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The Potential Impact of COVID-19 on GDP and Trade

A Preliminary Assessment

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Abstract

The virus that triggered a localized shock in China is now delivering a significant global shock. This study simulates the potential impact of COVID-19 on gross domestic product and trade, using a standard global computable general equilibrium model. It models the shock as underutilization of labor and capital, an increase in international trade costs, a drop in travel services, and a redirection of demand away from activities that require proximity between people. A baseline global pandemic scenario sees gross domestic product fall by 2 percent below the benchmark for the world, 2.5 percent for developing countries, and 1.8 percent for industrial countries. The declines are nearly 4 percent below the benchmark for the world, in an amplified pandemic scenario in which containment is assumed to take longer and which now seems more likely. The biggest negative shock is recorded in the output of domestic services affected by the pandemic, as well as in traded tourist services. Since the model does not capture fully the social isolation induced independent contraction in demand and the decline in investor confidence, the eventual economic impact may be different. This exercise is illustrative, because it is still too early to make an informed assessment of the full impact of the pandemic. But it does convey the likely extent of impending global economic pain, especially for developing countries and their potential need for assistance.

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The Potential Impact of COVID-19 on GDP and Trade: A Preliminary Assessment

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1. Introduction

As the coronavirus emerged in China and spread globally, authorities have acted to limit its spread. Experience with similar diseases reveals that while the human costs are significant, the bulk of the economic costs are due to the preventive behavior of individuals and the transmission control policies of governments (Brahmbhatt and Dutta, 2008). Current experience is no different. As the virus spread internationally, many countries have already taken or will eventually take action to limit the spread, through social isolation policies, such as shutting educational institutions, limiting work and restricting the mobility of people. The preventive actions have had an immediate and significant impact on all economies, and through trade and tourism, on partner economies.

Economic models can be used to model the consequences of pandemics (Burns et. al. (2006), Bloom et. al. (2005), Lee and McKibbin (2004), McKibbin et. al. (2006), Evans et. al. (2014)). Building on previous studies, this paper focuses on four channels—i) the direct impact of a reduction in employment; ii) the increase in costs of international transactions; iii) the sharp drop in travel; and iv) the decline in demand for services that require proximity between people.

We consider two scenarios: a global pandemic and an amplified global pandemic. In the case of the global pandemic, it is assumed that countries bear only one-half of the impact of the full China shock. In the case of the amplified global pandemic, the shocks are uniform across all countries. A baseline global pandemic scenario sees GDP of the world fall by 2 percent below the baseline, of developing countries by 2.5 percent, and of industrial countries by 1.8 percent. The declines are nearly twice as large in an amplified pandemic scenario in which containment is assumed to take longer.

It is still too early to make an assessment of the impact of the virus based on full statistical evidence. High frequency data are providing some indicators, but it is hard to assess the depth and the breadth of the pandemic as it spreads, and to precisely estimate how long it will take countries to return to normal activity levels. This paper seeks to illustrate the transmission channels and heterogenous impact of COVID19 on output and trade in different scenarios. The results presented here should be regarded as scenario analyses, not as projections. The implemented shocks are illustrative and based on previous episodes of global epidemics or on preliminary data.

The assumptions on the spread of the disease are not grounded in epidemiological projections, they do not take into consideration the quality of the health systems in the affected countries, transport connections to affected countries, and health policy responses to the outbreak. The model incorporates the decline in demand due to reduced production and incomes but does not fully capture the independent contraction in demand, except for the reductions in tourism and other services that require close human contact. It also does not include the decline in investor confidence and any financial repercussions. We capture some aspects of global value chains trade, but a fuller analysis will require a richer data set. This analysis will evolve as we fine tune assumptions in line with early impacts and evaluate potential scenarios of the spread of the virus.

2. Methodology, transmission channels, and scenarios

2.1 Global computable general equilibrium model Envisage

The quantitative findings in this paper are based on simulations using a version of the Envisage model calibrated to GTAP Version 10A (Aguiar et al. (2019); see Annex 1 for aggregation mappings). The latter has a 2014 reference year and the model is being used in its comparative static specification. Envisage is a relatively standard computable general equilibrium (CGE) model.[2] The model has been configured for a short-term closure with the following assumptions:

- Production elasticities have been reduced to near zero, so there is little substitution possibility across inputs in production.
- In order to capture the typically durable relationship within global value chains, trade elasticities for goods have been reduced from their standard values to represent the short-run inability to replace imported components and final goods with products from other countries. The elasticity between domestic and imported goods has been set to 0.4. The elasticity of substitution across import sources has been set to 0.8.
- Labor supply is exogenous, while wages adjust to equate demand and supply of labor. The return to capital is fixed, while supply of capital is endogenous.

2.2 Transmission channels

The shocks have been divided into four sets, but all are assumed to occur simultaneously, i.e. the final shock encompasses all shocks.[3] The duration of the shocks is currently unknown, though, based on prior events, it is likely to last from 8-12 weeks and most likely unsynchronized across countries.

1. The first shock is a drop in employment by 3 percent below the baseline. With lower availability of labor, we would expect wages, ceteris paribus, to rise, while return to capital is unchanged under our assumptions. Lower labor also means lower demand for capital, as firms need a combination of labor and capital to produce goods and services.

Underutilization of capacity takes place due to factory closures (workers stay home, leaving capital and natural resources idle) as well as social distancing forcing workers to stay at home. Due to higher rates of contagion, immediate unemployment consequences of COVID-related business closures and negative demand shock, we conservatively assume the underutilization of the labor force to be 3% on average over the whole year across all sectors of the economy.[4] There is a lot of uncertainty surrounding these assumptions, and the country-specific employment effects will depend on the duration and intensity of the pandemic and containment measures, the sectoral composition of employment, and the flexibility of the labor market.

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[2] A full description of the Envisage model is available at https://mygeohub.org/groups/gtap/File:/uploads/ENVISAGE10.01_Documentation.pdf.

[3] The shocks are scaled down as compared with the shocks derived for Liberia under the Ebola epidemic, as in Evans et al. (2014).

[4] This is a conservative estimate. Some estimates put potential reduction of employment at the annual level at 10%, assuming unemployment of over 30% in Q2 and returning to pre-crisis level in Q3 and Q4. https://www.stlouisfed.org/on-the-economy/2020/march/back-envelope-estimates-next-quarters-unemployment-rate

2. The second shock (cumulative with the supply shock) raises the international trade costs of imports and exports by 25%. The shock is applied across all goods and services. Trade costs arise when goods cross borders.

The assumed increase in transport and transactions costs in foreign trade is driven by additional inspections, reduced hours of operation, road closures, border closures, increases in transport costs, etc. Evans et al. (2015) estimate that the outbreak of Ebola could lead to an increase in trade costs of 10%. Since COVID-19 is affecting more countries and the containment measures seem more severe due to the efforts to contain the virus, we amplified the shock increasing international trade costs of imports and exports to 25%.

3. The third shock entails a sharp drop in international tourism. This is captured via a 50% consumption tax on international tourism-related services, such as transport, accommodation, etc. This generates a typically small revenue for the relevant countries that is rebated back to households with a lump sum.[5] The export tax is applied to both outbound and inbound (tourist) services that include: accommodation, food and service activities; water, air and other transport; and recreational and other services.

