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TRADE IN THE TIME OF COVID-19: AN EMPIRICAL ANALYSIS BASED ON ITALIAN DATA

by Gianmarco Cariola*

Abstract

This study aims to analyze the impact of the COVID-19 pandemic on international trade. To do so, we used a new panel database that included information on imports and exports at the firm, product, country, year, and month level for the entire population of Italian trading firms. We merged it with additional data sources that provided further details on the characteristics of firms and on the lockdown stringency and death rate of COVID-19, both in foreign countries and Italian provinces. After presenting a descriptive analysis, we identified how the pandemic in foreign countries affected Italian firms' international trade; our results suggest that the impact on imports and exports was significant during the first wave, mainly driven by the stringency of the restrictions rather than by the death rate of COVID-19. Second, we analyzed how the local containment policies implemented by the Italian authorities affected trade flows and found that their effect was not significant. Finally, we showed that the varieties that were traded less intensively had a higher probability of being dropped in the aftermath of the COVID-19 crisis and those that were displaced in 2020 had a higher probability of not being traded one year later. This suggests that the pandemic affected the set of varieties traded by Italian firms and that its effects on the composition of imports and exports might be non-transitory.

JEL Classification: D22, F14, I10.
Keywords: trade, global value chains, COVID-19, Italian customs data.
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Contents

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1 Introduction[1]

The COVID-19 pandemic represented a massive shock to the global economy. According to the IMF (2021), the world GDP decreased by 3.1%. The Euro area experienced a sharper contraction than the global average (6.1%), and Italy was one of the most severely affected countries, with a year-on-year decrease of 8.9%. The Italian GDP collapse was more pronounced during the first and second quarter of the year (-6.3 and -17.8% respectively); as a comparison, the GDP decrease during the first and second quarter 2009, immediately after the Great Financial Collapse, was equal to -7,2 and -6,8%, respectively.

The pandemic had a disruptive impact on international trade as well: according to the WTO (2021), global exports declined by 7.6% in 2020, and the Italian economy was again one of the most severely hit markets, with a 10.4% drop in the aggregate value of trade followed by a relatively quick recovery.

In principle, the impact of COVID-19 on international trade could be driven by several different mechanisms. On the one hand, trade may have been negatively affected by demand-side disruptions due to either government policies, which restricted people's mobility, or voluntary social distancing, i.e. consumers avoiding crowded places that might increase the probability of contagion (IMF, 2020 and Buono and Conteduca, 2023). Additionally, there is evidence that the spread of COVID-19 was associated with a high degree of uncertainty about the future developments of the pandemic, the extent of the government interventions and the short and long-run effects on the economy (Altig et al., 2020), and this led a significant amount of European consumers to reduce their consumption expenditure (ECB, 2022).

On the other hand, trade could have been disrupted by negative supply shocks due to either the COVID-19 disease itself, which prevented the workforce from showing up at work and caused the temporary closure of many businesses, or the social distancing and lockdown policies implemented by many governments to face the spread of the virus, which restricted people's mobility and the activities of some industries (Baldwin and Tomiura, 2020). Another supply shock, especially when it comes to manufacturing, might have been firms in less affected nations encountering difficulties in sourcing inputs from hard-hit nations, and subsequently from each other, which would confirm that the shock propagated along Global Value Chains (GVCs) and had an impact on those firms that were indirectly exposed to it through their suppliers.

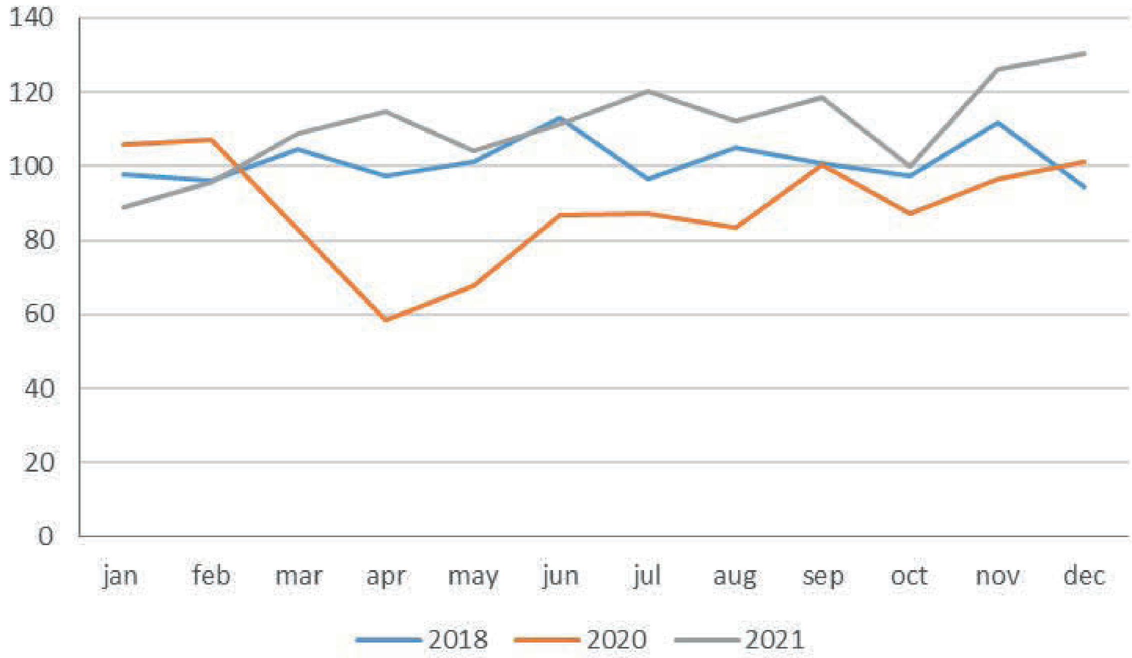
Quantifying the importance of the different mechanisms through which COVID-19 affected international trade is extremely relevant from a policy perspective, because it can help to disentangle the loss of import and export growth associated on the one hand with the spread of the virus, on the other hand with lockdowns and other social distancing policies. In a global health crisis policy-makers have a relatively broad menu of policy options to contain the pandemic, and they might be interested in understanding how the degree of policy restrictiveness affects international trade and, more in general, the economy.

At the same time, in a long-run perspective, a crucial issue is whether this shock was just temporary or we can expect it to have permanent effects on the set of varieties that Italian firms import and export. From a microeconomic perspective, the answer to this question relies on how traders adjusted to the shock: the hysteresis argument (Baldwin and Krugman, 1989) suggests that transitory shocks might have permanent effects on international trade if firms are displaced from certain markets and are not able to enter again because of fixed entry costs.

Italy is an extraordinary laboratory to study the trade impacts of COVID-19 for at least two reasons. First, it was the first European country to face the spread of the virus, and the trend of exports and imports in 2020 closely reflected the severity of the pandemic, as shown in Figure 1. In April 2020, when the first wave

[1] I would like to thank Richard Baldwin for his extremely valuable supervision and advice, Andrea Linarello for helping me to access the Italian customs data, and Antonio Accetturo, Giuseppe Albanese, Guglielmo Barone, Julia Cajal-Grossi, Francesco Paolo Conteduca, Marco Gallo, Claire Giordano, Andrea Lamorgese, Michele Mancini, Gianmarco Ottaviano, Marcello Pagnini, two anonymous referees and all the participants to the research seminars at the Bank of Italy, Geneva Graduate Institute and Paris School of Economics for their useful comments. The views expressed in this paper are those of the author and do not necessarily reflect those of the Bank of Italy.

Figure 1: Trade (imports+exports) by year & month (2019=100). Source: author's elaboration from the data of the Italian Customs and Monopolies Agency



of COVID-19 reached its peak in Western Europe, the value of Italian trade, defined as the sum of aggregate imports and exports, decreased by approximately 40% compared to one year before.

Secondly, Italy is a relatively open economy: according to the OECD[2], gross exports and imports respectively accounted for 32 and 28 per cent of the Italian GDP in 2019, and the Italian manufacturing sector is relatively large compared to other advanced economies, accounting for 16.6 per cent of the domestic value added[3].

In this paper, we use a novel firm-level database covering the universe of the Italian import and export transactions in order to study the impact of the COVID-19 pandemic on international trade. we preliminarily decompose the adjustment to the shock into three different margins: the extensive margin, which accounts for the net contribution of firms' entry and exit in/from foreign markets; the intensive margin, which captures the variation in the exported/imported value of those varieties (product $\times$ destination) that firms continue trading; and the sub-extensive margin, which captures the change in the set of exported/imported varieties by continuing traders. We show that: 1) the adjustment during the second quarter of 2020 was largely led by the extensive and sub-extensive margins, that accounted for approximately 16% and 36% of the collapse in exports and 15% and 32% of the collapse in imports; 2) the intensive margin accounted for a larger part of the variation during the recovery; 3) this asymmetry was more pronounced for the product-destination couples that accounted for a smaller share of imports or exports before 2020. In other words, firms reacted to the pandemic by dropping their marginal products and/or destinations and recovered by increasing the exports and imports of the varieties that survived the shock.

