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Questioni di Economia e Finanza

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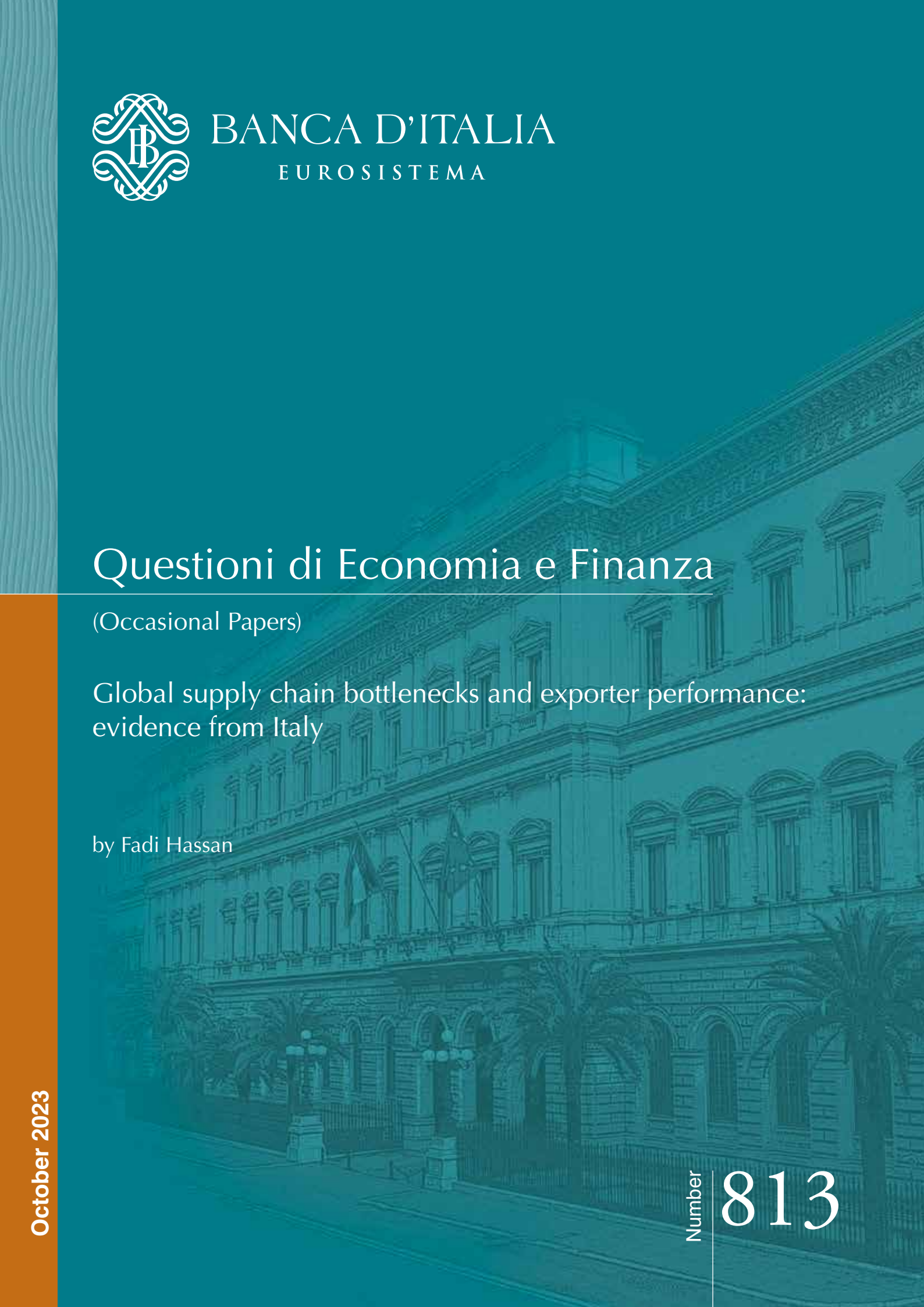

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GLOBAL SUPPLY CHAIN BOTTLENECKS AND EXPORTER PERFORMANCE: EVIDENCE FROM ITALY

by Fadi Hassan*

Abstract

Using custom-level and survey data for Italian firms, this paper examines the performance of firms exposed to global value chain (GVC) bottlenecks in terms of exports, revenues, and hours worked. We find evidence that firms reporting greater difficulties in sourcing the desired amount of inputs experienced posted significantly higher growth on average. The magnitude of this result is larger for firms with more diversified suppliers and is unaffected by the geographical distance of suppliers. We disentangle the role of demand and supply factors in firms' performance and the results suggest that, despite constraints on the supply side, problems in sourcing inputs mostly mirrored an increase in demand. These findings hold true when using alternative direct and indirect measures of firms' exposure to bottlenecks, as well as when taking into account several firms' characteristics and fixed effects. We also examine firms' future GVC strategies through a survey. There is limited evidence of firms willing to retrench from GVCs through re-shoring or near-shoring, but there is strong evidence of firms aiming to increase GVCs' resilience through greater diversification of suppliers and larger inventories.

JEL Classification: F1, F6, D22.
Keywords: GVCs, production bottlenecks, exports.
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Contents

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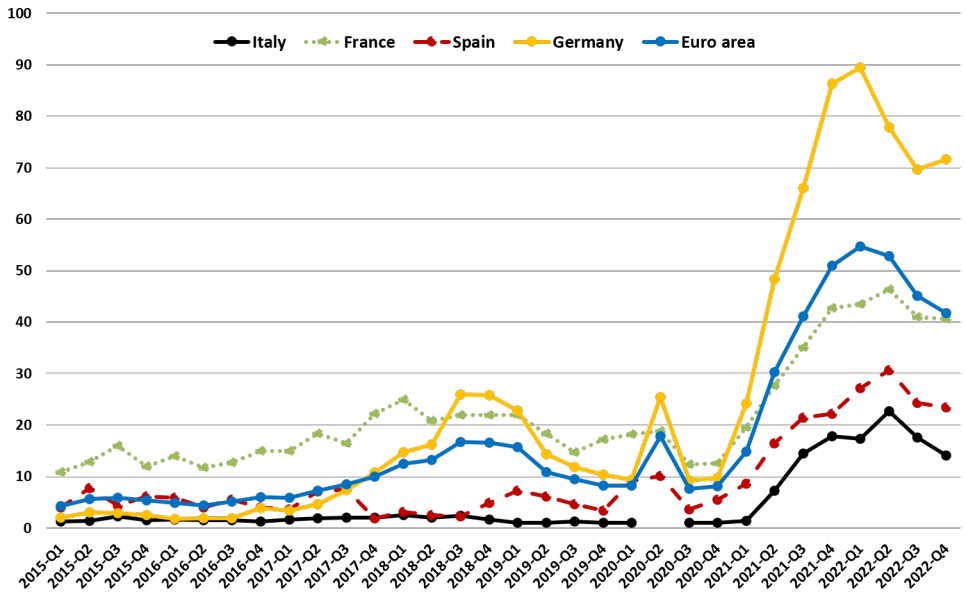
1 Introduction