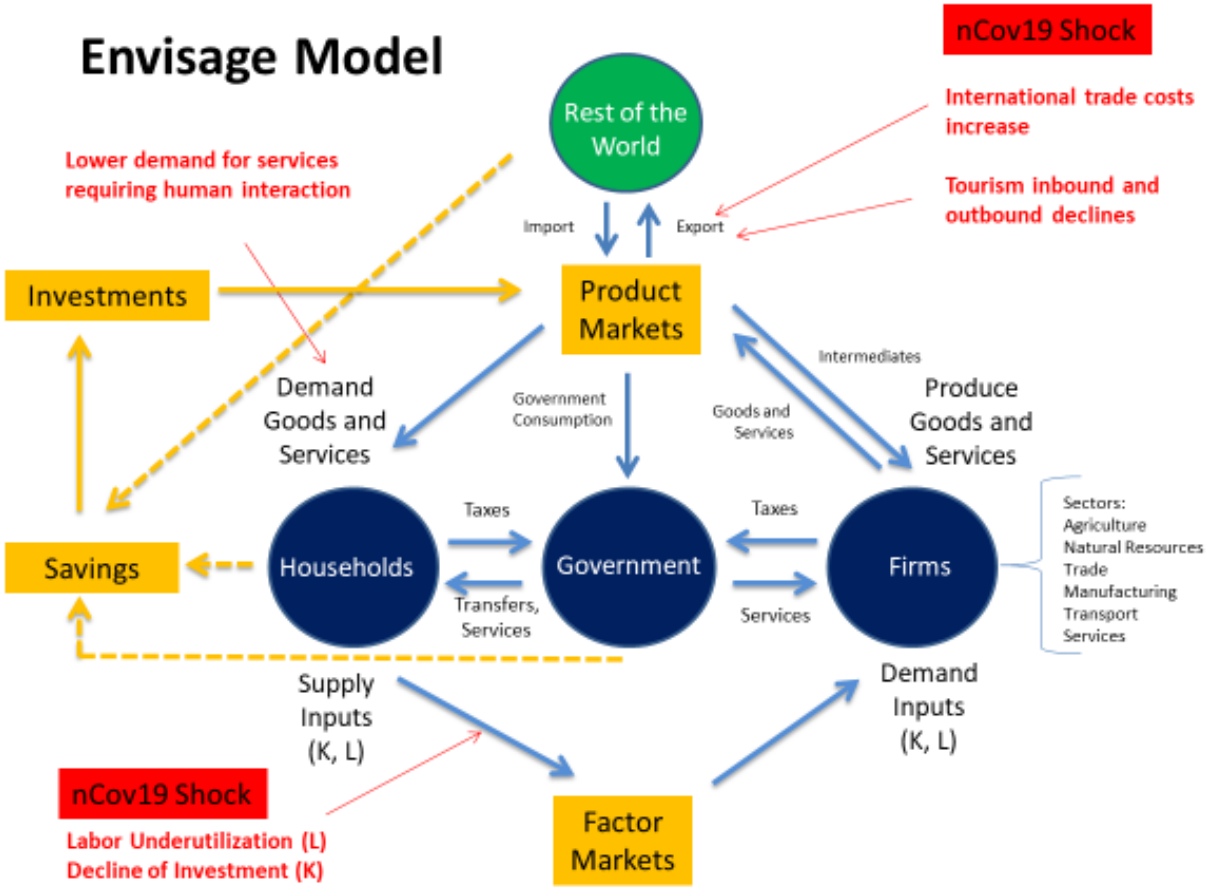
The effects of COVID-19 in the tourism, hospitality and recreation sectors have been unprecedented. In the accommodation and lodging sectors, quarterly revenues are down 75%. Travel agents saw a slowdown in bookings of 50% in March of 2020. Airlines worldwide are expected to lose $113 billion in revenues for 2020. In the peak of the outbreak, 70% of scheduled flights in China have been canceled. As of mid-March 2020, international travel has ground to a halt, with the World Travel and Tourism Council (WTTC) estimating that global travel would decline at least 25 percent in 2020. To capture the effects of the drop in tourism, hospitality and recreation services, we implemented a 50% tax on the export of trade-related services, resulting in a drop in exports of tourism services at a global level of 20-32%.

4. The fourth shock represents a demand switch by households who purchase fewer services requiring close human interaction, such as mass transport, domestic tourism, restaurants, and recreational activities, while redirecting demand towards consumption of goods and other services. Demand for the targeted services is assumed to drop by 15%. This results in a reallocation of household demand across sectors, while total expenditures are still driven by previous shocks and relative prices of goods in the consumption basket.

It is difficult to estimate the impact of social distancing and overall decline of economic activity on those selected sectors, but anecdotal evidence suggests that it is likely to be significant. With social distancing measures and closures of nonessential businesses, the bookings through Opentable network declined by 100% in the second half of March (data form the United States, the United Kingdom, and Germany). Depending on the length of the business closures, the annual impact could vary drastically. The decline of 15% at an annual level seems like a middle of the road estimate.

[5] There are a number of ways to affect demand choices by increasing the cost of purchasing the relevant good. The solution in this case has been to impose export taxes that directly affect the price of the targeted services. The revenues generated by this tax are rebated back to households.

Figure 1. Implications of the COVID-19 as implemented in the Envisage model.



2. 3 Scenarios

We start by considering the effects of COVID-19 on world supply capacity, trade costs, international tourism, and demand switching, as discussed above. Then we study the consequence of similar shocks under the "amplified global pandemic" scenario.

"Global pandemic" scenario

In the global pandemic scenario, we aim to capture relatively rapid recovery and limited contagion, where the shocks are implemented to the full degree in China, but other countries experience shocks amounting to only half the shocks described below:

- Underutilization of labor by 3 percent across all sectors in the global economy results in declining capital usage.
- Trade costs of global imports and exports increase by 25%, applied across all goods and services.
- Sharp drop in international tourism (captured via a 50% tax on inbound and outbound tourist-related services such as transport, accommodation, etc.).
- Reallocation of demand away from sectors requiring human interaction.

"Amplified global pandemic" scenario

In the amplified global pandemic scenario, we capture a bigger reduction in annual output due to a deeper and more prolonged pandemic. The same shocks are assumed in all countries, effectively doubling the shocks for all countries and keeping the China shock unchanged.

3. Impacts of COVID-19

3.1 Macroeconomic impacts

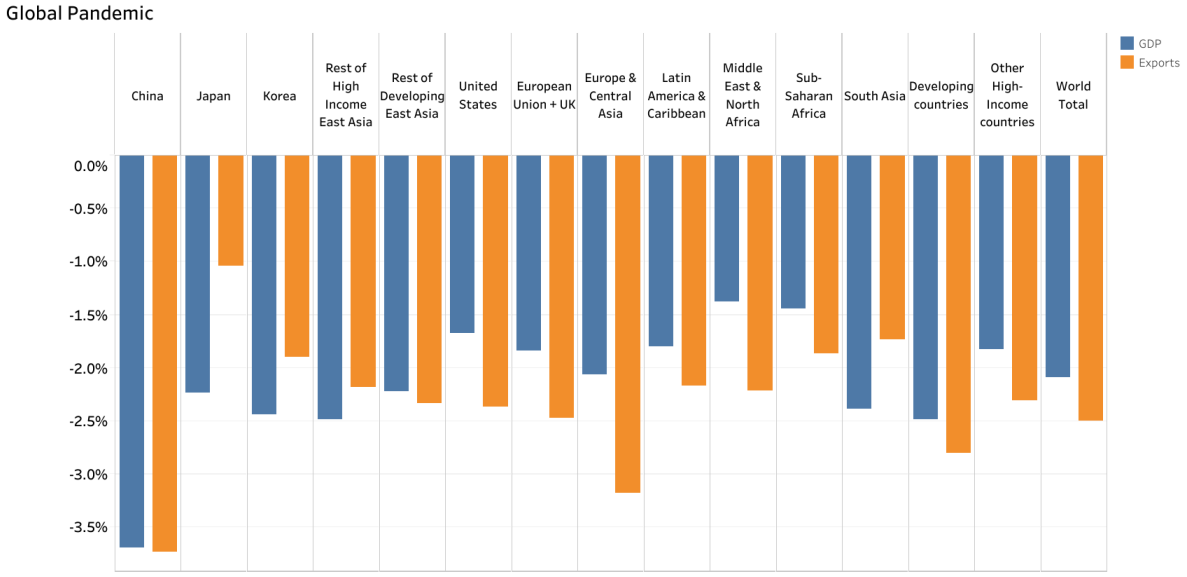
The global pandemic scenario assumes that the pandemic hits China the hardest, but also hurts other countries, so we use it as an example to explain the impacts on other countries. The global pandemic is expected to reduce Chinese GDP by 3.7% (all percentage changes are reported in relation to the baseline). The impact on China becomes progressively more negative as impacts of the shocks accumulate. First, the supply shock reduces GDP through reduction in employment (and capital) leading to lower production and exports, as well as lower imports due to lower income of households and shrinking production.

