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Regional Diffusion of Foreign Demand Shocks Through Trade and Ownership Networks

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Highlights

- International demand shocks are transmitted within the trade and ownership firms' networks and impact directly or indirectly domestic firm productivity and labor.
- Considering manufacturing firms for Italy, Spain and France over the period 2009-2017, we quantify these transmission channels from the global economy to the domestic firms, and within the domestic economy across locations, sectors and firms.
- Our results confirm that global shocks are transmitted through trade networks and that this transmission is largely mediated by firms' ownership networks both across and within the borders of the three countries.

Abstract

International demand shocks are transmitted within the trade and ownership firms' networks and impact directly or indirectly domestic firm productivity and labor misallocation. Considering manufacturing firms for Italy, Spain and France over the period 2009-2017, we quantify these transmission channels from the global economy to the domestic firms, and within the domestic economy across locations, sectors and firms. We compute in a shift share fashion international demand shock at the district-sector-year level as plausibly exogenous to individual firms. Our results confirm that global shocks are transmitted through trade networks and that this transmission is largely mediated by firms' ownership networks both across and within the borders of the three countries.

Keywords

Globalization, Productivity, Networks, FDI.

JEL

F14, F23, F61.

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RESEARCH AND EXPERTISE ON THE WORLD ECONOMY

Introduction

How globalization, global competition and foreign demand shocks affect domestic firms' productivity and the reallocation of resources across firms has been extensively studied in the empirical literature and economic theory provides sound foundations for the underlying mechanisms. Import competition drives the least productive firms out of the market, while the most productive firms benefit from foreign demand and thrive (Melitz 2003). In presence of multi-product firms, the within-firm product selection adds to the previous selection mechanisms (Mayer, Melitz & Ottaviano 2014).

A related issue is *how shocks are transmitted within the trade and ownership firms' networks* and affect their performance. Highly integrated county-pairs exhibit higher business cycle correlation (Frankel & Rose 1998), not only because they are facing common shocks (Imbs 2004) but also because cross-border trade is transmitting the shocks through exports or vertical production linkages between *sectors* (Di Giovanni & Levchenko 2010).

Combining these two frameworks helps to understand the microeconomic origins of aggregate business fluctuations: idiosyncratic shocks to individual firms, or idiosyncratic reactions to common shocks, do not wash out in the aggregate either due to the fat-tailed distribution of productivity and firm size (Gabaix 2011, Di Giovanni & Levchenko 2012, Bricongne, Carluccio, Fontagné, Gaulier & Stumpner 2022), or because vertical linkages and related business networks generate co-movements between firms (Acemoglu, Carvalho, Ozdaglar & Tahbaz-Salehi 2012, Carvalho 2014). The latter explanation, suggesting the possibility of "cascade effects" whereby productivity shocks to sectors or firms propagate throughout the economy, accounts for about two-thirds of the contribution of firm-specific shocks to the aggregate fluctuations (Di Giovanni, Levchenko & Mejean 2014).

Within firms multinational transactions (through affiliates) also play a role in the transmission of shocks to, and among, firms (Kleinert, Martin & Toubal 2015, Cravino & Levchenko 2017, Di Giovanni, Levchenko & Mejean 2018, Boehm, Flaaen & Pandalai-Nayar 2019, Bena, Dinc & Erel 2020). Firm-to-firm connections therefore contribute to explain why domestic firms are *indirectly* affected by foreign shocks through their business network (Carvalho, Nirei, Saito & Tahbaz-Salehi 2020, Dhyne, Kikkawa, Mogstad & Tintelnot 2020, Barrot & Sauvagnat 2016).

Indeed, firms are localized in space. Within each country, region-industry pairs will adjust differently to foreign shocks because of complex ownership structures and business networks of local firms. The research question of this paper is therefore to *quantify how foreign shocks affect domestic firms productivity and labor misallocation within industries and districts, as a consequence of their trade and ownership networks.* Using firm level and regional data, we aim to reveal these transmission channels, controlling for the confounding factor of the firm's industry-region competitiveness. The transmission channels we consider are from the global economy to the domestic firms, and within the domestic economy across districts, sectors and firms, connected through business relationships (either Foreign Direct Investment – FDI thereafter – or within country business groups).

Instead of relying on idiosyncratic firm-specific shocks correlated with the firm performance, we first compute an aggregated *external demand* shock which is common to all firms in a given administrative district (based on the European "Nomenclature of territorial units for statistics", NUTS3 level) and industry (2-digit NACE rev 2). Being computed in a shift share fashion at the district-sector-year level this shock is plausibly exogenous to the individual firms in a given district. We alternatively instrument the demand shock using the foreign countries conditional demand based on a structural gravity framework. Moreover, external shocks are evaluated at a given level of competitiveness of the exporting industry-district the firm belongs to, as we consider the variation in import demand at destination excluding our countries of interest own exports. As a result, the usual export competitiveness channel (being the aggregate realization of individual firms productivity shocks) is therefore silenced.

This exercise is performed on manufacturing firms operating in three European countries – France, Italy and Spain – for which we know their precise location and industry in each of the three countries. Starting from industry-location specific shocks we evaluate the role of ownership network on their diffusion within a country. In light of the relevance of indirect shocks on firm performances (Dhyne et al. 2020, Huneeus 2018) we investigate whether foreign shocks on a given location propagate to connected locations throughout domestic production networks.

The contribution of this paper is to estimate, for a given level of competitiveness of the exporting country, how exogenous external demand shocks impact firm performance – i.e. productivity and labor misallocation– while separating both their direct (location specific) and indirect impact. The latter impact is modeled as the spillover effect from other locations through domestic network of trade and investments. We finally illustrate our conceptual and empirical framework by providing an estimate of the expected impact of the Covid-19 shock on firm level outcome, showing for each of the analyzed countries the most impacted districts and sectors.

This paper speaks to the literature addressing productivity spillovers within the international and regional networks of the firms. Buyer-supplier relationships and the structure of the production network of the firm affect its productivity (Bernard, Moxnes & Saito 2019). Production networks amplify regional or local shocks on productivity as a result of sectoral and interregional linkages (Caliendo, Parro, Rossi-Hansberg & Sarte 2018). Local demand shocks propagate through the firm's internal networks, across regions, and impact employment at the plant level as a result of optimal within firm labor allocation (Giroud & Mueller 2019). Beyond the borders of the firm, after the setting of a large manufacturing plant in a certain location, productivity spillovers propagate throughout the other regions of the economy through the networks of multi-region firms (Giroud, Lenzu, Maingi & Mueller 2021). Our contribution is i) to combine firm-level evidence on productivity and labor misallocation in the regions of three European countries with industry-region data and international trade data; ii) to rely on a demand shock exogenous to the firm; and iii) to quantify how firms' trade and ownership networks transmit these shocks and ultimately affect their outcomes, within industries and districts. We are therefore able to distinguish the direct transmission channels from external demand shocks to the district sector-year in which a firm operates, from the spillover flowing across districts and sectors within each country (the indirect channel).

Our strategy is conducive to a series of novel results. We show that i) most of the foreign demand impact is channeling through the combined network of trade and ownership relationships: firms operating in a district-sector with largely overlapping trade and ownership networks are twice as much affected; ii) the impact of an external demand shock is 50% higher for firms connected to foreign markets through FDI; iii) global business networks transmit the demand shock to firms that are not themselves engaged in trade or international ownership, but are located in a connected regions; iv) concerning misallocation, undersized firms faced by a positive foreign demand shock distribute returns away from the labor share instead of growing; and v) 70% of the total impact of an external demand shock is channeling through spillovers across different districts of a given sector-country.

The rest of the paper is organized as follows. Data and construction of variables are described in the Section 1. Section 2 details the empirical analysis, while Section 3 discusses the results. Section 4 offers some concluding remarks.

1 Data description and variable construction

Our main source of firm data is the commercial dataset Orbis[1] from which we extract a comprehensive panel of manufacturing firms in Italy, Spain and France over the period 2009-2017. Importantly, the estimation panel is built as the recollection of different vintages of the database as to ensure the greatest yearly coverage. Three types of information are retained: i) firms' annual balance sheets, from which we source revenues, value-added, total employment and capital stock; ii) headquarter location (NUTS 3, referred to as "district" thereafter) and main sector of activity (2-digit NACE rev. 2); iii) firm global ownership network (in year 2007). We choose this year because it is prior the start of our estimation sample and to the 2008 financial crisis that contributed to reshuffling ownership networks. In such a way, the distribution of ownership connections is likely to be "pre-determined" to the external demand shocks tackled in the empirical analysis. Based on this information, we build both firm-specific and district-specific linkages with foreign countries as well as with other districts within a given country.[2]

The main outcome variable of our analysis is the variation in firm productivity and misallocation *vis-à-vis* a change in external demand, conditional on the unobserved time-varying characteristics of the district and sector in which the firm operates.[3].

