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The Effect of Lockdown Policies on International Trade: Evidence from Kenya

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Abstract

This study analyzes how Kenya's import and export trade was affected by lockdown policies during the COVID-19 outbreak. Analysis is conducted using a weekly series of product-by-country data for the one-year period from July 1, 2019 to June 30, 2020. Analysis using an event study design shows that the introduction of lockdown measures by trading partners led to a modest increase of exports and a comparatively larger decline of imports. 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 results within the event study framework reveal that food exports and imports increased, while the effect of the lockdown on medical goods was less clear-cut. Overall, we find that the strength of lockdown policies had an asymmetric effect between import and export trade.

Keywords: COVID-19; Lockdown; Social Distancing; Imports; Exports; Kenya
JEL Codes: F10, F14, L10

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1 Introduction

The COVID-19 pandemic has spawned an unprecedented level of social and economic crisis worldwide. The pandemic is projected to reduce global GDP and international trade by at least 4.9% and 13%, respectively, in 2020 (WTO, 2020a; IMF, 2020), which would make it the most potent health and economic crisis since the Second World War (Kassa, 2020; Barichello, 2020; Baldwin and Tomiura, 2020). In an effort to contain the spread of the virus, governments around the world 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 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).

Lockdown policies have further introduced demand–side shocks that varied across product categories. The onset of the pandemic has seen significant stockpiling of essential commodities such as food products 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 instabilities in financial services sectors that are important in the smooth running of international trade (Banga et al., 2020).

This 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 subsequently affected the country's import and export trade. The event variable identifies the introduction dates of lockdown policies covering measures such as the closure of workplaces and public transportation, stay-at-home requirements, and internal mobility and international travel restrictions. 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).

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 23% on average after the measures were put in place, while exports to those countries increased by 13%. 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 significant disruption of imports by sea from countries that introduced lockdown measures, which was large enough to compensate for an almost 100% increase in air cargo imports. The results suggest a substitution from sea to air cargo trade as a result of lockdown policies, possibly due to the perceived safety of air cargo and cheaper air fares from airlines that faced a collapse in passenger traffic[1].

We subsequently estimated difference-in-differences (DiD) regressions within the event-study framework to test for divergent effects of lockdown measures across countries and commodities. The regressions reveal that the import and export of food commodities increased in response to the lockdown measures by an average of 21% and 31%, respectively. The increase in food imports indicates that the decline in aggregate imports is caused by

[1]Facing a substantial collapse of passenger traffic, several airlines turned to cargo transport as a new lifeline of revenue streams. 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.

a substantial demand fall for imported (durable) commodities that more than compensated the rise in food imports. In line with prior research (Evenett, 2020; Gereffi, 2020; Fuchs et al., 2020), we compiled a list of medical goods relevant to 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.

Finally, we find that the effect of the lockdown policies was somewhat different in countries that had more stringent lockdown measures. Kenyan exports to countries with more stringent lockdown policies decreased, while imports from them increased significantly. Further, the lockdown measures led to an increase of imports from OECD countries, but led to a decline of imports from China.

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, it adopts a robust event study design that exploits a natural experimental setup created by the different introduction dates of lockdown policies across countries. Prior research that assessed the effects of COVID-19 on international trade, on the other hand, used more descriptive approaches. Among other things, the existent literature looked into supply chain disruptions (Verma and Gustafsson, 2020; Oldekop et al., 2020) and demand changes in export or import trade (Cao et al., 2020; Maliszewska et al., 2020; Baldwin and Tomiura, 2020), often using country-level data. Our analysis, in contrast, provides a complete picture of the effects of lockdown policies, including supply-side disruptions that affected trade via different modes of transport, as well varying demand patterns that effected commodities differently.

Second, the study provides rich evidence on the economic effects of COVID-19 in the

under-researched context of developing countries [2]. Kenya offers an interesting set up for our analysis as it is one of the five largest economies in Sub-Saharan Africa with a dynamic and liberalized trade sector. It is also a major player in the East African Community regional economic block. Import and export trade constitutes about a third of total GDP, and export of coffee, tea, cut-flowers, and horticulture is a source 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, accounting for close to 3% of total cases in Africa (cumulative confirmed cases surpassed 50,000 by late October 2020). The country also introduced stringent mobility restrictions and workplace closures by mid-March 2020, which precipitated a contraction of real GDP by 5.7% in the second quarter of 2020 relative to the same quarter in 2019 (Kenya National Bureau of Statistics, 2020). The pandemic further reduced monthly exports and imports by about 8% and 25%, respectively (see Figure A1 in the Appendix). Our results indicate that lockdown measures had relatively limited effect on the export performance of developing countries like Kenya in part because of robust demand for food commodities that make up a sizeable share of their export baskets.

Finally, the study provides 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 in developing countries (Edwards et al., 2020; Aluko and Adeyeye, 2020).

The rest of this paper is organized as follows. Section 2 lays out our empirical econometric strategy. Section 3 describes our data sources and measurement of variables. Section 4 discusses our empirical results and Section 5 concludes the study.

[2]The few studies that focus on Africa, such as Djiofack et al. (2020), Banga et al. (2020) and Adam et al. (2020), mainly focus on making projections through computable general equilibrium modeling.

2 Empirical Methodology

Following the recent micro-econometrics literature (e.g. Fajgelbaum et al., 2020; Lovo, 2018), we conduct an event-study analysis to assess the effects of lockdown measures on international trade. Event study designs provide a flexible framework for assessing the potential time-varying effects of lockdown measures over different periods prior and subsequent to their introduction. The event-study analysis relates weekly trade flows (in log) with a series of event-time dummies while accounting for product-country fixed effects α_{ic} and weekly time fixed effects α_t. Specifically, we estimate the following two-way fixed effects model:

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

where the dependent variable, Y, is bilateral import and export trade (in value or quantity), and the subscripts i, c, and t represent the product, country and time in weeks respectively. The dummy variables $\{t - t_{lockdown} = j\}$ indicate the number of weeks until or since lockdown is put in place $\{t_{lockdown}\}$, and their coefficients, β_j, capture 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. We follow the recommended practice and bin the periods ten weeks before and twenty weeks after the introduction of lockdown. Schmidheiny and Siegloch (2019) show that under this specification, the event study coefficients are identical to the cumulated lags and leads in a distributed-lag model. 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 average effects of

lockdown measures at different periods before and after their introduction. We subsequently estimate two sets of difference-in-differences (DiD) models, within the event study framework of Equation (1), to test for potential heterogeneous effects of lockdown policies across commodities and countries[3]. The first set of DiD regressions assesses if lockdown policies have a greater effect on food products and medical items relevant for the prevention and treatment of COVID-19. The analysis is done by including interaction terms between dummy variables representing the two commodity groups and the series of event-time dummies. Given Kenya's competitive advantage in agricultural commodities, we expect that the import (export) of food commodities will decrease (increase) in response to lockdown measures, while we expect the reverse for trade in medical goods for treating and preventing COVID-19.

We subsequently assess if the effect of lockdown measures depends on the stringency of their implementation by interacting the event-time dummies with a binary variable showing the stringency of lockdown policies. In this specification, we also include additional interaction terms between the event-time dummies and dummies representing the two major trading partners of Kenya: the OECD and China. This is done to reduce the possibility that the interaction terms of lockdown stringency capture the effects of high-quality public health policy in OECD countries and the effects of an early lockdown response by China.

The only identification assumption in the event study design of Equation (1) is a condition of parallel trends between the treated and control groups to ensure that the treatment effects are not confounded by divergent pre-treatment trends (pretrends) (Schmidheiny and Siegloch, 2019; Ervin, 2019). Given that all countries in our sample imposed lockdown measures in response to an exogenous public health hazard, there is limited scope for a

[3]Note that this specification is not identical with the canonical difference-in-differences model that compares treatment and control groups before and after treatment. Since all countries in our analysis imposed lockdown measures, we do not have a non-treated control group- which is also why we adopt the event study design. Our DiD estimates only allow the event-time dummies to differ across country and commodity groups. Recent studies reveal the difficulty of interpreting DiD results from a two-way fixed effects model in cases where observations receive treatment at different points in time, which arises from the presence of multiple groups that can serve as a control group. The application of DiD within a flexible event study framework can mitigate these concerns in cases where treatments are random, which is a plausible assumption in our research context (Goodman-Bacon, 2018).

violation of the parallel trend assumption. There is, however, a possibility for an anticipatory effect in countries that locked down at a later date, which could confound the treatment effect. A significant anticipatory hike of trade before lockdowns could lead us to understate the effects of lockdown policies in these countries – an issue that can be assessed by including a sufficient number of leads and lags (Fajgelbaum et al., 2020; Coglianese et al., 2017). Following standard practice, we check the presence of anticipatory effects by testing the significance coefficients for leads of the lockdown treatment (i.e. $\beta_j = 0$ for $j < -1$).

