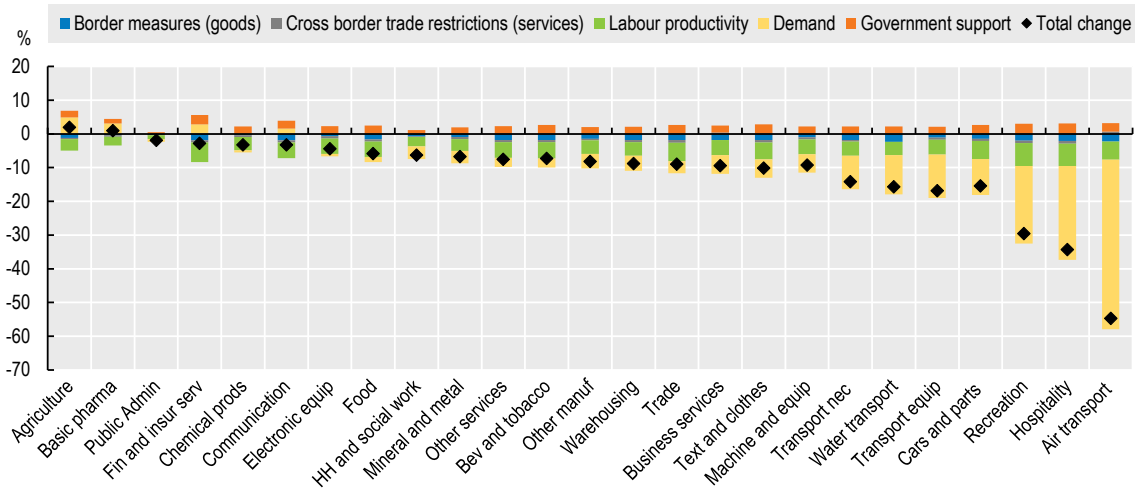
Ideally, the model and data should be calibrated to match the changes in product-specific demand in 2020. Demand information, however, is not available at a detailed sectoral level for many countries. Instead, information from the OECD National Accounts Database, Eurostat data on production, and national accounts of individual countries are used to compute the changes in output by product category for all the countries in the database (see Annex Table A C.1 for the list of country sources). This information on sectoral output changes in each region is used to calibrate the demand shock for the model. Specifically, the gap between the sectoral output change computed from National Accounts data and the output change resulting from the implementation of all the other shocks into the model is the implied change in sectoral output due to the demand shifts related to COVID-19 containment measures. The model framework is then used to determine the demand shock needed to produce this sectoral output change.

Figure 4 illustrates this imputation procedure. It depicts the global change in output for each sector based on model simulations, before applying the demand shock, and the total change in 2020 output computed from the National Accounts data (represented by the black diamonds). The bars represent the changes in output resulting from the various COVID-19 related factors. The yellow bar is the implicit change in output that is attributed to the demand shock.

Sectors shutdown by government containment measures to limit social interactions, such as the hospitality and recreation sectors, or the spread of the virus across borders, e.g. air transport, experienced the sharpest decline most of which is attributed to the changes in demand for the sector. Retail trade, finance and insurance, and services that can be transacted online as well as essential services, on the other hand, saw less of a decline and most of this decline is attributed to other factors. Output of basic pharmaceuticals

and the agriculture products saw a small but positive increase in 2020, where a surge in demand is estimated to have played a pivotal role.

Figure 4. Computing changes in production due to shifts in demand



Note: Not all countries report their National Accounts information at the same level of detail. For sectors that were reported only at the broad ISIC level, the output changes at the broad level were split in so that the relative changes within the larger category reflect the relative changes of countries reporting sectoral output at the detailed analysis level.
Source: Authors' calculation based OECD METRO Model, OECD and National Data on National Accounts (see Annex Table A C.1 for more details).

4.5.1. Calibrating the demand shock in METRO

Two types of demand shocks are calibrated[13] – household and intermediate demand to reflect the fact that some products are mainly demanded by households for final consumption while some are demanded by firms for production. For each type of demand shock only the portion of the output change in the sector that is supplied to each use, intermediate or household, was targeted to calibrate the shock. For example, if a third of the output produced in the sector is used for household consumption, then a third of the output change was assumed to come from changes in household demand. If a quarter of the output is supplied for intermediate use, then a quarter of the targeted output change was assumed to come from changes in

[13] While there are four sources of demand (uses) for a commodity in the model – household, intermediate, government, and capital – only two types are calibrated in this paper. Changing a sector's output level impacts all the amount supplied and consumed by these four different use type categories. Moreover, calibrating the demand shocks requires changing the level of consumption of a particular commodity without necessarily keeping its share of consumption in the region fixed. For example, during the COVID-19 pandemic, governments had to increase the level consumption of certain commodities, basic pharmaceuticals, and human health and social work activities, more than their level of consumption of food or financial and insurance services. However, in the model, government consumes commodities in fixed proportions. Therefore, this method of targeting production to determine the demand shock cannot be implemented if a large share of the production is used by the government. Similarly, investment goods are also consumed in fixed proportions in the model. This model limitation is addressed by targeting the production level supplied only to households and firms (i.e. the production target is decreased by the share of the output supplied for households and intermediate use). For some sectors, government and investment consumption is large enough that a demand shock could not be calibrated in any region. This is the case for human health and social work activities and public administration, which are predominantly used by the government in almost all countries (on average 75% or more is supplied to government). The sector-specific demand shock for basic pharmaceuticals could also not be calibrated because most of this sector is used as an input into human health and social work activities. Transport equipment is used as a capital good in large shares for several countries, and therefore a demand shock could also not be calibrated.

intermediate demand. This ensures that the output change that is assumed to come from intermediate or household demand does not exceed the amount demanded by firms or households.[14]

To implement the household demand shock, the consumer price of a product was shifted to accommodate the derived changes in demand for those products.[15] To implement the intermediate demand shock, total factor productivity was adjusted to change the amount of intermediate goods required for production. The calibrations of the two demand shocks were implemented separately. The intermediate demand shock was implemented first by calibrating sectors that are predominantly used as intermediates, and then the value added tax was determined on the resulting database calibrating sectors mainly supplied to households.[16]

Because of the increase in consumer demand for electronics products in 2020, as illustrated by significant increases in international trade of these products (Arriola, Kowalski and van Tongeren, 2021[2]), the output change in this sector, after accounting for the changes in intermediate demand from the other sectors, was fully attributed to households. Therefore, only the value added tax was used to calibrate this sector in regions that are among the top five producers or consumers of this product. In addition, a 16% 'virtual subsidy' in the electronics sector was applied in regions where at least 30% of the jobs are teleworkable.[17]

Table 2 presents the weighted average of the intermediate and household demand shocks across regions. Sectors consumed by households where output declined considerably, like air transportation, hospitality, and recreation sectors, face larges increases in the value added tax on average. Air transport is also used as an intermediate input and the output decline was also induced by a decline in total factor productivity in the sector. The world production of agriculture increased by 5% in 2020. To generate the same output change in the model, total factor productivity in agriculture increased on average about 10% and in regions where agriculture is mostly consumed by households the value added tax is also reduced five percentage points.

Figure 5 compares the resulting change in world production from the METRO simulation that includes all COVID-19 related factors, including the demand shocks. The change in world production in most sectors are close to those computed from National Accounts data. Exception are those sectors where a majority of the regions could not be calibrated for the demand shock (basic pharmaceuticals, transport equipment, warehousing, public administration, and human health and social work) as well as the cars and parts, air, and water transportation sectors where we had to reduce the assumed change in production target to get the demand calibration to solve. The production in the electronics sectors increases in the simulation, while the targeted output change was negative. The simulated increase in production of the electronic sector stems from the 'virtual subsidies' needed to match China's consumption and exports data.

[14] Additionally, to help the model solve, it was necessary to limit the regions included in the calibration for a sector. In general, regions were included in the calibration if the region was among the top producer or consumer of the commodity, or most of the production was supplied to that particular use.

[15] The size of the shift was determined through a pre-simulation calibration of the required adjustments in the value added tax to match the assumed demand change. The calibration uses the model's implied general equilibrium price elasticities.