The firm level outcome variables we focus on are: i) labor productivity (measured as the log of value added – VA – per worker of firm f, LP_{ft}^{VA}); ii) revenues per worker (in logs, LP_{ft}^{REV}); iii) Total Factor Productivity (TFP) (computed using both a Cobb-Douglas, TFP_{ft}^{CD}, and a translog, TFP_{ft}^{TL}, production function); iv) absolute labor misallocation ($|GAP^L|_{ft}^{TL}$). Labor misallocation is computed following Fontagné & Santoni (2019) and Petrin & Sivadasan (2013) as:

$$|GAP^L|_{ft}^{TL} = ln\left(|VMP_{ft}^L - w_{ft}|\right) \tag{1}$$

where w_{ft} is the marginal cost of labor[4], and VMP_{ft}^L its marginal product from:

$$VMP_{ft}^L = \varphi_{ft}^l \frac{P_{ft} * Q_{ft}}{L_{ft}} \tag{2}$$

[1] `http://www.bvdep.com`

[2] A district is "connected" with a foreign country if: a domestic firm has an investment (including portfolio ones) abroad; or a foreign firms has an investment in the district. Investments are identified using the direct shareholder position in the Orbis owenrship database for year 2007.

[3] Baseline estimation is conducted using linearly interpolated values of firms' balance sheets variables. As a robustness check we report our main estimation results using non interpolated values in the Appendix, results are barely affected.

[4] Since we do not observe the salary paid to the marginal employee, we use the average wage as a proxy.

with φ^{l}_{ft} that is the labor elasticity estimated from a translog production function. A positive labor gap implies that the marginal product of labor is higher than its marginal cost, and therefore the firm is likely undersized. The opposite is true when the gap is negative. In absolute terms, the higher the absolute gap, the higher is the firm deviation from its "optimal" size.

The main variable of interest is the external demand shock. As trade flows at the firm level are credibly endogenous, we opt for measuring the external demand shock at the district-sector-year level. For the three countries we are interested in (i.e. France, Italy and Spain), we follow Mayer, Melitz & Ottaviano (2021) and build plausibly exogenous (to the individual firms in a given district) demand shocks by combining foreign countries' import demand (excluding exports from France, Italy and Spain) with pre-determined trade shares in a *shift-share* fashion. The *shift* component measures the conditional import demand of foreign countries using the BACI dataset (Gaulier & Zignago 2010). From yearly industry-destination imports M_{dkt} we derive demand shocks as Davis-Haltinwanger growth rates: $\Delta Demand_{dkt} = (M_{dkt} - M_{dkt-1})/(.5 * M_{dkt} + .5 * M_{dkt-1})$.[5]

We derive the external demand term for each district-sector-year, ED_{jkt}, by aggregating destination market total imports, i.e. *shift*, using predetermined district-sector-destination export *shares* as follow:

$$ED_{jkt} = \sum_{d=1}^{D} w_{jdk,2009} * \Delta Demand_{dkt} \tag{3}$$

We compute district-sector-destination specific export *shares*, $w_{jdk,2009}$, at the beginning of the estimation sample – in order to derive a pre-determined exposure to external demand shocks – using trade data at district-sector level for each country:

$$w_{jdk,2009} = \frac{X_{jdk,2009}}{\sum_{d=1}^{D} X_{jdk,2009}} \tag{4}$$

where $X_{jdk,2009}$ are exports by district j to country d in sector k in 2009. *"Italian National Institute of Statistics (ISTAT)"* and *"Ministero de Industria, Comercio y Turismo"* provide trade data disaggregated by sector, district and destination market for Italy and Spain respectively. As an example, we observe exports from the district of Turin to Japan, in the automotive sector (division 29 of NACE rev. 2). Unfortunately, this information is not ready available for France at the district level, hence we proceed differently. Transaction-level export data of the French customs provide information on the destination of exports for each French manufacturing firm by destination market, product and year.[6] The *Stocks d'entreprises* database documents the precise location of exporting firms on the French territory. Thanks to the common administrative identifier, we are able to merge the two databases and obtain the corresponding information for France.

As a robustness check we instrument the demand shock, ED_{jkt} using the change in foreign countries conditional demand (excluding exports from France, Italy and Spain) derived from the following structural gravity equation, performed separately for each sector k on the CEPII-BACI dataset (Gaulier & Zignago 2010): $\mathrm{X}_{odt} = exp[\gamma_{ot} + \delta_{dt} + \beta log(distance_{od}) + contig_{od} + \beta PTA_{odt}] \times \varepsilon_{odt}$; where we purge, for each sector, im-

[5] As recalled in Mayer et al. (2021) such measure is monotonic in Δ log $Demand_{dkt}$ and preserve observations when demand depart from 0. As our demand shock is computed at the district-industry level results are virtually unaffected when growth rates are approximated using delta log instead.

[6] Lionel Fontagné thanks the *Direction Générale des Douanes et Droits Indirects* for granting access to the Statistics of External Trade.

port demand of country d from country of origin-by-time (γ_{ot}) factors (most importantly productivity) and origin-destination unobserved characteristics (such as distance, contiguity and the presence of preferential trade agreements, PTA). By virtue of the gravity principles, the resulting vector of destination-sector-time fixed effects, $\widehat{\delta_{dkt}}$, map to the theoretical Inward Multilateral Resistance (IMR) term of each destination, thus capturing the theory consistent determinants of demand for each destination-sector-year triplet. We then aggregate the conditional demand as $CED_{jkt} = \sum_d w_{jdk,2009} * \Delta exp(\widehat{\delta_{dkt}})$. Our results are robust to this alternative construction of the demand shock.

1.1 Spillover Effect

So far we model the *direct* transmission channels from external demand shocks to the district-sector-year in which a firm operates. The last step is to drill into the *indirect* transmission channel, defined as the internal transmission of the direct external shocks to the three countries considered (i.e. spillover flowing across districts and sectors within each country). We will loosely call this channel the "spillover" effect.

To construct such metric we need a measure of trade easiness between districts within countries, i.e. *internal* trade. Unfortunately, trade between districts is not reported in official statistics, we thus rely on geography to proxy intra-national connections within France, Italy and Spain. As a first approximation we start with a district adjacency matrix and compute the spillover of a given district based on neighbors direct shocks (first order) and extend the range progressively.

As a robustness check we also calibrate trade elasticity to physical distance, β_k, from a gravity estimation using country-by-country trade flows between EU28 State Members; [7] and derive the "virtual" trade easiness districts in a given country and sector, $ln(\tilde{X}_{jj'kt=2009})$, as the product of the geodesic distance between districts' centroid and the industry level (distance) elasticities estimated over the intra EU28 trade flows. Our results are robust to this alternative strategy.

The construction of the *indirect* shock mimics that of the *direct* one, aggregating external demand shock of connected district $ED_{j'kt}$:[8]

$$Spill_{jkt} = \sum_{j'=1, j'\neq j}^{J} \tilde{w}_{jj'k,2009} * ED_{j'kt} \tag{5}$$

2 Empirical analysis

In this section we present our empirical strategy to study the impact of an external demand shock on firm-level outcomes. All firms i in a given district j operating in sector k in year t face the same external demand shock, i.e. *external demand* , ED_{jkt}. Being computed as conditional import demand from the rest of the world excluding France, Italy and Spain and controlling for district and industry unobserved time-varying characteristics, the

[7] Industry specific (2-digits NACE rev. 2) trade elasticity to physical distance is estimated by running, for each industry k, the following regression: $ln(X_{odkt}) = \beta_0 + \beta_{(k)} ln(Distance_{od}) + FE_{ot} + FE_{dt} + \varepsilon_{odkt}$ where o is the exporter country, d the importer country, both of them within EU-28, and t goes from 2009 to 2017. Given that we consider trade flows within the single EU market, clear of tariffs and Non-Tariff Barriers, we can safely assume that such elasticities equally apply at the sub national level.