3 Data and Variables

3.1 Lockdown data

The lockdown event variable gets a value of one when one or more of the following lockdown measures is introduced: (i) workplace 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 of 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 provinces. Workplace closure was put in place on January 26 and additional stay-at-home rules were imposed on February 1, eventually followed by an international travel control on the 25$^{\text{th}}$ of February. The closure of public transport was temporarily suspended on March 28, and stay-at-home restrictions and internal mobility controls were also lifted on April 8, but all three were reinstated on the 10$^{\text{th}}$ of May following a second wave of infections.

The first lockdown measure in Kenya was implemented almost two months after the one in China, on the 16$^{\text{th}}$ of March, when restrictions were placed on international travel to

selected countries. These restrictions were expanded on the 24th of March with the passage of workplace closure measures and, three days later, additional stay-at-home requirements and internal mobility restrictions. Finally, a new measure of public transport closure was put in place on April 6. All of the five lockdown measures were in effect by June 30, the end date of our sample frame. Our measure of lockdown was set to one on the introduction of the first measures, on the 23rd January 2020 in China and on the 16th March 2020 in Kenya, and remained one after that because at least one of these measures was in effect.

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 was done using a dummy variable that identified countries with stringent public policy measures, which was constructed from a Lockdown Stringency Index from the same source as our lockdown measures (i.e. Hale et al., 2020). The original index is a continuous variable that measured the strength and implementation of policies like school closure, workplace closure, stay-at-home requirements, restrictions on internal mobility, and international travel controls. We use the median value across countries to convert the index into a dummy variable for our analysis.

—[Figure 1 about here]—

3.2 Trade data

We use transaction-level customs records of imports and exports from the Customs Services Department of the Kenya Revenue Authority (KRA), which was compiled and updated under the World Bank's Exporter Dynamics Database. The data covers the one-year period from 1st July 2019 to 30th June 2020. Transaction records identified product ID at 8-digit HS level, country of destination/origin, date of transaction and value of transaction in Kenya shillings. We compiled the data by aggregating trade flows to a weekly series of imports and exports at product and country-of-origin/destination level. The dataset for the baseline analysis

identifies products using 6-digit HS codes that are internationally comparable (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 5,921,323 in Kenyan Shillings (USD 59,213.23), while the average weekly product-country-of-origin for imports over the same period was 4,521,253 Kenyan Shillings (USD 45,212.53). Although average weekly imports are smaller than exports at product-by-country level, there are more than three times as many import items than there are export items. As a result, Kenya ran a massive current account deficit of more than 10 billion USD in the reported period. Our sample closely reflects the official balance of payment statistics for the last two quarters of 2019 and the first two quarters of 2020[4].

The average lockdown dummy for exports and imports was 28.1% and 32.2% respectively, indicating the percentage share of observations for periods after lockdown measures were introduced. Table 1 also shows that about 50% of Kenya's export trade and 74% of its import trade is with countries that have stringent lockdown policies. Food commodities were identified based on the HS code of the commodities, and include all 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), vegetables (4.2% of total exports) and fruits and nuts (3.5% of all exports). These commodities made up about a quarter of the observations (23.7%) in our export dataset, but represented 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 (e.g. Evenett, 2020; Gereffi, 2020; Fuchs et al., 2020). The original list of medical goods included 109 distinct commodities (at the level of

[4]More specifically, our data suggests aggregate annual exports of 608 billion Kenyan Shillings (Ksh) while official export statistics for the four quarters sums up to 612 billion Ksh. Imports in the same period were 1,615 billion Ksh in our data and 1,590 billion Ksh in official statistics. The small gaps potentially reflect accounting differences between our data and official statistics, but are small enough not to be causes of concern.

6-digit HS codes) that were identified by the WTO as relevant for treating and preventing COVID-19 (WTO, 2020b), and included items like hand sanitizers, gloves, masks and other personal protective equipment (PPE) and hygiene products. Out of these items, we were able to match 88 items with our export data and 103 with our import data. 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 about here]—

3.3 Trends and composition of trade

Our transaction–level customs data identifies 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 aggregated the data into weekly product by origin/destination trade series for each of the three modes of transportation. Table 2 reports the percentage share of import and export trade that passed through these stations in terms of number of transactions and volume of trade. The Table reveals the limited use of land transportation in Kenya's import–export trade, revealing the low level of regional integration (Eberhard–Ruiz and Moradi, 2019). The bulk of international trade was conducted via sea cargo, which constituted 56% and 81% of the average value of exports and imports, respectively. Air cargo was more important for export trade, constituting 75% of export transactions and 43.4% export value, reflecting the importance of low–weight, high–value export commodities like tea, coffee, cut flowers, fruits and vegetables.

—[Table 2 about here]—

Figure A1 reveals the monthly trend in exports and imports, scaled to the initial month of July 2019. Exports increased consistently during the early lockdown period, gaining about 25% in value between January and March 2020, before falling sharply in April 2020. Imports,

on the other hand, declined consistently. At the end of the time period (June 2020), monthly exports and imports were 8% and 25% lower than their respective values in July 2019.

Figures A2 and A3 in the Appendix provide monthly trends of export and import trade, respectively, for shipments via air, sea and land stations. Figure A2 shows that export trade temporarily jumped up for all modes of transport around February 2020; subsequently, exports by land contracted sharply followed, with some delay, by air cargo exports, while sea cargo exports, having peaked in March, remained flat. Figure A3 reveals that import trade also exhibited different trends depending on the mode of transport. In line with the overall fall in total imports in Figure A1, imports via land and air started to fall in late 2019, and imports by sea followed suit after January 2020. This decline continued throughout the remaining lockdown period so that, at the end of the period, import levels were significantly lower than they were in July 2019. The relative month-on-month import shortfall at the end of the period was the highest for imports by land (44%), followed by imports by air (39%) and imports by sea (30%). These significant trends illustrate the importance of controlling for time dummies in Equation 1 to capture changes in aggregate trade.

China was by far the largest source of imports (22%) followed by India (10%) and United Arab Emirates (8%). Uganda was the largest export market with an export share of 10%, followed by the United States and Pakistan, which bought about 8% of Kenyan exports each. The OECD country block is a major export destination and 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 22% below their initial levels in 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, and even increased by 18% in February although they stabilized afterwards.

4 Results

4.1 Results for aggregate trade

We start by reporting the results from the event study model in Equation 1, which includes weekly time dummies to capture aggregate temporal changes in demand and supply. These dummies capture changes in trade patterns, including those related to COVID-19 but are not driven by lockdown policies by individual countries. Figure 2 plots the coefficients of the event-time dummies from the regressions, after modifications, to reflect percentage changes in trade from the introduction of lockdown measures[5].

The coefficient plots in Figure 2 reveal that lockdown measures affected exports and imports differently. Exports to countries that introduced lockdowns increased marginally while imports from them exhibited a much larger reduction, revealing an asymmetric response. The jump in export volume started two weeks after lockdowns were implemented, and continued consistently until nine weeks after the introduction of lockdown, although occasional surges also occurred much after that period. Lockdown measures increased the value of exports by an average of 13% in the 20 weeks after their introduction (see Table 3). The coefficient plots based on export quantities in Figure 3 reveal the same pattern although the size of the coefficients is smaller and their statistical significance is relatively weaker. This is most likely because of the poor precision in quantity–based estimates that arises from the difficulty to capture quality differences in quantity values.

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 four weeks. Seven weeks after lockdowns were introduced, however, imports from these countries saw a precipitous fall (see Figure 2), leading to an average fall of 23.4% over the 20-week

[5]Estimated coefficients of dummy variables in log-linear models need transformation to indicate appropriate elasticities (Halvorsen and Palmquist, 1980). We followed standard practice and transformed the event-time coefficients β_j into elasticities ε_j as follows: $\varepsilon_j = (exp^{\beta_j} - 1) * 100$. The same transformation was applied on the standard errors used for building confidence interval bands.

window. 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 35% on average. The weekly value and quantity of imports remain significantly lower than the period before the lockdown 20 weeks after the lockdowns were introduced.

—[Figure 2 about here]—

In sum, the event study results reveal that the lockdowns had a greater effect on import trade than on export trade. This result is in line with official statistics that indicate a fall of imports by a quarter between March and May 2020, while exports of some agricultural commodities increased over the same period (Mold and Mveyange, 2020). Moreover, we do not observe a noticeable anticipatory effect, given the insignificance and small size of the coefficients for the lead event-time dummies. This suggests that lockdowns were not predictable and thus did not lead to a major anticipatory effect on trade flows.

