Does JIT production change the network structure of GVCs? Evidence from Italian firms *

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Abstract

This paper aims to study how Just-in-Time (JIT) production systems shapes the trade networks of manufacturing firms, relative to traditional business models. Using Italian balance sheet data, we construct a proxy for JIT production. We document two main empirical regularities. First, we show that firms adopting JIT production usually perform better in terms of sales and profits, and have lower costs of labour and debts with providers, compared to non-JIT firms. Second, we use novel Italian custom data to analyse the geographical patters of JIT firms' GVCs, finding that JIT firms trade with country partners that are geographically closer.

Keywords: Value chains, Just-in-time, Inventories

JEL Codes: F21, F41, G31

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1 Introduction

Covid-19 and supply chain bottlenecks highlighted the importance of value chains. There is an intense debate on the resilience of supply chains, whether policy makers should promote diversification of sources, reshoring of the production either domestically or regionally, or a combination of the two strategies (Grossman et al., 2021). The micro structure of firms trade network is crucial to understand how aggregate demand and supply shocks propagate internationally. Our work aims to show that JIT inventory management is a key determinant to regional and global value chains. Just-in-time (JIT) is a system of manufacturing logistics in which inputs are ordered and delivered just before they are needed for the production process. On one side, holding inventories allows to hedge against delayed input delivery, gives time to inspect the quality of both inputs and outputs, and potentially reduces costs though bulk orders (Billesbach et al., 1991). On the other side, JIT production increases firms flexibility in their ordering decisions, reduces the stocks of inventory held on-site, and eliminates inventory carrying costs, such as transportation, depreciation, obsolescence, storage, up to 10% of the inventory's value (Blinder and Maccini, 1991). Therefore, as argued by Ortiz (2021), just-in-time production creates a trade-off between firm profitability and vulnerability to large unexpected shocks.

Starting from the early 80s, and due to the growing digitalization of communication through the 90s, firms in advanced and emerging economies have started lowering inventory holdings (Chen et al. (2007), Dalton (2013), Saranga et al. (2015)) which account for part of the lower volatility in output (McConnell and Perez-Quiros, 2000). Diminishing transportation costs have facilitated JIT inventory management at domestic, regional, and global level.[1]. Moreover, since the 80s, the geography of individual raw materials, intermediate inputs and final good production have been scattered across countries (Gereffi, 2014) and global value chains (GVCs) have gained importance. Hence, JIT firms trading in an international value chain face an extra trade-off: setting a regional network which allows a better information sharing along the chain to maximise just-in-time efficiency,

[1]US data show a declining inventory-to-sales ratio from the 80s to the 2008 financial crisis, while increased global uncertainty might have led to increasing overall inventories.

versus acquiring from the cheapest supplier globally, potentially at increased distance. Global and regional sourcing have been studied in (Antràs and De Gortari, 2020), who show that global integration of firms monotonically increases with declining trade costs at the expenses of domestic chains; regional chains follow a hump-shaped pattern, increasing with the initial declining trade costs, and declining when very low costs make global sourcing the only optimal option. This aggregate result does not take into account the heterogeneity of firms.

In this work, how heterogeneity in inventory management is crucial to understand the micro origins of aggregate supply chain network determination and resilience. For our analysis we rely on balance sheet and novel custom data for Italian firms. We first study whether JIT firms, conditional international trading, choose trade partners that are geographically closer. In other words, are JIT firms integrated in more regional, as opposed to global, value chains? Then, we investigate whether JIT firms are more diversified in terms of products and country partners. Two papers are close to our frameworok: Pisch (2020) studies a model of JIT with French custom data and finds that JIT firms tend to chose closer trade partners, as we do. The author restricts the analysis to 3000 firms and EU trading partners, while we have more than 20000 Italian firms and the entire world as partners. Lafrogne-Joussier et al. (2021) study how supply shocks propagate through high and low inventory French firms, with a sample comparable to ours, without addressing the geographical structure of the trade network arising from inventory management.

The paper is structured as follows: Section 2 explains in details the data used and the construction of the JIT variable; in Section 3 we investigate JIT firms' characteristics; Section 4 presents the results of an analysis of geographical distance of JIT firms' trade partners compared to traditional ones'. Section 5 concludes.

