METHODOLOGY FOR THE WTO TRADE FORECAST OF APRIL 8 2020

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This paper describes the methodologies employed to generate the WTO trade forecast of April 2020. The approach consists of two quantitative parts, combined with expert judgements as needed. Part 1 describes the methodology used to develop estimates for GDP impacts. Part 2 describes the way in which the forecast for trade was generated based on the estimated GDP impacts.

The WTO's normal approach employs consensus estimates for GDP (usually drawn from IMF, World Bank, and OECD) in various regions as inputs into the trade forecast model. At the time of our most recent forecasting exercise, the available consensus estimates were not reflecting the drastically changing circumstances since March 2020 in the global economy because of the Covid-19 pandemic. We therefore found it necessary to generate our own GDP estimates.

In Part 1 three scenarios are developed for the impact of the Covid-19 pandemic, a V-shaped, U-shaped and L-shaped recovery scenario. The WTO Global Trade Model, a recursive dynamic CGE model, is employed to simulate the GDP effects of the crisis. We then choose two scenarios to generate the trade forecast, an optimistic scenario corresponding to a V-shaped recovery and a pessimistic scenario corresponding to a L-shaped recovery.

In Part 2, autoregressive distributed lag (ADL) equations are used to produce univariate estimates for selected countries and regions, which were then aggregated up to the global level. Inputs into the model are historical values for trade, GDP and other variables and then projections for GDP. Two scenarios were chosen to reflect the profound uncertainty about the duration of the pandemic and the economic mechanisms and responses that might play out through the economy.

Although the approach chosen is very model based, it involves expert judgements. The assumptions underlying the different scenarios have to be made based on limited information available and therefore required expert judgement from a number of perspectives. Furthermore, we use projections on GDP from a model that generates both GDP and trade impact estimates but then use only the GDP impacts in our other model to generate trade estimates. The reason to do so is twofold. First, we want the trade estimates to be generated in a consistent fashion as previous forecasts. Given the lack of up-to-date projections on GDP we think the current approach is the best choice. Second, the trade-to-GDP elasticity in CGE models is lower than historically observed during recessions. Therefore, an empirical time series model, reflecting the historical relation between trade and GDP, is expected to deliver a better forecast.

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PART 1: SIMULATING SOME POTENTIAL ECONOMIC EFFECTS OF THE COVID-19 PANDEMIC

Scenario analysis based on quantitative trade modelling

ABSTRACT

The WTO Global Trade Model, a quantitative trade model, is employed to project the impact on the global economy of the Covid-19 pandemic with quantitative trade modelling. Because of the profound uncertainty about the duration of the pandemic and the containment measures, three scenarios are constructed, V-shaped, U-shaped, and L-shaped recovery, corresponding with a duration of 3 months, 6 months and more than a year. The pandemic and containment measures are assumed to lead to a general reduction of labour supply, a rise in trade costs, and reductions in both demand and supply in sectors most affected by the containment measures. GDP and trade are projected to fall by respectively 5% and 11% the V-shaped and L-shaped scenarios and trade by respectively 8% and 20%. The response of trade to the reduction in GDP, measured by the trade-to-GDP elasticity, is projected to rise as the crisis lasts longer. The reason is that a longer duration will lead to a larger drop in spending on durables which are highly tradable.

The use of the modelling framework, its standardized database, as well as the detailed description of how the shocks are specified will allow other interested researchers to see how estimates were generated. This should allow other researchers to build on this analysis and examine alternative scenarios and approaches. There are a number of areas where we have had to make preliminary assumptions in a rapidly evolving environment and as new information becomes available. We expect more information about the nature of the economic shocks and/or how the disease and the policy responses evolve, particularly in developing and least developed countries, which should allow us to update and refine our analysis over time.

Keywords: Covid-19, Scenario analysis, Quantitative trade models
JEL-codes: C68, F17

1 INTRODUCTION

Covid-19 is rapidly changing the world. As the virus is spreading across the globe, more and more countries are taking social distancing measures. Because of a lack of a vaccine or effective medical treatment, countries turn to non-pharmaceutical interventions (NPIs) to stop its spread. Based on insights from epidemiologists (for example Ferguson et al., 2020) most countries eventually choose the strongest form of social distancing: suppression. Most countries conclude that the reproduction rate of the virus together with the relatively large share of patients requiring intensive medical treatment make it necessary to take these measures. Otherwise countries run the risk that the required hospital capacity would be a multiple of the available capacity leading to a massive number of victims.

The policy of suppression provokes large changes in the organization of society. People have to stay inside and work from home and social life and travel are limited to a minimum. Countries are imposing restrictions on international travel, adding border controls, and in some cases export restrictions for medical equipment and food.

The social distancing measures have large economic effects. Entire sectors of the economy such as restaurants, a large part of retail shops and personal services are closed down and not operating. Demand for tourism is drastically reduced and people start postponing consumption of durable goods, because of the difficulty shopping and uncertainty about the future. School closures, illness and social distancing force people to stay home and/or work from home if they can, leading to a fall in labour supply. International trade costs rise, because of increased border controls, a lack of supply of air cargo, and restrictions to personal travel raising trade costs of services. Companies working with complex value chains have trouble organizing their production as plant closures in one part of the value chain, because the virus and the social distancing measures, occur at different moments in time across countries.

Governments have responded with large scale fiscal policy and monetary policy, raising expenditures in health care, giving income support to workers in affected sectors, providing liquidity support to companies, and interventions in financial markets to prevent rising spreads. Nevertheless, indicators of economic activity in the US and Europe are dropping to record lows and the first numbers of actual economic activity in China show large declines.

Predicting the economic effects of the crisis is complex, with many interrelated factors. It is not clear how long countries will have to continue with the social distancing measures and what the exit strategy will look like. Currently there is no effective medical treatment and the development of a vaccine is projected to take 12 to 18 months. Will better weather bring relief? Will countries manage to control the virus with limited social distancing after some months through smart testing policies? And will countries manage to coordinate their policies such that restrictions to international transport and travel can be minimized? These are all open questions whose answers will have a strong impact on the expected economic damage of the Covid-19 virus and the associated social distancing measures.

To organize our thinking, we build three scenarios and project the economic effects with the WTO Global Trade Model, a quantitative trade model. Because of the level of uncertainty about the duration of the pandemic and the containment measures, three scenarios are constructed. In an optimistic scenario the measures will stay in place for three months and after that there will be a V-shaped recovery. In a less optimistic scenario measures stay in place for six months, leading to a U-shaped recovery. In a pessimistic scenario the suppression measures will have to stay in place for the entire year of 2020 with limited recovery in 2021, leading to an L-shaped recovery.

Three shocks are imposed the model the pandemic and containment measures: (i) a general reduction of labour supply; (ii) a rise in trade costs, (iii) reductions in both demand and supply in sectors most affected by the containment measures. GDP is projected to fall by respectively 5% and 11% the V-shaped and L-shaped scenarios and trade by respectively 8% and 20%. The response of trade to the reduction in GDP, measured by the trade-to-GDP elasticity, is projected to rise as the crisis lasts longer. The reason is that a longer duration will lead to a larger drop in spending on durables which are highly tradable.

The projections presented in this paper imply a smaller trade elasticity than during the financial crisis of 2008/2009. In the L-shaped scenario the trade-to-GDP elasticity is projected to be 2.1, whereas this elasticity was between 4 and 6 in the financial crisis. On the one hand the reduction in demand was more concentrated in highly tradable durable manufacturing goods in the financial crisis than what is expected in the current crisis, which is affecting in particular also non-tradable sectors. On the other hand, trade costs are expected to rise considerably in this crisis, a factor not playing a big role during the financial crisis according to the economic literature on this topic. Furthermore, the simulations of the current crisis do not take into account the bullwhip effect, an important factor contributing to the high trade elasticity in 2008. Firms run down inventories in times of crisis which leads to a magnified response of trade to a fallout in demand.

The next section describes the three scenarios and the corresponding economic shocks implemented in the model. Section 3 presents the results of the analysis and Section 4 compares the simulation results with the rapidly expanding related literature on the economic effects of Covid-19. Section 5 concludes by comparing the projected changes in the current crisis with the actual changes in the last economic crisis, the financial crisis of 2008.

2 SCENARIOS AND MODEL

Three scenarios are developed to help illustrate potential impacts of the Covid-19 pandemic on the global economy, based on a V-shaped (optimistic), U-shaped (less optimistic), and L-shaped (pessimistic) recovery.

2.1 Description of scenarios

In the V-shaped recovery the health effects of the pandemic and related social distancing measures are assumed to disappear relatively quickly. Improved weather conditions ease the spread of the virus such that social distancing measures can be relaxed. Or an effective medical treatment of the virus infection is discovered such that the virus can be treated without a heavy burden on the medical infrastructure. The social distancing measures are assumed to stay in place for three months in the V-shaped scenario.

