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Global Value Chains During the Great Trade Collapse: A Bullwhip Effect?

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Abstract

This paper analyzes the performance of global value chains during the trade collapse. To do so, it exploits a unique transaction-level dataset on French firms containing information on cross-border monthly transactions matched with data on worldwide intra-.rm linkages as defined by property rights (multinational business groups, hierarchies of firms). This newly assembled dataset allows us to distinguish firm-level transactions among two alternative organizational modes of global value chains: internalization of activities (intra- group trade/trade among related parties) or establishment of supply contracts (arm's length trade/trade among unrelated parties). After an overall assessment of the role of global value chains during the trade collapse, we document that intra-group trade in intermediates was characterized by a faster drop followed by a faster recovery than arm's length trade. Amplified fluctuations in terms of trade elasticities by value chains have been referred to as the "bullwhip effect" and have been attributed to the adjustment of inventories within supply chains. In this paper we first con.rm the existence of such an effect due to trade in inter-mediates, and we underline the role that different organizational modes can play in driving this adjustment.

1 Introduction

The "Great Trade Collapse" has been one of the most striking features of the recent global financial crisis, with the ongoing recovery still driving a wedge between output and trade. Apart from its magnitude, the fall in trade during the crisis has also been quite homogeneous across all countries: more than 90% of OECD countries have exhibited simultaneously a decline in exports and imports exceeding 10%. The fall has also been very fast, with trade virtually grinding to a halt in the last quarter of 2008. All these findings have led to qualifying the drop in trade during the crisis as "severe, sudden and synchronized" (Baldwin and Evenett, 2009). A number of transmission mechanisms (Baldwin, 2009) have been proposed which could account for such peculiarities, making the latest generalized trade drop quite unique among the many episodes of trade decline after a financial crisis (Abiad, Misha and Topalova, 2010). Among those mechanisms, a particular role has been attributed to the emergence of global supply chains over the last decade, and to the different compositional effects of the demand shock on trade and GDP. A role has also been acknowledged for the credit crunch suffered by internationalized firms (Bricongne et al., 2011).

Considering the transmission mechanism of global value chains, a first argument is that the magnitude of the trade drop is due to a problem of multiple accounting. In a world increasingly characterized by vertical specialisation, i.e. with goods produced sequentially in stages across different countries, the same component of a final good is exchanged (and thus recorded at gross value as trade) several times before the final product reaches the consumer. As a result, for a given reduction in income, trade should decline "not only by the value of the finished product, but also by the value of all the intermediate trade flows that went into creating it" (Yi, 2009; but also previously Bergoeing et al., 2004).

A second channel that relates the magnitude and the synchronization of the latest trade drop to the emergence of global value chains is the inherent adjustment in inventories after a demand shock that the existence of inter-firm linkages implies. The wider fluctuations in terms of trade elasticities are in this case an overreaction due to adjustments in the stocks of intermediate inputs by firms involved in complex supply chains (Stadtler, 2008; Escaith et al., 2010; Freund, 2009). According to this argument known as the "bullwhip effect" (Forrester, 1961), each participant to a supply chain had a greater observed variation in demand during the crisis and the initial negative shock propagated up the value chain. The logic is as follows. When final demand is subject to volatility, businesses typically face forecast errors against which they try to shelter by building safety stocks of inventories. Upstream participants to a supply chain face greater demand volatility than downstream ones, so the need for such stocks rises moving up the value chain. The result is that variations in final demand are amplified as one moves away from the final customer. When applied to the current context, the foregoing logic implies that, with falling demand, orders decreased more than proportionally because firms were able to draw on inventories after expectations of lower future demand. Firms involved in value chains reduced their stocks more than proportionally while the shock propagated up the value

chain. Alessandria et al. (2011) successfully tested this argument for the US.

Exploiting transaction-level French trade data matched with ownership data for the period 2007-2009, we first find evidence of an overreaction of trade in intermediates in line with what suggested by Alessandria et al. (2011), then we notice different dynamics of value chains according to their organizational mode: trade of intermediates among related parties reacted with a a faster drop at the outburst of the crisis and a faster recovery thereafter. In other words, verticalized multinational groups were able to adjust faster to the negative demand shock. While a role for the financing capabilities internal to the group cannot be excluded in softening the financial constraints in times of recovery, our hypothesis is that hierarchies of firms belonging to the same multinational groups are better able to optimize inventories management and do not suffer from the informative asymmetries of buyer/supplier contracts when compared with value chains consisting of independent parties. For example, to better manage orders along the supply chain, Wal-Mart stores frequently transmit sales data to the headquarters, which then use this information to fine tune the shipments from suppliers to stores through the distribution center. Clearly, the successful implementation of this sort of demand-driven strategies requires a degree of trustful collaboration and information sharing that is much easier to attain among related than independent parties.

The paper is organized as follows. In Section 2 we introduce our newly assembled dataset that allows us to capture inter-firm proprietary linkages and we provide some descriptives of the peculiarities of value chains organized by multinational business groups. In Section 3 we exploit our dataset to draw some stylized facts that relate the trade collapse to the organizational modes of value chains. In Section 4 we discuss the results of our empirical investigation. In Section 5 we present some concluding remarks.

2   The dataset: trade and inter-firm linkages

Our transaction-level dataset has been built exploiting three different available sources: French customs'monthly data for exports and imports by firms; Orbis by Bureau Van Dijk for annual balance sheet data; and the Ownership Database by Bureau Van Dijk for data on intra-group linkages. In particular, the first source allowed us to collect over 62 million monthly transactions of products classified according to the HS (Harmonized System) 6-digit classification with their countries of origin and destination for the period 2007M1 to 2009M12; we therefore cover the whole period of the trade collapse and the following recovery. The second source reports the core and secondary economic activities of firms involved or not in international trade, as well as annual data on firms'size and financial accounts. The third source, which is based on information provided by company themselves or by national official bodies when in charge, allows us to track the proprietary network of affiliates belonging to the same headquarter and located worldwide.

The final outcome is a sample with different levels of interlocking economic disaggregation, from consolidated multinational groups to single affiliates, from industries to products, which are traded by single firms organized as multinational groups or as independent firms. Moreover,

a space disaggregation and a time disaggregation are present in the sample. The former enables us to consider both the geographical dispersion of trade flows and the locations of the property networks of hierarchies composed by a French or a foreign headquarter and their own affiliates worldwide. The disaggregation by month, on the other hand, allows us to properly split the period of analysis following the timing of the financial crisis and hence its fast transmission to firm trading activities.

We end up with over 62 million of transactions by 167,833 exporting and/or importing firms located in France in the period 2007-2009 from all sector of economic activities, including manufacturing, services and primary industries. Out of the total number of recorded firms, only 6,760 are owned by a foreign multinational group (defined as a group with at least one affiliate and the headquarter abroad) while 9,482 are part of a French multinational group (with the headquarter in France and at least one affiliate abroad). The number of headquarters, i.e. the number of multinational groups to which the affiliates belong, is 5,754 (either foreign or French), whereas the total figure for the worldwide affiliates to which French firms can be linked (either as headquarters or as domestic affiliates of French multinational groups) is about 690,500.