[8] Using the matrix of trade easiness we construct within-country shares $\tilde{w}_{jj'kt=2009} = \tilde{X}_{jj'k,2009} / \sum_{j'=1, j'\neq j}^{J} \tilde{X}_{jj'k,2009}$

estimated effects are plausibly exogenous to individual firms productivity shocks. The first set of regressions read as follow:

$$\Delta Y_{ft} = \beta_0 + \beta_1 \Delta ED_{jkt} + \delta_{kt} + \delta_f + \Delta\varepsilon_{ft} \tag{6}$$

where the dependent variable of Equation 6 may take the form of: labor productivity, ΔLP^{VA}_{ft}; log revenues per worker, ΔLP^{REV}_{ft}; Total Factor Productivity, under a Cobb-Douglas, ΔTFP^{CD}_{ft}, or a translog production function, ΔTFP^{TL}_{ft}. The operator Δ indicates first differences. Individual firm fixed effects are thus removed from the estimation and δ_{kt} controls for industry time trends (most importantly sectoral prices) and δ_f controls for any trend at the firm level.[9] As the main variable of interest varies only by district industry and year standard errors are clustered at the district-sector-year and the firm level. Estimation results are reported in Table 1.

We extend the analysis to test the role of ownership linkages in the transmission of external demand shocks. Using information on the parent/subsidiary locations, we partition ED_{jkt} according to the degree of "FDI exposure" in a given district-industry cell. By looking at the pre-determined ownership network in year 2007 we separate ED_{jkt} between district-sectors internationally connected through a foreign parent/subsidiary linkage, $\Delta ED^{FDI_{jk}=1}_{jkt}$, and district-sectors exposed to external demand shock only through trade.

We further refine the analysis by investigating the degree of synchronization between trade and ownership networks. To proceed, we first compute the Euclidean distance between trade and ownership networks, ρ; and then split $ED^{FDI_{jk}=1}_{jkt}$ between district-sectors with high, $FDI^{\rho \leq 10^{pc}}_{jk=1}$ and low synchronization.

Furthermore, as an additional measure of the degree of "FDI exposure" we split the $ED^{FDI_{jk}=1}_{jkt}$ according to the number of firms with a foreign ownership linkage, $FDI^{\# \geq 75^{pc}}_{jk=1}$. Results for productivity related outcomes are shown in Table 3 whereas results looking at labor misallocation are reported in Table 4.

Our last set of equations aims at quantifying the *indirect* effects of external demand shocks spreading through domestic linkages. The estimated equation now reads as follow:

$$\Delta Y_{ft} = \beta_0 + \beta_1 \Delta ED_{jkt} + \beta_2 \Delta Spill_{jkt} + \gamma_f + \delta_{kt} + \Delta\varepsilon_{ft} \tag{7}$$

Equation 7 looks at both productivity and labor misallocation adding to the direct effect of ΔED_{jkt} the indirect one channeling through domestic trade and ownership linkages, $Spill_{jkt}$. The domestic transmission channel is modeled using inter-district intra-national "virtual trade" at the sectoral level, projected by means of a gravity equation embarking production at origin and income destination, geodesic distance between districts centroid and an elasticity of trade to distance recovered from international intra-European Union trade flows. Mirroring the analysis of FDI_{jk}, we split the spillover variable between district-sector with/without domestic ownership connections; where $DDI_{jk} = 1$ indicates that a district-sector is linked to other districts within a country through domestic direct investments.

[9] As re-locations are not observable in the firm database δ_f also absorbs district specific trend.

3 Results

This section presents the results of the econometric analysis described in Section 2 and then provides a quantification of the expected impact of the Covid-19 related shock based on the estimated elasticity of domestic productivity to foreign demand shocks. To illustrate the transmission mechanisms at stake, we detail the expected regional impact of the pandemic induced foreign demand collapse by districts and sectors in France, Italy and Spain (based on their pre-pandemic sectoral specialization and global production linkages).

3.1 The impact of foreign demand shocks

Table 1 considers the impact of a foreign demand shock considering different estimators aiming to control for firm specific unobservable factors with firm fixed effects (*FE*) in column 1 or with first difference (*FD*) in column (2). In column (3) and (4) we opt for a more stringent model with firm fixed effects on first difference data (*FD-FE*) thus controlling for firm and sector-location trends.[10] Column (4) uses a more demanding clustering. The estimated parameters using the gravity instrument reported in column (5) (*FD*) and column (6) (*FD-FE*) largely overlap with the corresponding OLS results in columns (2-4) suggesting that the demand shock variable ED_{jkt} is not affected by country specific productivity shocks.

For all the different measures of firm productivity, in Table 2, the estimated parameter of ΔED_{jkt} is positive and significant, confirming that labor productivity of domestic firms tends to co-move with foreign demand (Kleinert et al. 2015, Bakker 2021, Di Giovanni, Levchenko & Mejean 2020). Quantitatively, a 10% increase in foreign demand faced by a district-sector implies an increase of firm total factor productivity located in that district-sector of about 0.47%. Global shocks are thus transmitted to domestic firms through trade networks, as expected.

Table 3 separates the impact of foreign demand shock according to the local FDI exposure by district and sector. The FDI exposure is measured with a dummy variable, FDI_{jk}, equal to 1 if at least one firm in the considered district and industry holds an equity share in a foreign enterprise, or if a foreign entity holds an equity share in a local firm. The dependent variable is the TFP (based on a Trans-Logarithmic production function, TL), ΔTFP_{ft}^{TL}. Columns (1) and (2) show that the transmission is largely mediated by firms' ownership networks. On one hand, as revealed by column (1), district-sectors with no FDI connection ($\text{ED}_{jkt}^{FDI_{jk}=0}$) are only marginally affected by foreign demand shocks with an estimated elasticity of 0.03. On the other hand, firms in FDI-connected district-sectors ($\text{ED}_{jkt}^{FDI_{jk}=1}$) are strongly affected by foreign demand shocks, with an estimated elasticity of 0.07. Hence, most of the foreign demand impact is channeling through the combined network of trade and ownership relationships.

In column (2) we split firms operating in FDI-connected district-sectors according to the intensity of the district-sector exposure. The variable $High$ takes the value of 1 for the district-sectors above the 75^{th} percentile of the number of foreign investments with the district-sectors as origin or destination. Symmetrically, the variable *Low* equals to 1 for the rest of the distribution. Firms in district-sectors in the top quartile of the distribution are significantly more affected than firms in district-sectors with a lower level of FDI exposure. This

[10] As in Mayer et al. (2021) a *FD-FE* approach allows to control also for any trend in the growth rate of demand shocks over time.

Table 1: Foreign demand direct impact on productivity

Dep. var:	TFP_{ft}^{TL} (1)	(2)	(3)	ΔTFP_{ft}^{TL} (4)	(5)	(5)
$\log(ED_{jkt})$	0.0296**					
	(0.0126)					
ΔED_{jkt}		0.0576***	0.0473***	0.0473***	0.0523***	0.0407***
		(0.0104)	(0.0113)	(0.0122)	(0.0140)	(0.0142)
Observations	1,684,899	1,403,532	1,370,699	1,370,699	1,403,532	1,370,699
R-squared	0.919	0.0022	0.167	0.167	0.169	0.169
FEs	f kt	kt	f kt	f kt	kt	f kt
Cluster	f	f	f	f jkt	f jkt	f jkt
Instrument					Gravity	Gravity
First stage					0.776***	0.764***
F-test					3,610	4,335
Model	FE	FD	FD-FE		FD	FD-FE

Notes: Clustered standard errors in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1. "Country all" means France, Italy and Spain pooled. *FE* includes firm fixed effects; *FD* refers to a model on first difference data and *FD-FE* refers to a model with firm fixed effects on first difference data.

Table 2: Foreign demand direct impact on different productivity measures

Dep. var:	ΔLP_{ft}^{VA} (1)	ΔLP_{ft}^{REV} (2)	ΔTFP_{ft}^{CD} (3)
ΔED_{jkt}	0.0494***	0.0436***	0.0469***
	(0.0144)	(0.0134)	(0.0121)
Observations	1,370,699	1,370,699	1,370,699
R-squared	0.169	0.174	0.168
FEs	f kt	f kt	f kt
Cluster	f jkt	f jkt	f jkt
Model		FD-FE	

Notes: Clustered standard errors in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1. "Country all" means France, Italy and Spain pooled. *FE* includes firm fixed effects; *FD* refers to a model on first difference data and *FD-FE* refers to a model with firm fixed effects on first difference data.

evidence suggests that beyond the documented impact of the intensive margin of FDI exposure, the extensive margin is playing a role in shaping the overall effect.

