

How did disruptions in in-person production affect global production and trade? Lessons from the recent COVID-19 pandemic

The sudden onset of the COVID-19 shock at the beginning of 2020 severely disrupted economic activity, due to the containment measures imposed on a large part of the world's population and the various restrictions put in place to reduce the spread of the virus. Policies imposing social distancing hampered production activities requiring the physical presence of workers and face-to-face contact. Global production was extremely affected by the sharp contraction in the supply of Chinese products used as intermediate goods in most production processes. Global trade volume fell by 13 percent in the first half of 2020, before rebounding strongly thereafter (World Bank, 2020).

Our analysis in Bas et al. (2023) presents a series of stylized facts about short-term resilience of exports to the COVID-19 pandemic and explores its determinants at

the product level. Our study is part of the growing literature on the impact of the pandemic on trade and global value chains (Bonadio et al. 2021). A number of studies show that the locking measures implemented by exporting and importing countries have had a negative impact on trade (Berthou and Stumpner, 2021; Bricongne et al., 2021). However, these studies do not explore differences according to product characteristics. Only studies on China and France respectively take into account the particularity of developments according to the specificities of the products traded. Liu et al. (2021) point out that, against a backdrop of generalized decline, certain products exported by China have risen sharply: these include medical products, but also products with a high proportion of home-based work, high contract intensity and capital goods. Lafrogne-Joussier et al. (2021) focus

on a particular vulnerability corresponding to production dependence on inputs from China. They show that French companies importing intermediate goods from China have had to reduce their exports due to block-ages in their supply chains linked to input shortages.

The main contribution of our work compared with these studies is that it is not limited to exports from a single country (China and France) and to one or a few specific dimensions of how production has been affected by COVID-19. Our study covers exports from all countries to the 29 largest markets, and explores a wide range of specific dimensions of product vulnerability. Also, our paper shows where vulnerabilities in global product supply have emerged in the short term and identifies the costs and benefits of building resilience.

Our empirical analysis is guided by two assumptions based on a standard production function framework. We assume that the COVID-19 shock affected export production through the effects on variable inputs and technology used in the production process. First, COVID-19 shock resulted in global disruptions in the production of domestic inputs and trade of intermediate goods. Products that rely on a poorly diversified portfolio of input suppliers (or those whose inputs have China as main supplier) may be at higher risk of disruption during the pandemic and less able to absorb an adverse shock affecting production and trade. However, we expect that imported input reliance per se has a positive effect on exports since it captures the ability of firms to have a more diversified portfolio of suppliers and not only depend on domestic suppliers of inputs. Second, COVID-19 shock reduced overall in-person labor supply due to social distancing and lockdowns. This labor supply shock concerns all economic

activities that cannot be carried out at home, and which require manual, unskilled labor-intensive tasks. We assume that the shock mainly affects exports of products whose production process is less automated and more intensive in unskilled labor.

Determinants of export resilience to shocks

Our estimates are based on detailed monthly data on bilateral import flows for the EU, Japan, and the United States between January 2018 and December 2021 at the product level (4-digit harmonized system (HS)). We measure the incidence of COVID-19 by the total number of COVID-19 deaths per population per month for each country. We use input-output table and trade data from the pre-crisis period to construct product-level indicators of the vulnerability of countries' exports to shocks. These include the importance of foreign intermediate inputs used in production as well as the weight of China and the

concentration of suppliers in the supply of intermediate inputs necessary for the production of exported goods. We also consider indicators that are specific to a given product and that do not vary between exporting countries, since they reflect differences in the production process between products for all countries. These include unskilled labor intensity from the NBER-CES database of US manufacturing, robot use from Artuc et al. (2023), and also a measure of the degree of technology used in the production process of a product focusing on product complexity (Hidalgo and Hausmann, 2009).

Our analysis relies on econometric estimates that measure how the value of monthly bilateral exports by HS4 products is affected by the COVID-19 incidence in the exporting country and explores how this effect differs by different product vulnerability indicators.¹

1 The equation explains Y , the export value (in logarithms) by country e of HS4 product p to destination market i in month-year t :

$$Y_{eip,t} = \sum_p \beta_p \text{covid_incid}_{e,t-n} + \text{vulnerability}_{eip,t} + \sum_e \alpha_e \text{covid_incid}_{e,t-n} + \text{vulnerability}_{eip,t} + \sum_i \gamma_i \text{covid_incid}_{i,t-n} + X_{ip} + \epsilon_{eip,t}$$

The main coefficients are those on the interactions between each measure of vulnerability at product level - p - (robots, unskilled labor intensity and complexity) or vulnerability at product-exporting country level - ep - (reliance on foreign inputs, export concentration of inputs, and China export share in inputs) and the covid incid is total COVID-19 deaths per capita per exporting-country-month with specific lags n . The analysis includes exporting country-importing country-product fixed effects k_{eip} , exporting country-month-year fixed effects O_{et} and importing country-month-year fixed effects π_{it} to focus on the variation over time for an exporter-importer pair while neutralizing partner-specific supply and demand shocks. X_{ip} includes indicators for COVID-19 medical products and the longevity of product trade relations.

