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ORIGINAL ARTICLE

An Empirical Analysis of the Impact of COVID-19 on Trade: Evidence from a Small Island African Economy

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Abstract

This study investigates the potential impacts of the COVID-19 pandemic and the related containment measures on the trade system of Mauritius for the period January 2010 to June 2021. As the pandemic spread across the globe due to high interconnectedness across countries, the Mauritian authorities also established stringent health containment measures in the form of restrictions on people and businesses to slow the propagation of the virus. Being a small island economy highly dependent on international trade, Mauritius faced the brunt of the pandemic which disrupted its economic activities and trade flows with its main trading partners. COVID-19 incidence and lockdown measures impacted both exports and imports in Mauritius. The study was conducted using monthly data and the Bayesian structural time-series framework for causal analysis. Our findings reveal that the trade values for each of the country's trading partners decreased substantially. Furthermore, the stricter the containment measures, the bigger the negative impacts on both imports and exports. This study thus highlights the vulnerability of Mauritius as a small island economy to pandemics, emphasizing the need for tailored response strategies to mitigate the effects on trade.

Keywords: COVID-19, Trade, Mauritius, Bayesian structural time series

1. Introduction

The global outbreak of the coronavirus, an infectious disease caused by the severe acute respiratory syndrome SARS-CoV-2 virus, was triggered in the city of Wuhan, China in December 2019. The virus has since then been spreading rapidly to other countries across the world, causing the World Health Organisation to characterise the outbreak as a pandemic in March 2020. Since the start of the COVID-19 pandemic, the world has registered more than 6.4 million deaths attributed to the virus (Johns Hopkins University Centre for Systems Science and Engineering, 2022). The death rate however varies by region, depending on the health care system and services quality of countries, governments' responses in terms of health containment measures, population characteristics in terms of comorbidities or age as well as vaccination rates of the population, amongst others.

Apart from being a health crisis, the COVID-19 pandemic is having massive consequences for the world economy, impacting communities, individuals, households, societies and varied economic sectors. Moving rapidly across borders, along the travel connections and transport corridors facilitated by globalisation and high interconnectedness across countries, the virus has spared no nation. Since the virus started to spread, with new variants being more dangerous and difficult to manage, the repercussions for development became apparent and more so for small developing nations that are highly vulnerable to shocks. The incidence of the COVID-19 pandemic along with containment measures has impacted countries' economic activities. Proceeding in waves, with countries succumbing and recovering at different times, the virus and its aftermath are likely to stay for some time. It is clear that in the midst of the pandemic, trade becomes a more valuable tool to ensure an

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undisrupted supply of essential products like medicines, vaccines and health equipment.

The pandemic has created disruptions on an unprecedented scale and uncovered the vulnerability of many countries, especially in small and developing economies. The evidence on the trade effects of the pandemic on small developing economies is rather scant. Existing writings have focused mainly on developed or emerging economies or a sample of trading partners (Büchel et al., 2020; Espitia et al., 2022; Liu et al., 2021; Minondo, 2021). Small island economies are contingent on international trade and as such the COVID-19 burden is likely to be significant. Further, little attention has been paid to the impacts of COVID-19 on trade for countries of different income levels (Barbero et al., 2021). For instance, the composition of trade costs (information, transportation, and transaction costs) is more important for trade between high-, low- and middle-income economies, while trade policy and regulatory differences better explain trade between low and middle-income economies (WTO, 2021). The impact of COVID-19 on trade may further differ across countries due to the composition of traded products. For example, products traded in high-income countries require higher skills, and more embedded knowledge and tend to be more complicated than those in low- and middle-income economies (Minondo & Silvente, 2013). In addition, low-income countries present a lower share of jobs and activities that can be done at home so rendering them more sensitive to lockdowns and the effects of the virus (McMahon et al., 2020). The latter may also have a constrained and inappropriate healthcare system, which makes them more vulnerable to the pandemic. Owing to these differences across countries, it becomes important to assess the impact of COVID-19 on the trade structure of a small island economy like Mauritius, which is highly dependent on international trade.

To manage the COVID-19 pandemic and address its health and socio-economic consequences, governments have been implementing a combination of support measures to preserve businesses and jobs, ensure quality health care services, reduce the vulnerability of different segments of the population via social protection policies, ensure continuity in the education system and maintain the stability of the financial markets amongst others. Countries around the world adopted health containment measures to prevent the spread of the virus while ensuring the provision of essential services. Trade policy has also been an important instrument adopted by governments to mitigate the health and economic impacts of COVID-19. Countries have attempted to keep supply chains flowing to secure the availability of pharmaceuticals, critical medical services and personal protective equipment amid the increasing global demand for such products (UNCTAD, 2022). Nations have also adopted export controls and import liberalisation measures to prevent disruptions in the food supply, but at the same time, trade policies have been implemented to regulate or prohibit imports of products, which may be carriers of the coronavirus like clothing, and animal products. These restrictions have affected countries significantly, particularly small ones that are highly dependent on international trade to access essential products.

Abbreviations

BSTS	Bayesian structural time-series
GVCs	Global Value Chains
UNCTAD	United Nations Conference on Trade and Development

The purpose of this study is thus to assess the effects of the COVID-19 pandemic and related containment measures on the trade system of Mauritius. In the same spirit as Khan Jaffur et al. (2022), the Bayesian structural time-series (BSTS) framework for causal analysis, proposed by Brodersen et al. (2015), was employed. In line with the aim of this study, this technique is usually employed in examining the impact of any intervention variable (in our case the COVID-19 pandemic and related containment measures) on time series data. In other words, it outperforms other models for inferring causal impact. However, this study demarcates from the previous one in that it provided an in-depth analysis of the effects of the pandemic on both the import and export sectors of the country within different time windows. For our analysis, monthly 'total import' and 'total export' time-series data covering the period from January 2010 to June 2021 (138 observations) were employed. This was further broken into five main time windows for deeper insights.

The paper is structured as follows. Section 2 illustrates the trend in the trade data for Mauritius. Section 3 reviews the existing literature on the impact of shocks on international trade by referring to recent studies analysing the effects of COVID-19 on exports and imports. Section 4 introduces the methodology adopted. Section 5 discusses the findings, and we finally conclude in Section 6.

2. Situational analysis

The outbreak of the COVID-19 pandemic affected several countries' economic performance. Mauritius

has been no exception to that, more so given that the small island economy is highly dependent on international trade. Amid the pandemic, trading activities have undergone major changes in Mauritius, both on the international and domestic fronts. With travel restrictions and lockdowns across countries to contain the virus, air and maritime traffic has reduced drastically, causing a disruption in both supply chains and trading patterns. Fig. 1 below shows the export and import patterns in Mauritius from 2006 to 2021.