We further decompose in column (3) of Table 3 the effect of a demand shock by considering the intensity of the overlap between trade and ownership networks. The dummy variable ρ is taking the value of 1 for the districts-sectors with an high overlap between trade and FDI networks.[11] The interaction between $\mathrm{ED}_{jkt}^{FDI_{jk=1}}$ and the dummy ρ tells us how firms operating in district-sectors where the two networks – trade and FDI – overlap the most react to foreign shocks, compared to firms operating in district-sector with a lower proximity of the two networks. The estimated coefficients from column (3) reveal that firms operating in a district-sector with overlapping trade and ownership networks are around 60% more affected compared to firms operating in district-sectors with more limited overlap. The parameter for district-sector with no FDI involvement is again not statistically different from zero, suggesting that, in our sample, ownership linkages are the main transmission channel of foreign shocks with trade operating as a magnifier.

In column (4) of Table 3 we focus on the sub-population of firms operating in FDI-connected district-sectors, and split them according to their own connection (or not) with the dummy FDI_f (taking the value of 1 if the firm f is directly linked to foreign markets, either as a parent or as an affiliate). Column (4) confirms that the impact of the demand shock is 50% higher for connected firms, compared to unconnected firms (both in highly connected districts). Interestingly, the estimated positive effect for firms not directly involved in FDI, i.e. $\mathrm{ED}_{jkt}^{FDI_f=0}$, suggests that global business networks transmit the demand shock to firms that are not themselves engaged in international ownership, but are located in a connected regions (think of subcontractors relations for instance). In terms of magnitude the estimated effect of foreign demand shock on FDI connected firms, 0.141, is remarkably close to what Mayer et al. (2021) estimates for French manufacturing firm exporters, 0.106.[12]

The extent to which firms adapt to the demand shock, whether direct or indirect, determines the degree of misallocation of labor, measured here as the gap between marginal productivity and wages. Table 4 focuses on the impact of demand shock on labor misallocation. The two first columns show the impact of a demand shock on the magnitude of the gap (for firms with negative or positive gaps separately), while the two last columns show this impact on the value added and the employment. Interestingly, the direction of this change in the gap matters, i.e. whether the gap is in negative territory, meaning that marginal cost of labor is greater than its marginal return (column 1), or, on the contrary, whether the gap is on positive territory, meaning that marginal cost of labor is smaller than its marginal return (column 2).

For firms in FDI-connected district-sectors ($\mathrm{ED}_{jkt}^{FDI_{jk}=1}$), we show in column (1) that the same impact at place for TFP (Table 3, column (1)) manifests also for labor misallocation: a 10% increase in foreign demand is associated with a 2.8% decrease in negative labor gaps (column 1); while an increase in foreign demand is associated with an increase of 2.1% in positive gaps(column 2). In other words, oversized firms in column (1)

[11] The trade and FDI network overlaps if the Euclidean distance between their shares at the district and sector level at the beginning of the estimation period (i.e. year 2009) falls below the 10^{th} percentile. In year 2009, the average Euclidean distance between trade and investment networks is slightly lower in Italy (0.55) than France (0.61) and Spain (0.62). The lowest Euclidean distance in the sample, 0.02, involves pharmaceutical production (NACE 21) in the Meuse district in France (FR412), where the vast majority of investments and trade happens with Germany. In Italy the largest overlap, 0.14, occurs in machinery manufacturing (NACE 28) in the Perugia district (ITI21) due to the strong linkages with United States and Germany. Finally in Spain, the largest overlap, 0.19, arise in pharmaceutical production (NACE 21) in the Barcelona district, due to strong ties with Switzerland and United States. In Table A3 in the annex we present results using different cutoffs.

[12] The closest specification is reported in Table 6 of Mayer et al. (2021).

Table 3: The role of FDI

Dep. var:	ΔTFP_{ft}^{TL}			
	(1)	(2)	(3)	(4)
$\Delta ED_{jkt}^{FDI_{jk}=1}$	0.0727***			
	(0.0137)			
$\Delta ED_{jkt}^{FDI_{jk}=1\,\&\,High\#}$		0.0888***		
		(0.0152)		
$\Delta ED_{jkt}^{FDI_{jk}=1\,\&\,Low\#}$		0.0586***		
		(0.0148)		
$\Delta ED_{jkt}^{FDI_{jk}=1\,\&\,\rho=1}$			0.1079***	
			(0.0188)	
$\Delta ED_{jkt}^{FDI_{jk}=1\,\&\,\rho=0}$			0.0667***	
			(0.0138)	
$\Delta ED_{jkt}^{FDI_{f}=1\,\&\,\rho=1}$				0.1418***
				(0.0461)
$\Delta ED_{jkt}^{FDI_{f}=0\,\&\,\rho=1}$				0.0948***
				(0.0187)
$\Delta ED_{jkt}^{FDI_{jk}=0\,or\,\rho=0}$				0.0448***
				(0.0122)
$\Delta ED_{jkt}^{FDI_{jk}=0}$	0.0315**	0.0325**	0.0320**	
	(0.0131)	(0.0131)	(0.0131)	
Observations	1,370,699	1,370,699	1,370,699	1,370,699
R-squared	0.1670	0.1670	0.1670	0.1670
FEs	f kt	f kt	f kt	f kt
Cluster	f jkt	f jkt	f jkt	f jkt
Model	FD-FE			

Notes: Clustered standard errors in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1. "Country all" means France, Italy and Spain pooled. *FD-FE* refers to a model with firm fixed effects on first difference data.

take benefit of the increased demand to reduce their inefficiency. In contrast, undersized firms do not take advantage of the positive demand shock to hire additional workers. The positive and significant increase in value added, columns (3), associated with a much lower effect on labor, column (4), provides evidence on the mechanism at play in such firms with positive gaps. The improvement in the total efficiency of the firm's production is reflected in an increase in the return on the factors employed, labor and/or capital.

These results contrast with the evidence obtained for firms in district-sectors with no FDI connection ($\text{ED}_{jkt}^{FDI_{jk}=0}$) for which the only (weakly) statistically significant impact of a demand shock is on value added. This impact is also much lower than for firms in FDI-connected district-sectors.

Table 4: Impact on labor misallocation

Dep. var:	$(\Delta \mid GAP_{ft}^{TL} \mid)$		ΔVA_{ft}	ΔEMP_{ft}
	(1)	(2)	(3)	(4)
$\Delta ED_{jkt}^{FDI_{jk}=1}$	-0.2779***	0.2063***	0.1026***	0.0476***
	(0.0670)	(0.0399)	(0.0162)	(0.0135)
$\Delta ED_{jkt}^{FDI_{jk}=0}$	-0.0370	0.0756*	0.0432***	0.0346***
	(0.0603)	(0.0391)	(0.0155)	(0.0127)
Observations	384,496	927,261	927,261	927,261
R-squared	0.1879	0.1503	0.2816	0.2284
FEs	f kt	f kt	f kt	f kt
Cluster	f jkt	f jkt	f jkt	f jkt
Sample	$GAP_{ft}^{TL} < 0$	$GAP_{ft}^{TL} > 0$	$GAP_{ft}^{TL} > 0$	$GAP_{ft}^{TL} > 0$
Model	FD-FE			

Notes: Clustered standard errors in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1. "Country all" means France, Italy and Spain pooled. *FD-FE* refers to a model with firm fixed effects on first difference data. $GAP_{ft}^{TL} < 0$ refers to the sample of firms with negative gaps at time t; whereas $GAP_{ft}^{TL} > 0$ refers to the sample of firms with positive gaps at time t.

Finally, we study the *indirect* impact of a foreign shock, i.e. the diffusion of external demand shocks through the domestic production network. In Table 5 we consider a broader definition of spillover as detailed in Section 1.1. To give an example, a firm located in Barcelona and operating in the mechanical industry may be indirectly exposed to the foreign demand shocks faced by her subsidiaries located in other Spanish districts. To proceed, we use a matrix of adjacency of districts. For each district, the indirect spillovers channel firstly through the impact of the directly adjacent district(s), namely $\Delta Spill_{jkt}^{1stOrder}$. Subsequently, we add the spillovers channeling through the district(s) adjacent to the first circle of adjacent district (resp. $\Delta Spill_{jkt}^{2ndOrder}$). We finally extend this logic to the third order, before cumulating all-ranked spillovers (resp. $\Delta Spill_{jkt}^{All}$). Columns (1) to (4) show the impact of the direct demand shock (ΔED) and of the different types of spillovers (first order, second order etc.). Columns (5) and (6) introduce the domestic spillovers channeling through the domestic ownership networks: the district-sectors connected through domestic ownership networks of any order ($\Delta Spill_{jkt}^{All\,DDI_{jk}=1}$) are expected to be exposed to higher spillovers than the non-connected district-sectors ($\Delta Spill_{jkt}^{All\,DDI_{jk}=0}$). The last two columns of Table 5 show the impact on the misallocation gap for firms in the positive territory (undersized firms).

