The Effect of Lockdown Policies on International Trade Flows from Developing Countries: Event Study Evidence from Kenya

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Abstract

The coronavirus (COVID-19) pandemic has disrupted global trade flows; there is, however, limited evidence on the nature and extent of this effect on the trade performance of developing countries. This study analyzes how Kenya's import and export trade responded to lockdown policies that were imposed by trading partner countries to contain the spread of the virus. The analysis is based on a weekly series of product-by-country data (at HS-6-digit level) for the universe of import and export trade during the one-year period from July 1, 2019 to June 30, 2020. Event-study analysis shows that the introduction of lockdown policies by trading partners led to an average increase of weekly exports from Kenya by 12% and an average decline of imports by 28%. The decline in imports was caused by disruption of sea cargo trade with countries that introduced lockdown measures, which more than compensated for a significant rise in air cargo imports. Difference-in-differences estimates reveal that food exports as well as imports increased, by an average of 18% and 25%, respectively, in response to lockdown measures. The rise in food exports explains part of the increase in overall exports, while the increase in food imports implies a fall of demand for other durables that more than compensated for the increase in food imports. We found scant evidence that lockdown policies affected trade in medical goods relevant for the prevention and treatment of COVID-19. On the other hand, we find that the strength of lockdown policies had an asymmetric effect between import and export trade.

Key words: COVID-19, Lockdown, Social Distancing; Imports, Exports, Kenya

JEL Classification: F10, F14, L10

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1. Introduction

The Coronavirus pandemic (COVID-19) has spawned an unprecedented level of social and economic crisis worldwide. The pandemic is projected to reduce global Gross Domestic Product (GDP) and international trade by at least 4.9% and 13%, respectively, in 2020 (WTO, 2020a; IMF, 2020). This will make it the most potent health and economic crisis since the Second World War, by far exceeding previous epidemics like SARS and economic depressions and recessions (Vidya and Prabheesh, 2020; Kassa, 2020; Barichello, 2020; Baldwin and Tomiura, 2020).

To contain the spread of the virus, governments around the world have imposed lockdown policies that restricted the mobility of people and goods, which impeded trade flows at local, regional and international levels. One of the outcomes of these lockdown policies is a supply chain disruption that created a negative supply shock (Baldwin and Tomiura, 2020). Measures like work place closure, border closure and international travel restrictions have hindered global trade flows by increasing trade costs and delaying or entirely prohibiting border clearance (Maliszewska, Mattoo and Van Der Mensbrugghe, 2020; Banga et al., 2020).

Second, lockdown policies have introduced demand-side shocks that varied across product categories. The onset of the pandemic has seen significant stockpiling of essential commodities such as food and medical items, which further fueled a surge of demand for these commodities (Kassa, 2020; Banga et al., 2020; Mold and Mveyange, 2020). The pandemic and accompanying lockdowns have also led to business closure and shrinking of economic activity, creating massive unemployment that reduced demand for internationally traded goods, particularly for durables (Verma and Gustafsson, 2020; Djiofack, Dudu and Zeufack, 2020; Kassa, 2020). Lastly, the pandemic has led to financial shocks that created instabilities in the financial services sectors that are important in the smooth running of international trade (Banga et al., 2020; Demir and Javorcik, 2020).

The current study analyzes the effects of lockdown policies that restricted domestic and international mobility on Kenya's import and export trade. Using daily, transaction-level data of imports and exports during the one-year period from July 1, 2019 to June 30, 2020, we build a weekly series of import and export trade data at 6-digit Harmonised System (HS) product level by country of origin (for imports) and destination (for exports). We conducted an event study analysis using a two-way fixed effects model to assess if the introduction of lockdown policies by Kenya's trading partners affected the country's import and export trade during the weeks prior and subsequent to their introduction. An event variable was created that captures the introduction dates of one of the following five lockdown variables: i) work place closure

ii) closure of public transport iii) stay at home requirements iv) restrictions on internal mobility and v) restrictions or controls on international travel. International, daily time series data for the introduction dates of these lockdown measures was taken from the *COVID-19 Government Responses Tracking Database* compiled by Blavatnik School of Government of the University of Oxford (Hale et al., 2020).

We further assess if lockdown policies had divergent effects on trade via different modes of transport (air and sea) using more disaggregated import-export data. We subsequently estimate difference-in-differences (DiD) regressions to assess potential divergent effects of lockdown measures between countries (by the stringency of lockdown policies and income level) and between commodities, in particular comparing differential effects on essential commodities such as food products and medical products for preventing and treating COVID-19.

The results show that the introduction of lockdown measures by Kenya's trading partners had a positive effect on exports but a negative one on imports. Weekly imports from countries that introduced lockdown measures fell by 28% on average after the measures were put in place, while exports to those countries increased by 12%. Our subsequent analysis reveals that these changes capture both demand and supply responses, with a potentially greater demand effect. Analysis using disaggregated data by mode of transport shows that the fall in Kenya's imports was due to a near-total disruption of imports by sea from countries that introduced lockdown measures, which was large enough to compensate for a significant rise in air-based imports. The results suggest a substitution from sea to air cargo trade as a result of stringent lockdown policies, which was potentially due to the perceived safety of air cargo and cheaper air fares from airlines that faced a collapse in passenger traffic[2].

The DiD regressions reveal that the import and export of food commodities increased in response to the lockdown measures by an average of 18% and 25%, respectively. The increase of food imports indicates that the decline of aggregate imports is caused by a significant demand fall for imported durables that more than made up for the rise in food imports. In line with prior research (Evenett, 2020; Gereffi, 2020; Fuchs et al., 2020), we also compiled a list of medical goods relevant for the prevention and treatment of COVID-19 and assessed if they responded differently to the introduction of lockdown measures. The results, however, did not show major responses from these medical commodities.

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[2] With the near-total closure of passenger traffic, several airlines turned to cargo transport for a new lifeline of revenue stream. As a significant share of cargo capacity came from the bellies of passenger aircraft, the halting of passenger transport reduced cargo capacity, pushing several airliners to transform passenger aircraft into cargo vessels. Our results suggest that most of the expansion in air-cargo trade was directed to countries that implemented lockdown measures

Finally, we find that the effect of the lockdown policies was somewhat different in countries that had more stringent public health policy measures. Kenyan exports to countries with more stringent lockdown policies decreased, while imports from them increased significantly. Further, we find that lockdown measures did not affect exports to OECD countries while they led to an increase of imports from them. On the other hand, both import and export trade with China fell significantly when the country introduced lockdown measures.

These results indicate that the lockdown measures had an asymmetric effect on import and export trade, which also diverged by mode of transport, stringency of lockdown measures, and the identity of the trading partner. Overall, Kenya's export trade seems to have endured the pandemic without significant disruptions, while imports suffered due to the combined effects of interruptions in sea shipments and a fall of demand.

This study makes three contributions to the literature. First, the study uses a standardized measure of lockdown policies that are suitable for tracing trade responses in the weeks before and after their introduction. Current research on the topic that has assessed the pandemic's effects on international trade have concentrated on specific issues such as supply chains (Verma and Gustafsson, 2020; Oldekop et al., 2020; Vidya and Prabheesh, 2020; Eppinger et al., 2020), export or import flows (Cao et al., 2020; Maliszewska et al., 2020; Baldwin and Tomiura, 2020), and trade policy (Pelc, 2020; Gruszczynski, 2020; Barichello, 2020; Evenett, 2020; Baldwin and Evenett, 2020), often using country-level data. Our analysis, in contrast, provides a rich account of supply side disruptions that affect trade by different modes of transport, as well varying effects on essential commodities whose demand was differently influenced by the pandemic.

Second, the study provides rich evidence on the effects of the pandemic in a developing country setting, which is currently an under-researched context[3]. Kenya offers an interesting set up for our analysis as it is one of the ten largest economies in Africa with a dynamic and liberalized trade sector, which is a major player the East African Community, a regional economic block (Mold and Mveyange, 2020). Import and export trade constitutes about a third of total GDP, and exports in sectors like coffee, tea, cut-flowers, and horticulture are sources of livelihood for millions of Kenyans. By the end of our sample frame, June 30, Kenya had more than 6,000 confirmed cases of COVID-19, which grew by early September 2020 to more than 34,315, accounting for close to 3% of total cases in Africa. The country also introduced stringent mobility restrictions and workplace closures by mid-March 2020, which precipitated a significant decline in GDP (Were, 2020; Deloitte, 2020), and reduced monthly exports and imports by about 8% and 25%,

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[3] A few exceptions here are studies on Africa such as Djiofack et al. (2020), Banga et al. (2020) and Adam et al. (2020). Nonetheless, they predominantly use macro-level data to make projections through computable general equilibrium (CGE) modeling.

respectively, compared to the pre-pandemic period (see Figure A1 in the Appendix). Our analysis thus provides new evidence on the effects of public health measures that were implemented in the wake of COVID-19 on international trade performance in developing regions.

Finally, our research contributes to the literature by providing rigorous analysis that relied on disaggregated product-level data, which is in line with recent trends in international trade research. A large part of the emerging research on COVID-19, however, uses macro-level data, often for making aggregate macroeconomic projections (Djiofack et al., 2020; Banga et al., 2020) or describing key trends (Mold and Mveyange, 2020; Kassa, 2020). Our focus on exports as well as imports also addresses a major caveat of the existent trade literature that disregard import trade (Wagner, 2016), although imported (intermediate) inputs are major factors of production developing countries (Edwards et al., 2018, 2020; Aluko and Adeyeye, 202 (IMF, 2020)0).

The rest of this paper is organized as follows. Section Two lays out our empirical econometric strategy. Section Three describes our data sources and measurement of variables. Section Four discusses our empirical results and Section Five concludes the study.

2. Empirical methodology

Following Fajgelbaum et al. (2020) we conduct an event-study analysis to assess the effects of lockdown measures on trade at different time periods prior and subsequent to the introduction of lockdowns. This approach provides a flexible framework that allows lockdown policies to have different effects over time, including potential anticipatory effects prior to the event, and lagged responses subsequent to the event. We estimate the log of import and export (in value and quantity) in an event-study specification that includes product-country fixed effects (α_{ic}), weekly time fixed effects (α_t) and a series of event-time dummies capturing the evolution of treatment effects before and after the lockdown is implemented. The estimation was done using the two-way fixed effects model that includes individual fixed effects and time fixed effects:

$$log(Y_{ict}) = \alpha_{ic} + \alpha_t + \sum_{j=-10}^{-2} \beta_j 1\{t - t_{lockdown} = j\} + \sum_{j=0}^{20} \beta_j 1\{t - t_{lockdown} = j\} + \epsilon_{ict} \qquad (1),$$

where the dependent variable, *Y,* is bilateral import and export trade in log form, and the subscripts *i, c,* and *t* represent the product, country and time in weeks respectively. The dummy variables $\{t - t_{lockdown} = j\}$ capture the weeks until or since lockdown is put in place ($t_{lockdown}$), and their coefficients, β_j, indicate the associated change in trade caused by the lockdown measure *j* weeks prior or subsequent to its introduction. In our specification, we allow lockdown policies to have a lead (anticipatory) effect on trade for up to ten weeks, and a lagged response for up to 20 weeks, while binning periods ten weeks before and twenty weeks after the introduction of lockdown measures. We use the period one week prior to the introduction of

lockdowns (j = -1) as the base group, so that β_j will indicate the instantaneous percentage change in trade during period *j*, relative to the level of trade during the base period. The error term, ϵ_{ict}, is corrected for clustering within country-product groups.

We start by reporting the standard event-study results that trace the effects of lockdown measures at different periods before and after their introduction, which are equivalent to analysis based on a fully specified distributed lag model (Schmidheiny and Siegloch, 2019). We subsequently conduct two sets of difference-in-differences analyses to test potential variations in the effects of lockdown event-time dummies across commodities and countries. The first set of difference-in-differences regressions assess if lockdown policies have a greater effect on food commodities, and medical commodities relevant for the treatment of COVID-19. The analysis is done by including interaction terms between dummy variables representing the two commodity groups and the series of time-event dummies. Given Kenya's competitive advantage in agricultural commodities vis-à-vis medical goods, we expect that the import of medical items and export of food commodities will increase in response to lockdown measures, while we expect the reverse for the export medical items and the import of food items.

We subsequently consider potential heterogeneous effects of the lockdown measures between countries with stringency of lockdown policies and those with weaker policies. To test for this possibility, we include an interaction between the event-time dummies and a dummy variable showing the *stringency of public health policy responses* to COVID-19. In this specification, we also include additional interaction terms between the event-time dummies and dummies representing the two major trading partners of Kenya, namely the OECD and China. This is done to address the possibility that our interaction terms with lockdown stringency could confound the effects of high-quality public policy in OECD countries, which are more likely to adopt stringent policies, and the effects of an early response by China.