In the U-shaped recovery social distancing measures are assumed to stay in place for about six months. Under this scenario an effective medical treatment is assumed to become available only after six months. Alternatively, countries manage to organize forms of targeted social distancing with much less severe economic effects after six months. In this scenario economic activity resumes after six months, although restrictions to international travel will stay in place for a longer time.

Under the most pessimistic scenario, L-shaped recovery, the social distancing measures are assumed to stay in place for a year, until an effective vaccine is developed. In the meantime, countries do not manage to implement efficient social distancing measures with minimal economic damage. Large-scale economic uncertainty kicks in, leading to a big drop in expenditures on durable manufacturing goods.

2.2 Shocks to the model

To translate the three scenarios into shocks to the Global Trade Model, it is assumed that the economy is affected along three different channels: (i) reduced labour supply; (ii) reduced demand and supply in specific sectors; (iii) rising trade costs because of border controls and restrictions to personal travel. Table 1 summarizes the three shocks for the three scenarios.

Labour supply falls economy-wide for three reasons. First, people getting sick have to stay home together with the rest of their household. Furthermore, a share of people falling ill will die. Both lead to a reduction of labour supply, although the first effect is much more important than the second because of the social distancing measures. The share of people getting sick with symptoms is assumed to be 1% over 3 months (V-shaped scenario) and proportionally higher in the other two scenarios. Second, some people work from home which leads to a loss in productivity, because of a lack of coordination, shirking, and a lack of interaction between people decreasing creativity. Conservatively it is assumed that this leads to a productivity loss of 5%.[1] Third, school closures also

[1] Although the economics literature has reported productivity increases as a result of working from home, this literature finds that the beneficial effects of working from home are only satisfied under certain conditions such as the attitude towards working from home (Bloom et al., 2015; Neufeld & Fang, 2005) and the degree of social interaction (). Dutcher (2012) finds that workers performing creative tasks are likely to

lead to a reduction in labour supply, because at least one parent has to stay home to take care of the children.

Table 1 Economic shocks under the three scenarios

	V-shaped (optimistic)	U-shaped (mildly optimistic)	L-shaped (pessimistic)
Labour supply			
Morbidity and mortality	1% and 2%	2% and 2%	4% and 2%
Working from home	3 months	6 months	1 year
School closures	3 months	3 months	3 months
Sectoral demand and supply			
Tourism and recreation	3 months -80%: -20%	6 months -80%: -40%	Year 2020: 3 months -80% and 6 months -40%: -40%[2]
Retail	3 months -20%: -5%	6 months -20%: -10%	Year 2020: 9 months -20%: -15%
Manufacturing	Full recovery in 2020: 0%	6 months -80% with half of the loss recovered after: -20%	3 months -80% and 6 months -40%: -40%
Trade costs			
Higher costs air cargo	6 months 70% increase price air cargo	12 months 70% increase price air cargo	18 months 70% increase price air cargo
Goods in transit	6 months 3 day extra: 1.2%	12 months 3 day extra: 2.4%	18 months 3 day extra: 2.4% in 2020
Services transport costs	6 months 22.5% extra multiplied by share not digitally delivered	Idem for 12 months	Idem for 18 years
Transport costs specialized equipment	6 months 22.5% extra for specialized equipment, proxied by share transported by air	Idem for 12 months	Idem for 18 months

The social distancing measures also lead to a fall in both demand and supply in targeted sectors. Restaurants and bars are closed, cultural activities and events cancelled, and personal services not offered. Following assumptions in the study by CBO (2006) on the economic costs of a pandemic, we assume that this leads to a fall in demand and supply in these sectors by 80% for the duration of the shock. Demand for retail also falls but less severely, because people can shop online, supermarkets and food shops stay open, and in many countries also other shops stay open. However, because of fear less people will go shopping. CBO (2006) assumes a reduction in demand of 10%, we assume that it will be double as high. The reason is that CBO only takes into account the behavioural responses and not the confinement policies. The demand for manufacturing only falls in the U-shaped and L-shaped scenario. In the V-shaped scenario the fall in demand in the second quarter of 2020 is assumed to be fully compensated by higher (pent-up) demand in the third and fourth quarter. We assume that demand for durables manufacturing is falling by 80% for the duration of the confinement measures. In the U-shaped scenario, half of the reduced demand is compensated for in the rest of the year, resulting in a yearly reduction in consumption of 20%. In the L-shaped scenario the yearly reduction in demand for durable manufactured goods is 40%.

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benefit from increases in productivity when working remotely, in contrast to workers performing repetitive tasks. Bloom (2020) discusses why permanently working from home can be expected to reduce productivity, because of the reasons mentioned in the text. Conservatively, we assume that productivity falls by 5%.

[2] In year 2021, the recovery is 25% of the 2020 shock in the L-shaped scenario.

Although the assumed drop in durable manufacturing consumption seems high, it aligns with preliminary statistics. Reports from China for example find that car sales dropped by 80% in February 2020 (Bloomberg, 2020). Furthermore, the L-shaped scenario is characterized by rising economic uncertainty leading to postponement of durable consumption.

Finally, the costs of transporting goods and services are expected to increase for four reasons. First, air cargo prices have increased because of the lack of cargo-belly capacity in passenger planes. Based on data from the industry, it is assumed that cargo prices increase by 70% in 2020.[3] Second, because of increased border controls the time in transit of goods has increased. Conservatively, it is assumed that the time in transit increases by three days, corresponding with a 2.4% rise in trade costs, based on the median estimate of the ad valorem equivalent trade cost of an extra day in transit (Hummels and Schaur, 2013). Third, trade costs for services have increased because of severe travel restrictions. Fourth, much equipment requires travel of specialized workers. Hence, it will be difficult to deliver this equipment. Both for the third and fourth channel the increase in trade costs assumed by the World Bank (2014) during the Ebola outbreak in West-Africa is followed (22.5%), scaled down by the share of goods shipped by air for specialized equipment (as a proxy for specialized equipment) and by the share of services not delivered digitally (based on Eurostat data).

The shocks to labour supply and sectoral demand and supply are assumed to hold for 3 months, 6 months, and 9 months in the three scenarios (respectively V-shaped, U-shaped, and L-shaped). In the L-shaped scenario, labour supply is assumed to recover only for 25% in 2021, reflecting hysteresis in the labour market. The increases in trade costs instead are assumed to stay in place twice as long as the social distancing measures. The reason for this assumption is that countries will get over the peak of infections at different moments in time. Therefore, governments will decide to keep restrictions to international travel in place for a much longer time and they may be relatively slow in removing measures put in place.

Table 2 Per cent reduction in labour supply and the contribution of the different factors in the V-shaped recovery scenario

Regions	Morbidity	Mortality	School closure	Work home	Total
ASEAN	-0.12	-0.0068	-3.30	-1.25	-4.68
Australia New Zealand	-0.12	-0.0068	-2.61	-1.25	-3.98
Brazil	-0.12	-0.0068	-2.66	-1.25	-4.03
Canada	-0.12	-0.0068	-2.15	-1.25	-3.52
China	-0.12	-0.0068	-2.11	-1.25	-3.49
European Union 28	-0.12	-0.0068	-2.11	-1.25	-3.48
India	-0.12	-0.0068	-1.79	-1.25	-3.17
Japan	-0.12	-0.0068	-1.87	-1.25	-3.24
Latin America	-0.12	-0.0068	-3.41	-1.25	-4.78
Mexico	-0.12	-0.0068	-3.40	-1.25	-4.78
Middle East and North Africa	-0.12	-0.0068	-3.91	-1.25	-5.28
Newly industrialized countries	-0.12	-0.0068	-1.60	-1.25	-2.97
Other Asian countries	-0.12	-0.0068	-4.24	-1.25	-5.61
Rest of World	-0.12	-0.0068	-2.72	-1.25	-4.09
Sub-Saharan Africa	-0.12	-0.0068	-3.36	-1.25	-4.74
United States	-0.12	-0.0068	-2.51	-1.25	-3.88
Global average	-0.12	-0.0068	-2.49	-1.25	-3.86

Table 1 contains an overview of the different components of the three shocks in the three scenarios, focusing on the impact in 2020. The scenarios assume that central banks and governments manage to stabilize the financial sector, such that there are no large effects knock-on effects from firm

[3] https://www.wired.com/story/airlines-use-empty-passenger-jets-ease-cargo-crunch/

closures, bankruptcies, which could further reduce economic activity and cannot be modelled properly with the current framework.