Thanks to the information provided by the Ownership Database, we are able to track the complete control chains of these groups, from the bottom of the network up to the final ultimate owner, considering also cross-participations and taking the majority of 50.01% as the threshold to identify corporate control. This last threshold is already adopted as an international standard to define MNEs' activities (OECD, 2011), and by international accounting standards when attributing control on profits and hence tax liabilities across national borders[1]

We then define a "trading firm" as a firm that exports and/or imports at least one product in a month in the period of analysis, with two thresholds provided by French Customs, according to which it is mandatory to report trading activity only when exports to a non-EU country exceed 1,000 euro for each transaction and when exports to all EU-countries exceed 150,000 euro on a yearly basis. On the other hand, the only limitation of firm level sources is the selectivity of the mandatory presentation of a yearly balance sheet, which leaves out some 2,000 firms registered as trading from the French Customs. These firms, however, account for only 1.20% of the total number of trading firms and 0.55% of trade volumes[2]

To better exploit the information at the product level, we have employed the correspondence tables provided by the United Nations Statistics Division and EUROSTAT, to convert the transactions of HS 6-digit products into CPA (Classification of Products by Activity) categories. These are easily grouped in 4-digit NACE rev. 2 economic activities, which is the industrial classification we employ for firm-level analysis, and in BEC (Broad Economic Categories) reclassified according to SNA (System of National Accounts), which distinguishes between capi-

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[1] An advantage of this criterion is also to partition affiliates among groups avoiding double counting by different headquarters. For a more complete reference on methodologies to track group control chains from affiliates to ultimate headquarters, see Altomonte and Rungi (2011).

[2] The original source of Bureau Van Djik's database for French firms are the Tribunaux de Commerce that are responsible to collect balance sheet data according to national legislation, according to which some smaller "sociétés de personne" and "sociétés coopératives" are exempted from the obligation of a complete balance sheet.

tal, consumption and intermediate goods, according to the main end-use of traded products. A further classification capturing the distinction between durable and non-durable goods has also been adopted: the Main Industrial Grouping (MIG) by EUROSTAT has allowed us to reclassify trade flows in order to account for the different demand shocks that those two categories of goods have suffered during the crisis[3].

The sample covers all industries in manufacturing, services and primary sectors, as shown in Table 1, where a matching of ownership and firm-level trade data provides a picture of the sectoral degree of internationalization. Firms pertaining to multinational groups, whether French or foreign, have the lion's share of trade, i.e. 65% of export and 62% of import flows (Figure 1). In the sample, there is a prevalence of service firms, among which those involved in distribution activities (whether wholesale or retail) account for about 56% of the total service industry (43% of the whole sample)[4]. Firms involved in the distribution industry are recognized to have an important role as intermediaries in trade (see for example Bernard et al., 2010, Ahn et al., 2011), establishing so-called indirect modes of exporting and importing. In our sample wholesalers are prevalently both importers and exporters and retailers are prevalently importers. Whereas the vast majority (89%) of firms in the sample do not belong to any group, group affiliation (whether French or foreign) increases with firm size (Figure 2).

Table 1: Sample coverage by macrosectors and ownership status, number of firms

| | ownership status (N. firms) | | | | trading status (N. firms) | | | |
	affiliates to French groups	affiliates to foreign groups	independent firms	Total	exporters and importers	only exporters	only importers	Total
Primary sectors	185	51	2,454	2,690	437	1,693	560	2,690
	6.88%	1.90%	91.23%	100.00%	16.25%	62.94%	20.82%	100.00%
Manufacturing	2,869	2,065	31,847	36,781	18,113	10,997	7,671	36,781
%	7.80%	5,61%	86.59%	100.00%	49.25%	29.90%	20.86%	100.00%
Services	6,426	4,639	117,242	128,307	35,046	42,429	50,832	128,307
%	5.01%	3.62%	91.38%	100.00	27.31%	33.07%	39.62%	100.00%
of which								
Wholesale trade	1,948	2,310	45,412	49,670	20,164	12,618	16,888	49,670
%	3.92%	4.65%	91.43%	100.00%	40.60%	25.40%	34.00%	100.00%
Retail trade	547	224	21,579	22,350	4,191	6,185	11,974	22,350
%	2.45%	1.00%	96.55%	100.00%	18.75%	27.67%	53.57%	100.00%

In Figure 3 we group affiliates by headquarter and plot their distribution in terms of size, where size is measured by number of affiliates. In this case, thanks to the coverage of our dataset, we are able to consider all foreign affiliates worldwide of foreign groups operating in France, as well as the total number of affiliates of French groups, thus drawing a more complete picture of the network of firms developed within multinational business groups. Recalling the definition provided above, a French group is included in our dataset if it has at least an affiliate abroad

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[3]MIG end-use categories are based on the NACE rev.2 classification and are defined by the European Commission regulation (EC) n°656/2007 of 14 June 2007.

[4]According to NACE rev. 2, 2-digit industry codes, firms involved in wholesale trade are classified as NACE code 46 and firms involved in retail trade are classified as NACE code 47.

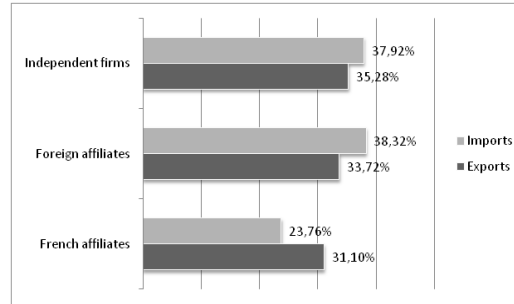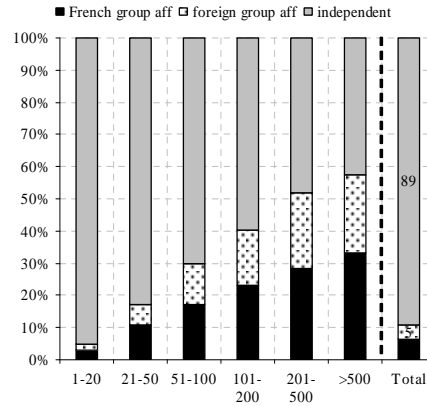Figure 1: Trade volumes by ownership status

Figure 2: Trading and ownership status by firm size (employment)


Ownership status and firm size

and the headquarter in France, whereas a foreign group (with a foreign headquarter) owns at least one affiliate in France. In the graph and the table provided in Figure 3 we report some descriptives of the group size distribution by affiliates and locations of headquarters.

