Simulating the trade effects of the COVID-19 pandemic
Scenario analysis based on quantitative trade modelling

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INTRODUCTION

COVID-19 has rapidly changed the world. As the virus spread across the globe, more and more countries have taken social distancing measures. Because of a lack of a vaccine or effective medical treatment, countries have turned to non-pharmaceutical interventions (NPIs) to stop its spread. Based on insights from epidemiologists,1 most countries eventually chose the strongest form of social distancing: suppression. After roughly three months of social distancing measures, many countries opened up again, relaxing restrictions to social interaction. However, in Fall the virus has been making a comeback, forcing governments to take new measures. The outlook is uncertain. The development, introduction and provision of a vaccine to broad segments of the population are expected to take place at some moment in 2021, without knowing when exactly.

The severe social distancing measures in Spring 2020 have provoked large changes in the organization of society. People stayed inside working from home with social life and travel limited to a minimum. Countries have imposed restrictions on international travel, adding border controls, and in some cases export restrictions for medical equipment and food. Although it is expected that the social distancing measures in the Fall are less severe, the outlook is uncertain because it is not clear how aggressive the virus will spread.

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

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1See for example Ferguson et al. (2020).
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 organising 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 expendi-
tures 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.

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 minimised? 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.

The objective of this study is to examine the expected effects of the COVID-19 pandemic on inter-
national trade. We build three scenarios and project the economic effects with the WTO Global Trade
Model, a quantitative trade model. With its detailed structure with multiple sectors, intermediate link-
ages and different end users, the model is a good instrument to show how various scenarios for the
development of the pandemic will affect international trade; to identify the economic channels along
which the pandemic is impacting trade; and to show how the relation between international trade and
GDP compares with previous crises, in particular the Great Financial Crisis. Although time-series
ecometric models might be better able to predict short-run developments, our quantitative trade
model is better suited to identify the channels through which global trade is affected by the pandemic
and to build economic intuition on the effects.

Because of the level of uncertainty about the duration of the pandemic and the containment mea-
sures, 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 in total, leading to either a U-shaped recovery scenario or a W-shaped
scenario. 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: (a) a general reduc-
tion of labour supply; (b) a rise in trade costs; and (c) 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 nontradable 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.

This paper makes three contributions to the literature. First, it provides a quantitative framework to analyse the potential impact on GDP and trade modelling the various channels through which the pandemic will affect international trade. Second, it develops various economic scenarios for the economic impact of the COVID-19 pandemic. Third, it compares the response of trade to the fall in GDP in the current crisis with the response in the financial crisis of 2008, identifying similarities and differences. The use of the modelling framework, its standardised database, as well as the detailed description of how the shocks are specified will enable 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. However, the scenarios provide a rigorous quantitative framework to analyse the most important channels through which international trade is affected.

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 scenario, 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. This scenario is included in the analysis to explore what would happen if the virus would disappear after a first wave.

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 organise 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. The U-shaped recovery scenario can also be interpreted as a scenario in which social distancing measures are in place for about six months in 2020, possibly in waves. Hence, after a first wave in Spring, the pandemic is largely under control, social distancing measures are eased over the Summer, after which a
second wave appears in the Fall. In this W-shaped scenario, social distancing measures stay in place for about 6 months.²

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. This scenario is included to explore how global trade would develop in a situation where it takes a long time before governments are able to control the pandemic without far-reaching social distancing measures.

The objective of exploring the three scenarios is to analyse how global trade would develop under different assumptions for the spread of the pandemic and the ability of governments to control its spread.

### 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; and (iii) rising trade costs because of border controls and restrictions to personal travel. Table 1 contains an overview of the different components of the three shocks in the three scenarios, focusing on the impact in 2020.³ 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.

#### 2.2.1 Labour supply shocks

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,

³Since our model is annual, a negative shock of two times three months will, under the assumption of an identical shock size in each month, have the same impact as a shock of six months. The equivalence in our model of a U-shaped and W-shaped scenario is recognized in Freeman et al. (2020) who employ the U-shaped scenario to determine the impact on the Dutch economy of a decrease in global trade in case social distancing associated with the COVID-19 pandemic stay in place for 6 months in 2020.