At the beginning of 2020 Covid-19 pushed the world into a deep recession, but after the first round of lockdowns implemented in several countries, the world economy started to recover at a faster pace than foreseen at the onset of the pandemic. However, since 2021 manufacturing production has been impaired by a global shortage of inputs. Figure 1 shows the share of firms in manufacturing that report a lack of material and/or equipment as a key factor limiting production, according to the European Commission Business Survey. For the euro area as a whole, such share turned well above both the 2015-2019 average and the spike at the time of the first wave of lockdowns in 2020-Q2. Even if the level of shortage is heterogeneous across countries and has been on a declining trend in 2022, it remains very high from a historical perspective.

Figure 1: **Shortage of material and/or equipment as a factor limiting production** (percentage shares)

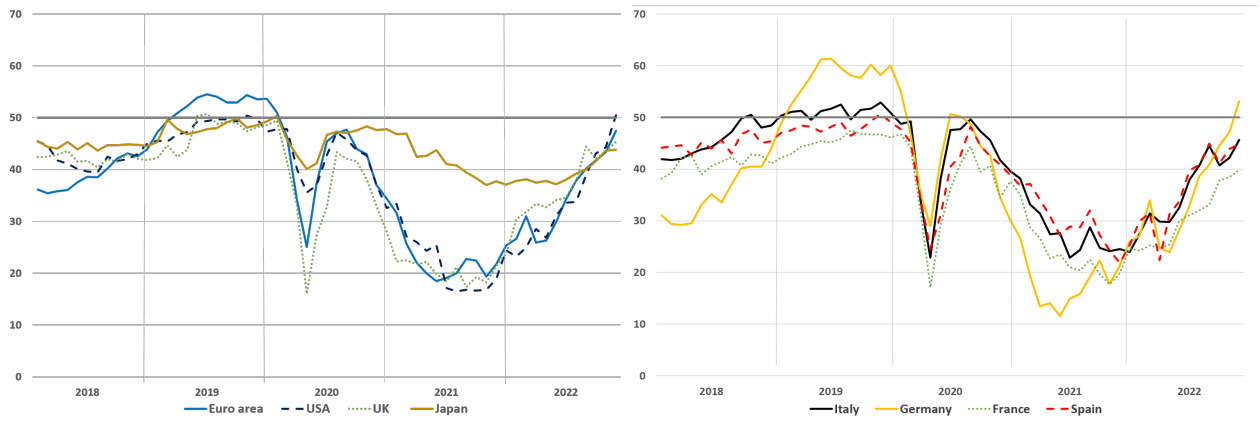


Note: Data from the European Commission Business Survey. Share of survey respondents, within manufacturing, indicating that shortage of material and/or equipment was a key factor limiting production in the reference quarter. Data are seasonally adjusted. The 2020-Q2 observation for Italy is missing because the April 2020 survey was not carried out due to the lockdown.

The shortage of inputs translated into high delays in delivery times of manufacturing products across the globe. According to PMI data this issue was particularly severe in

2021; the share of firms reporting a worse situation relative to the previous month, although declining, was higher than that of firms reporting an improvement or no change also in 2022 (Figure 2).

Figure 2: **Delivery time, manufacturing PMI**



Note Data from Markit, Refinitiv Eikon Datastream. A value below 50 indicates a lengthening of delivery times relative to the previous month, a value of 50 no change and a value above 50 an improvement.

A combination of both demand and supply factors led to the shortage of inputs (IMF, 2022, ECB, 2021). From one side, large fiscal stimulus in US and Europe, as well as consumers' expenditure switching from non-tradable to tradable goods, put high pressure on demand. From another side, the shipping of products from Asia was hampered by outbreaks of Covid-19 in key hubs, as well as by the lower worldwide availability of cargo ships and containers. Moreover, the effects of these shocks on manufacturers have been amplified by the just-in-time production system, which strongly relies on low inventories and round-the-clock input supplies.

Arguably, the shortage of inputs favored inflationary pressures around the world and in the euro area (Lane, 2022). However, the relative contribution of supply versus demand factors in triggering production bottlenecks is still under discussion (di Giovanni et al., 2022) and the impact that this shock will have on firms' global value chain strategies is yet unclear (Antràs, 2021). The paper contributes to the debate on these issues using firm-level data from Italy. The paper aims to answer these questions exploiting custom data and firm-level survey for Italy.

First, we provide some descriptive analysis using the Bank of Italy's annual surveys.

We find evidence that firms declaring to have experienced sourcing problems faced higher growth in revenues and hours worked. This first result is consistent with the idea that firms' problems in sourcing inputs, despite the presence of bottlenecks on the supply side, mostly mirrored an increase in demand. In fact, we also find evidence that firms with sourcing problems were more likely to experience a higher-than-expected demand; but they were not more likely to slowdown or suspend their activity. We also analyze firms' answers on their future sourcing strategy. We find that they are planning to increase the resilience of their supply chains through higher diversification and inventories, but there is not much evidence of firms willing to retrench from GVCs by re-shoring or near-shoring their input supply.

Second, we extend our analysis to the universe of incorporated firms exploiting custom-level data matched with firms' balance sheet data. This data allows for a tighter identification of the effects of firm-exposure to GVCs bottlenecks on exports and it helps to disentangle the role of demand and supply factors. We rely on a diff-in-diff strategy that allows us to look at whether, after accounting for the supply shock that a firm faced due to bottlenecks, exports in 2021 (by product-destination) were above or below the pre-Covid level.

Our estimates show that on average a one standard deviation increase in firm exposure to supply bottlenecks is associated to a 1.2% higher export growth. This implies that despite the negative supply shock that firms had to face, the demand shock was strong enough to push firms' exports above the pre-Covid level of 2019. These estimates become closer to zero and no longer significant if a firm was sourcing from countries with stringent lockdown measures or if a firm had a low geographical diversification of suppliers. However, even in these cases, where the supply shock is larger, export growth did not turn negative and the demand shock was strong enough to push firms' exports to the same level as in 2019. At the same time, our estimates are unaffected by the distance of suppliers. These results are consistent with firms' response about their future GVCs strategy, as firms declared to aim to diversify their suppliers, but they did not plan getting their suppliers closer (i.e. no clear strategy of near-shoring).

