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Reply to

Reply to: Observations of the effects of the COVID-19 pandemic on global trade

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In Guan et al.[1], we analyzed the supply-chain effects of a set of stylized COVID-19 lockdown scenarios, using a disaster assessment model[2,3] in combination with a widely validated and used global trade database[4]. Despite significant data limitations at this early stage of the outbreak, we provided a number of insights important for decision-makers attempting to minimize economic loss and acting under significant urgency and uncertainty. Verschuur and colleagues[5] estimate global supply-chain dynamics using real-time ship tracking data and voiced some concerns on our modelling study[1] based on the comparison of their findings with our modelling results. While we appreciate their complementary follow-up research based on real-time data, it is impossible to compare the stylized lockdown scenarios we developed with their data reflecting actual changes in the economy and policies that were implemented in response to COVID-19. In addition, there are differences in modelling scope and limitations of their data to reflect changes in global supply chains. We call for broad and practical collaborations on integrating epidemiological modelling with economic forecasting tools to provide full information to both policy and public stakeholders about effective protective measures that are needed for public health as well as the economy.

First, in Guan et al.[1] we did NOT aim at predicting the true cost of COVID-19; instead, we illustrate possible consequences under different types of lockdown scenarios, none of which has been exactly imposed in that manner in any of the countries. It would have been impossible to assess the real costs at this early stage given the differences (and day-to-day adjustments) in actual responses across the globe. Forecasting the economic impact of the pandemic is impossible given the dynamics of the situation. Instead, we identified the most important aspects of disease control (such as strictness, duration, and recurrence of lockdowns) by comparing the losses under several sets of idealized scenarios for containment measures and tested the sensitivity of these factors as their impacts ripple through global supply chains. The combinations of strictness and duration are

based on stylized scenarios rather than the actual policies implemented in any particular country. Thus, a comparison of our findings based on types of lock-down measures with real-time shipping data reflecting changes in actual lockdown measures is not assessing in any way the validity of our model and approach, as the underlying lockdown measures are not the same. While using real-time data is important and complementary to our modeling approach, it is not suited to validate the model given the differences of measures in the real world and those used in the scenarios. The real-time data sketches a combined trading consequence due to the COVID-19 disruptions. Attribution analysis is what modelling validations would require, but, unfortunately, would be premature at this stage.

Second, data from Verschuur and colleagues[5] only reflects a specific part of international trade, which is another reason why their results are incomparable with our results (in which all international trade is considered). Although Verschuur and colleagues[5] argue that "Maritime trade accounts for approximately 80% of international trade in terms of volume", about 40% of trade by value, however, is through air[6]. Considering the different impacts of the COVID-19 control measures on air and sea cargo[7,8], it is difficult to use the estimated results from ship tracking data to represent changes in all international trade due to the pandemic. Change in online services is another factor that is included in Guan et al.[1] but not in Verschuur and colleagues[5]. During COVID-19, online services related to physical production will decline due to the decline in physical production, while pure online services (such as education or meeting software services) increased as other real-time data shows[9]. These increases in certain areas and losses in other areas of the service economy are captured in our modeling approach but is not reflected when using ship tracking data reflecting physical trade.

The changes in the trade structure under the impact of the COVID-19 have further contributed to uncertainty about their estimates of trade value. Verschuur and colleagues[5] established a conversion table that describes the probability that a certain vessel type is associated with an economic sector using historical data. However, the rapidly changing trade structure during the pandemic[10,11] is likely to affect their estimated probability. This may be the most important reason for the inconsistency between their estimates of disruption dynamics and the data released by the General Administration of Customs of Vietnam (see details in the paragraph below where we respond to their first concern). Moreover, it is very difficult to predict the load of each container or each ship. In the shipping industry, there are many fully filled containers shipped from China to the EU and the US. Some of the containers are sold and used within the US and the EU, the cargo ships return with fewer containers or many empty containers. Hence, as can be seen from their estimates, the accuracy in predicting Japanese trade data in volume (Supplementary Figure 1h) and export trade data in value (Supplementary Figure 2b) is limited, especially for countries with low trade value. Customs trade data after the crisis can be a useful source to analyze trading pattern changes during COVID-19 and post recoveries.

After raising the above points, we would like to analyze their concerns one by one. For their concerns on Vietnam: Figure 2 in Guan et al.[1] shows that Vietnam would suffer about 5%-30% of value-added loss in different scenarios. The latest report from the General Department of Vietnam Customs shows that Vietnam's total imports in the first half of 2020 fell by 2.9% and total exports

remained almost unchanged compared with 2019[10,11] (note that: the global lockdown scenarios we set are more stringent than those in reality, so the model results are larger than the actual values). Nevertheless, we have all witnessed some rapid increases in trading volumes in Vietnam and China in the last quarter of 2020 due to the failure of effective disease control, leading to multiple lockdowns and delaying economic restarts in the west.

For their concerns on *en route* goods: Verschuur and colleagues[5] argue that the *en route* goods will serve as a positive buffer to the downstream sectors, and slow down the forward effect. Guan et al.[1] modeled this aspect as the inventory of each sector. Inventory would play a buffer role in reducing or delaying any forward propagation of shocks (see "CN" panel in Supplementary Figure 2 in Guan et al.[1]). However, production is restricted by a number of factors, and raw material is one of those. During lockdown, limited labor availability is usually the key factor, compared to raw material shortages, in rapid production declines (see "GB" panel in Supplementary Figure 2 in Guan et al.[1]). Therefore, the steeper decline we simulated was because we considered factors other than trade.

For the third concern: Verschuur and colleagues[5] argue that heterogeneities exist by comparing import and export dynamics of countries with similar stringency dynamics of control measures. However, what we see is that the stringency index of the United States and the United Kingdom from April to July is almost the same as the stringency index of China in March (Figure 1c in Verschuur and colleagues[5]). We doubt the reliability of this indicator based on the actual situation and the huge differences in how these measures play out across sectors.

Overall, Verschuur and colleagues[5] provide an interesting data-driven approach to monitor aspects of actual international trade flows, even though their study cannot offer a direct validation or information of our modelling results. Model-based and data-based approaches are both needed to inform policy makers. In a more in-depth perspective, it is valuable to borrow ideas from mixed frequency modeling strategies to integrate high-frequency data into a disaster impact assessment system.

Finally, the main qualitative conclusions of our paper seem more valid than ever. First, short and intensive lockdowns able to stop the epidemics appear less economically costly than laxer lockdowns that slow down the spread without eliminating the disease. Second, overcoming the pandemic is a global 'public good'. The end of the pandemic depends on the last group of countries effectively implementing protective measures, and international collaboration – and support to the poorest countries – are essential to minimize the duration and economic cost of this pandemics.

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Author contributions

D.W., K. H., X. L., D. C., S. H. and D. G. contributed equally to the manuscript, all of them drafting parts of this reply. All authors approved the final version.

Competing interests

The authors declare no competing interests.