3. Data and variables

3.1. Lockdown data

Our measure of lockdown is a binary variable which is calculated using the starting dates of five specific lockdown measures that are likely to affect international trade. For each country, a lockdown is considered to start when one or more of the following five measures is introduced: (i) work place closure; (ii) closure of public transport; (iii) stay at home requirements; (iv) restrictions on internal mobility and (v) restrictions or controls on international travel. International, time series data for the introduction dates of these measures was taken from the *COVID-19 Government Responses Tracking Database* that is compiled by Blavatnik School of Government at the University of Oxford (Hale et al., 2020).

Figure 1 provides an exhibit of the pattern of the five lockdown measures in Kenya and China, a major trading partner. The first lockdown event started on January 23, following China's decision to close public transport and restrict the mobility of people in Wuhan and other districts. The closure of public transport was removed on March 28, and internal mobility restrictions were relaxed in April 6, but both were reinstated on the 10th of May following a second wave of infections, thereafter both remained in effect until the end of June.

The first lockdown response in Kenya was implemented almost two months later on the 16th of March after the introduction of restrictions on international travel to selected countries. These restrictions were expanded on the 24th of March with the passage of work place closure measures, three days later with additional stay at home requirements and internal mobility restrictions, and eventually by new laws of public transport closures on April 6. All of the five lockdown measures were in effect by 30th June 2020, the end date of our sample frame. Our measure of lockdown was set to one on the introduction of the first measures, on 23rd January 2020 in China and on 16th March 2020 in Kenya, and remained one after that since at least one of these measures was in effect across the time period considered.

As explained in our empirical methodology section, we also test for the presence of heterogenous effects between countries with high and low levels of lockdown stringency. This involved creating a dummy variable that identified countries with stringent public policy measures, which was conducted using a measure called Lockdown Stringency Index from the same source as our lockdown measures (i.e. Hale et al., 2020). The index is constructed from nine indicators that capture the strength of policies like school closure, workplace closure, stay-at-home requirements, restrictions on internal mobility, and international travel controls. The original index ranges between 0 and 100, and we constructed a binary *public health policy stringency* variable using the median value (60) as a cutoff point.
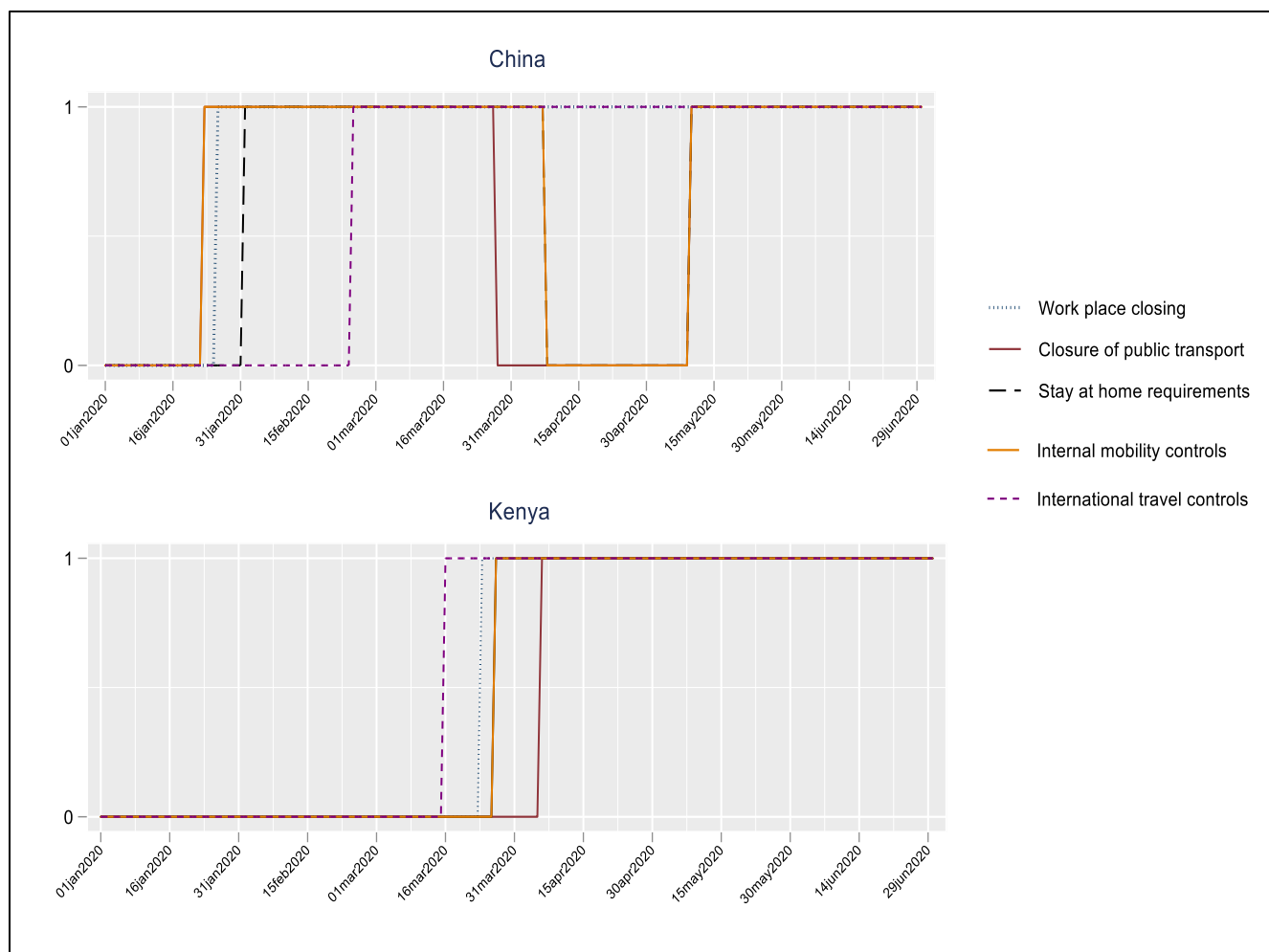
Figure 1: Introduction of different lockdown measures in China and Kenya

Source: Hale et al. (2020)

3.2. Trade data

Weekly aggregate import and export product-country data from the updated Exporter Dynamics Database (EDD) by the World Bank (Fernandes et al., 2016) is used in this study. This data contains transaction-level customs records from the Customs Services Department of the Kenya Revenue Authority (KRA). The data covers the period from 1st July 2019 to 30th June 2020. Transactions are recorded for each exporter and importer by product (at 8-digit HS level), destination/origin, date of transaction and value of transaction in Kenya shillings. Exporters and importers are identified by their tax ID. We begin processing the data by aggregating trade flows to establish the weekly value of exported and imported products to and from respective markets. The next step involved using the product concordance prepared by Cebeci (2012) to aggregate trade flows at the 6-digit level to form a list of HS 6-digit categories that are comparable

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internationally. This is important since HS classification has undergone several revisions over time (Cebeci et al., 2012; Bellert and Fauceglia, 2019).

Table 1 provides descriptive statistics for the value of exports and imports. The average weekly product-country of destination exports from Kenya between July 2019 and June 2020 was Kshs. 5,921,323 ($59,213.23), while the average weekly product-country of origin for imports over the same period was Kshs. 4,521,253 ($45,212.53). The monthly trend of exports and imports in Figure A1 of the Appendix indicates that exports surpassed imports for most months except December 2019. The divergence between exports and imports (total or excluding petroleum products and other fuels) increased from January 2020 and throughout the lockdown period, indicating a decline in trade deficit.

Table 1 also shows that most products were exported and imported by sea, other than air transport, over the period of our study. However, exports by air were nearly four times higher the imports by air. The average lockdown dummy for exports and imports was 28.1% and 32.2% respectively, which indicates the percentage share of observations for periods after lockdown measures were introduced. Table 1 further describes three other dummy variables used in our analysis. Food commodities were identified based on the HS code of the commodities, and include the 2-digit HS codes from 01-20 with the exception of cut-flowers, trees and plants (HS code = 07). Food exports include major export commodities such as coffee, tea, and spices (which make 24% of total export value) and vegetables (which make up 4.2% of total exports) and fruits and nots (making up 3.5% of all exports). These commodities made up about a quarter of the observations (23.7%) in our export data represented, but only 4.7% of all observations in our import dataset.

We followed previous literature in identifying medical goods that are relevant for the prevention and treatment of COVID-19 (such as Evenett, 2020; Gereffi, 2020; Fuchs et al., 2020). The original list of medical goods included 6-digit HS codes of 109 distinct commodities (WTO, 2020b), out of which 88 were matched with our export data and 103 with our import data. These commodities include items like hand sanitizers, gloves, masks and other personal protective equipment (PPE) and hygiene products that were identified by WTO and other studies as relevant for the prevention and treatment of COVID-19. These medical goods made up approximately 3.5% of both imported and exported commodities (more specifically, there were 3,558 weekly product-destination items of exported medical goods and about 12,600 weekly product-origin items of imported medical goods).

Table 1: Descriptive statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Export trade					
Export value	100,831	5,921,323	40,900,000	1	2,930,000,000
Exports by air	100,831	2,463,422	27,100,000	0	2,930,000,000
Exports by sea	100,831	3,427,466	30,800,000	0	1,580,000,000
Lockdown dummy	100,831	0.281	0.449	0	1
Stringency of public health policy	100,280	0.502	0.500	0	1
Medical goods dummy	100,831	0.035	0.185	0	1
Food items dummy	100,831	0.237	0.425	0	1
Import Trade					
Import value	353,579	4,521,253	48,100,000	1	5,210,000,000
Imports by air	353,579	634,585	14,700,000	0	5,210,000,000
Imports by sea	353,579	3,682,692	44,900,000	0	4,550,000,000
Lockdown dummy	353,579	0.322	0.467	0	1
Stringency of public health policy	353,294	0.736	0.441	0	1
Medical goods dummy	353,579	0.036	0.185	0	1
Food items dummy	353,579	0.047	0.211	0	1

4. Results

4.1. Event study results on total import and export series

Table A1 in the Appendix reports the fixed effects event-study estimates using import-export data from 1st July 2019 to 30th June 2020. Values measure import and export in Kenyan shillings, and quantities indicate trade volumes in terms of the relevant unit of measurement. The estimation is conducted using product-destination/origin level data that identifies sources or destinations of import and export trade. Products are defined at 6-digit HS classification level for all of our analysis except where quantities are used, in which case we use slightly more disaggregated data at 8-digit HS code level (which is the finest level of disaggregation in our dataset).

The coefficient plots in Figure 2 reveal that lockdown measures affected the value of exports and imports differently. Exports to countries that introduced lockdowns increased marginally, while imports from them exhibited much larger reduction, revealing an asymmetric response. The jump in export volume started four weeks ahead of lockdowns, and continued consistently until nine weeks after the introduction of lockdown, although occasional surges also occurred much after that period, up until the 20th week. These coefficients indicate changes in the value of exports relative to the export value one week prior to the lockdowns. The results thus show that the introduction of lockdown measures increased the value of exports to those destinations by an average of 12% in the weeks after the introduction of the measures. The coefficient plots

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based on exported quantities in Figure 3 reveal the same pattern although the size of the coefficients is smaller and their statistical significance is relatively weaker. This most likely reflects poor precision in quantity-based estimates, which arises from the difficulty to capture quality differences in quantity-based measures.