2 Supply bottlenecks, firms, and future GVC strategy: descriptive evidence from firm-level survey

The Bank of Italy runs two firm-level surveys per year. One is the Business Outlook Survey of Industrial and Service Firms (SONDTEL) in the Fall. The other is the Survey of Industrial and Service Firms (INVIND) in the Spring.[1] Since the Fall 2021 these surveys include questions that allow monitoring firms' exposure to supply chain bottlenecks. Table 1 shows the distribution of firms' response on the severity of sourcing problems for materials and intermediate inputs (excluding energy and labor) across different waves. We find that up to Fall 2022 more than 40% of firms declare very or fairly significant problems in sourcing inputs. Whereas, this share declines to 24% in the Spring of 2023.

Table 1: Problems in sourcing materials and intermediate inputs (percentage shares)

	Fall 2021	Spring 2022	Fall 2022	Spring 2023
Very significant	24.7	21.2	17.6	7.2
Fairly significant	22.9	26.1	31.5	17.2
Slightly significant	10.2	19.2	27.3	19.6
Not at all	37.2	23.0	20.7	45.1
Not available	2.0	10.5	2.9	10.9
Number of firms	2,709	2,362	2,664	2,358

Note: Data are from INVIND for Spring 2022 and from SONDTEL for Fall 2021 and 2022. The table shows the percentage shares of answers across manufacturing firms using sampling weights. Materials and intermediate inputs exclude energy and labor.

In the following analysis, we focus on the INVIND survey of Spring 2022, as it represents the peak of bottlenecks issues and it includes quantitative information on firms' economic activities. We consider "treated" a firm that experienced some degree of bottleneck in the supply of inputs in such survey. Our baseline definition ("treatment 1") includes all firms that had some sourcing issues (high, medium, or low) for either semiconductors or other inputs and it counts the firms with no sourcing problems as control.

[1] Both surveys offer a representative sample that includes more than 2,000 firms with 20 or more employees in manufacturing (and about 5,000 firms in total). SONDTEL gathers qualitative information on ongoing trends. INVIND gathers quantitative information on key economic variables.

As robustness, we also use a definition ("treatment 2") that considers treated only firms with high- or medium-level problems and as control the firms with low or no-problem.

Figure 3 shows the *unconditional* distribution of the growth rate of revenues and hours worked between 2021 and 2020 given the two definitions of treatment described above. The graph shows that firms more exposed to input bottlenecks tend to have stronger growth in revenues and, to some extent, of hours worked. Probably, without the presence of sourcing problems, these firms would have grown even further. However, this first evidence suggests that supply bottlenecks did not push firms' growth into negative territory.

We also look at the average growth differential between treated and control firms within sectors and conditional on firms' characteristics, by running the following OLS specification:

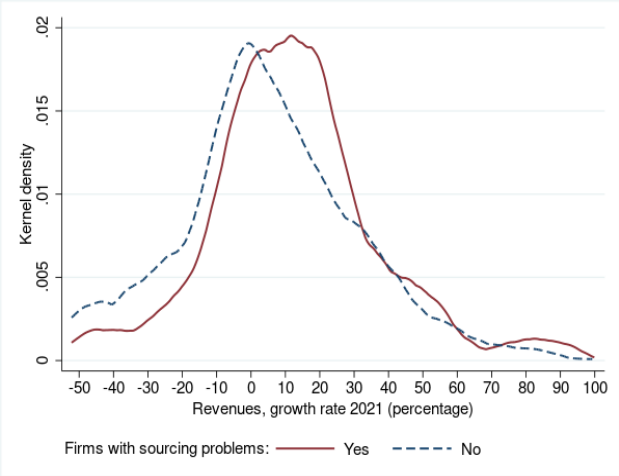
$$Y_{isg} = \beta_1 \, Treatment_i + \boldsymbol{X_i'\delta} + \alpha_s + \gamma_g + \epsilon_{isg} \tag{1}$$

where Y_{isg} represents the growth rate of revenues and hours worked between 2021 and 2020 of firm i operating in sector s and located in the geographic area g. $\boldsymbol{X_b}$ is a vector of firm-level control variables such as size (proxied by the number of workers), age, and a dummy capturing if a firm belongs to a group. The specification includes fixed effects for sectors (α_s) and geographic areas (γ_g). The level of aggregation of these two variables is broad (six manufacturing sectors and four geographic areas), but this choice accounts for the level of stratification of the survey, which strengthens the representativeness of our estimates to the universe of firms.[2] This is a conservative choice; using narrower definition of sectors or geographic areas reinforces the results in terms of magnitude and statistical significance. Errors are clustered at the sectoral level.

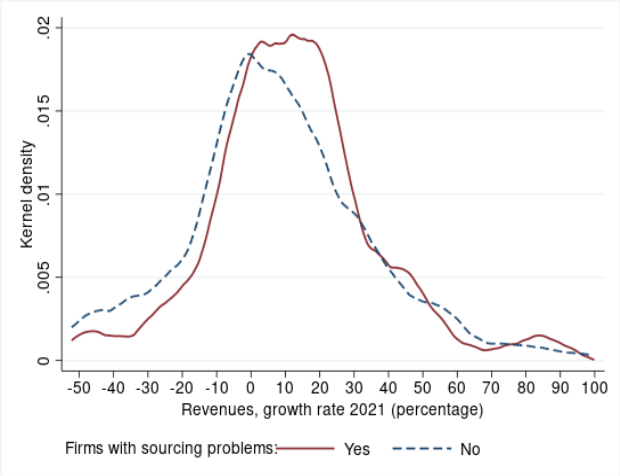
Table 2 shows that firms subject to bottlenecks had on average a 6%-7% higher growth in revenues (columns 1 and 2) and 2.6% in hours worked (columns 5 and 6). These results are robust to the inclusion of firm-level controls and geographic fixed effects, as well

[2]The manufacturing sectors are: "Food, beverages and tobacco"; "Textile, leather, apparel, and footwear"; "Coke, chemicals, rubber, and plastics"; "Mineral and metal products"; "Machinery, electronics, and automotive"; "Other manufacturing industries". The geographic areas are: "North-West"; "North-East"; "Centre"; "South and Islands"