Second, we merge customs data with the Oxford COVID-19 Government Response Tracker to investigate the effects of the stringency of the restrictions and the death rate of COVID-19 on the growth rate of imports and exports. We find that the stringency index had a significantly negative impact on import and export growth, while the impact of the death rate appears to be negligible, and we show that the effect was limited

[2]The OECD Trade in goods and services tool is available here: https://data.oecd.org/trade/trade-in-goods-and-services.htm (accessed on January 15, 2023)

[3]https://data.oecd.org/natincome/value-added-by-activity.htm, accessed on January 15, 2023

to the period of the first wave (January-October 2020).
Third, we analyze the trade impact of the locally differentiated domestic policies implemented by the Italian government since November 2020 by merging the customs data with an index of policy restrictiveness at the local level (Conteduca and Borin, 2022) as well as the local death rate of COVID-19. Consistently with the previous results for foreign countries, we find that the trade effects of local restrictions during the second and third waves were not significant.
Finally, building on the aggregate evidence provided by the margins decomposition, we study the mechanics of the adjustment from a microeconomic perspective, and we investigate its potential long-run implications. To do so, we employ a linear probability model to show that after controlling for firm-specific, time-invariant unobservables and foreign, time-varying and product-specific demand shocks, the varieties that displayed a smaller trade value before the pandemic had a higher probability of being dropped in the aftermath of the shock. On the other hand, we show that the varieties that were dropped in 2020 had a higher probability of not being traded in 2021, meaning that the pandemic might have changed the composition of the import and export portfolio of Italian firms.
Our work is nested in a recent and fast growing stream of papers that analyze the impact of COVID-19 on international trade using either product or firm-level data. For example, Hayakawa and Mukunoki (2021) investigate how the effects of COVID-19 on international trade changed over time using monthly data from the Global Trade Atlas for 34 reporting economies. Consistently with the evidence we provide in this paper, they show that the impact of the pandemic becomes non significant starting from the second wave. Espitia et al. (2022) enrich the standard gravity framework by studying the heterogeneous impact of COVID-19 across sectors and find that sectors where working from home is easier were less impacted by the supply shock associated with the pandemic. Berthou and Stumpner (2022) use the information provided by the Trade Data Monitor and find evidence that lockdowns implemented by governments around the world had a direct negative impact on trade as well as an indirect impact through GVCs. Similarly, Kejzar et al. (2022) find evidence that the shock propagated through indirect linkages using aggregate GVC indices from the Eora Multi-Region Input–Output tables[4].
There are also a few studies that investigate various aspects of the impact of the pandemic on international trade using firm-level data. Lafrogne-Joussier, Martin and Mejean (2022) exploit the differences in the exposure of French firms to Chinese inputs to build a diff-in-diff framework where the early lockdown in China is used as a quasi-natural experiment, finding that firms that were exposed to the shock not only imported less than the firms in the control group but also decreased their domestic and foreign sales. This finding is consistent with the idea that the pandemic generated a supply shock, which we also find in our regression analysis. On the other hand, the results we provide in this paper are more general because 1) we select a larger set of trading partners and 2) we consider both the demand and supply shocks associated with COVID-19. Bricongne et al. (2022) also employ French customs data to investigate how different firms reacted to common shocks during the COVID-19 pandemic and the Global Financial Crisis, focusing on top exporters and finding that the pre-crisis export value influences the mechanics of the adjustment[5].
The firm-level heterogeneity of the adjustment to the COVID-19 shock is a key issue also in our study, but, differently from Bricongne et al. (2022), we focus more on within-firm, variety-specific heterogeneity: section 3 performs two separate margin decompositions depending on the pre-pandemic relative importance of the trade flows, and shows that less intensively traded varieties were more easily dropped; moreover, in section 5 we identify impact of the pre-pandemic value of exports on the probability of firms shrinking their

[4]On the other hand, when it comes to GVC bottlenecks, a more recent paper by Hassan (2023) provides microeconomic evidence that the firms that experienced more difficulties in sourcing the desired amount of inputs were the ones that grew the most.

[5]Specifically, Bricongne et al. (2022) show that the largest exporters contributed to the export collapse disproportionately more than their pre-crisis export share.

export and import portfolios.

The existing paper which is closest to mine is Brussevich, Papageorgiou and Wibaux (2022), where the French customs data are employed to decompose the aggregate trade adjustment into the intensive, extensive and sub-extensive margins and to assess the impact of COVID-19 on the mid-point growth rates of imports and exports, which is similar to what we present in sections 3.3 and 3.4. Nevertheless, our contribution departs from their analysis in several different ways, as we study the differential impact of the pandemic across three different waves of COVID-19 in 2020 and 2021, we analyze the impact of domestic restrictions on trade and investigate the potential permanent effects of COVID-19 on the set of varieties that Italian firms trade.

This paper is organized as follows. Section 2 describes the data used in the analysis. Section 3 decomposes the aggregate adjustment to the shock into the intensive, extensive, and subextensive margins of trade. Section 4 describes the econometric methodology and investigates the effects of the pandemic in foreign countries on international trade as well as the impact of territorially differentiated containment measures implemented by the Italian government starting from November 2020. Section 5 analyzes the mechanics of the drop of varieties following the COVID-19 crisis and provides preliminary evidence that the shock might have permanent effects on the imports and exports of Italian firms. Section 6 concludes.

2 Data

In this study, we employ the customs data collected by the Italian Customs and Monopolies Agency (CMA), accessed through the Research Data Center of the Bank of Italy[6]. Italian firms are required to report to the CMA any transaction with extra-EU firms, indicating the date, value and quantity of product traded, the product at the Combined Nomenclature (CN) level, which comprises the Harmonized System (HS) subheading with further EU subdivisions, and the country of origin or destination. When it comes to intra-EU trade, Italian firms are required to report the import and export flows either monthly or quarterly depending on their total traded value[7]; either way, also the intra-EU data include information on the value and quantity of products traded, the product codes at the CN-level and the country of origin or destination.

In order to make the two datasets comparable, we aggregate them both at the firm-product-country-time (year and month) level, where the product codes are aggregated at the subheading level of the HS classification and the time span ranges between January 2017 and December 2021[8]. Since administrative data might be subject to reporting mistakes, we exclude all the products and firms that are observed only once throughout the database and trim export and import values below the 1st and above the 99th percentile for each HS chapter[9] (first two-digits of the CN code).

To proxy the severity of the pandemic shock, we employ the data of the Oxford COVID-19 Government Response Tracker (OxCGRT), which is described in Hale et al. (2021) and includes a large number of COVID-19 related indicators for nearly all countries in the world. Following Brussevich, Papageorgiou, and Wibaux (2022), we focus in particular on two indices: the (monthly average) stringency index, which is a synthetic measure of the stringency of the measures implemented by governments at each point in time, and

[6]The data employed in this paper are the same as in Allione and Giordano (2023), and they are consistent with the aggregate merchandise trade data provided by the Italian National Institute of Statistics (see Allione and Giordano, 2023, for further details on the data).

[7]In the period under analysis (2019-2021), firms are required to report their data monthly if the total value of trade is higher than a specific threshold in at least one of the four previous quarters; the threshold is equal to 50,000 euros for the exports of goods and 200,000 euros for imports; if this condition does not occur, firms are allowed to report their trade data quarterly, which happens in 3% of cases for imports and 2% for exports. In the following analysis, whenever intra-EU trade flows are reported quarterly and the above-mentioned conditions are met, we divide the quarterly trade flow by three and impute it to each month.

[8]The following sections will mainly focus on the period between January 2019 and June 2021, which covers the first three waves of the COVID-19 pandemic in Italy.

[9]The dropped trade flows represent approximately 3% of the total value of trade in the period under analysis.

Table 1: Summary statistics

	Mean	**Median**	**Std. Dev.**	**N**
Export value	38,842	1,275	850,506	43,285,477
Import value	38,284	1,140	1,874,575	41,888,693
International death rate (OxCGRT)	0.0030	0.0363	0.0820	3,312
International stringency (OxCGRT)	0.5197	0.5519	0.2485	3,330
Domestic death rate (C-B)	0.0994	0.0389	0.1343	1,819
Domestic stringency (C-B)	0.6025	0.6362	0.1615	1,819

Note: Export and import flows are expressed in thousands of euros and the level of aggregation is firm-product-country-year-month, where products are aggregated at the 6-digit level of the CN classification and the time span goes from January 2019 to June 2021. The international stringency and death rate indices come from the OxCGRT database (Hale et al., 2021), aggregated at the country-month level. Domestic death rate and stringency come from Conteduca and Borin (2022), aggregated at the province-month level and available starting from November 2020.

the monthly death rate of COVID-19 by country.

These two measures convey two different information: the death rate is an index of the severity of the COVID-19 pandemic, while the stringency index measures the *de iure* restrictiveness of the government's measures in response to COVID-19. Intuitively, two countries (for instance, Italy and the United Kingdom) might have a similar death rate of COVID-19, but their governments could react in very different ways depending on their political preferences. The two indicators are indeed correlated although not perfectly (0.25)[10].