2 Data and JIT measure

We mainly rely on two sources of data for our analysis. We take balance sheet data from CERVED, which provides yearly data of Italian companies since 1993. We select only the manufacturing firms (sectors 10-33 of the 2-digit Ateco classification) and drop from

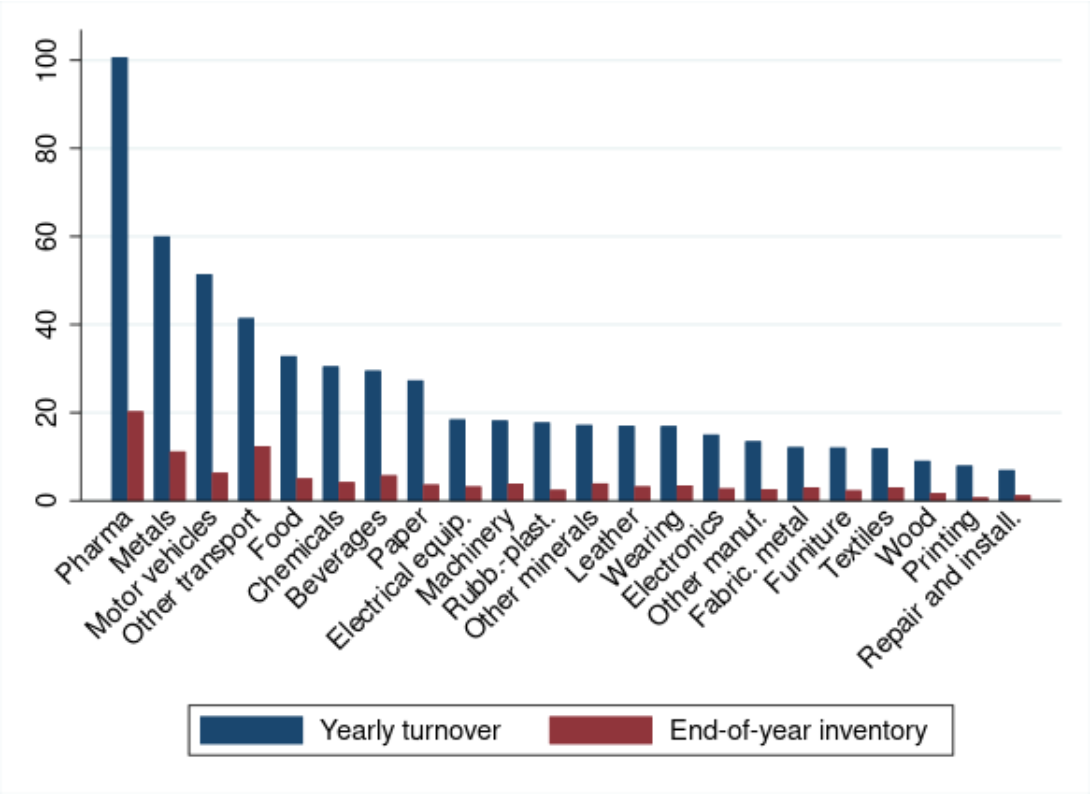
our database the companies with missing data for end-of-the-year inventories and yearly turnover in any of the last five years (2015-2019). Trade data are instead sourced by the Italian Custom Agency. Table 1 reports the summary statistics for the most important variables in our analysis.

Table 1: Summary statistics
(Italian firms; Inventory, Sales, Exports and Imports in million euros, 2019)

	Mean	Standard Deviation
Inventory	3.49	(30.66)
Sales	18.37	(96.03)
Days of inventory	70.83	(53.96)
Exports	6.66	(43.99)
Imports	2.78	(25.88)
Observations	34544	

Firstly, we use balance sheet data to assess whether a firm adopts a JIT production model, constructing a variable to measure the average number of days of stock and using it as a proxy for JIT production. Following Lafrogne-Joussier et al. (2021), this variable is computed as the value of end-of-the-year inventories (we cannot distinguish between finished good and input stocks in our data), divided by the firm's yearly turnover, times 365 (i.e. the number of days in an average year). A higher value indicates that a firm is adopting a more traditional business model, relative to a JIT one. Figure 1 shows the average yearly turnover and end-of-year value of inventories for each sector in 2019.

Figure 1: Average yearly turnover and end-of-year inventories by sector
(Italian firms, million euros, 2019)