Group size is heterogeneous in terms of number of affiliates, resembling a Pareto distribution with a shape parameter of 6.61 for all groups and even higher for French groups. As we can see from graph a) in Figure 3, multinational business groups operating in France are very dispersed, with a long right tail where a top 1% of headquarters control more than 1,000 affiliates and a median size of 10, while almost 40% of these groups are very simple organizations with one headquarter and only one affiliate. Groups with a French headquarter and a trading activity in France are on average smaller than foreign-owned trading groups, with a median size of 4 affiliates. In Table b) of Figure 3, providing a geographical coverage of home economies, we observe that 4,637 headquarters are actually located in EU members (2,964 in France), with

Figure 3: Group affiliation and worldwide networks, all groups vs. French groups)
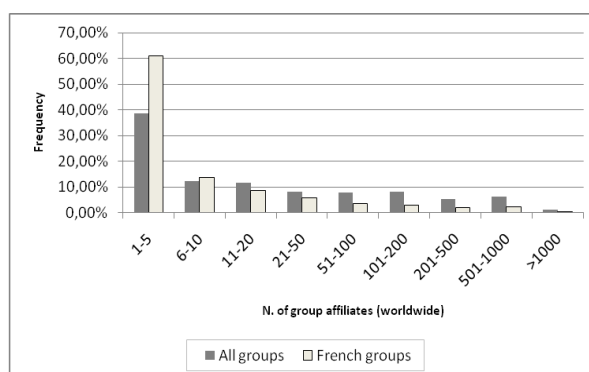
a) Group size distribution by N. affiliates (worldwide)

Home economy	N. headquarters	(%) on total headquarters	N. affiliates	avg. affiliates per headquarter	Median N. affiliates
EU-27	4,637	80.59%	429,760	93	2
Of which France	*(2,964)*	*(51.51%)*	*(144,050)*	*(49)*	*(4)*
Rest of Europe	350	6.08%	46,239	132	13
NAFTA	638	11.09%	140,521	220	14
Of which United States	*(599)*	*(10.41%)*	*(135,881)*	*(226)*	*(15)*
BRIC	31	0.54%	5,880	190	10
ASEAN	9	0.16%	5,122	569	39
Rest of Asia	154	2.68%	49,244	319	13
Of which Japan	*(138)*	*(2.40%)*	*(40,690)*	*(295)*	*(13)*
Africa	10	0.17%	2,446	245	19
Middle East	44	0.76%	7,149	162	9
South America	8	0.14%	1,305	163	8
Oceania	23	0.40%	4,611	200	16
Total	5,754		690,501	120	10
Pareto k-parameter	6.61				
for French groups	*(9.36)*				

b) Group home economies, average size and dispersion

a significant share in the United States, the rest of Europe and Japan. Considering the whole network to which affiliates in France can be connected through proprietary linkages, we have a total of 690,501 co-affiliates worldwide. In the fourth column of Table b) in Figure 3 we collect them by home economy of the headquarter and we calculate average and median size for some countries/regions. Here we note how on average groups originated in the rest of Asia (mainly Japan, Korea and Taiwan) are usually very much concentrated in affiliates, followed at a distance by few African groups involved in extractive activities and US groups. Brazil, Russia, India and China (BRIC) altogether report only 31 multinational business groups with trading activity in France.and almost two thirds of them (19) are based in India.

3 Global Value Chains, Organizational Modes and Trade Collapse

3.1 The Great Trade Collapse in France

By now it has been acknowledged that the origin of the great trade collapse mostly lies in a huge demand shock (Baldwin and Taglioni, 2009). Commodity prices tumbled when the price bubble burst in mid 2008 and continued to follow world demand in its downward spiral. The price movements and diminished demand sent the value and volume of commodities trade diving. The production and exports of manufacturing collapsed as the Lehman's induced shock-and-awe caused consumers and firms to wait and see. Private demand for all sorts of 'postponeables' crashed. The large observed drop in trade-to-GDP ratio can be ascribed to the ensuing compositional effect as postponeable products represent a larger share in trade than in GDP and global supply chains may have played a role in synchronizing the demand shock to GDP and the demand shock to trade.

According to the finding by Alessandria et al. (2011), supply chains shaped the response to demand shock through an adjustment in inventories by single firms involved in complex buyer-supplier relationships. The shape would show a "bullwhip effect" (a V-shape, here first dropping and then rebounding after a negative shock), explained by the reduction of stocks in times of crisis in order to adjust for new expectations about future demand. Forward and backward linkages within a supply chain and uncertainty about the real dimension of the demand shock would allow for its amplified transmission up the chain because each participant firm has a greater observed variation in demand for its production of (intermediate) goods. The bullwhip effect after a negative demand shock is depicted in Figure 4, where a simple value chain, composed by one retailer and two manufacturers, adjusts its orders exploiting previously stocked inventories as a buffer.

Figure 4: A bullwhip effect after a negative demand shock
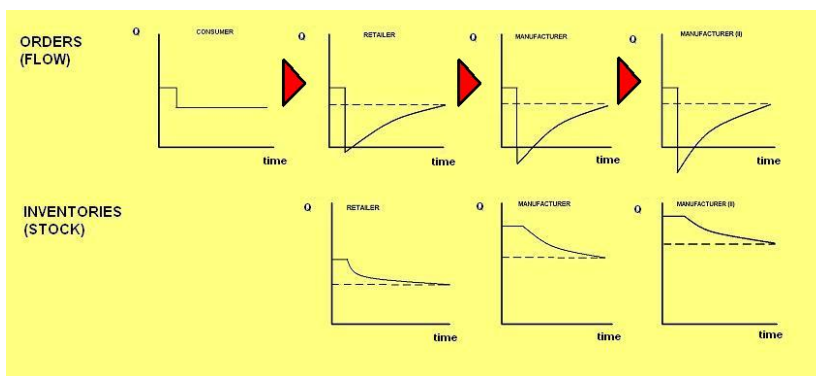
Once looking at our transaction-level data, we have a first confirmation of the posponement

story (Figure 5 and Figure 6), where we plot growth rates calculated on a year-on-year basis from January 2007 to December 2009, with trends reported as moving averages of two lagged periods. A generalized drop of total trade flows is observed from September 2008, while an overall reversal begins from June 2009.

In an effort to capture compositional effects, we first show in Figure 5 an aggregation by three broad categories of products (consumption goods, intermediates and capital goods) and then, in Figure 6, we decompose consumption goods in durable and non-durable components, always for exports and imports[5]. Assuming that trade in intermediate goods and capital goods is entirely driven by firm-to-firm relationships, whereas consumption goods are directed to final consumers (possibly through the mediation of firms involved in distribution activities), we observe that the first two categories react much more than the latter both along the export and the import dimensions. Indeed, while export and import growth rates of consumption register respectively an average of -6% and -4% in the middle of the crisis, the same averages for intermediates are -30% and -32%. On the other hand, capital goods show a different dynamics, sinking later and having yet to invert the ensuing downward trend in December 2009 while, on the consumption side, the durable component has hit exports harder with negative rates reaching a peak of -23% in July 2009, when total export volumes were already recovering.

