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Observed impacts of the COVID-19 pandemic on global trade

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Guan and colleagues[1] used a model of the global economy to quantify the impacts of the coronavirus disease 2019 (COVID-19) pandemic under different scenarios of pandemic spreading and lockdown stringencies. Using real-time ship tracking data from before and during the pandemic, we show how the onset of disruption to trade was slower than modelled by Guan et al. Whereas supply chains to some countries with strong trading links to China (for example, Australia and Malaysia) have been affected in ways that resemble the results of their model (although to a lower extent than predicted), others with equally strong links (for example, Vietnam) have managed to increase their trade, contrary to the model's predictions. Understanding the propagation of the economic shock from COVID-19, which can be informed by real-time observations as well as model predictions, will help to better allocate international aid and economic stimuli.

Adaptive economic input–output models, as used in Guan et al.[1], are one of the main classes of models used to estimate the direct and indirect economic losses from large-scale natural disasters such as floods and earthquakes[2–4]. To represent supply-chain linkages between countries, these models use multiregional economic input–output tables[5]. They are thus able to model the effects that the economic shock from a natural disaster will have on producers, intermediate businesses and consumers across countries and sectors. Although these models are based on increasingly sophisticated assumptions about impacts and recovery from disasters[3,4], they are inevitably difficult to validate because disasters are rare and relevant information on impacts is difficult to obtain[6]. We argue that the type of economic model used by Guan et al. needs more rigorous validation before being applied to a rather different context (a pandemic with worldwide impacts) to the one for which it was built (localized natural disasters).

We used real-time shipping data, using Automatic Identification System (AIS) signals of vessels (see Supplementary Methods), as a complementary data source and reflect on the similarities and differences between these observations and the modelled dynamics in Guan et al. Maritime trade accounts for approximately 80% of international trade in terms of volume[7], serving as an indicator of the status of the global supply-chain disruptions. We analysed the entire AIS database from the outset of the pandemic (January to June 2020) to track the quantities of goods moved by vessels[8] and estimate maritime trade flows at ports globally with an algorithm that we developed and validated (Supplementary Results and Supplementary Figs 1 and 2). We compared these data with equivalent data from before the pandemic (November to December 2019). It should be noted that the methodologies are not directly comparable, as maritime trade flows are only one component of the economic system and input–output models are not designed to represent sub-annual dynamics. However, with the more detailed data that we have obtained we show how the modelled and observed disruption dynamics differ due to the limited capabilities of the current state of input–output models in representing multi-country supply and demand disruption dynamics.

Figure 1a shows the impacts of the containment policies imposed in China after the first reported outbreak of the pandemic in Wuhan. The decline in exports resembles the four-month scenario in Guan et al.[1] (as presented in their supplementary fig. 2), although with a less pronounced trough. As in their model, the forward propagation to Malaysia (reduced imports from China) and backward propagation to Australia (less demand for iron ore) are clearly visible in the AIS data at the moment that China reduces exports (with a time lag for Malaysia). Thus, some of the impacts of the pandemic on global trade can be effectively reproduced in the model simulations.

However, Vietnam, which was predicted to show very large losses in all of the modelled scenarios, actually increased exports after an initial small reduction around Spring Festival (Fig. 1b). This contradictory result is probably a consequence of a shift of production processes from China to Vietnam during the initial stages of the COVID-19 pandemic[9], together with the less stringent and highly effective response of the Vietnamese government to contain the virus spread. Production shifts and substitution effects of this type are typically not well-represented in input–output-based impact models. Despite some of the improvements made by Guan et al. to the ARIO model[2], their results indicate a clear decrease in all production outputs, underestimating the potential benefits of production shifts for some actors in the economic system.

