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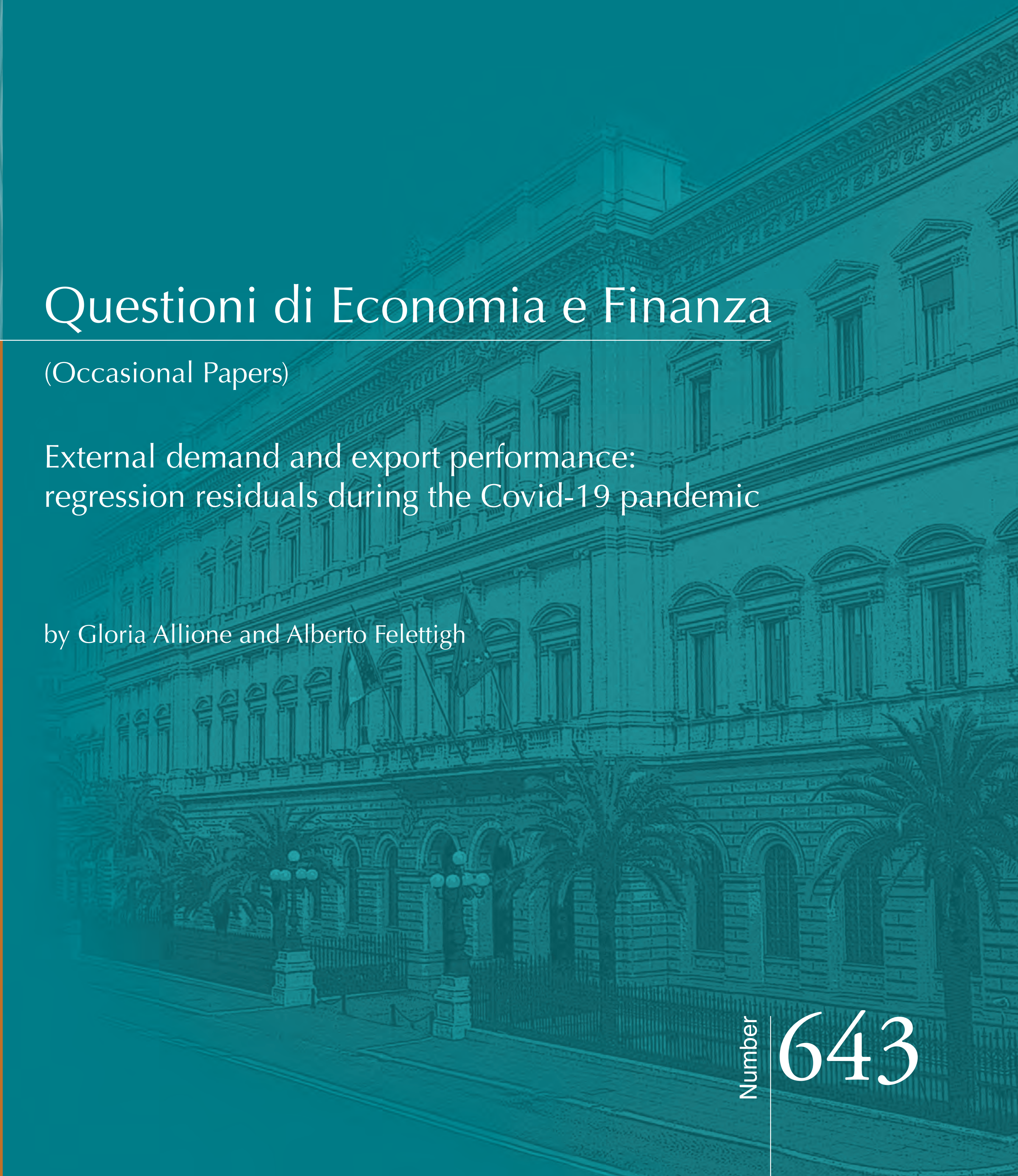

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by Gloria Allione and Alberto Felettigh

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EXTERNAL DEMAND AND EXPORT PERFORMANCE: REGRESSION RESIDUALS DURING THE COVID-19 PANDEMIC

by Gloria Allione* and Alberto Felettigh*

Abstract

We econometrically investigate the heterogeneous ability of Italian exporting sectors at coping with the COVID-19 shock, which affected both supply, mainly due to the selective suspension of non-essential activities in the country during the lockdown in March-April 2020, and foreign demand in an idiosyncratic fashion. Our results show that had the lockdown not impaired production, overall Italian manufacturing exports would have fallen essentially one-to-one with foreign demand. We conclude that there is no evidence, so far, of COVID-19 having permanently weakened the decade-long ability of Italian firms to safeguard their positions in international markets.

JEL Classification: F14, F40, L60.
Keywords: potential demand, export performance, sectoral heterogeneity, Covid-19 pandemic.
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Contents

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1. Introduction[1]

The performance of Italy's goods exports in 2020 was shaped by the consequences of the COVID-19 shock. On the one hand, demand for certain products, like protective personal equipment or electronic appliances, boomed worldwide due to the pandemic, while demand for other goods (such as garments or gasoline) slumped. On the other hand, a lockdown was implemented in Italy for six weeks in March-April 2020, which completely interrupted production of selected manufactures while imposing no legislative constraints for others.

This paper quantifies the effects of these demand- and supply-side shocks on Italian exports at the sectoral level and their contribution to the overall developments of merchandise exports.

We start by computing the potential demand stemming from Italy's outlet markets (henceforth, simply foreign demand[2]) at the NACE 2-digit sectoral detail. We then econometrically investigate in a sector-by-sector time-series approach the relationship between quarterly export volumes and foreign demand, controlling for price-competitiveness developments and for a reduced-form representation of slow-moving structural factors. To measure the sector-specific effects of the suspension of economic activity during the lockdown, we add a trading-day regressor and combine the estimated coefficient, which captures the historical benefit of one extra working day within the quarter, with the count of the working days lost to the lockdown, taking into account the sectoral share of activities suspended by normative provisions.[3]

We then aggregate all sectoral demand and exports developments to analyse the macroeconomic picture that emerges: we find that, had the supply-side impediments due to the lockdown not existed, in 2020 overall manufacturing exports, would have moved essentially one-to-one with foreign demand, in line with the evidence accrued in the 2010-19 period.[4]

We conclude that the documented decade-long ability of Italian firms to safeguard their positions in international markets has not been compromised by the pandemic beyond the short-run effects of the productive lockdown.

Our work intersects with a growing literature on the effects of the pandemic on international trade. In particular, using a sector-level gravity model, Espitia et al. (2021) investigate the interaction between the COVID-19 shock and sector characteristics, such as the possibility of remote work or the degree of global value chain (GVC) participation. Berthou and Stumpner (2021) estimate the impact of lockdowns on international trade in a panel setting, matching import and export data by product with the Oxford Stringency Index. This work is the most closely related to ours; our quantification of the damage inflicted to Italy's exports by the lockdown is quite in the ballpark of what can be inferred from their estimates by tailoring their exogenous variables to the Italian case, in

[1] We thank Silvia Fabiani, Stefano Federico, Claire Giordano and Alfonso Rosolia for helpful comments. All errors remain our own. The views expressed are our own and do not necessarily reflect those of the Bank of Italy or the Eurosystem.

[2] This is defined as a weighted average of partner countries' imports (from the rest of the world, not just from Italy) defined at the country-sector level; see section 2 for the details.

[3] The share ranges from zero in pharmaceuticals to one in motor vehicles; the manufacturing average is 0.625. This metric has the advantage of being sector-specific, contrary for instance to the popular Oxford Stringency Index (Hale et al., 2020). Existing sub-components of the composite Oxford Stringency Index can be interpreted as sectoral versions (for instance, the index tracking school closings can be interpreted as a stringency measure for education services), but these only refer to certain services, while the focus here is on manufacturing.

[4] See for instance Bugamelli et al. (2018).

fact smaller by one third. Other studies focus on the role of the GVC contagion effect (Cigna and Quaglietti, 2020, Friedt and Zhang, 2020, Keyzar and Velic, 2020); we do not take into account this transmission channel since it has been of limited relevance for Italian firms, as documented in Giovannetti et al. (2020) and in Giglioli et al. (2021).

Our work also adds to the literature on the importance of sectoral composition for the response of exports to movements in external demand and real exchange rates (Auer and Saurè, 2011, Wierts et al., 2014, Hanslin Grossmann et al., 2016). On the role of sectoral heterogeneity in explaining aggregate Italian exports, our focus on 2020 complements, although at a much coarser level of product granularity, the medium-run approach of Federico and Giordano (2021).

