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Theoretical and Practical Research in Economic Fields

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GLOBAL SUPPLY CHAINS AND THE GREAT TRADE COLLAPSE: GUILTY OR CASUALTY?

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Abstract

With globalization, trade and production have been increasingly interlinked, thanks to the vertical integration of industrial production processes through outsourcing and off-shoring. The expansion of international supply chains determined the apparent increase in trade elasticity observed since the late 1980s, and may explain also the overshooting of trade elasticity during the 2008-2009 trade collapse. After reviewing the available evidences, the article analyses the future of globalized production networks in a post-crisis scenario. In the short term, global rebalancing might prove easier than expected, because trade in intermediate goods inflated artificially some bilateral trade deficits, albeit bilateral exchange rate adjustments have reduced impacts. But supply chains may become smaller and more regional as a result of this rebalancing. This scenario creates a challenge for labour abundant less advanced developing countries in the periphery of the large regional networks, which will find more difficult to attract productive investments. Yet deglobalization remains a distant threat as long as the technical and institutional factors that made possible the internationalization of production are preserved.

Keywords: global supply chains, trade, outsourcing, off-shoring, trade elasticity, internationalization of production

JEL Classification: F42, E32, F23, O24, O19, G01

1. Global supply chains and the great trade collapse: guilty or casualty?

International trade and the nature of globalization have changed dramatically in recent years, with the emergence of new global players and a radically different competitive landscape. This new pattern emerged during the late 1980s and early 1990s, when the Berlin Wall fall brought down the barriers that had split the post-WWII world, and the Brady Bonds put an end to the decade-long debt crisis that plagued many developing countries. The 1990s saw the conclusion of the Uruguay Round and the birth of the WTO, which brought down many trade barriers and led to further liberalization in areas like telecommunications, financial services and information technologies.

This transformation, which was both geopolitical and economic, was accompanied by the emergence of new business models that built on new opportunities to develop comparative advantages (Krugman 1995; Baldwin 2006). With the opening of new markets, the technical revolution in IT and communications, and the closer harmonization of economic models worldwide, trade became much more than just a simple exchange of merchandise across borders. It developed into a constant flow of investment, of technologies and technicians, of goods for processing and business services, in what has been called the "Global Supply Chain".

Those changes have led the American author Tom Freidman to proclaim that now "The World is flat". This "Copernican revolution" where countries do not trade wine for clothes anymore (Grossman, and Rossi-Hansberg 2006) obliged trade analysts and international economists to revise their old beliefs and models, while trade statisticians and national account specialists were struggling to adapts their instruments to the new reality (Escaith 2008). Despite important advances, the analysis is still lacking appropriate models and good data to understand and measure appropriately this new dimension of globalization. Yet, less than twenty years after its emergence, this new business model is now challenged on two grounds: firstly, because global supply chains may have been a causing factor of the Great Recession which followed the financial collapse of September 2008; secondly because a return to business as usual after the international crisis is not possible on objective economic ground, nor it is desirable for normative social or environmental reasons.

Indeed, if the cause of the global crisis is clearly financial, its particular mode of dissemination through real channels has been related to the interdependency created by global productive networks, which served both as transmission and amplification channels. While the crisis spread initially to all developed countries through toxic

[20] Economic Research and Statistics Division-WTO, Geneva; DEFI, Aix-en-Provence. The essay builds on a series of related works which benefited from the contribution of Ch. Degain, F. Gonguet, N. Lindenberg, A. Maurer and S. Miroudot. The views expressed in this document are those of the author and do not represent a position, official or unofficial, of the WTO Secretariat or WTO Members.

assets and exposure to the US financial market and seemed to spare the developing economies, the premise of a new North-South "decoupling" vanished rapidly when the contagion spread to the real economy through the trade collapse.

The amplitude and simultaneity of the transmission of shocks came as a surprise to many analysts. International supply chains, one of the most salient features of the "new globalization" were rapidly identified as one of the main factors for such a synchronization of shocks. With unemployment increasing as recession spread in developed countries, the debate was also put on the public place as the delocalization of investment and jobs that rests behind these new productive networks, together with the lack of governance of the international finance, became the focus of much public scrutiny.

Since the every-day reality of international business models is running faster than the elaboration of new analytical paradigms, the crisis hit the global economy in largely uncharted waters. Guided by "old" economic models, the major developed and developing economies, known as G-20, met head-on the risk of a world-wide depression and coordinated global responses in the early months of 2009. The package, reminiscent of traditional Keynesian recipes, addressed principally the macro-economic transmission channels through massive fiscal stimulus. With the risk of global recession diminishing after the second quarter of 2009, the debate has now shifted to the exit strategies.