Total exports and total imports for the year 2020 were valued at Rs 128,824 million and Rs 209,228 million respectively, relative to Rs 191,680 million and Rs 267,408 million in 2019. This represented a 32.8% and 21.8% fall in exports and imports, respectively. A quarterly analysis of the data further shows that the impact of the pandemic was more pronounced in the second and third quarters of 2020, before recovering in the fourth quarter. In 2021, though exports and imports were higher as compared to the 2020 figures reaching, respectively Rs 132,972 million and Rs 242,264 million, they had not attained the pre-pandemic figure (i.e. 2019's figure). An overview of exports by region shows that in 2020, Europe remains the leading export destination for Mauritius, followed by Africa. In terms of importing countries, China, the United Arab Emirates, and India top the list.

3. Literature review

The COVID-19 pandemic has had and still has significant effects on international trade with disruptions in the economic activities of most countries around the globe. Amid the global impact of the pandemic on trade flows, the timing and the magnitude of these effects differ across countries. This heterogeneity in the impact results from the varied trade flow adjustments across nations. Nations differ in their trade structure, which depends in turn on the import and export basket compositions, their exposure to global value chains, their varied policy responses like import and export facilities and restrictions, domestic support packages and measures adopted to contain the virus (Baldwin & Tomiura, 2020; Comunale et al., 2021; Espitia et al., 2022; Evenett et al., 2022; Liu et al., 2021). Thus, the effects of the pandemic on international trade across nations differ.

From a theoretical perspective, COVID-19 significantly impacts international trade via various channels. The transmission mechanism of the effects of the COVID-19 shocks can be analysed in terms of demand, supply and global supply chains. The literature analysing the induced effects of COVID-19 on trade can be classified as burgeoning but also currently inconclusive in many instances (Barbero et al., 2021). The effects on international trade originate from both demand and supply disruptions caused by health containment measures such as lockdowns, quarantines, and travel restrictions (UNCTAD, 2021). On the demand side, the most immediate trade effect of the novel coronavirus has been on the sudden rise in the global demand for COVID-19 related medical supplies (McKibbin & Fernando, 2020), exceeding the domestic production levels, hence resulting in an increase in import demand and as such leading to rising prices. However, pandemics also depress aggregate demand by reducing household spending. Decreased earnings and fewer visits to

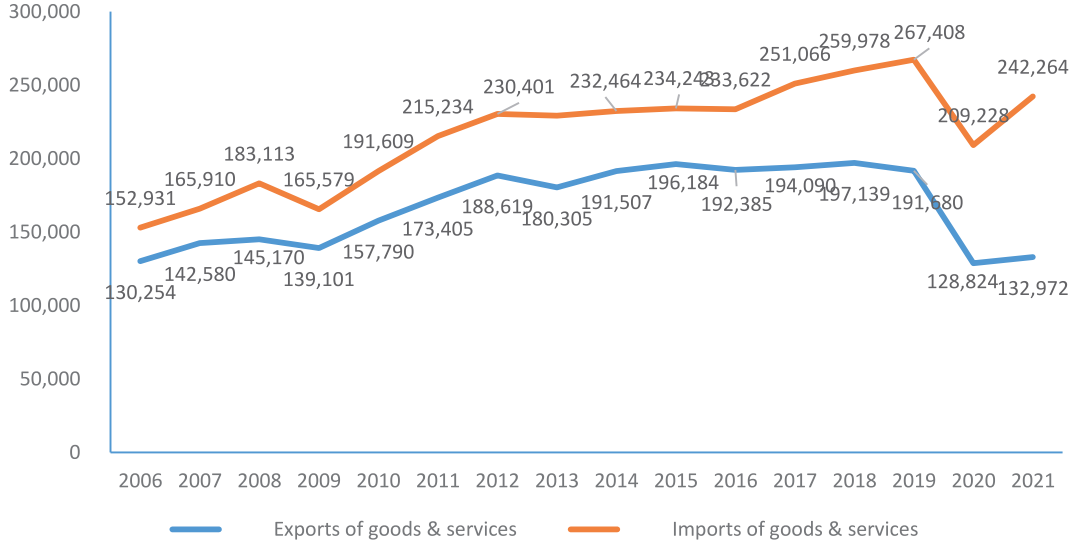

Fig. 1. Exports and imports of goods and services, 2006–2021. Source: Statistics Mauritius (2020).

retail stores lead to a fall in demand. Further, increased business uncertainty about future demand depresses the business environment (Correia et al., 2020). In addition, declining trade flows may arise not only from a fall in consumption demand but also from distorted usual consumption patterns and market anomalies due to panic among consumers and firms as preferences for certain activities change with the outbreak (McKibbin & Fernando, 2020). Demand disruptions thus occur via macroeconomic declines in aggregate demand that is resulting from recessions but also from the wait and see purchase delays by consumers and investment delays of enterprises (Baldwin & Freeman, 2020). Hence, the effect of the COVID-19 burden in an importing country is mainly due to decreased aggregate demand in that country.

On the supply side, the pandemic is affecting the health of workers and even causing deaths. This has led to reduced activity across all domestic economic sectors, including tradable sectors like manufacturing. Mortality and morbidity have led to the loss of a productive workforce and caused overall firm productivity to drop. Correia et al. (2020) noted that the Spanish flu depressed labour supply through self-isolation measures, restrictions on mobility, illness, and increased mortality, hence impacting nations' supply capacity. A fall in total labour supply is often accompanied by an increase in the costs of production across sectors (McKibbin & Fernando, 2020). Moreover, the lower availability of workers may entail a lower demand for capital as firms need a combination of both labour and capital to produce goods and services (Maliszewska et al., 2020, p. 9211). A higher COVID-19 burden in an exporting country decreases its scale of production and as such reduced export supply. Exports will fall mainly across those industries and countries where remote operations are less feasible (Hayakawa and Mukunoki, 2021a, b).

The international trade of a particular country may also be impacted by the COVID-19 burden in its neighbouring countries. For instance, falling exports from an affected country create an export opportunity for its neighbours whilst negative production shocks due to the pandemic in a country may reduce production in neighbouring countries via supply chain networks (Hayakawa and Mukunoki, 2021a, b). As per Baldwin and Freeman (2020), the most important impact of the pandemic is the massive disruptions it has led to international trade and global value chains (GVCs). The shocks to GVCs arise mainly because most economies are highly interconnected through globalisation. For instance, direct supply disruptions, which started in East Asian economies, one of the first economies hit by the novel coronavirus, spread fast in other industrialised countries in different parts of the globe. Supply-chain contagion has amplified the direct supply shocks as manufacturing sectors in less affected regions find it either harder or more expensive to acquire the necessary imported industrial inputs from those countries most affected by the pandemic (Baldwin & Freeman, 2020). Baldwin and Tomiura (2020) further argued that those sectors with large exposure to intermediate goods imports from China contracted more than other sectors. The decline in trade flows can also be viewed as a trade-induced effect caused by economic recessions (Maliszewska et al., 2020, p. 9211).