Second, with higher trade costs, the price of a unit of imports and exports increases and the competitiveness of Chinese production declines due to higher costs of exporting and higher costs of inputs; final goods' prices also increase. The rising trade costs represent a productivity loss, since additional inputs are needed to bring goods to their consumers, instead of being available for consumption and investment. Further, inbound and outbound tourism decreases significantly, resulting in further decline of Chinese GDP and exports. Finally, with the composition of expenditures changing with lower demand for sectors hit by social distancing (transport, hospitality) and relatively higher demand for goods, the composition of output tilts towards manufacturing. Loss of competitiveness and lower income result in a decline of total exports by 3.5%, while imports decline by 3.2 %. China's exports of tourist-related activities decline by 29%, while imports of tourist-related activities decline by 37%. Real consumption by households declines by 7.2%.

Global GDP is expected to decline by 2.1%, while developing countries' GDP is expected to decline by 2.5% and high-income countries by 1.9%. The biggest GDP losses under the global pandemic scenario are expected in East Asia and Pacific (EAP) countries due to their relatively deep integration through trade and direct impact on tourism, e.g. Cambodia (3.2 %), Singapore (2.1 %), Hong Kong SAR, China (2.3 %), Thailand (3 %), Vietnam (2.7 %), and Malaysia (2.1 %).

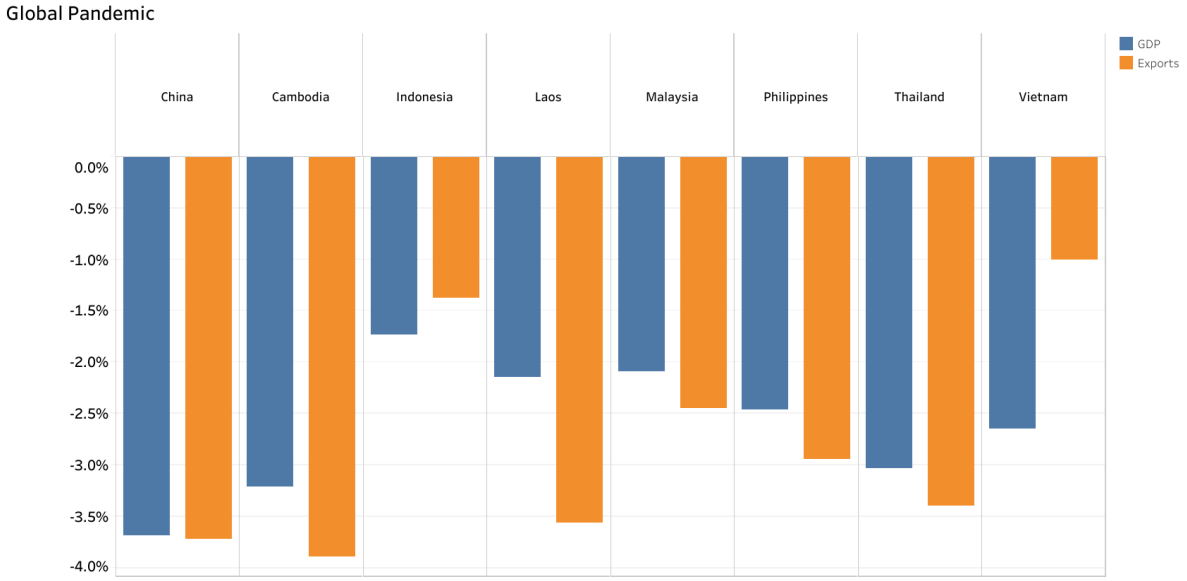
Exports at the global level are expected to decrease by 2.5%. China, considered to be the "world's factory", suffers a decline in production across all sectors and goods, due to an underutilization of labor and capital, and, together with an increase of its trade costs, increases the import costs for the rest of the world, which translates into a decline in global exports. China sees a contraction in exports of 3.7%. Vietnam 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. Some countries in the East Asia and Pacific region are the most affected in terms of export declines, with Hong Kong SAR, China, suffering the biggest losses (5.2 %), followed by the Lao People's Democratic Republic (3.6%), Cambodia (3.9%) and Singapore (4.4%). Selected countries see an increased demand for their tourism exports due to diversion of tourism from the EAP region, with some flows increasing by 2%-3% between countries outside the EAP region, but in all countries total tourism flows decline across the board, with exports from the EAP region declining by about 30%. These small bilateral tourism export gains disappear, as the shock spreads from China and East Asia to other parts of the world.

Figure 2a. GDP and export implications of the global pandemic scenario (% deviation from the benchmark)



Source: Envisage simulations

Figure 2b. GDP and export implications of global pandemic scenario for EAP countries (% deviation from the benchmark)



Source: Envisage simulations

Under amplified global pandemic scenarios, global GDP loss reaches 3.9 %, while Chinese GPD declines by 4.3% (Figures 3a, 3b). The biggest GDP losses are reported in the regions most integrated through trade and/or where tourism trade plays a big role in the economy. Cambodia and Thailand are expected to record GDP losses of over 6%, while Singapore; Hong Kong SAR, China; Taiwan, China; the Republic of Korea; Malaysia and the Philippines see losses of over 4.5%, which are also of higher magnitude than in China. High-income countries could see significant losses of GDP, with the estimated loss in the European

Union over 3.4%, Japan – 4.6%, the United States – 3.4% and Canada – 3.2%. Countries in Sub-Saharan Africa (SSA) and the Middle East and North Africa (MENA) are the least affected, and under the global and amplified global pandemic scenarios, the estimated loss of GDP is estimated to be around 3%.

Under the amplified global pandemic scenario, global exports decline 4.6 %. Several countries that experience larger than global average losses of exports are in the EAP region such as Hong Kong SAR, China (9.8%), Cambodia (7.4%), Singapore (8.5%), Lao PDR (7.3%), Thailand (6.8%), but also the Russian Federation and the Philippines see losses up of 6.4%, while Canada, Europe, and the United States see declines of around 4.5%. With the amplified global spread of the virus, all countries see their total exports decline, but the least integrated regions through trade and tourism, such as MENA, SSA, and Latin America and the Caribbean, are the least affected. Some EAP countries tend to be relatively less affected in this scenario than others, but all countries' exports decline the most under the amplified global pandemic scenario, e.g., Vietnam, Japan, and Korea.

Our estimates are broadly in line with previous studies. Annex 2 reviews several analyses by OECD, Brookings and S&P quantifying the potential impacts of the COVID-19 outbreak. The studies use a variety of tools, with OECD relying on a macroeconomic model and Brookings applying a hybrid CGE/DSGE model with rational expectations. Most estimates on the impacts on China range from 0.5% to 2% of GDP. World GDP is expected to decline between 0.1% and 1.5 %, while global trade is expected to decline between 0.2% and 3.75 %. The biggest impacts are reported in the extreme scenarios by McKibbin and Fernando (2020), with Chinese GDP declining by up to 6%, with GDP declines in the United States and Japan reaching, respectively, 8% and 10%.