The AIS data provides precise information about the propagation of disruption through international trade. Trade does not occur instantaneously, as transport (overland to and from ports, as well as in ships) takes time, goods may have to wait at ports and may be transhipped en route. For instance, goods imported into Western Europe from China typically take 25 to 30 days to travel port-to-port. The model used by Guan et al.[1] assumes that supply constraints (for example, due to factories not operating during lockdown) propagate through supply chains instantaneously—although they do assume the existence of stocks (for example, 20 days of production) that can be used to temporarily cope with shortages. In reality, the forward propagation of shocks would be lagged with the additive effect of inventories and transit times, explaining the observed impact curves that are generally less steep and more prolonged.

The Oxford COVID-19 Government Response Tracker (OxCGRT)[10] reports on the stringency of COVID-19 restrictions in 160 countries around the world, showing a great deal of

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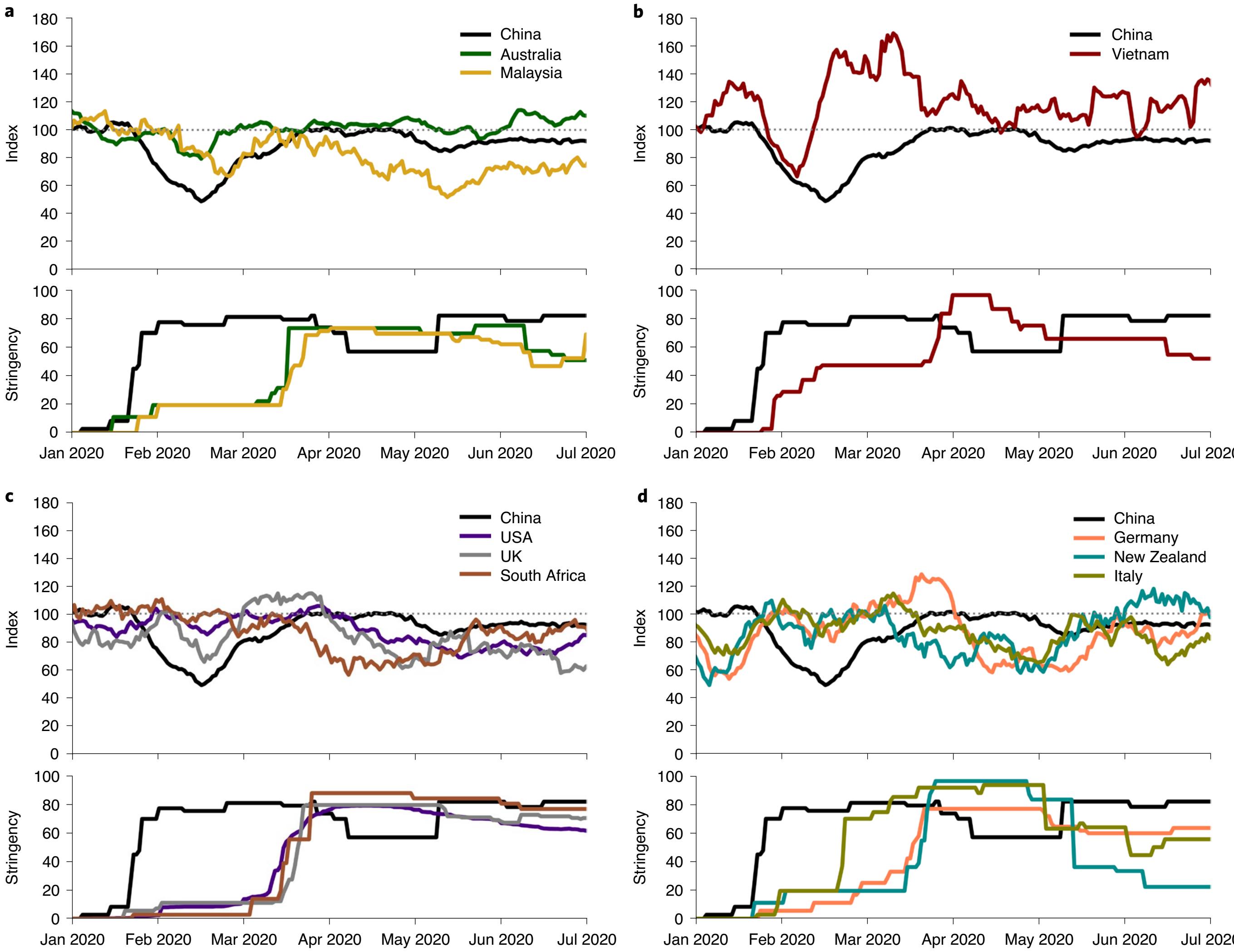