Table 3 Trade weighted average percentage increase in ad valorem trade costs by channel and exporting region (Optimistic Scenario: V-shaped recovery)

	Services trade costs	Specialized equipment	Border controls	Total
ASEAN	1.6	0.9	1.0	3.4
Australia New Zealand	1.4	0.3	1.0	2.7
Brazil	1.2	0.2	1.1	2.5
Canada	1.3	0.4	1.0	2.7
China	0.5	1.2	1.1	2.9
European Union 28	2.2	0.6	0.9	3.8
India	2.8	0.3	0.9	4.0
Japan	0.9	1.4	1.1	3.4
Latin America	1.5	0.3	1.0	2.8
Mexico	0.4	0.7	1.1	2.2
Middle East and North Africa	1.1	0.2	1.1	2.4
Newly industrialized countries	1.8	1.2	1.0	4.0
Other Asian countries	3.4	0.1	0.7	4.2
Rest of World	1.4	0.4	1.0	2.8
Sub-Saharan Africa	0.9	0.3	1.1	2.2
United States	2.4	1.3	0.9	4.6
Global average	1.7	0.7	1.0	3.4

Table 4 Trade weighted average percentage increase in ad valorem trade costs by channel and sector (Optimistic Scenario: V-shaped recovery)

	Services trade costs	Specialized equipment	Border controls	Total
Agriculture	0.0	0.0	1.2	1.2
Accommodation and recreation	8.0	0.0	0.0	8.0
Air transport	8.4	0.0	0.0	8.4
Basic pharmaceuticals	0.0	2.3	1.2	3.5
Business services	10.2	0.0	0.0	10.2
Construction	11.0	0.0	0.0	11.0
Electronic equipment	0.0	2.6	1.2	3.9
Electric equipment	0.0	2.6	1.2	3.9
Health care	9.9	0.0	0.0	9.9
Metals	0.0	1.0	1.2	2.2
Motor vehicles	0.0	0.7	1.2	1.9
Machinery and equipment	0.0	1.9	1.2	3.1
Fossil fuels	0.0	0.0	1.2	1.2
Other manufacturing	0.0	0.0	1.2	1.2
Transport equipment nec	0.0	2.8	1.2	4.0
Other transport	8.4	0.0	0.0	8.4
Other services	9.9	0.0	0.0	9.9
Petroleum and coal products	0.0	0.0	1.2	1.2
Processed food	0.0	0.0	1.2	1.2
Retail	9.2	0.0	0.0	9.2
Utilities	9.6	0.0	0.0	9.6
Average	**1.7**	**0.7**	**1.0**	**3.4**

Table 2 displays the annual reduction in labour supply in the three scenarios in the different countries and the contribution of the different channels. The table makes clear that the reduction in labour supply because of morbidity and in particular mortality is relatively small. The reason is that it is assumed that countries will take suppression measures to limit the spread of the virus for the reasons discussed in the introduction. Closure of schools is the biggest contributor to the reduction in labour supply, as parents have to take care of their children. The impact of working from home is relatively limited, because of the assumption that it will only lead to a 5% reduction in productivity. Because of the evidence that children seem to get sick only rarely, it is assumed that school closures will only stay in place for three months and will be lifted after the first peak of infections with Sars-Cov2. We note that as we move forward with our analysis we will probably need to look more closely at the range of shocks in the various categories, particularly as information comes to light on differentiation across developed, developing, and least developed countries.

Tables 3 and 4 display the average increase in trade costs respectively across exporters and sectors in the V-shaped scenario and the contribution of the different channels. The tables show that rising transport costs for services are assumed to be the biggest driver of higher trade costs, followed by border controls and higher costs of transporting specialized equipment. The projected increase in trade costs is biggest for the United States, because this country exports a lot of specialized equipment (in specific sectors and proxied by the share exported by air), and also exports a relatively large share of services.

2.3 Economic model and data

The WTO Global Trade Model is a recursive dynamic computable general equilibrium (CGE) model. A description of the model can be found in Aguiar et al. (2019). Although it is an equilibrium model whereas the Covid-19 crisis leads to situations of disequilibrium, the model also has important strengths, making it particularly suitable to build scenarios on the impact of the crisis. Three factors are important. First, the model contains a detailed sectoral breakdown, enabling us to study the impact of the sector-specific shocks to the economy because of the social distancing measures. Second, with the model it is possible to study the impact of higher obstacles to international trade because of travel restrictions and rising costs of air cargo. Third, the model contains intermediate linkages enabling the study of upstream and downstream effects of the sectoral shocks.

While the model usually aims to find new equilibrium from traditional shocks to a through the price mechanism it is possible to use the model and its extensive economic relationships to look at shocks differently.[4] In this case we can compare the initial shock to demand with the final reduction in demand in the equilibrium solution. For example, in the L-shaped scenario the initial shock to sectoral demand is 40% while the reduction in sectoral demand in the new equilibrium is about 50% in the selected sectors. The remaining reduction in demand is driven by the fall in GDP and thus income of about 10% (the global average.) Changes in prices, the other main determinant of demand besides income and the initial shock do not play a big role – between 1% and 3% in all sectors except national resources and health care. Thus the "move towards equilibrium" because of the price adjustment mechanism plays a minor role.

An aggregation of the GTAP Data Base to 16 regions and 21 sectors is employed. Parameter values are set at the usual values of the model and the trade balance is fixed.[5] A fiscal policy response is included in the model, since most countries have responded with large fiscal packages to the crisis. This policy takes the form of an increase in government demand, equal to half of the reduction in private demand. This corresponds with an average increase in government expenditures globally of respectively 1.7%, 3.7%, and 4.5% of total GDP. Within government expenditures, it is assumed that expenditures on health care are increased by 75% in 2020.

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[4] Dixon and Rimmer (2004, 2013) have explored the use of these models for gaining insights on economic relationships beyond the traditional uses in a number of studies. Strengths of the model in these areas include input/output relationships across sectors, differences across countries in the sectoral compositions of their economies, and cross border trade relationships at the sectoral level. The model also imposes economic discipline in that changes across a variety of variables must add up, and that economies operate within the constraints of their factor allocations and technological capabilities. For example see the discussion in section 3.2 of this paper.

[5] Reductions in private demand have an impact on GDP in the model by endogenizing capacity utilization of production factors and making investment demand exogenous. This means that a reduction in private household demand and a corresponding rise in savings leads to a reduction in the utilization of production factors. The change in investment is conservatively set equal to the change in investment without the demand side shocks times the ratio of the GDP changes with and without demand side shocks.

3 SIMULATIONS RESULTS

3.1 Macroeconomic effects

Table 5 displays the effects on real GDP (per cent changes) in the four scenarios and Table 3 the per cent change in real exports.

Table 5 Change in real GDP (yearly per cent change for 2020 and 2021 relative to benchmark without pandemic)

Real GDP	V-shaped		U-shaped		L-shaped	
	2020	2021	2020	2021	2020	2021
ASEAN	-6.1	4.6	-12.2	9.7	-14.7	3.3
Australia New Zealand	-5.2	4.7	-9.3	8.8	-11.2	3.1
Brazil	-4.8	4.5	-9.4	9.2	-11.6	3.3
Canada	-4.8	4.0	-8.8	7.5	-10.7	2.6
China	-4.0	3.5	-7.9	7.2	-9.9	2.5
European Union 28	-5.2	4.1	-10.1	8.4	-12.1	2.9
India	-5.4	4.6	-11.1	9.9	-13.4	3.2
Japan	-4.4	3.9	-8.1	7.4	-9.5	2.4
Latin America	-5.3	4.8	-9.8	9.1	-11.8	3.2
Mexico	-6.6	5.3	-12.8	10.4	-14.5	3.2
Middle East and North Africa	-4.1	3.4	-8.1	7.2	-10.2	2.9
Newly industrialized countries	-6.2	5.2	-12.6	11.2	-14.8	3.8
Other Asian countries	-5.8	5.1	-11.4	10.3	-13.4	3.2
Rest of World	-4.1	2.8	-6.0	3.7	-6.1	1.1
Sub-Saharan Africa	-4.1	3.4	-7.4	6.2	-9.3	2.3
United States	-5.0	4.8	-8.8	8.6	-10.8	2.9
Global	**-4.8**	**4.2**	**-9.2**	**8.1**	**-11.1**	**2.8**

Note: The numbers in this table deviate from the numbers in the press release (WTO, 2020). This table presents the per cent deviation of GDP from the baseline, whereas the press release contains the projected growth rate in 2020 relative to 2019.

Simulations with our model project that the global reduction in GDP ranges from 4.8% in the V-shaped recovery up to -11.1% in the L-shaped recovery scenario. The simulations indicate that the reduction in exports is considerably larger than the reduction in GDP in the three scenarios. Globally the elasticity of trade with respect to GDP is around 1.8. This elasticity is somewhat larger in the U-shaped and L-shaped scenario, because under these scenarios the demand for tradable manufacturing also fall.