The final outcome on the overall change in total trade volumes is then the result of a compositional effect, with trade in intermediates being more important (about 58% of both import and export volumes) than trade in consumption goods (nowadays only 25% of total French trade). Hence, the magnitude of the drop is clearly due to the exceptionally negative growth rates of both intermediates and capital goods, which are originated by the emergence of global value chains and have a higher weight on the overall export and import performance. Firms facing declining profits and uncertain demand have reduced their investment in capital goods and their acquisition of inputs, i.e. they have reduced production capacity, waiting for better future prospects. Indeed, at this stage of the analysis we could already dismiss the hypothesis of a multiple accounting effect as proposed by Yi (2009), since if the magnitude of the drop would be due to the same intermediate component crossing national borders several times, also growth rates of all final goods should reflect this effect, without regard to the durability of consumption, once the intermediate component is transferred to their gross value.

In the analysis that follows we will try to assess the role of the different organizational modes of a value chain during the crisis.

3.2 The role of global value chains

The emerging importance of global value chains is recognized by the increasing trade in intermediate inputs that nowadays represents a share between 56% and 73% of overall trade flows in

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[5]Capital goods, consumption goods and intermediates are main end-user categories from BEC classification of traded products reclassified according to the System of National Accounts, see Table 4 in the Appendix for details. The Main Industrial Groupings (MIG) allow for a reclassification of consumption goods among durables and non-durables on the basis of the end-use of final consumer. For details, see Table 5 in the Appendix.

Figure 5: French trade in 2007-2009 by end-user (BEC-SNA) categories, year-on-year monthly flows

Exports   Imports
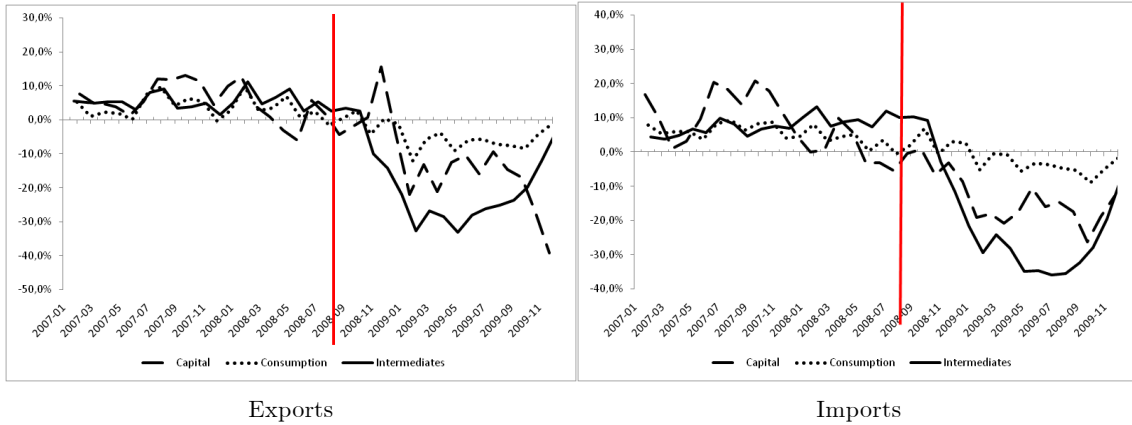
goods and services for developed economies (Miroudot et al., 2009). Indeed, trade in intermediate inputs is itself an indication that firms across national borders are engaged in backward and forward linkages, hence establishing global value chains where final goods or services undergo separate processing processes across different national borders before reaching the final consumer. From the point of view of a single firm, the decision is to relocate part of the production abroad with the establishment of affiliates or to license an unaffiliated supplier outside its own boundary of economic activity. Several theoretical models explain the choice between these two organizational modes (see, e.g., Antras 2005; Grossman and Helpman, 2005; Feenstra and Spencer, 2006; Helpman, 2006) that originate intra-firm (better, intra-group) trade in the first case and arm's length trade in the second case.

In the end, the internalization of production processes leads to the emergence of multinational business groups that collect affiliates under the coordinated direction of headquarters, i.e. hierarchies of firms linked by complex control chains that organize their activities under a unique control rather than through market relationships. As we have seen in the data presented in the previous section, in the case of France for the period 2006-2009, affiliates operating in France that are part of a multinational business group account for the majority of trade volumes, since they are responsible for about 65% of exports and 62% of imports even if they represent only 7% of the total number of firms. As we have seen, this concentration of trading activity among multinational business groups is paired with a relevant degree of heterogeneity in terms of size. Unfortunately, from our data we are still not able to directly measure intra-group trade via related parties, since exports and imports by affiliates located in France can include both a component of trade with related parties abroad (intra-group trade) and a complementary component of trade with non related parties (arm's length trade). On the contrary, in the case of

Figure 6: French trade in 2007-2009, durable vs non durable consumption, year-on-year monthly flows
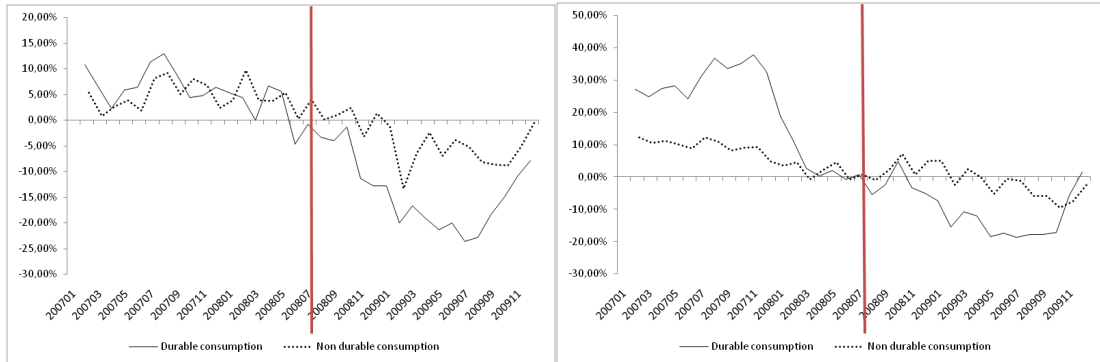
trading activity by French non-affiliates we can be sure that international trade is exclusively at arm's length.