The paper is organized as follows. Section 2 presents our data and provides some descriptive evidence. Section 3 offers a narrative of our empirical sectoral regressions, with details postponed to Appendix A. Section 4 implements our bottom-up approach to put forth the macroeconomic evidence that supports, together with some robustness exercises (section 5), our main conclusions (section 6).

2. Data and descriptive evidence

An investigation of export and demand behaviour in volume terms at the sectoral level (we loosely use the terms “sectors”, “industries”, “goods” or “products” interchangeably throughout the paper) requires the following data, for each sector:

- Italy’s exports at current prices to each partner country;
- Italy’s export price indices (PPIX[5]);
- imports at current prices (in national currency) for each of Italy’s partner countries;
- import deflators, for which we prefer import price indices[6] or producer price indices (PPIs) over unit values,[7] for each of Italy’s partner countries.

We strike a balance between data availability, time coverage and export representativeness by focusing on Italian foreign sales of manufactures, between 2000q1 and 2020q4, to the European Union (EU) member States and the three major partner countries outside the EU (Switzerland, United Kingdom, United States). Our sample period being bound to start in 2000q1, since no PPIX data for Italy exist before that, data availability for trade flows at current prices poses no constraints. Much more varied and disorderly is the situation for import deflators, varying from full availability (all country-quarter couples for some sectors), to sectoral incompleteness (for a subset of sectors time series are complete only for some importing countries), to time-span incompleteness (time series that start after 2000q1 or end before 2020q4 for some country-sector pairs). Essentially no sectoral import deflator exists for (i) six EU countries (Cyprus, Estonia, Luxembourg, Latvia, Malta and Slovakia); (ii) tobacco articles and (merchandise productions of) “printing and recording services”, which are however negligible in Italy’s manufacturing exports[8].

[5] Export price indices are a subset of production price indices (PPI), pertaining to the share of production that is exported; hence the acronym PPIX.
[6] These are available only for a very small subset of euro-area countries, with varying time coverage.
[7] Unit values are not price indices and are widely known to deliver biased price signals. The same holds on the export side, and that is why we resort to PPIX.
[8] The share of printing and recording services in 2019 was 0.01 per cent (at current prices). The share of tobacco products, historically as tiny, has recently grown to a still modest 0.3 per cent, thanks to the diffusion of e-cigarettes.

We are ultimately left with 23 destination markets, covering around 70 per cent of Italy's manufacturing exports in 2019-20, and 21 NACE 2-digit manufacturing sectors that have satisfactory data coverage from 2000q1 onwards. For a minority of country-sector pairs we resort to imputation techniques in order to fill in the gaps that would have otherwise excessively limited our sample period. All data are sourced as raw and no seasonal adjustment is applied. Our sources are Eurostat, Istat and national institutions for countries outside the EU; the statistical domains are international merchandise trade statistics (IMTS) and producer prices.

We define X_s, the index (2010=100) for Italy's exports of sector *s* in volume terms, by deflating nominal exports with a weighted average P_{ITs} of the two PPIX components (intra-euro-area sales and extra-area sales[9]); weights come from the share of euro-area exports in overall exports to the 23 destinations we consider. We choose PPIX over unit values as our preferred deflator, as unit values are not price indices and are widely known to deliver biased price signals.

As for the price-competitiveness indicator of sector *s*'s exports, we define it as the relative price index (2010=1) $P_s = P_{ITs} / P_s^{avg}$, where the denominator is a weighted average of all partner countries' sector-*s* euro-based PPIs[10]. An increase in P_s indicates a competitiveness loss. To our knowledge, high-frequency sectoral real exchange rates are readily available only in Sato et al. (2015), yet they use a coarser industry classification, not suitable for our analysis.

We define M_{is}, the index (2010=100) for partner country *i*'s imports of product *s* in volume terms, by deflating nominal imports with the corresponding producer price index P_{is}; only occasionally are we able to use import prices as deflator and some judgmental imputation is needed in order to fill in missing observations or missing time series for PPIs. Ideally, one would like to have data for both deflators and build a weighted average reflecting the relative share of imports and of domestic supply in country *i*'s final absorption of product *s*[11].

We then compute the index (2010=100) of foreign demand for Italy's exports of product *s*, variable D_s, as a weighted average of partner countries' imports of that product in volume terms; each country receives a weight equal to its (lagged) share in Italy's exports of product *s* at current prices[12]. Therefore, demand D_s internalises geographic-composition effects within product *s*: the impact of any change in imports is different whether it takes place in a (historically) relevant partner country or in a marginal one.

In section 4, we shall take a weighted average in order to aggregate up all demand indices D_s into a macro index *D*, each D_s receiving a weight equal to the share of sector *s* in Italy's overall manufacturing exports. Therefore, the aggregate demand index *D* will internalise, although in a two-stage fashion, both geographic and sectoral composition effects. Similarly, we shall add up all sectoral exports and build an aggregate export index *X*.

We define the performance index for sector-*s* Italy's exports as $PI_s = X_s / D_s$. By construction, it equals 1 in 2010 on average; if it stays flat thereafter, it signals that after 2010 exports of sector *s* moved in line with foreign demand.

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[9] The euro-area share in our data is around 56 per cent in 2020; it is 41 per cent in official data. In section 5 we come back to this difference.

[10] Each partner country receives a weight equal to its share in Italian exports by sector *s*.

[11] Indeed, Italy's exports compete, in each destination *i*, both with *i*'s imports and *i*'s domestic supply. WIOD data show that the latter is often the biggest component, especially in large economies.

[12] This is a replica, at the sectoral level, of the methodology employed for instance by the ECB: see Hubrich and Karlsson (2010).

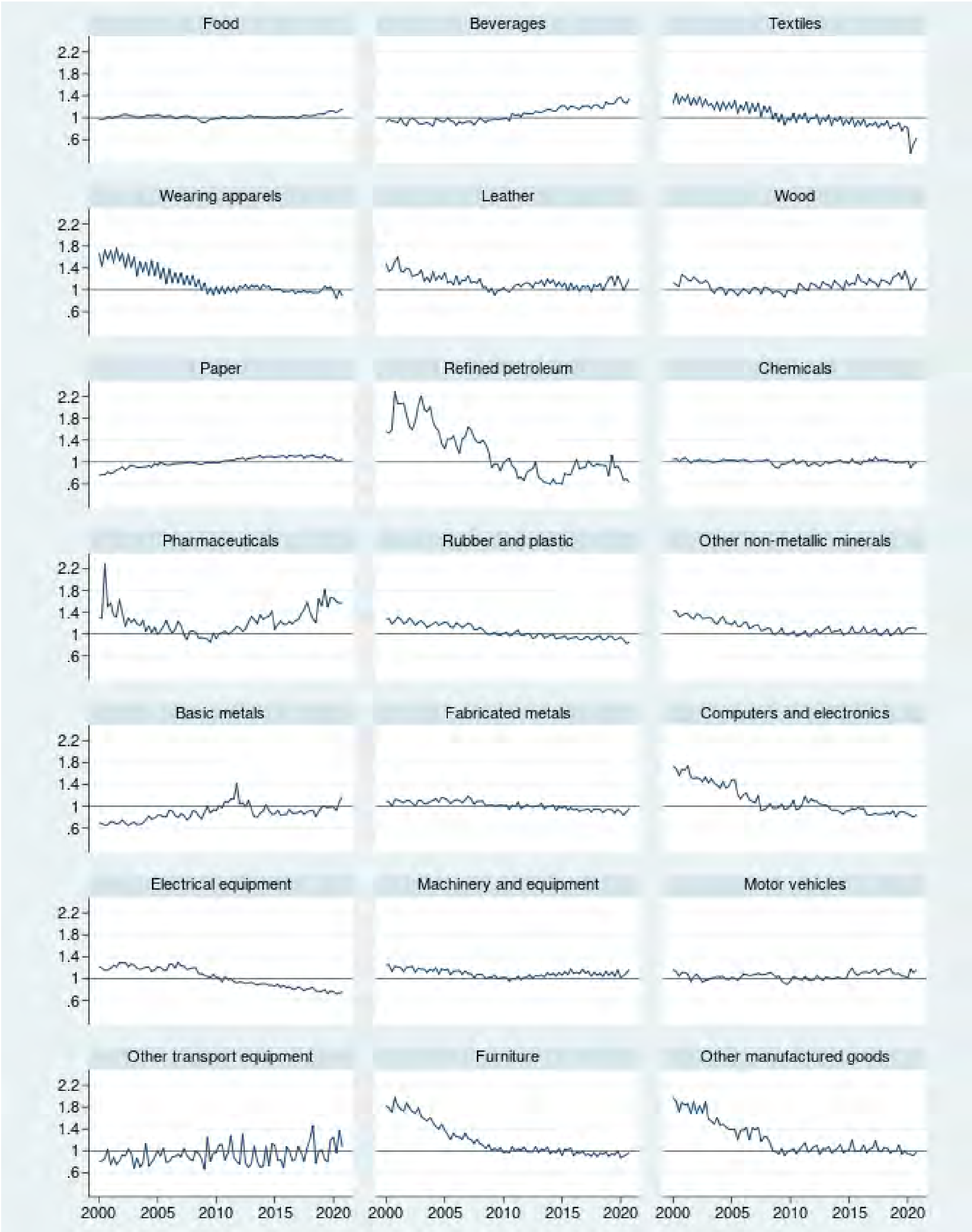
To measure the selective suspension of non-essential activities during the lockdown back in March-April 2020 we compute for each 2-digit sector the value-added 'suspension share' of activities that ended up being suspended, given the normative provisions detailing which of the 5-digit sectors were (entirely) put on a productive hold and which were instead (entirely) spared from the lockdown[13]. The 'suspension share' for overall manufacturing activities was 0.625. Our metric has the advantage of being sector-specific, contrary for instance to the popular Oxford Stringency Index, but it is clearly only an imperfect gauge of the supply-side impediments that affected firms during the first wave of the pandemic (as discussed in section 3).