The huge fiscal deficits have sustained public consumption in industrialized countries, but private consumption and investment remains depressed. If the danger of inflation seems under control, rebalancing the current account imbalances which characterized the pre-crisis period would create an additional negative shock, as high spending countries would have to increase their national savings. The alternatives medium-term forecasts range from "back-to-business-as-usual" to "deglobalization" scenarios, producing an alphabetical string of V, U, L or W profiles.

Against this background, the present article explores in a first section the particular role of supply chains in transmitting and amplifying external shocks. A second part analyses their potential responsibility in the 2008-2009 trade collapse, and a third one is dedicated to exit scenarios and the perspective of global supply chains after the crisis, including some of the consequences of global rebalancing for less advanced developing countries.

1. Supply chains as transmission channels

Like in previous global financial crisis, the international banking system came to a "sudden stop" after September 2008. Two aspects were nevertheless original: the shock emanated from the largest world financial centre instead of initiating in developing countries, and the shocks spread very quickly and almost simultaneously to many industrial and emerging countries. In particular, trade reacted very strongly to the first signals of recession, and sectors were differently affected. The sectors most affected by the recession were fuels and minerals (due to a strong price effect), and machinery and transport equipment (strong demand effect).

With the financial crisis, the sectors producing consumer durable and capital goods were on the front line, as demand for these products relies on credit. In turn, the lower industrial activity reversed brutally the trend in the prices of key primary commodities, which had been rising substantively since 2003. Between the third and the fourth quarter of 2008, the difference in growth rate is, respectively, 41 and 37 percentage points for iron and steel, and for minerals (Table 1). The collapse in trade mostly affected merchandises; except the financial transactions, the commercial services, other than those related to trade in goods, were more resilient.

Indeed, world trade dropped five times more rapidly than global GDP, supply chains playing their part in explaining the magnifying effect of the crisis on international trade. Some of the mechanisms are purely of accounting nature: while GDP is computed on a net basis, exports and imports are registered on their gross value. In addition, because supply chains cover various countries, a lot of double counting takes place while goods for processing cross the borders at each step of the production process. But the core of the explanation is to be found in the nature itself of the 2008-2009 crisis.

International transmission of shocks takes usually two forms, commercial and financial. In previous instances of global crisis, most of the systemic commercial and financial shocks where of macroeconomic nature. A recession in a foreign economy reduced demand for exports, which in turn depressed the activity in the home country. The propagation of such demand-driven shocks through the productive sectors of the home economy can be traced using an input-output model, through traditional Input-Output modelling. In addition, both financial and real channels are interlinked at the macro level, because credit crunch affects household consumption and firms' investment.

Table 1. Quarterly growth of world manufactures exports by product, Q1/08-Q3/09
(percentage change over previous quarter, current dollar values)

Quarter/Sectors	Q1/08	Q2/08	Q3/08	Q4/08	Q1/09	Q2/09	Q3/09	Q4/09
Manufactures	-1	9	-2	-15	-21	7	9	9
Office and telecom equipment	-12	5	5	-10	-27	13	14	16
Automotive products	1	6	-14	-18	-33	14	13	21
Iron and steel	11	23	7	-34	-31	-8	10	10
Ores and other minerals	10	20	4	-33	-35	13	24	7

Source: WTO.

The gradual substitution of trade in goods by trade in tasks that took place during the 1990s have changed this traditional mode of transmission, and added another layer of transmitters which are operating at micro economic level but have also an international dimension because of the geographical segmentation of the productive chains. When industrial production is spread across various countries, and that all segments of the chain are critical (supplied constrained), a shock affecting one segment of the chain will reverberate through all the chain. At the difference of the macro-economic case, shocks are moving forward, from supplier to clients, and not backward as in the demand-driven Leontief model (from client to suppliers).

These effects are still largely unknown as they affect firms that are eminently "heterogeneous", as recognized by the new "new trade theory". It is a cliché to say that time is accelerating, but it carries a lot of truth in the present situation. In the race between the practitioners –engineering and business schools – on the one hand, and the university, on the other hand, praxis is well ahead despite significant advances in the theoretical aspects (Box 1).

On the empirical side, Escaith and Gonguet (2009) (E-G09 thereafter) jointly models the real supply-side and financial effects from a complementary viewpoint of monetary circuit and international Input-Output (I-O) matrices. The rest of this section builds on their results.