Interpreting the numbers, it is important to keep in mind that the tables contain per cent changes relatively to a baseline. Therefore, even though the projected per cent increase in global GDP in 2021 in the U-shaped scenario (+8.1%) is close to the projected fall in 2020 (-9.2%), the simulations still project a substantial cumulative fall by 2021.[6]

Looking at the regional patterns shows that ASEAN, Mexico and the Newly Industrialized Countries are projected to see the biggest drops in GDP. The regional patterns will be further analysed when decomposing the contribution of the different shocks to the fall in GDP. For the United States the reduction in trade is projected to be much larger than the reduction in GDP. The main reason for this pattern is that the share of goods traded by air is large for the United States and that a relatively large share of exports for the United States is services. Therefore, the trade weighted increase in projected trade costs is large.

[6] First reducing 100 to 90.8 (a fall by 9.2%) and then raising 90.8 by 8.1% leads to a level of only 98.2.

Table 6 Change in real exports (yearly per cent change for 2020 and 2021 relative to benchmark without pandemic)

Real exports	V-shaped		U-shaped		L-shaped	
	2020	2021	2020	2021	2020	2021
ASEAN	-9.3	6.7	-18.2	14.8	-22.1	6.1
Australia New Zealand	-6.4	4.7	-12.8	10.1	-15.6	4.7
Brazil	-8.0	6.2	-16.8	14.3	-20.2	6.1
Canada	-4.7	3.7	-13.2	11.6	-18.4	6.1
China	-8.3	6.0	-16.0	12.5	-19.3	4.9
European Union 28	-7.3	5.4	-16.1	13.7	-20.4	5.8
India	-12.0	9.5	-23.5	22.5	-28.0	8.5
Japan	-9.8	7.4	-18.5	15.4	-21.8	5.7
Latin America	-7.5	5.9	-15.3	13.2	-18.8	5.8
Mexico	-4.8	4.8	-12.2	12.7	-16.3	5.3
Middle East and North Africa	-5.2	3.1	-10.5	7.2	-13.4	4.1
Newly industrialized countries	-11.0	8.3	-21.0	18.4	-25.0	7.1
Other Asian countries	-7.6	6.3	-17.5	16.7	-22.5	7.0
Rest of World	-5.3	2.9	-8.6	4.0	-9.4	1.9
Sub-Saharan Africa	-5.2	3.1	-10.6	7.0	-13.4	3.6
United States	-14.3	10.0	-27.8	23.8	-33.9	10.9
Global	**-8.1**	**5.9**	**-16.5**	**13.6**	**-20.4**	**5.8**
Elasticity of global trade to global GDP	**1.68**	**1.40**	**1.80**	**1.67**	**1.84**	**2.10**

Note: The numbers in this table deviate from the numbers in the press release (WTO, 2020). This table presents the per cent deviation of trade from the baseline based on the CGE-analysis, whereas the press release contains the projected growth rate in 2020 relative to 2019 employing the ADL model based on historical data described in Part 2.

3.2 Decomposition: contribution of different shocks

Tables 7 and 8 decompose the changes in 2020 in the trade scenario into the contribution of the three types of shocks, to labour supply, to trade costs, and to sectoral demand. These tables shed lights on three sets of questions.

First, the tables show the contribution of the different shocks to the fall in GDP and trade providing various insights. Comparing the contribution of the different shocks to GDP and trade shows that in the V-shaped scenario the labour supply, trade cost, and sectoral demand shocks contribute respectively 42%, 20%, and 38% to the fall in GDP. For trade the three shocks contribute 21%, 54%, and 25% respectively and the contribution of the trade cost shock to changes in trade is as expected much bigger.

Comparing the different scenarios shows that in the U-shaped and L-shaped scenarios the contribution of the sectoral demand shocks rises. This is expected, because the sectoral demand shocks rise most in 2020 when going to the more pessimistic scenarios. The contribution to the global reduction in GDP of the sectoral demand shocks rises from 38% in the V-shaped scenario to 50% respectively 52% in the U-shaped and L-shaped scenarios. For trade the share of the demand-side shocks rises even to 55% in the L-shaped scenario.

Second, the tables provide insights into the variation across countries of the reductions in GDP and trade. The table makes clear that the largest differences between countries are driven by the sectoral shifts. In the V-shaped scenario for countries like Mexico and the Newly Industrialized Countries (NIC), the contribution of the sectoral shift is much larger than for example for China and Canada. The reason is that the sectors affected by a negative demand shock constitute a larger share in total household consumption in the former countries than in the latter and thus lead to a bigger reduction in consumption demand.

The contribution of trade costs also varies across regions, depending on the sectoral specialization of countries and the openness of countries. For example, for the United States the contribution of trade cost increases to the fall in GDP is small (in the V-shaped scenario 0.5 percentage point), because the US is a relatively closed economy. Instead, the contribution to the reduction in trade of the trade cost increase is much more elevated (in the V-shaped scenario 9.4 percentage points), because the US is exporting a relatively large share of its goods by air and has a comparative advantage in services, which are assumed to face large increases in trade costs.

Table 7 Contribution of the different shocks to the projected change in real GDP in 2020 under the three scenarios

	V-shaped			U-shaped			L-shaped		
	Labour supply	Trade costs	Sectoral shifts	Labour supply	Trade costs	Sectoral shifts	Labour supply	Trade costs	Sectoral shifts
Australia New Zealand	-2.3	-0.7	-2.2	-3.1	-1.3	-4.9	-3.8	-1.3	-6.1
ASEAN	-1.9	-2.0	-2.2	-2.5	-3.7	-6.0	-3.0	-3.7	-7.9
Brazil	-2.1	-0.5	-2.2	-2.8	-1.0	-5.6	-3.5	-1.0	-7.1
Canada	-2.1	-1.2	-1.5	-2.9	-2.3	-3.7	-3.6	-2.3	-4.8
China	-1.9	-0.8	-1.4	-2.6	-1.4	-3.9	-3.3	-1.4	-5.3
European Union 28	-1.8	-1.4	-2.0	-2.5	-2.7	-4.9	-3.1	-2.7	-6.3
India	-1.6	-0.8	-3.0	-2.4	-1.4	-7.3	-3.0	-1.4	-8.9
Japan	-1.5	-0.7	-2.1	-2.2	-1.3	-4.6	-2.8	-1.3	-5.5
Latin America	-2.3	-0.8	-2.3	-2.9	-1.4	-5.4	-3.5	-1.4	-6.8
Mexico	-1.7	-1.5	-3.5	-2.2	-2.8	-7.7	-2.6	-2.8	-9.0
Middle East and North Africa	-1.8	-1.0	-1.3	-2.2	-1.9	-4.0	-2.7	-1.9	-5.7
Newly industrialized countries	-1.5	-1.7	-3.1	-2.2	-3.1	-7.3	-2.8	-3.1	-9.0
Other Asian countries	-2.1	-0.9	-2.8	-2.6	-1.6	-7.2	-3.1	-1.6	-8.7
Rest of World	-1.7	-1.3	-1.0	-2.3	-2.5	-1.1	-2.9	-2.5	-0.7
Sub-Saharan Africa	-2.4	-1.0	-0.6	-3.1	-1.9	-2.4	-3.8	-1.9	-3.7
United States	-2.8	-0.5	-1.7	-3.8	-0.9	-4.1	-4.7	-0.9	-5.2
Global	**-2.0**	**-1.0**	**-1.8**	**-2.8**	**-1.8**	**-4.5**	**-3.5**	**-1.8**	**-5.8**
Contribution shocks	**42%**	**20%**	**38%**	**30%**	**20%**	**50%**	**31%**	**16%**	**52%**

Third, combining the numbers in Tables 7 and 8, we can calculate the trade-to-GDP elasticity of the separate shocks, generating many interesting insights. First, as expected the rise in trade costs has a much bigger impact on trade than on GDP. The simulations generate a trade elasticity of more than 3.5 in all three scenarios.[7]

Second, the sectoral shifts in demand lead for all three scenarios to a trade-to-GDP elasticity larger than one. For the V-shaped scenario this might seem remarkable, since mostly non-tradable sectors such as Recreation and Accommodations are affected by these sectoral shifts in demand. However, it is assumed that fiscal policy partially compensates for the loss of consumption demand and government demand is concentrated in relatively non-tradable sectors.