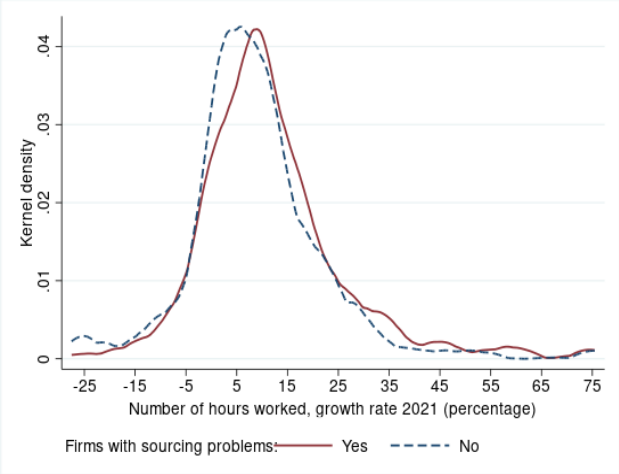
Figure 3: Input sourcing and firms' performance (distribution)



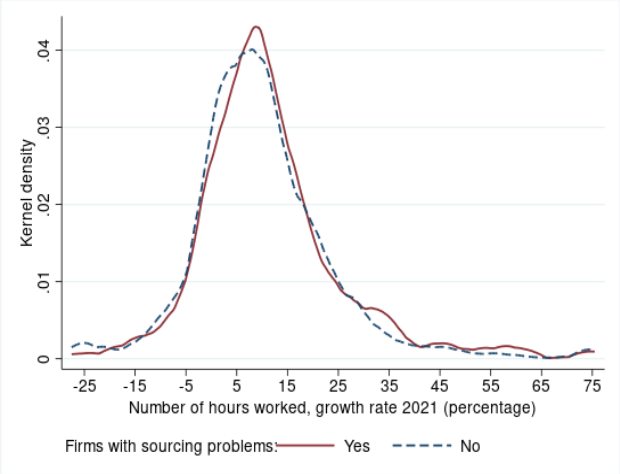
(a) Revenues growth rate (treatment 1)



(b) Revenues growth rate (treatment 2)



(c) Working hours, growth rate (treatment 1)



(d) Working hours, growth rate (treatment 2)

Note: the figure shows the firm-level distribution of growth in revenues (panels a and b) and hours worked (panel c and d) between 2021 and 2020 for firms subject and not subject to supply constraints, using Treatment 1 and Treatment 2 as alternative definitions. Data on revenues are at constant prices using the average value of the deflator computed in INVIND.

as across definitions of firm-level treatment. The correlation between supply bottlenecks and growth of hours worked is positive, but not statistically significant when using "treatment 2" (columns 7 and 8). Overall, these results confirm that the presence of bottlenecks did not have a negative effect on firms' growth, but it was rather associated to a better firm performance also when controlling for other firm-level characteristics, sector, and location.

Table 2: Supply bottlenecks and firm performance

	Revenues				Hours worked			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treatment 1	6.08**	7.20**			2.61**	2.61**		
	(2.37)	(2.42)			(0.94)	(0.84)		
Treatment 2			3.45**	4.62**			1.37	1.40
			(1.20)	(1.27)			(1.12)	(1.09)
Sector F.E.	✓	✓	✓	✓	✓	✓	✓	✓
Firm Controls		✓		✓		✓		✓
Location F.E.		✓		✓		✓		✓
Observations	2,297	2,238	2,297	2,238	2,297	2,238	2,297	2,238
R-squared	0.14	0.15	0.13	0.14	0.04	0.06	0.04	0.05

Note: The table shows the result of the OLS regression 1 where the dependent variable is the growth rate between 2020 and 2021 of firm revenues (columns 1-4) and hours worked (columns 5-8). The variable "Treatment 1" counts as treated any firm that reported some problems in sourcing intermediate inputs (low, medium and high) and as control the firms that reported no problems. The variable "Treatment 2" considers treated the firms that reported medium and high problems in sourcing inputs, and control the firms that reported low or no problems. Firm controls include the number of workers as a proxy of firm size, age, and a dummy that captures if a firm belongs to a group. Sector and geographical fixed effects are defined at the level of the survey's stratification to strengthen representativity to the universe of firms. These includes 6 broad manufacturing sectors and 4 macro-geographic areas. Standard errors are clustered at the sector level. ***significant at the 1% level, ** significant at the 5% level, * significant at the 10% level.

Table 3 shows firms' developments according to their exposure to bottlenecks (*unconditionally*). For instance, the table shows that 10.2% of firms with bottlenecks experienced a higher-than-expected demand in a "very significant" way, whereas only 5.9% of the firms with no bottlenecks did. Similarly, 24.1% of firms with bottlenecks had a "fairly significant" increase in delivery times, but only 9.4% of firms without bottlenecks did.

Overall, Table 3 shows that the firms more exposed to bottlenecks, when compared to firms with little exposure, had a more significant higher-than-expected demand, increase in prices, reduction of profit margins (a proxy of reducing mark-ups), increase in delivery time and to some extent a change in their network of suppliers; whereas the exposed firms did not face a remarkably larger suspension or reduction of production. The fact that firms exposed to bottlenecks had a more significant unexpected increase in demand, and not a more severe disruption in production, is consistent with the idea that demand factors were stronger than supply factor in triggering such bottlenecks. Whereas, the increase in prices and reduction in profit margins can point towards either direction.

Table 3: Firms' developments by exposure to bottlenecks
(percentage shares)

Degree of firms' experience:	Very significant		Fairly significant		Slightly significant		Not at all	
	Bott	No-Bott.	Bott	No-Bott.	Bott	No-Bott.	Bott	No-Bott.
Firms experienced:								
Higher-than-expected demand	10.2	5.9	21.5	17.0	18.3	22.2	50.1	54.7
Increase in prices	11.0	5.8	29.3	23.1	38.3	38.7	21.2	32.4
Reduction of profit margins	8.0	3.3	21.3	12.2	41.3	41.6	29.4	42.8
Reduction/suspension of business	0.7	0.2	3.4	2.1	8.2	5.9	87.7	91.8
Increase in delivery time	6.3	2.0	24.1	9.4	27.8	27.1	41.8	61.5
Changes in network of suppliers	1.8	0.4	15.8	7.0	37.3	24.4	45.2	68.2

Note: Data are from INVIND and they refer to firms' actions between Fall 2021 and Spring 2022. Firms with bottlenecks are the ones that declared to have "very significant" or "fairly significant" problems in sourcing inputs as in Table 1. The table shows the percentage shares of answers across manufacturing firms using sampling weights. Materials and intermediate inputs exclude energy and labor.

Next, we run a linear probability model with the same econometric specification of Equation 3, in order to look at the correlation of firms' responses and bottlenecks, accounting for firm sector, location and other characteristics. The dependent variable taking

the value of one if the firm answered positively (”very signficant” or ”fairly significant” to having faced one of the actions listed in Table 3 and zero otherwise.