[16] A sector was calibrated as an intermediate demand shock if the largest share of the production was supplied as an intermediate input in most regions (20 or more regions). Similarly, a sector was calibrated as a household demand shock if most of the production was supplied as a household good. Some exceptions were required if the calibration simulation would not solve. Cars and parts, air transport, and communication were calibrated as both an intermediate and household demand shock.

[17] The 16% 'virtual subsidy' level is the amount that results in a simulated increase of exports of electronics from China of the size documented in Arriola, Kowlaski and van Tongeren (2021[2]), while minimizing the spurious positive effects on real GDP.

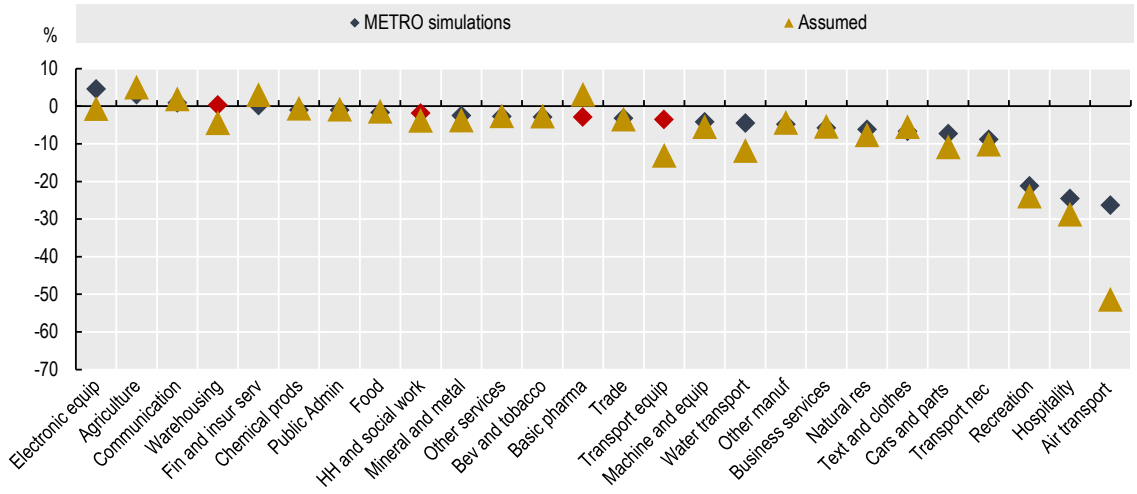
Table 2. Calibrated demand shocks

		Intermediate demand		Household demand	
	Change in world production in 2020	Average+% change in TFP	Number of regions calibrated	Average+ percentage point change in the value added tax	Number of regions calibrated
Agriculture	5.1	10.5	29	-5.5	3
Natural resources	-7.6	-10.8	29	0.0	0
Food	-1.4	-1.6	4	-5.9	29
Beverage and tobacco	-2.7	-0.3	5	-13.5	29
Textile and wearing apparel	-5.5	5.3	21	1.7	14
Other manufacturing	-4.3	2.9	29	0.0	0
Basic pharmaceuticals*	3.2	0.0	0	-3.2	7
Chemical products	-0.6	-16.9	29	0.0	0
Mineral and metal products	-3.6	-9.0	29	0.0	0
Electronic equipment	-0.6	0.0	0	-33.8	19
Machinery and equipment	-5.5	-7.7	29	0.1	1
Cars and parts†	-10.8	5.7	28	7.2	19
Transport equipment	-13.0	-0.5	14	1.7	1
Trade	-3.4	3.3	29	-5.6	29
Hospitality	-28.7	0.0	0	40.8	29
Transport nec	-10.1	-6.6	29	0.3	3
Water transport†	-11.8	-5.7	23	0.0	0
Air transport	-51.3	-49.2	29	32.0	27
Warehousing	-4.4	0.0	0	-1.7	1
Communication	1.9	26.3	29	-9.6	29
Financial services and insurance	3.1	12.7	29	-0.5	2
Business services	-5.4	8.2	29	0.0	0
Recreational and other services	-23.9	0.0	0	31.6	29
Public administration and defense*	-0.8	0.0	0	0.0	0
Human health and social work activities*	-3.8	0.0	0	-0.1	1
Other services	-2.6	6.6	29	-5.9	29

Note: +Average change in TFP weighted by production volumes while average change in value added tax weighted by household consumption volumes; * Sectors that are predominantly consumed by government, Public administration and defense and Human health and social work activities, were not calibrated in most regions. Basic pharmaceuticals are mostly consumed by the Human health and social work sectors and therefore was also not calibrated in most regions; † The output assumption for cars and parts, air, and water transport had to be reduced relative to the available statistical sources by 10%, 40% and 70% respectively in the intermediate demand shock calibration step. The original output target is too far away from the base equilibrium for the model to find a new equilibrium solution. Similarly, the assumed output change in the air transport services sectors was reduced 75% when calibrating the household demand shock.
Source: OECD Metro Model and National Account sources.

Figure 5. Difference between simulated and assumed changes in world production

Percentage change from base



Note: Red diamonds denote sectors where only a limited number of regions were included in the demand shock calibration (see Table 1 for the number of regions calibrated in each sector).
Source: OECD METRO model, and authors calculation based on National Accounts information.

The travel restrictions and border closures in the early part of the pandemic severely disrupted air travel. The estimated output decline of the air transport sector, using available national accounts information, was over 50%. The air transport sector is an essential input in production involved in global value chains. The international interconnectedness of this sector along with the production assumptions of the other sectors, made calibrating such a large decline in output impossible in a general equilibrium framework. The calibrated reduction in output of the air transport sector is still the largest among the sectors in the model, but it does underestimate the drop in output and subsequent trade of the sector.

5. Results

5.1. World GDP declines 2.2%, even if government support mitigates some of the negative effects

World Real GDP declines by 2.3% in the simulation that includes all the shocks discussed above. Reductions in labour productivity in all sectors and regions is the largest contributor to this decline, on its own lowering world real GDP 4.6% (Table 3). Measures placed at the border to control the spread of the virus have less of an impact, reflecting perhaps the efforts some governments made to include trade facilitating measures such as electronic documents or implementation of 'green lanes' to assist in the flows of goods and services across borders.[18] Demand shifts overall had the smallest impact on world real GDP, accounting for only 0.1% in the total decline. Government support to firms and households helped to mitigate the negative impact of the other COVID-19 related factors. For every dollar of support transferred to households and firms in the model, real GDP increased by USD 0.97.

Macro results from the model are close but slightly more optimistic compared to official estimates from the IMF and OECD (Table 4), although the relative impacts of COVID-19 among countries are the same. China and Turkey are among the few countries to see growth coming in the first year of the pandemic due to an increase in domestic private consumption and an improvement in trade balances. Model results show strong declines in real GDP in southern European Union countries, which consists of Greece, Portugal, and Spain, which had relatively strict and prolonged lockdowns in 2020. Mexico and the United Kingdom

[18] See https://ec.europa.eu/info/live-work-travel-eu/coronavirus-response/transportation-during-pandemic_en.

are among the most negatively affected regions in the simulation where demand shifts, particularly in the hospitality and recreation sectors, had a strong negative impact on private consumption.

Table 3. World real GDP changes by COVID-19 related factors

Percentage difference from the base

All factors	**-2.3**
Border measures (goods)	-1.3
Cross border trade restrictions (services)	-0.4
Labour productivity	-4.6
Government support	4.2
Demand shifts	-0.2

Source: OECD Metro Model.