The monetary circuit: The financial aspects are introduced through endogenous money. In order to produce, individual firms need to obtain a loan from a bank. The bank grants the loan in relation to three parameters: the macroeconomic context, the specific behaviour of the sector of activity in the business cycle, and the specific situation of the firm (credit rating, soundness of the management). Credit money is created by the bank when according the loan, and is spent by the firm on wages and other production costs. The money remains in the circuit as long as the firm does not sell the products and reimburse the loan. In particular, a traditional result of the endogenous money theory is that any increase in stock of credit money corresponds to an increase in inventories in the national account circuit.

E-G09 adds to this classical building block [21] a late XXth century feature: the capital-asset adequacy ratio, a prudential mechanism –such as Basel II– set by the authorities and designed to guarantee liquidity and solvability of the banking sector. At the difference of monetary circuit and I-O tables, which track flows, the adequacy ratio is a stock variable reflecting the accumulation of loans and assets. Under normal conditions, the ratio is not binding and the circuit is almost a pure flow model. Money is endogenous to investment, as banks can modulate their assets to accommodate new credits.

Box 1 The Microeconomics of Supply Chains and Trade in Tasks

The question of what steers imports and exports has a very long history in the economic literature. Traditional normative trade theory is built on the premises of gains from international trade, based on the Ricardo's arguments of comparative advantages which allow to increase output by reallocating resources within countries. The Hecksher-Ohlin model extends the results when there are many productive factors and different factor endowments which create gains from international specialization. Economic theory points also to other sources of gains which are not liked to comparative advantages, for example access to a wider variety of goods and economies of scale on the consumption and production sides, or contesting monopoly powers on the institutional one. The critic and testing of these traditional hypotheses has led to a vast literature (see WTO 2008 for a review).

[21] Even if endogenous money and sectoral modeling seems quite heterodox now-a-days, both monetary circuit and supply-use tables can be traced to the Physiocrats.

Trade in tasks and the fragmentation of production along global supply chains has challenged the validity of the traditional models, based on the exchange of final goods. As for trade in intermediate goods, two main approaches have been explored. The first one rests on the hypothesis that factors (capital and labour) are fixed. Offshoring is similar to technical progress in the production of the final good: by shifting production processes to the countries with comparative advantages, more of the final goods can be produced with the same (fixed) amount of factors. A firm with better technology at home wills offshore some tasks if the initial wage gap is larger than the offshoring costs. Offshoring releases domestic workers who, under the traditional neo-classical market assumptions, can focus on the tasks where they have a trade-cost-adjusted comparative advantage.

When some factors are mobile sectorally and internationally, the law of comparative advantage can be generalized, albeit analyzing the outcome of even simple normative models becomes a complex matter, particularly regarding the distributional effects. Comparative advantages are no more a robust predictor of a country's trade pattern. For example, reversal of comparative advantages is possible under certain assumptions. When factors are mobile, movement of factors between sectors and between countries that tend to equalize endowments reduce the incentives to trade. The return of the mobile factor rises, while those of to sector-specific factors decline. But if factor prices are not equalized, factor mobility will at contrary lead to an increase in the volume of trade.

The new trade theory, by introducing imperfect competition, consumer preference for variety and economies of scale, look at explaining why countries that are similar in factor endowment and technology, have a significant part of their trade in the same industries. When two such identical countries open up to trade, firms with differentiated products gain access to larger markets and offer more choice to consumers. While consumers face a greater choice of products, product differentiation imparts firms with a degree of market power. But the entry of new firms modifies the way consumers substitute between products as prices and product offerings change, and reduce the market power of the firm. In addition, the total size of the market does not increase, and some firms will go out of business.

A similar pattern can be used to model trade in intermediate goods, provided the cost of production is lower the larger is the number and scale of production of intermediates. If trade is restricted, the domestic firm needs to use outsourcing to realize these economies of scale and choice. For example, firms (and governments) may solicit bids to supply goods or services in context of information asymmetry and imperfect competition. If international trade is free, it does not matter anymore where the production of intermediaries is located (besides the additional transaction costs), and the firm producing the final good uses a mix of outsourcing and offshoring. Even in presence of free trade, it is expected that monopolistic behaviour tend to predominate, as organized supply chains (business groups) exercise market power in their sales of intermediate inputs. Feenstra and Hamiston (2006) relate that firms belonging to such groups treated their member firms preferentially, buying and selling at prices different than those used for non-member firms.