Table 1: GDP implications of various scenarios - cumulative impacts (% deviations from the benchmark)

	Global pandemic	Amplified global pandemic
China	-3.69	-4.31
Developing EAP excluding China	-2.38	-4.76
Cambodia	-3.21	-6.57
Lao PDR	-2.15	-4.05
Malaysia	-2.09	-4.23
Thailand	-3.03	-6.21
Vietnam	-2.65	-4.49
Philippines	-2.46	-4.80
Indonesia	-1.74	-3.51
Hong Kong SAR, China	-2.31	-4.82
Korea, Rep.	-2.44	-4.89
Singapore	-2.08	-4.45
Taiwan, China	-2.81	-5.67
Canada	-1.57	-3.18
Europe	-1.85	-3.85
Japan	-2.23	-4.57
United States	-1.67	-3.40
Middle East & North Africa	-1.38	-2.95
Sub-Saharan Africa	-1.44	-2.95
Brazil	-1.71	-3.42
Rest of Latin America & Caribbean	-1.85	-3.73
Russian Federation	-1.94	-3.99
Rest of Europe & Central Asia	-2.21	-4.60
India	-2.41	-4.93
Rest of South Asia	-2.31	-4.68
Oceania	-1.70	-3.37
Developing countries	-2.49	-4.00
High-income countries	-1.84	-3.77
World Total	-2.09	-3.86

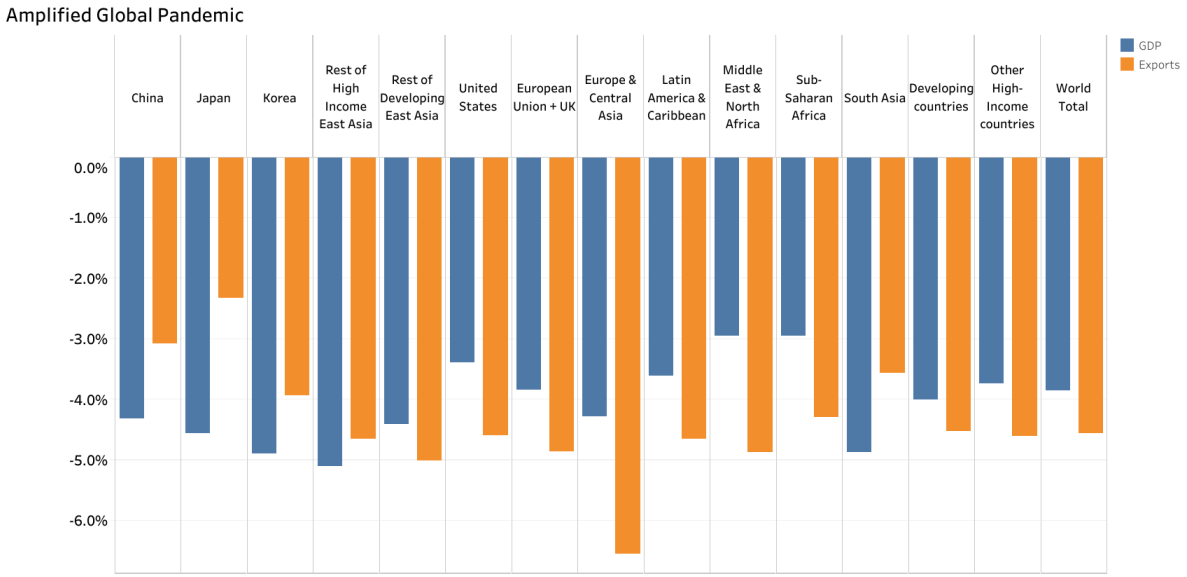
Source: Envisage simulations

Table 2: Real exports implications of various scenarios - cumulative impacts (% deviations from the benchmark)

	Global pandemic	Amplified global pandemic
China	-3.73	-3.08
Developing EAP excluding China	-1.75	-4.07
Cambodia	-3.89	-7.40
Lao PDR	-3.57	-7.29
Malaysia	-2.45	-5.28
Thailand	-3.40	-6.81
Vietnam	-1.00	-2.82
Philippines	-2.94	-6.35
Indonesia	-1.38	-3.21
Hong Kong SAR, China	-5.18	-9.80
Korea, Rep.	-1.90	-3.95
Singapore	-4.39	-8.48
Taiwan, China	1.14	1.07
Canada	-2.30	-4.73
Europe	-2.48	-4.86
Japan	-1.04	-2.33
United States	-2.37	-4.60
Middle East & North Africa	-2.22	-4.87
Sub-Saharan Africa	-1.87	-4.29
Brazil	-2.03	-4.27
Rest of Latin America & Caribbean	-2.21	-4.76
Russian Federation	-3.49	-7.44
Rest of Europe & Central Asia	-2.89	-5.72
India	-1.68	-3.45
Rest of South Asia	-1.99	-4.12
Oceania	-2.32	-4.98
Developing countries	-2.80	-4.54
High-income countries	-2.30	-4.59
World Total	-2.50	-4.57

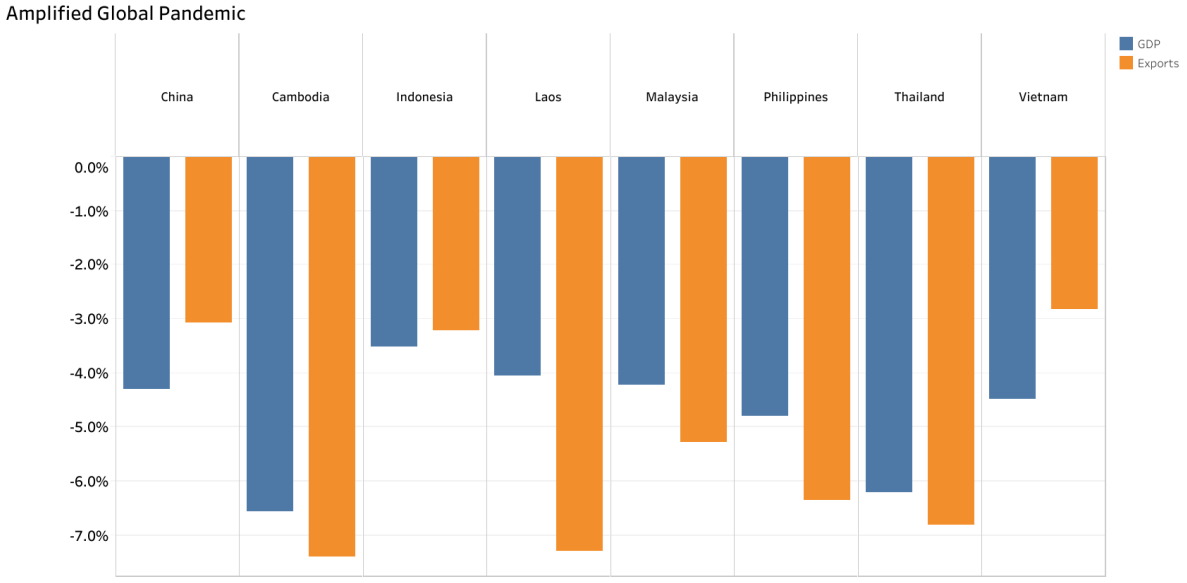
Source: Envisage simulations

Figure 3a. GDP and export implications of amplified global pandemic scenario (% deviation from the benchmark)



Source: Envisage simulations

Figure 3b. GDP and export implications of amplified global pandemic scenario (% deviation from the benchmark)



Source: Envisage simulations

3.2 Trade impacts

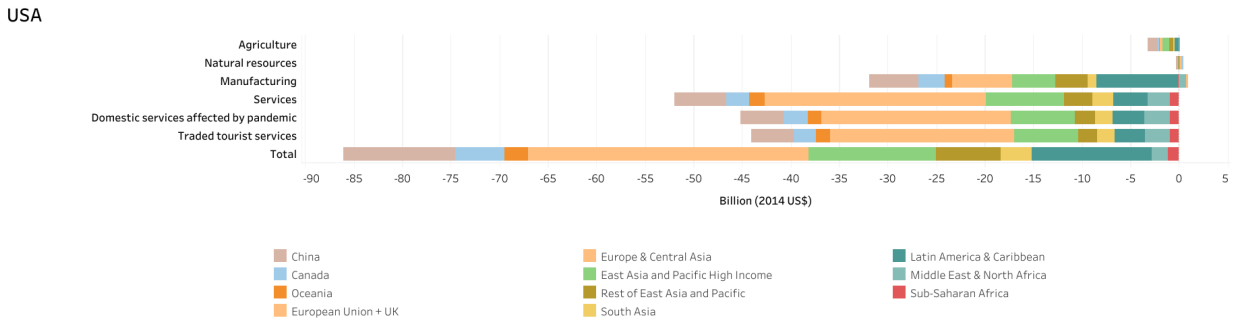
In our illustrative simulations of the shocks are identical across countries, and the deep recession under the amplified global pandemic scenario results in negative impacts on exports across all sectors and most destinations. The country-specific results are driven by the initial composition of output and exports by sector and destination, but also by the country's level of openness and relative changes in the competitiveness of the exporting country and its trading partners.