Starting from column (1) in Table 5, the estimated parameter for firms in unconnected district-sectors is lower than the one in column (1) of table 3 because we now control for the indirect spillover of first order. And the direct effect decreases as we introduce indirect spillovers of higher order. The same comparison pertains to firms in connected district-sectors. Symmetrically, the indirect impact of a foreign demand shock increases as we consider higher order of spillovers from column (1) to (4) in Table 5. Overall, 70% of the total impact of the demand shock in connected district-sectors is channeling through indirect diffusion effects across a given country.[13] Domestic ownership networks also play a role in the transmission of foreign shocks to TFP as evidenced in columns (5) and (6) of Table 5, while their effect on gaps is imprecisely estimated (column 8).

[13] Using estimates from column 4 in Table 5 the share of the spillover effect is computed as $0.2131/(0.2131 + 0.0902)$).

Table 5: Direct and indirect impact

Dep. var:	ΔTFP_{ft}^{TL}						ΔGAP_{ft}^{TL} $GAP_{ft}^{TL} > 0$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta ED_{jkt}^{FDI_{jk}=0}$	0.0269**	0.0263**	0.0225*	0.0185	0.0188	0.0160	0.0241	0.0262
	(0.0133)	(0.0134)	(0.0134)	(0.0134)	(0.0135)	(0.0135)	(0.0406)	(0.0407)
$\Delta ED_{jkt}^{FDI_{jk}=1\,\&\,\rho=1}$	0.1009***	0.0986***	0.0927***	0.0902***	0.0881***	0.0812***	0.2725***	0.2618***
	(0.0189)	(0.0192)	(0.0192)	(0.0191)	(0.0196)	(0.0196)	(0.0575)	(0.0592)
$\Delta ED_{jkt}^{FDI_{jk}=1\,\&\,\rho=0}$	0.0594***	0.0582***	0.0529***	0.0498***	0.0490***	0.0435***	0.1090**	0.1048**
	(0.0141)	(0.0143)	(0.0143)	(0.0143)	(0.0143)	(0.0144)	(0.0426)	(0.0430)
$\Delta Spill_{jkt}^{1stOrder}$	0.0484***							
	(0.0175)							
$\Delta Spill_{jkt}^{2ndOrder}$		0.0614***						
		(0.0237)						
$\Delta Spill_{jkt}^{3rdOrder}$			0.1042***					
			(0.0273)					
$\Delta Spill_{jkt}^{All}$				0.2131***			0.1191	
				(0.0339)			(0.1162)	
$\Delta Spill_{jkt}^{All\,DDI_{jk}=1}$					0.2169***	0.2200***		0.1394
					(0.0353)	(0.0351)		(0.1199)
$\Delta Spill_{jkt}^{All\,DDI_{jk}=0}$					0.2120***	0.2150***		0.1125
					(0.0341)	(0.0339)		(0.1165)
Observations	1,370,699	1,370,699	1,370,699	1,370,699	1,370,699	1,370,699	927,261	927,261
R-squared	0.1670	0.1670	0.1670	0.1670	0.1670	0.1670	0.1487	0.1487
FEs	f kt	f kt	f kt	f kt	f kt	f kt	f kt	f kt
Cluster	f jkt	f jkt	f jkt	f jkt	f jkt	f jkt	f jkt	f jkt
Estimator	FD-FE							

Notes: Clustered standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. "Country all" means France, Italy and Spain pooled. *1st Order* measure the spill-over as the average demand shock of a district direct neighbors; *2nd Order* includes neighbors of neighbors; and *3rd Order* includes neighbors of neighbors of neighbors; *All* consider an average over all the districts in a country (in column 6 the other district shocks are weighted by distance and industry specific elasticities). *FD-FE* refers to a model with firm fixed effects on first difference data. $GAP_{ft}^{TL} > 0$ refers to the sample of firms with positive gaps at time t.

3.2 The Covid-19 shock

We conclude our analysis on the transmission of foreign demand shocks with a simple exercise that intends to visualize and quantify the exposure of district-sectors of a given country to the foreign demand shock triggered by the Covid-19 pandemic. This shock had an impact on the economy through many channels, both on the supply- and demand-side, with important consequences also linked to domestic lock-downs. Therefore, the following exercise is not an attempt to quantify the whole impact, but rather an application of the framework presented above that exploits the exogeneity of the Covid-19 shock.

We construct district-sector (jk) specific Covid-19 shocks closely following the definition of ED_{jkt} in Equ. 3. The only difference is that, due to data limitations, we now use as *shift* component the log-difference between sectoral imports by foreign countries in the first three quarters of year 2020 with respect to the same period of year 2019. We consider 31 countries which account for approximately the 80% of the exports of Italy, Spain and France[14]. We then obtain location-industry specific Covid-19 shocks, ΔED_{jk}^{Covid}, weighting the log-change in imports with the pre-determined (2009) export *shares* of the location-industry given by Eq. 4:

$$\Delta ED_{jk}^{Covid} = \sum_{d=1}^{D} w_{jdk,2009} * (logM_{d2020} - logM_{d2019}) \tag{8}$$

To provide evidence of the different exposure of districts, we average district-sector shocks weighting by the share of each sector (jk) in a district (j) GDP:[15]

$$\Delta ED_{j}^{Covid} = \sum_{k=1}^{K} \frac{GDP_{jk}}{\sum_{k=1}^{K} GDP_{jk}} * ED_{jk}^{Covid} \tag{9}$$

On average, a typical sector-by-industry in our sample experiences a reduction in foreign demand of about 10.4 percent (out of which 6.5 percent is due to FDI-connected industries within the district). Table 6 reports the most impacted locations and industries in Spain, France and Italy. In almost all districts, listed in column (1), the major contribution to the aggregate shock originates in FDI connected sectors, listed in column (2). The only exceptions are the districts of Jaén for Spain, Ardennes for France, and La Spezia and Potenza for Italy, marked with * in column (2). Looking at the sectors which contribute the most for each district, we have a dominance of *Motor Vehicles* (NACE division 29) and related sectors such as *Metal Products* (NACE division 25), *Machinery and Equipment* (NACE division 28), and *Other Transport Equipment* (NACE division 30).

The right panel of Table 6 lists the most impacted sectors, column (3), in each country. *Motor Vehicles* (NACE division 29), *Leather* (NACE division 15), *Transport Equipment* (NACE division 30) and *Apparel* (NACE division 14) are the four most impacted sectors in all countries. The fifth ones are *Machinery* (NACE division 28), *Paper* (NACE division 17) and *Textiles* (NACE division 13) for respectively Spain, France and Italy. The

[14]We downloaded countries imports from the rest of the world at the HS6-digits level from Trade Data Monitor and aggregated them at the 2-digits NACE rev. 2 industry level. Included countries are: Australia, Austria, Belgium, Brazil, Canada, China, Czech Republic, France, Germany, Greece, Honk Kong, Hungary, India, Italy, Japan, Morocco, Mexico, Netherlands, Poland, Portugal, Romania, Russia, Saudi Arabia, Singapore, South Korea, Spain, Sweden, Switzerland, Turkey, UK, USA. Data for Australia are recorded for the period January-July.

[15]We consider the sectoral composition in year 2009, prior to the estimation period.

total shock is also in this case driven by the contribution of FDI-connected district-sectors: only the *Leather* sector in Spain has a significant contribution detained by district-sectors without FDI (i.e. Alicante). Column (4) lists the most impacted district within the sector of column (3). The district of Barcelona is the most affected by the shock to the automotive industry in Spain. In this sector, the same is true for the Hauts-de-Seine in France and for Turin in Italy. The reader will easily be able to put company names to these districts given the granularity of this industry.