The real circuit: The industrial supply side aspects and the transmission of real shocks across sectors and countries is modelled by E-G09 using an international input-output matrix (a set of interlinked national I-O matrices), rearranged to track forward linkages.[22] E-G09 computes an indicator, called **"***imported real supply-driven impact coefficient***"** (IRSIC), defined in the price space to simulate cost-push due to intermediate inputs:

$$IRSIC = \Delta Q(I\text{-}B)^{-1} \bullet 1/Q \qquad (1)$$

where, for "*n*" countries and "*s*" sectors; *Q*: line vector of initial sectoral output (1 x *n.s*), B : matrix of [b_{ij}] allocation coefficients (*n.s* x *n.s*) [23], $(I\text{-}B)^{-1}$: Ghosh-inverse matrix, i.e. the sum of direct and indirect forward effects, Δ*Q*: line vector of supply shocks (initial increases in sectoral production costs emanating from the shock-exporter country) (1 x *n.s*), and ● 1/Q : Hadomard (entry wise) product.

[22] In an international *IO* matrix (*I-IO*), cross-national transactions of intermediate goods are identified: exports of intermediate consumption are separated from final demand and traced to the importing country and sector. This provides a better definition of vertical network participation of the countries included in the *I-IO*, allowing tracking shock transmission caused by vertical integration.

[23] In a supply-use table, inter-sectoral relationships are represented by the coefficients Q_{ij}, with the use of goods and services to supply other firms, final consumers and rest of the world (exports) on horizontal lines and requirements (purchases from domestic and foreign suppliers; primary inputs or value added) in columns. The *technical* coefficients used by the Leontief matrix represents interindustry sales by sector *i* and are derived by normalizing the intermediate coefficients Q_{ij} by the value of total production ($a_{ij}= Q_{ij}/Q_j$). The Ghosh matrix *B* also is build using supply-use table, but the *allocation* coefficients represent now the purchase by *j* of interindustry inputs from *i* ($b_{ij}= Q_{ij}/Q_i$).

Albeit the supply oriented Ghosh matrices are very similar to the Leontief demand-driven model, their theoretical robustness for modelling real shocks is much weaker, in particular because it cannot track substitution effects in presence of bottlenecks. For this reason, *IRSIC* is used only **1.** in the price space, and **2.** as a tracking mechanism. [24] Results based on an international *IDE* – Jetro *I-O* matrix updated for 2006 by the authors, and covering the USA, Japan, Korea and selected emerging Asian countries, indicate that:

1. In 2000 and 2006, Japan is the largest potential exporter of cost-push supply shocks, because it is a large supplier of intermediate goods to the other economies;

2. Malaysia and Thailand are the largest importers of such shocks, because of the high degree of integration of their manufacturing sectors in international supply chains and their reliance on imported inputs rather than domestic ones;

3. Between 2000 and 2006, China increased notably its forward international linkages and its domestic backward linkages. It became a large exporter of "shocks" in 2006, at par with Japan, but its vulnerability to an imported shock remained relatively stable because Chinese manufacturers are increasingly relying on domestic suppliers;

4. Repatriating the production of manufactured parts in Japan and the USA would lead to an average increase in sectoral production costs of 2%. Albeit this seems a small impact, it should be remembered that the input-output matrix are based on nation-wide samples of enterprises. In developed economies, most intermediate consumption is sourced domestically and only a minority of firms actively engage in outsourcing: this average impact would fall disproportionately on a few outward oriented firms, causing serious disruptions at microeconomic level.[25] Because these firms are also the most dynamic and innovative ones in a given sector, these microeconomic disruptions would have significant negative systemic effects.

Real-Financial resonance: The real and monetary circuit can interfere negatively when an unexpected financial shock, such as a credit crunch affecting production or trade finance, impede a foreign supplier to fulfil its contractual engagement. Confronted to such a disruption of their supply chain, client firms can shift to alternative partners. But shifting to an alternative supplier, when decision results from an unexpected event (a shock) takes time and always carries a cost. Higher production costs are transmitted along the global supply according to the *IRSIC* mechanism, reducing firms' profitability, while the longer production circuit increase demand for loans.

The accumulation of micro-disruptions in the productive chain, typical of a serious credit crunch in a large country, disturbs the international monetary circuit: production plans take longer to be completed, leading to an accumulation of outstanding loans, a decrease in profit margins. These microeconomic effects, combined with the overall negative macroeconomic outlook caused by the initial crisis, cause a reduction of the credit worthiness of firms. Confronted to this situation, banks have to adjust their asset holding in order to compensate for the higher risk of their loan portfolio and respect the Basel II capital adequacy ratio.