Table 4. Change in real GDP in 2020

Percentage change

	METRO model	World Economic Outlook October 2021 (IMF)	Economic Outlook May 2021 (OECD)
World	-2.3	-3.0	-3.5
Argentina	-7.7	-9.9	-9.9
Australia and New Zealand	-2.6	-2.3	-1.8
Brazil	-1.8	-4.1	-4.1
Canada	-3.8	-5.3	-5.4
China and Hong Kong (China)	3.9	2.2	2.3
United Kingdom	-7.5	-9.8	-9.8
France	-6.0	-8.0	-8.2
Germany	-3.5	-4.6	-5.1
Italy	-6.7	-8.9	-8.9
Sweden	-1.5	-2.8	-3.0
Finland	-2.9	-2.9	-2.8
EU east	-0.4	-3.9	-3.9
EU south	-9.6	-10.1	-8.9
EU all other	-3.1	-2.9	-3.1
EFTA	-1.6	-1.9	-1.9
Indonesia	0.1	-2.1	-2.1
India	-2.5	-7.3	-7.7
Japan	-4.7	-4.6	-4.7
Korea	-0.2	-0.9	-0.9
Mexico	-8.7	-8.3	-8.2
Russian Federation	-1.3	-3.0	-2.6
South Africa	-7.2	-6.4	-7.0
Turkey	1.5	1.8	1.8
United States	-2.2	-3.4	-3.5
Latin America	-6.8	-7.9	na
South East Asia	-3.4	-4.5	na
North Africa and Saudi Arabia	-4.0	-4.7	na
Rest of the world	-1.5	-1.9	na

Note: IMF statistics are % annual changes of Gross Domestic Product at constant prices for 2020. For country aggregates are weighted averages using GDP based on PPP share of world total. OECD statistics are Gross Domestic Product, Volume growth in 2020 compared to previous period. Aggregates are simple averages. Incomplete data are noted as "na".
Source: OECD METRO model, WEO Outlook October 2021 Database, Economic Outlook May 2021 (OECD, 2021[3]).

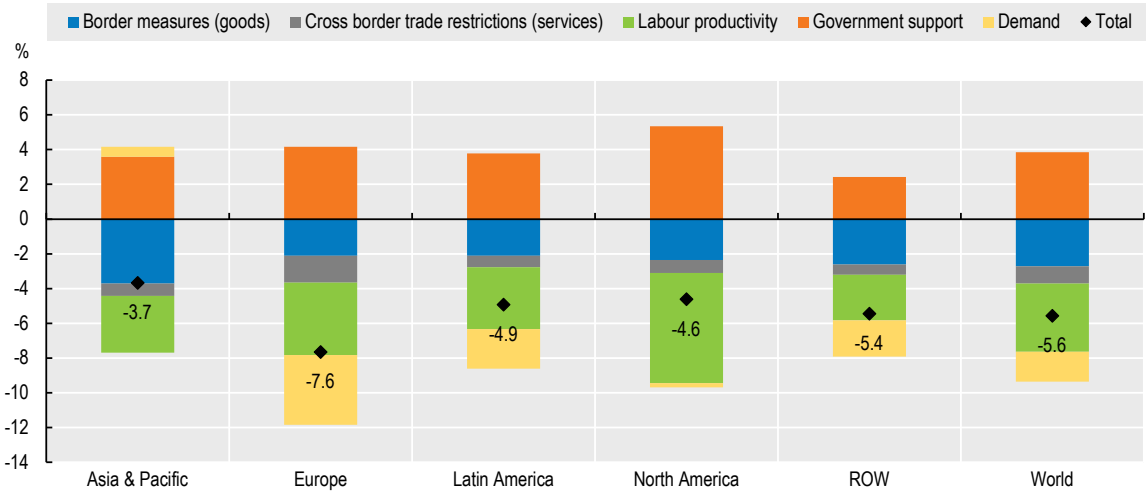
5.2. World trade volume declines by 6% and trade in services is more negatively impacted than merchandise trade

World trade declines 6 % in the simulation. This result is similar in direction, though more optimistic, as other estimates from the OECD, which estimated that world trade volumes decreased 8.5% in 2020 (Arriola, Kowalski and van Tongeren, 2021[2]), and the WTO which estimated a 12% decline in world trade of goods and services (WTO, 2021[29]). Trade in services was more negatively impacted by COVID-19 related factors and services export volumes declines 8%[19] in the simulation compared to the 5% decline of merchandise trade.

While total trade in all aggregate regions declined in the simulation (Figure 6), some faired relatively better than others. The negative impact on trade in the Asia and Pacific was less pronounced than in other regions, helped by government support as well as changes in demand. Changes in demand particularly for electronics, minerals and metals and metals, as well as other manufacturing, which accounts for 45 % of the Asia and Pacific exports at the base, increased export demand from the region, although border measures and labour productivity declines prevented an overall positive effect in these sectors. Exports from Europe declined the most among the regions in the simulation where border measures on goods and shifts in demands were predominant factors.

Figure 6. Change in trade volume by COVID-19 factors

Percentage change from base



Source: OECD METRO model.

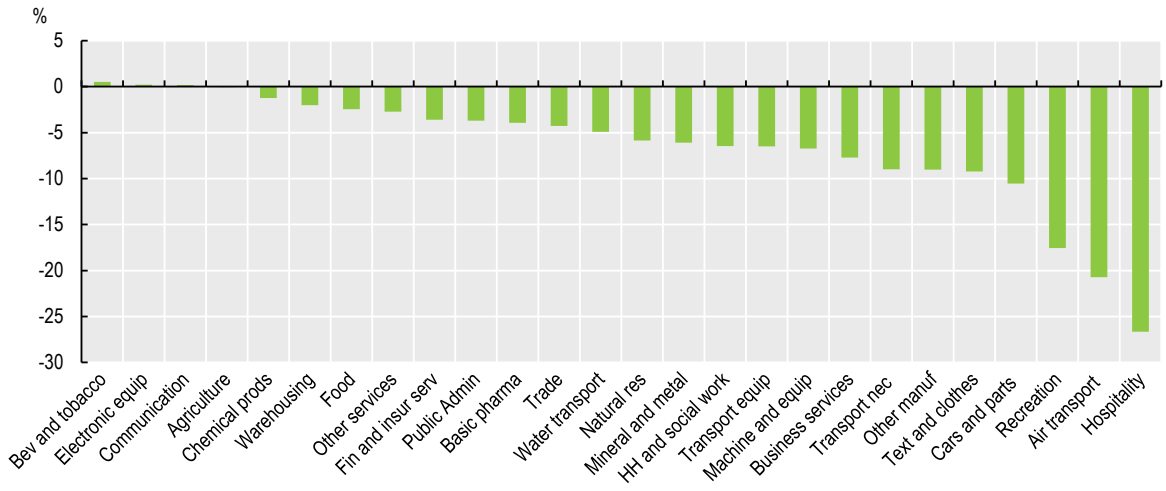
Trade impacts across sectors are uneven (Figure 7). Sectors which were virtually shut down due to strict lockdown measures were most negatively impacted. Exports of the hospitality, air transport, and recreation sectors declined 26.6, 20.7 and 17.6% respectively in the simulation, where shifts in demand were the predominant factor. Exports of cars and parts declined by 10.7% in the simulation, due to shifts in demand, productivity and border restrictions on goods. A few sectors saw positive growth in the simulation, thanks to government support and shifts in consumer and intermediate demand. Cases in point are beverage and

[19] The estimated decline in services trade is most likely underestimated since most CGE models have limited coverage of trade in services – covering only cross-border trade and not other modes of supply. Moreover, model limitations prevented calibration of the full demand shock of the air transport sector. The international interconnectedness of the air transport sector along with the production assumptions of the other sectors, made calibrating such a large decline in output impossible in a general equilibrium framework. The air transport sector is among the hardest hit sectors in the model results, but the output and trade decline of this sector is most likely underestimated.

tobacco products, electronics and communication, which experienced small but positive trade growth in this modelling exercise.

Figure 7. Change in trade volumes by sector

Percentage change from base



Note: Includes all COVID-19 factors implemented in the model.
Source: OECD METRO Model.