Table 6: COVID-19 foreign shock: most impacted districts and sectors by country

	District (NUTS3)		Sectors (NACE)	
		main sector		main district
	(1)	(2)	(3)	(4)
ES	Burgos	Motor vehicles (29)	Motor vehicles (29)	Barcelona
	Zaragoza	Motor vehicles (29)	Leather (15)	Alicante*
	Jaén	Motor vehicles (29)*	Trans. equip. (30)	Madrid
	Pontevedra	Motor vehicles (29)	Apparel (14)	Barcelona
	Gipuzkoa	Machinery (28)	Machinery (28)	Madrid
FR	H.-Garonne	Trans. equip. (30)	Motor vehicles (29)	Hauts-de-Seine
	Doubs	Motor vehicles (29)	Leather (15)	Paris
	Moselle	Motor vehicles (29)	Trans. equip. (30)	Haute-Garonne
	Yvelines	Motor vehicles (29)	Apparel (14)	Paris
	Ardennes	Motor vehicles (29)*	Paper (17)	Hauts-de-Seine
IT	La Spezia	Metal products (25)*	Motor vehicles (29)	Turin
	Torino	Motor vehicles (29)	Leather (15)	Florence
	Potenza	Motor vehicles (29)*	Trans. equip. (30)	Rome
	Pisa	Leather (15)	Apparel (14)	Milan
	Chieti	Motor vehicles (29)	Textiles (13)	Prato

Notes: column (1) reports the list of most impacted districts within a country and column (2) the most impacted sector within the district. Column (3) lists the most impacted sectors within a country and column (4) the most impacted district within the sector. In column 2, * denotes whether a sector-district is *not* (or marginally) involved in FDI. The detailed estimated effects by district and sectors are reported in the Annex, Table A1 and Table A2 respectively.

Figure 1 and Figure 2 quantify the different exposure of French, Italian and Spanish districts to the foreign demand shock induced by the Pandemic. In Figure 1 we report the expected impact on TFP of the external demand shock ΔED_j^{Covid}. Given the role of FDI in transmitting foreign shocks, in Figure 2 we split the contribution due to the sectors involved in trade only (ΔED_j^{noFDI}, Panel a) and in trade and FDI (ΔED_j^{FDI}, Panel b).

Figure 1 reveals the geographic distribution of most impacted districts within each country. As for Spain, districts in North-West of the country have been more impacted: 4 out of 5 of the main affected districts are located in this region, see Table 6 (Burgos, Zaragoza, Pontevedra and Guipuzkoa). As for France, the most impacted districts are the ones close to the German, Belgian and Swiss border (among them Doubs, Ardennes, Moselle). The district of Haute-Garonne, in the South-West of the country, owes its large exposure to foreign shock to its specialization in the aeronautic industry, an industry particularly penalized by the worldwide travel restrictions imposed during the year 2020 to contain the spread of the epidemics. Finally, as concerns Italy, most impacted districts are more geographically dispersed with respect to France and Spain: in the North-West one of the most severely affected districts is Turin: which is the location, as the district of Potenza in the

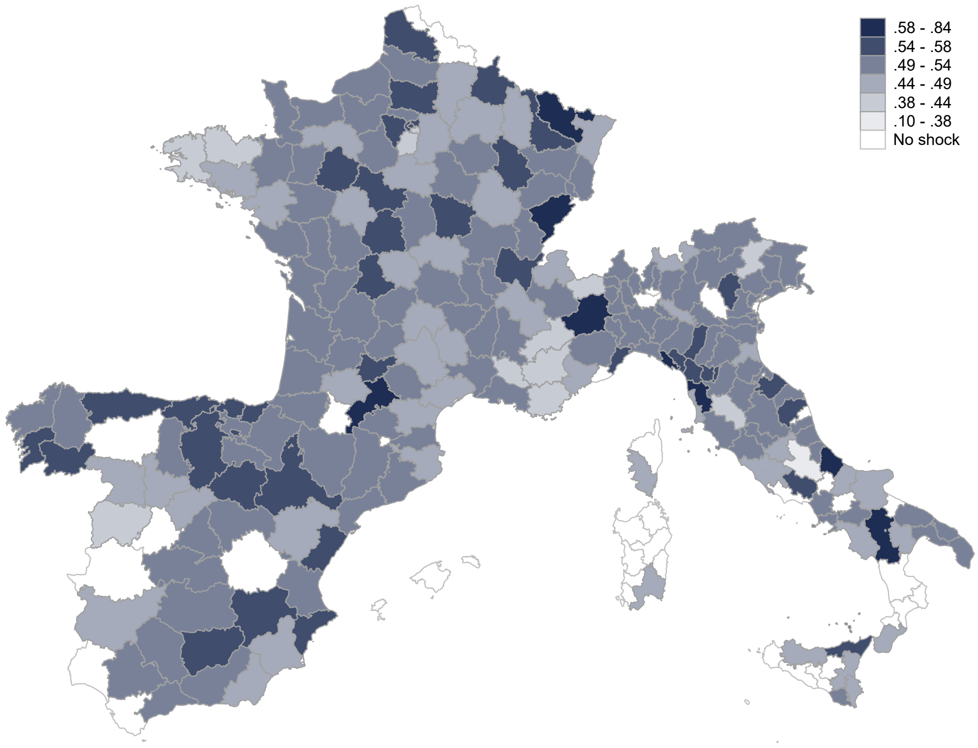
South of the country, of the main production facilities of FIAT (one of the most sizeable car makers in the country). The other heavily affected districts are scattered in the central-northern part of the country, due to the socio-economic industrial poles that characterize the Italian economic structure: among them are Pisa in the west and Chieti in the east of the country.

Figure 2 provides the decomposition of the Covid-19 shock according to FDI connections of each district. Two main points emerge: first, the shock transmitting through trade and FDI, Panel (b), is on average higher than that transmitting through trade only, Panel (a). The total shock in the previous figure is mainly determined by the contribution given by FDI connected sectors in each district. Secondly, geographical differences exist within country: in all of the three, the Southern part is on average less connected to foreign markets than the rest of the country. In Spain and France the most economically developed districts contribute largely to the sectoral impact: Barcelona, Madrid, Île-de-France and Haute-Garonne. The Italian situation again reflects the heterogeneity of its economic structure: Turin, Florence, Rome, Milan and Prato are districts respectively specialized in the five most impacted sectors.

Looking at firms outcomes, while the Covid-19 shock is expected to reduce TFP growth in the medium term, on average up to 0.49 percentage points, within locations the impact of contraction in foreign demand can reach 1.53 percentage points of TFP growth for connected industries (as for example French Motor vehicles industry in Hauts-de-Seine).[16]

[16]The average effect is computed using the estimated coefficient from column (4) of Table 1 considering an average Covid-19 shock of -10.4%, to quantify the impact of foreign demand shock for FDI-connected sectors we use the estimated coefficients in column (1) of Table 3. The detailed quantification for the most impacted locations and sectors in each country is reported in the Annex, see Table A1 and Table A2 respectively.

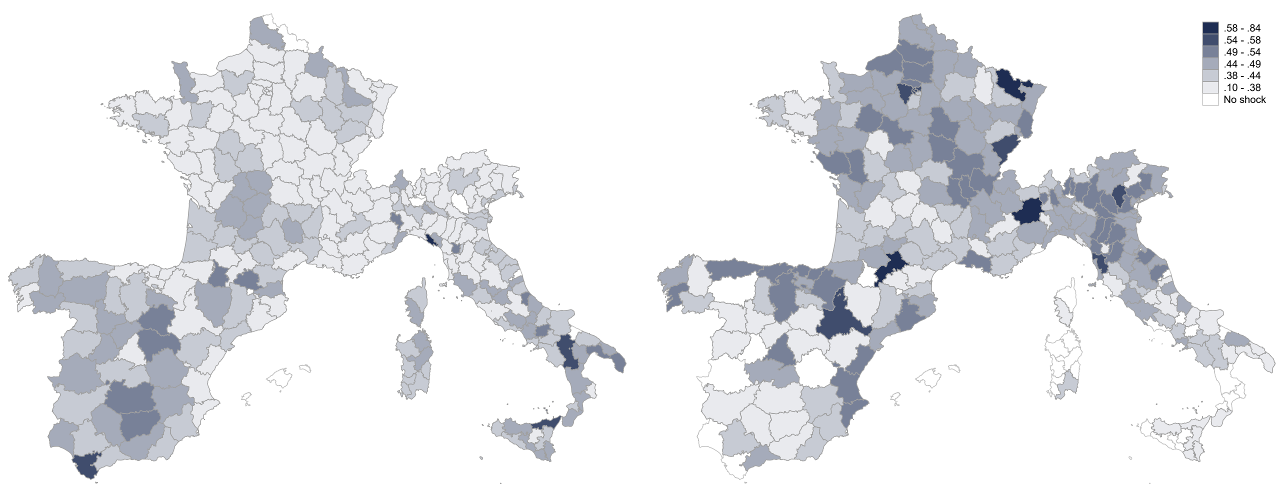
Figure 1: Impact of direct foreign shock on TFP



Notes: The figure plots the impact on TFP of the external ΔED_j^{Covid} shock using the estimated coefficients from Table (column d). The geographical unit is NUTS3. A more intense color is associated with a more pronounced drop in TFP. The reported impacts are percentage changes.