This is not an issue when financial markets are functioning normally, but in times of global crisis and flight to liquidity, not only the risk profile of borrowers deteriorates, but also the market value of assets goes down. Because assets are priced to market when evaluating the capital adequacy ratio, banks can rapidly been squeezed between the rising risk-rating of their debtors on the one hand, and the shrinking value of their asset portfolio on the other hand. When such situation arises, as happened after September 2008, the circuit unravels and the credit rivers run dry: banks look for safety, stop extending new credit and even do not renew existing credit lines. The very same pro-cyclical mechanisms that led to the apparition of financial bubbles, with the concomitant asset price inflation and lower perception to risk (meaning lower interest rates and larger volume of credit), can have a catastrophic outcome when the trend is reversed and a resonance effect between real and financial circuits amplifies the initial supply shocks.

Moreover, the accumulation of supply shocks leads to secondary demand-driven adjustments, either through a price effect (increasing production costs translate into higher retail prices and lower demand) or income effect (lower activity leading to unemployment). The succession of micro waves followed by secondary macro shocks leads to a "*W*" or "*L*" crisis patterns.

Crisis, exits and (de)globalization

Trade in tasks and the greater interconnections of the global economy have created, as we saw, newer and faster channels for the propagation of adverse external shocks. Because production is internationally

[24] The dual form of the Leontief can also be used to simulate cost-push due to primary inputs (Oosterhaven, 1996).

[25] In the United States, for example, in 2002 the top 1 percent of firms by size generated 81% of manufacturing exports, while the top 10 percent controlled 96% (WTO 2008).

diversified, adverse external shocks affect firms not only through final demand, but also through a rupture in the flow of inputs received from their suppliers.

1. Trade Collapse: the Role of Supply Chains

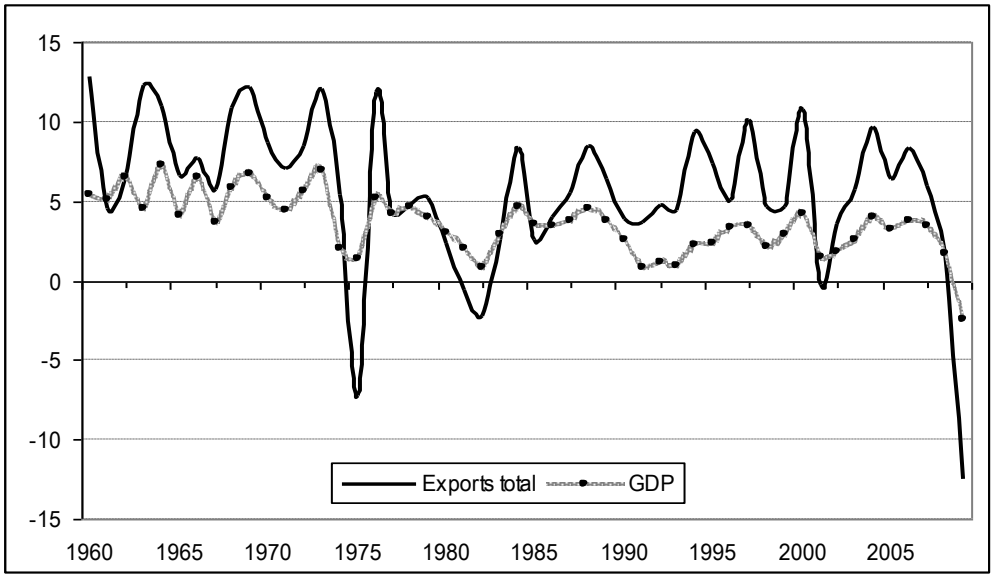

Figure 1. World merchandise exports and GDP, 1960-2009 (Real annual percentage change)

Source: WTO, International Trade Statistics and 2009 forecasts

▪ **Trade Elasticity**

Various authors attribute the large drop in trade registered since the end of 2008 (Figure 1), with an apparent trade-GDP elasticity larger than 5, to the leverage effect induced by the geographical fragmentation of production (Tanaka 2009; Yi 2009). Others contest the hypothesis of higher demand elasticity due to vertical integration (Benassy – Queré *et al.* 2009) because it affects only the relative volume of trade in relation to GDP, while elasticity should remain constant in a general equilibrium context. It is probable that the *observed* reality lays somewhere in-between the variable trade elasticity hypothesis and the constant one.

As seen in Figure 2, the world trade elasticity is shaped like an inversed "U", increasing at the end of the 1980s and decreasing in the most recent years. Because elasticity should indeed remain constant in an equilibrium context, this humped shape probably signals a long-term transition from one steady state to a new one.