Table 4 shows that firms exposed to bottlenecks were 23% more likely to modify the structure of their inputs' suppliers and 24% more likely to record an increase in delivery time. They also had a higher probability to have faced a higher-than-expected demand and to compress their profit margins, and to some extent increase prices. However, such firms did not experience a higher probability to slowdown or suspend their activity. This result, combined with the evidence above, supports the idea that firms' problems in sourcing input, despite the presence of bottlenecks on the supply side, mostly mirrored an increase in demand.

Table 4: Supply bottlenecks and firm's response

	Higher than expected demand	Increase price	Reduce profit margins	Reduce/suspend production	Increase delivery time	Change network suppliers
Treatment 1	0.07**	0.11***	0.18***	0.03	0.24***	0.23***
	(0.02)	(0.01)	(0.02)	(0.03)	(0.06)	(0.02)
Sector F.E.	✓	✓	✓	✓	✓	✓
Firm Controls	✓	✓	✓	✓	✓	✓
Location F.E.	✓	✓	✓	✓	✓	✓
Observations	2,238	2,211	2,194	2,202	2,199	2,189
R-squared	0.03	0.07	0.06	0.02	0.16	0.07

Note: The table shows the result of a linear probability model with the same econometric specification as in 1. The dependent variable takes the value of one if the firm has undertaken one of the actions in each column and zero if it did not. The variable ”Treatment 1” counts as treated any firm that reported some problems in sourcing intermediate inputs (low, medium and high) and as control the firms that reported no problems. Firm controls include the number of workers as a proxy of firm size, age, and a dummy that captures if a firm belongs to a group. Sector and geographical fixed effects are defined at the level of the survey's stratification to strengthen the representativity of the results to the universe of firms. These includes 6 broad manufacturing sectors and 4 macro-geographic areas. Standard errors are clustered at the sector level. ***significant at the 1% level, ** significant at the 5% level, * significant at the 10% level.

Finally, the survey offers information about firms' future strategy on global value chains. It asks whether in the period 2022-23 firms are likely to: i) substitute foreign suppliers with domestic suppliers (re-shoring); ii) substitute their current foreign suppliers with other foreign suppliers, but located more closely to Italy (near-shoring); iii) substitute domestic suppliers with foreign suppliers (off-shoring); iv) increase the number of suppliers for the same input (diversification); v) increase inventories of raw material and

intermediate inputs; and vi) increase inventories of final goods produced.[3]

Table 5 reports the results for firms that were subject to bottlenecks. It shows that 67% of these are likely or certain to increase the diversification of suppliers, 56% plan to raise the level of inventories of intermediates and materials and 45% the inventories of final goods. At the same time, there is a low share of firms that aim to re-shore or near-shore the source of their input, and some firms are even likely to increase off-shoring (so the net re-shoring is relatively small). These results suggest that firms are planning to increase the resilience of global value chains through diversification and inventories, but there is not much evidence of firms willing to retrench from globalization or GVCs.[4]

Table 5: GVC future strategy of treated firms

	Re-shoring	Near-shoring	Off-shoring	Diversification of suppliers	Inventories intermediates	Inventories final goods
Certainly	2.4%	0.9%	0.8%	16.7%	20.9%	14.7%
Likely	16.9%	17.0%	10.5%	49.3%	35.7%	29.2%
Unlikely	64.4%	65.7%	81.7%	32.5%	20.9%	50.9%
Not-Applicable	16.3%	16.3%	7.0%	1.4%	3.5%	5.1%
Observations	1,492	1,492	1,492	1,492	1,492	1,492

Source: INVIND, 2021. **Note:** The table shows firms' answers (using sampling weights) to the following question in the INVIND survey: "Does your firm plan to take any of the following actions in 2022-2023?". The possible answers were: "Yes, definitely" (Certainly); "Yes, probably" (Likely), "No" (Unlikely), "Not applicable".

[3]The set of possible answers is: "Yes, certainly", "Yes, likely", "No, unlikely", "Not applicable".

[4]Table A.2 in the Appendix show that results for the full sample of firms are similar. These results are confirmed also looking at the INVIND survey of 2023 (available upon request).

3 GVC's sourcing bottlenecks and exports' performance: disentangling supply and demand factors

In this section, we expand the analysis to the universe of incorporated firms exploiting custom-level data matched with firms' balance sheet data, as well as leveraging on the information contained in the survey described in the previous section. This data allows for a tighter identification of the effects of firm-exposure to GVCs bottlenecks on their exports and it helps to disentangle the role of demand and supply factors on firms' performance.

Our baseline specification relies on the following two-periods diff-in-diff in log-differences:

$$\Delta \ln Exports_{ipd} = \beta_1 \; Supply \; Bottleneck_i + \boldsymbol{X_i'\delta} + \alpha_{pd} + \epsilon_{ipd} \tag{2}$$

where the dependent variable is the change in log-exports between 2021 (the post-period) and the pre-Covid level in 2019 (the pre-period) of firm i for product p to destination d; *Supply Bottleneck*$_i$ captures firm-level exposure to input supply problems, which we will measure in several alternative ways; $\boldsymbol{X_b}$ is a vector of ex-ante firm-level characteristics in 2019 such as size, profitability, leverage, wage-bill over revenues, and age; α_{pd} is a product-destination fixed-effect that accounts for aggregate demand shocks in that specific market; firm fixed effects are absorbed by taking differences; errors are clustered at the sector level.[5] [6]