5.3. Consumers shifted demand from outside leisure activity to home nesting and entertainment products and production followed

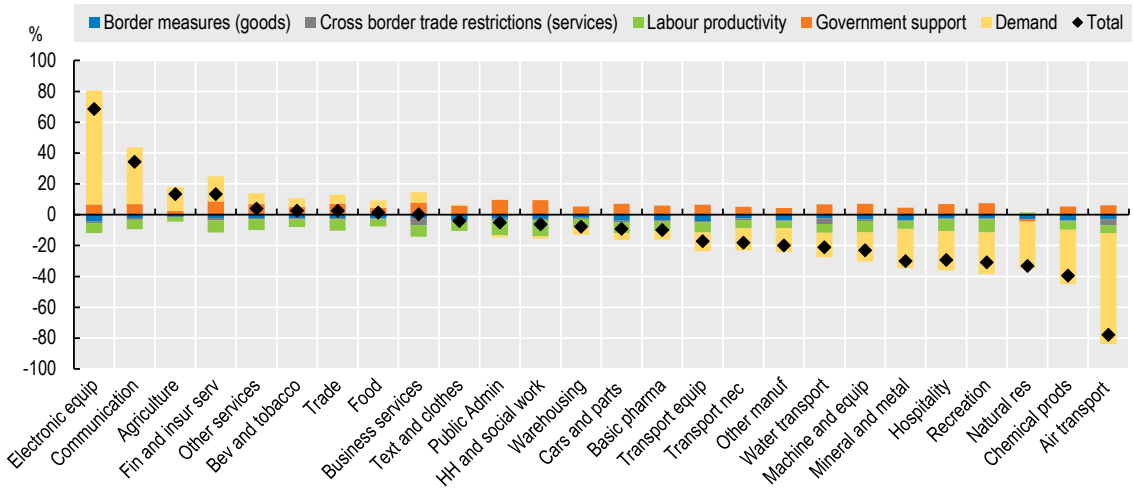
With large sections of the economy shuttered, consumers were forced to save and delay some of their spending. The household savings rate in most countries increased from their pre-COVID-19 levels in the simulation. On average, household savings rates rose by about 7 percentage points.

The increase in savings rates accompanies a 3% decline in private consumption on average. However, not all sectors were negatively impacted by COVID-19-related factors (Figure 8). Sectors that were shut down by governments to prevent the spread of the virus saw steep reductions in private consumption. Private consumption of air transportation, recreation, and hospitality declined by 77.8%, 30.9% and 29.8% respectively. With more time spent at home, consumers shifted demand from these sectors towards home nesting products and products consumable from home. Electronic equipment, communications services (e.g. Netflix, internet services, book publishing), food, and beverages as well as retail trade (which includes on-line shopping) saw an increase in private consumption.[20]

[20] See the GTAP website for a detailed definition of sectors, including ISIC Rev 4 correspondence: GTAP Data Bases: Two Concordances (purdue.edu)

Figure 8. Change in private consumption by sector and COVID-19 related factors

Percentage change from base



Source: OECD METRO model.

Global production decreased by 3.8% in the simulation. COVID-19-related factors had a more negative effect on the services sectors where global production declined by 4.6%. Overall, labour productivity declines had stronger negative effect on production than the other COVID-19 related factors. However, for sectors such as hospitality, air transport, and recreation, the shift in demand resulted in a steep decline in production (Figure 9). For other sectors, government support along with the shift in demand results in an increase in output from the sector.

Figure 9. Change in world production

Percentage change from base

Source: OECD METRO model.

6. Conclusions and next steps

The COVID-19 pandemic had an unprecedented impact on the world economy. The year 2020 marked some of the largest reductions in trade and output volumes since WWII (Arriola, Kowalski and van Tongeren, 2021[2]). Measures put in place to control the virus increased trade costs, slowed down supply chains, and disrupted consumer spending patterns. This paper documents an approach to incorporating COVID-19 related factors into the METRO model to assess the impact of the COVID-19 pandemic and government policy measures on the global economy and trade in the short-run and to inform thinking about the possible longer term developments. Additionally, the exercise produces a consistent estimate of the entire world economy in 2020 that includes the impact of COVID-19 and that can serve as basis of further analyses.

The analysis incorporates four main COVID-19 related factors into the model: (i) labour market changes, (ii) consumer demand shifts; and the impact of government policies affecting (iii) trade costs for goods and services trade, and (iv) fiscal policy measures directed at supporting firms and households. These factors do a good job in replicating the key features of the COVID-19 pandemic as known from macroeconomic surveillance exercises and available statistical data. In the current simulation, world GDP is found to decline by 2.3% in 2020 which is not far from the OECD and IMF macroeconomic projections. At the level of individual countries and regional aggregates, the model comes close to replicating the numbers in those sources, although some divergences remain. Government support is the main factor mitigating the size of the downturn. Somewhat more optimistically than estimates from WTO and macroeconomic projections from the OECD, world trade volumes are found to decline by 6% in 2020 with services trade affected more negatively than trade in merchandise goods.

The simulation underscores the substantial heterogeneity of impacts and shifts between sectors that underlie the aggregate GDP numbers. In particular, the simulation identifies the role of the shift in consumer demand from products and services that were locked down to prevent the spread of the virus towards products and services that have become more important for working and entertaining from home. In the Asia and Pacific regions, these demand shifts were a factor in mitigating the output and trade declines. More generally, some of the factors considered in this paper reinforce each other in some sectors, while they abate each other in other sectors. Overall, changes in consumer and intermediate demand as well as labour productivity changes – reflecting the ability to adopt teleworking – explain the bulk of the output and trade changes.

A large number of trial model runs was necessary to accommodate the features of the COVID-19 pandemic into our CGE model, and, as witnessed by the extensive technical documentation above, some of the features of 2020 cannot be fully captured in a general equilibrium framework: the economy was very much shaken out of its equilibrium. The pandemic exercised a significant pressure on the global economy, resulting in a substantial heterogeneity of consumption, output and trade changes across countries and sectors. Together with evidence from detailed high frequency data (Arriola, Kowalski and van Tongeren, 2021[2]) these results suggest a much larger size of the shocks that specific supply chains had to endure than during the Global Financial Crisis and revealed hitherto undetected bottlenecks and vulnerabilities. Moreover, buoyant trade in 2021 has not yet cleared all the backlogs created in 2020. The accumulated trade shortfall relative to normal periods differs widely across products, suggesting that trade of some products recovered fully while that of others is still lagging behind (Arriola et al., 2022[30]). The size of the gaps differ more across products than across countries, suggesting continuing non-trivial product or supply chain-specific 'micro' factors, similar to some of those modelled in the current exercise.

What do these findings imply for the medium- to long-term trade outlook? Will the COVID-19 pandemic leave a permanent mark on the global economy and will this involve significant re-orientations of trade? The answer is highly uncertain, but modelling a set of long-term scenarios could provide information on possible developments under alternative assumptions. Additionally, METRO could be usefully employed to further analyse the effects of different kinds of shocks in a highly interlinked global economy.

References

Aguiar, A. et al. (2019), "The GTAP Data Base: Version 10", *Journal of Global Economic Analysis*, Vol. 4/1, pp. 1-27, https://www.jgea.org/resources/jgea/ojs/index.php/jgea/article/view/77. [20]

Arriola, C. et al. (2022), *International Trade During The COVID-19 Pandemic: Big Shifts and Uncertainty*, https://www.oecd.org/coronavirus/policy-responses/international-trade-during-the-covid-19-pandemic-big-shifts-and-uncertainty-d1131663/. [30]

Arriola, C. et al. (2020), "Efficiency and risks in global value chains in the context of COVID-19", *OECD Economics Department Working Papers*, No. 1637, OECD Publishing, Paris, https://dx.doi.org/10.1787/3e4b7ecf-en. [1]

Arriola, C., P. Kowalski and F. van Tongeren (2021), "The impact of COVID-19 on directions and structure of international trade", *OECD Trade Policy Papers*, No. 252, OECD Publishing, Paris, https://dx.doi.org/10.1787/0b8eaafe-en. [2]

Asian Development Bank (2020), *An Updated Assessment of the Economic Impact of COVID-19*, Asian Development Bank, https://doi.org/10.22617/brf200144-2. [9]

Barrero, J., N. Bloom and S. Davis (2020), *"Why Working From Home Will Stick," RESEARCH / BFI WORKING PAPER.*, https://bfi.uchicago.edu/working-paper/why-working-from-home-will-stick/. [33]

Beckman, J., F. Baquedano and A. Countryman (2021), "The impacts of COVID-19 on GDP, food prices, and food security", *Q Open*, Vol. 1/1, https://doi.org/10.1093/qopen/qoab005. [14]

Benz, S. and F. Gonzales (2019), "Intra-EEA STRI Database: Methodology and Results", *OECD Trade Policy Papers*, No. 223, OECD Publishing, Paris, https://dx.doi.org/10.1787/2aac6d21-en. [22]

Benz, S. and A. Jaax (2020), *"The Cost of Regulatory Barriers to Trade in services; New Estimates of ad valorem Tariff", OECD Trade Policy Paper.*, http://www.oecd.org/publications/the-costs-of-regulatory-barriers-to-trade-in-services-bae97f98-en.htm. [23]