—[Figure 3 about here]—

—[Table 3 about here]—

4.2 Results by mode of transport

To assess if lockdowns affected import and export trade by creating logistical disruptions, we next estimate the event study model for trade flows via different modes of transport. Given the severe disruption of international travel due to flight restrictions, we expect that lockdown measures would affect air cargo trade more than they would affect sea cargo trade. This is, however, assuming that the decline in air cargo capacity is proportional to the change in air passenger traffic, which is a reasonable assumption considering the significant shipment capacity of passenger aircraft (Mold and Mveyange, 2020). If airliners introduced dedicated cargo aircraft that more than compensated for the capacity lost due to interruptions in passenger traffic, however, it is possible that lockdowns would lead to an increase in air-based trade.

We estimated our event study model of Equation 1 on disaggregated data of import and export trade by air and sea. Since less than 5% of import and export trade used road transport (Table 2), the weekly series for trade by land is patchy with many zero and missing values. Moreover, a large share of land-based trade involves reimports and reexports of goods that already passed through sea and land routes. Given this, we limit our disaggregated analysis to import and export trade that passed through air and sea stations.

Figures 4 and 5 report the coefficient plots of the event-time dummies based on export and import trade, respectively, that passed through air and sea stations. Figure 4 reveals a statistically insignificant effect of lockdowns on export trade via both air and sea stations. We also find some evidence of anticipatory effects, although these are sporadic effects confined to a few weeks. For example, exports by air jumped by 32% and 39% five and four weeks before lockdowns respectively, and exports by sea likewise increased by about 26% two and six weeks before the lockdown[6]. After the lockdown, exports by air remained unchanged, while exports by sea increased by an average of 8.3% (see Table 3). These results suggest that the lockdowns had a modest, mostly anticipatory positive effect on sea and air cargo export trade.

—[Figure 4 about here]—

Figure 5 reveals that lockdowns had a clear effect of increasing air cargo imports and reducing sea cargo imports. Air cargo imports were volatile in the first few weeks before and after the lockdown, but after about 6 weeks, they registered a large, persistent increase. The average week-on-week increase after the lockdown period was 98%, indicating a doubling of air cargo shipments. This could reflect supply-related factors since an increasing number of airlines have expanded their cargo capacities to compensate for lost revenues from passenger traffic. It could also reflect increased demand for air transport due to the need for emergency supply of medical and food commodities – including donations of medical goods (CGTN

[6]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.

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 that imports by air increased, indicating a substitution effect.

Imports by sea routes started to fall sharply seven weeks subsequent to the introduction of lockdowns, and remained persistently lower than the pre-lockdown period. The average percentage changes (Table 3) in sea cargo imports was -55%, confirming a shift of import trade from sea to air cargo transport once trading partners imposed lockdown measures. This result suggests that the 30-35% reduction in average imports by sea (Figure A3) is possible due to a substantial decline of sea cargo trade from countries that imposed lockdown measures. Together, these results point to a significant reallocation of import trade from sea to air transport in response to lockdown measures.

—[Figure 5 about here]—

4.3 Differential effects across commodities

We subsequently estimate difference-in-differences (DiD) regressions to assess possible heterogenous effects of lockdown policies across countries and product categories, following comparable approaches in the recent trade literature (e.g. Fajgelbaum et al., 2020). Our first analysis will test the importance 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 dummy and event-time dummies are reported in Figure 6. The coefficient plot shows that the export of medical goods for preventing or treating COVID-19 registered a decline for a short period, four to five weeks prior to the introduction of lockdowns (this is only significant at 10% level). After the lockdowns, there was no significant change in the export of medical goods. The import of medical goods also did not register any significant change before or after the lockdowns. This result provides limited evidence to the suggestion that lockdown policies were used to

restrict trade in medical products by producing countries (Gereffi, 2020; Kassa, 2020). The lack of evidence in our data, however, could be because of the generic nature of our lockdown measures, which may fail to capture restrictions in trade for medical items such as face masks (Fuchs et al., 2020).

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 of lockdown policies, although these changes are only significant at 10% level. The average monthly change in food exports was a large 21%, and partially explains the positive response of overall exports in Kenya (Figure 2). These results also tally with official statistics of agricultural production, which increased by 6.4% in the second quarter of 2020 (Kenya National Bureau of Statistics, 2020).

—[Figure 6 about here]—

The bottom panel of Figure 7 shows that food imports registered a significant increase (relative to non-food imports) for several weeks after the introduction of lockdown measures. These differences are also comparatively large, averaging 31%, and persisted throughout most of the lockdown period. These results indicate that the fall in aggregate imports (Figure 2) was caused by a much larger fall in the import of non-food items, which more than compensated for the relative increase in the import of food commodities. The resilience of the food products during the COVID-19 period was also observed in other developing countries (Ker and Cardwell, 2020), and was attributed to its low income elasticity (Barichello, 2020).

—[Figure 7 about here]—

Table 3 reports the average changes of sea and air cargo shipments pertaining to trade of food and medical items (rows 2 and 3). The differential changes in food exports and imports in air cargo shipments were large, with average values of 36% and 35%, respectively. The

same goes for air shipments of medical items, which increased by 144% for exports and 82% for imports, relative to other commodities[7]. This suggests that the significant expansion of air cargo shipment in response to the lockdown (Figure 5) was partly the result of increased import of essential food and medical commodities. The significant hike of medical exports in air cargo trade also reflects Kenya's role as a regional distribution hub for medical items for the prevention and treatment of COVID-19.

4.4 Differential effects across countries

If lockdown measures are implemented to different degrees across countries, our binary variable that merely indicates their introduction will be inadequate to capture these differences. Our final analysis tests for the presence of divergent lockdown effects between countries that adopted highly stringent and less stringent containment measures to the pandemic. For this purpose, we use a Lockdown Stringency Index from Hale et al. (2020) that indicates the strength of lockdown measures in a country in terms of the number of containment measures and the rigor of their implementation. The original index ranges between 0 and 100, and we constructed a binary variable that indicates whether a country has high or low lockdown stringency using the median value of the average index (60) as a cutoff point.

The DiD analysis is done by allowing the event-time dummies to vary between high and low stringency countries. To mitigate the confounding effects of income/institutions and early lockdown by China, 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 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 and source of Kenyan imports, with an annual share of

[7]While these estimates are large in absolute terms, they also had large standard errors, so they were not statistically significant for all but very few time periods (i.e. event time dummies). This is potentially due to the large fluctuation in trade in medical items owing to the small number of medical items under consideration.

34% and 28% respectively.

Figure 8 plots the coefficients of the interaction terms between the event-time 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. Lockdown measures reduced exports to countries with more stringent policies by an average of 11% relative to exports to countries with less stringent policies. Interestingly, Kenyan imports from countries with more stringent lockdown policies increased by an average rate of 24%. This suggests that demand rather than supply patterns shaped trade responses to stringent public health measures.

Figures A5 and A6 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 16% on average after lockdown measures were put in place. Exports to China showed greater decline than exports to the rest of the world, but the differences are generally insignificant, possibly due to the volatility of 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 fall of import trade with China associated with the introduction of the lockdowns was substantial, averaging around 30%.

—[Figure 8 about here]—

4.5 Robustness tests

The analysis thus far did not consider the potential effects of lockdown measures by Kenya itself. The expectation is that any change in aggregate trade caused by these measures will be picked by the time dummies in Equation 1. There are two reasons of potential concern. First, the effect could be heterogeneous across countries and commodities. If lockdowns

in Kenya lead to a fall of income, for example, their effect could vary between commodities depending on their income elasticities, and also across countries depending on the transaction costs of trade. Second, a firsthand experience of lockdowns among traders could affect their expectations, and consequently their responses to lockdown measures by other countries. It is possible, for example, that traders could be better prepared to predict lockdowns in other trading partners, and to take anticipatory responses in their orders and deliveries.

We conduct a series of robustness tests to address these potential issues by estimating Equation 1 on the subsample of countries that imposed lockdown before Kenya did. As shown in Figure 1, Kenya's response to the pandemic trailed China's by about 8 weeks as the pandemic found its way to the country relatively later. As a result, excluding from our sample countries that introduced lockdowns after Kenya did led to a small reduction of only 6% in our observations.

The bottom panel of Table 3 reports the average post-lockdown response of trade using this subset of countries. The average effects of the lockdown are qualitatively similar to the baseline results, which are reported in the top panel. Some modest differences emerge, however. The average change in exports, for example, is larger in the robustness analysis (19.4% compared to 13% in the baseline), suggesting a larger export increase to countries that imposed lockdowns earlier. The increase in the export of medical items also appears larger in the robustness analysis (18% relative to 12% in the baseline), and especially for export of medical items via air cargo (202.5% relative to 144% in the baseline). These changes are perhaps not surprising since countries that were late to impose lockdowns were a distinct set of developing countries where the virus arrived late. Overall, the results from the robustness analysis based on the subsample of countries are broadly in line with our baseline results.