Third, the trade-to-GDP elasticities are considerably larger in the U-shaped and L-shaped scenarios than in the V-shaped scenario. Table 8 shows that the trade-to-GDP elasticities of the sectoral shocks are 1.10, 1.6, and 2.04 in respectively the V-shaped, U-shaped and L-shaped scenarios. The reason for this pattern is that in the V-shaped scenario the reduction in demand is concentrated in relatively non-tradable sectors, whereas in the U-shaped and especially the L-shaped scenarios, there is a much stronger fall in demand in durable manufacturing goods which are highly tradable. This result suggests that the negative impact of a longer duration of the crisis on trade is magnified by the sectoral pattern of demand shocks. As the crisis takes longer, it can be expected that consumers will raise precautionary savings and cut expenditures on durable manufacturing goods, thus having a stronger impact on trade. The shift in demand away from durable manufacturing is the main

[7] Tables 7 and 8 also show that the trade elasticity of the generic labour supply shock is below one. This can be explained from the fact that non-tradable sectors are relatively labour intensive, thus having a stronger impact on GDP than on trade.

explanation for the large trade-to-GDP elasticity during the financial crisis (Bems et al., 2012). Our simulations suggest that this could happen again in 2020 if the crisis is long-lasting.

Table 8 Contribution of the different shocks to the projected per cent changes in real exports in 2020 under the three scenarios

	V-shaped			U-shaped			L-shaped		
	Labour supply	Trade costs	Sectoral shifts	Labour supply	Trade costs	Sectoral shifts	Labour supply	Trade costs	Sectoral shifts
Australia New Zealand	-1.2	-3.4	-1.7	-1.6	-5.6	-5.6	-2.0	-5.5	-8.5
ASEAN	-1.7	-5.3	-2.3	-2.2	-7.8	-8.2	-2.6	-7.8	-10.7
Brazil	-1.4	-4.1	-2.5	-1.9	-7.0	-7.9	-2.3	-7.0	-14.6
Canada	-1.2	-2.7	-0.8	-1.8	-4.9	-6.5	-2.2	-4.8	-12.5
China	-1.8	-5.1	-1.3	-2.5	-8.1	-5.4	-3.2	-8.0	-6.8
European Union 28	-1.9	-3.2	-2.2	-2.6	-5.4	-8.1	-3.3	-5.3	-14.2
India	-2.7	-3.0	-6.4	-3.8	-4.6	-15.2	-4.7	-4.6	-15.8
Japan	-2.0	-5.1	-2.7	-2.8	-7.5	-8.1	-3.6	-7.5	-14.4
Latin America	-1.5	-3.8	-2.1	-2.0	-6.0	-7.3	-2.4	-6.0	-13.8
Mexico	-1.1	-0.5	-3.2	-1.4	-0.8	-10.1	-1.6	-0.7	-18.2
Middle East and North Africa	-0.6	-3.6	-1.0	-0.8	-5.6	-4.1	-0.9	-5.6	-4.6
Newly industrialized countries	-1.7	-5.9	-3.4	-2.4	-8.5	-10.1	-3.0	-8.5	-15.1
Other Asian countries	-2.2	-2.2	-3.3	-2.8	-3.5	-11.2	-3.3	-3.5	-23.5
Rest of World	-1.2	-4.2	0.2	-1.7	-6.7	-0.2	-2.1	-6.6	0.8
Sub-Saharan Africa	-1.3	-3.6	-0.3	-1.6	-5.9	-3.0	-2.0	-5.9	-6.2
United States	-2.3	-9.4	-2.6	-3.2	-14.0	-10.6	-3.9	-13.9	-20.0
Global	**-1.7**	**-4.4**	**-2.0**	**-2.3**	**-6.9**	**-7.3**	**-2.9**	**-6.9**	**-11.8**
Contribution shocks	**21%**	**54%**	**25%**	**14%**	**42%**	**44%**	**13%**	**32%**	**55%**
Global trade elasticity	**0.84**	**4.47**	**1.10**	**0.84**	**3.75**	**1.60**	**0.84**	**3.76**	**2.04**

In table 9 we summarize the contribution of the different shocks to the per cent changes in real GDP and real exports in 2020, separating also between the impact of changes in trade costs and rising prices of air cargo. Obviously, the shares for the other shocks than air cargo are the same as in Tables 7 and 8. The table makes clear that the contribution of rising air cargo prices is negligible for GDP, whereas it has a sizeable impact on the fall in trade, ranging between 7% in the L-shaped scenario and 20% in the V-shaped scenario. Furthermore, the table shows that the sectoral shifts contribute less to the fall in trade than GDP under the V-shaped scenario (respectively 25% and 38%), whereas they contribute more to the fall in trade than GDP in the L-shaped scenario (55% respectively 52%). The reason is that in the L-shaped scenario in particular the demand for manufacturing is assumed to fall, leading to a bigger reduction in trade.

Table 9 Contribution of different shocks to the projected per cent change in real GDP and real exports in 2020

		Labour supply	Trade costs	Air cargo	Sectoral shifts
V-shaped	GDP	42%	20%	1%	38%
	Trade	21%	34%	20%	25%
U-shaped	GDP	30%	20%	0%	50%
	Trade	14%	32%	10%	44%
L-shaped	GDP	31%	16%	0%	52%
	Trade	13%	24%	7%	55%

3.3 Sectoral effects

Finally, we turn to the sectoral patterns of trade. Table 10 displays the projected per cent changes in global trade by sector for the three scenarios, together with the initial share (in 2019) of the different sectors in total trade. The results are as expected. The sectors with the largest decreases in trade are the sectors affected by the negative shocks to consumption demand such as Recreation and Accommodation and Air transport. In the U-shaped and L-shaped scenarios the demand for durable manufactured goods is also assumed to fall considerably, thus projected to display a large reduction in real exports. Contrary to the other sectors, trade of Basic Pharmaceutical Products is projected to rise, because it is an important input into the sector Health Care, whose demand in the government sector is assumed to rise by 50%. Although output in Health Care is projected to rise, because of the assumed increase in government demand, trade is projected to fall slightly in this sector (health care tourism), because of the rising trade costs.

Table 10 shows that also trade in other sectors is projected to fall significantly, for example agriculture and processed food. The reason is twofold. Trade costs are assumed to rise significantly and furthermore income is expected to fall substantially, thus reducing demand for all imported goods and services.

Table 10 Per cent changes of global real exports per sector under different scenarios in 2020

	Initial shares	V-shaped	U-shaped	L-shaped
Agriculture	2.1%	-6.5	-11.2	-12.7
Fossil fuels	10.7%	-5.5	-10.8	-13.4
Processed Food	4.8%	-7.4	-12.6	-13.9
Petroleum, coal products	12.9%	-7.7	-13.8	-16.3
Basic pharmaceutical products	2.4%	6.6	7.9	8.7
Other manufacturing	10.1%	-8.2	-20.7	-30.0
Metals	7.8%	-6.8	-13.8	-17.5
Computer, electronic and optic	4.0%	-10.5	-19.0	-22.6
Electrical Equipment	10.6%	-8.8	-18.9	-24.1
Machinery and equipment	6.2%	-8.7	-15.8	-18.8
Motor vehicles	6.9%	-5.6	-17.3	-26.1
Transport equipment nec	2.4%	-9.7	-19.3	-23.5
Utilities	0.5%	-17.3	-31.0	-32.6
Construction	0.6%	-11.6	-20.8	-21.6
Retail	1.8%	-11.0	-21.5	-24.5
Accommodation and recreation	1.7%	-19.2	-35.8	-37.4
Other transport	2.9%	-12.6	-24.8	-26.8
Air transport	1.4%	-18.2	-33.5	-34.9
Business Services	8.8%	-10.6	-19.6	-21.5
Other Services	1.0%	-12.3	-19.0	-20.4
Health care	0.4%	-1.2	-6.4	-8.0
Total	**100.0%**	**-8.1**	**-16.5**	**-20.4**

4 RELATED LITERATURE

The overview of related literature is split up into two parts: (i) simulation studies on the economic effects of previous epidemics and pandemics such as SARS and H1N1. (ii) Other studies projecting and forecasting the economic effects of Covid-19. The broader economic literature on Covid-19 and required policy responses is rapidly expanding as we write this paper and is therefore not included in this overview.

4.1 Simulation studies on previous pandemics and epidemics

There is a relatively small literature on quantitative simulations of the impact of previous epidemics and pandemics. This section will provide a brief overview of the modelling approaches, the shocks included in the simulations, and the projected effects on (global) GDP.

Lee and McKibbin (2004) employs a forward-looking dynamic model to project the impact of the SARS-epidemic. The same approach is employed in follow-up papers, examining the impact of a pandemic in general (McKibbin and Sidorenko, 2006) and Covid-19 (McKibbin and Fernando, 2020). Shocks included in the model are a fall in total labour supply, a rise in the risk-premium, an increase in the costs of production in all sectors depending in their use of affected sectors such as recreation, tourism and transport, and a fall in aggregate consumption demand. In McKibbin and Sidorenko (2006) a mild pandemic would cost 0.8% of GDP, whereas global GDP would shrink by up to 12.6% in a severe pandemic. The GDP reduction is mostly driven by the increase in the costs of production.