Bloom, N. et al. (2020), *The impact of Covid-19 on productivity*, National Bureau of Economic Research, http://www.nber.org/papers/w28233. [25]

Boissay, F. and P. Rungcharoenkitkul (2020), *Macroeconomic effects of Covid-19: an early review*, https://www.bis.org/publ/bisbull07.htm. [5]

Boissay, F. and P. Rungcharoenkitkul (2020), *Macroeconomic effects of Covid-19: an eraly review*, https://www.bis.org/publ/bisbull07.htm. [31]

Cadot, O., J. Gourdon and F. van Tongeren (2018), "Estimating Ad Valorem Equivalents of Non-Tariff Measures: Combining Price-Based and Quantity-Based Approaches", *OECD Trade Policy Papers*, No. 215, OECD Publishing, Paris, https://dx.doi.org/10.1787/f3cd5bdc-en. [21]

Cadot, O., J. Gourdon and F. van Tongeren (2018), "Estimating Ad Valorem Equivalents of Non-Tariff Measures: Combining Price-Based and Quantity-Based Approaches", *OECD* [35]

Trade Policy Papers, No. 215, OECD Publishing, Paris, https://dx.doi.org/10.1787/f3cd5bdc-en.

de Vries, K., A. Erumban and B. van Ark (2021), "Productivity and the pandemic: short-term disruptions and long-term implications", *International Economics and Economic Policy*, Vol. 18/3, pp. 541-570, https://doi.org/10.1007/s10368-021-00515-4. [37]

Espinoza, R. and L. Reznikova (2020), "Who can log in? The importance of skills for the feasibility of teleworking arrangements across OECD countries", *OECD Social, Employment and Migration Working Papers*, No. 242, OECD Publishing, Paris, https://dx.doi.org/10.1787/3f115a10-en. [26]

European Commission (2020), *The impact of the Covid-19 pandemic on global and EU trade*, https://trade.ec.europa.eu/doclib/docs/2020/may/tradoc_158764.pdf. [8]

Gopalakrishnan, B. (2020), *COVID-19 and Tourism; Assessing the Economic Consequences*. [32]

Guillemette, Y. and D. Turner (2021), "The long game: Fiscal outlooks to 2060 underline need for structural reform", *OECD Economic Policy Papers*, No. 29, OECD Publishing, Paris, https://dx.doi.org/10.1787/a112307e-en. [36]

Keogh-Brown, M. (2020), *The impact of Covid-19, associated behaviours and policies on the UK economy: A computable general equilibrium model*. [12]

Lahcen, B. (2020), *Green Recovery Policies for the COVID-19 Crisis: Modelling the Impact on the Economy and Greenhouse Gas Emissions*. [11]

Leroy de Morel, L. (2020), *The potential local and regional impacts of COVID-19 in New Zealand; With a focus on tourism*, https://nzier.org.nz/publication/the-potential-local-and-regional-impacts-of-covid-19-in-new-zealand-with-a-focus-on-tourism-nzier-public-discussion-paper-20203. [10]

Maliszewksa, M., A. Mattoo and D. van der Mensbrugghe (2020), *The Potential Impact of COVID-19 on GDP and Trade. A preliminary Assessment. Policy Research Paper 9211. The World Bank Group*, https://doi.org/10.1596/1813-9450-9211. [7]

McDonald, S. and K. Thierfelder (2013), *Globe v2: A SAM Based Global CGE Model using GTAP Data, Model Documentation*, http://cgemod.org.uk/Global%20CGE%20Model%20v2.pdf. [19]

McKibbin, W. and R. Fernando (2020), *"The Global Macroeconomic Impacts of Covid-19: Seven Scenarios", CMA Working Paper No. 19/2020.*, http://dx.doi.org/10.2139/ssrn.3547729. [4]

OECD (2022), *Modelling Trade Policy Scenarios: Different Horses for Different Courses. Macroeconomic and trade effects of restrictions in cross border labour mobility*. [34]

OECD (2021), *OECD Economic Outlook, Volume 2021 Issue 1*, OECD Publishing, Paris, https://dx.doi.org/10.1787/edfbca02-en. [3]

OECD (2020), *"METRO Version 3 Model Documentation", TAD/TC/WP/RD(2020)1/FINAL.*, https://one.oecd.org/document/TAD/TC/WP/RD(2020)1/FINAL/en/pdf. [18]

OECD (2020), *OECD Economic Outlook, No. 108, December 2020*. [28]

OECD (2018), *Trade Facilitation and the Global Economy*, OECD Publishing, Paris, https://dx.doi.org/10.1787/9789264277571-en. [24]

OECD (2017), *"Metro development: Modelling Non-Tariff Measures and Estimation of Trade Facilitation Impacts"*, OECD, https://one.oecd.org/document/TAD/TC/WP(2016)20/FINAL/en/pdf. [27]

Perdana, S. (2020), *Modeling COVID-19 scenarios with a Computable General Equilibrium model*. [17]

Rum, I. (2021), *Policy Strategies to Strengthen the Travel and Tourism Sectors from the COVID-19 Pandemic Shocks: A Computable General Equilibrium Model for the Indonesian Economy. ERIA Discussion Paper Series. No. 406.*, https://www.eria.org/publications/policy-strategies-to-strengthen-the-travel-and-tourism-sectors-from-the-covid-19-pandemic-shocks-a-computable-general-equilibrium-model-for-the-indonesian-economy/. [16]

Scarpetta, S. et al. (2020), *Job retention schemes during the COVID-19 lockdown and beyond.*, https://www.oecd.org/coronavirus/policy-responses/job-retention-schemes-during-the-covid-19-lockdown-and-beyond-0853ba1d. [38]

UNCTAD (2020), *COVID-19 and Tourism. Assessing the Economic Consequences.*, https://unctad.org/system/files/official-document/ditcinf2020d3_en.pdf. [15]

UNDP (2020), *COVID-19 Economic and Social Impact Assessment in Cambodia*, https://www.kh.undp.org/content/cambodia/en/home/library/covid-19-economic-and-social-impact-assessment-in-cambodia.html. [13]

WTO (2021), *World Trade Statistical Review 2021*, OECD Publishing, Paris/World Trade Organization, Geneva, https://dx.doi.org/10.30875/604b3e6d-en. [29]

WTO (2020), *"Methodology for the WTO Trade Forecast of April 8 2020"*, https://www.wto.org/english/news_e/pres20_e/methodpr855_e.pdf. [6]

Annex A. Summary of related CGE analyses on the economic impact of COVID-19

Table A A.1. Summary table of related CGE analyses on the economic impact of COVID-19

Publication month-year	Reference	Description	Main economic findings
Early pandemic COVID-19 assessments (global)			
March 2020	(McKibbin and Fernando, 2020[4])	Examines seven scenarios on macroeconomic outcomes and financial markets in a global hybrid DSGE/CGE model with 6 sectors and 24 regions. Scenarios based on a range of epidemiological events from a temporary epidemic limited to China to one where a mild case is expected to recur ever year for the indefinite future. Five types of shocks applied in each scenario: 1) Decrease in labour supply 2) Change in equity risk premium 3) Increase in cost of production 4) Reduction in consumer spending via an increase in savings 5) An increase in government spending	Average GDP losses in 2020 ranged from 1.6 to 6.7% in the pandemic scenarios, where all regions were impacted by COVID-19. A mild pandemic is expected to reduce global GDP by USD 2.4 trillion and a more serious outbreak reduces global GDP by over USD 9 trillion in 2020. Equity markets drop sharply both because of the rise in risk but also because of the expected economic slowdown and the fall in expected profits.
April 2020	(WTO, 2020[6])	Describes the methodology and assumptions used to generate the WTO April 2020 trade forecast via the WTO Global Trade model, a recursive dynamic CGE model aggregated to 16 regions and 21 sectors. Three scenarios were developed based on the potential impact of the pandemic on the global economy: V-shaped (optimistic); U-shaped (less optimistic); and L-shaped (pessimistic) recovery. **COVID-19 scenarios apply three types of shocks to the model:** 1) Reduced labour supply and productivity 2) Reduced demand and supply in specific sectors 3) Increase trade cost due to border controls and restriction on personal travel	Reduction in GDP ranges from 4.8% (V-shaped recovery) up to -11.1% (L-shaped recovery scenario). The simulations indicate that the reduction in exports is considerably larger than the reduction in GDP in all scenarios. ASEAN, Mexico and the Newly Industrialized Countries are projected to see the biggest drops in GDP. Sectors with the largest decreases in trade are the ones affected by the negative shocks to consumption demand such as recreation and accommodation and air transport. Trade in basic pharma increases.
April 2020	(Boissay and Rungcharoenkitkul, 2020[31])	Provides an early review of empirical studies on the economic costs of epidemics and latest quantitative estimates of COVID-19's impact on global growth.	The estimated impact on global GDP growth for 2020 is around –4%, with substantial downside risks if containment policies are prolonged. Output losses are larger for major economies.
April 2020	(Maliszewksa, Mattoo and van der	Simulates the potential impact of COVID-19 on GDP and trade, using the Envisage Model, a standard global CGE model, aggregated to 27 regions and 29 sectors.	Under the "global pandemic" scenario, global GDP falls 2.1% from base. The biggest GDP losses are expected in East Asia and Pacific (EAP)