Imports were affected in the opposite direction, as they registered a decline following the introduction of lockdown measures. They exhibited a modest but significant decline relative to the baseline period (the week prior to the introduction of lockdowns) in the first weeks. Seven weeks after lockdowns were introduced, however, imports from countries that introduced those lockdowns saw a precipitous weekly fall (see Figure 2), leading to an average fall of 28% in Kenyan imports. The decline appears even greater when import quantities are considered in Figure 3, which reveals that the volume of imports from those destinations fell by 45% on average. The weekly value and quantity of imports remains significantly lower than the period before the lockdown twenty weeks after the lockdowns were introduced.
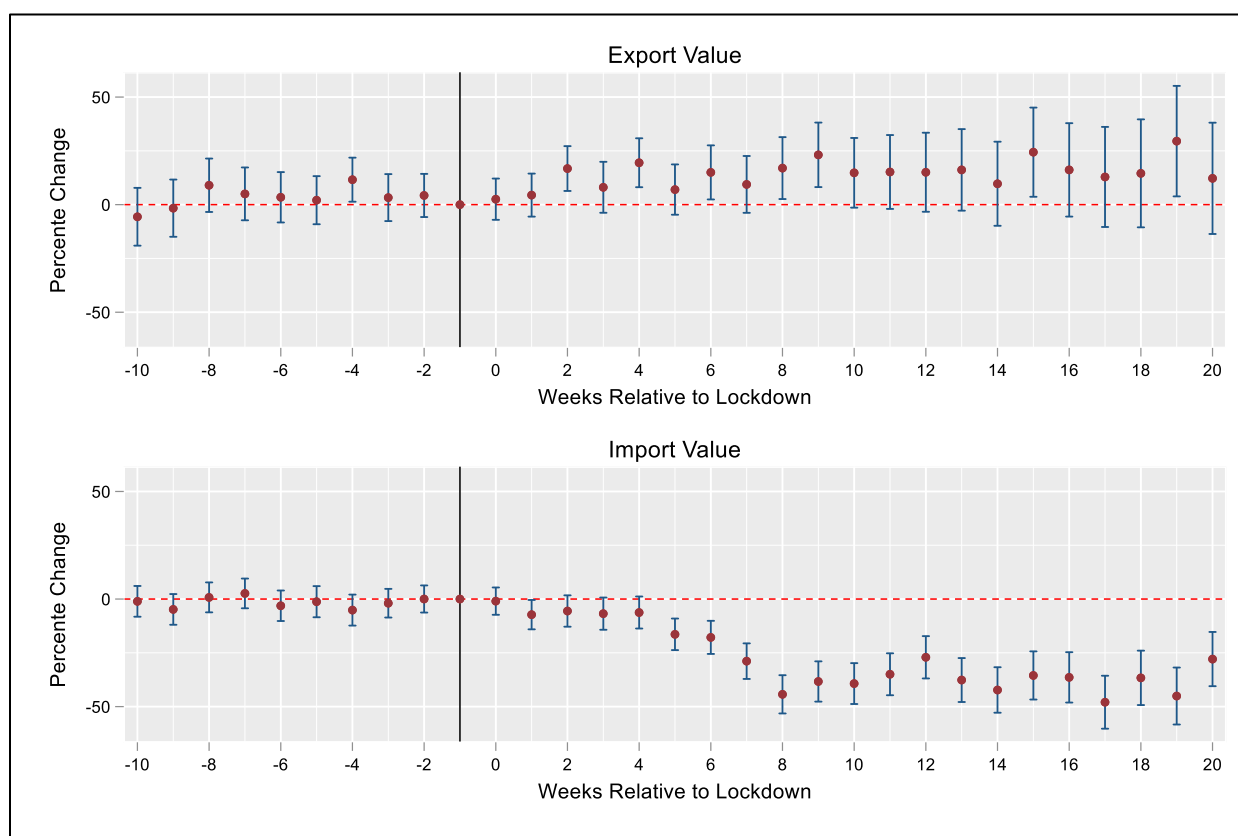

Figure 2: Effects of lockdown on the value of Kenya's imports and exports

Note: The red dots indicate the coefficients, also reported in Table A1, and the spiked lines indicate the 95% confidence interval of the coefficients. Estimates are based on the log-value of weekly-product trade data at 6-digit HS level of aggregation.

In general, our results show that imports were more affected by the lockdowns compared to exports in Kenya. This result is in line with official data sources that revealed a fall of imports by a quarter between March and May 2020 while exports of some food commodities increased over the same period (Mold and Mveyange, 2020).
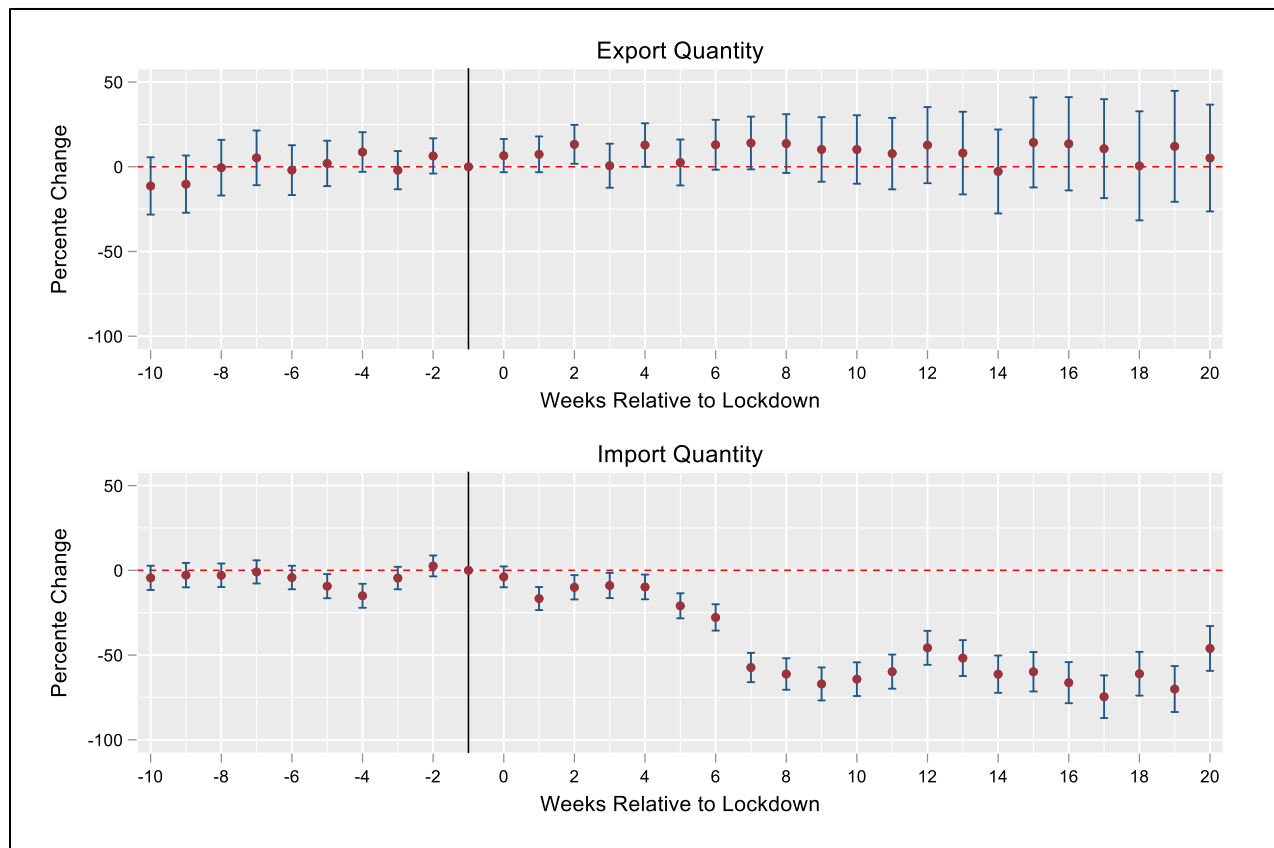

Figure 3: Effects of lockdown on the quantity volume of Kenya's imports and exports

Notes: The red dots indicate the coefficients, also reported in Table A1, and the spiked lines indicate the 95% confidence interval of the coefficients. Estimates are based on the log-transformed quantity of weekly product trade data at 8-digit HS level of aggregation.

4.2. Event study by mode of transport

To assess if the changes in import and export trade were induced by logistical disruptions, we next estimate the event study framework on the volume of trade that used different modes of transport. Given the strong disruption of international travel due to flight restrictions, we expect that lockdown measures would affect trade through air more than it would affect trade through sea. This will happen only if the decline in air cargo capacity is proportional to the change in air passenger traffic, a reasonable assumption considering

that passenger aircraft have significant air cargo shipment capacity (Mold and Mveyange, 2020). If airliners introduce dedicated cargo aircraft that more than compensates for the lost capacity in interrupted passenger travel, however, we could expect that lockdowns will lead to an increase in air-based import and export trade.

Our transaction-level data reveals the station through which each item was imported or exported. In consultation with Kenya's customs office, we classified these stations into sea, land and air stations, and subsequently aggregated the data into weekly product by origin/destination trade series for each of the three modes of transportation. Table 2 reports the percentage of import-export trade that passes through these stations both in terms of share of transactions and volume of trade. Figures A2 and A3 in the Appendix provide monthly trends of export and import trade, respectively, that passed through air, sea and land stations.

Table 2: Trade via air, sea and land stations

	Exports		Imports	
	Share in #transactions	Share in value of exports	Share in #transactions	Share in value of imports
Land	1.4%	0.7%	4.2%	4.3%
Air	74.9%	43.4%	39.3%	14.2%
Sea	23.7%	55.9%	56.5%	81.2%

Table 2 shows that Kenya's import-export trade is for the most part conducted through air and sea, revealing the low level of regional integration (Geda and Seid, 2015; Eberhard-Ruiz and Moradi, 2019; Umulisa, 2020). Figure A2 in the Appendix shows that export trade temporarily jumped up for all modes of transport around February 2020, but the overall trends subsequently diverged between the three modes of transport. Land-based exports contracted sharply after a brief increase, air-based exports saw a more persistent rise before they fell, while sea-based exports were mostly unaffected with the exception of a modest increase in March.

Figure A3 reveals that imports also responded differently based on the type of transport. After an increase in late 2019, relative to July 2019, air-based imports started to fall in December 2019, when they declined by about 10%, followed by another 10% decline in January 2020. This fall continued throughout the remaining lockdown period. Sea-based imports registered a steady decline from the beginning of the sample period, slightly recovered in January 2019 before falling about 30% on month-on-month basis at the end of the period. Land-based imports also registered a steady decline since late 2019, falling by about 45% on a month-on-month basis by June 2020.

Imports based on sea and land (see Figure A3) as well as total imports (see Figure A1) started to decline very early, since august 2019. Air imports also increased slightly from September to November 2019 but started falling from December 2019. Therefore, it seems the lockdowns reinforced the existing trend of falling imports in Kenya.

To assess if lockdowns had a different impact across commodities that are transported via different routes, we applied the event-study framework of Equation 1 on disaggregated trade data by different modes of transport. Because of the small degree of land-based trade, our weekly data for this mode of transport is patchy with many zero and missing values. Moreover, a large share of land-trade involves regional reimports and reexports of imported goods that already passed through sea and land routes. We, therefore, limit our disaggregated analysis to analysis on import and export series that passed through air and sea stations.

Figures 4 and 5 report coefficients plots for β_j based on Equation (1) for export and import series of air and sea trade, respectively. The complete set of results for the fixed effects regressions are reported in Table A2 of the Appendix. Figure 4 reveals that lockdowns had a sporadic but occasionally significant effect of raising air-based exports, but a generally insignificant effect on sea-based exports. The positive effect of lockdowns on air-based exports was mostly related to anticipatory measures confined to a few weeks before their introduction. For example, air-based exports increased by 28% and 33% five and four weeks before lockdowns respectively, relative to air-based exports one week before[4] the lockdown. After the lockdown, air-based exports decreased by an average of 1.7%, while sea-based exports increased by an average of 7.3%. Given significant volatilities in the levels of trade, however, these changes were generally insignificant.

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[4] Figure 4 also reveals that air-based exports increased by about 35% nine weeks before the lockdowns, but that is more likely to be a fluke association rather than an anticipatory effect considering the difficulty to predict lockdowns that far in advance.
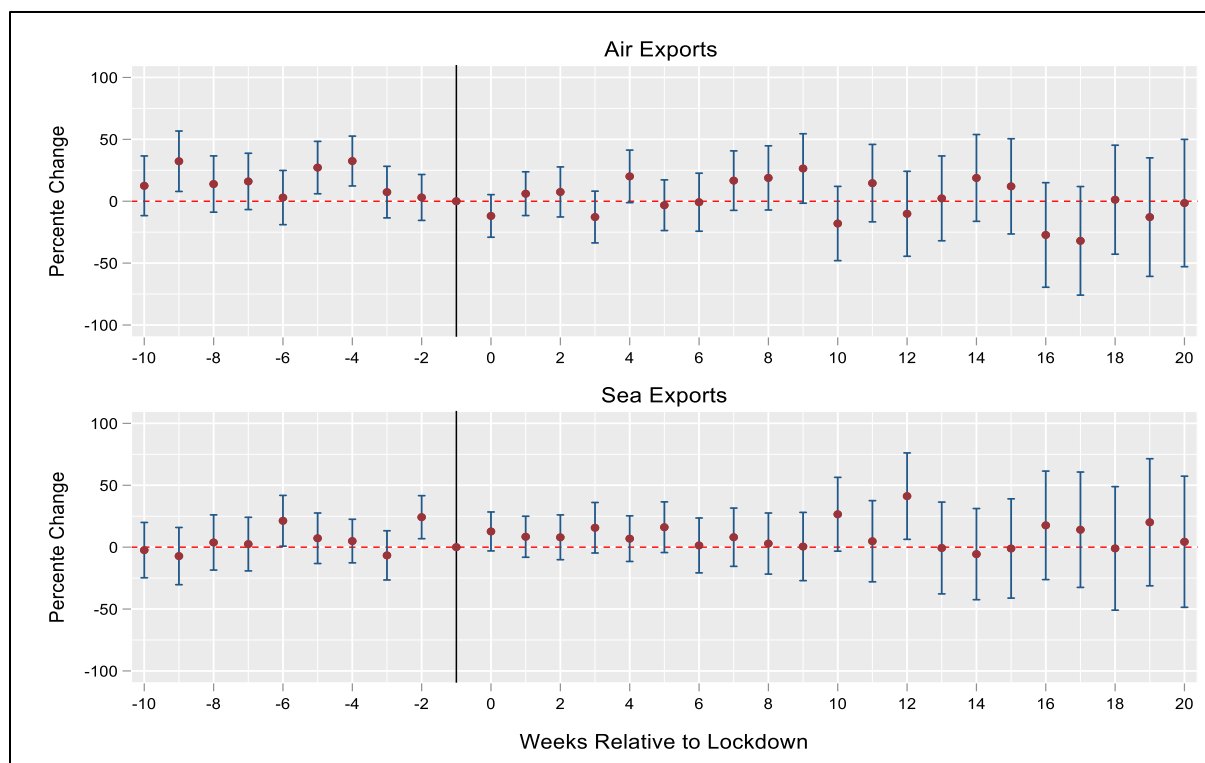
Figure 4: Relative change in export trade by mode of transport