Under the amplified global pandemic scenario, US exports are expected to decline by almost $85 billion (2014 dollars) (Figure 4a). The most impacted are exports of services, especially tourism and services requiring face-to-face interaction. The biggest declines are expected in exports to Europe and EAP, driven by recession and lower demand in those regions, the main destinations for US exports in services.

In the case of China, the biggest decline of exports is registered in manufacturing goods, and in Chinese exports directed to the United States, Europe and EAP countries (Figure 4b). There is a small increase in exports to ECA and MENA countries, where Chinese products become relatively more competitive than products of other suppliers, and where domestic producers cannot fully satisfy the domestic demand.

Finally, in the case of Thailand, the biggest impacts are on exports of manufacturing goods and services, with very little impact on agricultural goods or natural resources (Figure 4c). Services exports to the United States and Europe register the biggest declines, while manufacturing exports to China and EAP partners take the biggest hit.

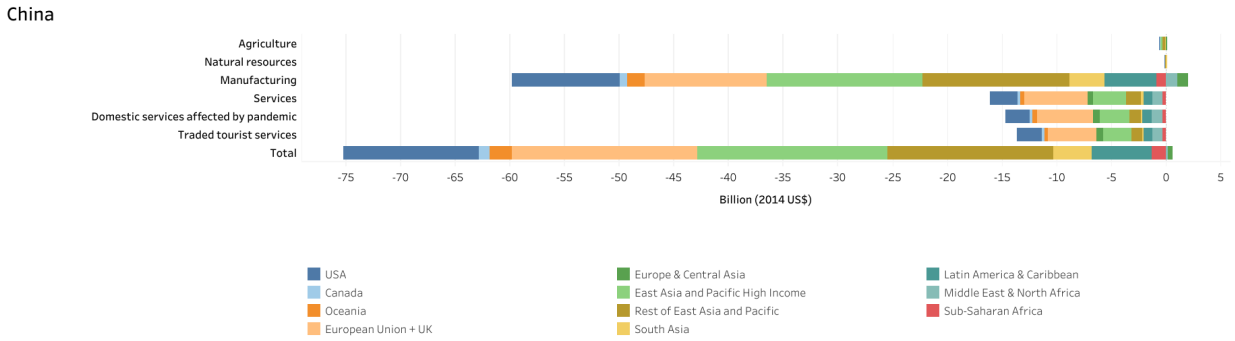
Figure 4a. Impacts on US exports in the amplified global pandemic scenario (difference from the benchmark)



Note: Europe & Central Asia – Russian Federation, rest of Europe & Central Asia; East Asia and Pacific High Income - Hong Kong SAR, China; Japan; Republic of Korea; Singapore; South Asia – India, rest of South Asia; Latin America & Caribbean – Brazil, rest of Latin America & Caribbean;

Source: Envisage simulations

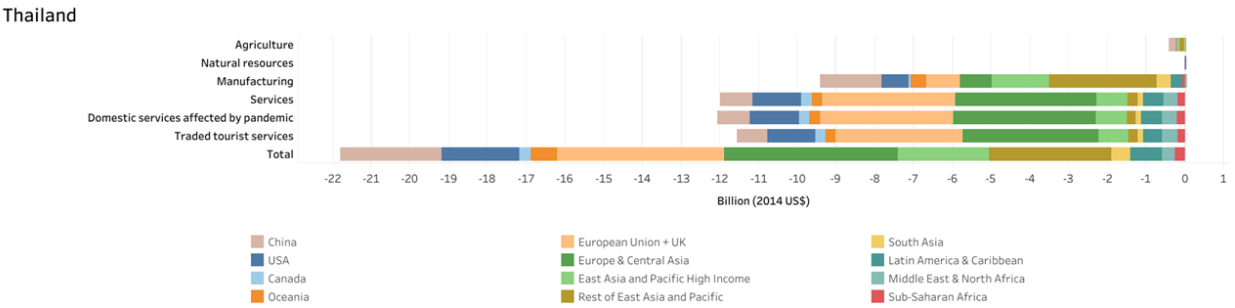
Figure 4b. Impacts on Chinese exports in the amplified global pandemic scenario (difference from the benchmark)



Source: Envisage simulations

Note: Europe & Central Asia – Russian Federation, rest of Europe & Central Asia; East Asia and Pacific High Income - Hong Kong SAR, China; Japan; Republic of Korea; Singapore; South Asia – India, rest of South Asia; Latin America & Caribbean – Brazil, rest of Latin America & Caribbean;

Figure 4c. Impacts on Thai exports in the amplified global pandemic scenario (difference from the benchmark)



Note: Europe & Central Asia – Russian Federation, rest of Europe & Central Asia; East Asia and Pacific High Income - Hong Kong SAR, China; Japan; Republic of Korea; Singapore; South Asia – India, rest of South Asia; Latin America & Caribbean – Brazil, rest of Latin America & Caribbean;