A graphical analysis of the data shows that export performance at the sectoral level is very heterogeneous (fig. 1). First, it is quite evident that around 2010 many sectoral trends experienced a structural break, often reverting or remarkably slowing down a decade-long decline (the revived ability of Italian firms to safeguard their positions in international markets, as mentioned in the introduction). Leaving 2020 aside for the time being, the products whose performance index PI_s was the highest in 2019, on average relative to 2010, are pharmaceutical products, beverages, wood products (excluding furniture), leather products, mechanics and food. At the opposite extreme, electrical equipment, textiles, electronics, rubber and plastic productions, furniture and refined petroleum products only managed to tilt upwards their declining trend, albeit notably so in some cases.

[13] The decrees that detailed the list of suspended activities allowed individual firms to ask the permission from local authorities (the prefects) to be exempted from the suspension. We ignore this aspect and therefore our suspension shares may turn out to be somewhat overestimated.

Fig. 1 –Performance indices for Italy's exports, by sector

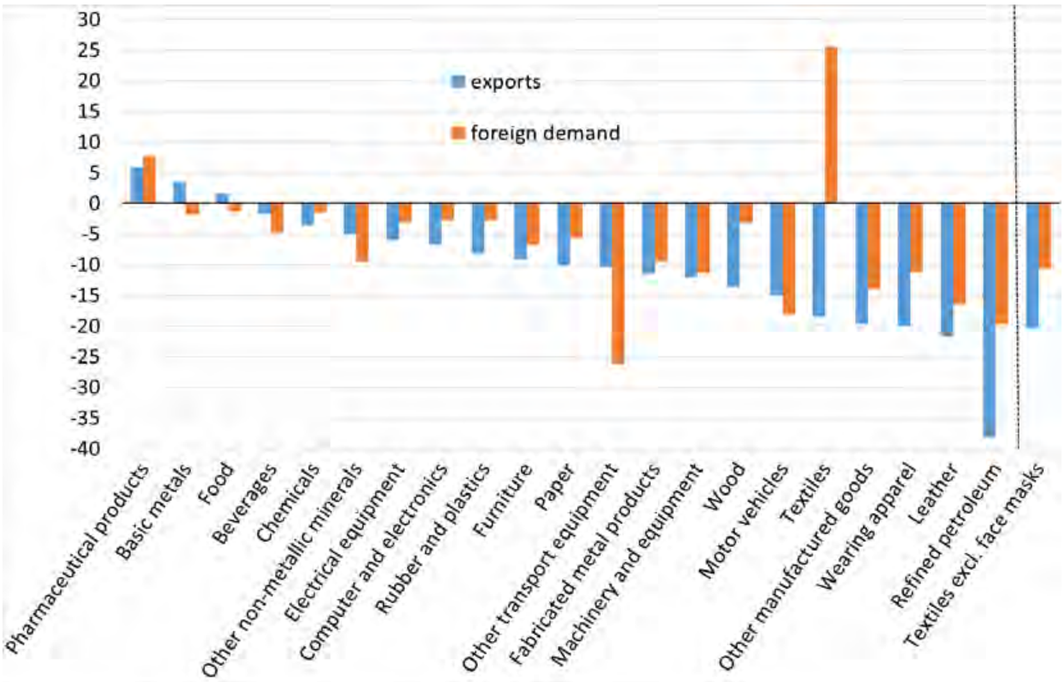
(indices 2010=1)



Sources: our elaborations on data from Istat, Eurostat and national institutions for countries outside the European Union.
Notes: The performance index, denoted as PI_s in the main text, is the ratio between the index (2010=100) of sectoral exports and the index (2010=100) of sectoral foreign demand.

Focusing on 2020, figure 2 breaks down the evolution of the performance index between the year-on-year percentage change in exports (the numerator of the index) and that in foreign demand (the denominator). The few sectors that recorded an increase in exports are pharmaceutical products and, despite a falling demand, food products and basic metals (thanks to sales of processed precious metals, which typically increase at times of crisis). Moving to productions that witnessed a reduction in demand, export contraction was less than proportional for four sectors (beverages, non-metallic mineral products, motor vehicles and other transport equipment) and very similar for machinery and equipment, Italy's major exporting sector. Exports decreased more than demand in the remaining sectors, especially for refined petroleum products, wood products (which exclude furniture), wearing apparel and textiles. Figure 2 indicates that in 2020 also relative export performance, namely the difference between the percentage year-on-year variation of exports and that of the corresponding demand, was quite heterogeneous across sectors.

Fig. 2 - Exports and foreign demand in 2020, by sector
(percentage changes on 2019)



Sources: our elaborations on data from Istat, Eurostat and national institutions for countries outside the European Union.

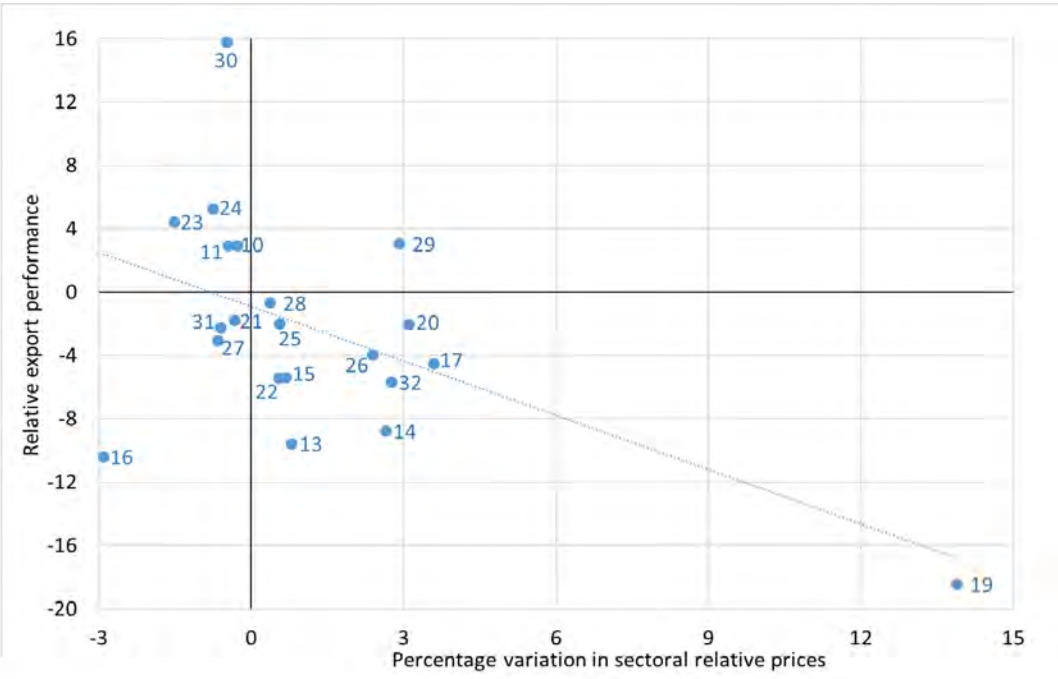
Textiles are an instructive example of how COVID-19 affected international trade and its composition: the exceptional increase in demand for personal protective equipment, in particular face masks, was so large that it translated in potential demand for Italian textiles growing by more than 25 per cent. Yet, at the beginning of the pandemic Italy produced almost no face masks at all, so that there was essentially no corresponding activation of Italian exports[14]. When we exclude protective face masks (last two bars in fig. 2), foreign demand for textiles actually decreased (by around 11 per cent, yet around half the decrease recorded by Italy's exports). The difference is so large, depending

[14] To give a sense of the magnitudes, 2019 Italian exports of textile face masks (HS code 630790) amounted to just 0.1 billion euros (possibly including re-exports); imports by the other members of the EU to 22,9 billion euros in 2020.

on whether face masks are included or not, that the drop in foreign demand for Italian exports of *overall* manufactures (as computed in section 4 below) is 0.8 percentage points smaller when we exclude this single product. In the rest of the paper, textiles always include protective face masks (both on the demand and on the export side), unless otherwise noted.