Figure 5 reveals that lockdowns had a clear effect of increasing air-based imports and reducing sea-based imports. Air-based imports were volatile in the first few weeks before and after the lockdown, but after about 6 weeks, they registered a clear and persistent increase. The average week-on-week increase after the lockdown period was 56%, which reveals a shift of trade towards air-transport. This could be an outcome of supply-related factors since an increasing number airlines have expanded their cargo capacities to compensate for lost revenues from passenger traffic. Demand could also have risen for air-transport due to the need for emergency supply of medical and food commodities – including donations of medical goods (CGTN Africa, 2020). Moreover, the relative flexibility of air cargo compared to maritime trade that involves complex, forward-looking trade contracts can make it more attractive during a period of high uncertainty. Imports by sea registered a significant decline at about the same time period as air-based supplies increased, highlighting a substitution effect.

Imports by sea routes started to fall sharply starting from seven weeks subsequent to the introduction of lockdowns, and remained persistently lower than the pre-lockdown period. The percentage changes, which are in excess of 100% in some periods[5], indicate that sea cargo imports from lockdown-imposing countries

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[5] Note that the regression coefficients in Figure 5 and Appendix Table A2 exceed 100%, suggesting an implausibly high contraction of air-based imports. These very high instantaneous changes in trade translate into more meaningful

virtually stopped. This result is not unlikely since Figure A3 in the Appendix shows that sea-based imports in June 2020 were 30% lower than they were in July 2019. The event study results suggest almost all of this fall can be attribute to a near-total closure of sea cargo trade from countries that imposed lockdown measures. Together, these results point to a significant reallocation of trade from sea to air in response to lockdown measures.

One major concern in these regressions is that air- and sea-based trade has several zero values, creating significant volatilities that could limit the predictive power of our fixed effects estimator. As a robustness test, we estimated the same model by excluding product-country groups that are punctuated by high trade volatilities. Specifically, we excluded product-country groups whose zero trade episodes make up more than two-thirds of the number of valid observations. For example, a product-country group for which we have trade data for 52 weeks is excluded from the analysis if traded value is zero for 35 or more weeks. The fixed effect estimated based on this restricted sample are reported in Table A3 of the Appendix, and the coefficient plots are presented in Figures A5 and A6 in the Appendix. Table A3 shows that the observations fell by about half for air and sea exports, and by more than one third for air and sea imports, indicating the presence of high levels zero-trade episodes in this disaggregated data. The regression coefficients in Figures A5 and A6 are, however, generally similar to the full sample results. In particular, they suggest that lockdowns had only a modest effect on exports, but a divergent effect of dramatically increasing air imports and reducing sea-imports.

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values if we convert them into the equivalent compound growth rate. For example, the effect of lockdowns on sea-based trade 8 weeks after their implementation is close to -140% (Table A3, regression 3). This suggests a compounded growth rate of exp(-1.4)-1 = -0.75. In other words, import trade fell by an average compounded rate of 75% during the considered time period, which is a reasonable amount given the significant fall in sea-based trade.
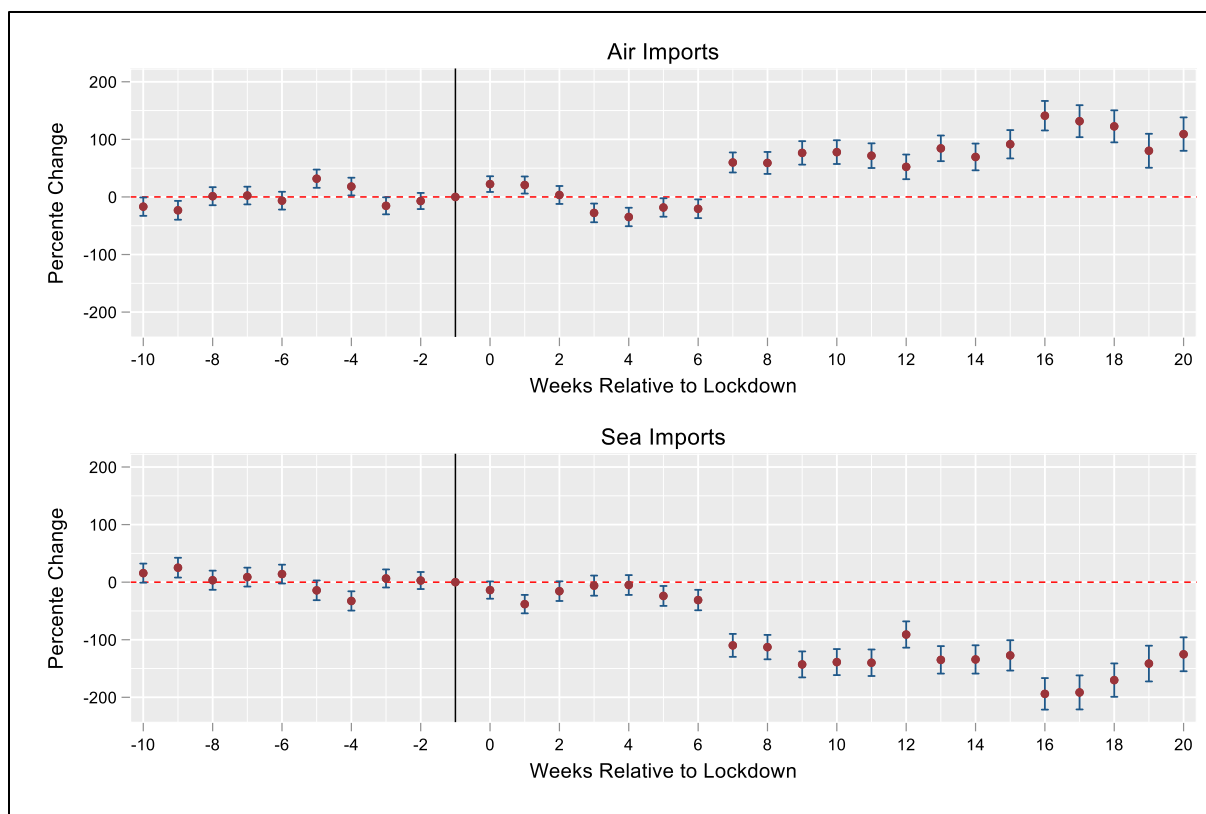
Figure 5: Relative change in import trade by mode of transport

Another concern is that the fall in maritime trade could reflect the fall of oil prices, which also coincided with the onset of the pandemic and the introduction of lockdown policies. We re-estimated the regressions for sea-based exports and imports by excluding petroleum products and other fuels from our data (more specifically, we excluded all HS codes that start with 27). The results for this estimation are reported in Figure A7 of the appendix, and are highly in line with the baseline results in Figures 4 and 5.

4.3. Difference-in-differences across commodities

We subsequently estimate difference-in-differences (DiD) regressions to assess possible heterogenous effects of the lockdown policies across countries and product categories, following comparable approaches in the recent trade literature (see Fajgelbaum et al, 2020). Our first analysis will seek to shed light on the potential role of demand factors by examining if lockdown policies have a statistically different effect on the trade of essential food and medical products. The coefficients of the interaction terms between the medical commodity and the time-event dummies are reported in Figure 6. The coefficient plot shows that the export of medical goods relevant for treating COVID-19 registered a significant decline for a short period, four to five weeks prior to the introduction of lockdowns. After the lockdowns, there was no significant change in the export of medical goods. The import of medical goods also did not register any

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significant change before or after the lockdowns, indicating that the effect of public health policies on Kenya's trade of medical goods was negligible.

Figure 7 reports the coefficients of the interaction terms between event-time dummies and the dummy for food commodities. The figure reveals that food exports became somewhat greater than non-food exports immediately after the implementation lockdown policies, although these changes are only significant at 10% level. The average monthly change in food exports was a large 18%, and partially explains the positive response of overall exports in Kenya (Figure 2).
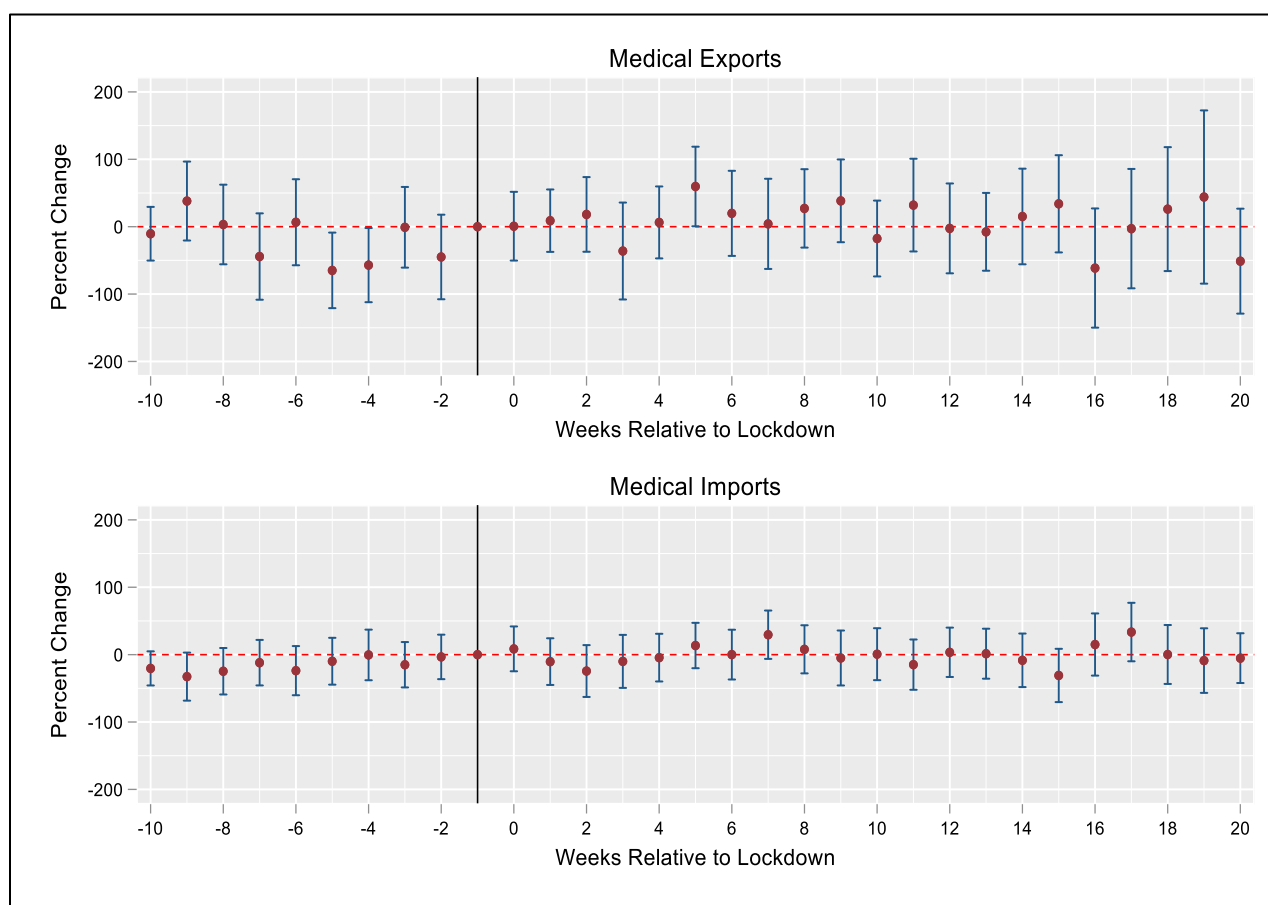
Figure 6: Relative change of trade in medical commodities relevant for the treatment of Covid-19

The bottom panel of Figure 7 shows that food imports registered a significantly greater increase than non-food imports for several weeks after the introduction of lockdown measures. These differences are also comparatively large, averaging 25%, and persisted throughout the lockdown period although they were not consistently significant. These results indicate that the fall in aggregate imports (Figure 2) was caused by a much larger fall in non-food, durable items, which more than made up for the relative increase in the import of food commodities.