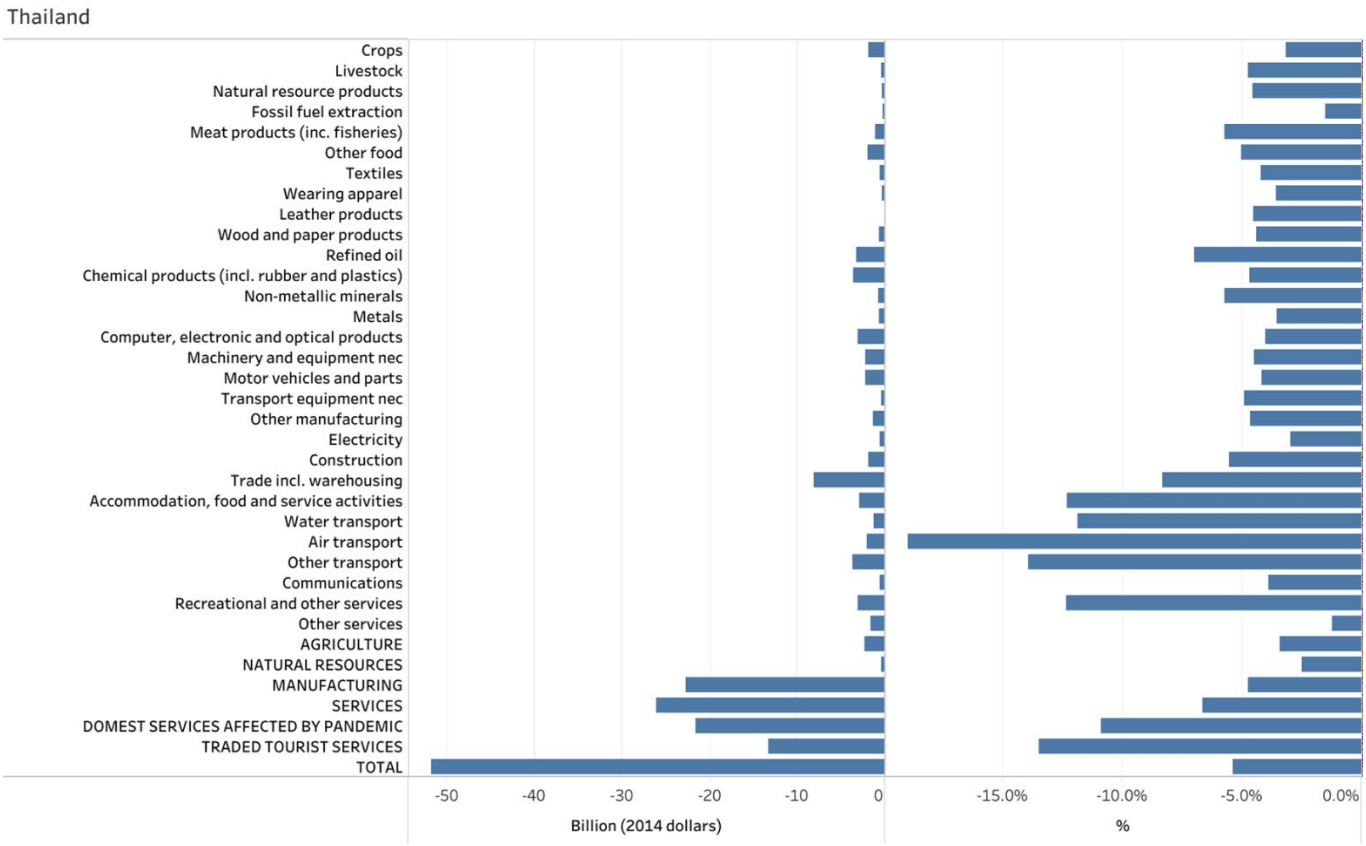
Source: Envisage simulations

3.3 Sectoral output impacts

Each transmission channel results in a somewhat different sectoral reallocation of output due to changes in demand and supply. The first shock affects all sectors in a similar fashion, by limiting the availability of labor and capital, though labor-intensive sectors are likely to be hit harder. The trade costs impact tradeable sectors, as well as goods and services that rely heavily on imported inputs. The increase in the tourism tax results in a decline of tourism, but all other industries that supply inputs needed to generate tourism services will be impacted by a negative demand shock as well. Finally, social distancing results in lower demand for selected sectors, but some substitution towards goods and remaining services sectors. Overall, the sectoral impact of the amplified global pandemic scenario (Table 3) leads to a steeper decline in services as compared to agriculture and manufacturing. The biggest negative shock is recorded in the output of domestic services affected by the pandemic, as well as in traded tourist services. At the global level, output of services affected by the pandemic could decline by 9.3%, tourism services could decline by 8.8%, with a decline in agricultural and manufacturing output of about 3%.

Under the amplified global pandemic scenario, Thailand, for example, is expected to record an aggregate output loss of 5.3%, the largest drop among the developing countries covered by our analysis (Figure 5). All sectors would see a decline of output, but the biggest percentage drops are recorded in transport services, recreational activities, and accommodation (between 10% and 20%). However, the sectors that suffer the most in absolute terms include trade and selected agricultural (crops) and manufacturing goods (chemicals, electronics, refined oil). These are the real impacts on the volume of output. The declining commodity prices and changing relative prices would result in a somewhat different ranking of the most impacted sectors. These are only illustrative impacts that rely on the type and the size of the assumed shocks. However, they serve as a useful representation of distributional impacts across sectors, with likely diverse impacts on employment and wages of skilled and unskilled workers, as well as female and male workers. Further analysis will be conducted to understand the potential distributional impacts of the pandemic.

Figure 5. Output implications of Amplified Global pandemic scenario for Thailand (difference and % deviation from the benchmark)



Note: Agriculture – Crops, Livestock; Manufacturing - Meat products (incl. fisheries), Other food, Textiles, Wearing apparel, Leather products, Wood and paper products, Refined oil, Chemical products (incl. rubber and plastics), Non-metallic minerals, Metals, Computer, electronic and optical products, Machinery and equipment nec, Motor vehicles and parts, Transport equipment nec, Other manufacturing; Services – Electricity, Construction, Trade incl. warehousing, Accommodation, food and service activities, Water transport, Air transport, Other transport, Communications, Recreational and other services, Other services; Natural resources - Natural resource products, Fossil fuel extraction; Domestic services affected by pandemic - Trade, Accommodation, food and service activities, Water transport, Air transport, Other transport, Recreational and other services; Traded tourist services - Accommodation, food and service activities, Water transport, Air transport, Other transport, Recreational and other services.

Source: Envisage simulations

Table 3. Output implications of amplified global pandemic – cumulative impacts (% deviations from the benchmark)

	Agriculture	Natural resources	Manufacturing	Services	Domestic services affected by pandemic	Traded tourist services	Total
China	-3.12	-1.08	-3.61	-3.67	-4.85	-4.64	-3.54
Developing EAP excluding China	-2.70	-1.04	-3.21	-5.40	-9.45	-11.28	-4.12
Cambodia	-2.87	-3.98	-2.69	-9.66	-14.96	-19.00	-5.11
Lao PDR	-2.41	-3.89	-2.60	-5.85	-12.18	-15.02	-3.57
Malaysia	-4.19	-0.79	-4.11	-4.34	-7.30	-9.73	-4.03
Thailand	-3.06	-2.91	-4.43	-6.84	-11.53	-14.64	-5.29
Vietnam	-3.06	-0.72	-3.34	-3.93	-8.52	-8.99	-3.37
Philippines	-2.51	-2.65	-3.93	-5.16	-11.10	-13.30	-4.44
Indonesia	-2.70	-0.61	-3.03	-3.67	-7.65	-8.84	-3.15
Hong Kong SAR, China	-1.29	-3.24	-1.33	-6.06	-8.46	-9.23	-5.35
Korea, Rep.	-3.91	-4.25	-3.68	-4.53	-6.87	-6.15	-4.10
Singapore	-2.61	-3.47	-4.32	-4.01	-7.18	-6.28	-4.11
Taiwan, China	-1.04	-7.75	-1.80	-6.84	-7.82	-7.17	-4.15
Canada	-4.30	-1.10	-3.25	-3.02	-8.95	-9.16	-2.96
Europe	-3.00	-1.02	-2.89	-4.02	-9.04	-9.06	-3.65
Japan	-4.71	-2.85	-2.77	-4.62	-8.75	-8.35	-3.98
United States	-3.60	-0.21	-2.45	-3.80	-9.99	-11.27	-3.38
Middle East & North Africa	-2.76	-1.65	-2.67	-3.02	-9.11	-10.03	-2.65
Sub-Saharan Africa	-2.51	-1.72	-2.95	-3.02	-6.35	-8.13	-2.79
Brazil	-3.40	-1.20	-2.86	-3.14	-8.55	-9.28	-2.99
Rest of Latin America & Caribbean	-2.64	-1.21	-2.94	-4.05	-10.51	-11.87	-3.49
Russian Federation	-3.00	-2.19	-3.73	-3.86	-8.72	-9.62	-3.58
Rest of Europe & Central Asia	-2.20	-0.59	-3.53	-5.07	-10.20	-11.36	-4.20
India	-3.36	-0.84	-3.98	-4.35	-8.23	-8.76	-4.03
Rest of South Asia	-2.62	-2.64	-3.25	-5.23	-8.04	-9.28	-4.14
Oceania	-3.93	-1.89	-3.10	-3.20	-8.21	-8.07	-3.11
Developing countries	-2.90	-1.42	-3.47	-3.87	-7.98	-8.63	-3.51
High-income countries	-3.49	-0.95	-2.78	-4.00	-9.20	-9.60	-3.59
World Total	-3.04	-1.29	-3.13	-3.95	-8.77	-9.26	-3.56

Note: Agriculture – Crops, Livestock; Manufacturing - Meat products (incl. fisheries), Other food, Textiles, Wearing apparel, Leather products, Wood and paper products, Refined oil, Chemical products (incl. rubber and plastics), Non-metallic minerals, Metals, Computer, electronic and optical products, Machinery and equipment nec, Motor vehicles and parts, Transport equipment nec, Other manufacturing; Services – Electricity, Construction, Trade incl. warehousing, Accommodation, food and service activities, Water transport, Air transport, Other transport, Communications, Recreational and other services, Other services; Natural resources - Natural resource products, Fossil fuel extraction; Domestic services affected by pandemic - Trade, Accommodation, food and service activities, Water transport, Air transport, Other transport, Recreational and other services; Traded tourist services - Accommodation, food and service activities, Water transport, Air transport, Other transport, Recreational and other services.