There are extensive empirical works on the impact of COVID-19 on trade (Liu et al., 2021). Though the common finding is that the pandemic is negatively affecting international trade flows, results vary across studies due to differences in the empirical approach, the methodology adopted, the level of aggregation, the types of goods being analysed and the data coverage (Liu et al., 2021). The existing studies on the induced effects of COVID-19 on trade tend to be inconclusive and vary across sectors. Specific country studies like Büchel et al. (2020) for Switzerland applied a conventional time series model to observe that during the lockdown, Swiss trade fell by 11% compared to the same period of 2019 with a contraction in exports which was correlated with the number of COVID-19 cases in importing countries. At the same time, the fall in Swiss imports was associated with the stringency measures set by the government in the exporting country. In terms of products, only pharmaceutical and chemical products remained resilient to the trade shock. Liu et al. (2021) have obtained similar results for China when using a gravity model; they note that COVID-19 has a significant negative effect on trade and the impact is lessened for medical goods and products that involve working from home. Further, De Lucio et al. (2022) note that stringency measures put in place at the destination countries reduced Spanish exports while imports were not highly negatively impacted. Minondo (2021) built on the above study to show that COVID-19 led to a more distinct decline in trade in services as the tourism sector is a major contributor to the Spanish economy. Moreover, Liu et al. (2021) assess the impact of COVID-19 incidence and lockdown measures on the monthly growth rate of China's imports from 2019 to 2020. Using monthly trade data and applying the standard log-linear gravity model, their results indicate that the direct effects of the COVID-19 incidence measured by the number of deaths per capita, and COVID-19 induced government measures, computed

by the stringency index of lockdowns are negative. This indicates that the negative own-demand effect on countries' imports from China prevails over the negative own-supply effect. Government measures to curb economic activities had a larger impact on China's imports than the direct health and behavioural effects of the pandemic. In contrast, though average lockdowns in third countries do not appear to affect a nation's imports from China, the direct effects of the pandemic in third countries impact trade. In effect, more deaths in the main trading partners of a nation (non-China) cause that country to import more from China than it otherwise would. The positive effects of COVID-19 incidence in the main trading partners more than offset the own negative pandemic incidence effect.

Other studies assessed the impact of COVID-19 on trade across a sample of countries. For instance, Zajc Kejžar et al. (2020) analysed the role of chain forward linkages in the transmission of the COVID-19 pandemic across EU member states. Applying the gravity model to monthly bilateral trade data, their results reveal that the spread of the virus together with containment measures imposed by the authorities led to a decline in demand causing a labour supply shortage and a halt in production. Espitia et al. (2022) further assess the impact of the novel coronavirus on trade across 28 countries and their most important trade partners. There is evidence that COVID-19 has reduced sectoral trade growth by decreasing countries' participation in global value chains. Along the same line, Verschuur et al. (2021) use a larger sample of 35 reporting countries and 250 partner-training nations and find a negative impact of COVID-19 stringency measures on exports of medical goods. Moreover, Barbero et al. (2021) examine the effects of the pandemic on bilateral trade flows using the gravity model and monthly trade data of 68 countries exporting across 222 destinations. Their findings show that the negative impact of the pandemic on bilateral trade is more pronounced for those nations, which were members of regional trade agreements before the outbreak of the coronavirus. Their study also reveals that there is a significant negative impact of COVID-19 on trade when indicators related to governmental actions are included. There is further evidence that the negative trade effects are more intense when exporter and importer countries share identical income levels. The highest negative effects are noted for exports between high-income economies. Hence, a country having the highest level of COVID-19 deaths per thousand people in a month will experience a fall of the order of 13% from China in that month. Likewise, moving from no lockdowns to the maximum level of stringency index will generate a fall of 17.6% in imports from China. Lastly, using the gravity model, Khorana et al. (2021) assessed the impact of COVID-19 on trade among Commonwealth countries and found that a rise in the number of COVID-19 cases in low-income economies reduced Commonwealth exports while a similar scenario in high-income economies increased their export flows.

Most of the above studies have assessed the impact of COVID-19 on trade via the gravity model or conventional time series model for specific countries. None of the existing empirical evidence has adopted the Bayesian structural time series framework for causal analysis. For instance, Xie (2022) used this method to analyse and forecast COVID-19 cases in the United States. Feroze (2020) also investigates the temporal dynamics of the pandemic in the top five affected countries and examines the causal impact of lockdown in these countries using the same methodology. Further, Feng and Li (2021, pp. 1–17) undertake a causal estimation of COVID-19 and SARS on China's stock market via the Bayesian structural time series framework. Hence, this study applies an innovative methodology to assess the potential impacts of the COVID-19 pandemic and related containment measures on the trade system of Mauritius.

4. Methodology and data

4.1. Model

Understanding the size and direction of the impact of an event and the effects of related policies remains a key ingredient of research and practice. This not only forms the basis of strategic decision-making but also helps in the development of appropriate policies and the enhancement of existing ones to curb the impact. In line with recent advancements in the analysis of the influence of a certain intervention variable (see Brodersen et al., 2015; Scott & Varian, 2014) on a specific time series and previous studies (see Campedelli et al., 2021; Perles-Ribes et al., 2021; Soto-Valero & Pic, 2019; Takyi & Bentum-Ennin, 2021), this study employed the Bayesian structural time series framework for causal analysis, proposed by Brodersen et al. (2015), to investigate the potential impacts of the COVID-19 pandemic and related containment measures on the trade system of Mauritius. The latter was implemented using the CausalImpact R-package (R Core Team, 2020). The model can be specified in terms of these two equations:

$$y_t = Z_t^T \alpha_t + \varepsilon_t \quad (1)$$

$$\alpha_{t+1} = T_t\alpha_t + R_t\eta_t \quad (2)$$

where y_t is a scalar observation, Z_t a d-dimensional output vector, T_t is a $d \times d$ transition matrix, R_t is a $d \times q$ control matrix, $\epsilon_t \sim N(0, \sigma_t^2)$ is a scalar observation error with noise variance σ_t and $\eta_t \sim N(0, Q_t)$ is a q-dimensional system error with a $q \times q$ state-diffusion matrix Q_t, where $q \leq d$ and is independent of all unknowns. Equation (1) is the observation equation whereby the observed data y_t is linked to a latent d-dimensional state vector α_t whereas Equation (2) refers to the state equation, which governs the dynamic change of the state vector α_t over time (Brodersen et al., 2015).

The above equations estimate the difference between the observed time series of the response variable (in our case the trade values) and a simulated time series that would have occurred without the intervention variable (in our case the outbreak of the COVID-19 pandemic) during the post-intervention period (in our case the post-COVID-19 period). It works as follows: first, the observed data in the pre-intervention period are simulated, counterfactual scenarios are then used to create the predictions of the observed data for the post-intervention period and finally, the model provides the difference between the predicted values and the observed ones during the post-intervention period[1]. This is then interpreted as the causal impact of the occurrence of the intervention variable on the observed data.