Figure 7: DiD coefficients showing the differential effect of lockdown measures on food commodities

4.4. Difference-in-differences across countries

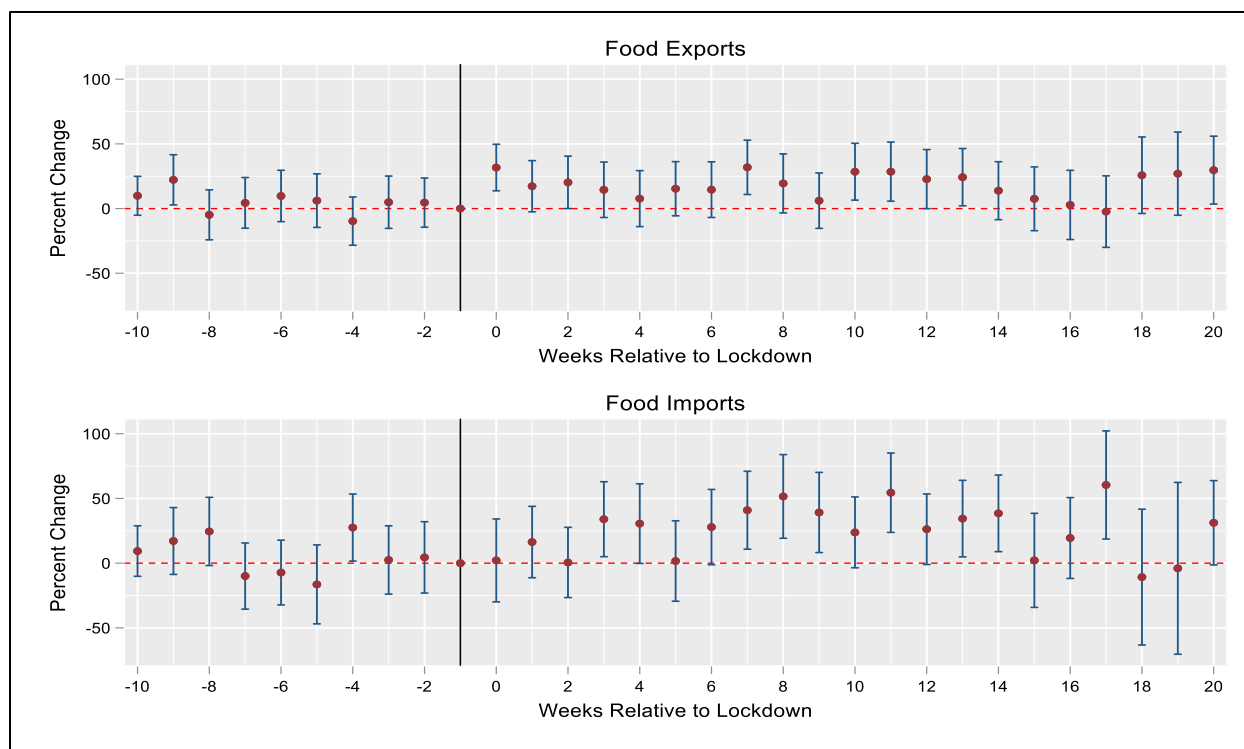This subsection tests for the presence of divergent lockdown effects on Kenya's trade flows with countries that adopted highly stringent and less stringent containment measures to the pandemic. This is done by allowing the event-time dummies to vary between these two country groups. To mitigate the confounding effects of income/institutions and early lockdown by China in this analysis, we include two sets of interaction terms between the event-time dummies on the one hand, and dummy variables for OECD countries and China on the other. China is only a small export market to Kenyan producers, making up just below three percent of annual exports in the time period considered. It is, however, a major source of imports, contributing to about 22% of annual imports to Kenya.

The OECD, on the other hand, is a major export destination as well as a source of Kenyan imports, with an annual share of 34% and 28% respectively. Figure A4 in the Appendix reveals that Kenya's export to China is extremely volatile, which perhaps is not surprising given the relatively small value of exports to that country. Imports from China were hit hard by the pandemic, falling by almost 60% in March, but recovered gradually, although they remained 20% below their initial levels as at 30th June 2020. Imports from OECD countries, on the other hand, fell less dramatically than imports from China, but remained 20% below their

initial level by June 2020. Surprisingly, exports to OECD countries remained resilient throughout the period, falling by only 4% in April after increasing by 12% in March.

Figure 8 plots the coefficients of the interaction terms between the time-event dummies and the lockdown stringency dummy. The top panel shows that the lockdowns led to a greater fall of exports in countries with more stringent lockdown policies. The introduction of these policies reduced exports to countries with more stringent policies (relative to those with stringent policies) by an average of 12.5%. Interestingly, Kenyan imports from countries with more stringent lockdown policies increased by an average rate of 22%. This suggests that demand rather than supply patterns shaped trade responses to stringent public health measures.

Figures A8 and A9 in the Appendix report the responses of trade with OECD countries and China, respectively, to the introduction of lockdown policies. Exports to OECD did not change to a different degree than exports to the rest of the world, while imports from OECD increased by 15% on average after lockdowns measures were put in place. Exports to China showed greater decline than exports to the rest of the world, though the difference is significant only for a few periods, potentially due to the large volatility in exports to that country. Imports from China followed a clear pattern of starting to decline about five weeks into the introduction of lockdown measures (i.e. after early March – see Figure 1), contracting sharply in the course of two months, before subsequently recovering to a level closer to the pre-lockdown period (also see Figure A4). The average fall of weekly export and import trade with China was a large, 68% and 42% respectively.
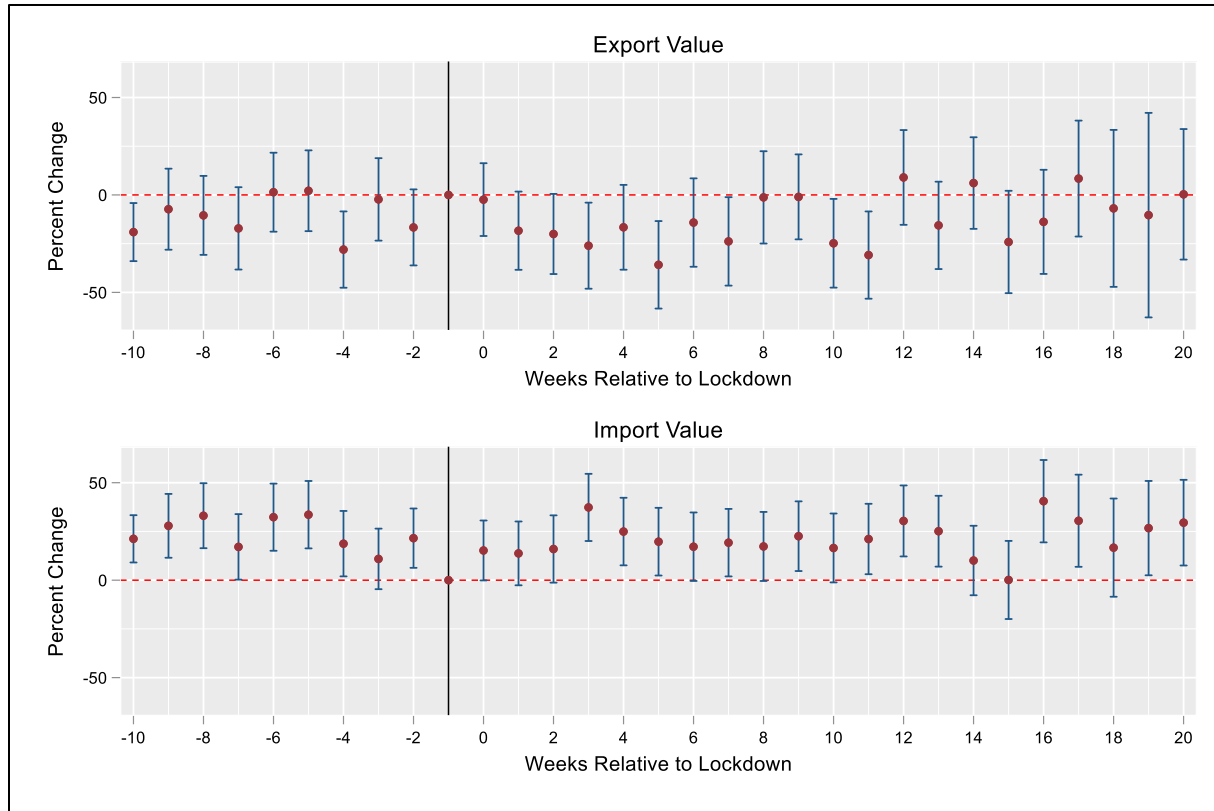
Figure 8: Relative change of trade in countries with high level of lockdown stringency

5. Conclusion

This paper provides novel evidence of the effect of the lockdown policies during the COVID-19 crisis on the flow of international trade in a major developing economy, Kenya. We applied an event-study analysis on a weekly series of product-by-country import and export flow data from 1st July 2019 to 30th June 2020. Estimation was conducted using the two-way fixed effects estimator to establish the overall effect of the lockdown on trade volumes and values, and trade via different modes of transport (air and sea). We subsequently estimated difference-in-differences (DiD) regressions to assess if the effects of lockdown varied between trader partner countries (by the stringency of lockdown policies and income level) and between commodities (food and medical).

The results indicate that the introduction of lockdown measures by Kenya's trading partners led to an increase of export trade by an average rate of 12%, and a significant drop of imports by an average rate of 28%. The decline in imports was mainly caused by disruption of imports by sea from countries that introduced lockdown measures. Import and export of food commodities increased in response to the lockdown measures, by 18% and 25% respectively, reflecting how inelastic demand for food commodities sustained Kenya's exports. The increase in food imports, on the other hand, reveals that aggregate imports

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declined due a greater fall in demand for non-food commodities. Our analysis did not reveal a major change in the trade of medical goods that are essential for the protection and treatment of COVID-19.

Kenyan exports to countries that had more stringent public health policy responses were significantly lower while imports from these countries were significantly higher. We also find that lockdown measures did not affect exports to OECD countries but led to an increase of imports from them. Export and import trade with China registered marked decline in the first fourteen weeks of the lockdown, after which it recovered to pre-lockdown levels.

Together, these results provide nuanced evidence on the effects of COVID-19 on the trade performance of a developing country. The results suggest that demand factors are perhaps more important than supply chain disruptions in explaining the responses of trade to COVID-19 in developing countries. It appears that export trade was marginally affected, potentially because food commodities, which are major export categories in countries like Kenya, are not sensitive to lockdowns due to inelastic demand. The significant fall of (non-food) imports, on the other hand, points to a decline of demand for non-essential imports in the face of a looming health and economic crisis that introduces significant uncertainties. The results, therefore, shed light on the asymmetric effects of lockdown policies between exporters and importers, as well as between different modes of transport, and various commodities and trading partners.