5 Conclusion

This paper provides new evidence of the effect of the lockdown policies during the COVID–19 crisis on the international trade performance of a developing economy, Kenya. We applied an event–study analysis on a weekly series of product–by–country import and export data from 1st July 2019 to 30th June 2020. A two–way fixed effects model was estimated to establish the overall effect of lockdowns on trade volumes and values, and on trade via different modes of transport (air and sea). We subsequently estimated difference–in–differences regressions to assess if the effects of lockdown policies were different for food and medical commodities, and between trading partners with different levels of lockdown stringency.

The results indicate that the introduction of lockdown measures by Kenya's trading partners led to an average increase in export trade by 13%, and a drop of imports by 23%. The decline in imports was mainly caused by relatively greater disruptions of sea cargo trade with countries that introduced lockdown measures. Import and export of food commodities increased in response to the lockdown measures, by 21% and 31% respectively, reflecting the income inelasticity of food commodities. The increase in food imports reveals that aggregate imports declined due to a greater fall in demand for non–food commodities. Our analysis offered less clear–cut results for trade in medical goods that are essential for the protection and treatment of COVID–19. Lockdowns led to a reduction of Kenyan exports to countries with stringent lockdown policies, while imports from these countries responded positively. We also find that lockdowns did not affect exports to OECD countries but led to an increase in imports from them. Import from China, on the other hand, registered marked decline in the first 14 weeks of the lockdown.

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. Kenya's export trade was marginally affected by the lockdowns due in part to robust demand for income–inelastic food exports, which registered

some increase despite the lockdowns and ensuing economic crisis. 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 significant uncertainties caused by a looming health and economic crisis. These results shed light on the asymmetric effects of lockdown policies between export and import trade, on trade via different modes of transport, and across different commodities and trading partners.

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Tables

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
Lockdown stringency	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
Lockdown stringency	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

Note: Value is measured in Kenyan Shillings (Ksh).

Table 2: Trade flows through 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 3: Average change of trade in post-lockdown periods for baseline and robustness analysis

	Total export	Air cargo exports	Sea cargo exports	Total import	Air cargo imports	Sea cargo imports
Baseline						
Overall effect	13.0	-0.44	8.3	-23.4	98.3	-55.2
Differential effect						
Food items	20.8	35.8	-12.0	30.6	34.4	17.8
Medical items	12.2	144.3	-4.3	0.8	82.0	-19.0
Stringent countries	-11.0	26.1	-8.4	24.4	18.0	8.5
Robustness						
Overall effect	19.4	2.1	10.8	-23.2	103.4	-55.4
Differential effect						
Food items	19.9	34.6	-9.2	31.0	34.5	19.6
Medical items	18.2	202.5	-11.2	1.1	82.8	-18.6
Stringent countries	-8.1	35.1	-10.8	26.4	24.1	6.0

Figures

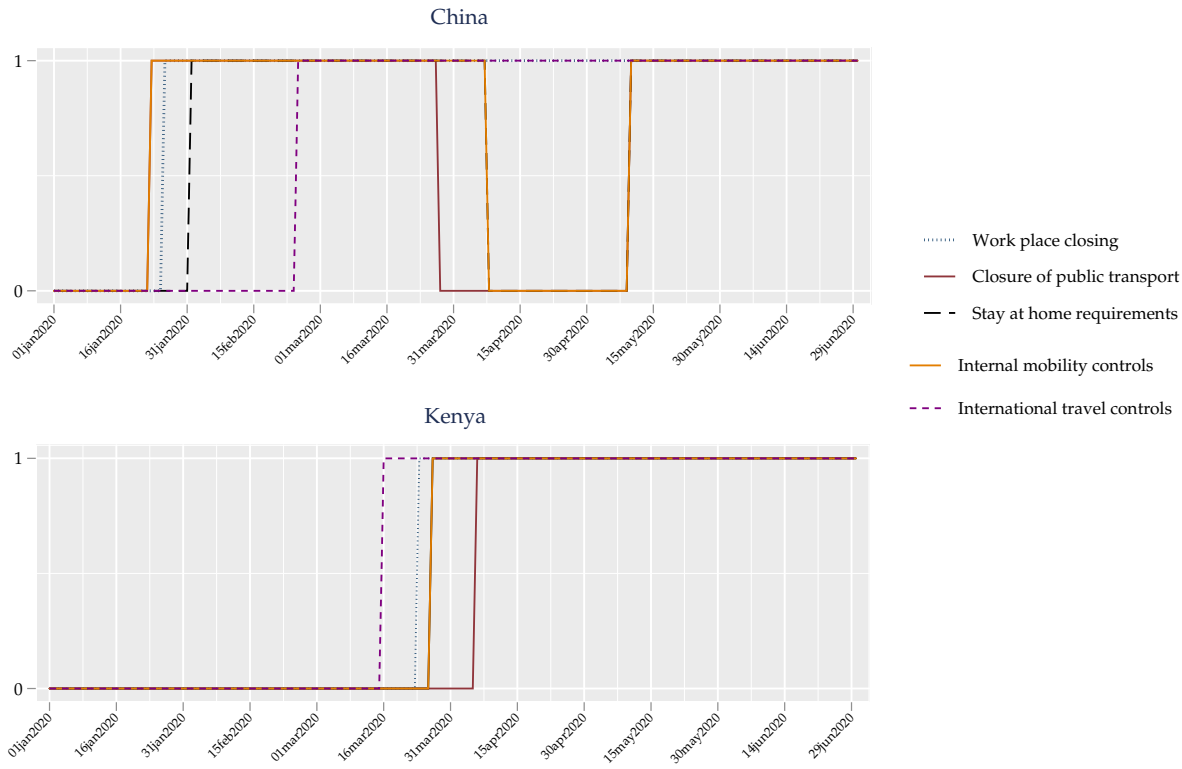

Figure 1: Introduction dates of different lockdown measures in China and Kenya

Source: Based on data from Hale et al. (2020)

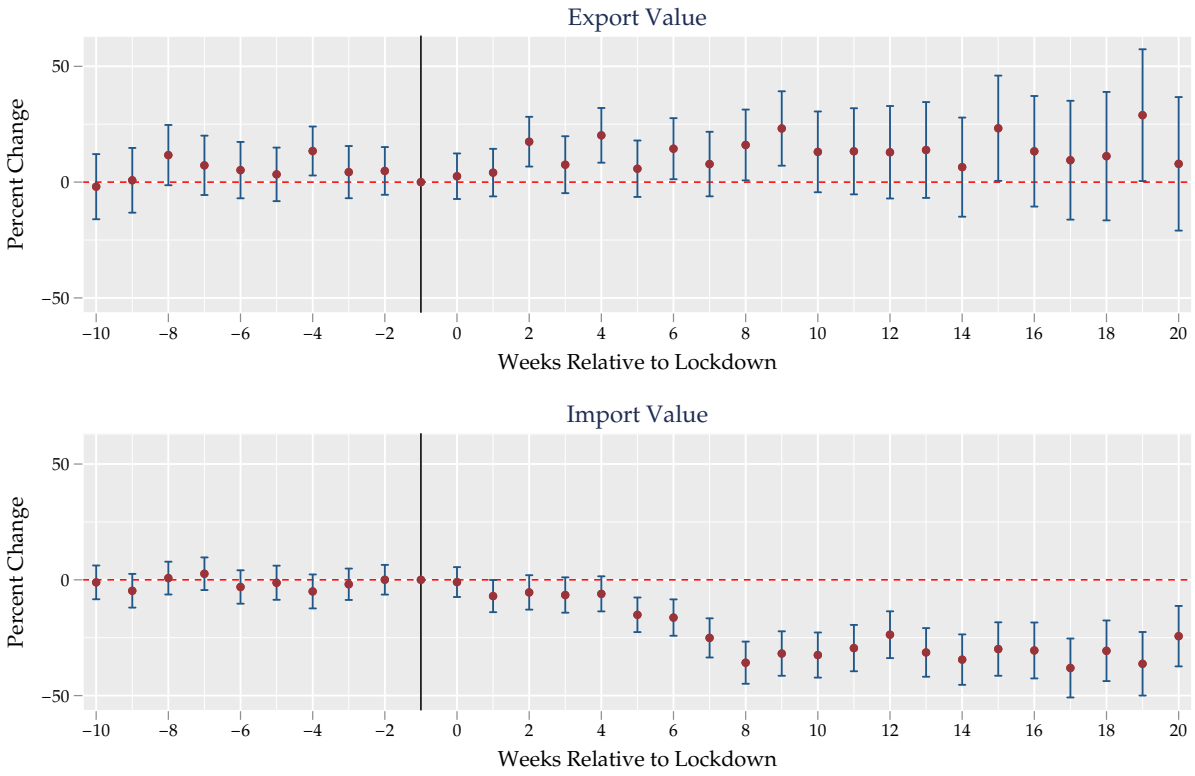

Figure 2: Effects of lockdown on the value of Kenya's imports and exports

Notes: The red dots indicate the regression coefficients for the event-time dummies, and the spikes indicate their 95% confidence interval bands. The coefficients are transformed to reflect percentage change in import and export trade associated with the lockdown event dummies. The sample covers a one-year period from 1st of July 2019 to 30th of June 2020, where observations are weekly product-by-country import and export values (in Kenyan Shillings), and products are defined at 6-digit level of HS codes.