Based on the OxCGRT database, Conteduca and Borin (2022) produced an analogous index that measures the restrictiveness of policies in Italy starting from the beginning of the pandemic; the Italian government started to locally differentiate containment policies especially after November 2020, when the so-called "color system" was implemented allowing for different levels of restrictiveness depending on the local severity of the pandemic. To identify the impact of local restrictions on the imports and exports of Italian firms, we merge the dataset produced by Conteduca and Borin (2022)[11] with customs data after extracting the geographical location[12] of firms from the CERVED dataset, which covers the universe of Italian corporations. The firms included in CERVED are a subset of Italian importing and exporting firms, but the sample is relatively large, covering 92% of the total value of imports and 93% of the total value of exports in 2019-2021.

3 Descriptives

Table 1 displays the mean, median, standard deviation and number of observations of trade (both import and export values at the firm-product-country-year-month level of aggregation), the death rate and stringency indices in foreign countries at the country-year-month level from OxCGRT, the Italian death rate and stringency indices from Conteduca and Borin (2022) at the province-year-month level.

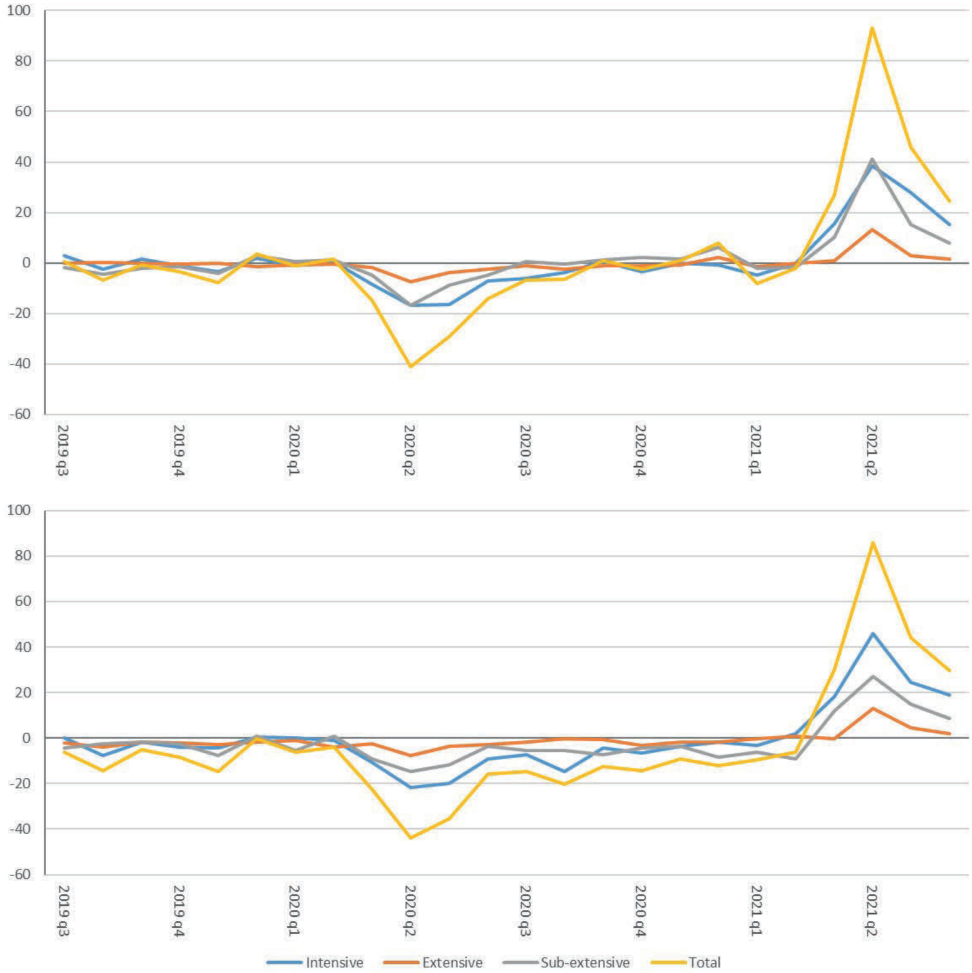
Trade flows are relatively skewed: the median export value is equal to 1.3 million euros, but the first decile of the distribution of monthly export flows is equal to 50 thousand euros and the ninth decile is equal to 44.3 million euros; similarly, the median import value is equal to 1.1 million euros, but the first decile of the distribution is equal to 48 thousand euros and the ninth decile to 40.4 million euros.

[10] Governments react to the evolution of health indicators by adopting measures whose restrictiveness also reflects policy-makers' preferences (among other things). On the other hand, the epidemic indicators follow the adoption of NPIs with some lags (see Marchetti et al., 2022). On top of that, similar policies may produce different effects across countries, depending on the demographic characteristics, readiness of the healthcare, and compliance to the social distancing.

[11] Available at https://www.dropbox.com/sh/s6j0eb12ipsomc4/AAAfAeoAJch9Nf8pBUlrfBNma?dl=0. The link was retrieved on December 29, 2022

[12] The geographical location is based on the place where the firm operates ("sede operativa").

Figure 2: Decomposition of export (upper panel) and import (lower panel) adjustments based on Gopinath & Neiman (2014)



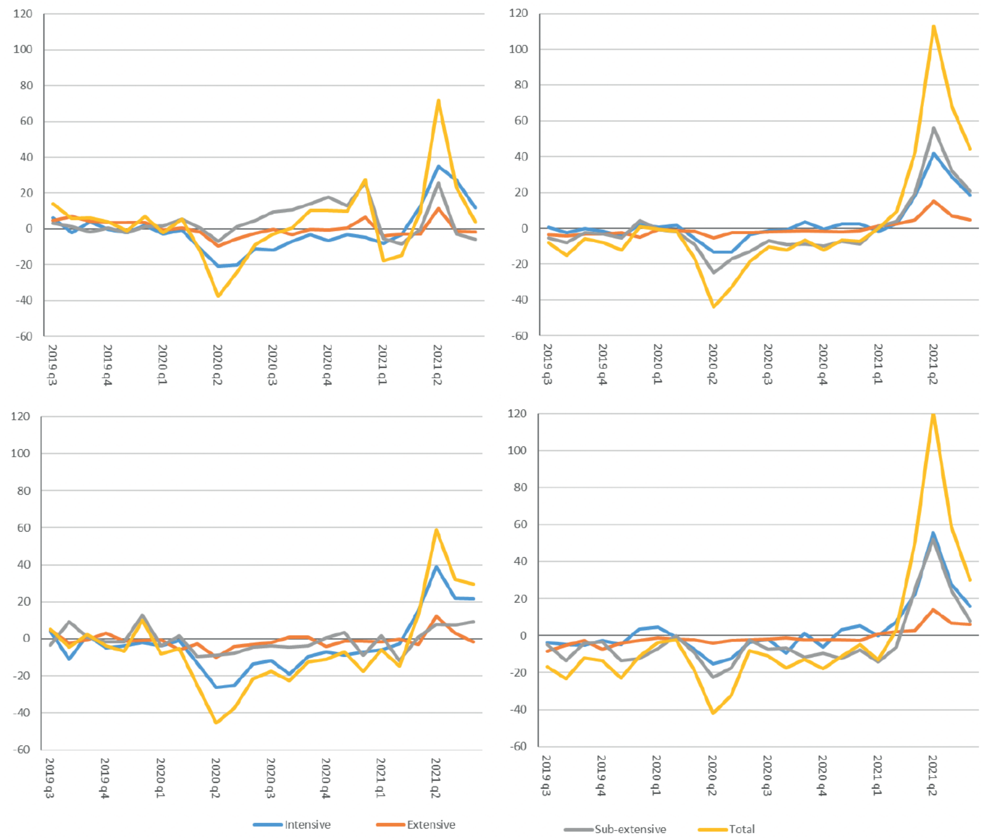
The pronounced heterogeneity of trade values is an important characteristic to consider when it comes to the nature of the adjustment to the COVID-19 shock and its potential long-run repercussions. To have a systematic understanding of this issue, we decompose the year-on-year aggregate growth rate of trade into the intensive, extensive and sub-extensive margins. Following Gopinath and Neiman (2014) and Brussevich et al. (2022), the adjustment[13] on the intensive margin has to do with those firms that continue exporting (importing) a variety (product x destination) but adapt their exported (imported) value, the extensive margin is about firms stopping exporting (importing) all varieties, while the sub-extensive margin has to do with firms continuing exporting (importing) but changing their set of exported (imported) varieties. Formally, each margin's contribution to aggregate trade adjustment can be expressed as follows:

$$\frac{\Delta v_t}{v_{t-12}} = \left(\sum_{j \in \Phi_{t-12} \cap \Phi_t} \frac{v_{j,t} - v_{j,t-12}}{v_{j,t-12}} \right) + \left(\sum_{j \in \Phi_t, j \notin \Phi_{t-12}} \frac{v_{j,t}}{v_{t-12}} - \sum_{j \notin \Phi_t, j \in \Phi_{t-12}} \frac{v_{j,t}}{v_{t-12}} \right) + \left(\sum_{i \in \Psi_t, i \notin \Psi_{t-12}} \frac{v_{i,t}}{v_{t-1}} - \sum_{i \notin \Psi_t, i \in \Psi_{t-12}} \frac{v_{i,t}}{v_{t-12}} \right) \tag{1}$$

where v is the trade flow, the subscript i indicates the variety (product x destination), j indicates the firm-

[13]A similar exercise for the Italian economy in 2000-2015 can be found in Bugamelli, Linarello and Serafini (2019).