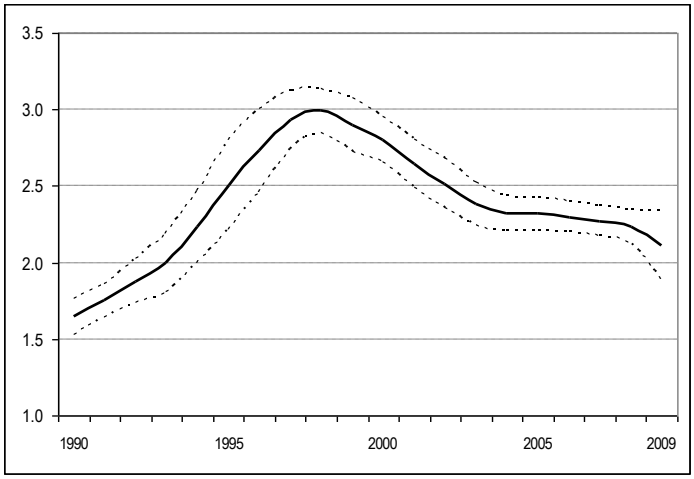

Figure 2. World: GDP Elasticity of Imports, 10 year average

Note: Rolling windows of 10 years; the date indicates the last year. World GDP is the sum of countries' data using market exchange rates; 2009 based on forecasts.

Source: Escaith, Lindenberg, and Miroudot (2010)

Short-term shocks can also affect *apparent* elasticity, even in presence of stable structural relationships. These short-term variations are to be expected when external shocks do not apply uniformly to all industries. A negative shock suffered by a single sector with high reliance on imported input will initially translate into a higher change in trade than in total GDP, leading to higher elasticity.

In absence of structural changes affecting production function (i.e., when technical coefficients, as described by an input-output matrix, are constant), the relationship linking demand for intermediate inputs with can be described by the following linear relationship:

$$\Delta M^{IC} = u \,.\, M^{\circ} .\, (I-A)^{-1} \,.\, \Delta D \qquad (2)$$

Where, in the case of a single country with "*s*" sectors): [26]

ΔM^{IC} : variation in total imported inputs (scalar)

u: summation vector (1 x *s*)

M°: diagonal matrix of intermediate import coefficients (*s* x *s*)

$(I-A)^{-1}$: Leontief inverse, where *A* is the matrix of fixed technical coefficients (*s* x *s*)

ΔD: initial final demand shock (*s* x 1) [27]

Similarly, changes in total production caused by the demand shock (including the intermediate inputs required to produce the final goods) is obtained from:

$$\Delta Q = u.\, A.\, \Delta Q + \Delta D \qquad (3)$$

Solving for ΔQ yields the traditional result:

$$\Delta Q = u.\, (I-A)^{-1} \,.\, \Delta D \qquad (4)$$

The comparison between Equations 2 and 4 is illustrative. Since $[M^{\circ} .\, (I-A)^{-1}]$ is a linear combination of fixed coefficients, the ratio $(\Delta M^{IC} / \Delta Q)$ is a constant.

Nevertheless, this tells only part of the story, because the initial shock ΔD is not a scalar, but a vector (*s* x 1), and the individual shocks affecting each element – a sector – do not need to be always in the same proportion from one year to another one. As the sectoral import requirements $[M^{\circ}_{s}]$ differ from industry to industry, and then the apparent import elasticity will change according to the sectoral distribution of the shock.[28]

It was in particular the case after the financial crisis of September 2008, as the demand of consumer durable and investment goods (consumer electronics, automobile and transport equipment, office equipment and computers, etc.) was particularly affected by the sudden stop in bank credits. Because these sectors are also vertically integrated, the impact on international trade in intermediate and final goods was high. And because services sectors, which are the main contributors to GDP in developed countries, were also more resilient to the financial crisis contribute, the drop in imports was much higher than the drop in GDP. Thus, in the initial phase of the financial crisis, the apparent Trade-GDP elasticity soared to 5.

When the initial shock reverberates through the rest of the economy, transforming the global financial crisis into a great recession, GDP will continue to slow down; meanwhile, the rate of decrease in trade will tend to stabilise as the import content of services sectors is much lower than those of manufacturing sectors. As can be seen in, there is a negative correlation between the variation in the volume of production of goods and the growth in total GDP that can be attributed, at least partially, to this time lag effect between goods and services. It is thus normal to expect a regression to normality of the trade elasticity for 2010.