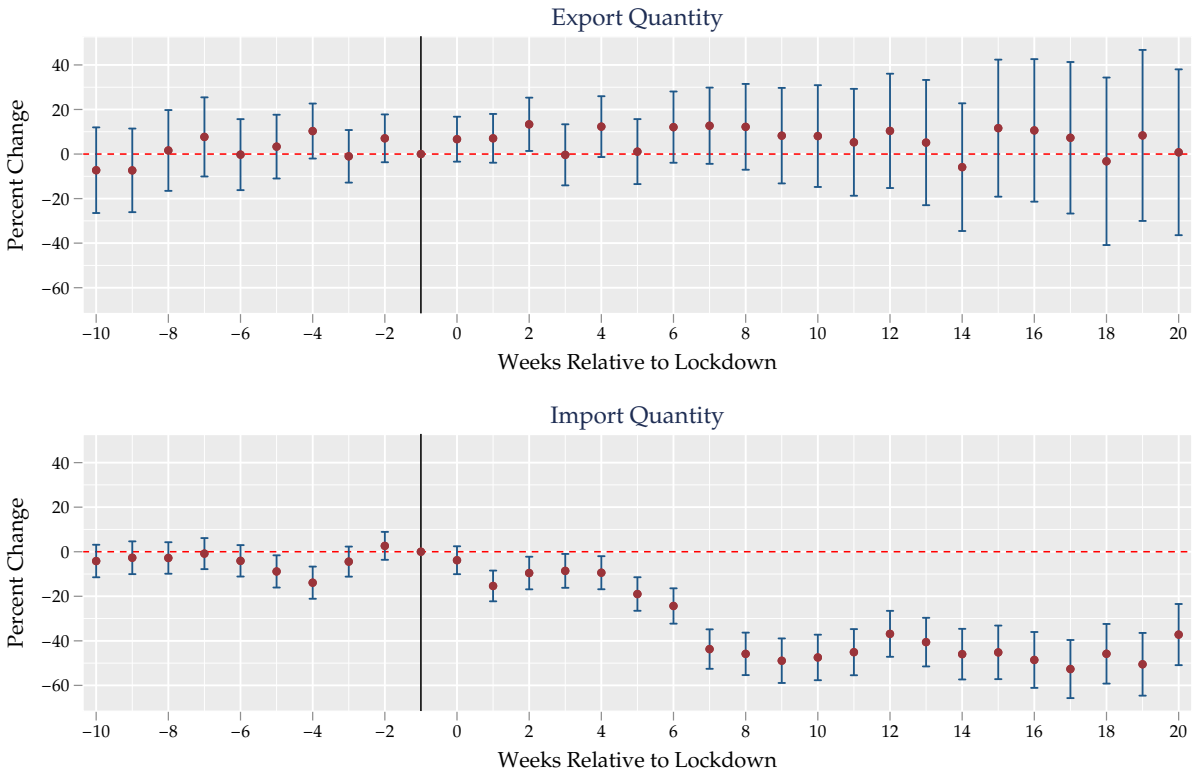

Figure 3: Effects of lockdown on the quantity volume of Kenya's imports and exports

Notes: The red dots indicate regression coefficients for the event-time dummies, and the spikes indicate their 95% confidence interval bands. The coefficients are transformed to reflect percentage change in import and export trade associated with the lockdown event dummies. The sample covers a one-year period from 1st of July 2019 to 30th of June 2020, where observations are weekly product-by-country import and export quantities in relevant units, and products are defined at 8-digit level of HS codes.

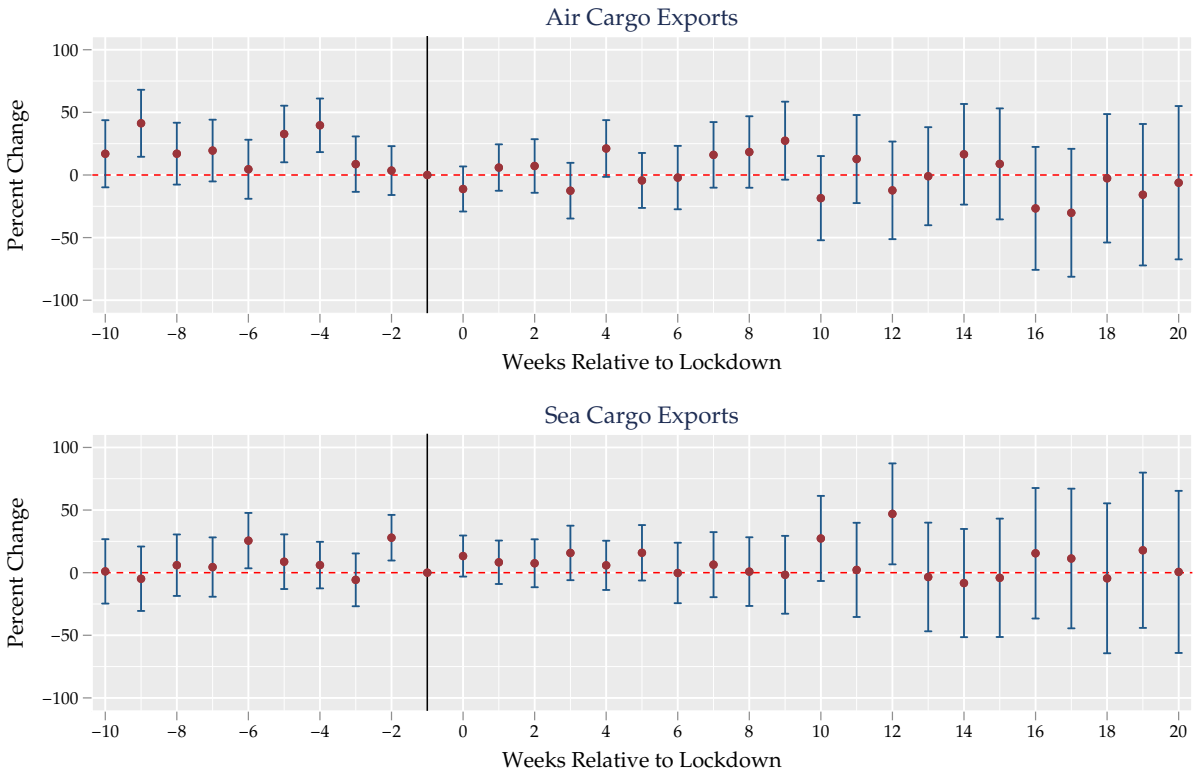

Figure 4: Effects of lockdown on exports through air and sea cargo

Notes: The red dots indicate the regression coefficients for the event-time dummies, and the spikes indicate their 95% confidence interval bands. The coefficients are transformed to reflect percentage change in export trade associated with the lockdown event dummies.