Publication month-year	Reference	Description	Main economic findings
	Mensbrugghe, 2020[7])	Under the **"global pandemic" scenario** the shocks are : 1) Underutilization of labor (3%) in all sectors resulting in a decline in capital usage 2) Increase in international trade costs of 25% 3) 50% tax on inbound and outbound tourist related services (transport, accommodations, recreation, and other services) 4) Reallocation demand away from activities that require social interaction (such as mass transport, domestic tourism, restaurants, and recreational activities). Demand for the targeted services is assumed to drop by 15%. The **"amplified global pandemic" scenario** captures a deeper and more prolonged pandemic. Under this scenario, China's shock is unchanged while the shocks in other regions are doubled.	countries due to their relatively deep integration through trade and direct impact on tourism. Exports at the global level are expected to decrease by 2.5%. China sees a contraction in exports of 3.7%. Viet Nam sees a decline in its total exports by only 1%, because it benefits to an extent from the gap left by the decrease in Chinese exports. Under amplified global pandemic scenarios, global GDP loss reaches 3.9%, and global exports decline 4.6%.
May 2020	(European Commission, 2020[8])	To estimate the effect of COVID-19 on trade, first the impact on trade flows using predicted COVID19-related GDP shocks for 2020 are estimated. The changes in the macroeconomic forecasts are then incorporated into the computable general equilibrium (CGE) models MIRAGE2 and GTAP3 to estimate the effect on trade. Uses IMF April 2020 assumptions and macro estimates: i) the spread of the virus would be contained in the second half of 2020; ii) widespread lockdown measures would be gradually relaxed; iii) effective targeted economic measures would be put in place to support households and businesses.	They estimate that global trade for 2020 decreases between 10%-16%. Compared to pre-COVID expectations for 2020, the reduction in world trade could be as much as 19%. Exports of primary sectors (other than energy) and services trade turn out to be less affected than manufacturing sectors. Although they note that the impact on services trade is most likely underestimated "as most CGE models have limited coverage of trade in services and several import modes of supply."
May 2020	(Asian Development Bank, 2020[9])	Estimates the economic impact of COVID-19 using a comparative static GTAP model aggregated to 42 regions and 52 sectors. **Two scenarios**: short and long containment that differ in the length of time it takes to get the outbreak under control and the economy to normalize (3 months and 6 months respectively). Each scenario implements three "known and measurable" channels: 1) Increase in trade costs that affects movement of people and inbound tourism as well as global supply chains 2) Negative supply-side productivity shock that cuts wages and corporate earnings, leading to reduction in consumption and investment; 3) Fiscal stimulus through various macro economic policy instruments	Global GDP impact: range from -6.4% (3 months scenario) to -9.7% (6 months scenario) without government support. About 30% of this global impact will be accounted for by Asia, where in the two scenarios output will fall by USD 1.7 trillion and USD 2.5 trillion, which is 6.2% to 9.3% of regional GDP (excluding government stimulus). Border closures, travel restrictions, and lockdowns will cut global trade by USD 1.7 trillion to USD 2.6 trillion (1.9% to 2.9% of GDP) under the two scenarios. Including the stimulus packages reduces the COVID-19 impact under both scenarios. Real GDP declines -4.5 % and -5.9% respectively.

Publication month-year	Reference	Description	Main economic findings
Region or sectors specific assessments			
July 2020	(Lahcen, 2020[11])	Uses a CGE model, aggregated to 3 regions and 12 sectors, to examine the macroeconomic impact of the COVID-19 crisis in **Belgium** and the potential effects of government investment in eco-friendly construction projects. The model is extended with CO2 equivalent emissions per million EUR of spending to estimate the impact on the economy and on the climate. **Four COVID-19 scenarios:** 1) Workforce stays at home - 10% decrease in working time 2) Workforce stays at home - 20% decrease in working time 3) Overall demand drops to 90% levels, only essential sectors remain 100% active 4) Overall demand drops to 90% levels **The recovery policy:** subsidized renovations aimed at meeting energy efficiency standards (government transfers to households linked to the consumption level of construction projects and services).	The decline in GDP from base ranged from 5.14% when overall demand drops to 90% levels (scenario 4) to 12.06% in scenario 2 when work time declines 20%. CO2 equivalent emissions follow a similar trend, decreasing 3.82% in scenario 4 and decrease 9.29% under scenario 2. The introduction of the sustainable investment policy would have a small but positive impact on GDP (0.04% - 0.05%) and would reduce CO2 equivalent emissions about 0.3% in all scenarios.
July 2020	(UNCTAD, 2020[15])	Analyses the impact of COVID-19 on **tourism** using the GTAP model and version 10 database that was adjusted via macroeconomic targets to reflect the economy in 2018. **Moderate (optimistic) scenario:** 4 months standstill of international tourism: 1/3 of annual inbound tourism is removed in each country. **Intermediate scenario:** 8 months standstill of international tourism: 2/3 of inbound tourism is removed in each country. **Dramatic (pessimistic) scenario:** 12 months standstill of international tourism: All inbound tourism expenditure is removed in each country. In each scenario, annual tourism expenditure is reduced as a productivity shock. The shocks are proportionate to the inbound tourist expenditure.	Global GDP losses under the most optimistic tourism reduction scenario amount to an estimated USD 1.17 trillion, about 1.5% of global GDP. Extending the four months lockdown to eight and 12 months increases the losses in a fairly linear fashion, to USD 2.22 trillion (2.8 % of world's GDP) and USD 3.3 trillion (4.2% of world's GDP) respectively. The indirect losses due intersectoral linkages in the tourism industry produce a multiplier effect throughout the economy. Findings show that the losses in GDP are approximately 2-3 times higher [than the tourism sector]. As a result, a USD 1 million loss in international tourist revenue can lead to a fall in national income of USD 2-3 million.
August 2020	(Leroy de Morel, 2020[10])	Uses the New Zealand regional CGE model TERM-NZ, extended to include 5 new tourism industries, to assess the potential impact of COVID-19 on **New Zealand** and its regions. They run three scenarios based on the different alert levels imposed by the government. Focus on restrictions applied to the entry and movement of people as well as on labour and capital temporarily rendered idle due to isolation and social distance rules. **Phase 1: Lockdown and travel ban- year ended June 2020** • Borders are closed to foreign visitors; New Zealanders cannot travel abroad or in-country • Export of Education decreases 20%	Real GDP decreases 7.1% (phase 1) and 2.2% (phase 3) as New Zealand transition through the different phases. Real GDP losses dominated by labour and capital underutilization The decline in exports volumes range from 10.8% (phase 1) and 5.6% (phase 3). Imports decline 11.1% in first phase and 4.1% in Phase 3.