Figure 3 shows that relative-price dynamics as well differed across sectors, and the portrayed regression line suggests that this heterogeneity helps to explain the one observed for the performance index: the negative slope indicates that, as expected, a price-competitiveness loss (namely an increase in the relative price) is associated with a smaller growth rate for exports, for given foreign demand dynamics. Percentage changes are clustered between -2.9 and 3.6 per cent, except for a large outlier (the 13.9 per cent impairment by refined petroleum products); the weighted average for the manufacturing sector as a whole indicates a 1 per cent competitiveness loss.

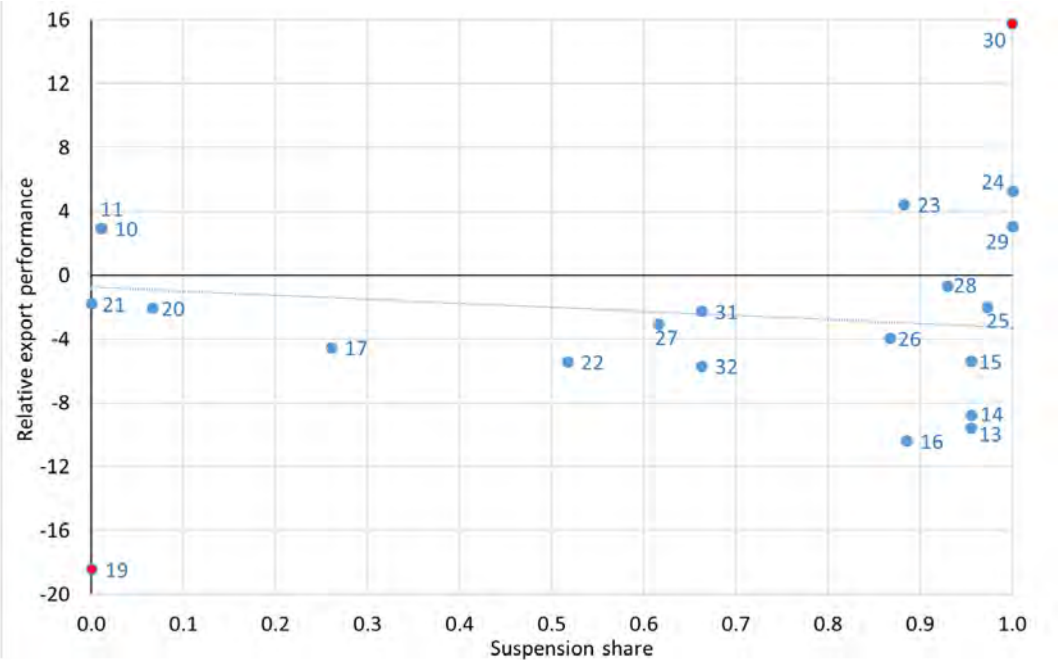
Fig. 3 - Export performance and price competitiveness developments in 2020
(percentage changes and differences between percentage changes)



Sources: our elaborations on data from Istat, Eurostat and national institutions for countries outside the European Union.
Notes: Relative export performance on the y-axis is defined as the difference between the percentage year-on-year variation of exports and that of the corresponding demand.
Legend: 10 = food; 11 = beverages; 13 = textiles (excluding protective face masks); 14 = wearing apparel; 15 = leather; 16= wood; 17= paper; 19 = refined petroleum; 20 = chemicals; 21 = pharmaceuticals; 22 = rubber and plastic; 23 = other non-metallic minerals; 24 = basic metals; 25 = fabricated metal products; 26 = computer and electronics; 27 = electrical equipment; 28 = machinery and equipment; 29 = motor vehicles; 30 = other transport equipment; 31 = furniture; 32 = other manufactured goods.

Figure 4 relates the various sectors' relative export performance to our measure that captures the suspension of economic activities within each sector, ranging from productions being "entirely open" (pharmaceutical and refined petroleum products) to activities being "entirely closed" (basic metals, motor vehicles and other transport equipment). After omitting refined petroleum and other transport equipment, which stand out as clear outliers (the two red dots in the figure), the negative slope of the regression line suggests that indeed sectors where the supply shock hit the hardest (i.e. activity was suspended the most) also fared worse in terms of relative export performance.

Fig. 4 - Export performance in 2020 and lockdown stringency
(percentage changes and differences between percentage changes)



Sources: our elaborations on data from Istat, Eurostat and national institutions for countries outside the European Union.

Notes: The suspension share on the x-axis is the share of activities that ended up being suspended in each of our 2-digit sectors, given the normative provisions detailing which of the 5-digit sectors were (entirely) put on a productive hold and which were instead (entirely) spared from the lockdown. Relative export performance on the y-axis is defined as the difference between the percentage year-on-year variation of exports and that of the corresponding demand. The OLS line is obtained after omitting the two outlier sectors identified by a red dot (refined petroleum products and other transport equipment).

Legend: 10 = food; 11 = beverages; 13 = textiles (excluding protective face masks); 14 = wearing apparel; 15 = leather; 16= wood; 17= paper; 19 = refined petroleum; 20 = chemicals; 21 = pharmaceuticals; 22 = rubber and plastic; 23 = other non-metallic minerals; 24 = basic metals; 25 = fabricated metal products; 26 = computer and electronics; 27 = electrical equipment; 28 = machinery and equipment; 29 = motor vehicles; 30 = other transport equipment; 31 = furniture; 32 = other manufactured goods.

3. Sectoral econometric regressions, in words

We next resort to econometrics in order to shed light on how foreign demand and price-competitiveness developments interplayed with supply-side constraints in shaping export dynamics. The basic idea is to estimate relevant parameters up to 2019q4, project fitted values into 2020 and then compare such "expected" export behaviour with the observed one. We run a quarterly time-series regression for each sector; model specification, dynamic structure, seasonality and estimated parameters turn out to be so diverse across sectors that a panel setting would probably miss some of this heterogeneity.

We start with a battery of regressions using the year-on-year percentage variation in exports as the dependent variable (the order-4 log-change), a choice we will ultimately confirm only for chemical products and motor vehicles. For the other sectors, given the unsatisfactory goodness-of-fit, we turn to using the performance index as our dependent variable, in the vein of Murata et al. (2000) and Pain et al. (2005).

Although it is unfeasible to select the same econometric specification for all sectors, as figure 1 has already suggested, they all share the same structure. The starting point is to model the log of the performance index PI_s as a function of the log of the relative price index P_s, quarter time dummies[15] in order to deal with seasonality, an 'augmented' trading-day regressor to capture calendar effects (and supply-side constraints, as detailed below), and a cubic time trend. We are therefore taking as exogenous the impact of the pandemic on foreign demand (the denominator of our dependent variable) for Italy's exports. The time trend, which we verify to be indeed slow-moving in our estimations, is a shortcut for capturing the sector-specific effects of all structural determinants of Italian exports, as identified mainly at the aggregate level by the existing literature[16]: the competitive pressures exerted by China and by the integration of Central and Eastern-European countries into the EU, non-price competitiveness developments, the gradual re-composition of Italian exports towards larger firms (especially after 2010), which are usually better equipped to thrive on international markets.

In order to allow for the possibility that Italy's exports fell short of demand in 2020q1 and 2020q2 due to firms' activities being suspended for six weeks from 23 March to 30 April 2020, we leverage on the basic intuition that the scope of an 'ordinary' trading-days regressor is to capture the effect of an extra working day, and that the lockdown weeks were akin, with the caveats to be discussed below, to a prolonged period of bank holiday. Specifically, we move from the 'ordinary' trading-days regressor[17] and augment it to represent the 'counterfactual scenario' where all days in between 23 March and 30 April were bank holidays.[18] Since this only changes our independent variable in the out-of-sample period (regressions are estimated using data up to 2019q4), our quantification of the supply-side impact on exports rests on the interaction between the estimated coefficient of the 'augmented' trading-days regressor, the difference between the 'augmented' and the 'ordinary' regressor, and the sectoral-specific suspension share as defined earlier.