Structural time series models are more useful in practice as compared to traditional univariate models. The Bayesian framework allows flexibility and inferential power, enabling the method to effectively capture important features of the data and as such, provides appropriate estimates of the cummulative difference between the actual data and a counterfactual scenario. It also controls the risk of excluding relevant patterns that may not be specifically related to the intervention variable and avoid the risk of ignoring long-term dynamics (Campedelli et al., 2021). Moreover, Bayesian structural time series models outperform intervention analysis based on univariate models; they enable the creation of counterfactual predictions by constructing a synthetic control based on a combination of markets that have not been treated (Perles-Ribes et al., 2021).

4.2. Data

The empirical analysis was undertaken using monthly imports and exports trade values (in US$) for the period January 2010 to June 2021 for the top ten trading partners of the country[2]. Based on the country's import and export partner shares for 2019, these countries include Belgium, China, France, Germany, Italy, Japan, South Africa, Spain, United Kingdom and United States of America (see Table A1 in Appendix). Data were collected from the International Trade Statistics Database of UN Comtrade (UN Comtrade, 2021). Summary statistics for the sample of countries considered are reported in Table A2 of the Appendix.

The time-series data were split into two, namely pre-COVID-19 (January 2010–December 2019) and post-COVID-19 (January 2020–June 2021) periods for all countries. The post-intervention period, in our case the post-COVID-19 period, was further broken into five time windows to examine the overall impact of the COVID-19 pandemic (January 2020–June 2021), its immediate effect (January 2020–March 2020) and the influence of containment measures implemented at different time intervals on the trade values. Table 1 displays the date for each time window considered for the influence of the containment measures together with the different measures implemented.

It can be observed from Figures A1-A2 of the Appendix that the series of both the imports and exports trade values departed from their original trends shortly after the outbreak of the pandemic was first declared in December 2019 in China: an overall decline can be seen. A closer look shows that exports were the most affected with the largest dip in April 2020 following national and global lockdowns. As for the import series, the latter varied according to the country of investigation due to the measures implemented for these countries. A question that arises here is whether these declines were due to the pandemic or global trade wars and uncertainties. For instance, in 2019, the container throughput index, an important indicator of global trade, experienced a fall reaching 134.1 in December 2019 (ISL, 2021). Similarly, during the same year,

Table 1. Time windows and measures implemented.

Period	Measures implemented
January 2020–March 2020	First national lockdown as from March 20, 2020; Closure of national borders as from March 19, 2020; planes were grounded
January 2020–May 2020	Global lockdown in April 2020; planes grounded worldwide
January 2020–February 2021	Resumption of cargo/commercial flights as from May 06, 2020
January 2020–April 2021	Second national lockdown as from March 10, 2021; National borders were again closed and cargo/commercial flights were suspended until July 15, 2021

global airfreight volumes registered negative growth (−3.3%), the first since 2012 and the slowest since the global financial crisis in 2009 (IATA, 2020).

In our case, the Bayesian structural time series (BSTS) framework for causal analysis was applied as follows. As mentioned earlier, the time-series data were split into two, namely pre-COVID-19 (January 2010−December 2019) and post-COVID-19 (January 2020−June 2021) periods for all countries. The intervention event was fixed to December 2019 when the outbreak of the pandemic was first declared. For each time window, the pre-intervention period (i.e. January 2010−December 2019) data was used to find an optimal BSTS model for each series. Under the assumption that the outbreak of the pandemic did not occur, the optimal model was then employed to provide forecasts for the post-intervention period (for instance, for the first time window: January 2020−March 2020). The real values of the series were then subtracted from the predicted data for each post-intervention period. The difference between the observed values and the predicted ones was considered as the magnitude of the causal impact (See Figure A3 in the Appendix for an illustration).

5. Results and discussion

This section presents the results obtained using the methodology proposed by Brodersen et al. (2015) and computed automatically using the CausalImpact R-package (R Core Team, 2020). As mentioned previously, the model was applied at different time windows: the first capturing the overall effect of the pandemic (January 2020−June 2021), the second consisting of the first three months following the outbreak of the pandemic in China (January 2020−March 2020) to assess the immediate impact of the pandemic. The remaining windows are to examine the effects of the containment measures implemented at different time intervals: January 2020−May 2020, January 2020−February 2021, and January 2020−April 2021. For each trading partner, the same analytical structure was provided: the overall impact was first reported (see column [1] of Table 2), followed by the immediate impact (see column [2] of Table 2) and the effects of the containment measures (see columns [3]-[5] of Table 2). In this study, only the cummulative effects for the different time intervals are discussed. Table 2 provides a breakdown of the results according to the ten main trading partners investigated. A quick look at the results shows that imports to Belgium were the most affected, recording an overall decrease of 32% for the whole post-COVID-19 period (January 2020−June 2021) while exports towards France were the most impacted with an overall decline of 46% for the same period (see column [1] of Table 2).

For both Belgium and China, it can be observed that only imports trade values were negatively affected by the pandemic and the containment measures implemented. For the overall period of investigation, imports from Belgium decreased by 32% while that of China by 17%. Nevertheless, these negative effects were not apparent in the first three months following the outbreak of the pandemic (January 2020−March 2020). It can be seen that the imports trade values from Belgium continued to fall, reaching a minimum of −36% when the country enforced a second lockdown. As for China, the latter decreased by 19%, the lowest in the post-intervention period, and the second post-intervention window (January 2020−May 2020) before starting to slightly increase in the subsequent periods. This is because Mauritius restricted imports of live animals and fish from China, Italy and other European countries from March 16, 2020 to June 03, 2020 in an attempt to contain the spread of the virus.

Moreover, during the whole post-COVID-19 period, both the imports trade values and exports trade values of France experienced a fall: ranging from −29% to −23% for imports and −68% to −46% for exports. It can be seen that exports towards France were the most affected. The trade values plummeted the most during the second post-intervention window (January 2020−May 2020) due to the introduction of a global lockdown in addition to the ongoing national lockdown to curb the transmission of the virus worldwide. Subsequently, the trade values began to rise after the relaxation of containment measures.

Regarding Germany, it can be seen that the containment measures did not have any significant effect on its imports trade values. However, the cummulative relative effects depicted a negative relationship between the pandemic and its exports trade values. For the whole post-COVID-19 period (January 2020−June 2021), this amounted to a decrease of 26% in exports trade values towards Germany. This value decreased further to −44% during the second post-intervention window due to the global and national lockdowns. The latter started to increase after the relaxation of the containment measures, whereby the national and global lockdowns were removed, reaching −23% in the third post-intervention window (see column [4] of Table 2). Nevertheless, this again plunged by 1% in the following time window due to the imposition of a second national lockdown (see column [5] of Table 2).

Table 2. Relative cumulative effect per country.