Figure 3: Decomposition of export (upper panels) and import (lower panels) adjustments by relative size: the left panels decompose the aggregate adjustement of the varieties (country x product) that represented at least 10% of the exports/imports of each firm in 2019, the right panels decompose the adjustment of the remaining varieties



variety combination, t the time (year-month), Φ_t is the set of all the firm-variety combinations in period t and Ψ_t is the set of exporting (importing) firms in period t. The first term of equation 1 represents the intensive margin, the second term represents the sub-extensive margin and the third term represents the extensive margin.

Figure 2 displays the results of the decomposition for the time period from June 2019 to June 2021 for exports (top panel) and imports (bottom panel). The yellow line shows the annual percentage change in aggregate trade (i.e. the left-hand side of equation 1), while the blue, orange, and gray lines represent the contribution of the intensive, extensive and sub-extensive margins, respectively, to the total variation. The drop in imports and exports was largely driven by the extensive and sub-extensive margins, respectively accounting for 16% and 36% of the collapse in exports and 15% and 32% of the collapse in imports during the second quarter of 2020[14]. For the remaining months of 2020 and the first semester of 2021, the recovery was primarily driven by the intensive margin, suggesting a reallocation toward the firm-product-country triples that were not displaced during the peak of the crisis. This implies that the COVID-19 shock may have a persistent effect on the structure of the Italian economy's export and import flows. Microeconomic evidence for this phenomenon is provided in Section 5.

Next, I repeat the analysis separately for the product-country couples that represented more than 10% of the exports or imports for each firm in 2019[15] (*core* varieties) and those that represented less than 10%

[14]Comparing this result to previous studies conducted using French data (in particular, Brussevich et al.), it appears that the role of the sub-extensive margin was more pronounced in Italy than in France. This might be due to the different structure of the two economies; for example, Italian manufacturing firms are, on average, smaller than French firms.

[15]The varieties that accounted for more than 10% of exports at the firm-level represented 37% of aggregate exports in 2019,

of the exports or imports for each firm in 2019. The results are shown in Figure 3. The adjustment to the COVID-19 shock for the non *core* varieties mainly took place through the extensive and sub-extensive margins, which accounted for 68% of the fall in exports and 62% in imports, while *core* varieties mainly adjusted along the intensive margin, which accounted for 74% of the change in exports and 62% in imports. These stylized facts are consistent with the hypothesis that the pandemic significantly increased the costs of accessing foreign markets, and, as a consequence, firms dropped the varieties that were less traded, as they were less likely to generate enough revenues to pay for the increased costs.

On the other hand, this differentiated dynamics might be explained by a composition effect, as different industries might be characterized by different product/country portfolios. Additional microeconomic evidence on the relationship between adjustments on the sub-extensive margin and the pre-pandemic value of trade will be provided in Section 5.

4 The direct impact of COVID-19 on firm-level trade

4.1 Methodology

To identify the direct impact of the COVID-19 pandemic in foreign countries on the international trade of Italian firms, we estimate the following equation for imports and exports separately through OLS:

$$y_{ipct} = \beta_1 Stringency_{ct} + \beta_2 Death_{ct} + \alpha_{ip} + \gamma_{pt} + \delta_c + \epsilon_{ipct} \qquad (2)$$

where the subscript i indicates the firm, p indicates the product at the 6-digit level of the CN classification, c is the country of origin or destination and t is time (year & month). Following Brussevich et al. (2022), since a non-negligible part of the adjustment took place through the extensive and sub-extensive margins, the dependent variable is the monthly year-on-year mid-point growth rate, defined as follows:

$$y_{ipct} = \frac{v_{ipct} - v_{ipc(t-12)}}{\frac{1}{2}(v_{ipct} + v_{ipc(t-12)})} \qquad (3)$$

Mid-point growth rates are bounded by construction between -2 and 2, where -2 means that a previously exported variety is dropped and 2 means that a new variety is introduced: the bounds identify the extensive and sub-extensive margins of trade, while any mid-point growth rate between -2 and 2 falls into the intensive margin.

The two variables of interest are *Stringency*, i.e. the monthly average OxCGRT index of policy restrictiveness at the origin or destination country level, and *Death*, the monthly death rate of COVID-19. These regressors are expected to have a negative impact on the growth rates of both imports and exports but for different reasons. When it comes to exports, an increase in the severity of the pandemic (*Death*) or the degree of policy restrictiveness (*Stringency*) in destination countries is expected to affect the growth rate of exports, other things being equal, through a decrease in foreign demand: the set of foreign consumers is temporarily reduced and consumers change their consumption patterns either because of government restrictions or because of voluntary social distancing associated with the spread of the virus (Buono and Conteduca, 2023). The shock to the growth rate of imports, on the other hand, mainly occurs because the pandemic has a negative effect on the supply side both directly (the disease temporarily reduces the labor supply) and indirectly through containment and social distancing measures (Baldwin and Tomiura, 2020); as a consequence of these shocks, domestic firms find it more difficult to source inputs from foreign markets that are hit by COVID-19. In practice, given the pandemic situation in the area where the exporting/importing firm is located, the negative impact of the stringency index and the death rate of COVID-19

while the varieties that accounted for more than 10% of imports at the firm-level represented 49% of aggregate imports.

in destination/origin country i should be interpreted as a demand shock for exports, as a supply shocks for imports.

Equation 2 includes firm-product Fixed Effects (FEs) α_{ip} in order to account for firm and product specific productivity shocks (including the severity of the pandemic in the area where the firm is located), product-time FEs γ_{pt} to control for product specific demand shocks that changed over time during the pandemic and are common across firms (for example, the demand for pharmaceutical products, face masks and hand sanitizers strongly increased because of the deteriorating healthcare situation) and country FEs δ_c to control for time invariant country characteristics, like gravity variables (distance, language, cultural proximity and so on) and the quality of the institutions, that might affect the reporting of the COVID-related data. For the same reason, and to account for the correlation among observations within the same country (*Stringency* and *Death* are defined at the country-time level, while the dependent variable also varies along the firm-product dimensions) the standard errors are clustered at the origin/destination country level. An alternative specification, the results of which are displayed in Appendix I, includes firm-product-time and country Fixed Effects to account for time-varying firm and product-specific unobservables. The results do not change when this set of FEs is employed.

Using the mid-point growth rate of imports and exports as a dependent variable has the non-negligible advantage of taking into account the impact of the pandemic on both the intensive and the extensive and sub-extensive margins. Appendix III sheds further light on the mechanics of the adjustment by re-running equation 2 using the subset of trade flows that are positive both in the initial and final period (which proxies for the intensive margin) and regressing either the log number of products traded within continuing destinations or the number of destinations served for each product, which capture two different mechanisms through which the adjustment along the sub-extensive margin might occur (see Appendix III for further methodological details).

When it comes to the the impact of the domestic containment measures implemented by the Italian authorities at the local level starting from November 2020, the specification is the following:

$$y_{ipct} = \beta_1 Stringency_{Pt} + \beta_2 Death_{Pt} + \alpha_{cpt} + \delta_i + \epsilon_{ipct} \tag{4}$$

Where P indicates the province, *Stringency* is the Borin-Conteduca monthly average index of restrictiveness and *Death* is the monthly death rate of COVID-19, both at the province level. The set of FEs includes country-product-time and firm FEs, which respectively control for foreign time-varying and product-specific shocks (for instance, the severity of the pandemic in the country of origin or destination) and firm-specific time-invariant characteristics.

The main difference between the analysis in equations 2 and 4, other than the set of Fixed Effects employed, is that the OxCGRT index employed in equation 2 covers the whole period of the pandemic starting from the beginning of 2020, while the domestic stringency index is characterized by a systematic variation across provinces (which is essential to identify equation 4) starting from November 2020, when the Italian government began to locally differentiate the restrictiveness of containment policies[16].

For this reason, equation 2 is estimated both for the whole period under analysis (January 2020-June 2021) and for two sub-periods, roughly corresponding to the first (January-October 2020) and second and third waves (November 2020 - June 2021) of COVID-19 in Italy. Splitting the sample is useful not only to make equations 2 and 4 more comparable but also to check if the impact of the pandemic on international trade changed over time (Hayakawa and Mukunoki, 2021), which actually appears to be the case.

[16]On the contrary, data on the local death rate of COVID-19 are available starting from January 2020. Appendix IV displays the results of a specification which is identical to equation 4, but the only regressor is the death rate of COVID-19 and the observations relate to January-October 2020.