Publication month-year	Reference	Description	Main economic findings
		• Labour demand decreases 7% • Impose a households' tastes change from consumer goods and services (retail, hotels and restaurants, transport, childcare, sports, and recreation activities) • Increase export demand for dairy, fruit, meat, and seafood products • Decrease export demand for forestry and non-food manufactured goods. **Phase 2: Only domestic tourism is allowed – year ended June 2021** • Borders stay closed to foreign visitors, but international students with visas are allowed into the country. People can travel domestically • More economic activities resume • Households' tastes partially move back to consumer goods and services • Slight increase in labour demand and capital is put back to use. Capital stays immobile in air transport **Phase 3: Both foreign and domestic tourism allowed – year ended June 2022** • Borders open to foreign travelers and students with mandatory self-isolation. Domestic tourism is allowed. • Most economic activities back to normal with the exception of air transport.	
October 2020	(UNDP, 2020[13])	Two CGE models are used to analyse the impact of COVID-19 on **Cambodia**: 1) A single country CGE model using data from the Cambodian 2020 SAM and the Macroeconomic and Fiscal Framework 2020-2020; and 2) the multi-country, multi-sector CGE model GTAP with 2014 data. Each model is used to assess the economic impact of COVID-19 and the government response. The results of the single Country CGE are then fed into employment and poverty modules. **COVID-19 scenario assumptions (Demand shock)** 1) Duration of the global outbreak impacts (base month is February) 2020 full year 2) **Garments** (incl. textiles and footwear): 13.1% output decline; 20.1% reduction in exports 3) **Construction**: 10.6% output decline; 24% reduction in project approval 4) **Hotels and restaurants**: 13.3% output decline (42% reduction in international tourist arrivals and 30% in domestic tourists) 5) **Transportation and communication**: 1.5% output decline 6) **Agriculture**: Based on MEF data (the agricultural GDP growth rate is estimated at 0.9%) **Government response assumptions** 1) Estimated government response: social protection +1.9% of GDP, tax relief +0.7% of GDP, savings on capital schemes –3.5% of GDP (net –0.9% of GDP) **Government response + social protection assumptions** 1) UN social protection proposals: Government program (above), plus additional UN social protection proposal4 (net +3.5% of GDP)	Without government support, real GDP declines 4.11% in the single country CGE model and 4.9 % using GTAP. Unemployment increases to 4.8% of the labour force (under single Country CGE) and poverty rates increase to 17.6%. Government stimulus package does little to improve social and economic conditions – under the single country CGE model real GDP decline slightly more than the COVID-19 scenario (-4.41 %). Using the GTAP model, the decline in real GDP is less pronounced (-2.5 %). With case transfers to households into the government response, real GDP declines only 3.3% in the single country model, while real GDP increase 1.9% using GTAP. The poverty rate increase is mitigated somewhat – increasing to only 14.3%.

Publication month-year	Reference	Description	Main economic findings
December 2020	(Keogh-Brown, 2020[12])	Estimates the potential impact of COVID-19 and mitigation policies on the **United Kingdom** by linking an epidemiological model of infection to the IFPRI standard CGE model, single country, which was calibrated and adjusted via macroeconomic targets to reflect the UK economy in 2019. **Scenario 1: Direct health costs and effects only** **Labour supply loss and health costs** based on portion of people who suffer symptomatic illness (CAR); case fatality rate for symptomatic cases (CFR), Hospitalization rates, ICU admissions rates. Losses of productive labour supply are calculated by multiplying rates of hospitalisation, ICU and fatal cases by absenteeism duration to form work time loss estimates. Cost per case for hospitalisation and ICE treatment taken from literature. **Scenario 2: Direct health effects plus mitigation** Health effects of Scenario 1 plus mitigation policies applied for 12 weeks: • **14 day home quarantine**: Change in assumption of work absences for infected cases from 7 working days to ten working days; Reduced deaths (CFR) • **Social distancing**: invoking business closures of non-essential activities modelled as a 90% reduction in labour and capital factor employment in hotels and restaurants and entertainment/recreation sectors; and 50% reduction in labour and capital employment in remaining non-essential activities. • **School closure**: 50% of all UK mothers will take time off work for the duration of school closures. **Scenario 3: Direct health effects plus suppression** Similar shocks to Scenario 2 but mitigation policies are applied through end of 2020 (end year of the modelling) - business and school closures are 74% longer than in scenario 2 while CFR rates improve.	Total direct economic burden from COVID-19 in the UK (Scenario 1) measured as the change in real GDP is over 3 GBP 9.6 bln or 1.73% of GDP. Total economic impact of the mitigation scenarios (Scenario 2) amounts to GBP 308 bln or 13.5% of real GDP. Indefinitely applying the mitigation policies to try and suppress the virus (Scenario 2) amounts to a real GDP loss of GBP 668.4 bln or 29.2% of GDP.
January 2021	(Beckman, Baquedano and Countryman, 2021[14])	Analyses the impact of COVID-19 on **food security** by linking results from the GTAP CGE analysis (GDP and grain prices) to the International Food Security Assessment (IFSA) model that estimates changes in food consumption, and food gaps in developing countries. The GTAP 2104 database was adjusted via macroeconomic targets to reflect the global economy in 2020. **COVID-19 Scenario** 1) **Unemployment:** Implemented change in unemployed labour based on OECD and IMF data between September 2020 and 2019; and assumes no change in capital.	The model estimates a reduction in global GDP of 7.22%. The changes estimated by the model also tend to be larger for the major economies of the world: US GDP decreases by 7.92% and that of China decreases by 9.79%. Across the seventy-six countries covered by the IFSA model, COVID-19 is anticipated to increase the number of food-insecure people in 2020 by 211.2 million (or almost 27.8%), for a total of 972 million people in food insecurity.

Publication month-year	Reference	Description	Main economic findings
		2) **Trade**: Implemented change in global exports of each commodity in the model database using data from the Trade Data Monitor for the period January-September 2020 compared to same months in 2019 (export volumes shocked while trade costs adjusts). 3) **Oil prices**: Assumes a 37% decrease 4) **Domestic output**: Implemented output change on goods sectors and allowed technology to change. Target output changes are based on US data on primary and manufacturing sectors published by the US Federal Reserve. Data for other countries are extrapolated by using the Oxford University Stringency Index.	
September 2021	(Rum, 2021[16])	Analyses the impact of the COVID-19 pandemic shock on **Indonesia** and the implications of government policies to strengthen the **travel and tourism sectors**. Uses the simplified CGE model, MINIMAL, and the Indonesian 2014 Input-Output table as the data source. Two COVID-19 baselines are produced to which the policy scenarios are compared. **COVID-19 baseline – low recovery** 1) All inbound tourism expenditure is removed 2) Real household consumption declines by 3% **COVID-19 baseline – lower-middle recovery** 1) 2/3 inbound tourism expenditure is removed 2) Real household consumption declines by 2% **Policy scenario – moderately effective support** 1) 2/3 of the Rp423.23 trillion stimulus package is implemented 2) 25% reduction in production tax **Policy scenario – highly effective support** 1) All of the stimulus Rp423.23 trillion package is implemented 2) 50% reduction in production tax **Policy scenario – tourism support** 1) All of the Rp423.23 trillion stimulus package is implemented 2) 50% reduction in production tax 3) Tourism stimulus plan (Rp3.3 trillion injected into the sector)	A lower-middle recovery results in a nominal GDP decline of –1.99% from the baseline and for the tourism and travel sectors -6.81% change from the baseline. Real GDP declines by –0.29%. Total imports decline by –2.44%, and exports increase by 1.05% from the baseline. A low recovery results in a nominal GDP decline of -2.97% and tourism and travel sectors decline -10.38%. Real GDP declines by –0.42% from the baseline and total imports experience a decline of –3.62%. Though total exports increase 1.43% from base. If we take into account the government mitigation plan, under a lower-middle recovery with moderate government support, real GDP increases by 1.03% from the baseline. With increase government support, under the highly effective scenario, real GDP increase 1.57%. Additional support targeting the tourism sectors increase real GDP 1.6%

Annex B. Model database aggregation

Table A B.1. Analysis region aggregation

Analysis region	Original region	Analysis region	Original region
Argentina	Argentina	EFTA	Switzerland
Australia and New Zealand	Australia		Norway
	New Zealand	Indonesia	Indonesia
Brazil	Brazil	India	India
Canada	Canada	Japan	Japan
China and Hong Kong (China)	China	Korea	Korea
	Hong Kong (China)	Mexico	Mexico
United Kingdom	United Kingdom	Russian Federation	Russian Federation
Germany	Germany	Turkey	Turkey
Finland	Finland	United States	United States
France	France	South Africa	South Africa
Italy	Italy	Chile and Israel	Chile
Sweden	Sweden		Israel
EU East	Czech Republic	Latin America	Colombia
	Estonia		Peru
	Hungary		Costa Rica
	Latvia	North Africa and Saudi Arabia	Saudi Arabia
	Lithuania		Morocco
	Poland		Tunisia
	Slovakia	South East Asia	Brunei Darussalam
	Slovenia		Cambodia
	Bulgaria		Malaysia
	Croatia		Philippines
	Romania		Singapore
EU South	Cyprus		Thailand
	Greece		Viet Nam
	Portugal	Rest of the world	Chinese Taipei
	Spain		Kazakhstan
EU All other	Austria		Rest of the World
	Belgium		
	Denmark		
	Ireland		
	Luxembourg		
	Malta		
	Netherlands		

Notes
1. Note by Turkey: The information in this document with reference to “Cyprus” relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the “Cyprus issue”.
2. Note by all the European Union Member States of the OECD and the European Union: The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.
Source: Authors’ compilation.