Total Trade	[1]	[2]	[3]	[4]	[5]
Belgium					
Imports	−32%*** (9.5%) [-51%, −13%]	−17% (14%) [-43%, 11%]	−34%*** (12%) [-56%, −11%]	−34%*** (9.5%) [-53%, −15%]	−36%*** (9.5%) [-55%, −17%]
	99.95%	*89%*	*99.78%*	*99.95%*	*99.98%*
Exports	15% (23%) [-29%, 60%]	2.3% (31%) [-56%, 65%]	−23% (25%) [-70%, 25%]	20% (23%) [-25%, 66%]	18% (23%) [-27%, 63%]
	75%	*57%*	*82%*	*81%*	*79%*
China					
Imports	−17%*** (4.5%) [-25%, −7.9%]	−13% (11%) [-35%, 9.5%]	−19%** (8.1%) [-35%, −3%]	−16%** (4.9%) [-25%, −6.3%]	−15** (4.7%) [-24%, −5.7%]
	99.94%	*87%*	*99.02%*	*99.88%*	*99.84%*
Exports	−3.5% (21%) [-45%, 39%]	29% (54%) [-77%, 137%]	19% (43%) [-66%, 104%]	−1.8% (23%) [-47%, 44%]	0.5% (23%) [-44%, 45%]
	56%	*71%*	*67%*	*53%*	*52%*
France					
Imports	−24%*** (4.6%) [-33%, −15%]	−23%** (11%) [-45%, −1.8%]	−29%*** (8.3%) [-46%, −13%]	−24%*** (5.1%) [-34%, −14%]	−23%*** (4.8%) [-33%, −14%]
	99.98%	*98.23%*	*99.92%*	*99.98%*	*99.98%*
Exports	−46%*** (6%) [-58%, −35%]	−58%*** (14%) [-85%, −32%]	−68%*** (9.9%) [-87%, −48%]	−48%*** (6.6%) [-61%, −35%]	−47%*** (6.2%) [-59%, −35%]
	99.98%	*99.98%*	*99.98%*	*99.98%*	*99.98%*
Germany					
Imports	−0.53% (5.3%) [-11%, 9.7%]	16% (13%) [-8.4%, 41%]	2.3% (9.6%) [-17%, 21%]	1.2% (5.8%) [-10%, 12%]	0.95% (5.6%) [-9.9%, 12%]
	55%	*90%*	*58%*	*57%*	*56%*
Exports	−26%** (8.6%) [-43%, −9.7%]	−27% (20%) [-68%, 13%]	−44%*** (15%) [-74%, −15%]	−23%** (9.7%) [-42%, −4.1%]	−24%** (9.1%) [-42%, −6.9%]
	99.86%	*92%*	*99.90%*	*99.14%*	*99.68%*
Italy					
Imports	−6.7% (4.7%) [-16%, 2.7%]	−3.6% (12%) [-27%, 20%]	−11% (8.4%) [-27%, 5.7%]	−10%* (5.1%) [-20%, −0.1%]	−6% (4.9%) [-15%, 4.1%]
	92%	*62%*	*90%*	*97.61%*	*89%*
Exports	−33%*** (9.4%) [-52%,-15%]	−34% (22%) [-77%, 8.6%]	−43%* (16%) [-75%, −12%]	−26%** (11%) [-47%, −5%]	−30%* (10%) [-49%, −10%]
	99.96%	*94%*	*99.63%*	*99.17%*	*99.80%*
Japan					
Imports	−14%** (5.9%) [-26%, −2.5%]	4.1% (14%) [-24%, 33%]	−14% (11%) [-34%, 8.2%]	−15 (6.7%) [-28%, −1.4%]	−13%* (6.2%) [-25%, −0.3%]
	99.19%	*61%*	*89%*	*93.40%*	*97.83%*
Exports	−35%* (18%) [-71%, −0.28%]	90%* (46%) [-0.87%, 178%]	39% (38%) [-37%, 113%]	−28% (20%) [-67%, 10%]	−31%* (19%) [-70%, 5%]
	97.54%	*97.30%*	*85%*	*93%*	*95.58%*
South Africa					
Imports	−12%* (5.9%) [-23%, 0.15%]	−6.6% (14%) [-34%, 21%]	−22%* (11%) [-42%, −0.57%]	−19%** (6.5%) [-31%, −5.8%]	−15%** (6.2%) [-27%, −2.8%]
	97.30%	*68%*	*97.76%*	*99.72%*	*99%*
Exports	3.3% (5.8%) [-8.1%, 14%]	−6.2% (14%) [-34%, 21%]	−34%** (11%) [-56%, −12%]	−1.3% (6.3%) [-14%, 11%]	0.43% (6%) [-11%, 12%]
	72%	*69%*	*99.84%*	*58%*	*53%*
Spain					
Imports	−11% (12%) [-32%, 13%]	57%* (31%) [-1.8%, 118%]	21% (23%) [-24%, 66%]	−5% (13%) [-30%, 21%]	−5.6% (12%) [-29%, 19%]
	82%	*97.06%*	*82%*	*65%*	*67%*
Exports	−26%** (8.4%) [-43%, −9.7%]	−11% (20%) [-51%, 27%]	−30%* (15%) [-59%, −1.2%]	−28%** (9.2%) [-46%, −9.6%]	−28%* (8.8%) [-45%, −11%]
	99.82%	*72%*	*97.89%*	*99.82%*	*99.84%*
United Kingdom					
Imports	−26%*** (7.9%) [-42%, −11%]	−12% (20%) [-50%, 28%]	−16% (15%) [-44%, 14%]	−29%*** (8.6%) [-46%, −12%]	−28%*** (8.2%) [-44%, −12%]
	99.94%	*72%*	*86%*	*99.94%*	*99.94%*
Exports	−22%** (9.2%) [-40%, −4.1%]	−19% (14%) [-46%, 8.1%]	−36%*** (11%) [-58%, −14%]	−22%** (9.1%) [-40%, −3.8%]	−25%** (9.1%) [-42%, −6.7%]
	99.03%	*92%*	*99.94%*	*99.13%*	*99.55%*

United States of America						
Imports	−28%** (10%) [-47%, −7.8%]	−0.66% (25%) [-51%, 48%]	−28% (18%) [-63%, 7.3%]	−32%*** (11%) [-54%, −10%]	−28%** (11%) [-49%, −7.1%]	
	99.57%	*51%*	*94%*	*99.78%*	*99.43%*	
Exports	−39%*** (5.6%) [-50%, −28%]	−20% (14%) [-47%, 8.1%]	−42%*** (11%) [-63%, −21%]	−39%*** (6.2%) [-51%, −27%]	−38%*** (6%) [-50%, −27%]	
	99.98%	*92%*	*99.96%*	*99.98%*	*99.98%*	

Notes: The values represent the cummulative relative effects and those in the parentheses are their respective standard deviations, those in the brackets show the 95% confidence interval while those in italics represent the posterior probability of a causal effect. [1]: whole post-intervention period (January 2020–June 2021), [2]: first post-intervention window (January 2020–March 2020), [3]: second post-intervention window (January 2020–May 2020), [4]: third post-intervention window (January 2020–February 2021), [5]: fourth post-intervention window (January 2020–April 2021); ***, **, * indicate significance at the 5%, 1% and 0.1% levels respectively.