Figure 2: Decomposition of the impact of direct foreign shock on TFP

(a) Trade without FDI (b) Trade and FDI



Notes: The figure decompose the impact on TFP of the external ΔED_j^{Covid} shock between locations connected through trade and FDI or only trade using the estimated coefficients from the main equation, Table 3 (column 1). The geographical unit is NUTS3. A more intense color is associated with a more pronounced drop in TFP. The reported impacts are percentage changes.

4 Conclusion

This paper asked how globalization, global competition and foreign demand shocks affect domestic firms' productivity, with a focus on how shocks are transmitted within the trade and ownership firms' networks. To answer this question, we quantified how foreign demand shocks affect, directly and indirectly, domestic firm productivity and labor misallocation, as the result of their trade and ownership networks. The transmission channels we considered are from the global economy to the domestic firms, and within the domestic economy across districts, sectors and firms, accounting for business relationships and the prevalence of Foreign Direct Investment relationships and of relations between firms belonging to the same group within a country. An important element of our identification strategy worth stressing is that the external demand shock: i) is constructed at the district-sector-year level by combining foreign countries' import demand with pre-determined trade shares in a shift-share fashion; and ii) as a robustness check is instrument using the change in foreign countries conditional demand derived from a structural gravity equation.

We considered an extensive panel of manufacturing firms in Italy, Spain and France over the period 2009-2017. Each firm has been identified according to the district and industry of operation. We addressed transmission channels through the export structure of these district-sectors, through the international network of ownership connections between firms, and through the domestic business networks characterized by *internal* (i.e. domestic) trade and internal ownership structures.

Our conclusions are clear-cut. Global shocks are transmitted through trade networks and this transmission is largely mediated by firms' ownership networks. Firms operating in FDI-connected district-sectors are two-time more affected by external demand shocks. In addition, firms operating in sectors in districts with significant overlap in trade and ownership networks, or that belong to the top quantile of the FDI distribution, are 1.6 times more affected than firms in districts with less overlap or exposure to FDI. Moreover, unconnected firms that are not themselves engaged in international ownership, but are located in an internationally connected district-sector, are indirectly affected by external demand shocks, plausibly as a consequence of local business relationships between connected and unconnected firms. Domestic spillovers have been shown to play also a big role in the transmission of external demand shocks. Results hold for both firm productivity and labor misallocation. As regards the latter, the shock transmits only to firms with positive misallocation gaps, i.e. firms with a marginal product of labor higher than its costs.

Finally, we exploit the exogeneity of the Covid-19 shock to provide descriptive and graphical evidence of our conceptual and empirical approach. We show that the drop in foreign demand triggered by the pandemic has mainly transmitted to districts connected to the international ownership network. At the sectoral level, there are no particular differences concerning impacted sectors between the considered countries.

From a policy perspective, our findings stress that the impact of foreign shocks is not limited to firms engaged in international business through commercial or ownership connections. All firms operating in exposed district-sectors are affected as a result of their business relationships, and this result extends to firms operating in a different district and/or sector of the affected country. From the point of view of firms operating in the three EU Member states covered by our analysis, the economy has really become global. Shocks are transmitted across borders by trade and/or within the boundaries of the firms as a result of decisions made by headquarters.

And international shock are even transmitted across districts of a given country, as a result of complex business relationship, commerce or ownership, between domestically located firms.

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Appendix

Covid shock by location

The following tables report the detailed estimated effects by main district, Table A1 and main sectors Table A2 by country. We obtain the average impact on each sector in each country by aggregating district-sectors specific shocks weighting by the share of each district-sector (jk) GDP on total national sector (k) GDP[17]:

$$\Delta ED_k^{Covid} = \sum_{j=1}^{J} \frac{GDP_{jk}}{\sum_{j=1}^{J} GDP_{jk}} * ED_{jk}^{Covid} \tag{10}$$

Table A1: COVID-19 foreign shock: most impacted districts

	District	ΔED_j	ΔED_j^{FDI}	ΔED_j^{noFDI}	Main sector (NACE)	Impact on ΔTFP
ES	Burgos	-14.4%	-9.5%	-4.9%	Motor vehicles (29)*	-0.69%
	Zaragoza	-14.3%	-13.6%	-0.8%	Motor vehicles (29)*	-0.98%
	Jaén	-14.1%	-2.6%	-11.5%	Motor vehicles (29)	-0.19%
	Pontevedra	-13.9%	-11.0%	-2.9%	Motor vehicles (29)*	-0.79%
	Gipuzkoa	-13.3%	-11.1%	-2.1%	Machinery (28)*	-0.82%
FR	H.-Garonne	-17.9%	-17.8%	-0.1%	Trans. equip. (30)*	-1.29%
	Doubs	-16.4%	-14.7%	-1.6%	Motor vehicles (29)*	-1.07%
	Moselle	-15.9%	-15.0%	-0.9%	Motor vehicles (29)*	-1.08%
	Yvelines	-14.4%	-14.3%	-0.1%	Motor vehicles (29)*	-1.03%
	Ardennes	-14.3%	-6.4%	-7.9%	Motor vehicles (29)	-0.47%
IT	La Spezia	-17.7%	-1.6%	-16.1%	Metal products (25)	-0.11%
	Torino	-16.5%	-1 5.3%	-1.2%	Motor vehicles (29)*	-1.11%
	Potenza	-16.2%	-3 .4%	-12.9%	Motor vehicles (29)	-0.24%
	Pisa	-15.9%	-1 3.3%	-2.6%	Leather (15)*	-0.96%
	Chieti	-15.5%	-8.8%	-6.7%	Motor vehicles (29)*	-0.63%

Notes: ΔED_j reports district demand shocks computed as Equation 9. ΔED_j^{FDI} and ΔED_j^{noFDI} split ΔED_j in two bins which consider demand shocks of sectors respectively with and without FDI. The last column report the estimated impact on ΔTFP^{TL} obtained by multiplying ΔED_j^{FDI} and ΔED_j^{noFDI} for their respective impact measured as the coefficients of Table 3 (column 1) for ΔTFP^{TL}. *Main sector (NACE)* identifies the sector which contributes the most to ΔED_j, with the corresponding NACE heading. * denotes whether the sector is involved in FDI.

[17] As before, we consider the sectoral composition in year 2009, prior to the estimation period.

Table A2: COVID-19 foreign shock: most impacted sectors

	Sectors (NACE)	ΔED_k	ΔED_k^{FDI}	ΔED_k^{noFDI}	Main district	Impact on ΔTFP
ES	Motor vehicles (29)	-25.06%	-22.36%	-2.70%	Barcelona*	-1.23%
	Leather (15)	-24.06%	-11.98%	-12.08%	Alicante*	-0.66%
	Trans. equip. (30)	-23.27%	-18.34%	-4.94%	Madrid*	-1.01%
	Apparel (14)	-20.61%	-13.83%	-6.78%	Barcelona*	-0.76%
	Machinery (28)	-17.62%	-15.61%	-2.01%	Madrid*	-0.86%
FR	Motor vehicles (29)	-31.04%	-27.94%	-3.10%	Hauts-de-Seine*	-1.53%
	Leather (15)	-23.43%	-18.35%	-5.08%	Paris*	-1.01%
	Trans. equip. (30)	-18.57%	-17.88%	-0.68%	Haute-Garonne*	-0.98%
	Apparel (14)	-16.82%	-13.72%	-3.09%	Paris*	-0.76%
	Paper (17)	-14.19%	-9.86%	-4.33%	Hauts-de-Seine*	-0.54%
IT	Motor vehicles (29)	-25.47%	-22.54%	-2.93%	Turin*	-1.24%
	Leather (15)	-22.24%	-15.96%	-6.28%	Florence*	-0.88%
	Trans. equip. (30)	-19.27%	-12.30%	-6.97%	Rome*	-0.68%
	Apparel (14)	-16.04%	-11.28%	-4.76%	Milan*	-0.62%
	Textiles (13)	-13.86%	-11.66%	-2.20%	Prato*	-0.64%

Notes:: ΔED_k reports sectoral demand shocks computed as in Equation 10 but using as weights country sector weights. ΔED_k^{FDI} and ΔED_k^{noFDI} split ΔED_k in two bins which consider demand shocks of district-sectors respectively with and without FDI. The last column report the estimated impact on ΔTFP^{TL} obtained by multiplying ΔED_j^{FDI} and ΔED_j^{noFDI} for their respective impact measured as the coefficients of Table 3 (col. 1) for TFP^{TL}. *Main district* identifies the district which mostly contributes to ΔED_k. * denotes whether the district is involved in FDI.