Source: Envisage simulations

4. Conclusion

COVID-19 is spreading fast across the globe. At the time of writing,[6] the WHO reported cases of COVID-19 in 206 countries with the tragic deaths of more than 40,000 people. The primary focus is necessarily on containment, treating the ill and helping communities cope with the epidemic. Our illustrative scenarios indicate that the potential loss of income in affected countries could be significant, with global GDP declining by up to 3.9%, and developing countries hit the hardest (4% on average, but some over 6.5%). Governments will need to offer significant support to affected businesses and households.

Our analysis is likely to underestimate the potential economic costs of the epidemic. We do not fully capture several important channels, such as the uncertainty-driven contraction in demand and FDI, and other real effects of a financial shock. We capture some aspects of global value chains trade through input-output linkages and assumptions that mimic the durability of relationships between firms in value chains but plan to extend the analysis using a richer data set. We have examined, but not yet finalized, the effects of raising domestic trade costs as well as demand switching away from activities requiring direct contact with other people. Our analysis will evolve as we bring assumptions and scenarios in line with more recent health and economic indicators.

Early indications of the economic costs and the magnitude of estimated impacts demonstrate the need for a coordinated international response to the crisis. A global crisis requires a global response and there is a need for global collaboration not just on health, but also on trade, finance and macroeconomic policies. Fortunately, global institutions are beginning to catalyze and coordinate global efforts, as well as to provide technical and financial support to countries coping with the health and economic consequences of the outbreak.

[6] March 31, 2020.

Annex 1 Regional and sectoral aggregations

Regional concordance

	Region/Country	GTAP concordance
1	Oceania (ANZ)	Australia (AUS), New Zealand (NZL)
2	Rest of Oceania (XOC)	Rest of Oceania (XOC)
3	China (CHN)	China (CHN)
4	Hong Kong SAR, China (HKG)	Hong Kong (HKG)
5	Japan (JPN)	Japan (JPN)
6	Korea, Rep. (KOR)	Korea (KOR)
7	Taiwan, China (TWN)	Taiwan (TWN)
8	Cambodia (KHM)	Cambodia (KHM)
9	Indonesia (IDN)	Indonesia (IDN)
10	Lao PDR (LAO)	Laos (LAO)
11	Malaysia (MYS)	Malaysia (MYS)
12	Philippines (PHL)	Philippines (PHL)
13	Singapore (SGP)	Singapore (SGP)
14	Thailand (THA)	Thailand (THA)
15	Vietnam (VNM)	Viet Nam (VNM)
16	Rest of East Asia (XEA)	Mongolia (MNG), Rest of East Asia (XEA), Brunei Darussalam (BRN), Rest of Southeast Asia (XSE)
17	India (IND)	India (IND)
18	Rest of South Asia (XSA)	Bangladesh (BGD), Nepal (NPL), Pakistan (PAK), Sri Lanka (LKA), Rest of South Asia (XSA)
19	Canada (CAN)	Canada (CAN)
20	United States (USA)	United States of America (USA)
21	Brazil (BRA)	Brazil (BRA)
22	Rest of Latin America & Caribbean (XLC)	Mexico (MEX), Rest of North America (XNA), Argentina (ARG), Bolivia (BOL), Chile (CHL), Colombia (COL), Ecuador (ECU), Paraguay (PRY), Peru (PER), Uruguay (URY), Venezuela (VEN), Rest of South America (XSM), Costa Rica (CRI), Guatemala (GTM), Honduras (HND), Nicaragua (NIC), Panama (PAN), El Salvador (SLV), Rest of Central America (XCA), Dominican Republic (DOM), Jamaica (JAM), Puerto Rico (PRI), Trinidad and Tobago (TTO), Rest of Caribbean (XCB)
23	Europe (EUR)	Austria (AUT), Belgium (BEL), Cyprus (CYP), Czech Republic (CZE), Denmark (DNK), Estonia (EST), Finland (FIN), France (FRA), Germany (DEU), Greece (GRC), Hungary (HUN), Ireland (IRL), Italy (ITA), Latvia (LVA), Lithuania (LTU), Luxembourg (LUX), Malta (MLT), Netherlands (NLD), Poland (POL), Portugal (PRT), Slovakia (SVK), Slovenia (SVN), Spain (ESP), Sweden (SWE), United Kingdom (GBR), Switzerland (CHE), Norway (NOR), Rest of EFTA (XEF), Rest of Europe (XER), Rest of the World (XTW)
24	Russian Federation (RUS)	Russian Federation (RUS)
25	Rest of Europe & Central Asia (XEC)	Albania (ALB), Bulgaria (BGR), Belarus (BLR), Croatia (HRV), Romania (ROU), Ukraine (UKR), Rest of Eastern Europe (XEE), Kazakhstan (KAZ), Kyrgyzstan (KGZ), Tajikistan (TJK), Rest of Former Soviet Union (XSU), Armenia (ARM), Azerbaijan (AZE), Georgia (GEO), Turkey (TUR)

26	Middle East & North Africa (MNA)	Bahrain (BHR), Iran (IRN), Israel (ISR), Jordan (JOR), Kuwait (KWT), Oman (OMN), Qatar (QAT), Saudi Arabia (SAU), United Arab Emirates (ARE), Rest of Western Asia (XWS), Egypt (EGY), Morocco (MAR), Tunisia (TUN), Rest of North Africa (XNF)
27	Sub-Saharan Africa (SSA)	Benin (BEN), Burkina Faso (BFA), Cameroon (CMR), Côte d'Ivoire (CIV), Ghana (GHA), Guinea (GIN), Nigeria (NGA), Senegal (SEN), Togo (TGO), Rest of Western Africa (XWF), Central Africa (XCF), Rest of South-Central Africa (XAC), Ethiopia (ETH), Kenya (KEN), Madagascar (MDG), Malawi (MWI), Mauritius (MUS), Mozambique (MOZ), Rwanda (RWA), Tanzania (TZA), Uganda (UGA), Zambia (ZMB), Zimbabwe (ZWE), Rest of Eastern Africa (XEC), Botswana (BWA), Namibia (NAM), South Africa (ZAF), Rest of South African Customs Union (XSC)