4.2 Baseline results

The results of the estimation of equation 2 are reported in Table 2[17]. The dependent variables are the mid-point growth rate of exports (upper section of the table) and imports (lower section), as defined in equation 3. Columns (1) to (3) report the regression results for the overall period of interest, while columns (4) to (6) report the results for the initial months of the pandemic, corresponding to the first wave of COVID-19 in Italy (January–October 2020), and columns (7) to (9) report the results for the second and third waves (November 2020–June 2021)[18].

These results convey two distinct pieces of information.

First, the impact of the pandemic on both imports and exports appears to be driven by the stringency of containment measures rather than the death rate of COVID-19, meaning that policy restrictions were more relevant for the slowdown in international trade than the severity of the pandemic itself[19].

Second, the results in Table 2 suggest that such negative effect was mainly concentrated during the first months of the pandemic, consistent with the aggregate evidence in Figure 1. There are several possible explanations for this phenomenon. For example, the shock could have been unexpected at the beginning, and it could have been characterized by a higher degree of uncertainty about the future developments of the pandemic, the likelihood of developing vaccines and the severity of the disease itself, as masks and other personal protective equipment were harder to find in early 2020. This could have implied a greater deterioration of expectations and foreign demand (which explains the negative impact on exports) and greater difficulties in the organization of production and transportation (which influenced the availability of foreign inputs), as workers and firms were affected either by COVID-19 itself or by mobility and other policy restrictions (Espitia et al., 2022). An alternative explanation is that the index of restrictiveness was reliable at the beginning of the pandemic, when policy restrictions were tougher and nationally implemented, but became less precise in a later stage of the pandemic because many governments started to locally differentiate the containment policies, these restrictions mainly concerned services (that are less tradeable than manufacturing) and were less stringent in terms of people's mobility. A further explanation, which is also coherent with the aggregate evidence presented in Figure 2, might be that firms dropped their marginal varieties at the beginning of the pandemic and did not have much room for further adjustment along the sub-extensive margin during the second and third waves.

When it comes to the size of the estimated effects, according to the coefficient in column (6) of Table 2, an increase of one standard deviation of the regressor *Stringency* would decrease the mid-point growth rate of exports and imports respectively by 0.0602 and 0.05560. This result is non-negligible because mid-point growth rates are bounded between -2 and 2.

Appendix III enriches the results presented in Table 2 by distinguishing the impact of the pandemic during the first wave that was channeled through the intensive margin and its impact through different mechanisms associated with the sub-extensive margin (namely the change in the number of traded products within each destination and the change in the number of destinations associated to each product). In line with the aggregate evidence provided by Section 3, it appears that the negative impact of the pandemic was mainly conveyed by the extensive and sub-extensive margins through the drop of previously traded products and, in particular, the exit from the destinations where the restrictions were stronger (Tables 12 and 13).The

[17]The results of estimating equation 2 with firm-product-time and country FEs are presented in Table 7 and are consistent with the evidence presented in Table 2.

[18]The size, sign and significance of the coefficients of *Stringency* and *Death* does not change much if one or both regressors are included, confirming that the two variables are not collinear.

[19]Tables 8, 9, and 10 in Appendix II repeat the analysis separately for three groups of countries, namely Advanced Economies, Emerging and Least Developed Economies exluding China and Emerging and Least Developed Economies including China. While the results for Advanced Economies are broadly comparable to those presented in Table 2, it must be noted that the death rate appears to have played a more significant role for Emerging Economies, especially for imports and during the first wave.

Table 2: Baseline results: foreign restrictions

		All			First wave			Second-third wave		
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Exports	Stringency	-0.24751***		-0.24209***	-0.23296***		-0.24223***	-0.14131		-0.06391
		(-3.84)		(-4.17)	(-4.18)		(-4.53)	(-1.04)		(-0.47)
	Death		-0.07006	-0.02609		-0.19217	-0.21269		-0.16748*	-0.15105*
			(-0.74)	(-0.30)		(-1.55)	(-1.80)		(-2.15)	(-2.12)
	N	22,987,602	22,987,553	22,987,553	11,300,289	11,300,267	11,300,267	11,481,887	11,481,861	11,481,861
	R^2	0.16776	0.16765	0.16776	0.21904	0.21897	0.21908	0.22053	0.22058	0.22058
Imports	Stringency	-0.21662**		-0.21115**	-0.21178***		-0.22513***	-0.14584		-0.05478
		(-2.87)		(-3.12)	(-3.64)		(-3.94)	(-0.97)		(-0.35)
	Death		-0.06210	-0.02765		-0.19191	-0.21765		-0.19045*	-0.17692*
			(-0.63)	(-0.30)		(-1.50)	(-1.76)		(-2.39)	(-2.33)
	N	22,215,507	22,155,070	22,215,507	10,931,204	10,931,204	10,931,204	11,087,752	11,087,752	11,087,752
	R^2	0.17011	0.17003	0.17011	0.22277	0.22272	0.22281	0.22393	0.22399	0.22399

Note: *** if $p \leq 0.01$; ** if $p \leq 0.05$; * if $p \leq 0.1$. Columns (1) to (3) report the regression results for the overall period of interest (January 2020 - June 2021), columns (4) to (6) report the results for the initial months of the pandemic, corresponding to the first wave of COVID-19 in Italy (January - October 2020) and columns (7) to (9) report the results for the second and third wave (November 2020 - June 2021). The t statistics are reported between brackets and the standard errors are clustered by origin/destination country. All regressions include firm-product, product-time and country fixed effects.

Table 3: Baseline results: domestic restrictions

	Exports			Imports		
	(1)	(2)	(3)	(4)	(5)	(6)
Stringency	0.00039		0.00051	0.00022		0.00031
	(0.35)		(0.37)	(0.19)		(0.23)
Death		-0.00131	-0.00968		-0.00260	-0.00769
		(-0.04)	(-0.21)		(-0.07)	(-0.17)
N	7,434,648	7,434,648	7,434,648	7,220,198	7,220,198	7,220,198
R^2	0.17255	0.17255	0.17255	0.17325	0.17325	0.17325

Note: *** if p $\leq$ 0.01; ** if p$\leq$0.05; * if p$\leq$0.1. All regression results relate to the November 2020 - June 2021 period, columns (1) to (3) report the results for exports while columns (4) to (6) report the results for imports. The t statistics are reported between brackets and the standard errors are clustered by province. All regressions include country-product-time and firm fixed effects.

role of the intensive margin, on the other hand, was not significant (Table 11).

When it comes to the impact of the domestic policies implemented by the Italian authorities at the local level starting from November 2020, the results of the estimation of equation 4 are reported in Table 3. Again, the dependent variable is the mid-point growth rate of imports and exports, but *Stringency* is the Conteduca-Borin index of restrictiveness and *Death* is the death rate of COVID-19, both at the Italian province level. The coefficients are non significant across all specifications: this might sound contradictory with respect to the results reported in Table 2, but it must be stressed that the estimates in Table 3 only cover the second and third wave period, when the Italian authorities launched the so called "color system" of locally differentiated policies, and the coefficients for this time span were weakly or non significant also in Table 2. Again, this might be explained either by the nature of the restrictions, which did not limit manufacturing activities and allowed the mobility of workers, or by the idea that firms learnt to coexist with the pandemic after several months of experience[20].

5 Potential long-term effects

One of the main questions regarding the COVID-19 pandemic concerns its potential long-term effects. The traditional hysteresis argument (Baldwin and Krugman, 1989) suggests that macroeconomic shocks may have permanent effects on trade because importing and exporting are costly activities, and firms displaced from a foreign market because of a temporary shock might not be able to enter again. When it comes to COVID-19, the aggregate data (Figure 1) show that the downturn in the first half of 2020 was followed by a persistent recovery, which implies that the impact of the pandemic on the aggregate volume of trade was temporary. Nevertheless, there might have been non-transitory composition effects: Figure 2 shows that, at least at the aggregate level, firms mainly adjusted along the extensive and sub-extensive margin during the downturn, but mainly along the intensive margin during the recovery, suggesting that they might have dropped their marginal products and destinations as a consequence of the negative shock. At the same time, Figure 3 suggests that the adjustment on the sub-extensive margin mainly concerned relatively smaller trade flows, whereas larger export and import flows mainly adjusted along the intensive margin.

To formally test that less intensively traded varieties had a higher probability of exiting foreign markets conditional on firm characteristics and foreign demand shocks, we focus on those product-destination couples

[20] Appendix IV modifies the specification of equation 4 such that the only regressor is the death rate of COVID-19 and the observations relate to the first-wave period, when the stringency index did not vary significantly across provinces. The result is that local death rate had a non significant impact on the growth rate of both exports and imports.