Additional Robustness checks

In this section we report a set of additional results. Table A3 reports the estimated effects of foreign demand shock across different definition of trade and FDI network overlapping. In order to check if our results are driven by a specific district-industry, we estimated the direct effect of foreign demand shocks, as in the baseline specification of column (2) of Table 1, by dropping one district-industry at time. The point estimates reported in Figure A1 are not sensitive to such sample restrictions, which confirms that our baseline results do not depend on one specific district-by-sector cell.

As spillovers are computed within a country we test our inference against a more restrictive cluster structure in Table A4 where we adopt a two-way cluster at the country-year (Ct) and firm (f) level, as expected the standard errors are now larger but the main results are still significant the conventional levels, except for the spillover effects on labor misallocation which turn insignificant.

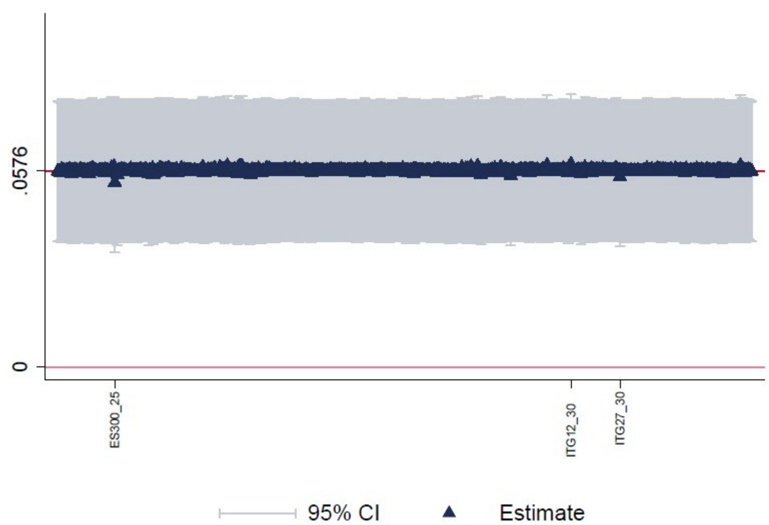
To asses the extent of potential violations of the exclusion restriction we follow the approach of and report in Table A5 the results of a regression that include both the gravity based conditional demand (our instrument) and the main variable of interest, ED_jkt, as well as the same set of fixed effects used in the preferred *FD-FE* specification. Overall the reported results confirms that the log-log gravity based instrument (in column 1) does not have a direct impact on the dependent variable suggesting for its plausible exogeneity.

Table A3: Overlapping between Trade and FDI network

Dep. var:		ΔTFP_{ft}^{TL}	
	(1)	(2)	(3)
$\rho = 1$ if distance $< 10^{pc}$			
$\Delta ED_{jkt}^{FDI_{jk}=1\,\&\,\rho=1}$	0.1079***		
	(0.0188)		
$\Delta ED_{jkt}^{FDI_{jk}=1\,\&\,\rho=0}$	0.0667***		
	(0.0138)		
$\rho = 1$ if distance $< 25^{pc}$			
$\Delta ED_{jkt}^{FDI_{jk}=1\,\&\,\rho=1}$		0.0907***	
		(0.0163)	
$\Delta ED_{jkt}^{FDI_{jk}=1\,\&\,\rho=0}$		0.0647***	
		(0.0141)	
$\rho = 1$ if distance $< 50^{pc}$			
$\Delta ED_{jkt}^{FDI_{jk}=1\,\&\,\rho=1}$			0.0779***
			(0.0147)
$\Delta ED_{jkt}^{FDI_{jk}=1\,\&\,\rho=0}$			0.0648***
			(0.0156)
$\Delta ED_{jkt}^{FDI_{jk}=0}$	0.0320**	0.0321**	0.0318**
	(0.0131)	(0.0131)	(0.0131)
Observations	1,370,699	1,370,699	1,370,699
R-squared	0.1670	0.1670	0.1670
FEs	f kt	f kt	f kt
Cluster	f jkt	f jkt	f jkt
Estimator		FD-FE	

Notes: Clustered standard errors in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1. “Country all” means France, Italy and Spain pooled.

Figure A1: Baseline OLS results excluding one district-industry at the time.



Note: the graph reports the distribution of the estimated coefficient for ED along with 95 % confidence interval. All specifications replicate column 2 of Table 1 in the main text. Only the coefficients with an absolute difference with respect to the unrestricted specification greater than 0.0001 are reported.

Table A4: Direct and indirect impact

Dep. var:	ΔTFP_{ft}^{TL}						ΔGAP_{ft}^{TL} $GAP_{ft}^{TL} > 0$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta ED_{jkt}^{FDI_{jk}=0}$	0.0269**	0.0263**	0.0225*	0.0185	0.0188	0.0160	0.0241	0.0262
	(0.0134)	(0.0132)	(0.0131)	(0.0134)	(0.0134)	(0.0132)	(0.0388)	(0.0390)
$\Delta ED_{jkt}^{FDI_{jk}=1\,\&\,\rho=1}$	0.1009***	0.0986***	0.0927***	0.0902***	0.0881***	0.0812***	0.2725***	0.2618***
	(0.0205)	(0.0203)	(0.0200)	(0.0201)	(0.0202)	(0.0194)	(0.0637)	(0.0628)
$\Delta ED_{jkt}^{FDI_{jk}=1\,\&\,\rho=0}$	0.0594***	0.0582***	0.0529***	0.0498***	0.0490***	0.0435***	0.1090***	0.1048***
	(0.0156)	(0.0153)	(0.0152)	(0.0155)	(0.0156)	(0.0154)	(0.0394)	(0.0396)
$\Delta Spill_{jkt}^{1stOrder}$	0.0484**							
	(0.0213)							
$\Delta Spill_{jkt}^{2ndOrder}$		0.0614*						
		(0.0323)						
$\Delta Spill_{jkt}^{3rdOrder}$			0.1042***					
			(0.0385)					
$\Delta Spill_{jkt}^{All}$				0.2131***			0.1191	
				(0.0647)			(0.1681)	
$\Delta Spill_{jkt}^{All\,DDI_{jk}=1}$					0.2169***	0.2200***		0.1394
					(0.0656)	(0.0610)		(0.1727)
$\Delta Spill_{jkt}^{All\,DDI_{jk}=0}$					0.2120***	0.2150***		0.1125
					(0.0646)	(0.0597)		(0.1678)
Observations	1,370,699	1,370,699	1,370,699	1,370,699	1,370,699	1,370,699	927,261	927,261
R-squared	0.1670	0.1670	0.1670	0.1670	0.1670	0.1670	0.1487	0.1487
FEs	f kt	f kt	f kt	f kt	f kt	f kt	f kt	f kt
Cluster	f Ct	f Ct	f Ct	f Ct	f Ct	f Ct	f Ct	f Ct
Estimator	FD-FE							

Notes: Standard errors in parentheses, clustered at the country-year (Ct) and firm (f) level (*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). Clustered "Country all" means France, Italy and Spain pooled. *1st Order* measure the spill-over as the average demand shock of a district direct neighbors; *2nd Order* includes neighbors of neighbors; and *3rd Order* includes neighbors of neighbors of neighbors; *All* consider an average over all the districts in a country (in column 6 the other district shocks are weighted by distance and industry specific elasticities). *FD-FE* refers to a model with firm fixed effects on first difference data. $GAP_{ft}^{TL} > 0$ refers to the sample of firms with positive gaps at time t.

Table A5: Plausible exogeneity, structural regression

Dep. var:	ΔTFP_{ft}^{TL}	
	(1)	(2)
ΔED_{jkt}	0.0750***	0.0684***
	(0.0249)	(0.0246)
$\Delta ED_{jkt}^{PPMLgravity}$	-0.0175	-0.0211
	(0.0226)	(0.0220)
Observations	1,403,532	1,370,699
FEs	kt	f kt
Cluster	f jkt	f jkt
Estimator	FD	FD-FE

Notes: Clustered standard errors in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1.