To solve this problem we are able to proxy intra-group trade by building on the findings of Bas and Carluccio (2010), showing that 88% of trade by affiliates in France in a certain destination/origin is made either following a "pure outsourcing" (arm's length in our words) strategy or a "pure offshoring" (intra-group) strategy, with a mere 12% of cases following a mixed (outsourcing and offshoring) strategy.[6]
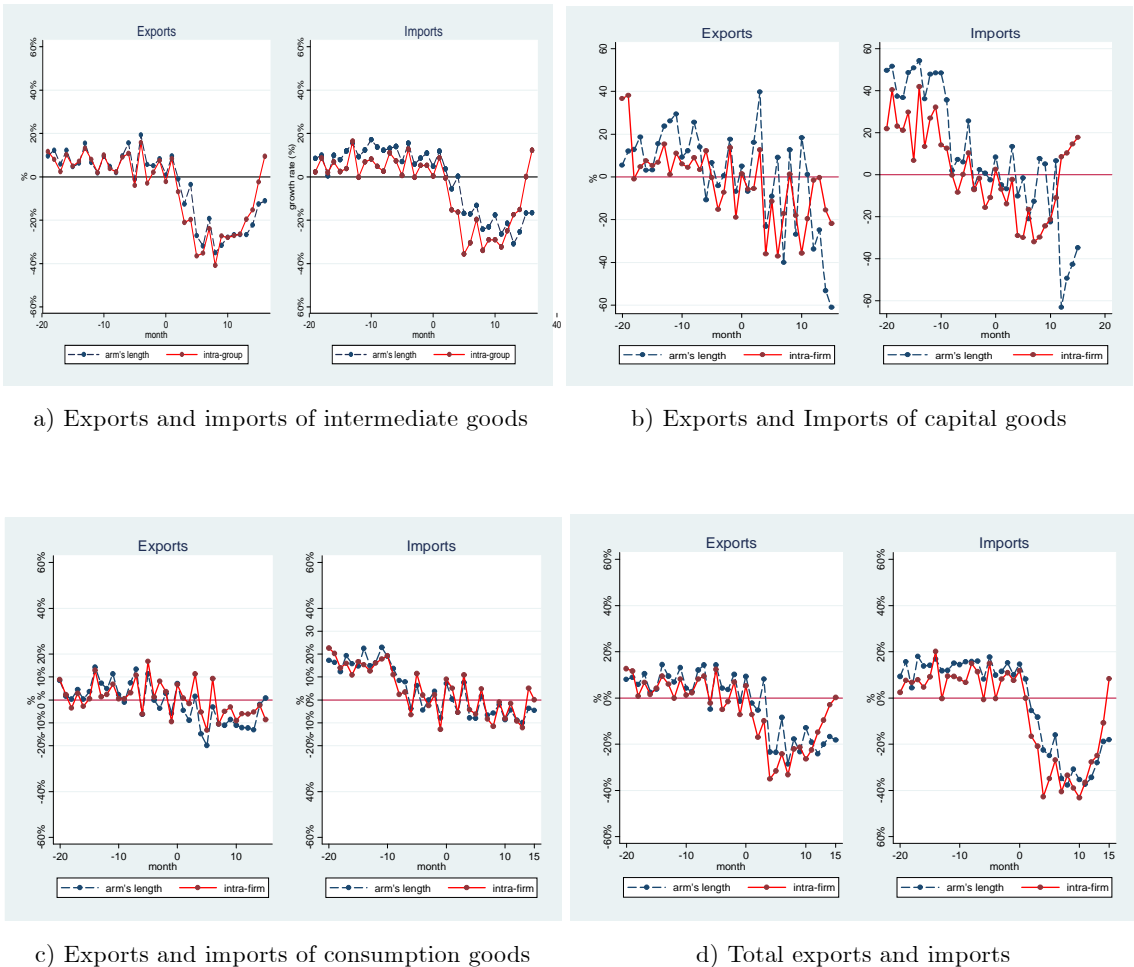
Henceforth, we will assume that trade occurs within the boundary of the business group when transactions undertaken by French affiliates in a given partner country find in the same country a corresponding subsidiary that belongs to the same multinational business group. While allowing us to bypass the lack of related-party data, such a proxing assumption could still bias our measure of intra-group trade since it might include a non-observed share of arm's length trade, due to the mixed strategy of outsourcing and offshoring. This can be considered an acceptable bias if one is willing to believe, as we do, that the latter is not correlated with any specific characteristic of the sample firms. On the other hand we have no doubt that, if transactions are undertaken by independent firms, or if they are not directed towards a country in which there are co-affiliates, those transactions are exclusively at arm's length, as they fall by construction outside the boundaries of the multinational business group. Following our approximation we can then estimate a total of 48% of exports and 46% of imports in 2007 being undertaken as intra-group trade.

To validate our measure, we can rely on a number of references against which compare our proxy of French trade among related parties. In 1999, the "Enquête sur les échanges intra-groupe", a survey on firms representing 55% of French imports and 61% of French exports,

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[6]In the international trade and the business studies literatures the term offshoring is used sometimes indifferently to define either a general relocation of activities abroad (including both intra-group and arm's length trade) or more specifically activities that are internalized by the firm (only intra-group). Bas and Carluccio (2010) prefer to use the term (pure) offshoring for trade originated by vertical integration only, hence intra-group trade.

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estimated that 32% of transactions (not trade volumes) were among related parties. Among these 93% were by firms located in developed countries (mainly EU and US). Given the spectacular increase of outsourcing/offshoring decisions over the last decade, our estimate of 48% does not seem inconsistent with these numbers. More interestingly, a partial direct validation is possible considering bilateral trade between France and US. Indeed, according to the Related Party Database by US Census Bureau (as reported by Lanz and Miroudot, 2011), 55.9% of imports from France in 2009 are originated by intra-group trade, a figure not very distant from the 61.9% we find in our dataset in the same year (exports from France to US); in this case, the overestimation would be 10.7%, slightly less than what reported by Carluccio and Bas (2010) as a mixed strategy. Furthermore, using Census Bureau data as a cross-country reference, the amount of intra-group trade in the US (46.8% of exports) is very similar to our estimation for France (48%)

Figure 7: Organizational modes and trade collapse in 2007-2009, monthly growth rates year-on-year basis

a) Exports and imports of intermediate goods

b) Exports and Imports of capital goods

c) Exports and imports of consumption goods

d) Total exports and imports

In Figure 7 we therefore report monthly growth rates of trade volumes distinguishing between end-user categories (consumption goods, capital goods and intermediates) as in Figure 5, but now taking into account whether transactions are intra-group or arm's length, as proxied by our methodology. Consistent with our prior, in both graphs of Figure 7 trade originated by vertical integration (i.e. intra-group, graph a) in the case of intermediates and graph d) in the case of total trade) drops faster at the outburst of the crisis but rebounds also faster once the recovery begins, when rates have become positive again at the end of 2009, with values well above 10%; on the contrary, in the same period arm's length growth rates show still a consistent decline: -11% for export of intermediates and -17% for import of intermediates. The organizational modes of global value chains thus seem to show a different dynamics that was concealed when looking at more aggregate data. Total trade flows for both imports and exports are clearly driven by the trend in intermediates (graph a of Figure 7), thus confirming the compositional effect of the trade collapse induced by the creation of complex supply chains and the fact that intermediates account for about 60% of total volumes. Also, the faster drop and faster rebound of intra-group trade is determined by the sole trade in intermediates, since in the case of consumption and capital goods such a different trend is not observed.

In the econometric analysis of Section 4 we will test whether the different behavior of multi-national groups is confirmed once looking at disaggregated data and controlling for several compositional effects.