Table 4: The probability of exiting foreign markets as a function of export size

	Exports		Imports	
	(1)	(2)	(3)	(4)
Log trade 2019	-0.06927***	-0.07081***	-0.06646***	-0.06874***
	(-95.79)	(-87.82)	(-77.32)	(-77.66)
Constant	0.42392***	0.35086***	0.44725***	0.39399***
	(8318.24)	(7027.04)	(12284.68)	(12008.51)
N	9,878,993	5,319,073	4,804,643	2,619,835
R^2	0.27353	0.28666	0.27406	0.28714

Note: *** if p $\leq$ 0.01; ** if p$\leq$0.05; * if p$\leq$0.1. All regression results relate to the January-December 2020 period; columns (1) and (2) report the results for exports while columns (3) and (4) report the results for imports. Columns (1) and (3) are based on the subset of firms that were already exporting or importing in 2019 and the time frequency is monthly, while columns (2) and (4) report the results obtained after aggregating the dataset at the quarterly level and including only the firms that exported or imported for at least three quarters each year between 2017 and 2019. The t statistics are reported between brackets and the standard errors are clustered by firm.

that were traded by firm i in month t of 2019 and run the following linear probability model:

$$OUT_{ipct}^{2020} = a + \beta ln\_v_{ipct}^{2019} + \alpha_i + \gamma_{cpt} + \epsilon_{ipct} \quad (5)$$

Where $OUT_{ipct}^{2020} = 1$ if firm i does not export (import) product p to (from) country c in month t of 2020 (but exported (imported) product p to (from) country c in 2019). The regressor of interest is $ln\_v_{ipct}^{2019}$, that is the (centered) log value of trade in 2019 at the firm-product-country-month level. Firm FEs α_i control for time-invariant firm characteristics (such as the sector, size, productivity and geographical location), while country-product-time FEs γ_{cpt} capture the impact of foreign demand shocks at the product-time level. To exclude firms that export and import only occasionally, we also run a robustness check where we aggregate the data at the quarterly level and retain only the firms that exported or imported for at least three quarters in 2018 and 2019. Moreover, as an alternative to the log of trade in 2019, we run a set of regressions in which the size of exports or imports at the firm-product-country-month level in 2019 is proxied by the quintile of the distribution of exports or imports in 2019. In all cases, results are robust across specifications.

The results of estimating equation 5 through OLS are reported in Table 4, where columns (1) and (3) are based on the sample of firm-product-month triples that were already present in 2019, while columns (2) and (4) report the results obtained after aggregating the dataset at the quarterly level and including only the firm-product-quarter triples that were observed for at least three quarters each year in 2018 and 2019.

The constant term, which is significant at the 1% level and whose value ranges between 0.35 and 0.45 across different specification, represents the probability that firm i stops exporting/importing product p to/from country c in month (quarter) t conditional on the time-invariant characteristics of the firm, the time varying foreign demand shocks and the value of (log) trade being equal to its average. The estimated coefficient β represents the semi-elasticity of the probability of exiting foreign markets with respect to the pre-pandemic trade value. With reference to the estimates in columns (1) and (3), which are relatively more conservative, it conveys the information that a 1 % increase in the value of trade at the firm-product-country level decreases the probability that firm i stops exporting (importing) product p to (from) country c by approximately 0.07 percentage points.

A similar picture emerges from Table 5, where the independent variable is the quintile of the distribution of the export/import values according to 2019 data. Here, the constant term represents the probability that firm i stops exporting/importing product p to/from country c in month (quarter) t if the variety

Table 5: The probability of exiting foreign markets as a function of export size (quintiles of exports in 2019)

	Exports		Imports	
	(1)	(2)	(3)	(4)
2nd quintile	-0.13018***	-0.15542***	-0.13010***	-0.14403***
	(-64.01)	(-77.28)	(-71.79)	(-78.19)
3rd	-0.23230***	-0.27642***	-0.22739***	-0.25683***
	(-96.65)	(-97.56)	(-95.64)	(-100.93)
4th	-0.34294***	-0.39027***	-0.33207***	-0.36923***
	(-112.95)	(-99.08)	(-92.28)	(-94.44)
5th	-0.46870***	-0.50134***	-0.47941***	-0.51591***
	(-103.52)	(-91.36)	(-84.26)	(-82.80)
Constant	0.65991***	0.61655***	0.68159***	0.65166***
	(321.78)	(236.96)	(285.54)	(245.20)
N	9,878,993	5,319,073	4,804,643	2,619,835
R^2	0.26711	0.28005	0.26634	0.27888

Note: *** if p $\leq$ 0.01; ** if p$\leq$0.05; * if p$\leq$0.1. All regression results relate to the January-December 2020 period; columns (1) and (2) report the results for exports while columns (3) and (4) report the results for imports. Columns (1) and (3) are based on the subset of firms that were already exporting or importing in 2019 and the time frequency is monthly, while columns (2) and (4) report the results obtained after aggregating the dataset at the quarterly level and including only the firms that exported or imported for at least three quarters each year between 2017 and 2019. The t statistics are reported between brackets and the standard errors are clustered by firm.

belongs to the first quintile of the size distribution, whereas the coefficients associated with higher quintiles are progressively more negative, confirming a negative impact of the size of the trade flow in 2019 on the probability of exit in 2020.

This size effect is consistent with the hypothesis that, in front of the increase in trade costs associated with the pandemic, importing and exporting firms dropped the varieties that were not profitable enough to pay for the increased cost of accessing foreign markets. This result resembles the evidence provided by Bernard, Redding and Schott (2011), which shows that the reaction of firms in the aftermath of an international trade shock is to drop their least successful products. Nevertheless, it must be noted that the driving force of variety selection is very different in this study: Bernard, Redding and Schott (2011) analyze the impact of increased competition following trade liberalization, whereas our analysis focuses on the increase in trade costs associated with the pandemic.

It must be noticed that the fact that less intensively traded varieties have a higher probability of exiting foreign markets is not specific of the COVID-19 pandemic. Table 15 in Appendix V replicates the analysis for 2018 and 2019 and finds negative coefficients for the size effect, which are not significantly different from the ones reported in Table 4. On the other hand, the uniqueness of the COVID-19 shock is due to its magnitude, which led to an increase in the adjustment along the sub-extensive margin (see Figure 3) and made this phenomenon more pervasive.

After establishing that less intensively traded varieties had a higher probability of being dropped, the next question is whether these adjustments were just temporary or might have long-term consequences on the import and export structure of the Italian economy. Of course, data on the trade impact of COVID-19 are still limited to 2020 and 2021, but they can already provide some preliminary information.

Our identification strategy relies again on a linear probability model that captures the impact of dropping

Table 6: The long-term effects of COVID-19

	Exports		Imports	
	(1)	(2)	(3)	(4)
Out 2020	0.35712***	0.40533***	0.37105***	0.41705***
	(158.64)	(208.50)	(166.95)	(202.55)
Constant	0.32593***	0.28126***	0.33095***	0.30123***
	(337.65)	(407.27)	(330.86)	(368.95)
N	5,9878,993	5,319,073	4,804,643	2,619,835
R^2	0.37390	0.42243	0.38648	0.42750

Note: *** if $p \leq 0.01$; ** if $p \leq 0.05$; * if $p \leq 0.1$. All regression results relate to the January 2020-December 2021 period; columns (1) and (2) report the results for exports while columns (3) and (4) report the results for imports. Columns (1) and (3) are based on the subset of firms that were already exporting or importing in 2019 and the time frequency is monthly, while columns (2) and (4) report the results obtained after aggregating the dataset at the quarterly level and including only the firms that exported for at least three quarters each year between 2017 and 2019. The t statistics are reported between brackets and the standard errors are clustered by firm.

a variety in 2020 on the probability of not trading that variety one year later[21][22]. Focusing on the subset of firm-product-country triples present in the database in 2019, we estimate the following equation through OLS:

$$OUT^{2021}_{ipct} = \beta_1 OUT^{2020}_{ipct} + \alpha_i + \gamma_{cpt} + \epsilon_{ipct} \tag{6}$$

where $OUT^{y}_{ipct} = 1$ if firm i does not export (import) product p to (from) country c in month t of year y (but exported (imported) product p to (from) country c in 2019). In other words, the estimation strategy relies on comparing the export status in 2021 of the varieties that were dropped in 2020 with those that were not dropped, conditional on those varieties being traded in 2019.

Again, to exclude occasional exporters and importers, we also run a robustness check where we aggregate the data at the quarterly level and keep only the firms that exported or imported for at least three quarters in 2017, 2018 and 2019. The set of Fixed Effects in equation 6 is analogous to that employed in equation 5, and the standard errors are clustered at the firm level.

The results are reported in Table 6. Columns (1) and (2) report the results for exports, whereas columns (3) and (4) report the results for imports. Columns (1) and (3) are based on the subset of firms that were already exporting or importing in 2019, and the observations are aggregated at the monthly level. Columns (2) and (4) report the results obtained after aggregating the dataset at the quarterly level and including only firms that exported for at least three quarters each year between 2017 and 2019. In all cases, the coefficient is significantly positive, meaning that firms that exited a foreign market or dropped a product within a market that they already covered in 2019 had a higher probability of not exporting or importing the same variety one year later. For instance, according to the specification in column (1), varieties exported in month t of 2019 but dropped in 2020 had a 36% higher probability of not being traded one year later than varieties that were not dropped, conditional on firm characteristics and foreign demand shocks. This result preliminarily suggests that the COVID-19 shock in 2020 might have had a non-transitory impact on the set of varieties that Italian firms trade, even if further research will be needed to assess to what extent this effect persisted beyond 2021.