Our identification strategy should capture the mechanical and contemporaneous effect of the lockdown, in terms of foregone production meant for exports. It neglects however all the pandemics' consequences in terms of labour-force organization after the lockdown was levied (connected for instance to social distancing on the workplace and to employees contracting COVID-19), as well as supply-chain disruptions (during and after the lockdown). In the opposite direction, our identification rules out the possibility that firms ramped up production after 30 April, in an attempt to catch up (at least part of) that foregone during the lockdown.

In summary, for 17 out of 21 sectors we ultimately prefer the (log of the) performance index PI_s as dependent variable, for 2 sectors (chemical products and motor vehicles) we opt for the order-4 log-change of exports, and for the remaining 2 sectors (refined petroleum products and other transport

[15] That is, for each quarter j ($j=1,2,3,4$), we define D_j as taking value *1* in quarter j of each year and *0* otherwise.
[16] See in particular Bugamelli et al. (2018) and Fabiani et al. (2019).
[17] The ordinary version of the regressor is sourced from Istat; in loose terms, it combines in a mathematical formula the count of week-days, weekends and bank holidays during each quarter.
[18] The lockdown actually finished on Sunday 3 May; Thursday 30 April was the last working day before that. This is why we refer to the March-*April* lockdown throughout the paper.

equipment, whose exports are historically very erratic[19]) we fail to come up with a satisfactory estimation (in our attempts, the goodness-of-fit is always below 0.4). The coefficient on the trading-days regressor is often statistically significant and always with the correct sign; for the motor vehicles sector it is estimated to be virtually zero. We are not able to quantify the impact of supply-side constraints for the "other transport equipment" sector, for which no reliable equation is available, as already mentioned. The same is true for refined petroleum products, but this is not a concern here since none of these activities was suspended at all so estimated supply-side effects are null by construction.

As a final caveat, due to data availability and to the use of log-changes, our estimations typically only rely on around 76 observations (from 2001q1 to 2019q4); a longer time span would benefit their robustness.

Appendix A spells out the details of our estimations and compares, sector by sector, the "expected" behaviour of exports in 2020 with the actual one. In the following, we instead focus on the macro picture that emerges when we aggregate up the sectoral evidence we have gathered in this section and in the previous one.

4. Aggregate outcomes

As anticipated in section 2, we now add up all sectoral exports into an aggregate export index X and we take a weighted average of all sectoral demand indices D_s in order to build a macro index D (each D_s receives a weight equal to the share of sector s in Italy's overall manufacturing exports in 2010, so that D internalises, although in a two-stage fashion, both geographic and sectoral composition effects). As shown in figure 5, manufacturing exports did not keep pace with our aggregate measure of foreign demand in the first decade of the century, while they expanded one-to-one with demand after 2010[20] (actually at a slightly brisker pace: 3.4 per cent, over ten years). Sales in 2020 fell more than demand (-8.7 vs -7.3 per cent), with a 1.4 percentage point negative gap.

To assess to what extent the productive lockdown in March-April 2020 explains such negative gap, we resort to our econometric regressions. In order to proxy the lockdown impact on the export capabilities of each sector s, we multiply the following three elements: (i) the estimated sector-specific coefficient of the trading-days regressor, which captures the historical benefit of having an extra working day within the quarter; (ii) the number of working days lost due to the lockdown; (iii) the sector-specific share of activities that got suspended during the lockdown. When we aggregate up all these estimated sectoral impacts[21], we find that the lockdown caused a loss of 1.7 percentage points to the year-on-year change in exports so that, had it not taken place, the 2020 fall in overall

[19] In particular, Italy's exports of other transport equipment are affected by occasional lumpy sales of very large ships.

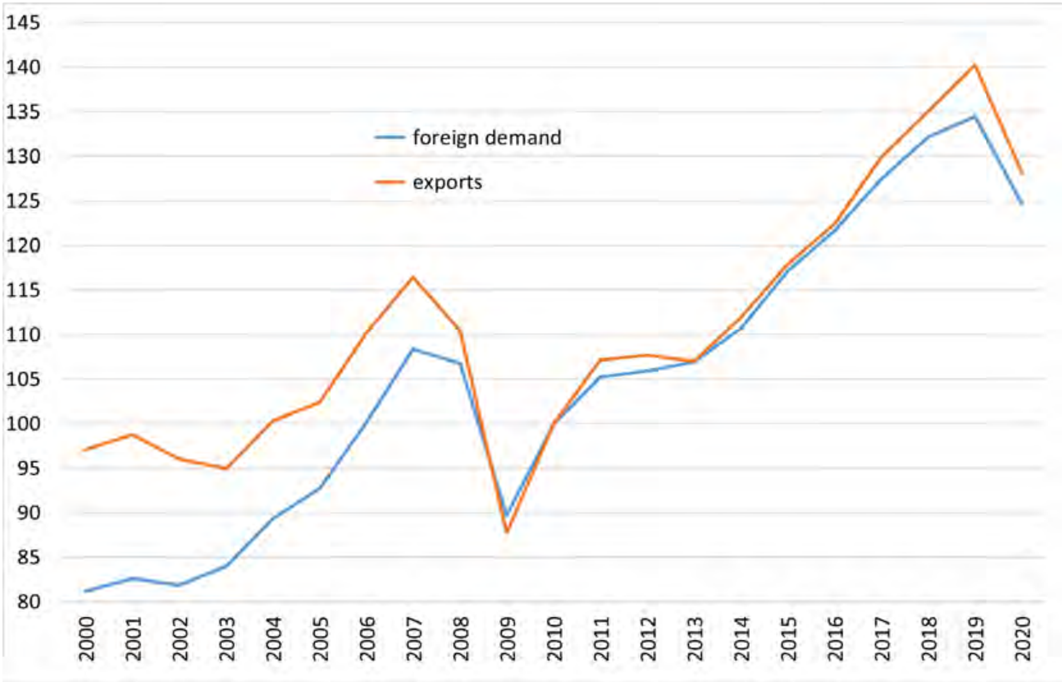
[20] This is consistent with the relative dynamics of exports and foreign demand as commented in some research work by Banca d'Italia staff: see for instance Bugamelli et al. (2018) and Fabiani et al. (2019). Their version of foreign demand is a weighted average of partner countries' imports, so that it only captures geographic composition effects. This is the main conceptual difference relative to our foreign demand index; other differences relate to product coverage (all goods vs manufactures only), statistical domain for partners' imports (national accounts vs IMTS) and geographic coverage (around 80 partner countries vs 23).

[21] A few of these may seem under- or over-estimated (see Appendix A): we expect possible biases to cancel out, to a large extent, once we aggregate all sectors. We assume that the impact for 'other transport equipment', which we are not able to estimate econometrically, is equal to the average of the remaining sectors.

manufacturing exports would have stopped at -7.0 per cent.[22] We thus conclude that in 2020, absent the lockdown measures, manufacturing exports (-7.0 per cent) would have slightly over-performed foreign demand (-7.3 per cent).

Fig. 5 – Aggregate manufacturing exports and aggregate foreign demand

(indices 2010=100)



Sources: our elaborations on data from Istat, Eurostat and national institutions for countries outside the European Union.

5. Robustness exercises

We carry out two robustness exercises to further support our main findings. The first one compares our quantification of foregone export supply due to the lockdown with the results in Berthou and Stumpner (2021). Their panel regressions indicate that a one-month-long complete lockdown – complete in the sense that the composite Oxford Stringency Index takes on the value of 1 – in the exporting country results in a decline of monthly (bilateral) total trade between 21.9 per cent and 10.9 per cent. After some calculations, for which we refer to Appendix B, these results can be recast in the Italian case as indicating that, had the lockdown not taken place, the value of Italy's exports in 2020 would have been 2.4 per cent higher. This figure compares to our finding of 1.9 per cent in volume terms (and similarly for the value of sales, as long as we assume that the lockdown had no impact on export prices), which is smaller by around one third.

The second robustness exercise addresses the concern that, being our sample of partner countries biased towards the euro area, the computations based on our dataset may be mis-measuring the changes in foreign demand and in exports compared to the corresponding 'true' overall variations. In Appendix C we show that, relative to a benchmark that uses back-of-the envelope calculations on

[22] Re-stated in level terms, for the sake of the benchmarking exercise below, the result of our "no-lockdown counterfactual scenario" is that exports would have been 1.9 per cent higher than actually recorded.