3.3 The geography of the trade collapse

In the remaining of the Section we verify instead whether geography matters for the dynamics of trade flows during the crisis. In Figure 8, we provide a geographical dimension of the organizational modes before and after September 2008, showing the heterogeneity of intra-group and arm's length growth by key partner countries/areas. In Figures 9 and 10 we draw two maps identifying only the performance after the beginning of the drop. The indicator we adopt here is an integration index that considers both imports and exports originated by respectively arm's length and intra-firm trade averaging them from 2007M9 to 2009M12.[7]

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[7]Our vertical integration indices are given by $(exports_{ijkt} + imports_{ijkt}) / (exports_{ijt} + imports_{ijt})$, where i is the home country, j is the partner country, k is either arm's length trade or intra-firm trade to/from the partner country and t is time. At the denominator we have the sum of total imports and exports between home i and partner j in the same period. This indicator, proposed in WTO (2008) to measure the degree of participation to value chains, can virtually range from $[0, 1]$, from economies that are completely closed to offshoring/outsourcing activities to economies that rely exclusively to value chains.

Figure 8: Organizational modes and trade collapse, monthly growth rates year-on-year basis, 2007-2009

	arm's length		intra-firm	
	pre-crisis	post-crisis	pre-crisis	post-crisis
OECD	4.08	-16.54	5.73	-16.16
emerging economies	7.78	-11.77	9.57	-13.34
EU-27	6.05	-18.29	7.25	-15.15
EU-15	6.19	-16.61	2.68	-16.99
New EU members	5.9	-20.25	12.98	-12.83
NAFTA	2.8	-13.17	5.46	-13.20
United States	0.12	-7.00	-1.37	-11.98
Canada	6.53	-20.06	6.78	-0.83
BRIC	15.11	-12.20	17.4	-24.65
China	13.34	0.09	11.31	-5.67
Brazil	16.23	-17.94	14.53	-25.25
India	14.49	-13.58	23.5	-26.50
Russia	16.35	-17.38	20.26	-41.17
ASEAN	0.33	-11.34	27.9	-8.70
Africa	8.81	-2.83	10.85	-6.64
Middle East	9.53	-6.58	2.03	-3.41
South America	2.88	-4.07	3.89	-15.21

In contrast with the finding of other authors (Kaplinsky and Farooki , 2010; Cattaneo, Gereffi and Staritz, 2010), we do not observe in our case that trade originated by value chains shifted substantially after the crisis towards emerging economies. Rather, quite the opposite, the integration of the so-called BRICs (Brazil, Russia, India and China) seems to take place well before the crisis, while it stops afterwards with negative growth rates. A notable exception is however China, where we observe that even during the crisis arm's length trade was not disrupted (+0.1%), and intra-group trade fell considerably less than in the case of other French emerging partners (with the exception of some African countries that instead have registered positive growth rates for the whole period).

Vertical integration (intra-group) has on average fallen from September 2008 to December 2009 for both OECD High Income Countries and Emerging Economies, with a slightly different dynamics at the beginning of 2009, when recovery begun a quarter earlier for intermediates exported in emerging economies, until the end of the same year, when growth rates became positive again. In absolute terms, trade is more substantial in OECD countries (74.8% of export values and 74.6% of import values in 2007)[8]. Among developed partners, French-based value chains with the European Union were severely hit both in the case of historical EU-15 and in the case of New EU Members, whereas intra-group trade with Canada was more resilient. With the US the negative trend begun well before the crisis.

Summing up, in line with the worldwide synchronized nature of the demand shock, it seems we can rule out a specific role of geography in affecting the dynamics of the trade flows differently across organizational modes. In any case, we will also control for the latter possible compositional effect in our econometric specification, to which we now turn.

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[8]According to an OECD definition, its members can be distinguished between High-Income countries and Middle-Income countries. This latter category includes only Turkey, Chile and Mexico and we exclude it from our variable. The definition of emerging economies is more controversial. Here we have adopted the one provided by Dow Jones, the American financial information firm, that lists 35 countries.

Figure 9: Arm's length trade and trade collapse, average growth rates year-on-year basis
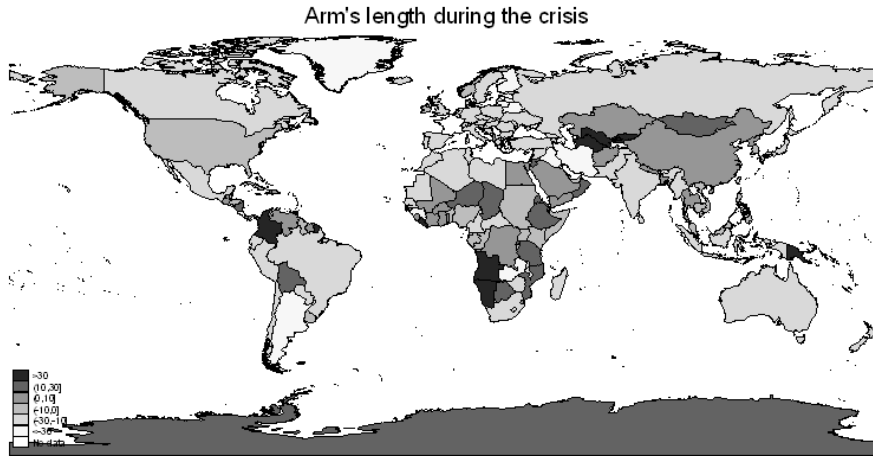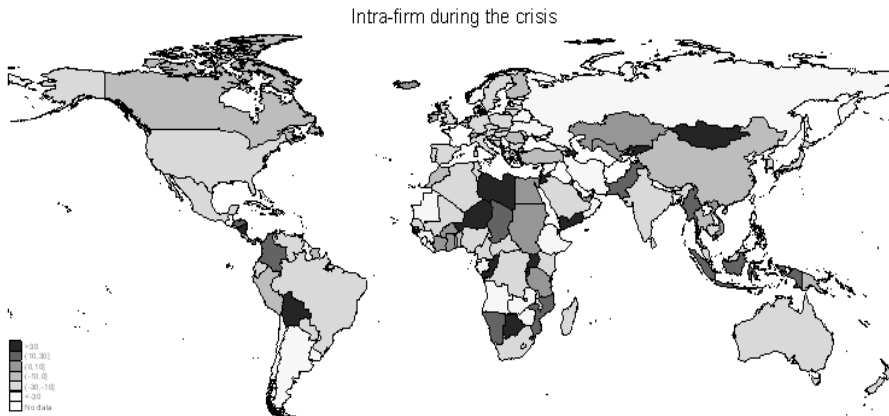

Arm's length during the crisis

Figure 10: Intra-firm trade and trade collapse, average growth rates year-on-year basis

Intra-firm during the crisis

4   Empirical strategy and results

In this section we test whether trade performance due to participation to value chains has been responsible for the magnitude of the drop, and if the two alternative modes of organization of inter-firm linkages have shown a different resilience during the crisis, for both imports and exports.

Our estimation strategy takes as dependent variable g_{isct}, the midpoint growth rate of trade flows, specific for product s traded by firm i in country c of origin/destination and month t. The mid-point growth rate, already employed by Bricongne et al (2011) for the French case during the crisis, correctly approximates the observed aggregate growth rates of exports but, unlike other methods, it controls for composition effects avoiding an attrition bias caused by the entry

and exit of sample observations and, also, for monthly seasonality[9].