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Appendix

Figure A1: Trends in import and export trade

Monthly export trends (2019-2020)

Legend: Exports, Imports, Import Excl Fuel
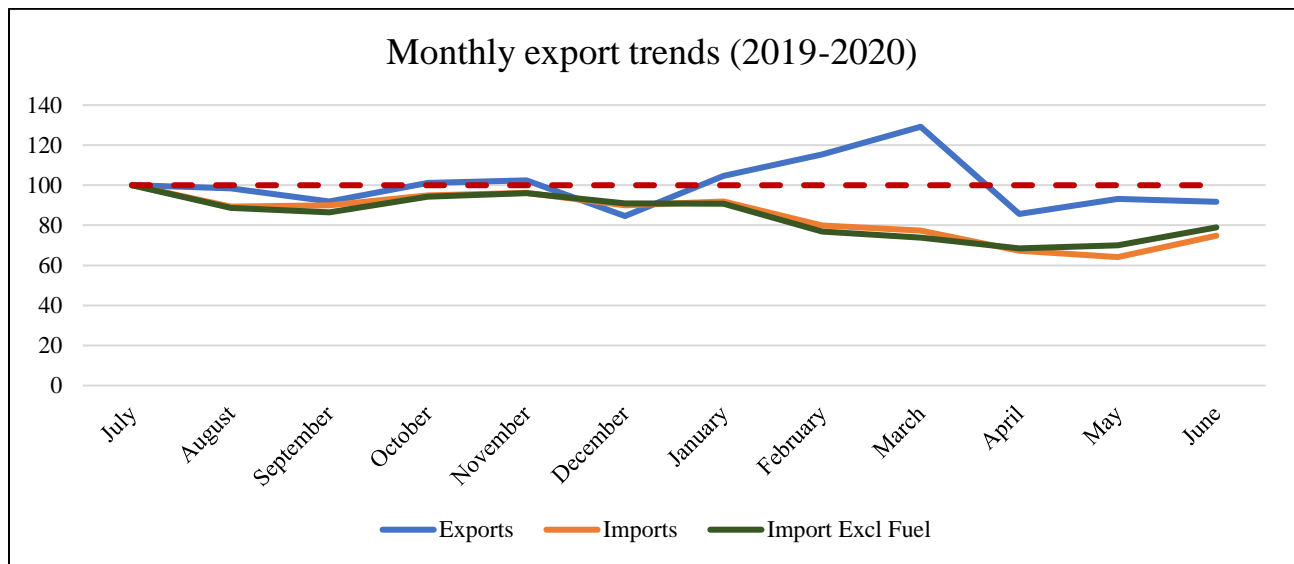
Figure A2: Relative change in export trade by mode of transport

Trends in Export Trade by Mode of Transport

Legend: Air Exports, Sea Exports, Land Exports
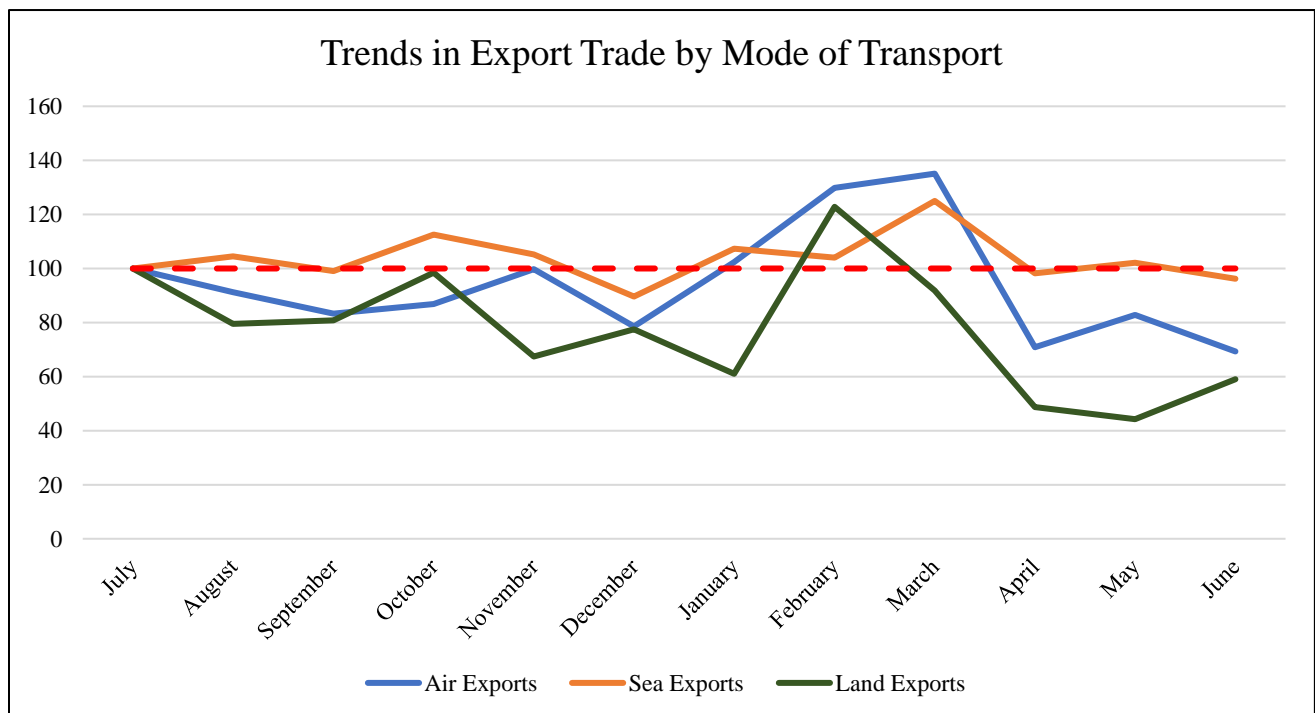
Figure A3: Relative change in import trade by mode of transport

Trends in Import Trade by Mode of Transport

Air Imports — Sea Imports — Land Imports
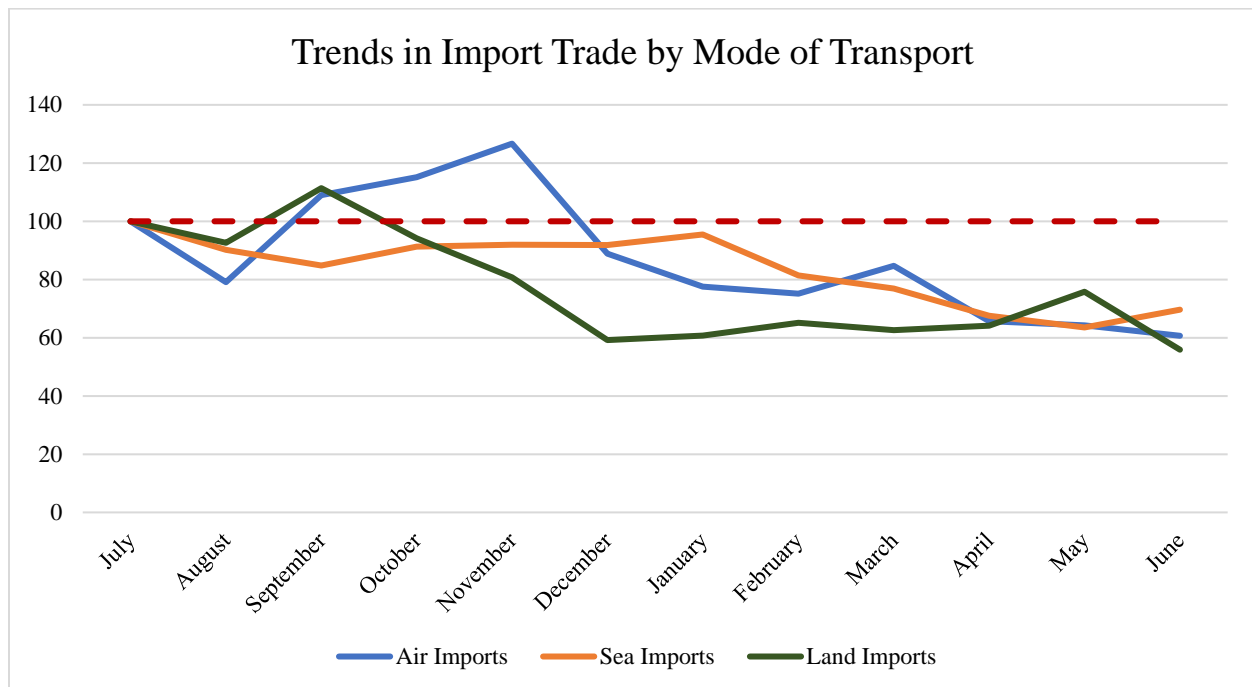
Figure A4: Import Export trade with China and OECD countries

Trends in Import Export Trade with OECD Countries and China

OECD Exports — OECD Imports — China Exports — China Imports

Figure A5: The effects of lockdown measures on export trade by air and sea transport (based on subsample)
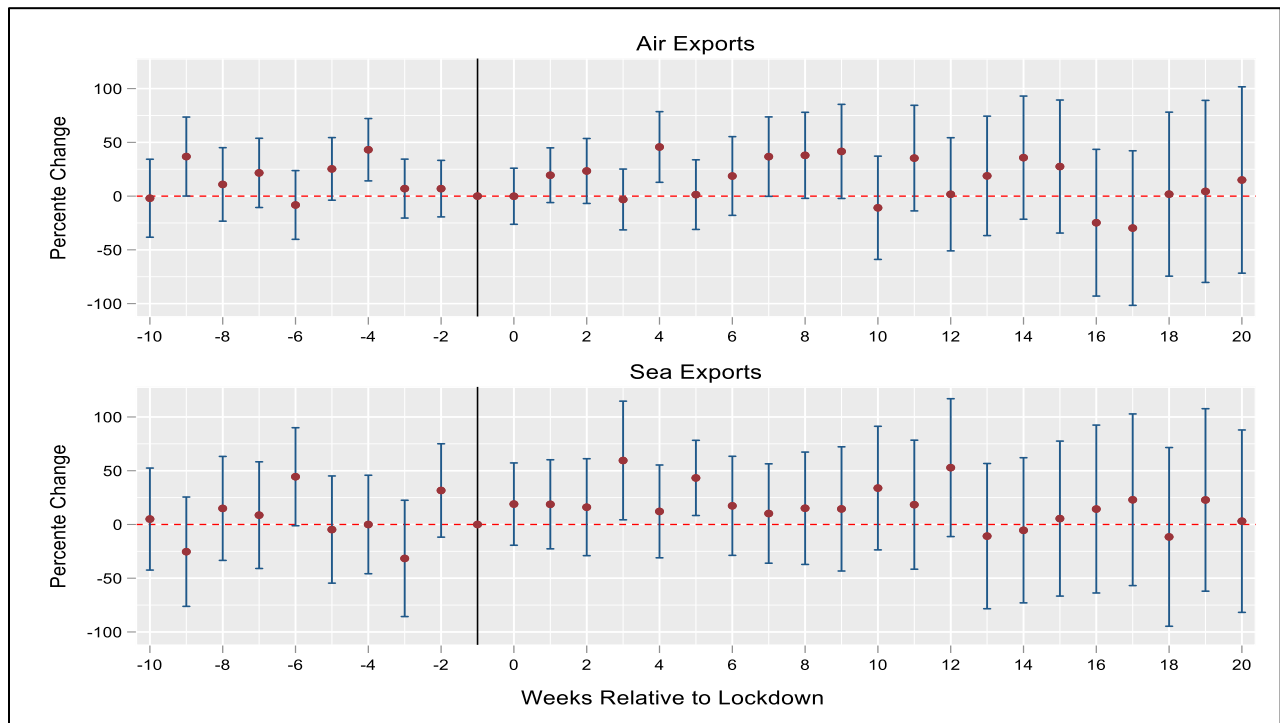
Figure A6: The effects of lockdown measures on import trade by air and sea transport (based on subsample)

Figure A7: The effects of lockdown measures on export and import trade by sea transport (excluding petroleum and other fuels)

Figure A8: Relative change of trade with OECD countries

Figure A9: Relative change of trade with China

Table A1: Effects of lockdown measures on import export trade – results based on event study framework