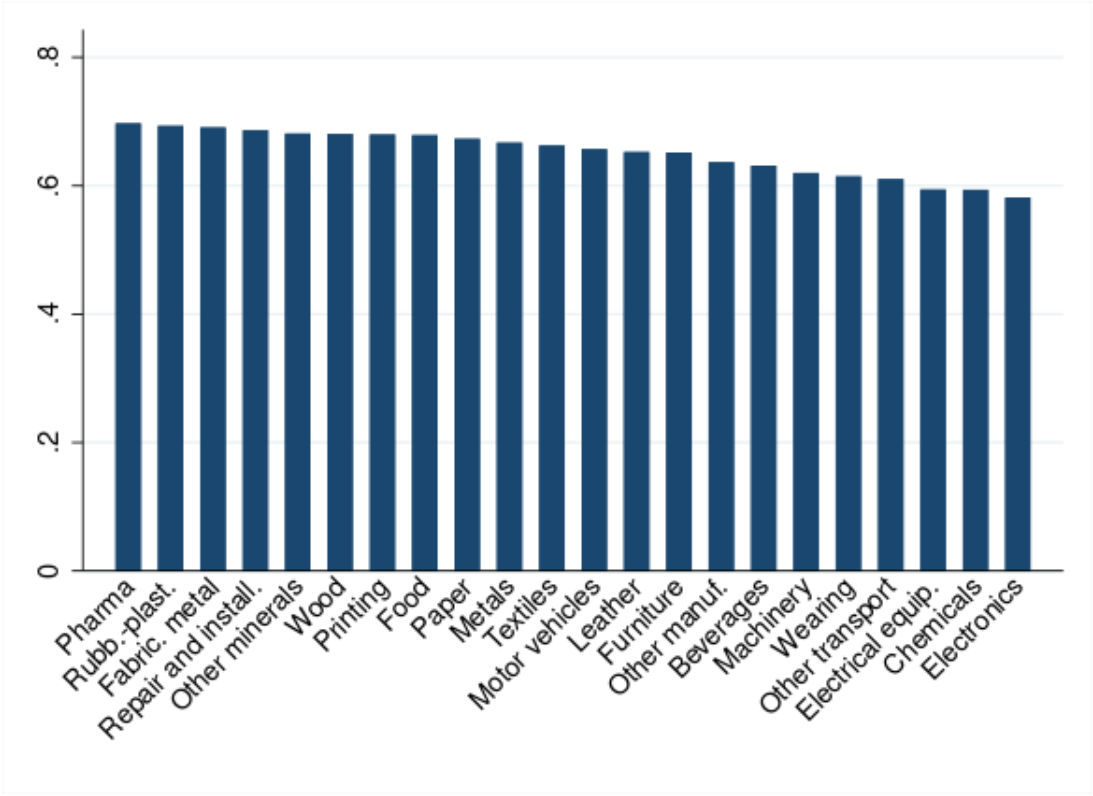
Source: Authors' elaborations on CERVED data.

We then standardize for each sector the days of inventory between 0 and 1 and compute the mean for the years 2015-2019 to give robustness to our measure. The resulting JIT measure for each firm f is then:

$$\text{JIT}_f = \frac{1}{T}\sum_{t=1}^{T}\left[1 - \left(\frac{dd_{tf} - \min\{dd_{ts}\}}{\max\{dd_{ts}\} - \min\{dd_{ts}\}}\right)\right] \in [0,1]$$

where $T = 5$ is the number of years between 2015 and 2019, s indicates the sector and dd are the days of inventory. Figure 2 reports, for each sector, the share of JIT firms, computed by looking at the number of JIT firms and at their yearly sales.

Figure 2: Mean of JIT indicator by sector
(Italian firms, 2019)



Source: Authors' elaborations on CERVED data.

We validate our measure of just-in-time production system by comparing it with the answer to Bank of Italy's survey Sondtel, which is a yearly survey conducted on nearly 3000 Italian firms with more than 20 employees. We use this question only to validate our measure and not as the measure itself for three reasons: (i) it is discrete, while using balance sheet data we have the possibility of constructing a continuous measure of JIT, so as to capture also the "intensity" with which a firm adopts a JIT business model; (ii) we can rely on a bigger sample of firms using balance sheet data; (iii) this specific survey question has only been introduced in 2021, so we do not have the historical series to give robustness to our data. Also, for this latter reason, we do not directly calibrate our JIT measure on the survey results: since balance sheet data are available up to 2020, using a 2021 survey as a basis for our variable (and considering the peculiarity of years 2020 and 2021 because of the pandemic) could be misleading. The question asked in Sondtel is: *Does your company use a just-in-time production organization? (This term means an organization of the production process for which inputs are bought exactly when they are*

required, in order to reduce the costs associated with the accumulation of stocks). There are four possible answers to the survey question: (1) "no", (2) "yes, for a minority of the productive processes", (3) "yes, for the majority of the productive processes", (4) "I do not know/I do not want to answer". For the scope of our analysis, we remove from our sample those firms that choose the fourth option and we consider to be JIT firms those that choose the second and the third one (companies that declare to use a just-in-time production system either for the minority or for the majority of processes). The remaining part are considered to be non-JIT. Without non-responding firms, our sample contains 2082 companies for which we have both balance sheet and survey data. We then compare the average number of days of inventory between JIT and non-JIT firms distinguished by the survey, so to see whether the days of inventory are actually a good proxy for just-in-time production. The evidence suggests that the average number of days in which inventory remains in stock is higher for non-JIT than for JIT firms (77.2 and 68.7, respectively), that is what we expected.