³The 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 closures, bankruptcies, which could further reduce economic activity and cannot be modelled properly with the current framework.
|                          | 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%\(^a\) |
| 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 specialised equipment | 6 months 22.5% extra for specialised equipment, proxied by share transported by air | Idem for 12 months | Idem for 18 months |

\(^a\)In year 2021, the recovery is 25% of the 2020 shock in the L-shaped scenario.
shirking, and a lack of interaction between people decreasing creativity. Conservatively it is assumed that this leads to a productivity loss of 5%. 4 Third, school closures also lead to a reduction in labour supply, because at least one parent has to stay home to take care of the children.

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-Cov-2. 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.

**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  |

4 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 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%.
2.2.2 Sectoral demand and supply shocks

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%. 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 characterised by rising economic uncertainty leading to postponement of durable consumption.

2.2.3 Trade cost shocks

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. 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 & Schaur, 2013). Third, trade costs for services have increased because of severe travel restrictions. Fourth, much equipment requires travel of specialised 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 specialised equipment (as a proxy for specialised equipment) and by the share of services not delivered digitally (based on the Eurostat database on the percentage of turnover from e-commerce, Eurostat, 2020).

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 specialised equipment. The projected increase in trade costs is biggest for the United States, because this country exports a lot of specialised equipment (in specific sectors and proxied by the share exported by air), and also exports a relatively large share of services.

5https://www.wired.com/story/airlines-use-empty-passenger-jets-ease-cargo-crunch/.
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. In this case, we can compare the initial shock to demand with the final reduction

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**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 | Specialised 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  |

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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.

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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.
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 Database 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.\(^7\) A fiscal policy response is included in the model, since most countries have responded with large fiscal packages to the crisis. This

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\(^7\)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.

### Table 4

| Sector                          | Services trade costs | Specialised 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     |
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.

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.

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 (Table 6).

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 2021.8

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.

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

8First 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.
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 United States 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 United States 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.

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.9

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 nontradable 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 nontradable 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 1.84 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 nontradable 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

9Tables 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.
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 explanation for the large trade-to-GDP elasticity during the financial crisis (Bems et al., 2013). Our simulations suggest that this could happen again in 2020 if the crisis is long-lasting.

In Table 9, we summarise the 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% |
| Country                        | V-shaped |             | U-shaped |             | L-shaped |             |
|-------------------------------|----------|-------------|----------|-------------|----------|-------------|
|                               | Labour   | Trade       | Sectoral | Labour      | Trade    | Sectoral    |
|                               | supply   | costs       | shifts   | supply      | costs    | shifts      |
| Australia New Zealand         | −1.2     | −3.4        | −1.7     | −1.6        | −5.6     | −5.6        |
| ASEAN                         | −1.7     | −5.3        | −2.3     | −2.2        | −7.8     | −8.2        |
| Brazil                        | −1.4     | −4.1        | −2.5     | −1.9        | −7.0     | −7.9        |
| Canada                        | −1.2     | −2.7        | −0.8     | −1.8        | −4.9     | −6.5        |
| China                         | −1.8     | −5.1        | −1.3     | −2.5        | −8.1     | −5.4        |
| European Union 28             | −1.9     | −3.2        | −2.2     | −2.6        | −5.4     | −8.1        |
| India                         | −2.7     | −3.0        | −6.4     | −3.8        | −4.6     | −15.2       |
| Japan                         | −2.0     | −5.1        | −2.7     | −2.8        | −7.5     | −8.1        |
| Latin America                 | −1.5     | −3.8        | −2.1     | −2.0        | −6.0     | −7.3        |
| Mexico                        | −1.1     | −0.5        | −3.2     | −1.4        | −0.8     | −10.1       |
| Middle East and North Africa  | −0.6     | −3.6        | −1.0     | −0.8        | −5.6     | −4.1        |
| Newly industrialized countries| −1.7     | −5.9        | −3.4     | −2.4        | −8.5     | −10.1       |
| Other Asian countries         | −2.2     | −2.2        | −3.3     | −2.8        | −3.5     | −11.2       |
| Rest of World                 | −1.2     | −4.2        | 0.2      | −1.7        | −6.7     | −0.2        |
| Sub-Saharan Africa            | −1.3     | −3.6        | −0.3     | −1.6        | −5.9     | −3.0        |
| United States                 | −2.3     | −9.4        | −2.6     | −3.2        | −14.0    | −10.6       |
| Global                        | −1.7     | −4.4        | −2.0     | −2.3        | −6.9     | −7.3        |
| Contribution shocks           | 21%      | 54%         | 25%      | 14%         | 42%      | 44%         |
| Global trade elasticity       | 0.84     | 4.47        | 1.10     | 0.84        | 3.75     | 1.60        |