[26] The model can be extended easily to the case of "*n*" countries, as in E-G09 by modifying accordingly the summation vector "*u*".

[27] In this traditional *IO* framework considering one country and the rest of the world, exports of intermediate goods are considered as being part of the final demand. The situation differs when extending the *IO* relationship to include international transactions of intermediate consumptions, as in Equation 1.

[28] The more complex the production process, the more potential for gaining in outsourcing part of it (Box 1); thus it is natural to expect much more vertical integration in the manufacturing sector. Miroudot and Ragoussis (2009) show that manufacturing sectors in OECD countries generally use more imported inputs than other industrial and services sectors. It is specially the case for final consumer goods like 'motor vehicles' and 'radio, TV and communication equipments', or computers. Services are, as expected, less vertically integrated into the world economy. But even these activities show an upward trend in the use of imported services inputs (e.g. business services).

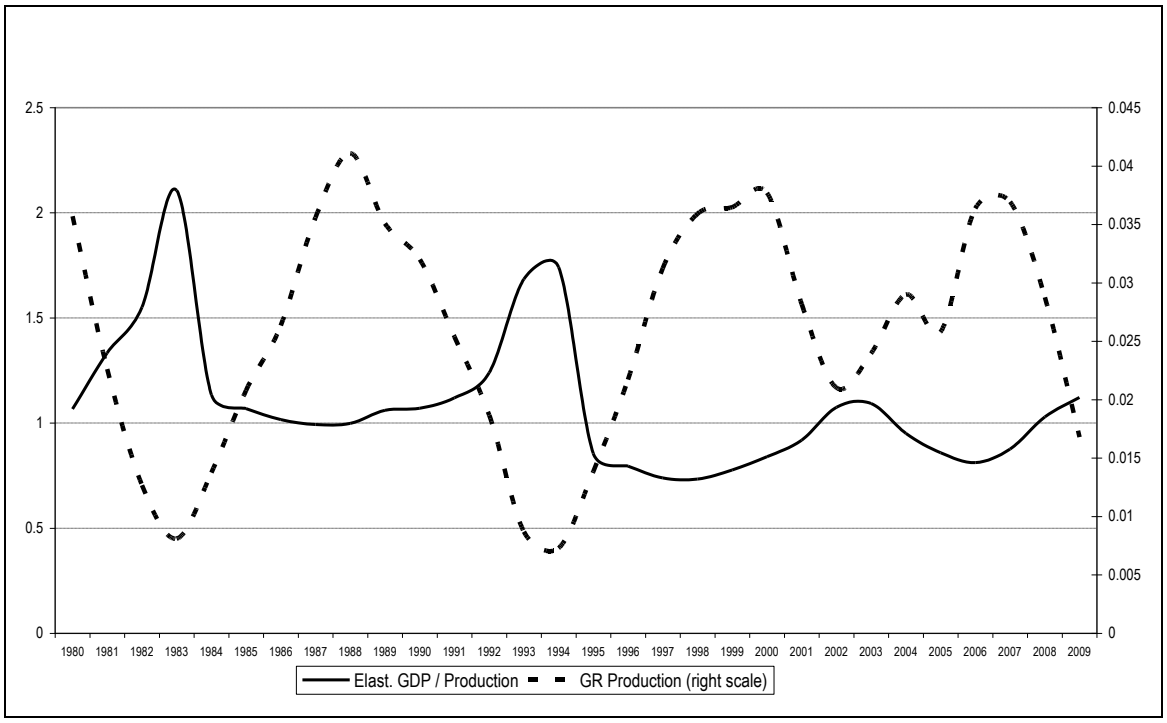

Figure 3. Delays in world production and GDP response, 1980-2009 (percentage growth and elasticity)

Notes: Five year rolling periods. Production includes agriculture, mining and manufactures.

Source: Based on WTO International Trade Statistics data base.

▪ **Inventory effects**

But recent changes in the *apparent* trade elasticity are also probably linked to global supply chain management practices. Even under "just-in-time" management (production-to-order), geographically fragmented networks need to maintain a minimum level of inventories (buffer stocks) in order to face the usual risks attached to international transportation. While large players try to keep their inventories at the lowest possible level considering their sales plans and the acceptable level of risk, they tend in the same time to force their suppliers to maintain large stocks (production-to-stock) in order to be able to supply them quickly upon request. In addition, some up-stream suppliers, engaged in highly capitalistic processes such as foundries, need to process large batches in order to benefit from economies of scale and lower their unit costs.