[21] Differently from Section 4, where the time of the regressions was truncated in June, this analysis exploits 2021 data until December.

[22] Table 16 in Appendix V repeats the exercise to capture the impact of dropping a variety in 2018 on the probability of not trading that variety in 2019. The results are similar to the ones presented in table 6

6 Concluding remarks

This paper investigates the impact of the pandemic on trade using a novel panel database that contains detailed information on the international transactions of Italian firms.

We preliminarily decompose the aggregate adjustment to the shock into three margins, namely intensive, extensive and sub-extensive, and show that the extensive and sub-extensive margins accounted for a large part of the variation during the collapse in the second quarter of 2020, while the intensive margin was prevalent during the recovery.

We merge the trade data with the OxCGRT database, that contains information on the stringency of the restrictions and the death rate of COVID-19 for all countries in the world, and we perform a regression analysis where we find that the pandemic in foreign countries significantly and negatively impacted firm-level imports and exports, and that the impact was driven by the stringency of the containment measures rather than the death rate of COVID-19. Moreover, such negative effect on firm-level trade was mainly limited to the first wave of COVID-19 (approximately corresponding to the first three quarters of 2020) and was attenuated later, suggesting that individuals and firms adapted to the new environment after a few months.

We analyze the trade effects of the locally differentiated restrictions implemented by the Italian authorities since November 2020, and we find that they were not significant, as the restrictions mainly concerned the services sector (which is less tradeable than manufacturing) and the data on domestic restrictions relate to the second and third waves of the pandemic, when the impact of the shock was already mitigated.

Finally, we study how the pre-pandemic value of exports and imports of a variety affected the mechanics of the adjustment along the extensive and sub-extensive margins. To do so, we employ a linear probability model and we show that, after controlling for firm and importer-product-time FEs, less intensively traded varieties had a lower probability of surviving the shock, meaning that exporters and importers reacted to the increase in the trade costs by abandoning their marginal products and/or partner countries. On the other hand, we show that the varieties that were dropped in 2020 had a higher probability of not being traded in 2021. Putting together these two stylized facts, we provide preliminary evidence that COVID-19 influenced the structure of import and export flows at the firm-level, and that this effect might be non-temporary.

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Appendix I: baseline results with an alternative set of FEs

Table 7: Baseline results (foreign restrictions and death rate) with firm-product-time and country fixed effects

		All			First wave			Second-third wave		
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Exports	Stringency	-0.21571*		-0.20037*	-0.19392***		-0.20578***	-0.12500		-0.04755
		(-2.36)		(-2.53)	(-3.35)		(-3.72)	(-0.77)		(-0.28)
	Death		-0.11166	-0.07856		-0.21618	-0.23698*		-0.16438*	-0.15274*
			(-1.19)	(-0.96)		(-1.78)	(-1.98)		(-2.32)	(-2.33)
	N	19,688,032	19,687,990	19,687,990	9,758,634	9,758,614	9,758,614	9,929,398	9,929,376	9,929,376
	R^2	0.26723	0.26716	0.26724	0.26543	0.26540	0.26548	0.27181	0.27186	0.27186
Imports	Stringency	-0.21012*		-0.19295*	-0.16673**		-0.18125**	-0.13356		-0.04786
		(-2.16)		(-2.27)	(-2.68)		(-3.00)	(-0.80)		(-0.27)
	Death		-0.11641	-0.08566		-0.20794	-0.22930		-0.17550*	-0.16395*
			(-1.25)	(-1.06)		(-1.70)	(-1.88)		(-2.50)	(-2.42)
	N	18,920,972	18,920,972	18,920,972	9,386,808	9,386,808	9,386,808	9,534,153	9,534,153	9,534,153
	R^2	0.27204	0.27199	0.27206	0.27090	0.27089	0.27095	0.27682	0.27688	0.27688

Note: *** if $p \leq 0.01$; ** if $p \leq 0.05$; * if $p \leq 0.1$. Columns (1) to (3) report the regression results for the overall period of interest (January 2020 - June 2021), columns (4) to (6) report the results for the initial months of the pandemic, corresponding to the first wave of COVID-19 in Italy (January - October 2020) and columns (7) to (9) report the results for the second and third wave (November 2020 - June 2021). The t statistics are reported between brackets and the standard errors are clustered by origin/destination country. All regressions include firm-product-time and country fixed effects.

Appendix II

Table 8: Baseline results (Advanced Economies)

		All			First wave			Second-third wave		
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Exports	Stringency	-0.19194		-0.15757	-0.22763**		-0.23020**	-0.18479		-0.06468
		(-1.76)		(-1.63)	(-3.03)		(-3.23)	(-0.89)		(-0.27)
	Death		-0.15770	-0.11382		-0.23261	-0.23689		-0.22068	-0.19873
			(-1.71)	(-1.48)		(-1.51)	(-1.63)		(-1.75)	(-1.38)
	N	18,264,836	18,264,836	18,264,836	8,986,750	8,986,750	8,986,750	9,102,386	9,102,386	9,102,386
	R^2	0.17622	0.17620	0.17624	0.22979	0.22976	0.22984	0.23575	0.23581	0.23582
	N	21,294,797	21,294,797	21,294,797	10,222,581	10,222,581	10,222,581	10,613,002	10,613,002	10,613,002
	R^2	0.15492	0.15496	0.15497	0.21719	0.21729	0.21742	0.20653	0.20656	0.20659
Imports	Stringency	-0.18190		-0.14780	-0.23256**		-0.23719**	-0.17673		-0.04826
		(-1.55)		(-1.41)	(-2.94)		(-3.15)	(-0.82)		(-0.19)
	Death		-0.15295	-0.11295		-0.22715	-0.23488		-0.22595	-0.20969
			(-1.62)	(-1.44)		(-1.46)	(-1.60)		(-1.77)	(-1.40)
	N	17,946,536	17,946,536	17,946,536	8,838,366	8,838,366	8,838,366	8,939,450	8,939,450	8,939,450
	R^2	0.17640	0.17639	0.17643	0.23088	0.23084	0.23093	0.23587	0.23594	0.23594

Note: *** if $p \leq 0.01$; ** if $p \leq 0.05$; * if $p \leq 0.1$. Columns (1) to (3) report the regression results for the overall period of interest (January 2020 - June 2021), columns (4) to (6) report the results for the initial months of the pandemic, corresponding to the first wave of COVID-19 in Italy (January - October 2020) and columns (7) to (9) report the results for the second and third wave (November 2020 - June 2021). The t statistics are reported between brackets and the standard errors are clustered by origin/destination country. All regressions include firm-product, product-time and country fixed effects.

Table 9: Baseline results (Emerging and Low Income Economies, excluding China)

		All			First wave			Second-third wave		
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Exports	Stringency	-0.31743***		-0.28207***	-0.29803***		-0.26825***	-0.02583		0.02376
		(-4.00)		(-3.68)	(-7.57)		(-8.17)	(-0.27)		(0.30)
	Death		-0.25892***	-0.20034***		-0.87098***	-0.63108*		-0.19759*	-0.20103*
			(-4.07)	(-4.08)		(-3.69)	(-2.56)		(-2.53)	(-2.41)
	N	4,578,390	4,578,343	4,578,343	2,206,085	2,206,063	2,206,063	2,266,796	2,266,768	2,266,768
	R^2	0.15168	0.15160	0.15175	0.21605	0.21598	0.21608	0.20017	0.20026	0.20026
Imports	Stringency	-0.31334**		-0.30515**	-0.26325***		-0.25728***	-0.00660		0.01679
		(-2.91)		(-2.99)	(-3.67)		(-5.30)	(-0.07)		(0.25)
	Death		-0.16553	-0.14825*		-1.16067**	-1.12199***		-0.24258**	-0.24337**
			(-1.69)	(-2.08)		(-3.35)	(-3.38)		(-2.70)	(-2.65)
	N	4,069,517	4,069,517	4,069,517	1,962,345	1,962,345	1,962,345	2,014,594	2,014,594	2,014,594
	R^2	0.16310	0.16300	0.16313	0.23219	0.23217	0.23223	0.21625	0.21638	0.21638

Note: *** if $p \leq 0.01$; ** if $p \leq 0.05$; * if $p \leq 0.1$. Columns (1) to (3) report the regression results for the overall period of interest (January 2020 - June 2021), columns (4) to (6) report the results for the initial months of the pandemic, corresponding to the first wave of COVID-19 in Italy (January - October 2020) and columns (7) to (9) report the results for the second and third wave (November 2020 - June 2021). The t statistics are reported between brackets and the standard errors are clustered by origin/destination country. All regressions include firm-product, product-time and country fixed effects.