World Trade Monitor data, 'true' demand may have fallen slightly (0.6 percentage points) less than we estimate. Vice-versa, as already mentioned, 'true' demand may have fallen slightly (0.8 percentage points) more than we estimate since we have included protective face masks in our computations, while the surge in the need for this product could not be expected to activate any (significant) export from Italy. Taking the balance of these two possible biases, we assess that a robust quantification for the 2020 percentage fall in foreign demand is the interval [-7.5, -7.3], where the upper limit is the 'point estimate' derived from our estimates in section 4.

As for export dynamics, manufacturing-wide data at current prices and export prices sourced directly from Istat indicate that the volume of foreign sales dropped in 2020 by 9.5 per cent. We therefore consider the interval [-9.5, -8.7] for the 2020 percentage fall in aggregate manufacturing exports, where the upper limit is the 'point estimate' based on our restricted set of partner countries, as reported in the previous section. Table 1 recaps our findings.

Table 1 – Year-on-year percentage changes in selected variables, 2020

Variable	Notation	Percentage change, 'point estimates' (1)	Percentage change, 'robustness intervals' (2)
Potential demand internalising both geographic and sectoral composition	*D*	-7.3	[-7.5, -7.3]
Manufacturing exports, as recorded	*X*	-8.7	[-9.5, -8.7]
Manufacturing exports, had the productive lockdown not taken place (3)	--	-7.0	[-7.8, -7.0]

Sources: our elaborations on data from Istat, Eurostat and national institutions for countries outside the EU.
Notes: (1) 'point estimates' refer to our quantification in section 4 – (2) 'robustness intervals' are built from 'point estimates' and the indications of our robustness exercises, as documented in section 5. – (3) This is the percentage change in exports, as recorded, minus our estimate for the contribution of the productive lockdown in March-April 2020, which is -1.7 per cent as indicated in section 4.

From the intervals in table 1, we build a worst-case 'scenario' and a best-case one. In the former, we take the lower bound for the change in exports and the upper bound for the change in demand and conclude that Italian exports fell 0.5 percentage points more than foreign demand (-7.8 vs -7.3 per cent). In the best-case 'scenario' we take the upper bound for the change in exports and the lower bound for the change in demand and conclude that exports fell 0.5 percentage points less than foreign demand (-7.0 vs -7.5 per cent).

6. Conclusions

We look into the heterogeneous ability of Italian exporting sectors at coping with the COVID-19 shock, which affected in an idiosyncratic fashion both supply – mostly due to the selective suspension of non-essential activities in the country during the lockdown in March-April 2020 – and external demand (for instance, demand for protective face masks and electronic appliances boomed worldwide, while that for gasoline slumped).

We build a quarterly dataset at the NACE 2-digit level that dissects Italy's manufacturing export behaviour at the sector-partner level (on a subsample of 23 destination countries, covering around 70 per cent of the country's manufacturing exports) and we use it to run a battery of time-series regressions. Each regression specifies a sector-specific equation linking the sector’s volume of exports to its potential demand stemming from outlet markets, its relative price, and its share of suspended activities during the lockdown. For our purposes, the suspension share is superior to the popular Oxford Stringency Index, which allows no sectoral differentiation within manufacturing.

Once we aggregate all the individual sectors, our estimates tell us that, had the lockdown not taken place, exports would have moved close to one-to-one with potential demand. We exclude that this may be an overstatement of the supply-side constraints stemming from the lockdown: had we taken the shortcut of using the findings of Berthou and Stumpner (2021), we would have concluded that the impact was even larger.

These results are robust to checks run in order to exclude any mis-measurement bias, due to our restricted set of partner countries or to our use of statistical sources other than the official ones for Italian exports or to the exclusion of specific goods (e.g. protective face masks).

We conclude that the COVID-19 shock has not impaired, beyond the short-run effects of the productive lockdown, the decade-long ability of Italian firms to safeguard their positions in international markets, although a re-assessment may be in order once the pandemic is definitively over.

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Appendix A

This Appendix documents our regression results and provides a short sector-by-sector analysis, focusing on the comparison between actual and model-projected exports in 2020.

Table 1A specifies the exact quarterly time-series regression we have implemented for each sector; the independent variable is the log of the performance index[23], except for chemicals and motor vehicles where goodness-of-fit is higher using the order-4 log-change in exports. Be reminded that we fail to come up with satisfactory regressions for refined petroleum products and other transport equipment, due to the extremely erratic behavior of their exports.

As already mentioned in the main text, the starting point of our typical regression is to model the log of the performance index PI_s as a function of the log of the relative price index P_s, quarter time dummies in order to deal with seasonality, an 'augmented' trading-days regressor to capture calendar effects and supply-side constraints, and a cubic time trend. One or two lags of the endogenous variable, typically the first and/or the fourth one, also depending on the seasonal pattern, are usually sufficient to deal with serial correlation in the residuals. Now suppose, for the ease of exposition, we always implement the order-one lag (denoted as Y_{t-1}), and only that one: once we control for Y_{t-1}, it is often the case that the *change* in the log of the relative price index P_s[24] is statistically significant, while log(P_s) itself no longer is. Also, once we control for Y_{t-1}, the predictive power of the econometric specification we have outlined so far would likely benefit from adding a variable that could capture "what happened" between *t-1* and *t*. To this end, we borrow the insight that when a demand shock hits, exports tend to respond only gradually over time, so that our performance index is expected to temporarily fall. Indeed, we typically find that adding the log-change of the demand index D_s (the denominator of the left-hand side variable, before taking logs) results in the corresponding estimated parameter being statistically significant, having the correct negative sign, and improving the overall fit of the regression.

As for the evolution in the course of 2020, we project fitted values on the basis of observed values for our dependent variables, conditional on the parameters estimated using the sample up to 2019q4. We use our quarterly fitted values to derive the corresponding export index; we then annualize it, compute the percentage change relative to the observed value in 2019 and compare it to the corresponding change in foreign demand (always an exogenous variable in our analysis). For the sake of interpretation, we present the results in terms of the difference in the year-on-year percentage change between exports and foreign demand ('relative export performance' in 2020). Figure 1A shows for each sector: the observed 'relative export performance' in 2020 (blue bar), the predicted one (red bar) and the estimated impact of the sector-specific lockdown implemented in March-April 2020 (green bar[25]).

A short sector-by-sector narrative follows; all percentage changes refer to year-on-year variations between 2020 and 2019, unless otherwise indicated.

[23] The performance index (2010=1) is the ratio between the index (2010=100) for export volumes and the index (2010=100) for foreign demand.
[24] The quarter-on-quarter or the year-on-year variation, where the latter option is consistent with the consensus that the effects of price-competitiveness shocks take time to unfold.
[25] The lockdown is modelled to have impacted on 'relative export performance' exclusively by affecting exports.

Food and Beverages. In both sectors the observed percentage change in exports was 2.9 percentage points (pp) higher than the observed percentage change in demand: food exports increased as opposed to their demand shrinking, while beverages exports fell less than their demand. For both sectors this observed 'relative export performance' is just above the estimated one.

Food exports slightly outperformed the model predictions mainly thanks to growth 'above expectations' in the third and fourth quarters (fig. 2A), when the performance index reached its historical post-2000 maximum (fig. 1 in the main text).

Beverages benefited instead from a very positive first quarter, before the pandemic hit, when exports increased more than 'expected' (by 6.4 per cent with respect to the same period of the previous year), mostly due to wine sales to Germany and the United States, while demand shrinked (by 3.5 per cent).

The lockdown had no impact on these two industries since only 1 per cent of their activities was suspended, according to our computations.

The fashion industry (textiles[26], wearing apparels and leather). For these industries, observed 'relative export performance' in 2020 was quite disappointing: the difference between export and demand growth was around -9pp for textiles and wearing apparels, at -5.4pp for leather (exports shrunk around 20 per cent for all three sectors; the fall in demand was steeper for leather). The lockdown suspended 95.5 per cent of activities in each of these sectors.

For both textiles and wearing apparels the model predicted a better outcome than the observed one. For wearing apparels this is partly due to exports failing, according to the model's dynamic structure, to replicate the good performance recorded in 2019 (fig. 1 in the main text). The estimated impact of the non-essential activity suspension is around 2.5pp for both textiles and wearing apparels.

Much larger is the estimated effect of the lockdown for leather, where it accounts for almost 7pp of the decline in exports. While the size may look as being overestimated (but it must be reckoned that the coefficient of the trading-days regressor is the highest among all our sectors and highly significant), it concurs to explain why the sector strongly outperformed the model predictions, in conjunction with a buoyant fourth quarter when the performance index (ratio of exports to demand, normalized to 1 in 2010) went almost back to its pre-pandemic levels.

Wood and Paper. Both sectors slightly underperformed the model predictions. In particular, wood exports (which exclude furniture) failed to confirm the slightly upward-sloping time trend, which the model estimates to have set in in recent years (the performance index, namely the ratio of exports to demand normalized to 1 in 2010, had touched its post-2010 maximum, above 1.3, in 2019q4; fig. 1 in the main text).