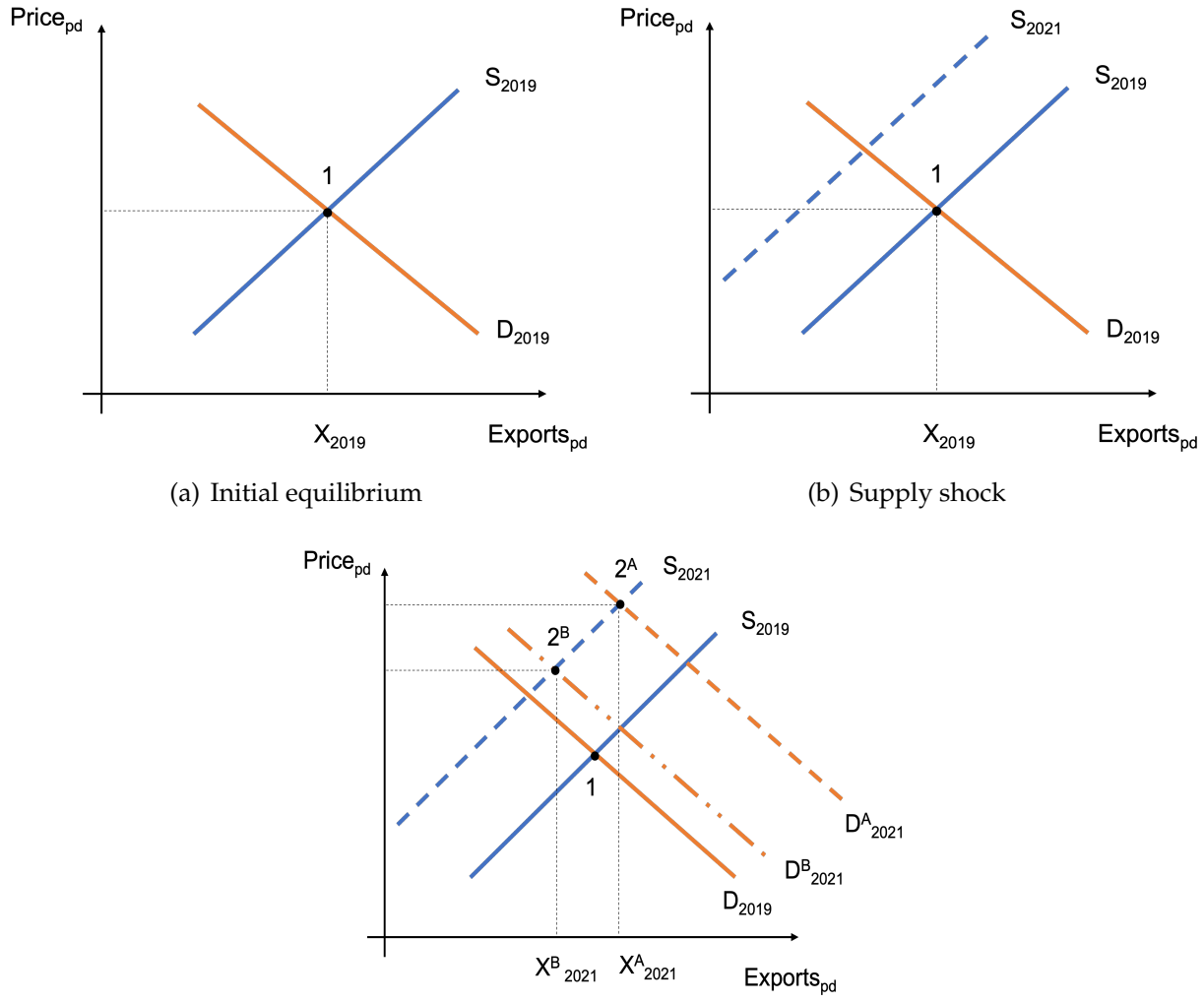
Figure 4 explains, in a simplified way, the thought experiment underlying specification 2. Let's start from the ex-ante equilibrium that a firm faced in 2019 for product p in market d. We know that in 2021 firms were subject to a negative supply shock because of GVCs bottlenecks (panel b). We measure the firm-specific supply shock with the variable *Supply Bottleneck*$_i$. Let's now suppose that in 2021 a firm faced a positive demand shock; it could be the case that it was strong enough to compensate for the negative supply shock and pushed firm's exports above the 2019 level (point 2A in panel c); or the demand shock could have not been strong enough and it may have left exports below the 2019 level. We

[5] This specification is a computationally more efficient way to estimate the following equivalent regression in levels: $\ln Exports_{ipdt} = \beta_1 \; Supply \; Bottleneck_i \times Post_t + \boldsymbol{X_i'\delta} \times Post_t + \alpha_{pdt} + \gamma_i + \epsilon_{ipdt}$.

[6] Our sample includes about 85,000 exporters that account for 73% and 58% of extra- and intra-EU Italian merchandise exports respectively.

do not observe the demand shock of a firm but, with some caveat in mind we discuss below, a positive coefficient of β_1 implies that, after accounting for the supply shock that a firm faced, its level of exports is above 2019 (a negative coefficient would imply that it is below). Therefore, equation 2 informs us about the role of demand factors for GVCs bottlenecks and by looking at the realization of firms' exports tells us wether problems in sourcing inputs reflected more a negative supply shock or a positive demand shock.

Figure 4: Supply and Demand Shocks



(a) Initial equilibrium

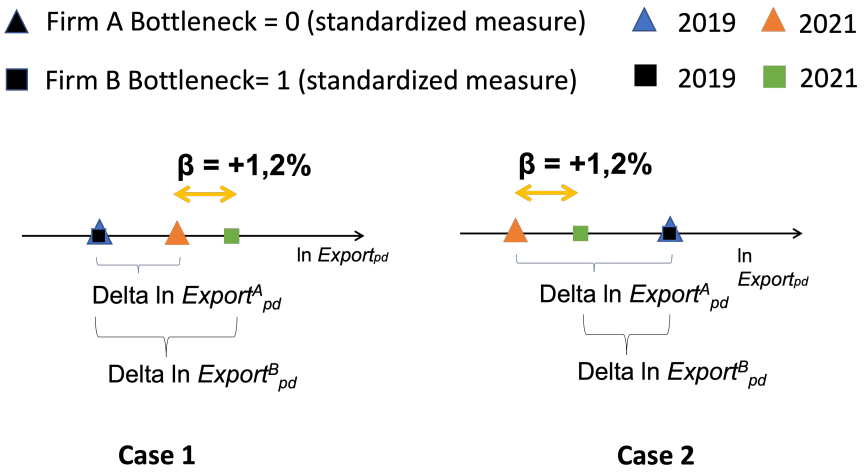
(b) Supply shock

(c) Demand shock and new equilibrium

Notice that the product-destination fixed effects control for the aggregate demand shock of a specific market, so the coefficient β_1 is informative about the role of firm-

specific idiosyncratic demand shocks on exports' growth. Looking at how β_1 changes between a specification with and without product-destination fixed effects is going to help us understand better the different role that aggregate and idiosyncratic demand shocks may have played.

Figure 5: Interpretation of the diff-in-diff results



Note: Case 1 shows a situation in which the diff-in-diff coefficient captures a positive differential effect when firms have a higher level of exports in 2021 relative to the baseline year in 2019. Case 2 shows that the same positive differential coefficient could arise from a situation where firms have a lower level of exports in 2021 relative to baseline.