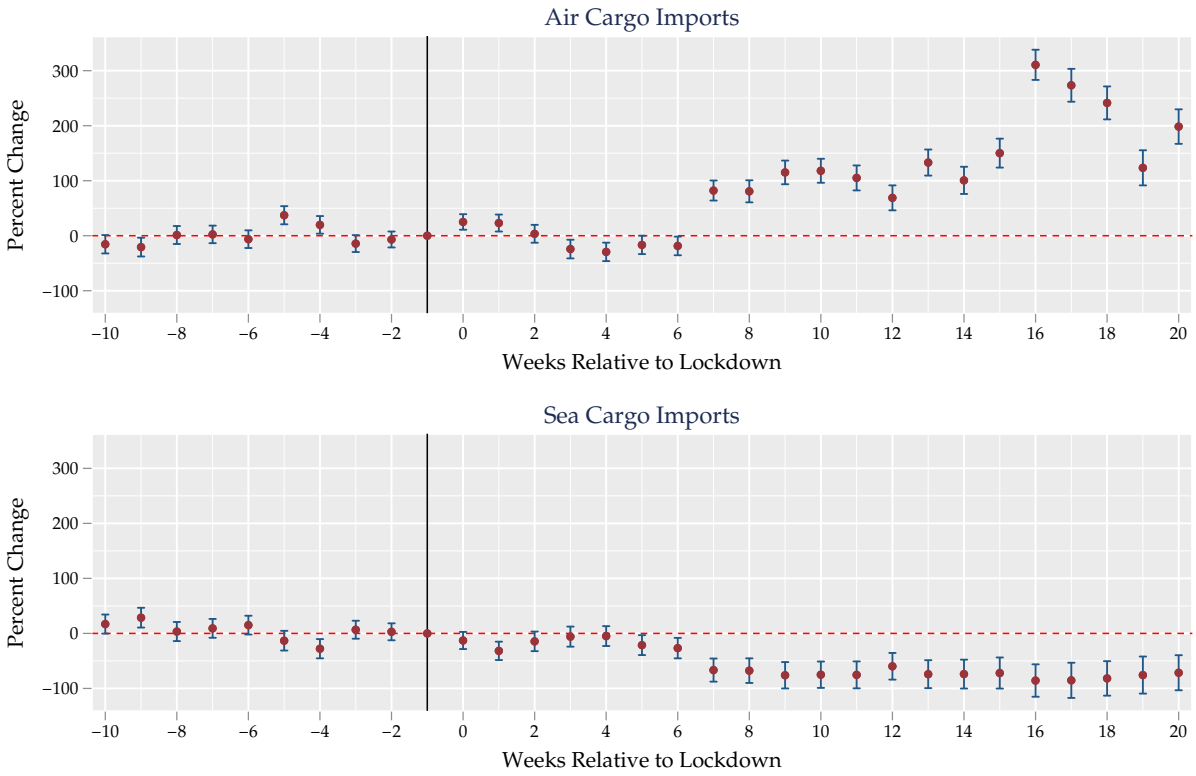

Figure 5: Effects of lockdown on imports through air and sea cargo

Notes: The red dots indicate the regression coefficients for the event-time dummies, and the spikes indicate their 95% confidence interval bands. The coefficients are transformed to reflect percentage change in import trade associated with the lockdown event dummies.

Figure 6: Differential effect of lockdown on trade of medical commodities for treating COVID-19

Notes: The red dots indicate the regression coefficients for the event-time dummies, and the spikes indicate their 95% confidence interval bands. The coefficients are transformed to reflect percentage change in trade associated with the lockdown event dummies.

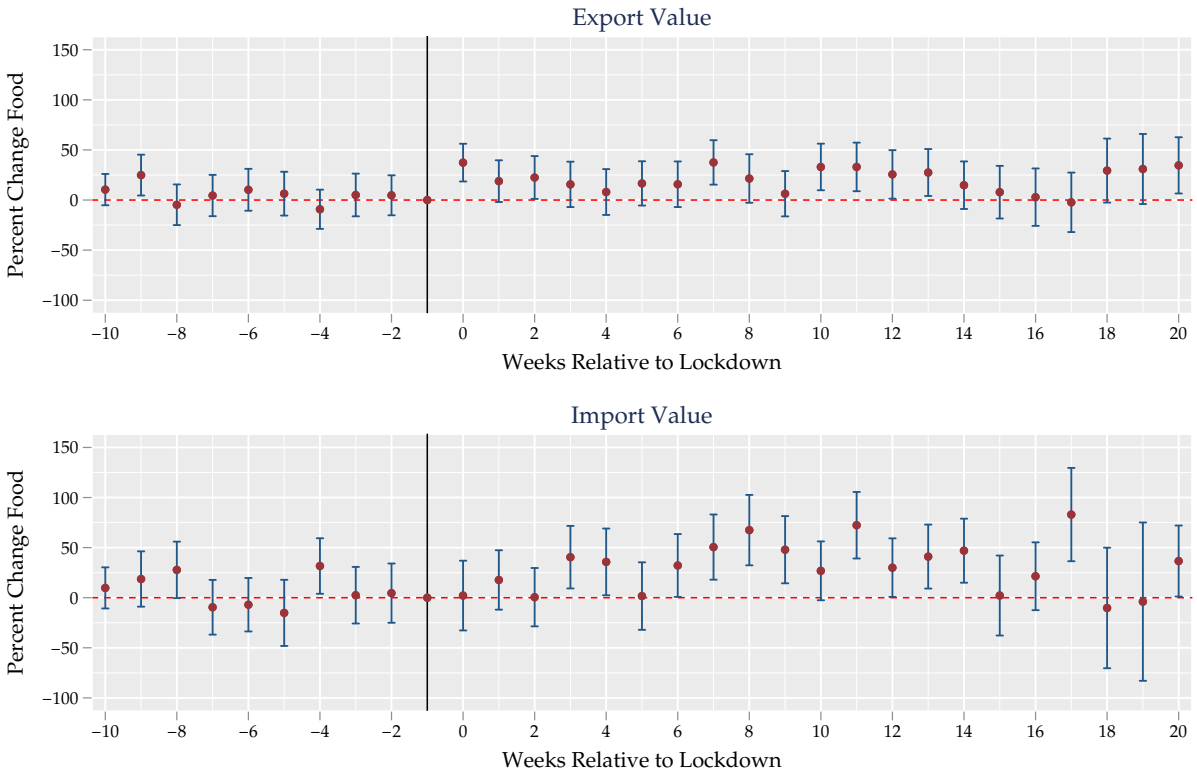

Figure 7: Differential effect of lockdown on trade of food commodities

Notes: The red dots indicate the regression coefficients for the event-time dummies, and the spikes indicate their 95% confidence interval bands. The coefficients are transformed to reflect percentage change in trade associated with the lockdown event dummies.

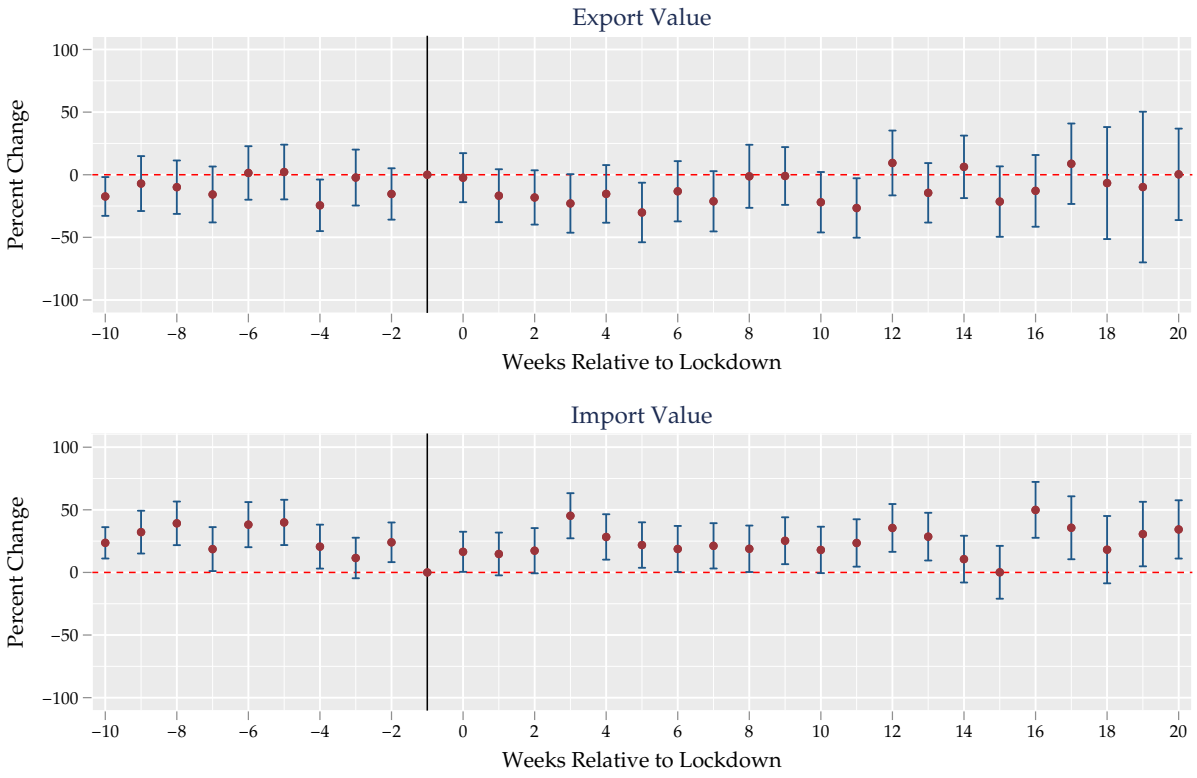

Figure 8: Differential effect of lockdown on trade flows with countries that have stringent lockdown implementation

Notes: The red dots indicate the regression coefficients for the event-time dummies, and the spikes indicate their 95% confidence interval bands. The coefficients are transformed to reflect percentage change in trade associated with the lockdown event dummies.