CBO (2006) calculates the potential effect of a mild and severe pandemic, similar respectively to the Spanish flu of 1918-1919 and the 1957 and 1968 pandemics. The shocks included are a reduction of labour supply because of mortality and morbidity and a fall in demand in selected sectors affected, rising in the degree of social interaction required. The study by CBO projects a fall in GDP of about 1% in the mild scenario and 4% in the severe scenario.

Burns et al. (2006) explore the potential impact of a human-to-human pandemic similar in mortality to the Spanish flu, modelling reductions in labour supply because of both mortality and morbidity, and a falling demand in transport, hotels and restaurants and recreation. They project that such a scenario would lead to a reduction in global GDP of 3.1%, with almost two third of the fall in GDP driven by the demand-side shock.

Keogh-Brown et al. (2009) employ a macroeconomic model to evaluate the potential impact of a global pandemic. They include negative shocks to labour supply, because of morbidity, mortality, and school closures, and to demand in specific sectors characterized by what is dubbed "social consumption." In mild and severe pandemic scenarios, the negative impact on the GDP in the UK is projected to be respectively 2.5% and 6%. Keogh-Brown find that school closures contribute most to the projected reduction in GDP.

Dixon et al. (2010) analyze the economic effects of an H1N1 Epidemic in the US with a quarterly CGE model. They include the following shocks in their model: a reduction in inbound and outbound tourism of 34%, a fall in labor input of 0.41% because of morbidity, mortality, and parents staying home to care for their children, an increase in medical expenditures, and a reduction in expenditures on leisure activities (cover arts, entertainment, accommodation, and food service) of 10%. An epidemic lasting two quarters would lead to a yearly reduction in GDP of 1.6%. Furthermore, Dixon et al. (2010) find that the demand side shocks drive most of the reduction in GDP.

Evans et al. (2014) analyze the impact of the Ebola epidemic in Western Africa in 2014 employing both a regional and a global CGE model. They model the economic effects of the Ebola epidemic through a fall in labor supply and utilization of capital and through a rise in trade and transaction costs, distinguishing between a high Ebola and low Ebola scenario. The reduction in GDP over the two years ranges between respectively 0.2% and 3.3% in the two scenarios.

Comparing the way in which the literature has modelled the economic effects of pandemics in the past with the current Covid-19 pandemic, there is a crucial difference. Previous literature has assumed that no severe social distancing measures would be implemented. This has a large impact on both the types of shocks hitting the economy and on the size of the shocks. In the current pandemic the negative shock to general labour supply seems to be smaller so far, but the reduction in economic activity (supply and demand) in specific sectors much bigger. The current crisis is also characterized by an increase in trade costs because of travel restrictions, which has only been included in previous literature in the work on Ebola in Western Africa.

4.2 Other projections on the economic effects of Covid-19

The list of studies on the expected economic effects of Covid-19 is rapidly expanding and many studies are continuously updated. Therefore, it is impossible to be complete. The overview in Table

11 contains studies from international organizations, national (semi-) public research institutes, private research institutes and banks, and academia. Covering studies from international organizations, the overview attempts to be complete. For the other categories the overview is a selection.

Table 11 Overview of projection studies on the economic effects of Covid-19

Institution	Impact relative to: Baseline	2019	Date	Specifics
International organizations				
OECD	-0.5% to -1.5%		March 2	Demand side shocks hitting mainly China.
OECD	-2 pp per month of confinement policy		March 27	Calculations share sectors in the economy
IMF				To be released April 2020
World Bank				To be released April 2020
ILO	5.3 to 24.7 million unemployment rise			Econometric model linking unemployment to GDP estimated by McKibbin and Fernando
UNCTAD	-30% to -40% for FDI		March 26	Based on earnings statements of large MNEs
ECB	-5.8% (3 months) -2% (1 month), -10% (6 months)	-5%	March 17	Not official. Based on press reports[8]
National research institutes				
IFO Germany	-5.1% (1 month) to -20% (3 months)		March 22	For Germany. Calculations share sectors in economy
CPB Netherlands		-1.2% to -7.7%	March 26	For The Netherlands. Macro-econometric model
INSEE	-3 pp growth per month of confinement policy		March 26	For France. Estimated 35% lower economic activity due to confinement, based on credit card payments and share sectors
GCEE		-2.8% to -5.4%	March 22	For Germany
Private research/banks				
Morgan Stanley	-3%		March 25	For the United States. Q2 effect in the US of -30%
Citigroup		0.5% to 1.3%	March 23	
Oxford economics		0% to -1.3%	End of March	0% is baseline and -1.3% is downside scenario
Academia				
McKibbin and Fernando	-0.2% to -7%		March 2	Assuming that virus would spread (no suppression)
Barro et al.	-6%		March 23	Analysis of effects of Spanish flu in 1918 on GDP

[8] https://www.faz.net/aktuell/wirtschaft/coronavirus-ezb-chefin-erwartet-konjunktureinbruch-von-5-prozent-16684805.html

We can distinguish between calculation-type studies and studies forecasting or projecting the impact of the crisis on GDP and other economic variables. Calculation type studies such as those by OECD, INSEE, and IFO combine the share of the sectors affected by the social distancing measures in total production with economic activity indicators in those sectors or assumptions on the reduction in output in those sectors. This leads to a calculation of the economic cost per month of (severe) social distancing. The OECD projects for example that each month of severe social distancing will reduce GDP by 2 percentage points. Projection and forecast studies employ an economic model to come up with an outlook for growth in 2020. They are thus based on assumptions on the duration of the pandemic, the social distancing measures, and the demand and supply responses. Because of the uncertainty about these parameters, some of these studies develop scenarios. This is the approach also followed in the current study. Comparing the two approaches suggests that the projection/forecast studies seem to be optimistic in light of the calculation-based studies. The OECD calculates a loss of 2 percentage points per month of confinement, INSEE 3 percentage points for France, and IFO 5 percentage points for Germany. Since the outlook about the duration of the confinement and the spread across countries is uncertain, we have decided to work with various scenarios. The pessimistic U-shaped scenario is in line with the results from the calculation-based approach assuming that the confinement will take a relatively long time and/or will have to be re-introduced.

The date of study is included in the overview since it illustrates that projections are deteriorating over time. The OECD for example still worked with scenarios of 0.5% to 1.5% loss in global GDP at the beginning of March 2020. At the end of March 2020, they published calculations on 2 percentage point reduction in GDP growth per month of containment.

5 CONCLUDING REMARKS

5.1 Summary

The current shocks to the world economy are unprecedented in modern times. The Covid-19 pandemic will have a large impact on the global economy and thus on global trade. As the virus has spread across the globe and we lack a vaccine or effective preventative medical treatment, countries have had to turn to widespread social distancing measures to limit its spread. Based on insights from epidemiologists most countries eventually are imposing a severe form of social distancing, suppression, thus slowing down economic activity.

It is not likely that any one economic model could handle the array and size of these shocks. However, we feel that the simulation results of the three scenarios provide a way to organize our economic thinking about the types of shocks occurring in the global economy. They also provide a ballpark for the size of the GDP effects under the different scenarios. We have developed three scenarios, mainly varying by the duration of the crisis, and dubbed V-shaped, U-shaped, and L-shaped recovery.

Three types of shocks have been included in the simulations. First, labour supply in the entire economy falls because people have to stay at home and schools are closed. Second, both supply and demand are drastically falling in entire sectors of the economy hit directly by social distancing measures such as hotels and restaurants, retail, personal services, and tourism. Demand and supply will also fall if the crisis lasts longer (in the U-shaped and V-shaped recovery scenarios) in durable goods manufacturing sectors, because of uncertainty about the future. In the simulations it is assumed that government expenditures will rise, partially offsetting the fall in consumption demand. Third, the costs of international trade are rising, because of increased border controls, trade policy measures, a lack of supply of air cargo, and restrictions to personal travel raising the costs of delivering services. Adding further to the increase in trade costs is that companies working with complex value chains are having difficulties organizing their production as plants are closed at different moments in time in various parts of the world and delivery of components is more uncertain due to both supply decreases and/or trade policy changes.

In an optimistic V-shaped recovery scenario global GDP is projected to fall by about 5% in 2020 compared to previously expected growth (or what is often referred to as "relative to baseline" or RTB) because of the pandemic and thus put the global economy on a negative growth trajectory of about -2.5% for 2020 relative to 2019. Under this scenario there is a big contraction of the global economy, but it is short-lived lasting only about three months. Under this scenario trade is projected to fall by about 8%, mainly driven by the increase in trade costs, which are projected to stay in place after the pandemic is over.