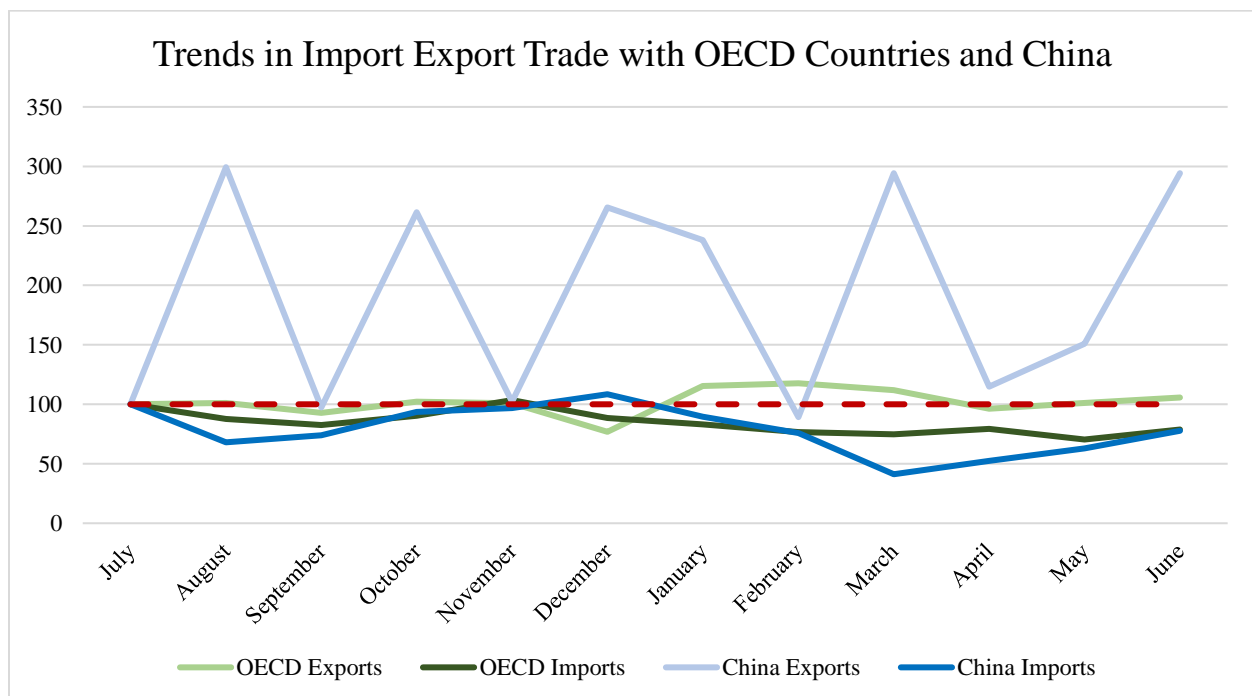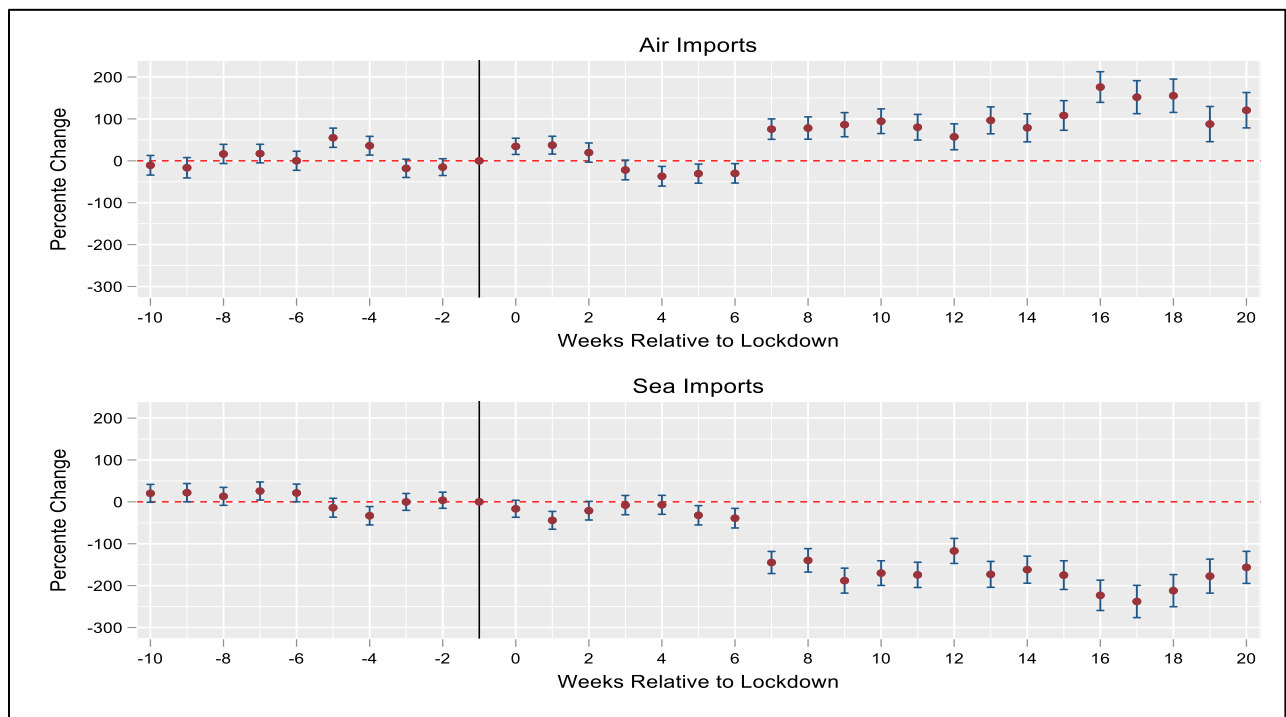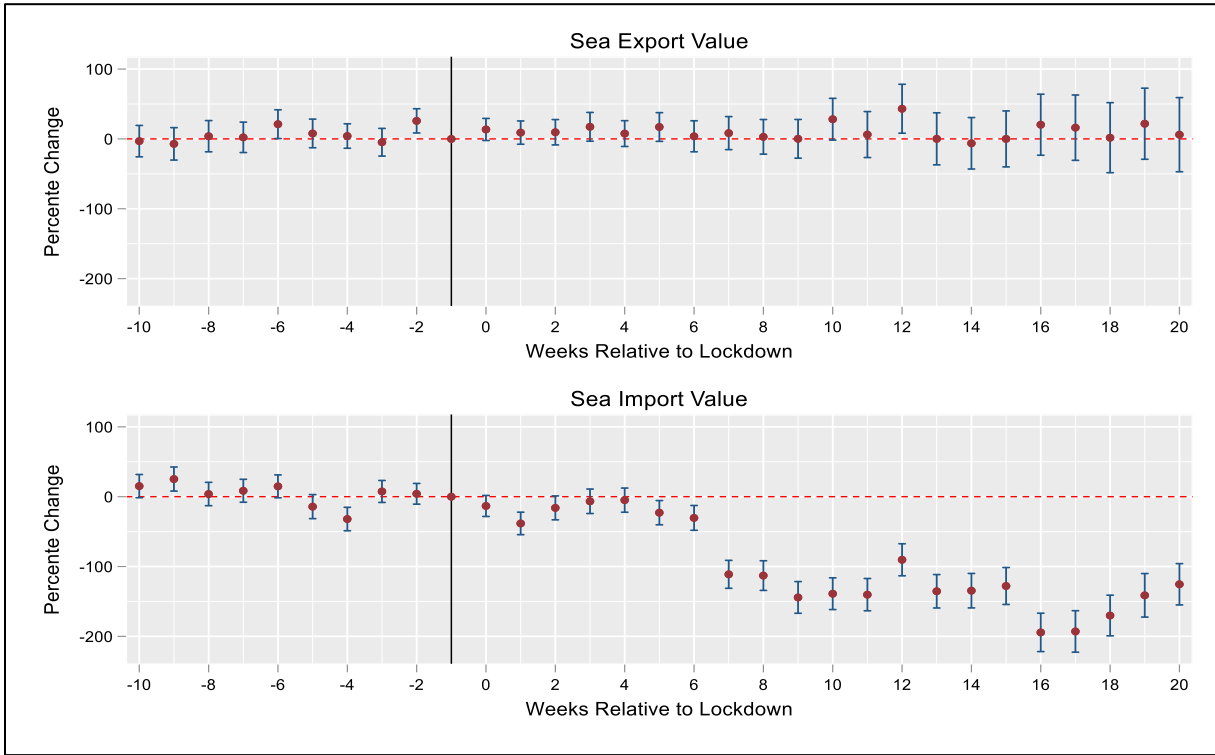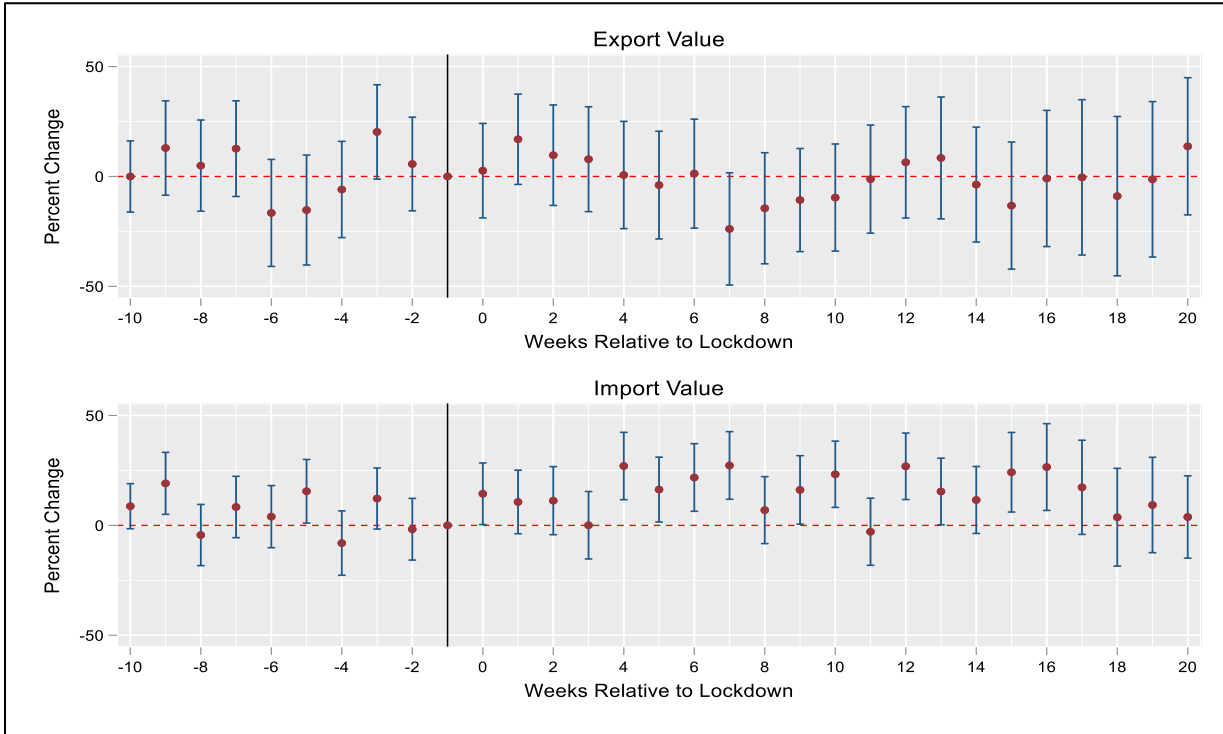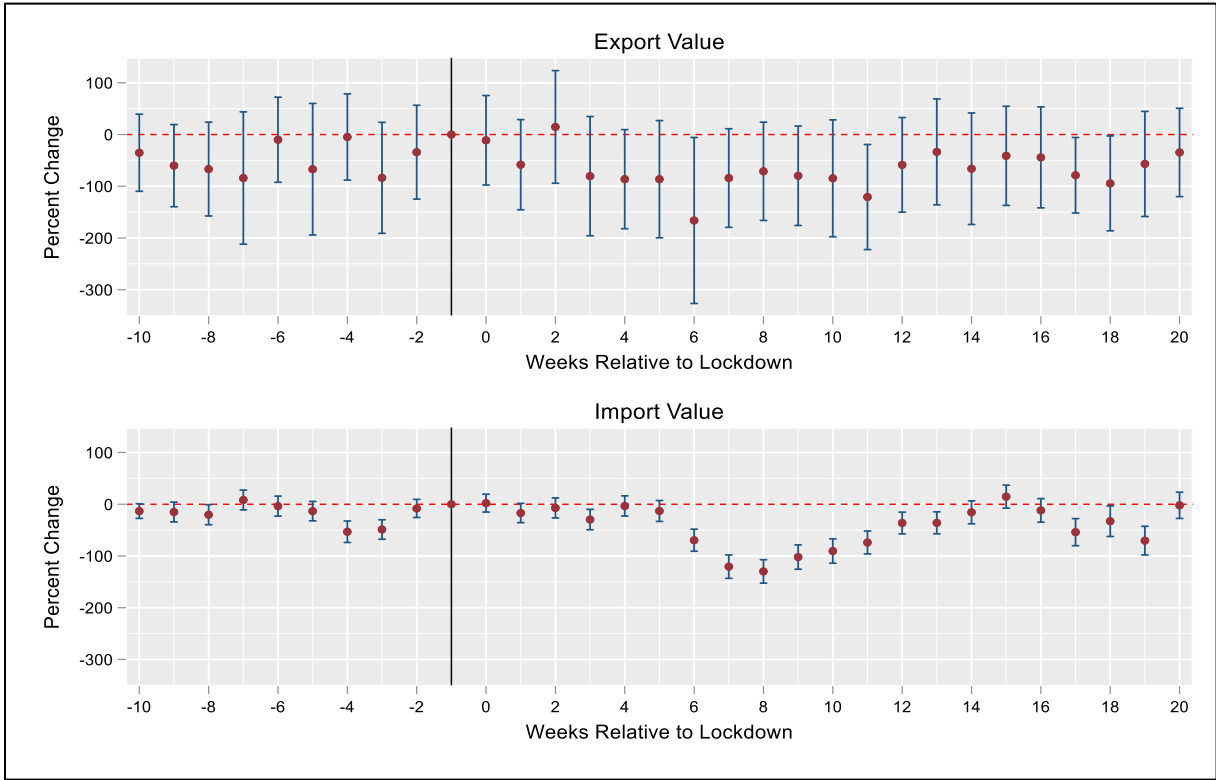| Lockdown event dummies	(1) Export value	(2) Import value	(3) Export quantity	(4) Import quantity
Lag10	-1.977	-1.101	-7.534	-4.263
	(6.929)	(3.653)	(9.357)	(3.658)
Lag9	0.781	-4.839	-7.616	-2.731
	(6.893)	(3.648)	(9.144)	(3.683)
Lag8	11.035*	0.745	1.592	-2.844
	(6.427)	(3.549)	(8.852)	(3.545)
Lag7	7.000	2.597	7.407	-0.844
	(6.334)	(3.531)	(8.671)	(3.491)
Lag6	5.062	-3.143	-0.270	-4.170
	(6.024)	(3.617)	(7.812)	(3.539)
Lag5	3.296	-1.268	3.279	-9.262**
	(5.732)	(3.692)	(7.047)	(3.625)
Lag4	12.608**	-5.147	9.820	-14.960***
	(5.251)	(3.672)	(6.109)	(3.620)
Lag3	4.233	-1.936	-1.024	-4.548
	(5.588)	(3.400)	(5.847)	(3.386)
Lag2	4.725	0.035	6.817	2.601
	(5.127)	(3.215)	(5.331)	(3.145)
Lead0	2.515	-0.978	6.450	-3.884
	(4.897)	(3.239)	(5.018)	(3.143)
Lead1	4.030	-7.279**	6.812	-16.679***
	(5.107)	(3.483)	(5.432)	(3.460)
Lead2	16.100***	-5.592	12.522**	-10.045***
	(5.333)	(3.722)	(5.929)	(3.664)
Lead3	7.259	-6.789*	-0.367	-8.981**
	(6.082)	(3.819)	(6.759)	(3.806)
Lead4	18.407***	-6.247*	11.601*	-9.896***
	(5.850)	(3.797)	(6.731)	(3.720)
Lead5	5.635	-16.379***	1.081	-21.056***
	(6.034)	(3.742)	(7.176)	(3.769)
Lead6	13.493**	-17.800***	11.402	-27.912***
	(6.511)	(3.930)	(7.843)	(3.966)
Lead7	7.517	-28.879***	11.964	-57.450***
	(6.869)	(4.225)	(8.368)	(4.417)
Lead8	14.880**	-44.303***	11.520	-61.333***
	(7.512)	(4.539)	(9.375)	(4.750)
Lead9	20.844***	-38.328***	7.925	-67.173***
	(7.880)	(4.780)	(10.378)	(4.972)
Lead10	12.287	-39.283***	7.757	-64.342***
	(8.523)	(4.852)	(11.024)	(5.080)
Lead11	12.501	-34.940***	5.132	-59.952***
	(9.063)	(4.978)	(11.547)	(5.146)
Lead12	12.132	-27.051***	9.899	-45.978***
	(9.703)	(5.026)	(12.301)	(5.126)
Lead13	12.998	-37.625***	5.025	-52.041***
	(10.039)	(5.217)	(13.401)	(5.418)
Lead14	6.279	-42.261***	-6.069	-61.562***
	(10.368)	(5.406)	(13.648)	(5.633)
Lead15	20.920*	-35.515***	10.992	-60.097***
	(10.975)	(5.723)	(14.575)	(5.958)
Lead16	12.502	-36.396***	10.085	-66.512***
	(11.496)	(5.982)	(15.120)	(6.205)
Lead17	9.042	-47.933***	7.045	-74.781***
	(12.304)	(6.290)	(15.999)	(6.442)
Lead18	10.633	-36.603***	-3.307	-61.270***
	(13.235)	(6.463)	(17.546)	(6.606)
Lead19	25.402*	-45.046***	8.021	-70.373***
	(13.555)	(6.764)	(17.881)	(6.936)