There are two relevant caveats to keep in mind when mapping the explanation in Figure 4 to the econometric specification 2. First, our baseline regression considers the value of exports, whereas our graphical example refers to export quantities. Nevertheless, the fixed-effects structure can control for product-destination price shocks. Second, the regression captures a differential effect across exporters with heterogenous exposure tos supply bottlenecks. Let's suppose that β_1 is equal to 1.2% (which is the value of our baseline estimates). As Figure 5 shows, this implies that on average a firm with supply bottlenecks experienced 1.2% higher exports relative to a firm with no bottlenecks. However, this may refer either to a situation where the level of exports is indeed above 2019 (case 1) or to a case where both firms are at a lower level of exports relative to 2019 (case 2). In order to disentangle between these two cases, we augment equation 2 with *Supply Bottleneck*$_i$ interacted with an indicator variable that takes the value of one if the level of

export of firm i for product p to destination d in 2021 is above the 2019 value and zero otherwise. In this way, we can investigate the symmetry of results between cases when exports are below or above the pre-Covid level.

3.1 Measuring exposure to GVCs bottlenecks

Having a reliable measure of firm exposure to supply bottlenecks is a key aspect of our identification strategy, as it allows us to control for the firm-level supply shock that companies have faced. We are going to leverage on both the firm-level survey and the custom data to compute alternative measures for the variable *Supply Bottleneck*$_i$. Each measure has its own advantage and looking at the results for the full set of measures increases the robustness of our estimates. Below we describe the different proxies that we use.

Measure 1: we use the ex-ante share of firms' imports over revenues (in 2019). The underlying intuition is that firms that rely on a higher share on imported inputs also have a higher exposure to GVCs bottlenecks (intention to treat). Indeed, we find that a one standard deviation increase in import share over revenues is associated with a 30% increase in the probability of declaring sourcing problems in the survey. The advantage of this measure is to be easy to compute and interpret and it allows us to extend the analysis to the universe of exporting firms.

Measure 2: we use the treatment variable from INVIND described in section 2. This allows us to have a direct measure of firms' problems in sourcing inputs, but it limits the analysis only to the sample of firms in the survey.

These measures capture firm level exposure to supply bottlenecks on international markets. However, firms may have had sourcing problems domestically too, for instance related to local lockdown measures or labor shortages. In order to account for possible domestic supply disruption we add province fixed effects to equation 2, which accounts for these type of common shocks to producers in a given province.

Next, we aim to identify heterogeneity in supply shortages accounting also for the sourcing structure of firms and the type of countries they buy their input from. For instance, two firms with the same ex-ante import share over revenues may have a differ-

ent degree of diversification of suppliers, which would translate into a different level of supply shocks. Similarly, firms with more distant suppliers or with suppliers located in countries subject to strict lockdown measures could have faced a stronger supply shock that we would need to account for. Therefore, we augment the baseline specification in the following way:

$$\begin{aligned}\Delta \ln Exports_{ipd} =& \beta_1 \; Supply \; Bottleneck_i + \beta_2 \; Supply \; Bottleneck_i \times K_i + \\ & \beta_3 \; K_i + \boldsymbol{X_i'\delta} + \alpha_{pd} + \epsilon_{ipd}\end{aligned} \tag{3}$$

where K_i is alternatively the ex-ante measure of firm's i i) exposure to lockdown measures in sourcing countries, proxied by the weighted average of the Oxford stringency index of the countries of a firm's suppliers; ii) degree of concentration of suppliers by country, measured by the Herfindahl index of sourcing countries; iii) weighted average of suppliers' distance, where the weights are the share of imports from each country. The linear combination of β_1 and β_2 allows us to capture the heterogeneous supply shock of firms according to their sourcing diversification and the characteristics of the sourcing countries. This specification allows us also to relate the export performance of firms more exposed to supply bottlenecks to the future GVC strategy we analyzed in Table 5.

3.2 Results

Table 6 shows the results using measure 1. In the first three columns we show the results for the aggregate level of firm's exports $\Delta \ln Exports_i$. The first column shows that on average a one standard deviation increase in exposure to bottlenecks is associated to 1.4% higher export growth. Column 2 controls for initial firm-level characteristics such as profitability, capitalization, size, labor costs, and leverage. Column 3 controls also for industry-level shocks. The coefficient for aggregate exports is remarkably stable across all specifications. In the following columns we look at export growth by firm-product-destination. Column 4 shows that on average in a given product-destination, firms with one standard deviation increase in bottlenecks experience 1.3% higher export growth. The results is stable to adding (firm-level controls) and product-destination fixed effects. These result suggests that firms that were experiencing problems in sourcing inputs were

performing better. This is consistent with the idea that demand pressure played a crucial role. If that were not the case, we should have observed a negative coefficient of firm exposure to GVCs bottlenecks.

Table 6: Exposure to GVCs bottlenecks and export growth

Dep Var:	$\Delta \ln Exports_i$	$\Delta \ln Exports_i$	$\Delta \ln Exports_i$	$\Delta \ln Exports_{ipd}$	$\Delta \ln Exports_{ipd}$	$\Delta \ln Exports_{ipd}$
	(1)	(2)	(3)	(4)	(5)	(6)
Supply Bottleneck	0.014**	0.016**	0.018***	0.013***	0.015***	0.012***
	(0.006)	(0.006)	(0.005)	(0.004)	(0.004)	(0.003)
Firm controls		✓	✓		✓	✓
Sector F.E.			✓			
Product-Dest. F.E.						✓
Observations	80,816	75,649	75,592	1,107,961	1,093,546	1,087,646
R-squared	0.01	0.01	0.03	0.01	0.01	0.05

Note: The table shows the result of the OLS regression 2 where the dependent variable is export growth rate between 2021 and 2019 at the firm-level (columns 1-3) and at the firm-product-destination level (columns 3-6). Firm controls include ex-ante measures of size, profitability, leverage, wage-bill over revenues, and capitalization. Standard errors are clustered at the 4-digit sector level. ***significant at the 1% level, ** significant at the 5% level, * significant at the 10% level.

Table A.1 in the Appendix, replicates Table 6 using Measure 2, as described in section 3.1; hence it restricts the sample to firms in the INVIND survey. The coefficients are typically larger, but less precisely estimated given the lower sample size. However, this alternative measure delivers the same results.

Table 7 looks at the results of the same specification of column 6 in Table 6 by splitting the sample between product-destination pairs whose exports in 2021 were above or below 2019. The results show that the average coefficient in the economy was driven mainly by markets with positive growth, which is consistent with Case 1 described in Figure 5.