The latter is regressed against a number of relevant controls via the following specification:

$$g_{isct} = \beta_0 + \beta_1 \Lambda + \beta_2 \Lambda * recovery + \gamma_j + \varepsilon_{isct} \tag{1}$$

where

$$\Lambda = \alpha_1 interm_{isct} + \alpha_2 intragroup_{isct} + \alpha_3 (interm * intragroup)_{isct} + OECD_{isct} \tag{2}$$

Among the set of regressors in Λ, the term $interm_{isct}$ stands for a binary variable that equals 1 if the traded product is an intermediate good and 0 otherwise, while $intragroup_{isct}$ is another binary variable that equals 1 if the flow is traded intra-group and 0 otherwise, following our approximation of intra-group vs. arm's length trade introduced in the previous section. The interaction between the intermediate and the intra-group dummies $(interm * intragroup)_{isct}$ is to be interpreted as the subset of trade flows that involve the exchange of intermediate goods between affiliates belonging to the same headquarter, i.e. a global value chain represented by a verticalized multinational group with backward and/or forward linkages. The binary variable $OECD_{isct}$ allows us to control for a geographic compositional effect induced by possibly different demand shocks registered in OECD countries after the financial crisis.

Taking into account the period from 2008M09 to 2009M12, that is from the beginning of the trade collapse until the last available month of our data, we differentiate the impact of our set of regressors Λ in two subperiods through the dummy $recovery$, that is before and after 2009M06. This is the month when overall trade flows began their recovery in France after a negative peak. More in general, this is the month in which conventionally the world economy starts to experience a generalized resumption of world trade.

Finally, compositional effects potentially induced by a change in the sectoral pattern of trade flows are captured by a set of NACE 4-digit industry fixed-effects (γ_k).

In Tables 2 and 3 we report the results for French exports and imports growth rates, respectively. In the first column of both Tables 2 and 3 we simply confirm that, once considering only the end-use of products and controlling for sector compositional effects, the magnitude of the drop is particularly due to trade in intermediates (inputs), namely to products that are exchanged by firms that establish backward and forward linkages either by proprietary or by buyer/supplier relationships, as observed in Figure 5. In particular, while we have an average negative growth rate for the whole period of, respectively, -8.8% and -6.1% for exports and imports (the coefficient of the constant term), a further negative and significant effect is to be added for trade in intermediates. A bullwhip-shape due to trade in intermediates is however

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[9]Applying the mid-point growth rate to our specific case we would have: $g_{isct} = \left(x_{isct} - x_{isc(t-12)} \right) / \left(0.5 * \left(x_{isct} + x_{isc(t-12)} \right) \right).$

The rate is bounded in the range $[-2, +2]$ with the extremes of the interval indicating the emergence ($+2$) or the disappearance (-2) of flows in month t with respect of the same month of the previous year $t - 12$. For other applications of this methodology, see also Haltiwanger (1992) and Buono et al. (2008).

detected from the estimation in the second column: at a negative premium for intermediates at the outburst of the crisis corresponds a positive premium once the recovery begins. Both the magnitude of the drop and the pattern of recovery are to be attributed to trade in intermediate goods that constitute already almost 60% of flows as we already know from aggregated data.

In the third column we begin to control for the organizational mode of the value chain, that is if products are exchanged by firms on the basis of proprietary or buyer/supplier relationships, whatever their end use. In this case, on average over the entire period, intra-group trade shows no significant difference with respect to arm's length trade in the case of exports, and a better performance in the case of imports. This shows that, at least on the import side, trade flows within multinational groups (whatever their end use) during the considered period have been in general more resilient than those undertaken by independent firms.

In the fourth column we start controlling for the interaction between the organizational mode of the value chain and the end use of traded products. For exports flows, the positive and significant coefficient on the interaction implies that intra-group trade on the average of the entire period has grown more in intermediates than in other end use categories. In the case of imports, the opposite effect holds. However, as observed in Figure 7, these effects are the outcome of two very different dynamics over time, with trade in intermediates first dropping and then recovering. Hence, it could well be the case that, in the case of exports, intra-group trade in intermediates has recovered more than it originally dropped during the crisis, while such a recovery is not yet fully undertaken in the case of imports. Our prior is instead more general, as it only postulates that intra-group trade in intermediates recovered more quickly (or fell faster) than all the other forms of trade (by end use or organizational form).

To test for the latter, in the fifth column of both Tables 2 and 3 we then split the effect between the crisis and the recovery period, in order to test whether there is such a difference in dynamics. The sign of the dummy identifying the recovery period shows that exports indeed performed better after the through of the crisis, independently on end uses or organizational modes. Moreover, the positive and significant coefficient on the triple interaction term implies that, during the recovery, exports of intermediates have performed better when taking place within multinational groups than at arm's length, thus confirming our hypothesis. Along the same lines, on average imports do not show any differential performance during the recovery across end uses or organizational modes, again consistent with the idea that the *overall* growth of intra-group trade in intermediates has not been such to absorb the effect of the collapse. However, once again, the positive and significant coefficient on the triple interaction term implies that during the recovery imports of intermediates have in any case performed *relatively* better when taking place within multinational groups than at arm's length, in line with our assumption.

In the sixth column, we finally check whether results are robust to a geographic compositional effect induced by the different (stronger) demand shocks coming from OECD countries. In general, we observe a negative premium for transactions that involve a developed partner at the beginning of the crisis. However in the second period of our analysis there seems to be no difference in trends of exports between developed and developing partners, while imports from

OECD countries recovered strongly. This result is in contrast with what suggested by Kaplinsky and Farooki (2010) and Cattaneo, Gereffi and Staritz (2010), according to whom the trade drop entailed also a substantial shift of value chains towards emerging economies. More importantly for our goals, our previous results on the triple interaction term are confirmed.

To sum up, for both exports and imports of intermediates, we find that trade flows have grown more when undertaken intra-group vs. arm's length, as soon as total trade begun its recovery. This result is consistent with the findings by Alessandria et al. (2011) for the US, attributing in general the faster drop and rebound of intermediates to adjustment in inventories. More specifically, we show that the overreaction at the beginning of the period, then compensated by a faster recovery in the aftermath, is particularly pronounced for verticalized multinational groups vs. arms' length trade. This shows a different and faster response of value chains organized by multinational groups. Our explanatory hypothesis is that the internalization of activities within the boundary of a group allows for a better management of information flows coming from the bottom of the value chain so that production and inventories can be more swiftly adjusted to demand shocks.