In a less optimistic U-shaped recovery scenario global GDP is projected to fall by about 9% and trade by about 17%. The pandemic and severe social distancing measures would last about 6 months under this scenario and besides the more non-tradable sectors affected directly by the social distancing measures the manufacturing sector would also be heavily hit, because of economic uncertainty. Nevertheless, under this scenario the economy would recover in 2021.

In a pessimistic L-shaped recovery scenario the contraction of GDP is projected to by about 11% and the fall in trade about 20%. Under this scenario the pandemic and the confinement measures of the first months would cause longer-lasting harm to the economy. Widespread economic uncertainty would lead to a drastic reduction in manufacturing expenditures and there would be little recovery in 2021. The reduction in expenditures on durable manufacturing goods in the U-shaped and L-shaped recovery scenarios is projected to lead to a larger response of trade to the fall in GDP.

5.2 Comparison with financial crisis

Looking back at the experience of previous crises such as the financial crisis of 2008, the fall in global trade could be larger than in the presented simulations. In our projections of the current crisis the elasticity of global trade with respect to global GDP is between 1.7 and 1.8, whereas in the financial crisis the elasticity was between 4 and 6, depending on the data employed. In the current projections a trade-to-GDP elasticity of 1.7-1.8 is driven by the assumed increase in trade costs and the concentration of the fall in demand in highly tradable manufacturing.

In the financial crisis trade responded much more heavily to the drop in GDP for three reasons. First, consumers postponed the purchase of durables and firms postponed investments, because of heightened economic uncertainty. Since both durable consumption and investment are highly tradable, this shift in demand away from tradable durables aggravated the fall in trade. Bems et al. (2012) argue that this shift in demand can generate a trade-to-GDP elasticity of 2.8. Second, companies reduced the size of their inventories leading to a magnified response of trade to falling demand (bullwhip effect).[9] Alessandria et al. (2010) argue that adjustments of inventories over the business cycle can explain that trade falls 37% more than GDP in a downturn, based on a two country DSGE model with inventory accumulation. Third, trade finance became more expensive. Although this played a smaller role for overall trade, it was an important factor for MSMEs and developing country/LDC based firms.

This economic crisis is different from the financial crisis. It is provoked by a shock outside of the economy, whereas the great recession in 2008 started within the economy (in the financial sector). For trade two differences between the two crises are relevant. First, the sectors directly affected by social distancing are mainly non-tradable services and this could temper the drop in global trade.[10] Second, trade costs are rising in the current crisis and this could raise the trade response. Air cargo becomes more expensive, countries close borders and impose restrictions on personal travel. Furthermore, there is a threat that export restrictions for medical equipment and pharmaceutical products are extended to other sectors.

Turning to our projections, the projected trade-to-GDP elasticity of 1.7 to 1.8 could be about 0.4 larger because of the bullwhip effect based on the work by Alessandria et al. (2010). The elasticity could rise further if there is a stronger reduction in demand for tradable goods than assumed in the current scenarios, because of a spending freeze on durables as a result of heightened economic uncertainty. Time series analysis based on historical relations between trade and GDP as described in the second part of the background document and employed for the WTO Trade Forecast (WTO, 2020) generates a larger trade-to-GDP elasticity. This estimate reflects the strong response of trade to GDP in previous downturns and is closer to what is observed historically in similar episodes such as the financial crisis of 2008. The response of trade to changes in GDP could also be smaller if rising trade costs are prevented through the right policy choices.

Summarizing, two questions are crucial for the path of global trade in 2020. First, how long does the crisis last? If the crisis passes relatively fast, tradable sectors of the economy could recover

[9] The bullwhip effect reflects that in times of uncertainty companies first decrease their inventories before ordering new goods, thus leading to a much bigger fall in trade than in production.

[10] The Global Trade Model can replicate this type of response of trade to GDP. Experiments with the model with only demand and supply shocks in durable manufacturing identical to the shocks in the L-shaped scenario lead to an elasticity of merchandise trade with respect to total GDP between 5 and 6.

relatively quickly and losses would likely be concentrated in the non-tradable sectors directly affected. Such a scenario could become reality if an effective medical treatment is discovered, better weather conditions ease the pandemic, or less costly forms of targeted social distancing become feasible. If the crisis instead lasts longer and people are uncertain about the trajectory of the crisis, savings will increase and durables consumption and investment collapse with dire consequences for trade. Such a scenario could become reality if targeted social distancing is not feasible and people fear that severe social distancing might stay in place and come back in fall as the virus keeps on spreading until a vaccine is discovered. The question – how long will the crisis last? - cannot be answered at the moment, as it depends on how the pandemic develops. This is the main reason why we have worked with different scenarios in this paper.

Second, do countries manage to limit the rising barriers to international trade? As discussed in the paper one of the key factors in the crisis affecting trade is the expected increase in trade costs. The costs of doing international business are rising and policies of national governments play a big role in this. The negative impact of the crisis on services trade and services-enabled manufacturing trade can be softened if countries manage to coordinate their restrictions to international travel. Extending export restrictions on medical equipment and pharmaceutical products to other goods instead would lead to a further reduction in trade.

5.3 Possible extensions of current work

There are two further implications of our analysis. First, the differences in projected economic losses between the various recovery scenarios are large. In the L-shaped recovery scenario the reduction of GDP would be 7 percentage points larger than in the U-shaped recovery scenario. This implies a very high economic pay-off both from designing efficient forms of social distancing and from efficiently putting the economy on hold, limiting long run effects. Second, for international trade it is crucial that countries coordinate their policies of social distancing after the first peak of the epidemic is over. The simulations in this paper suggest that a patchwork of long-lasting restrictions to international travel would have large consequences for international trade, in particular for services trade, trade in specialized equipment, and goods transported by air.

The work in the current paper with as central aim to project the trade effects of the Covid-19 pandemic can be extended in three main directions. First, the economic analysis can be refined, such as the response of investment in the model to the different shocks and the way fiscal policy is modelled, including responses on the tax revenue side. Second, more empirical work can be done to estimate the expected increase in trade costs because of travel restrictions. Important questions are which share of services trade is delivered digitally, how important travel of experts is for the delivery of services and manufacturing-enabled services, and how costly differences in travel restrictions are. Third, more work is needed to explore how costly it is for supply chains that the supply side shocks to manufacturing production are hitting different countries and so also different chains of the production process at different moments in time. There are indications that some plants outside of China had to be shut down or reduce the capacity of their production, because necessary intermediates were not available. It is not clear whether this is a widespread phenomenon with large macroeconomic effects.[11]

[11] For car plants in Europe for example the expected drop in demand also played an important role in the decision to shut down plants, besides the apparent lack of essential intermediates in the production process. Supply chain disruptions are harmful if intermediates from different regions are highly complementary. In such a situation, a production chain is only as strong as its weakest link. However, empirical work indicates that trade elasticities estimated at the sector level are relatively. Hence, except for the very short run, companies apparently manage to substitute between intermediates from different regions.

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PART 2: ESTIMATION OF TRADE FLOWS

Part 2: Estimation of trade flows

The WTO issues forecasts for annual merchandise trade volume growth two times per year, usually in April and October. These estimates are based on WTO annual trade statistics and other publicly available information, the most important being the latest GDP projections from other forecasting agencies. However, in April 2020, even the most up-to date GDP figures did not capture the magnitude of the shock to the global economy represented by the COVID-19 outbreak. Under these difficult circumstances, the WTO instead chose to use GDP growth rates generated by our own Global Trade Model under plausible scenarios for the progress of the disease. How these estimates were arrived at is discussed in greater detail in Part 1.

Forecasts for merchandise exports and imports are provided for the current year and the next year, with breakdowns by region and level of development. Global and regional estimates are calculated as weighted averages of univariate forecasts for selected economies and sub-regions, with US dollar values of relevant trade flows in the previous year acting as weights. These countries and county groups are shown in Table 1 (aggregate regions shown in red).

Table 1: Countries and regions estimated in WTO Trade forecasts

World
North America
Canada
United States
Other North America
South and Central America
Brazil
Other South and Central America
Europe
European Union
Intra
Extra
Other Western Europe
Other South-eastern Europe
Asia
Australia and New Zealand
Japan
China
India
NICs (4)
Other Asia
Other regions (AF/CIS/ME)
Developed Economies
Developing Economies

World trade growth is defined as the average of world merchandise export and import volume growth. Intra-EU export growth is equated to intra-EU import growth. The United Kingdom will be estimated separately in the future but was included in the European Union this year because sufficiently disaggregated data were not available in time for the forecasting exercise.