Next, we look at how the average effect shown in column 6 of Table 6 change according to the characteristics of the sourcing countries that firms were importing from. Figure 6 shows the linear combination of the marginal effect of the coefficients β_1 and β_2 estimated in regression 3 with 99% confidence intervals. For firms sourcing from countries with a one standard deviation higher stringency of lockdown measure the coefficient is close to zero. These firms are likely to have experienced higher sourcing bottlenecks, hence

Table 7: Exposure to GVCs bottlenecks and export by market type

Dep Var: Δ ln Export$_{ipd}$	Positive growth Product-destination	Negative growth Product-destination
Supply Bottleneck	0.0140***	0.009**
	(0.003)	(0.004)
Firm Controls	✓	✓
Product-Destination F.E.	✓	✓
Observations	588,867	498,779
R-squared	0.04	0.01

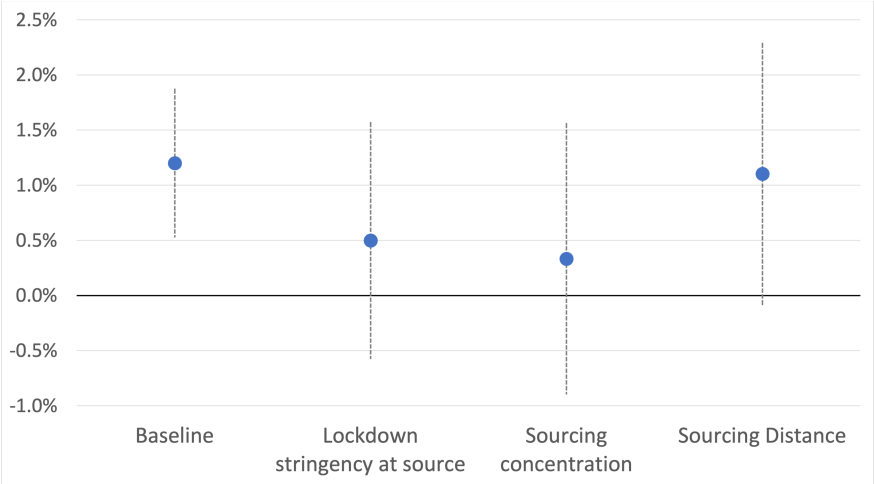
Note: Standard errors are clustered at the sector level. ***significant at the 1% level, ** significant at the 5% level, * significant at the 10% level.

a larger negative supply shock. However, even for them, the point estimate on export growth is not negative, but actually positive albeit statistically different from zero.

Similarly, if a firm has a one standard deviation higher concentration in input suppliers it did not experience stronger exports (but it also did not experience negative growth). This result implies that a higher geographical diversification of suppliers was beneficial to leaning against bottlenecks. This is consistent with the future GVC strategies of firms analyzed in section 2. In fact, firms' main response to bottlenecks seem to be an increase of sourcing diversification.

Finally, notice that the baseline coefficient is virtually unaffected for a one standard deviation increase of the distance of sourcing countries. The estimate becomes a bit more imprecise, but it remains significant at the 5% level. Also this result is consistent with firms' low willingness to re-shore or near-shore their suppliers discussed in section 2.

Figure 6: GVCs exposure and sourcing countries heterogeneity: marginal effects on export growth



Note: The Figure shows the linear combination of the marginal effect of the coefficients β_1 and β_2 estimated in regression 3 with 99% confidence interval. The details of the variable are described in section 3.1.

4 Conclusions

This paper analyzes the performance of firms exposed to GVCs bottlenecks. It finds evidence supporting the idea of a prominent role of demand factors in affecting firms' problems in sourcing intermediate goods. Firms more exposed to bottlenecks grew faster; probably they could have grown even further without such sourcing issues, but GVCs bottlenecks did not push firms into negative growth. We also find evidence of firms' willingness to increase the resilience of GVCs through a higher diversification of suppliers, but there is no evidence of firms willing to retrench from GVCs.

References

Antràs, P. (2021), De-globalisation? global value chains in the post-covid-19 age, ECB Sintra Volume.

di Giovanni, J., Kalemli-Özcan, Silva, A. and Yildirim, M. A. (2022), Global supply chain pressures, international trade, and inflation, ECB Sintra Volume.

ECB (2021), Economic bulletin, Issue 4.

IMF (2022), World economic outlook: War sets back the global recovery, April.

Lane, P. (2022), Bottlenecks and monetary policy, The ECB Blog.

Appendix

Table A.1: Exposure to GVCs bottlenecks (Measure 2) and export growth

Dep Var:	$\Delta \ln Exports_i$	$\Delta \ln Exports_i$	$\Delta \ln Exports_i$	$\Delta \ln Exports_{ipd}$	$\Delta \ln Exports_{ipd}$	$\Delta \ln Exports_{ipd}$
	(1)	(2)	(3)	(4)	(5)	(6)
Supply Bottleneck	0.092**	0.099**	0.077	0.064**	0.073**	0.028**
	(0.040)	(0.035)	(0.057)	(0.029)	(0.033)	(0.011)
Firm controls		✓	✓		✓	✓
Sector F.E.			✓			
Product-Dest. F.E.						✓
Observations	2,074	2,074	2,074	110,240	109,798	103,114
R-squared	0.01	0.01	0.03	0.01	0.01	0.12

Note: The table shows the result of the OLS regression 2 where the dependent variable is export growth rate between 2021 and 2019 at the firm-level (columns 1-3) and at the firm-product-destination level (columns 3-6). Firms' exposure to supply bottlenecks is measured using firms' answers to the INVIND survey as described in Section 3.1. Firm controls include ex-ante measures of size, profitability, leverage, wage-bill over revenues, and capitalization. Standard errors are clustered at the 2-digit sector level, which is the sector of stratification of the survey that guarantees its representativity. ***significant at the 1% level, ** significant at the 5% level, * significant at the 10% level.

Table A.2: GVC future strategy: full sample

	Re-shoring	Near-shoring	Off-shoring	Diversification of suppliers	Inventories intermediates	Inventories final goods
Certainly	2.1%	1.3%	0.7%	12.3%	16.8%	11.6%
Likely	14.2%	13.6%	9.7%	44.6%	32.8%	27.5%
Unlikely	67.5%	68.5%	81.2%	40.1%	45.6%	54.6%
Not-Applicable	16.2%	16.6%	8.4%	2.9%	4.8%	11.6%
Observations	1,492	1,492	1,492	1,492	1,492	1,492

Source: INVIND, 2021. **Note:** The table shows firms' answers (using sampling weights) to the following question in the INVIND survey: "Does your firm plan to take any of the following actions in 2022-2023?". The possible answers were: "Yes, definitely" (Certainly); "Yes, probably" (Likely), "No" (Unlikely), "Not applicable".