Similarly, it can be observed that exports from Italy were mostly affected by the pandemic as compared to its imports. The cummulative relative effects ranged from −43% to −30%. During the period January 2020 to June 2021, the exports trade values in Italy encountered an overall decrease of 33% (see column [1] of Table 2). The global lockdown together with the national lockdown caused the latter to experience a sharp dip of −43% (see column [3] of Table 2). The latter increased to −26% in the third post-intervention window (January 2020−February 2021) after the removal of the global and national lockdowns whereby cargo and commercial flights started operation from May 06, 2020. Nevertheless, the introduction of a second national lockdown in March 2021 and April 2021 due to a resurgence of local cases caused a further reduction of 4% in the exports trade values in the fourth post-intervention window (see column [5] of Table 2). Surprisingly, it was found that despite the relaxation of containment measures in the third post-intervention window (see column [4] of Table 2), the imports trade values from Italy encountered an overall decrease of 10%. One potential explanation was the restrictions imposed by Mauritius for imports of live animals and fish from that particular country.

For the specific case of Japan, it can be observed that the introduction of the global lockdown and the first national lockdown did not influence imports and exports (see column [2] of Table 2). For the whole post-COVID-19 period, imports trade values decreased by 14% while exports trade values by 35% (see column [1] of Table 2). One unanticipated finding was that the exports trade values towards Japan climbed to 90% during the first post-intervention window of our analysis. This could be explained by the high supply of frozen fish which amounted to a total of $10,787,823 for the said period. It can also be seen here that the introduction of the second national lockdown harmed both imports and exports; resulting in a decrease of 13% and 31% in total trade values for both imports and exports respectively (see column [5] of Table 2).

Concerning South Africa, the imports trade values were the most affected by the pandemic: a relative decrease of 22%−15%. For the whole post-intervention period, this was about 12% (see column [1] of Table 2). A closer look at the effects of the different containment measures on the trade values indicates that both the exports trade values and imports trade values of the country were disturbed during the introduction of the global lockdown; a decrease of 22% can be observed for imports and 34% for exports (see column [2] of Table 2). The

imports trade values started to climb up as soon as the containment measures were less strict in the third and fourth post-intervention windows.

Furthermore, for Spain, it can be seen that the pandemic influenced more the exports trade values as compared to the imports. The imports trade values were only found to be impacted during the first post-intervention window (see column [2] of Table 2). In particular, a positive and significant impact of 57% was recorded, thereby suggesting an increase in the demand for imports from Spain for the first three months following the outbreak of the pandemic. As for the exports trade values, the relative effects varied from −30% to −26%. For the period January 2020 to June 2021, a decrease of 26% was found in the exports trade values of the respective country. Exports from Spain experienced the greatest dip (−30%) as a result of the global lockdown (see column [3] of Table 2). Again here, it can be observed that the relaxation of containment measures, where cargo and commercial flights were allowed, led to an increase of 2% in the exports trade values.

Conversely, it can be observed that for the United Kingdom, the pandemic and related containment measures had impacted trade values. In contrast to the exports trade values, imports were the most affected with a decrease of 26% for the whole investigation period (January 2020−June 2021) compared to a 22% decline for exports. The global lockdown led to a sharp reduction of 36% in exports trade values emanating from the United Kingdom (see column [3] of Table 2). This was also the case during the enforcement of the second national lockdown whereby a decline of 25% was noted (see column [5] of Table 2). Again here, it can be seen that despite that cargo and commercial flights being allowed to operate, the imports trade values experienced the largest decline (−29%) in the third post-intervention window (January 2020−February 2021). One possible explanation resides in the depreciation of the country's currency; whereby the latter registered the highest depreciation in its currency during that period. This undoubtedly made importers less reluctant to trade.

Likewise, imports and exports for the United States of America were also reduced during the whole post-COVID-19 period (January 2020−June 2021). The pandemic caused a respective decline of 28% and 39% in imports and exports trade values. Zooming on the impact of the global lockdown, it can be seen that the latter only impacted the exports trade values whereby the latter decreased further by 42% during the second post-intervention window (see column [3] of Table 2). As for the remaining time windows, it can be deduced that the introduction of less strict measures led to a slight increase in both imports and exports trade values.

The findings are in line with Hayakawa and Mukunoki (2021a,b), suggesting that the COVID-19 pandemic harmed both importers' and exporters' foreign trade. They also further support the fact that strict containment measures tend to reduce export and import trade volumes (see, for instance, De Lucio et al., 2022; Arenas et al., 2022; Cengiz & Manga, 2022). Overall, it can be observed that the imports trade volumes were mostly affected by the pandemic and the relative containment measures. Similar results were reported by Büchel et al. (2020) and Wang and Mo (2022). Nevertheless, as compared to their imports, a much greater reduction can be seen in the export trade volumes towards the United States, France and the United Kingdom for the different time windows. Büchel et al. (2020) argued that exports were negatively correlated with the trading partners' infection rates. Zhao et al. (2021) also advocated that exports towards high-risk countries tend to shrink.

6. Conclusion

The paper analysed the impacts of the COVID-19 pandemic and different containment measures on Mauritian exports and imports. A quick look at the graphs of both the imports and exports trade series depicted clear evidence that the outbreak of the COVID-19 pandemic caused a decrease in the trade values of most trading partners: a departure from their original trends can be observed in most cases. The post-COVID-19 period (January 2020−June 2021) was subsequently broken into five time windows for investigation: (i) the overall impact of the pandemic, (ii) its immediate effect, and (iii) the effects of the containment measures applied at different time intervals. The estimations and analysis were conducted using the Bayesian structural time series model for causal analysis, proposed by Brodersen et al. (2015). We found that for the whole post-COVID-19 period (January 2020−June 2021), overall the trade values encountered a reduction. The immediate impacts were only apparent for four out of the ten trading partners considered (France, Germany, Japan and Spain). It is worth noting that the trade values were much hindered by the introduction of the national and global lockdowns whereby commercial planes were suspended and planes were grounded in some countries. The results also show that on the whole, the relaxation of the containment measures, with the re-opening of borders and operation of commercial flights, helped to curb these negative impacts. The findings thus confirm the vulnerability of small

island economies to the spread of the novel coronavirus and the restraint measures put in place to contain the virus. While the pandemic may be far from over, it has become clear that transforming global approaches to trade and development cannot be avoided when charting a sustainable course to recovery from the pandemic (UNCTAD, 2021).