The estimated impact of the lockdown is larger for wood because of the higher suspension share (0.89 vs 0.26). Wood is the sector where exports fell the most (more than 10pp) relative to demand.

Chemicals and Pharmaceuticals. Chemical exports decreased 2pp more than demand, slightly underperforming the model predictions. The lockdown had a marginal impact since only a small share (6.6 per cent) of the industry activities was suspended.

[26] The aggregate excludes face masks both on the export and the demand side.

Pharmaceuticals is one of the few sectors, with food and basic metals, to have witnessed a rise in exports in 2020; however foreign demand for these products expanded even more, leading to a difference of -1.8pp between the two growth rates. This is still a small underperformance relative to the model predictions, due to the model ‘expecting’ exports of pharmaceutical products to confirm the upward-sloping time trend that set in around 2010 (fig. 1 in the main text). Pharmaceutical activities were entirely spared by the lockdown, so it had no impact on exports.

Rubber and plastics. In 2020 exports fell by 5.4pp more than demand, essentially in line with model predictions; estimates suggest that almost one third of this gap is due to the forced suspension of (51.7 per cent of) production activities in March-April 2020.

Other non-metallic minerals and Basic metals. Both sectors witnessed the percentage change in exports exceed that of demand by around 5pp: foreign sales of other non-metallic minerals[27] fell only half compared to their demand, while for basic metals they actually increased against their demand diminishing.

Both sectors outperformed the model predictions, mainly due to the estimated effect of the lockdown, which completely stopped production of basic metals, while the suspension share for other non-metallic minerals was 88.2 per cent.

In particular, exports of basic metals in 2020q3 rebounded much beyond expectations (fig. 2A; exports in the third quarter are historically subdued relative to the year average, as one can infer from the negative coefficient on the corresponding seasonal dummy). To a further analysis, the entire increase in basic metals exports can be ascribed to non-monetary gold and other precious metals, whose exports – and presumably demand – typically increase during periods of crisis; price changes may also be at work, which we fail to fully capture due to our degree of sectoral disaggregation (precious metals are a 4-digit detail).

Fabricated metal products. Exports decreased by 11.5 per cent, demand by 9.5 per cent; the gap is in line with the model prediction. Though the share of production activities that were suspended in March-April 2020 is close to one (0.97), the estimated impact of the lockdown is quite small in comparative terms (suggesting it may be underestimated), due to the close-to-zero non-significant coefficient of the trading-days regressor. We further reckon that our regressions may fail to capture the constraints on production stemming from reduced deliveries of intermediate products from the national supply chain, in particular considering that the activities of the upstream basic metals sector were completely suspended during the lockdown, as mentioned earlier.

Computers and electronics. The decline in exports was almost 4pp larger than that of demand. The model estimates that the suspension of production activities in the industry reduced exports by 5.6pp. This is quite a large impact; it implies that, absent the lockdown measures, exports would have barely fallen. This is due to the high suspension share of the industry (0.87) and to the large, statistically significant, coefficient on the trading-days regressor.

[27] Mainly tiles, glass products and marble.

Electrical equipment. Exports fell around 3pp more than demand, in line with the predictions of the model, which internalizes a slightly downward-sloping time trend. The estimated impact of the lockdown is around -1pp, with 61.6 per cent of activities being suspended.

Machinery and equipment. The industry exports, which account for the largest share over the manufacturing total, grew quite in line with demand, both registering a drop over 10 per cent. Actually, if we take out the estimated lockdown effect, equal to -2.2pp on the grounds of a close-to-one suspension share (0.93), exports over-performed demand. Overall, exports exceeded the model expectations, especially due to a greater-than-expected rebound of sales in 2020q3 (fig. 2A); growth continued in the fourth quarter, when the performance index (the ratio of exports to demand, normalized to 1 in 2010) was close to its post-2010 max, above the 2019 average despite the pandemic.

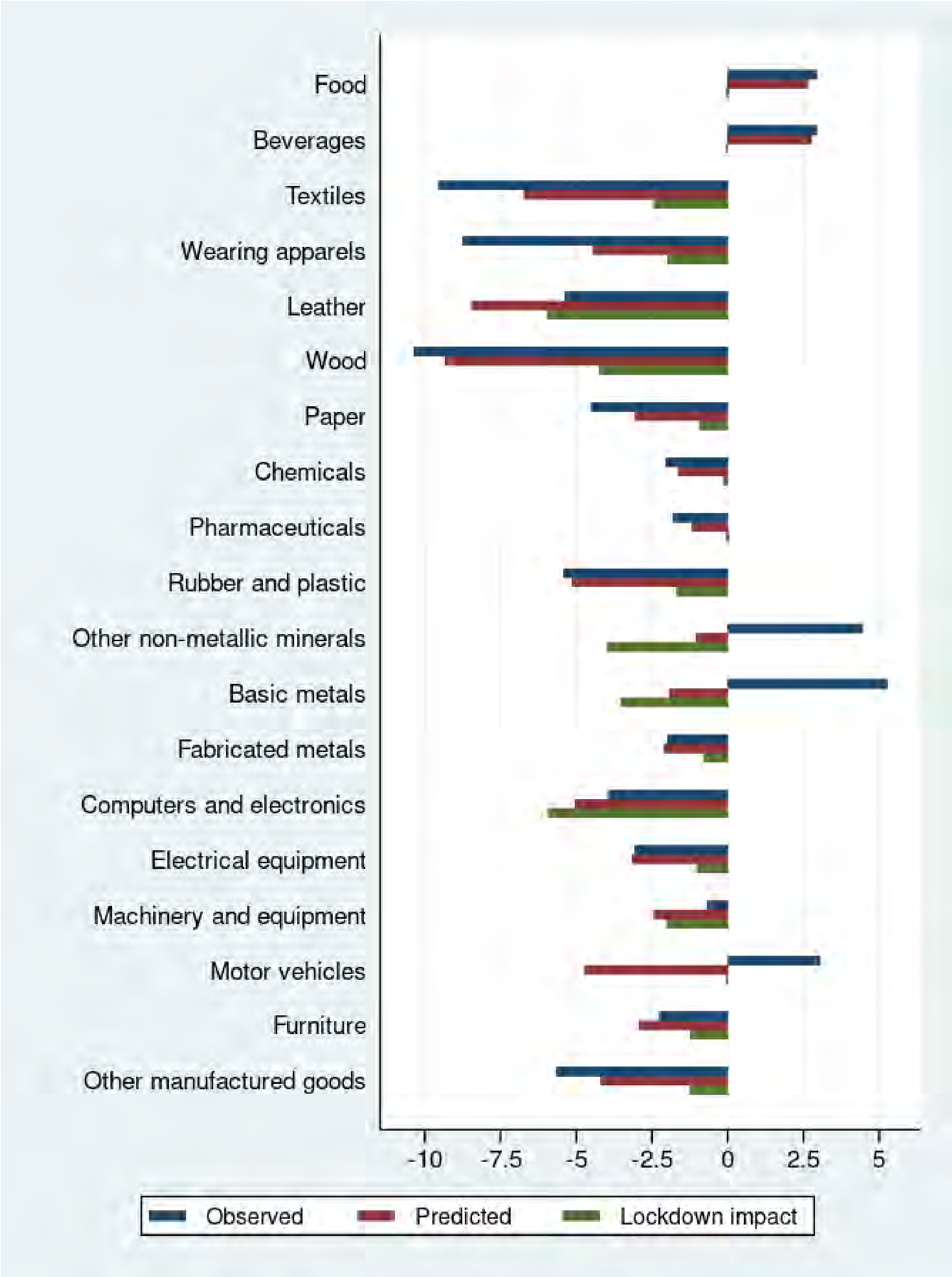
Motor vehicles. Demand decreased by 18.1 per cent, exports by 'only' 15.0; the model predicted a fall close to 23 per cent, with almost no impediments arising from the lockdown. This is due to the backward looking dynamic structure of the regression equation, since in 2019 export performance was disappointing given demand dynamics, and to the estimated drag of the large loss in price competitiveness, which may instead have had a very limited effect in the real world given the sharp contraction in demand (and the likely composition effects that this entailed). The estimated impact of the lockdown, which led to the suspension of all production activities in the industry, is likely to be underestimated: it is almost null because the coefficient of the trading-days regressor is very close to zero (and not statistically significant).

Anectodal evidence suggests that global supply-chain disruptions were an impediment for the automotive sector, especially in the early stages of the pandemic when China went into lockdown. Our model fails to capture these effects; if it did not, however, they would go in the direction of further depressing estimated export performance, thus making the actual one even more 'surprisingly good', given demand.