Fig. 1 | The impact of COVID-19 on shipping imports and exports from selected countries. a–d, Weighted index of imports and exports by ship (by value) based on average from November to December 2019 (100) (14-day moving averages of daily estimates). **a**, Shock propagation in China exports, Australia exports and Malaysia imports. **b**, Substitution effect in Vietnam exports during export reduction in China. **c**, Differences in exports for China, USA, UK and South Africa given similar lockdown stringency. **d**, Recovery dynamics for China, Germany, New Zealand and Italy exports after relaxing lockdown intensities.

heterogeneity between countries. Guan et al. demonstrated that the economic impacts of COVID-19 are sensitive to the speed of lockdown restrictions by testing a range of different rates of lockdown, implemented uniformly worldwide. They captured between-country heterogeneities by taking into account different sector compositions (using sector-specific multipliers). Although, admittedly, information on lockdown stringencies was not available at the time they did their analysis, our observations of trade and other work[11] show that countries with similar stringency of containment measures have incurred vastly different social and economic impacts. For instance, Fig. 1c compares the export curves for China, the USA, the UK and South Africa. Exports in South Africa started to decline before the lockdown, whereas the USA shows a lagged response relative to the moment when a lockdown was imposed. Between-country differences are also apparent when comparing countries that have partially relaxed lockdowns. In Guan et al., recovery rates are relatively similar across countries. However, as shown in Fig. 1d, New Zealand experiences a much faster recovery in international trade compared with Germany and Italy, with the latter countries showing signs of a second, smaller impact on exports. Although the trade data include the effects of the lockdown, supply-chain disruptions and additional country-specific behavioural aspects (for example, lockdown enforcement and consumer confidence), which are difficult to disentangle, they do show the non-uniformity across countries. Including a sensitivity analysis of heterogeneous lockdown restrictions and the effects they have on geographical disparities of impacts would have strengthened the main conclusions of Guan et al. and helped identify which countries were likely to be hit hardest.

The modelling undertaken by Guan et al.[1] provided an early indication of the scale and distribution of potential economic impacts of COVID-19 under different policy scenarios. However, using observational data of global trade from AIS ship tracking, we find both similarities and differences between the modelled dynamics and reality. Overall, the empirical evidence suggests that the modelling overestimated the negative economic impact of the pandemic. Complementary higher-frequency data sources of economic indicators, as presented here, should help to calibrate model parameters and refine and validate the modelled dynamics in cases where economic disaster models are used to evaluate scenarios of global supply-chain disruptions. Combining these methods, as is commonly used in nowcasting exercises, could provide policymakers with more decision-relevant information on the prioritization of post-COVID-19 recovery needs for the hardest-hit economies.

Reporting Summary

Further information on research design is available in the Nature Research Reporting Summary linked to this article.

Data availability

All derived datasets used for this analysis have been made publicly available at Zenodo under accession 4146993. The policy indicators were obtained from the Oxford Coronavirus Government Response Tracker (https://www.bsg.ox.ac.uk/research/research-projects/coronavirus-government-response-tracker).

Code availability

Custom code that supports the findings of this study is available from the corresponding author upon request.

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Author contributions

J.V. performed the analysis of the trade flows based on shipping data, with input from E.E.K and J.W.H. All authors contributed to the discussion and writing of the article.

Competing interests

The authors declare no competing interests.

Additional information

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Sampling strategy	No specific sampling strategy had to be implemented.
Data collection	Data was collected from an online geospatial server and further post-processing took place on a local machine.
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