The importance of trade for a small island economy like Mauritius is undeniable. To mitigate the effects of the COVID-19 pandemic on its bilateral trade flows, the short-term response of trade recovery strategies must focus on strengthening important sectors connected to its main trading partners that continue to grow despite global value chain breakdowns. These sectors include agriculture and food processing, health, pharmaceutical, sanitary industries, and information and communications technology. Likewise, support functions necessary for these sectors, such as transport, logistics management and e-commerce need to be further reinforced. An appropriate international freight assistance mechanism should be developed to better control airfreight rates. To strengthen existing sectors despite the uncertainty created because of the pandemic, it is also vital to identify tailor-made solutions for enterprises to enable them to navigate trade disturbances such as uncertain trade relations and shifts in production capacity, amongst others. Moreover, the government should expand its Foreign Trade Agreement networks to its main trading partners to maintain a smooth running of both its imports and exports activities. Additionally, the country's currency, especially with the US dollar, should also be maintained in equilibrium as far as possible since an appreciation/depreciation in the latter may entail a disruption in the bilateral trade flows.

Trade promotion is also an important aspect (with the use of digital marketing and online networking, amongst others) to focus on. Supporting the digitalisation of traditional value chains for enhanced quality, traceability and compliance will help the trade sector. To strengthen the resilience of exporters, it is critical to identify and plan for a sound business environment, especially competition, access to finance, trade facilitation and international logistics for businesses. This will help firms facing difficulties adopt agile management practices and connect to digital platforms and go global through e-commerce.

Availability of data and material

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Authors' contributions

The authors contributed equally to the article.

Notes

1. The pre-intervention period is the period from the first data point to the one just before the outbreak of the pandemic was first declared (i.e. up until December 2019); The post-intervention period considers data from January 2020 to June 2021.
2. Despite that our sample size was relatively small, it was adapted to the recommendations of Brodersen (2016) on the application of Bayesian structural time-series (BSTS) models for causal analysis, which stipulates that the length of the pre-intervention period should be approximately two or three times that of the post-intervention period whenever the impact of an intervention variable (in our case the outbreak of the COVID-19 pandemic) is examined on another variable.

Conflicts of interest

The authors have no conflicts of interest to declare.

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Appendix.

Table A1. Trade partner share (%).

Country/Year	Export					Import				
	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
Belgium	1.92	1.46	1.17	1.51	1.5	0.73	0.88	1.5	2.17	2.03
China	0.77	2.07	1.31	1.73	1.71	18.23	17.71	16.4	16.51	16.69
France	11.88	14.79	15.82	14	12.65	7.15	7.85	8.02	8.2	7.01
Germany	1.12	1.65	2	2.28	2.08	2.4	3.09	2.68	2.83	2.99
Italy	5.43	7.14	6.88	4.59	5.47	2.14	2.27	2.24	2.26	2.34
Japan	1.12	1.31	1.2	1.12	1.81	2.45	3.1	3.34	3.11	3.09
South Africa	8.64	8.13	8.93	10.97	10.44	6.46	7.49	8.51	9.23	8.07
Spain	4.35	4.48	5.58	5.19	4.41	2.98	2.98	3.23	2	3.12
United Kingdom	13.1	12.01	11.8	11.28	11.13	2.19	2.17	2.11	2.21	3.02
United States of America	10.63	11.19	11.2	11.95	10.75	1.66	2.12	2.38	2.43	2.07

Source: WITS (2021).

Table A2. Descriptive statistics.

Country	Exports Trade Value (US$)				Imports Trade Value (US$)			
	Minimum	Mean	Standard Deviation	Maximum	Minimum	Mean	Standard Deviation	Maximum
Belgium	398021	3712991	1673710	8872075	1709579	5284393	3066683	1.58e+07
China	130922	1758177	1529570	9236755	2.27e+07	6.77e+07	1.55e+07	1.12e+08
France	4463388	2.59e+07	7501688	4.89e+07	1.99e+07	3.35e+07	6922224	5.21e+07
Germany	661676	3056040	1056305	6647947	5855816	1.14e+07	2530680	1.93e+07
Italy	3821131	1.18e+07	4466468	2.40e+07	523031	9354429	2016420	1.54e+07
Japan	358085	2170904	1601111	1.39e+07	4817045	1.19e+07	3051179	2.57e+07
South Africa	1009620	1.58e+07	4245628	2.45e+07	1.64e+07	3.19e+07	7545596	6.03e+07
Spain	3808693	9892192	3232106	1.85e+07	3478148	1.31e+07	5767021	3.10e+07
United Kingdom	3062276	2.59e+07	9054703	4.88e+07	4454597	9165117	2916774	3.11e+07
United States of America	2214341	1.86e+07	5344572	4.62e+07	3162286	8318297	3252156	2.39e+07

Source: Authors' computation.

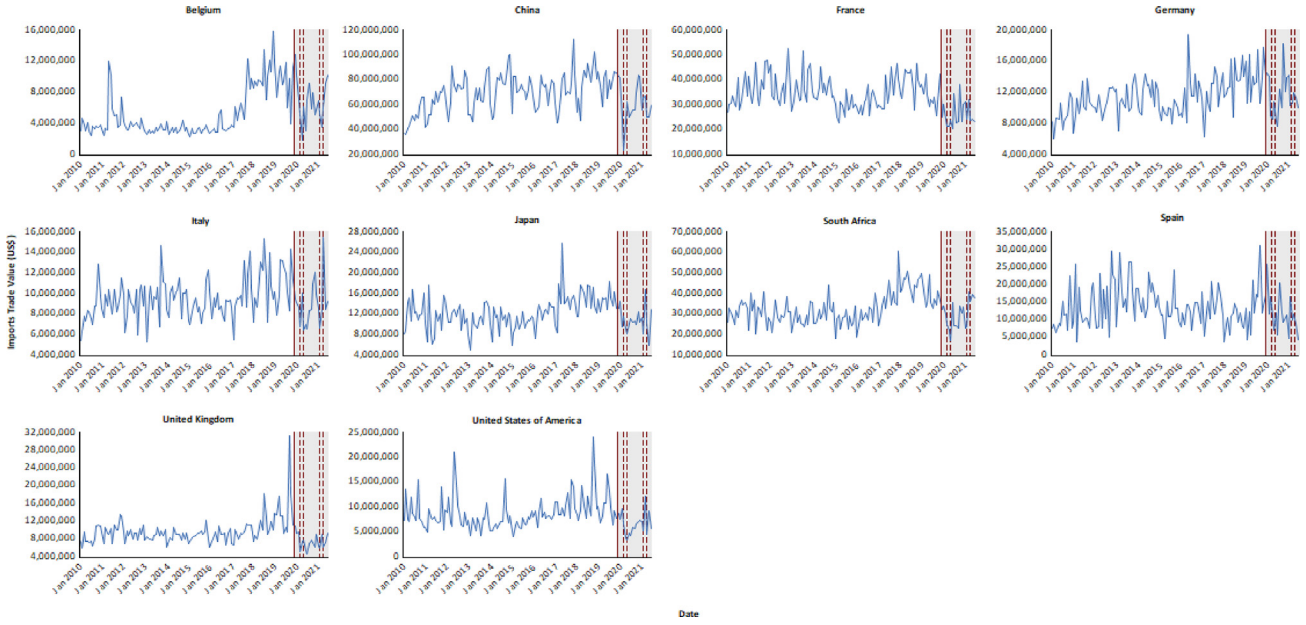

Fig. A1. Overview of imports trade value (US$) by country (January 2010–June 2021). Notes: Shaded areas represent the post-intervention period (January 2020–June 2021); solid line showing the month in which the outbreak of the pandemic was first declared in Wuhan (December 2019); dotted lines indicating the ending points of different post-intervention windows (from left to right: March 2020, May 2020, February 2021 and April 2021). Source: Authors' constructions based on UN Comtrade (2021).