Furniture and other manufactured goods. In both industries, exports fell more than demand (the difference for other manufactured goods was double the one for furniture) and two thirds of production activities were suspended during the lockdown, with a 1.3pp loss for export growth, according to the model projections. The model predicted export performance to be worse than the actual one for furniture, better than the actual one for other manufactured goods: this is in part due to the estimated time trend, which is more benign for the latter productions.

Fig. 1A – Percentage change in exports minus percentage change in demand, 2020

(percentage changes on 2019)



Notes: Textiles exclude protective face masks.

Fig. 2A - Difference between observed and predicted percentage changes in exports, 2020

(percentage changes on 2019)

Notes: Textiles exclude protective face masks.

Table 1A – Regression results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
	$\log(PI_t)$	$\log(PI_t)$	$\log(PI_t)$	$\log(PI_t)$	$\log(PI_t)$	$\log(PI_t)$	$\log(PI_t)$	$\Delta_4\log(X_t)$	$\log(PI_t)$	$\log(PI_t)$	$\log(PI_t)$	$\log(PI_t)$	$\log(PI_t)$	$\log(PI_t)$	$\log(PI_t)$	$\log(PI_t)$	$\Delta_4\log(X_t)$	$\log(PI_t)$	$\log(PI_t)$
$\log(PI_{t-1})$	0.485***	0.046	0.431***	0.352***	0.575***	0.598***	0.343**		0.609***	0.679***	0.659***	0.658***	0.211***	0.588***	0.454***	0.577***		0.694***	0.817***
	(0.077)	(0.104)	(0.105)	(0.082)	(0.090)	(0.081)	(0.130)		(0.108)	(0.055)	(0.092)	(0.091)	(0.072)	(0.086)	(0.095)	(0.097)		(0.088)	(0.101)
$\log(PI_{t-2})$				0.329***	0.834***								0.205***		0.232**				
				(0.106)	(0.072)								(0.072)		(0.094)				
$\log(PI_{t-3})$					-0.599***														
					(0.099)														
$\log(PI_{t-4})$	0.294***	0.447***	0.254***				0.469***		0.066		0.215**					0.347***		0.150**	
	(0.075)	(0.085)	(0.086)				(0.099)		(0.083)		(0.087)					(0.101)		(0.062)	
$\Delta_4\log(X_{t-1})$																	0.180***		
																	(0.041)		
$\Delta_4\log(X_{t-4})$								-0.111***											
								(0.036)											
$\Delta_1\log(D_t)$						-0.393***			-0.781***		-0.151*	-0.596***		-0.157***		-0.148*		-0.141	-0.201
						(0.119)			(0.273)		(0.080)	(0.121)		(0.055)		(0.085)		(0.088)	(0.164)
$\Delta_2\log(D_t)$					-0.360***														
					(0.112)														
$\Delta_4\log(D_t)$	-0.179**	-0.212*					-0.147**	1.011***									0.983***		
	(0.073)	(0.116)					(0.064)	(0.077)									(0.058)		
$\Delta_3\log(PI_{t-1})$								0.642***									0.471***		
								(0.125)									(0.088)		
$\Delta_1\log(P_t)$									-1.070*	-0.465***		-0.788**	0.012	-0.322*		-0.203**			
									(0.625)	(0.128)		(0.326)	(0.119)	(0.190)		(0.096)			
$\Delta_4\log(P_t)$	-0.443***	-0.353***	-0.112	-0.012	-0.042	-0.122*	-0.266**	-0.126			-0.147**				-0.120		-0.056	-0.096*	-0.107
	(0.072)	(0.064)	(0.088)	(0.086)	(0.099)	(0.070)	(0.116)	(0.170)			(0.065)				(0.110)		(0.096)	(0.055)	(0.120)
trading days	0.001	0.008**	0.004	0.004	0.011**	0.007*	0.005*	0.003	0.001	0.004*	0.006**	0.004	0.001	0.009*	0.002	0.003	0.000	0.003	0.003
	(0.001)	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)	(0.003)	(0.003)	(0.008)	(0.002)	(0.003)	(0.006)	(0.003)	(0.005)	(0.004)	(0.003)	(0.004)	(0.003)	(0.007)
Constant	0.029***	-0.005	0.151***	0.220***	0.089*	0.173***	0.009	-0.005	0.343***	0.095***	0.043	-0.149***	0.058***	0.266***	0.089***	0.067**	-0.053	0.191***	0.234***
	(0.008)	(0.024)	(0.029)	(0.065)	(0.052)	(0.030)	(0.026)	(0.016)	(0.121)	(0.016)	(0.043)	(0.053)	(0.016)	(0.059)	(0.019)	(0.025)	(0.037)	(0.059)	(0.075)
Time trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Seasonal dummies	No	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Dummy outliers	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Observations	76	76	76	76	76	76	76	72	76	79	76	79	78	79	76	76	75	76	76
R^2	0.853	0.945	0.975	0.979	0.892	0.928	0.948	0.931	0.840	0.981	0.964	0.914	0.915	0.960	0.977	0.914	0.947	0.992	0.952

* $p<0.10$, ** $p<0.05$, *** $p<0.01$

Standard errors in parenthesis.

Notes: Textiles exclude protective face masks.

Legend: 1 = food; 2 = beverages; 3 = textiles (excluding protective face masks); 4 = wearing apparel; 5 = leather; 6= wood; 7= paper; 8 = chemicals; 9 = pharmaceuticals; 10 = rubber and plastic; 11 = other non-metallic minerals; 12 = basic metals; 13 = fabricated metal products; 14 = computer and electronics ; 15 = electrical equipment; 16 = machinery and equipment; 17 = motor vehicles; 18 = furniture; 19 = other manufactured goods.

Appendix B

The panel regressions in Berthou and Stumpner (2021) indicate that a one-month-long complete lockdown – complete in the sense that the composite Oxford Stringency Index takes on the value of one – in the exporting country results in a decline of monthly (bilateral) total trade between 10.9 per cent (when trade is broken down at the HS2-digit level) and 21.9 per cent (when only overall trade is considered). Since we use an intermediate level of product granularity with 19 sectors (vs 99 for the HS2 classification), we take the average and consider as a benchmark an impact of 16.4 per cent[28]. In order to compare it with our estimate, we need to make the shock comparable in terms of duration (1/12 of a year in their case, 6 weeks of lockdown over 52 in our case) and intensity (the lockdown was less than complete in Italy), and then recast their estimates in terms of impact on annual exports.

For the first part, it suffices to multiply the benchmark by 1.281, which in turn is the product of [(6/52)/(1/12)] and 0.925: the term in square brackets deals with comparability in shock duration and 0.925 is the average value of the composite Oxford Stringency Index for Italy during our 6 weeks[29]. Then, multiplying 1.281 by their estimated impact of 16.4 yields 21.0.

Hence, the findings of Berthou and Stumpner can be recast as indicating that, had the lockdown not taken place, the value of Italy's exports in our 6-week-long period would have been 21.0 per cent higher than recorded, so that annual sales in 2020 would have been 2.4 per cent higher[30].

Appendix C

We address the concern that, being our sample biased towards euro-area destinations, the computations based on our dataset may be mis-measuring the percentage changes in foreign demand compared to the corresponding 'true' variations.

Starting with demand, World Trade Monitor data at constant prices and exchange rates indicate that overall (un-weighted) goods imports by the euro area (including Italy) fell by 8.2 per cent in 2020, against 4.4 per cent for countries outside the Eurozone (the world average is 5.4 per cent). According to Istat official data the (lagged) weight of euro-area destinations on Italian manufacturing exports at current prices was 0.41 in 2020.

If we were to build an alternative geography-only version of foreign demand based on these numbers (despite they refer to goods, rather than manufactures), we would take the weighted average (-8.2*0.41)+(-4.4*(1-0.41)), and conclude that this version of demand fell by 6.0 per cent in 2020. By repeating the same computations using instead the 'wrong' euro-area share taken from our dataset (0.57), a 6.6 per cent fall would result. This suggests that 'true' demand may have fallen a bit less (0.6 percentage points) than we estimate.

[28] If we instead assume that their estimates decrease linearly in product numerosity from 21.9 per cent (one product only, the total) to 10.9 (99 HS2 products), the benchmark would be 19.8 per cent.
[29] Conteduca (2021) shows that a modified version of the index for Italy, taking into account the regional dimension of the stringency measures, results in a lower overall degree of stringency.
[30] We have divided, in a linear fashion, the 6-week-long impact of 21.0 per cent by the number of 6-week-long periods in a year (52/6=8.67).