Empirical results

Our empirical results highlight two main determinants of the scale of the impact of the COVID-19 shock on countries' exports, which worked in opposite directions. The first factor is the degree of diversification that characterizes the supply of intermediate products. Products whose production depends more on China or a small group of countries as input suppliers have proved more vulnerable to the COVID-19 shock. The drop in exports induced by COVID-19 was hence greater in countries producing goods whose supply chains rely on a poorly **diversified portfolio of intermediate input suppliers**, or whose inputs have China as their main supplier. The second factor is the **degree of automation**. Products with more automated production processes were more resilient to the COVID-19 shock. The COVID-19 pandemic had a greater impact on exports of products whose production processes were less automated and more intensive in unskilled labor.

Our estimates suggest that countries with a higher incidence of COVID-19 (measured by the number of COVID deaths per capita) see their exports of products more dependent on inputs for which **China is a dominant supplier** fall by 1.4 percentage points compared to those of products

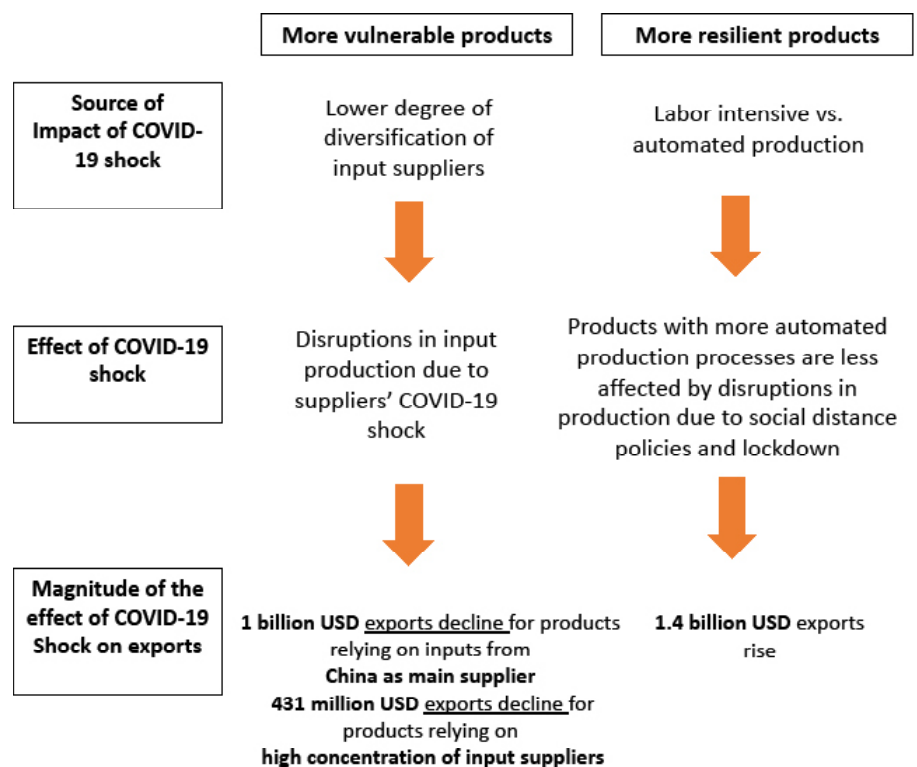
less dependent on China. The decline in exports of products relying more on inputs with a high concentration of suppliers was 0.6 percentage points higher than those of products relying on a more diversified portfolio of input suppliers. These two sources of vulnerability have resulted in decreases of 1 billion and 431 million USD respectively in the median value of exports (valued at 72 billion USD across all country-product-month observations). It is important to note that a **production's dependence on imported inputs** was not in itself a source of vulnerability in the context of the crisis. We measure a relative increase in exports of 2.1 percentage points for products that are more dependent

on foreign inputs, compared with products that have lower foreign input shares and depend mainly on domestic inputs, corresponding to an increase in median exports of 1.5 billion USD.

The degree of automation emerges as a major resilience factor. Our calculations are presented on the right-hand side of *Figure 1*, which shows the main channels and results of our analysis.

We estimate that countries with the highest incidence of COVID-19 recorded a 1.9 percentage point increase in exports of more robot-intensive products (compared to less robot-intensive products), corresponding to a 1.4 billion USD increase in median exports.

Figure 1.
The mechanism explaining the negative effect of COVID-19 on exports



Policy lessons for building resilience to future shocks

Our results inform policy debates on the need to diversify the portfolio of intermediate input suppliers, and to rethink the role of global production and supply agreements and dependency between countries. The study suggests resisting calls for the return of high trade barriers, the replacement of imported intermediate goods with local products and the unbundling of global value chains. This is not so much because it would be very costly, far outweighing the gains to be made (Baldwin and Evenett, 2020; OECD,

2022). What our results show is that the use of foreign inputs helped reduce the vulnerability of exports during the pandemic.

Moreover, the automation of production can also reduce production vulnerabilities as well as increase resilience to future pandemics. In those industries that have a strong reliance on unskilled labor and less automation in the production process, efforts aimed at achieving higher degree of automation and remote collaborations need to be a key priority for policy makers. Reliance on robots and new information tech-

nologies applied to foster remote work collaborations can allow higher resilience to future pandemics. Nevertheless, one has to take into consideration the potential negative impact of automation of production on unskilled employment (that is more easily replaced by machines) which can only be addressed through investments in training and skilled upgrading of production processes as well as alternative models for revenue sharing in the economy (Guellec and Paunov, 2017; Autor et al., 2020).

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