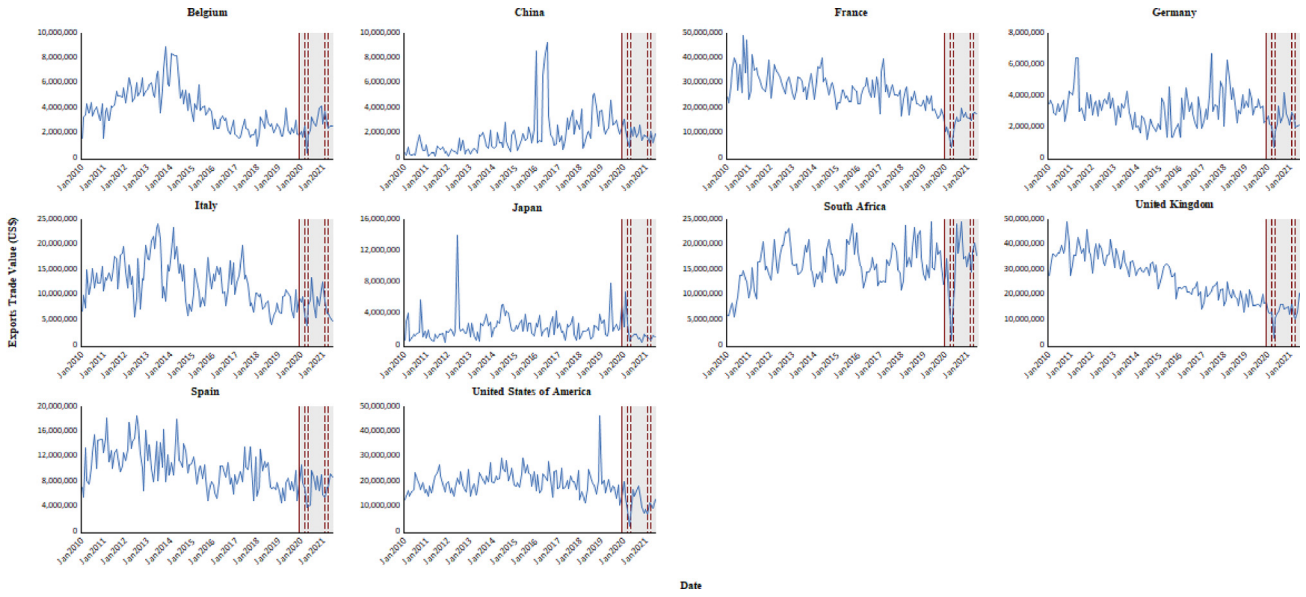

Fig. A2. Overview of exports trade value (US$) by country (January 2010–June 2021). Notes: Shaded areas represent the post-intervention period (January 2020–June 2021); solid line showing the month in which the outbreak of the pandemic was first declared in Wuhan (December 2019); dotted lines indicating the ending points of different post-intervention windows (from left to right: March 2020, May 2020, February 2021 and April 2021). Source: Authors' constructions based on UN Comtrade (2021).

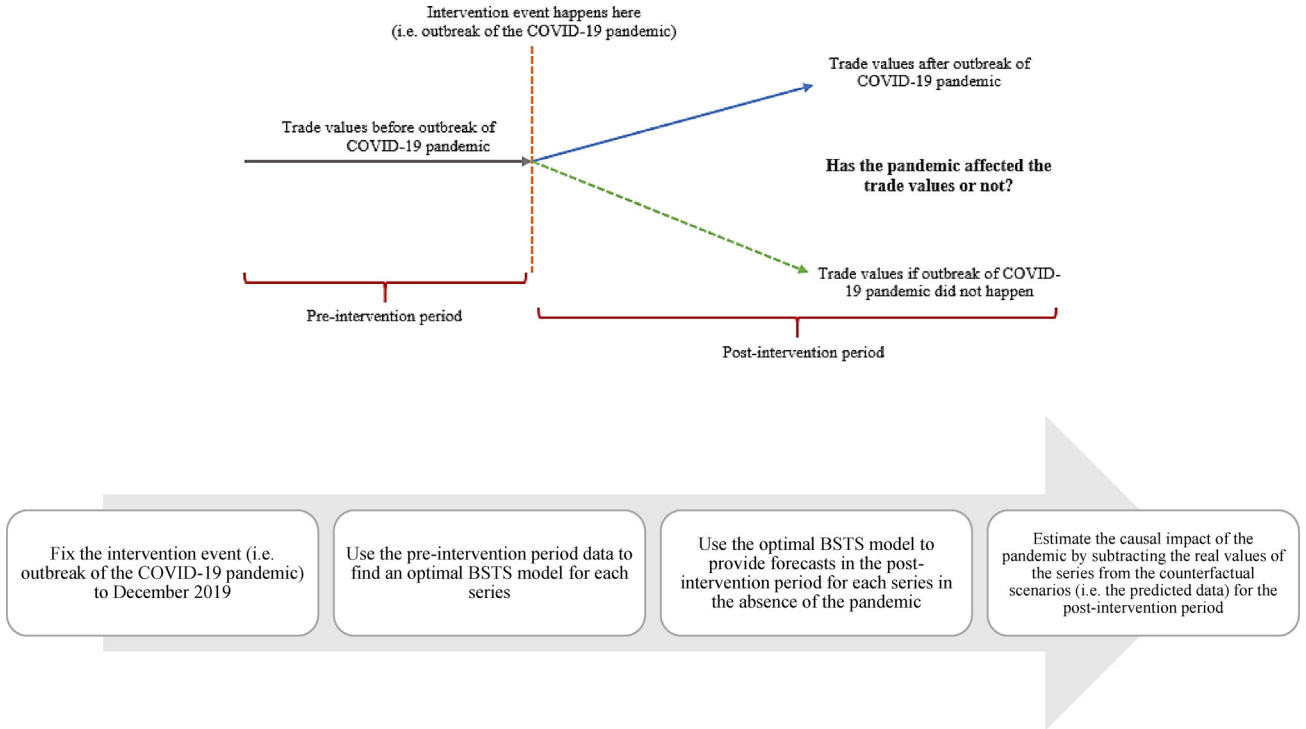

Fig. A3. Steps to estimate the causal impact of the COVID-19 pandemic on trade values based on Brodersen et al. (2015)'s BSTS model for causal analysis.

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