Lead20	7.607	-27.892***	0.794	-46.510***
	(13.724)	(6.444)	(17.384)	(6.768)
Constant	1,261.658***	1,203.642***	677.459***	492.218***
	(8.012)	(4.248)	(10.523)	(4.251)
Observations	100,280	353,294	101,313	359,518
R-squared	0.004	0.005	0.005	0.008
Number of ID	19,398	52,494	19,886	54,121

Note: Estimation was conducted on the weekly trade data using a fixed effects estimator that accounts for cross-country-product heterogeneities. Week dummies were included in all regressions but not reported. Standard errors are corrected for clustering within country-product groups. Asterisk indicate the level of significance, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A2: The effects of lockdown measures on import export trade by air and sea transport

Lockdown event dummies	(1) Air Exports	(2) Sea Exports	(3) Air Imports	(4) Sea Imports
Lag10	15.649	1.040	-16.861**	15.694*
	(12.817)	(12.324)	(8.174)	(8.476)
Lag9	34.561***	-4.957	-23.174***	25.151***
	(12.793)	(12.327)	(8.339)	(8.779)
Lag8	15.712	5.806	1.304	3.339
	(11.868)	(11.798)	(8.013)	(8.500)
Lag7	17.812	4.371	2.398	8.790
	(11.845)	(11.412)	(7.828)	(8.366)
Lag6	4.464	22.782**	-6.507	14.047*
	(11.359)	(10.691)	(7.878)	(8.334)
Lag5	28.316***	8.398	31.659***	-14.173
	(10.908)	(10.554)	(8.084)	(8.744)
Lag4	33.406***	5.862	18.026**	-32.610***
	(10.364)	(9.054)	(7.834)	(8.540)
Lag3	8.298	-5.908	-15.420**	6.482
	(10.693)	(10.211)	(7.554)	(8.000)
Lag2	3.459	24.631***	-7.087	2.901
	(9.491)	(8.891)	(7.134)	(7.555)
Lead0	-11.853	12.459	22.315***	-13.766*
	(8.785)	(8.034)	(6.956)	(7.653)
Lead1	5.761	7.978	20.736***	-38.169***
	(9.036)	(8.477)	(7.578)	(8.173)
Lead2	6.935	7.235	3.451	-15.629*
	(10.358)	(9.315)	(7.956)	(8.698)
Lead3	-13.392	14.632	-27.739***	-6.011
	(10.740)	(10.522)	(8.290)	(8.909)
Lead4	19.182*	5.685	-34.804***	-4.970
	(10.942)	(9.552)	(8.193)	(8.797)
Lead5	-4.464	14.733	-18.270**	-23.939***
	(10.611)	(10.698)	(8.182)	(8.820)
Lead6	-2.099	-0.236	-20.490**	-31.099***
	(12.147)	(11.615)	(8.309)	(9.054)
Lead7	14.891	6.220	59.962***	-109.878***
	(12.537)	(12.443)	(8.886)	(10.174)
Lead8	16.846	0.837	59.156***	-112.861***
	(13.597)	(13.093)	(9.726)	(10.808)
Lead9	24.208	-1.709	76.586***	-142.922***
	(14.744)	(14.716)	(10.428)	(11.534)
Lead10	-20.446	24.162	77.953***	-138.885***
	(15.826)	(15.984)	(10.540)	(11.546)
Lead11	11.982	2.188	71.813***	-140.030***
	(16.496)	(17.549)	(10.952)	(11.759)
Lead12	-13.099	38.498**	52.370***	-91.042***
	(18.136)	(18.697)	(10.946)	(11.674)
Lead13	-0.990	-3.505	84.587***	-135.027***
	(18.213)	(19.995)	(11.408)	(12.182)
Lead14	15.301	-8.660	69.617***	-134.358***
	(18.646)	(19.915)	(11.866)	(12.563)
Lead15	8.481	-4.186	91.682***	-127.300***
	(20.385)	(21.598)	(12.581)	(13.470)
Lead16	-31.034	14.404	141.245***	-194.082***
	(22.344)	(23.575)	(13.101)	(13.998)
Lead17	-35.954	10.723	131.762***	-191.619***
	(23.157)	(25.033)	(14.203)	(15.104)
Lead18	-2.689	-4.598	122.794***	-170.250***

	(23.238)	(26.646)	(14.226)	(14.832)
Lead19	-17.142	16.454	80.388***	-141.533***
	(25.316)	(27.486)	(15.075)	(15.860)
Lead20	-6.356	0.608	109.321***	-125.424***
	(27.178)	(28.531)	(14.843)	(15.062)
Constant	677.310***	564.213***	571.490***	730.621***
	(14.939)	(14.304)	(9.491)	(9.911)
Observations	100,280	100,280	353,294	353,294
Observations	55,891	50,180	220,798	237,159
R-squared	0.005	0.006	0.009	0.008
Number of ID	19,398	19,398	52,494	52,494

Note: Estimation was conducted on the weekly trade data using a fixed effects estimator that accounts for cross-country-product heterogeneities. Week dummies were included in all regressions but not reported. Standard errors are corrected for clustering within country-product groups. Asterisk indicate the level of significance, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A3: The effects of lockdown measures on import export trade by air and sea transport: Estimation based on subsample

Lockdown event dummies	(1) Air Exports	(2) Sea Exports	(3) Air Imports	(4) Sea Imports
Lag10	0.305	5.335	-10.512	20.093*
	(20.039)	(24.907)	(11.985)	(10.879)
Lag9	38.246*	-25.363	-16.516	21.768*
	(19.684)	(26.338)	(12.417)	(11.119)
Lag8	12.079	15.043	16.433	12.930
	(18.219)	(24.948)	(11.691)	(10.951)
Lag7	22.712	8.788	17.281	25.743**
	(17.040)	(25.602)	(11.312)	(11.033)
Lag6	-7.211	44.564*	0.145	21.189**
	(16.842)	(23.410)	(11.612)	(10.759)
Lag5	25.972*	-4.756	55.111***	-14.097
	(15.143)	(25.542)	(11.692)	(11.490)
Lag4	43.718***	-0.059	36.065***	-33.205***
	(15.006)	(23.470)	(11.416)	(11.179)
Lag3	7.537	-31.668	-17.984	-0.135
	(14.059)	(27.719)	(11.129)	(10.265)
Lag2	7.147	31.632	-15.033	3.832
	(13.450)	(22.200)	(10.225)	(9.817)
Lead0	-0.120	18.850	34.641***	-16.566
	(13.329)	(19.555)	(9.843)	(10.318)
Lead1	19.163	18.519	37.423***	-44.077***
	(13.066)	(21.157)	(10.857)	(10.853)
Lead2	22.892	15.935	19.798*	-21.063*
	(15.549)	(23.052)	(11.708)	(11.339)
Lead3	-3.564	59.500**	-21.767*	-7.716
	(14.664)	(28.275)	(12.010)	(11.745)
Lead4	45.003***	12.129	-36.844***	-7.027
	(17.166)	(22.077)	(11.993)	(11.576)
Lead5	0.420	43.259**	-30.517***	-31.967***
	(17.099)	(17.985)	(11.621)	(11.771)
Lead6	17.703	17.273	-29.796**	-38.914***
	(19.394)	(23.648)	(11.816)	(11.927)
Lead7	35.326*	10.073	75.792***	-144.701***
	(19.719)	(23.861)	(12.442)	(13.470)
Lead8	36.306*	15.043	78.402***	-139.542***
	(21.570)	(26.946)	(13.608)	(14.286)
Lead9	39.648*	14.558	86.435***	-187.965***
	(23.635)	(29.883)	(14.727)	(15.185)
Lead10	-12.922	33.901	94.700***	-169.939***
	(26.015)	(29.792)	(15.021)	(15.002)
Lead11	33.139	18.439	80.468***	-174.126***
	(26.682)	(31.049)	(15.668)	(15.389)
Lead12	-0.889	53.116	57.576***	-116.996***
	(28.690)	(33.307)	(15.818)	(15.249)
Lead13	15.911	-10.646	96.922***	-172.906***
	(30.398)	(35.151)	(16.465)	(15.780)
Lead14	32.638	-5.352	79.053***	-161.706***
	(31.457)	(35.060)	(17.103)	(16.473)
Lead15	24.272	5.576	108.544***	-174.705***
	(33.906)	(37.415)	(18.086)	(17.470)
Lead16	-28.327	14.420	176.333***	-222.968***
	(37.296)	(40.508)	(18.712)	(18.497)
Lead17	-33.637	23.035	152.177***	-237.620***

	(39.168)	(41.343)	(20.147)	(19.653)
Lead18	-1.803	-11.267	155.683***	-211.797***
	(41.318)	(43.204)	(20.360)	(19.570)
Lead19	0.442	23.032	88.046***	-177.125***
	(45.723)	(44.115)	(21.472)	(20.722)
Lead20	10.330	3.166	121.160***	-156.193***
	(47.076)	(44.105)	(21.611)	(19.518)
Constant	1,168.888***	1,107.943***	850.967***	1,027.180***
	(22.695)	(28.085)	(13.831)	(12.626)
Observations	55,891	50,180	220,798	237,159
R-squared	0.006	0.010	0.012	0.010
Number of ID	10,817	9,185	30,931	29,577

Note: Estimation was conducted on the weekly trade data using a fixed effects estimator that accounts for cross-country-product heterogeneities. Week dummies were included in all regressions but not reported. Standard errors are corrected for clustering within country-product groups. Asterisk indicate the level of significance, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.$