| Contribution shocks | 21% | 54% | 25% | 14% | 42% | 44% | 13% | 32% | 52% |
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.

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, and (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 & Sidorenko, 2006) and COVID-19 (McKibbin & 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 1918–19 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

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

| Sector                                | 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    |
school closures, and to demand in specific sectors characterised 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) analyse the economic effects of an H1N1 Epidemic in the United States 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 labour 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) analyse 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 labour 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 characterised 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 has been rapidly expanding and studies are continuously updated. In our overview, we focus on projections about the impact on GDP by international organizations and projections on trade by all researchers. The overview in Table 11 contains studies from various international organizations.

At the beginning of the pandemic, various institutions employed calculation-type studies, because of a lack of information. Later conventional forecasting and projection models were employed again. Calculation-type studies such as those by OECD (2020a), INSEE (2020) and IFO (2020) combined 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 (2020a) projected 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. The date of the studies is included in the overview since earlier studies had to work with less information to generate their projections.

Comparing forecasts at the beginning of the pandemic with calculation-type studies showed that the projection/forecast studies were optimistic. The OECD calculated 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 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.

Comparing the methodology of the different projections and forecasts shows that a mix of macro-econometric and applied general equilibrium models is employed, with the former used in studies by the IMF, OECD and World Bank. The study of the European Commission imposes the GDP projections from the IMF April 2020 projections on its CGE model, targeting the reduction in GDP projected by the IMF with a mix of total factor productivity and iceberg trade cost shocks. In comparison with the study of the European Commission, the current study derives the GDP projections from shocks to exogenous variables such as trade costs and labour supply. As such, it follows the approach in McKibbin and Fernando (2020) and Maliszewska et al. (2020).10

McKibbin and Fernando (2020) and Maliszewska et al. (2020) incorporate similar shocks in the model as the current study: reductions in labour supply, sectoral shocks, shocks to sectoral demand patterns and increases in trade costs. McKibbin and Fernando (2020) develop six scenarios depending on the number of waves, the presence of lockdowns and the number of years the COVID-19 virus will keep on causing harm to global health and economy. Compared to this work, the current study contains a more detailed analysis of the impact on trade, including an extensive discussion of the relation between trade and GDP during the COVID-19 pandemic in comparison with the 2008 recession.

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

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10These studies are not included in the overview in Table 11, because they are either based on preliminary information (Maliszewska et al., 2020) or do not report global GDP effects.
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 organise 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 organising 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 nontradable 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. (2013) 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).\footnote{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 (Zavacka, 2012).} 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 general equilibrium 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 nontradable services, and this could temper the drop in global trade.\footnote{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.} 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 exports 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.\footnote{WTO (2020) employs time series analysis to predict trade for 2020. This generates a larger trade-to-GDP elasticity, because this estimate reflects the strong response of trade to GDP in previous downturns. Therefore, it 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 on coordination of travel restrictions.\footnote{Simulations with our model indicate that an experiment with only shocks to consumption demand in the durables manufacturing sectors of the same size as in the L-shaped scenario implies a trade-to-GDP elasticity of 5.6. Hence, the model employed is able to replicate the high elasticity observed during the financial crisis. However, because also other shocks are occurring this crisis, the trade elasticity is expected to be lower in this crisis.}

Summarising, 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 relatively quickly and losses would likely be concentrated in the nontradable 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 such as food instead would lead to a further reduction in trade.

5.3 Possible policy implications and extensions of current work

There are two policy 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 specialised 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.

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DATA AVAILABILITY STATEMENT
The data that support the findings of this study are available from GTAP. Restrictions apply to the availability of these data, which were used under license for this study. Data are available from the authors with the permission of GTAP.

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