Appendix

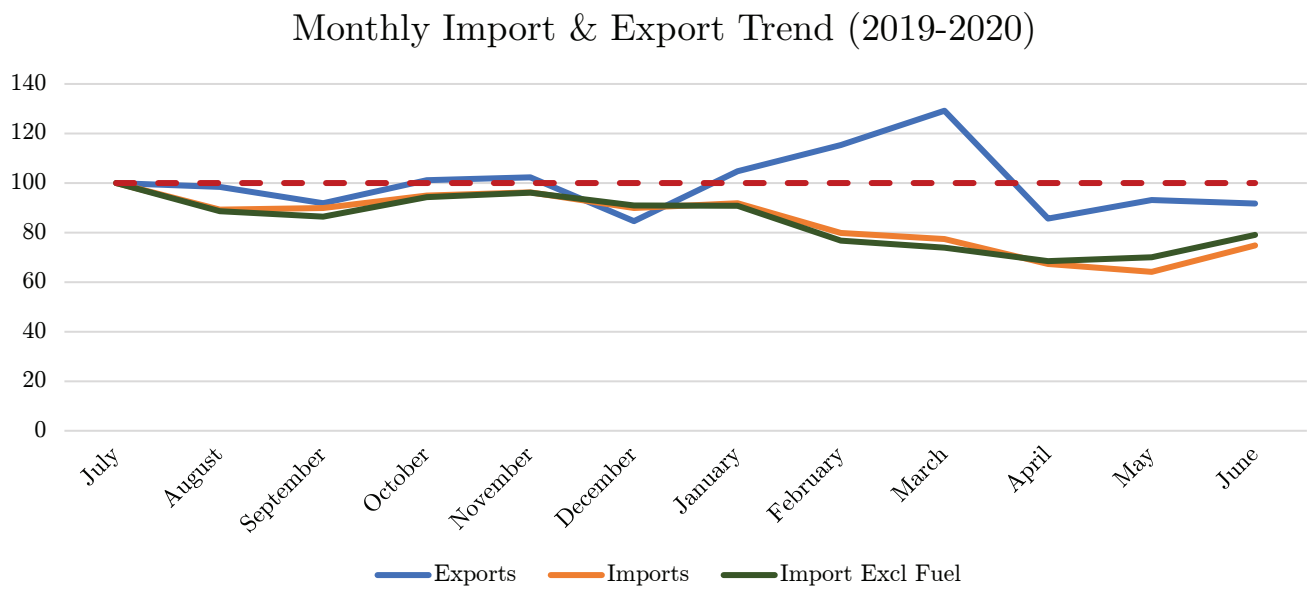

Figure A.1: Trends in import and export trade

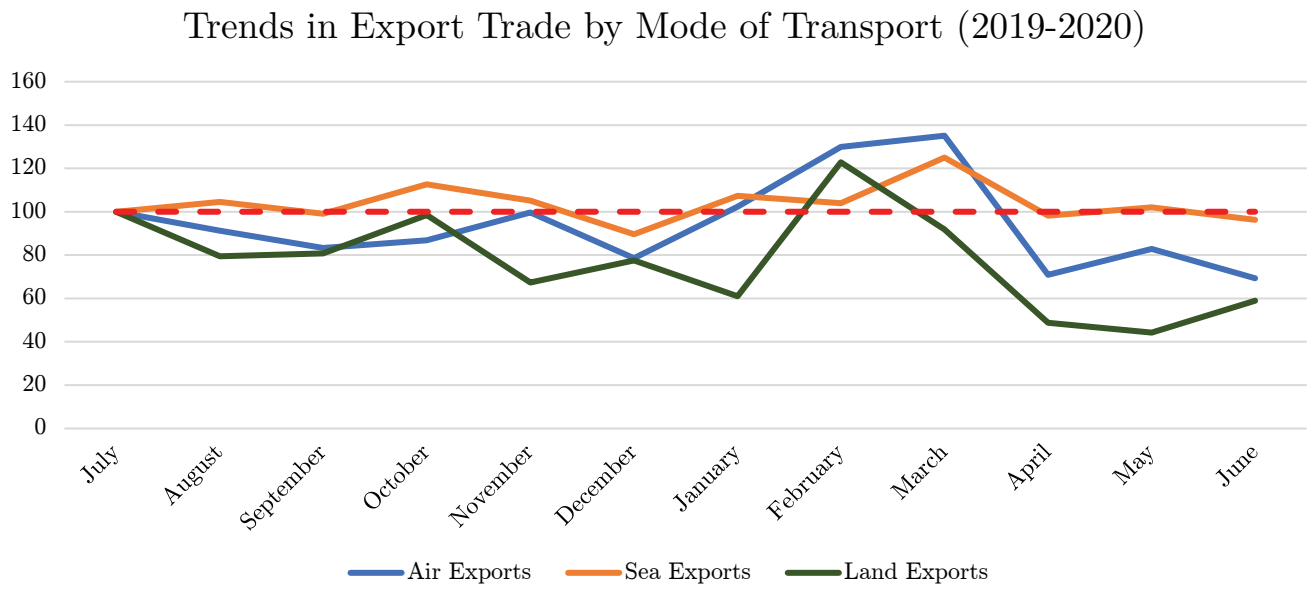

Figure A.2: Relative change in export trade by mode of transport

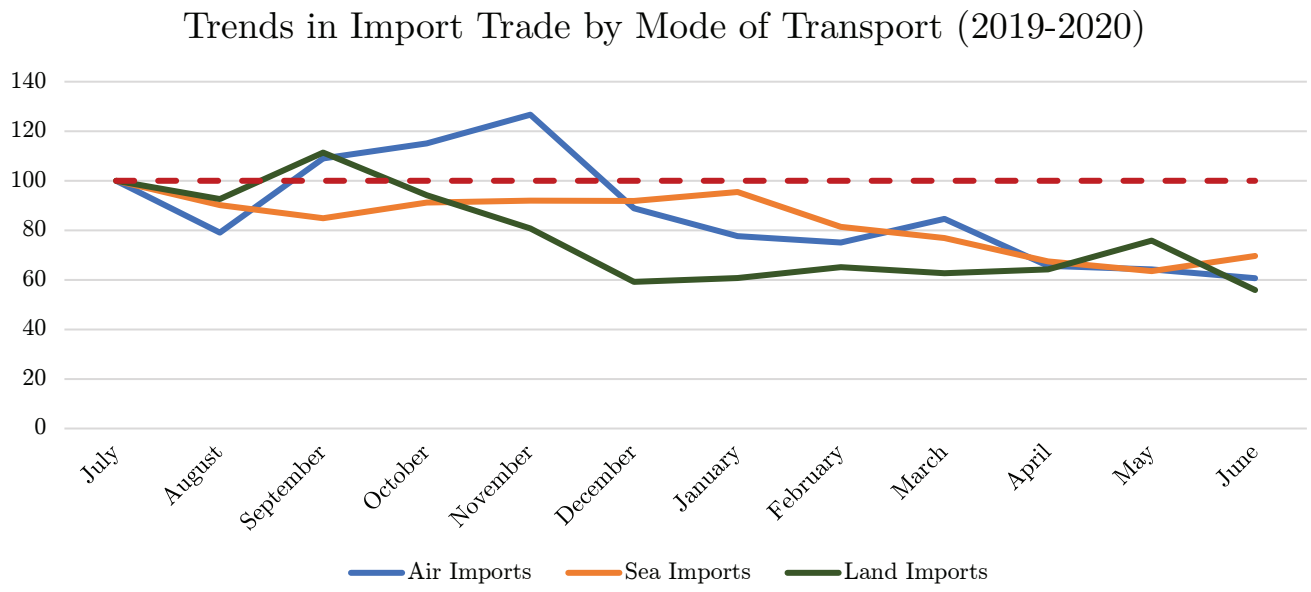

Figure A.3: Relative change in import trade by mode of transport

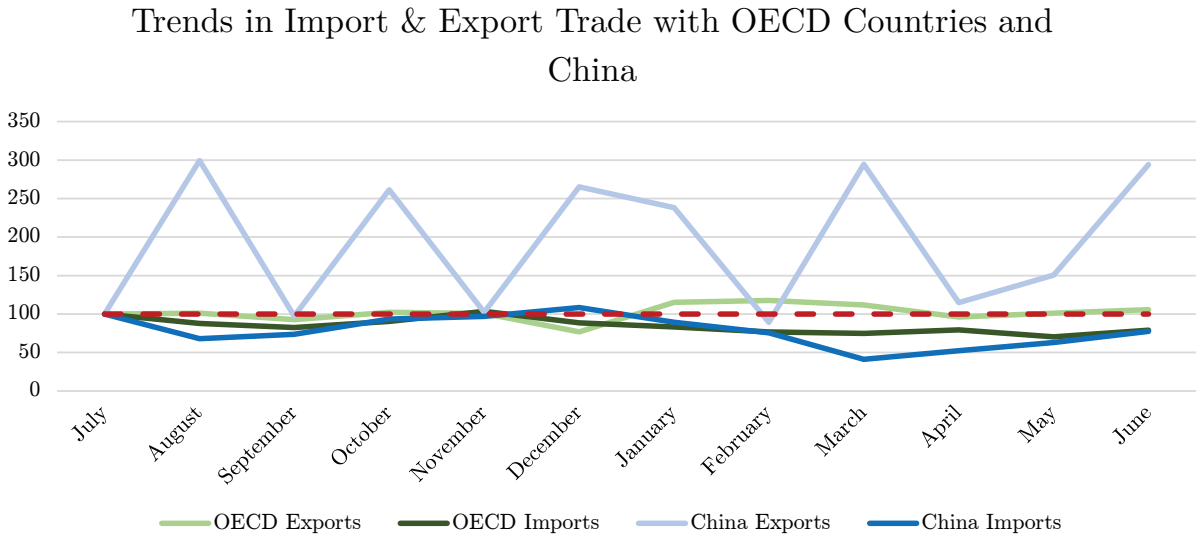

Figure A.4: Import and export trade with China and OECD countries

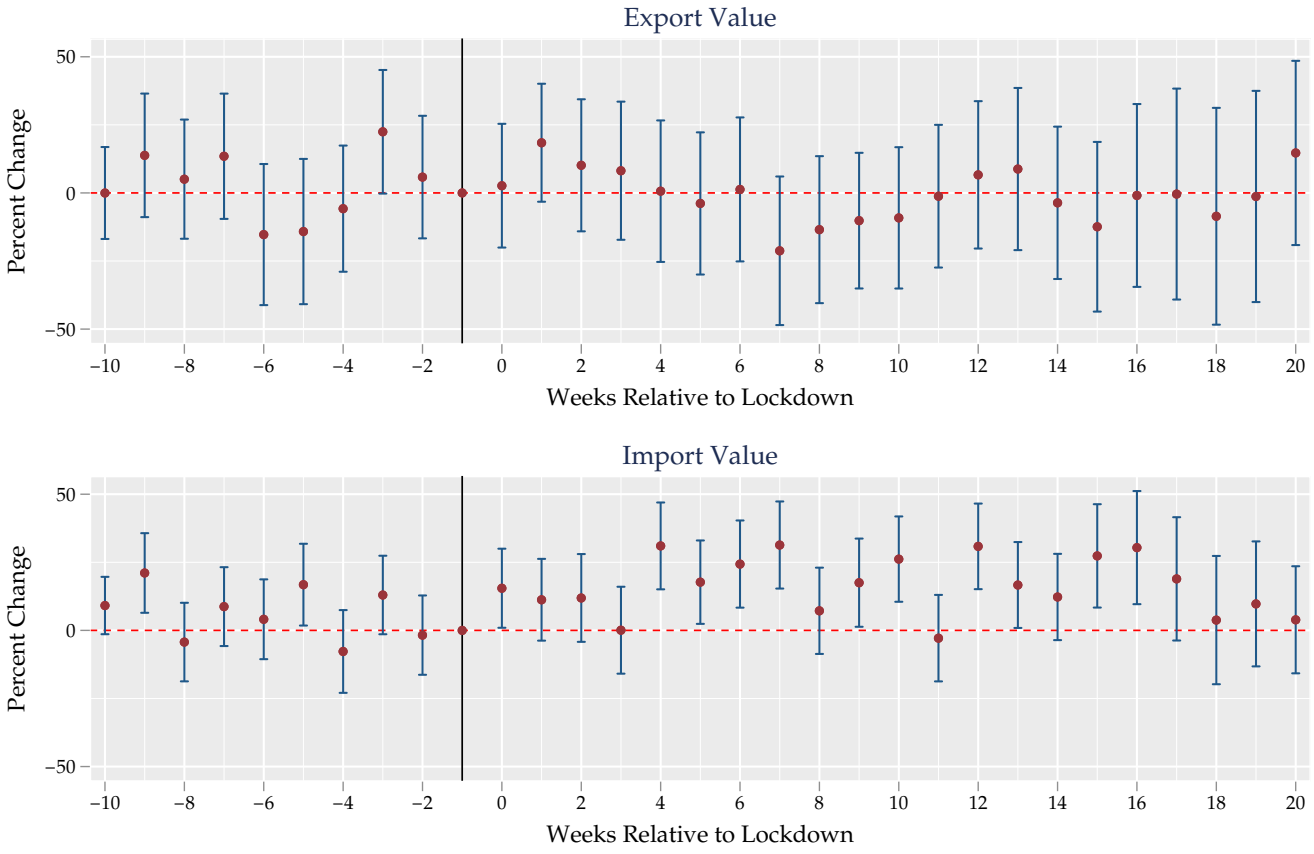

Figure A.5: Relative change of trade with OECD countries