Table 2: Exports and global value chains

Dependent variable: mid-point growth rates	OLS (I)	OLS(II)	OLS (III)	OLS (IV)	OLS (V)	OLS (VI)
intermediates	-.009***	-.013***	-.009***	-.012***	-.012***	-.012***
	(.001)	(.002)	(.001)	(.001)	(.002)	(.002)
intra-group			-.001	-.007***	.010***	.012***
			(.001)	(.001)	(.002)	(.002)
intermediates*intra-group				.013***	-.008**	-.008**
				(.002)	(.003)	(.003)
OECD						-.022***
						(.002)
recovery		-.002			.006***	.008***
		(.001)			(.002)	(.002)
intermediates*recovery		.010***			-.000	-.000
		(.002)			(.002)	(.002)
intra-group*recovery					-.038***	-.038***
					(.003)	(.003)
intermediates*intra-group*recovery					.048***	.049***
					(.005)	(.005)
OECD*recovery						-.003
						(.002)
Constant	-.088***	-.088***	-.088***	-.087***	-.089***	-.073***
	(.001)	(.001)	(.001)	(.001)	(.001)	(.002)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	11,985,900	11,985,900	11,985,900	11,985,900	11,985,900	11,985,900
Adjusted R-squared	.0010	.0010	.0010	.0010	.0010	.0010

*, **, *** stand respectively for significance at 90%, 95% and 99%. Robust standard errors in parenthesis.

Table 3: Imports and global value chains

Dependent variable: mid-point growth rates	OLS (I)	OLS(II)	OLS (III)	OLS (IV)	OLS (V)	OLS (VI)
intermediates	-.006***	-.013***	-.008***	-.001	-.006***	.004**
	(.001)	(.001)	(.001)	(.001)	(.002)	(.001)
intra-group			.026***	.046***	.064***	.074***
			(.001)	(.002)	(.002)	(.002)
intermediates*intra-group				-.032***	-.045**	-.051**
				(.002)	(.003)	(.003)
OECD						-.083***
						(.002)
recovery		-.007***			-.001	-.023***
		(.003)			(.001)	(.002)
intermediates*recovery		.015***			.012***	.007***
		(.002)			(.002)	(.002)
intra-group*recovery					-.043***	-.047***
					(.004)	(.003)
intermediates*intra-group*recovery					.029***	.032***
					(.005)	(.005)
OECD*recovery						.031***
						(.002)
Constant	-.061***	-.058***	-.066***	-.069***	-.069***	-.010***
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	15,432,528	15,432,528	15,432,528	15,432,528	15,432,528	15,432,528
Adjusted R-squared	.0009	.0009	.0009	.0009	.0010	.0012

*, **, *** stand respectively for significance at 90%, 95% and 99%. Robust standard errors in parenthesis.

5 Conclusions

In this paper we have analyzed the trade performance of global value chains during the Great Trade Collapse. Exploiting a unique transaction-level dataset matching French monthly trade data with ownership information for the period 2007-2009, we have been able to distinguish the trade performance of two alternative organizational modes of the value chain: internalization of activities by multinational business groups, entailing trade among related parties, and the establishment of buyer/supplier contracts, entailing arm's length trade.

We have first provided some stylized facts on multinational business groups: affiliation to a headquarter is a concentrated phenomenon since affiliates in France account for about 65% of exports and 62% of imports even if they represent less than 10% of the total number of trading firms. Moreover, the distribution of multinational business groups by size, measured by number of affiliates worldwide, is very dispersed resembling a Pareto distribution.

Second, in order to assess the role of global value chains at the outburst of the crisis, we have econometrically tested the differential performance of trade in intermediates. This has been shown to be the main determinant of the magnitude of the collapse. We have also found that intra-group trade in intermediates exhibited specific dynamics with a faster drop followed

by a faster rebound than trade in other end categories. In other words, trade originated within hierarchies of firms reacted faster to the negative demand shock but also recovered faster in the following months than arm's length trade. Among the alternative channels of transmission of the demand shock to trade performance proposed in previous studies, the adjustment in inventories seems the most consistent with these findings. As in the case of the US studied by Alessandria et al. (2011) for the general case of intermediates, amplified fluctuations of trade with respect to GDP could be associated to the so-called "bullwhip effect" (Forrester, 1961; Stadtler, 2008), that is, a magnification of the initial demand shock along the supply chain due to an adjustment of production and stocks to new expectations. In this case, also the finding of a better performance of intra-group trade could be explained by better handling of inventories thanks to the ability to react faster and optimize management of stocks within the boundaries of the group.

At this stage of the analysis, we cannot exclude also a role for trade credit constraints, since hierarchies of firms may have relied on an internal capital market that softened the crunch of external sources of financing. This would, however, explain a faster recovery but not a faster drop. Hence, while an interaction of both determinants (optimization of inventories management and softer financial constraints) may have been relevant as suggested for example by Escaith et al. (2010), softer financial constraints alone would not be able to account for the observed patterns of the data.

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Broad Economic Categories (BEC) is a reclassification of traded goods according to their main end use. It was developed by the UN Statistics Division to be matched with the System of National Accounts. Our data, originally registered as HS (Harmonized System) 6-digit flows, were converted first by BEC categories and then grouped by basic classes of the System of National Accounts following Table 4.

Table 4: Correspondence table, from Broad Economic Categories to the System of National Accounts

Basic classes System of National Accounts (SNA)	Broad Economic Categories (BEC)
Capital goods	41. Capital goods (exc. transport)
	521. Transport equipment, other, industrial
Consumption goods	112. Food and beverages, primary, mainly for household consumption
	122. Food and beverages, processed, mainly for household consumption
	51. Transport equipment, passenger motor cars
	522. Transport equipment, other, non industrial
	61. Consumer goods, durable
	62. Consumer goods, semi-durable
	63. Consumer goods, non-durable
Intermediate goods: Primary	111. Food and beverages, primary, mainly for industry
	21. Industrial supplies, primary
	31. Fuels and lubricants, primary
Intermediate goods: Parts and components	42. Capital goods, parts and accessories
	53. Transport equipment, parts and accessories
Intermediate goods: Semifinished goods	121. Food and beverages, processed, mainly for industry
	22. Industrial supplies, processed
	322. Fuels and lubricants, processed, other

An alternative classification by end-use is the Main Industrial Groupings (MIG) proposed by Eurostat, which is based primarily on NACE rev. 2 industrial sectors and it allows to distinguish also between durables and non-durables. Starting with HS product flows, we first converted them in NACE economic activities and then we reclassified following Table 5

Table 5: Correspondence table, from NACE rev.2 to Main Industrial Groupings

Main Industrial Groupings (MIG)	Nomenclature statistique des activités économiques dans la Communauté européenne (NACE), revision 2
Capital goods	251. - 252. - 253. - 254. - 262. - 263. - 265. - 266. - 28. - 29. - 301. - 302. - 303. - 304. - 325. - 33.
Consumer durable goods	264. - 267. - 275. - 309. - 31. - 321. - 322.
Consumer non-durable goods	101. - 102. - 103. - 104. - 105. - 107. - 108. - 11. - 12. - 139. - 14. - 15. - 18. - 204. - 21. - 323. - 324. - 329.
Intermediate goods	07. - 08. - 09. - 106. - 109. - 131. - 132. - 133. -16. - 17. - 201. - 202. - 203. - 205. - 206. - 22. - 23. - 24. - 255. - 256. - 257. - 259. - 261. - 268. - 271. - 272. - 273. - 274. - 279.
Energy	05. - 06. - 19. - 35. - 36.

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