Table A B.2. Sector aggregation

Analysis sector	Original sector	Analysis sector	Original sector
Agriculture	Paddy rice	Mineral and metal products	Mineral products nec
	Wheat		Ferrous metals
	Cereal grains nec		Metals nec
	Vegetables, fruit, nuts		Metal products
	Oil seeds	Electronic equipment	Computer, electronic & optical prods
	Sugar cane, sugar beet		Electrical equipment
	Plant-based fibers	Machinery and equipment	Machinery and equipment nec
	Crops nec	Cars and parts	Motor vehicles and parts
	Bovine cattle, sheep and goats, horses	Transport equipment	Transport equipment nec
	Animal products nec	Other manufacturing	Wood products
	Raw milk		Paper products, publishing
	Wool, silk-worm cocoons		Petroleum, coal products
	Forestry		Rubber and plastic products
	Fishing		Manufactures nec
Natural resources	Coal	Trade	Trade
	Oil	Hospitality	Accommodation, Food and services
	Gas	Transport nec	Transport nec
	Other Extraction	Water transport	Water transport
Food	Bovine meat products	Air transport	Air transport
	Meat products nec	Warehousing	Warehousing and support activities
	Vegetable oils and fats	Communication	Communication
	Dairy products	Financial services and insurance	Financial services nec
	Processed rice		Insurance
	Sugar	Business services	Business services nec
	Food products nec	Recreational and other services	Recreational and other services
Beverage and tobacco	Beverages and tobacco products	Public Administration and defense	Public Administration and defense
Textile and wearing apparel	Textiles	Human health and social work activities	Human health & social work activities
	Wearing apparel	Other services	Electricity
	Leather products		Gas manufacture, distribution
Chemical products	Chemical products		Water
Basic pharmaceuticals	Basic pharmaceutical prods		Construction
			Real estate activities
			Education
			Dwellings

Source: Authors' compilation.

Annex C. National Accounts sources

Table A C.1. National Accounts series used to compute sectoral output changes

Regions	Main source
ARG	Imputed using Brazil's sectoral changes and IMF GDP 2020 growth rate.
AUSNZL	(Australia only): Australian Bureau of Statistics. Gross Value Added by Industry, Chain volume measures (Table 6)
BRA	IBGE. Table 1620 - Chained series of quarterly volume index (Base: mean 1995 = 100)
CAN	Statistics Canada. Gross domestic product (GDP) at basic prices, by industry, monthly (x 1,000,000) 1 2; Trading-day adjusted; 2012 constant prices
CHN	OECD.Stat Quarterly National Accounts (National Currency, current prices)
GBR	ONS. Gross Value Added in pounds millions chained volume measure (constant prices)
FRA	INSEE + Eurostat for manufacturing detail. QNA. Value added in chain-linked volumes (WDA-SA data); Billions of euros
DEU	OECD.Stat + Eurostat for manufacturing detail (Production in industry - monthly data, vol index)
ITA	OECD.Stat + Eurostat for manufacturing detail (Production in industry - monthly data, vol index)
SWE	National Sources + Eurostat for transport services detail. Statistics Sweden GDP: production approach (ESA2010), constant prices reference year 2019, SEK million by industrial classification NACE Rev. 2 and quarter
FIN	National Sources + Eurostat for manufacturing and service sectors detail. Statistics Finland. 11uc -- Income and production by industry, quarterly, 1990Q1-2020Q3; Seasonally and per working day adjusted series, reference year 2010, millions of euro; B1GPH Gross value added at basic prices
EUeas	OECD.Stat + Eurostat for manufacturing and services sectors detail (Production in industry and Production in services - monthly data, vol index)
EUsou	OECD.Stat + Eurostat for manufacturing detail (Production in industry – monthly data, vol index)
EUrst	OECD.Stat + Eurostat for manufacturing detail (Production in industry – monthly data, vol index)
EFTA	Switzerland: SECO. ESA 2010, Quarterly aggregates of Gross Domestic Product, production approach, seasonally and calendar adjusted data; In Mio. Swiss Francs, at prices of the preceding year, chained values ("annual overlap"), ref year 2015,% change to previous quarter. Norway: Statistics Norway. Production account and income generation, by industry, contents and quarter; Value added at basic prices. Constant 2018-prices. Seasonally adjusted (NOK million)
IDN	National Sources: Statistics Indonesia. GDP by Industrial Origin (2010 Version); Constant prices 2010
IND	OECD.Stat Quarterly National Accounts
JPN	Services: The Portal Site of Official Statistics of Japan. Monthly Survey on Service Industries since January 2013 Monthly Survey; Sales by Industry of Business Activity (Medium Groups). Assumed changes in manufacturing output is similar to those of Korea.
KOR	Bank of Korea. Economics Statistics System. GDP and GNI by Economic Activities (seasonally adjusted, chained 2015 year prices, quarterly)
MEX	INEGI. Quarterly Gross Domestic Product, at market prices / f1 (Mlns of pesos at 2013 prices)
RUS	OECD.Stat Quarterly National Accounts
ZAF	OECD.Stat Quarterly National Accounts (National currency, constant prices, seasonally adjusted)
TUR	OECD.Stat Quarterly National Accounts and Eurostat data for Manufacturing.
USA	BEA. Chain-Type Quantity Indexes for Value Added by Industry; [2012=100] Seasonally adjusted at annual rates
ISR&CHL	OECD.Stat Quarterly National Accounts (Chile only)
LAm	Columbia: DANE. Annex Table: PIB constant prices; Chained volume series with reference year 2015 Index; Peru: INEI. Quarterly Gross Domestic Product according to Economic Activity (Level 14) 2007-2020-IV (constant 2007 prices)
SEA	Philippine Statistics Authority. Gross National Income and Gross Domestic Product by Industry; At Constant 2018 Prices. Thailand: NESDC. Gross domestic product, chain volume measures [reference year = 2002] (seasonally adjusted)
NASAU	OECD.Stat Quarterly National Accounts (National Currency, current prices; Saudi Arabia only)
ROW	Average across compiled regions

Note: All data extracted September and October 2021. OECD.Stat QNA were in national currency, chained volume estimates, seasonally adjusted unless otherwise stated. Information in aggregated regions are averages weighted by the valued added of available countries in the region. Not all regions provide information at the same level of detail. For example, some regions only provide information for total manufacturing. Changes in output for individual manufacturing sectors were imputed by assuming the same relative changes among the manufacturing sectors as those who reported detail sector information.
Source: Authors' compilation.

Table A C.2. Change in sectoral output in 2020

Simple average across METRO regions

Sector	%
Agriculture	1.3
Natural resources	-5.4
Food	-1.9
Beverage & tobacco	-3.9
Textile & wearing apparel	-9.6
Other manufacturing	-6.5
Basic pharmaceuticals	4.3
Chemical products	-1.6
Mineral & metal products	-6.7
Electronic equipment	-3.8
Machinery & equipment	-9.0
Cars & parts	-15.3
Transport equipment	-11.7
Trade	-3.4
Hospitality	-30.7
Transport nec	-11.9
Water transport	-13.5
Air transport	-59.7
Warehousing	-7.8
Communication	1.0
Financial services & insurance	3.3
Business services	-6.8
Recreational & other services	-18.8
Public Administration & defense	-0.6
Human health & social work activities	-2.1
Other services	-3.6

Source: Authors' calculation based OECD, Eurostat, and National Accounts statistics. See Table A C.1 for the complete list of data sources.

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Comments are welcome and can be sent to tad.contact@oecd.org.