3 JIT firms characterization

Following Pisch (2020), we compute the point estimate from a regression of firms' characteristics on the JIT indicator:

$$JIT_f = \alpha + \beta X_{fs} + \gamma_s + \epsilon_{fs}$$

where for each firm f, JIT is the JIT indicator we constructed, X contains: days of inventory, sales, cost of labor, profits, debt with providers and trade exposure (this latter computed as the sum of imports and exports on total sales) and γ_s is a sector fixed effect. Results of the regression are reported in Table **??**: column (1) refers to a regression without fixed effects, while column (2) includes also the sector fixed effect. Compared with traditional firms, JIT ones tend to perform better in terms of sales and profits. They have a lower cost of labor, that might be induced by less need of people working with the inventory, and lower debt with providers, possibly due to lower levels of stock. Finally,

JIT firms tend to trade less than the others.

Table 2: JIT firms' characteristics

	(1)	(2)
	JIT	JIT
log sales	0.313***	0.314***
log cost of labor	-0.166***	-0.173***
log profits	0.246***	0.258***
log debts with providers	-0.319***	-0.320***
Sector effects	No	Yes
Observations	34544	34544

Standardized beta coefficients

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

4 JIT and value chain regionalization

To assess whether JIT firms form more regional GVCs, using Italian custom data for 2019 we analyze whether they trade with geographically closer partners compared to traditional firms. We estimate the following equation:

$$y_{fsc} = \alpha + \beta_1 \text{JIT}_f \times \text{distance}_c + \beta_2 \text{JIT}_f \times X_{fc} + \gamma_{sc} + \gamma_f + \epsilon_{fsc}$$

where y_{fcs} is the trade flow (we perform the analysis for imports and exports separately) of the Italian firm f operating in sector s with country c; JIT is the just-in-time indicator; X is a set of control variables that includes: per capita GDP of the trade partner country, a dummy variable that takes value equal to 1 if the partner country is a member of the World Trade Organization, another dummy that is equal to 1 if there is a regional trade agreement between Italy and the partner country, and a third one indicating common currency between the country and Italy; finally, we include firm, country and sector fixed effects. The results of the regressions for imports are reported in Table 3, while those for

exports in Table 4.

Table 3: Imports

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Distance	-0.046***	-0.090***						
JIT			2.322***	2.081***	2.288***	1.208**	0.911*	
Dist.×JIT			-0.294***	-0.281***	-0.278***	-0.156***	-0.106*	-0.209***
GDPpc×JIT				0.043	0.047	0.040	0.017	0.093*
WTO×JIT					-0.243	-0.301	-0.387	-0.420
RTA×JIT						0.320***	0.287**	0.160
Curr.×JIT							0.292***	0.329***
constant	3.667***	4.025***	3.287***	3.288***	3.288***	3.287***	3.286***	4.278***
Firm FE	No	Yes	No	No	No	No	No	Yes
Country FE	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	140270	133666	140262	139824	139824	139824	139824	133216

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Our main variable of interest is the interaction between the distance of the trade partner's country and the JIT indicator. Considering both imports and exports, the coefficient for this variable is always negative, and significant for most of the regressions. This suggests that firms with a higher propensity to adopt a just-in-time production business plan tend to trade with countries that are geographically closer, relative to firms with a traditional inventory management. The effect is stronger for imports than for exports: the proximity of trade partners for JIT firms seems to be a more important factor in the sourcing of inputs than in the export market.

Table 4: Exports

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Distance	0.006	-0.117***						
	(0.0048)	(0.0043)						
JIT			0.586***	0.592***	0.579***	0.215	0.206	
Dist.×JIT			-0.071***	-0.071***	-0.072***	-0.031	-0.030	-0.079***
GDPpc×JIT				-0.000	-0.001	-0.004	-0.005	0.015
WTO×JIT					0.018	-0.003	-0.005	0.112*
RTA×JIT						0.120***	0.118***	0.102***
Curr.×JIT							0.011	-0.010
constant	3.586***	4.549***	3.611***	3.614***	3.614***	3.614***	3.614***	3.889***
Firm FE	No	Yes	No	No	No	No	No	Yes
Country FE	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	461224	455173	461219	457021	457021	457021	457021	450962

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5 Conclusion

This paper uses detailed firm-level data on balance sheet and trade flows to build a proxy for just-in-time production ad then explore differences in characteristics, value chains (and diversification) of firms that adopt a JIT business model compared to the more traditional ones. We find that JIT firms perform better in terms of sales and profits, and generally trade less than traditional firms. Moreover, JIT firms' trade partners are less distant than traditional ones', suggesting that the value chains of JIT firms' products are more geographically concentrated. Specifically, the effect is stronger for imports than for exports, indicating that the trade partner proximity is particularly important for the sourcing of inputs.

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