Sector concordance

1	Crops (crp)	Paddy rice (PDR), Wheat (WHT), Cereal grains nec (GRO), Vegetables, fruit, nuts (V_F), Oil seeds (OSD), Sugar cane, sugar beet (C_B), Plant-based fibers (PFB), Crops nec (OCR), Processed rice (PCR), Sugar (SGR)
2	Livestock (lvs)	Bovine cattle, sheep and goats, horses (CTL), Animal products nec (OAP), Raw milk (RMK), Wool, silk-worm cocoons (WOL)
3	Natural resource products (NRS)	Forestry (FRS), Other Extraction (formerly omn Minerals nec) (OXT)
4	Fossil fuel extraction (FFL)	Coal (COA), Oil (OIL), Gas (GAS), Gas manufacture, distribution (GDT)
5	Meat products (inc. fisheries) (PMT)	Fishing (FSH), Bovine meat products (CMT), Meat products nec (OMT), Dairy products (MIL)
6	Other food (OFD)	Vegetable oils and fats (VOL), Food products nec (OFD), Beverages and tobacco products (B_T)
7	Textiles (TEX)	Textiles (TEX)
8	Wearing apparel (WAP)	Wearing apparel (WAP)
9	Leather products (LEA)	Leather products (LEA)
10	Wood and paper products (WDP)	Wood products (LUM), Paper products, publishing (PPP)
11	Refined oil (P_C)	Petroleum, coal products (P_C)
12	Chemical products (incl. rubber and plastics) (CHM)	Chemical products (CHM), Basic pharmaceutical products (BPH), Rubber and plastic products (RPP)
13	Non-metallic minerals (NMM)	Mineral products nec (NMM)
14	Metals (MET)	Ferrous metals (I_S), Metals nec (NFM)
15	Computer, electronic and optical products (ELE)	Computer, electronic and optical products (ELE)
16	Machinery and equipment nec (OME)	Electrical equipment (EEQ), Machinery and equipment nec (OME)
17	Motor vehicles and parts (MVH)	Motor vehicles and parts (MVH)
18	Transport equipment nec (OTN)	Transport equipment nec (OTN)
19	Other manufacturing (XMN)	Metal products (FMP), Manufactures nec (OMF)
20	Electricity (ELY)	Electricity (ELY)
21	Construction (CNS)	Construction (CNS)
22	Trade incl. warehousing (TRD)	Trade (TRD), warehousing and support activities (WHS)

23	Accommodation, food and service activities (AFS)	Accommodation, food and service activities (AFS)
24	Water transport (WTP)	Water transport (WTP)
25	Air transport (ATP)	Air transport (ATP)
26	Other transport (XTP)	Transport nec (OTP)
27	Communications (CMN)	Communication (CMN)
28	Recreational and other services (ROS)	Recreational and other services (ROS)
29	Other services (XSV)	Water (WTR), Financial services nec (OFI), Insurance (formerly isr) (INS), Real estate activities (RSA), Business services nec (OBS), Public Administration and defense (OSG), Education (EDU), Human health and social work activities (HHT), Dwellings (DWE)

Annex 2 Literature review on the impacts of Covid-19

Title & Authors	Model	Assumptions	Scenarios		Results
"Coronavirus: The world economy at risk" (OECD 2020)	NiGEM macro model	Monetary policy is allowed to be endogenous.; The automatic fiscal stabilisers are allowed to operate fully in all countries, implying that governments do not react to the shock by attempting to maintain a previously announced budget path.	Contained Outbreak (short lived but severe downturn in China)	-Domestic demand in China and Hong Kong, China is reduced by 4% in the first quarter of 2020, and 2% in the second quarter of 2020. -Global equity prices and non-food commodity prices are lowered by 10% in the first half of 2020. - Higher uncertainty is modelled via a small rise of 10 basis points in investment risk premia in all countries in the first half of 2020. This raises the cost of capital and reduces investment.	China GDP loss = -0.2 percentage point in 2020H1; Reduction of China import demand = -6%; World GDP is reduced by to 0.5 percentage point in 2020; Global trade declines 0.9% in 2020 (and 1.4% in first half of 2020)
			A "domino" scenario: broader contagion	-Domestic demand in most other Asia-Pacific economies, including Japan and Korea, and private consumption in the advanced northern hemisphere economies is reduced by 2% (relative to baseline) in the second and third quarters of 2020. - Global equity prices and non-food commodity prices are lowered by 20% in the first nine months of 2020. - Heighted uncertainty is modelled via an increase of 50 basis points in investment risk premia in all countries in 2020.	World GDP is reduced by up to 1 ½ per cent; World trade is declining by around 3 ¾ per cent in 2020
"Coronavirus Casts Shadow		Assumption that the supply side of the economy –	Only one scenario	Top Asia-Pacific: Risk Coronavirus restrictions set back China's growth (risk level: High);	China GDP growth loss of 0.7 percentage point in 2020. Full recover in 2021; Global GDP

Over Credit Outlook" (S&P 2020)		labor force, productive capital, and productivity – is unchanged, meaning that output after the coronavirus shock returns to its original path.		Top Global Risk: Coronavirus restrictions less systemic globally, with sector variations (risk level: elevated)	growth loss of 0.3 percentage; The U.S. and Europe may experience minimal reductions in growth, while the impact is largest in East Asia.
"The Global Macroeconomic Impacts of COVID-19" (McKibbin and Fernando 2020)	G-Cubed Multi-Country Model – Global hybrid DSGE/CGE	-6 sectors and 24 countries; Long-run stock equilibrium obtains through the adjustment of asset prices; Nominal wages are sticky and adjust over time based on country-specific labor contracting assumptions.; Short run rigidities; Heterogeneous households and firms	Scenario 1	China Shock, Low Severity, Temporary. Attack rate for China = 1%; Case fatality rate China = 2%	GDP loss (2020): China = -0.4%; USA = -0.1%; Japan = -0.3%; Korea = -0.1%
			Scenario 2	China Shock, Middle severity, Temporary. Attack rate for China = 10%; Case fatality rate China = 2.5%	GDP loss (2020): China = -1.9%; USA = -0.1%; Japan = -0.4%; Korea = -0.2%
			Scenario 3	China Shock, High severity, Temporary; Attack rate for China = 30%; Case fatality rate China = 3%	GDP loss (2020): China = -6%; USA = -0.2%; Japan = -0.5%; Korea = -0.3%
			Scenario 4	Global Shock, Low severity, Temporary; Attack rate for China = 10%; Case fatality rate China = 2%	GDP loss (2020): China = -1.6%; USA = -2%; Japan = -2.5%; Korea= -1.4%
			Scenario 5	Global Shock, Middle severity, Temporary; Attack rate for China = 20%; Case fatality rate China = 2.5%	GDP loss (2020): China = -3.6%; USA = -4.8%; Japan = -5.7%; Korea = -3.3%
			Scenario 6	Global Shock, High severity, Temporary; Attack rate for China = 30%; Case fatality rate China = 3%	GDP loss (2020): China = -6.2%; USA = -8.4%; Japan = -9.9% Korea = -5.8%
			Scenario 7	Global Shock, Low severity, Permanent; Attack rate for China = 10%; Case fatality rate China = 2%	GDP loss (2020): China = -2.2%; USA = -1.5%; Japan = -2%; Korea = -1.3%

"Coronavirus could cost the global economy $2.7 trillion." (Orlik et al. 2020)	NiGEM —a large scale model of the global economy; Static assessment	Model allows: -monetary policy to respond to weaker growth; - a degree of import substitution Model does not allow: -supply chain impacts to propagate beyond the countries in which they are first felt	Scenario 1	Major blow to China, and spillover to rest of world; shock to China's GDP in 1Q - China's GDP growth to slow 4.7 ppt below our baseline forecast	GDP loss (2020): World (1st Quarter) = -1.2% China = -0.7% Japan = -0.1% Indonesia = -0.3 Canada = -0.1% Germany = -0.1%
			Scenario 2	Outbreaks cause localized disruption, countries with reported >100 cases in early March suffer half of the shock to China	GDP loss (2020): World = -0.8% China = -1.5% Japan = 01% US = -0.2% France = -1.3% Germany = -1.2% Russia = -0.9%
			Scenario 3	Widespread contagion, countries with current reported cases >100 suffer the same shock as China, and countries with any reported cases suffer half of the shock suffered by China	GDP loss (2020): World = -1.9% China = -2% Japan = -2.2% Indonesia = -2.8 USA = -1.3% Germany = -2.8% Brazil = -1.7%
			Scenario 4	Global pandemic, all countries suffer a severe shock	GDP loss (2020): World = -3.1%

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