Table 10: Baseline results (Emerging and Low Income Economies, including China)

		All			First wave			Second-third wave		
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Exports	Stringency	-0.32155***		-0.28723***	-0.32411***		-0.29714***	-0.01873		0.02947
		(-4.40)		(-4.07)	(-7.45)		(-7.21)	(-0.21)		(0.40)
	Death		-0.25403***	-0.19050***		-0.89707***	-0.61584*		-0.18603*	-0.19047*
			(-4.13)	(-3.81)		(-3.76)	(-2.44)		(-2.31)	(-2.22)
	N	4,636,073	4,636,027	4,636,027	2,233,359	2,233,338	2,233,338	2,295,622	2,295,595	2,295,595
	R^2	0.15058	0.15047	0.15064	0.21456	0.21444	0.21459	0.19892	0.19900	0.19900
Imports	Stringency	-0.32209***		-0.31324***	-0.27123***		-0.26066***	-0.07775		-0.04775
		(-3.70)		(-3.64)	(-5.06)		(-6.82)	(-0.68)		(-0.55)
	Death		-0.12615	-0.09103		-1.12120***	-1.00908**		-0.22860**	-0.22537*
			(-1.29)	(-0.98)		(-3.56)	(-2.88)		(-2.64)	(-2.60) [1em]
	N	4,190,435	4,190,435	4,190,435	2,018,903	2,018,903	2,018,903	2,070,694	2,070,694	2,070,694
	R^2	0.16052	0.16036	0.16053	0.22942	0.22936	0.22946	0.21478	0.21489	0.21489

Note: *** if $p \leq 0.01$; ** if $p \leq 0.05$; * if $p \leq 0.1$. Columns (1) to (3) report the regression results for the overall period of interest (January 2020 - June 2021), columns (4) to (6) report the results for the initial months of the pandemic, corresponding to the first wave of COVID-19 in Italy (January - October 2020) and columns (7) to (9) report the results for the second and third wave (November 2020 - June 2021). The t statistics are reported between brackets and the standard errors are clustered by origin/destination country. All regressions include firm-product, product-time and country fixed effects.

Appendix III

Equation 2 assesses the impact of the pandemic on both the intensive and extensive/sub-extensive trade margins. To isolate the contribution of the intensive margin, we re-run equation 2 keeping only the observations that display a positive trade value both in the initial and final periods. The results for the first-wave (when all the coefficients in Table 2 are significant) are reported in Table 11.

To assess the effects of COVID-19 on the sub-extensive margin, we follow a twofold strategy. On the one hand, we isolate the impact of the pandemic on within-destination product churning by regressing the log number of products exported to/imported from each country on the stringency and death rate indices, with the following specification:

$$ln\_n^{p}_{ict} = \beta_1 Stringency_{ct} + \beta_2 Death_{ct} + \alpha_i + \gamma_t + \delta_c + \epsilon_{ict} \tag{7}$$

This is equivalent to Equation 2, but the product dimension is missing.

To assess the impact of the pandemic on the number of partner countries, we regress the log number of destinations served by each firm-product couple on the stringency and death rate indices from OxCGRT, averaged at the firm-product-year-month level using the 2019 trade values as weights and controlling for product-time and firm-product FEs. In practice, we estimate the following equation by using OLS:

$$ln\_n^{c}_{ipt} = \beta_1 Stringency_{ipt} + \beta_2 Death_{ipt} + \alpha_{ip} + \gamma_{pt} + +\epsilon_{ict} \tag{8}$$

Tables 12 and 13 report the results of estimating through OLS equations 7 and 8 for the first wave period. Taking tables 12 and 13 together, the result is that the negative impact of the pandemic on trade was mainly conveyed by the extensive and sub-extensive margins, in particular by the exit from origin and destination markets where both the policy and the sanitary conditions were critical. On the other hand, Table 11 shows that the impact on the intensive margin was less relevant.

Table 11: Impact on the intensive margin

	Exports			Imports		
	(1)	(2)	(3)	(4)	(5)	(6)
Stringency	-0.10197		-0.11205	-0.09757		-0.11012
	(-1.37)		(-1.61)	(-1.28)		(-1.51)
Death		-0.29114	-0.29942		-0.28497	-0.29502
		(-1.76)	(-1.81)		(-1.71)	(-1.76)
N	4,341,206	4,341,204	4,341,204	4,253,076	4,253,076	4,253,076
R^2	0.08965	0.08979	0.08985	0.09043	0.09057	0.09063

Note: *** if p ≤ 0.01; ** if p≤0.05; * if p≤0.1. All regression results relate to the first wave period, columns (1) to (3) report the results for exports while columns (4) to (6) report the results for imports. The dependent variable is the mid-point growth rate of trade in January-October 2020, and the regressions are computed based on the sub-sample of observations that present positive trade flows both in the initial and in the final period. The t statistics are reported between brackets and the standard errors are clustered by country. All regressions include country, firm-product and product-time fixed effects.

Table 12: Impact on the sub-extensive margin (log number of products traded)

	Exports			Imports		
	(1)	(2)	(3)	(4)	(5)	(6)
Stringency	-0.01502		-0.01544	-0.02382*		-0.02356*
	(-1.73)		(-1.77)	(-2.08)		(-2.10)
Death		0.00866	0.01046		-0.01048	-0.00872
		(0.43)	(0.53)		(-0.48)	(-0.40)
N	4,940,725	4,940,713	4,940,713	4,690,165	4,690,165	4,690,165
R^2	0.94361	0.94361	0.94361	0.94378	0.94378	0.94378

Note: *** if p ≤ 0.01; ** if p≤0.05; * if p≤0.1. All regression results relate to the first wave period, columns (1) to (3) report the results for exports while columns (4) to (6) report the results for imports. The dependent variable is the log number of products traded by each firm in each destination in a given month and the sample goes from January 2019 to October 2020. The t statistics are reported between brackets and the standard errors are clustered by country. All regressions include country, firm and time fixed effects.

Table 13: Impact on the sub-extensive margin (log number of destinations)

	Exports			Imports		
	(1)	(2)	(3)	(4)	(5)	(6)
Stringency	-0.01253**		-0.01494**	-0.02995***		-0.03049***
	(-2.61)		(-3.15)	(-6.95)		(-7.18)
Death		0.03928***	0.04145***		0.00663	0.01088
		(4.22)	(4.49)		(0.70)	(1.16)
N	5,872,775	5,872,773	5,872,773	5,767,116	5,767,116	5,767,116
R^2	0.81083	0.81083	0.81083	0.81345	0.81345	0.81345

Note: *** if p ≤ 0.01; ** if p≤0.05; * if p≤0.1. All regression results relate to the first wave period, columns (1) to (3) report the results for exports while columns (4) to (6) report the results for imports. The dependent variable is the log number of destinations served by each firm-product couple in a given month and the sample goes from January 2019 to October 2020. The t statistics are reported between brackets and the standard errors are clustered by country. All regressions include country-product and product-time fixed effects.

Appendix IV

Table 14: The impact of the domestic death rate on export and import mid-point growth rates (January-October 2020)

	Exports	Imports
Death	-0.02146	-0.01855
	(-0.78)	(-0.67)
N	7,439,754	7,226,659
R^2	0.12458	0.12475

Note: *** if p $\leq$ 0.01; ** if p$\leq$0.05; * if p$\leq$0.1. All regression results relate to the January-October 2020 period. The t statistics are reported between brackets and the standard errors are clustered by province. All regressions include country-product, product-time and firm fixed effects.

Appendix V

Table 15: The probability of exiting foreign markets as a function of export size

	Exports		Imports	
	(1)	(2)	(3)	(4)
Log trade	-0.06196***	-0.06238***	-0.06202***	-0.06649***
	(-187.62)	(-198.97)	(-164.03)	(-140.25)
Constant	0.46716***	0.46411***	0.53935***	0.47147***
	(357142.31)	(441950.51)	(1370987.44)	(111131.86)
N	12,460,075	13,012,520	6,514,046	6,103,678
R^2	0.26084	0.25845	0.34804	0.26200

Note: *** if p $\leq$ 0.01; ** if p$\leq$0.05; * if p$\leq$0.1. Columns (1) and (2) report the results for exports while columns (3) and (4) report the results for imports. In columns (1) and (3) the dependent variable refers to the exit in 2018 and the regressor is the log of trade in the corresponding month of 2017, while in columns (2) and (4) the dependent variable refers to the exit in 2019 and the regressor is the log of trade in the corresponding month of 2018. The t statistics are reported between brackets and the standard errors are clustered by firm.

Table 16: The impact of dropping a variety on the probability of not trading it one year later: evidence from 2018-2019

	Exports	Imports
Out 2018	0.40505***	0.42915***
	(282.56)	(184.47)
Constant	0.31762***	0.35262***
	(474.05)	(281.06)
N	12,460,075	6,514,046
R^2	0.35670	0.43397

Note: *** if p $\leq$ 0.01; ** if p$\leq$0.05; * if p$\leq$0.1. The first column reports the results for exports while the second column reports the results for imports. The dependent (independent) variable is a dummy equal to 1 if a variety is not traded in a given month of 2019 (2018). The t statistics are reported between brackets and the standard errors are clustered by firm.

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