Notes: The red dots indicate the regression coefficients for the event-time dummies, and the spikes indicate their 95% confidence interval bands. The coefficients are transformed to reflect percentage change in trade associated with the lockdown event dummies.

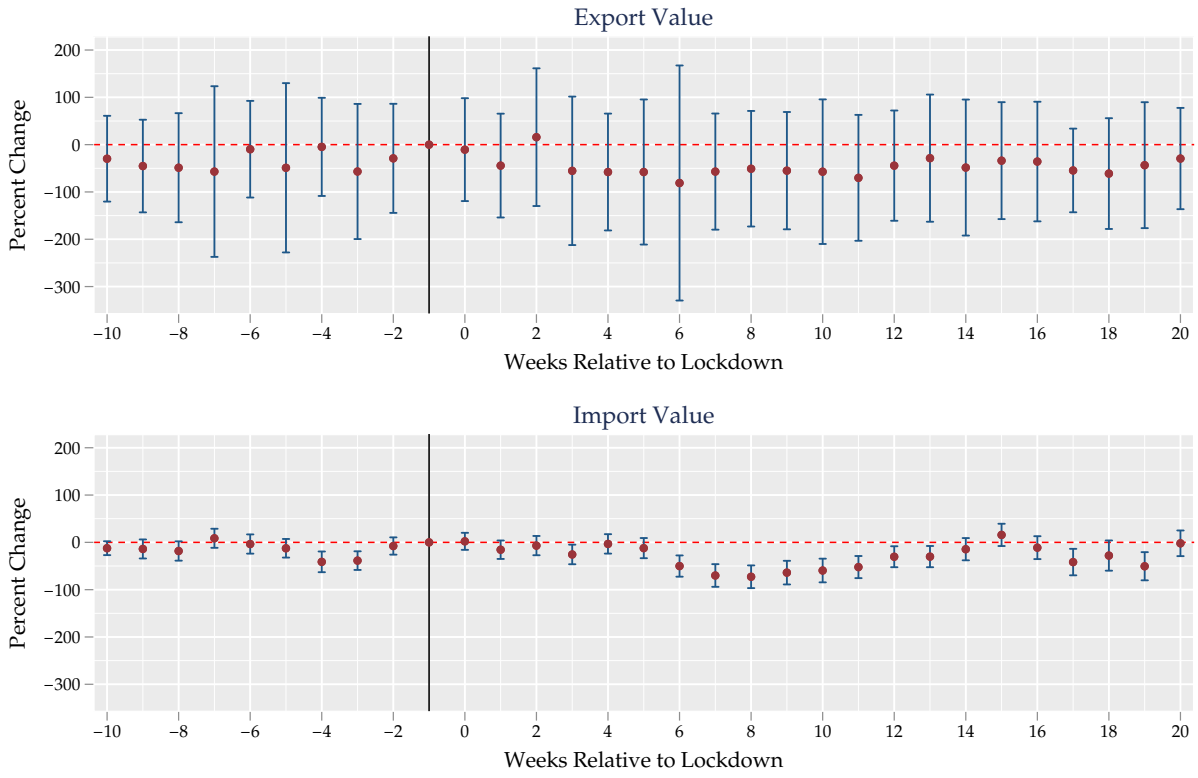

Figure A.6: Relative change of trade with China

Notes: The red dots indicate the regression coefficients for the event-time dummies, and the spikes indicate their 95% confidence interval bands. The coefficients are transformed to reflect percentage change in trade associated with the lockdown event dummies.

Acknowledgements

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