The main empirical determinants of export and import growth are well understood, although their relative importance may differ across countries depending on their economic structure. In general, imports are determined by domestic demand and relative prices (e.g. exchange rates, inflation, commodity prices, etc.) while exports are a function of demand in the rest of the world, as discussed in Blanchard et. al. (2003). Expectations about future economic conditions may also influence import demand in the short run, for example when households and businesses postpone purchases of consumer durables and capital goods during times of economic uncertainty. A country's purchases of imported intermediate goods may also depend more on demand for final goods in destination markets than on domestic demand in the importing country. Changes in productivity and technology also influence trade growth over longer periods of time but are less relevant in the short run. Finally, there tends to be a positive relationship between import volume growth in resource-based economies and commodity prices, as higher prices increase export revenues, allowing these countries to import more from abroad. This is particularly true of developing economies with less capacity to borrow than developed ones.

Relevant data may be difficult to obtain, particularly for forecast periods, where strong assumptions must be made about demand and prices. Domestic demand forecasts are generally unavailable, whereas GDP forecasts are easily obtained from a variety of sources. It is for this reason that we use GDP rather than domestic demand as the main explanatory variable in our univariate regressions for individual countries and sub-regions, while recognizing that exports and imports are also components of GDP. In principle there is an endogeneity issue here, but it is not a serious problem in practice since exports and imports enter into GDP with different signs, causing them to (at least partly) cancel each other out.

Data sources

Historical annual data on merchandise trade volume growth and merchandise trade values for individual countries and regions are taken from WTO statistics, which are published in the WTO World Trade Statistical Review and disseminated through the WTO Data Portal at www.wto.org. Trade volume growth in the latest year may be estimated from average growth of WTO quarterly merchandise trade indices, preliminary values for which are available in advance of annual statistics. The level of trade in volume terms for countries and regions is calculated by taking the US dollar value of merchandise trade in a chosen base year and growing the indices forward and backward using merchandise trade volume growth.

Annual data on real GDP growth for individual countries are normally collected from a variety of sources and aggregated up to WTO regions and world using chain-weighted real US dollar values for GDP at market exchange rates as weights. GDP growth for regions is calculated using market-based weights rather than PPP weights because the former better reflects the ability of countries to import goods and services. The main data source for GDP is the IMF World Economic Outlook database, which includes actual and estimated values for all countries in the world from 1980 to 2028. Unfortunately, data for forecast periods tend to be out of date by the time of the WTO forecasting exercise. These figures are usually replaced with more recent estimates from other sources, including the OECD Interim Economic Outlook, the World Bank's Global Economic Prospects, national sources such as central banks, and private sources such as the Economist Intelligence Unit. Out of necessity, this year they were generated by the WTO Global Trade Model, a CGE model taking account of effects of the Covid-19 pandemic, including rising trade costs, falling labour supply, falling demand in sectors affected by social distancing, and supply chain frictions, among others.

For commodity prices and exchange rates, we fix their values for the current year at their level for the year-to-date, then allow them to return to medium-run average values in the following year. Commodity prices in US dollar terms are deflated by core CPI for the United States to better reflect the real scarcity value of these goods over time. Commodity prices are sourced from the IMF while real effective exchange rates are sourced from the Bank for International Settlements (BIS). Core CPI for the United States is sourced from the Federal Reserve Bank of St. Louis.

Estimation

Annual estimation is done in two stages using the econometric software E-Views. In the first stage, import volume growth in each country or sub-region is estimated using time-series regression and regional aggregates are derived as weighted averages, with trade values in the previous year serving as weights. In the second stage, export volume growth of individual countries and sub-regions is estimated using import demand estimates from the first stage as the main explanatory variable and regional aggregates are calculated similarly as weighted averages. World trade growth is derived as a weighted average of trade growth in the regions.

Estimation equations for imports differ across countries and sub-regions to provide the best possible forecasting performance for each, with different variables and numbers of lags included using usual approaches such as the Akaike information criterion, but the main explanatory variable is always GDP. Like many economic data series, import volumes and real GDP tend to be non-stationary and upward trending, so regression of the former on the latter in level terms could produce spurious results. Non-stationarity can be detected by inspecting correlograms or by conducting formal tests such as the Dickey-Fuller test, as outlined in Asteriou (2007). Non-stationary series can usually be rendered stationary by taking first differences in logs, which is approximately equivalent to percentage changes. Series that become stationary after differencing *n* times are said to be integrated of order *n*, or I(n), but orders of integration higher than 1 are not encountered in the current context. Ordinary least squares (OLS) regressions with time-series data that are rendered stationary by differencing can yield consistent estimates, but information on the level of the series is lost. However, if a long-run equilibrium relationship exists between two or more I(1) variables, these are said to be co-integrated, and information on their levels can be exploited to improve the accuracy of estimates. Cointegration can be determined by formal tests such as the Engel-Granger procedure, as shown in Asteriou (2007). If a cointegration relationship exists, deviations from equilibrium values may be included as an explanatory variable in an Error Correction Model (ECM).

Imports and GDP are found to be cointegrated in many major economies, but cointegration cannot be established in others. If a such a cointegration relationship exists, the following simple ECM specification is used for univariate estimation:

(i) $\Delta m_t = \alpha_0 + \Sigma_i \alpha_i \Delta m_{t-i} + \beta_0 \Delta y_t + \Sigma_i \beta_i \Delta y_{t-i} + a[bm_{t-1} - cy_t] + \eta' z_t + u_t$

where m represents imports, y represents GDP, $a[bm_{t-1}-cy_t]$ is an error-correction term, η is a vector of coefficients and z_t is a vector of other explanatory variables, including changes in exchange rates, changes in oil prices, etc. The number of lags is generally low, usually one in the case of annual data. If the maximum lag is one, the following simple autoregressive distributed lag (ADL) specification is equivalent to an error correction model, as shown by Asteriou (2007):

(ii) $m_t = \alpha_0 + \alpha_1 m_{t-1} + \beta_0 y_t + \beta_1 y_{t-1} + \eta' z_t + u_t$

This can be estimated in level terms and growth rates can then be derived from the forecasted values. Estimation only requires one step rather than two as in the case of the more general error correction model. This specification is more convenient for forecasting purposes.

If a cointegration relationship cannot be confirmed the following autoregressive equation also performs well, with m and y in annual percentage change terms (this is preferable to taking differences in logs, since differences in logs only approximate percentage changes for small increments):

(iii) $m_t = \alpha_0 + \alpha_i m_{t-i} + \beta_0 y_t + \beta_1 \Delta y_t + \eta' z_t + u_t$

Estimation of the export side is simpler, with the following specification used for each country and sub-region:

(iv) $x_t = \beta_0 + \beta_1 mreg1_t + \beta_2 mreg2_t + \beta_3 mreg3_t + \beta_4 mreg4_t + \beta_5 mreg5_t + u_t$

with $mregi_t$ referring to import growth of region *i* in period t.

Export growth estimates for countries and sub-regions are aggregated up to regions and world as they were on the import side. Global growth on the export side is usually quite close to growth on the import side, but occasionally discrepancies are large enough to warrant further investigation. A scaling factor may be applied trade growth on the export side to force it to equal growth on the import side, since the latter is generally more reliable.

Supplementary information

Once annual trade growth estimates are calculated their accuracy must be assessed. Particularly in the case of mid-year updates, annual estimates based on currently available GDP information may be implausible given trade developments in the first half of the year. These can be observed in WTO quarterly trade volume indices, which are comparable to WTO annual indices. This may be the case if an economic shock has affected specific countries and/or regions disproportionately in the first half, causing imports or exports to diverge substantially from annual predictions. In such cases, annual trade growth can be re-estimated using quarterly data and these estimates substituted for annual figures. Unfortunately, there are no readily available quarterly forecasts for global and regional GDP growth, so quarterly estimation is usually performed with pure time series techniques such as ARIMA. For countries where GDP data are available, estimation may be conducted using an ADL specification with a generous lag structure. Quarterly estimates may also be improved by including other high frequency indicators, e.g. purchasing managers indices.

Data sources

Annual and quarterly merchandise trade values and volumes:

- World Trade Organization: data.wto.org

Annual and quarterly GDP:

- International Monetary Fund (IMF): https://www.imf.org/en/Publications/SPROLLs/world-economic-outlook-databases#sort=%40imfdate%20descending
- Organisation for Economic Cooperation and Development (OECD): https://stats.oecd.org/
- World Bank: https://www.worldbank.org/en/publication/global-economic-prospects
- Economists Intelligence Unit: https://www.eiu.com/

Prices and exchange rates:

- CPI, Federal Reserve Bank of St. Louis: https://fred.stlouisfed.org/series/CPILFESL
- Real Effective Exchange Rates, Bank for International Settlements (BIS): https://www.bis.org/statistics/eer.htm

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