As a result, there is always a significant level of inventories in a global supply chain, translating into a higher demand for banking loans (Escaith, and Gonguet 2009). When a drop in final demand reduces the activity of down-stream firms, or/and when they face a credit crunch, their first reaction is to run down their inventories. Thus, a slow-down in activity transforms itself into a complete stand-still for the supplying firms that are located up-stream. These amplified fluctuations in ordering and inventory levels result in what is known as "bullwhip effect" in the management of production-distribution systems (Stadtler 2008). As long as the down-stream inventories have not been reduced to their new optimum level, suppliers are facing a sudden stop in their activity and must reduce their labour force or keep them idle.

The timing and intensity of the international transmission of supply shock may differ from traditional demand shocks applying on final goods. For example, the transmission index proposed by E-G09 implicitly assumes that all secondary effects captured by the Ghosh inverse matrix occur simultaneously, while these effects may propagate more slowly than traditional final demand shocks depending on the length of the production chain. Also, there might be contractual pre-commitments for the order of parts and material that manufacturers have to place well in advance in order to secure just-in-time delivery in accordance to their production plans (Uchida, and Inomata 2009). Indeed, since the 1990s, in high-tech manufacturing, suppliers are no more minor partners in global supply chains. These suppliers have consolidated, taking a more prominent role in the industry through a process of mergers and acquisitions (Sturgeon, and Van Biesebroeck 2009). Lynn (2009) provides an example from the US automobile industry where key suppliers of parts had a quasi-

monopolistic position and were able to impose their terms to the up-stream firms (automobile constructors).

Nevertheless, in closely integrated networks, these mitigating effects are probably reduced, especially when the initial shock is large. A sudden stop in final demand is expected to reverberate quickly thorough the supply chain, as firms run-down their inventories in order to adjust to persistent changes in their market. This inventory effect magnifies demand shocks and is principally to blame for the initial collapse of trade in manufacture that characterised the world economy from September 2008 to June 2009.

Dvorak (2009), reporting on the exposition of the electronic equipment sector during the crisis, mentions that a fall in consumer purchase of 8% reverberated into a 10% drop in shipments of the final good and a 20% reduction in shipments of the chips that go into the product. The velocity of the cuts, according to operators, was much faster than in previous slumps, as reordering is now done on a weekly basis, instead of the monthly or quarterly schedules that prevailed up to the early 2000s. In addition, previously, supply chains were simpler, involving fewer links; the complexity of today's productive networks makes their management much more complex. When faced with an unprecedented crisis such as the September 2008 one, "everybody under-bet to a certain extent", with forwards and backwards ricocheting effects through the supply chain, affecting in turn investment plans and capital goods providers.

Thus, the apparent change in trade elasticity results probably from a mixture of short-term and long term effects. Escaith, Lindenberg and Miroudot (2010) analyses the issue from a the dual angle of comparative static and dynamic models. They conclude that, in the short term, inventory and composition effects did predominate to explain the trade collapse of 2008-2009 and were certainly accentuated by global supply chains. But long term effects on trade elasticity are unclear. As mentioned (Figure 2) aggregate data point to a rise of trade elasticity during the 1990s due to globalization, with a return to normal in the late 2000s once the new global trade pattern is in place. Yet, this long term variation is not robust to alternative specification, when long term and short term effects are modelled simultaneously and data is disaggregated at country level.

2. Exit scenarios and global supply chains

The debate on the role of vertical specialization in shaping globalization and international trade is central for understanding the present crisis, but even more crucial for analysing alternative exit scenarios. In the second half of 2009, there were signs that the crisis was reaching a bottom. But analysts remained divided on the medium-run prospects, offering a menu of alphabetical potages made of *L*, *U*, *V* and *Ws*. The last three scenarios are roughly based on a return to normal, after a period of recession that could be short (*V*), long (*U*) or bumpy (*W*). The *L* scenario is more pessimistic for international trade, as it involves a lasting deterioration from the high levels of globalization registered during the 1990s and the 2000s.

After the collapse of world trade in 2008-2009, and with the rise of murky protectionism as well as a higher risk aversion after the crisis, the risk is that manufacturers abandon global strategies to repatriate their operations domestically, or maintain them within a closer regional perspective. The globalization process may effectively be expected to slow down in the years to come. A September 2009 report by OECD, UNCTAD and WTO prepared before G-20 leaders meet in Pittsburgh states that as most leading economies have invoked "trade defence mechanisms" to weather the downturn, and the growing unemployment due to the crisis will also continue to fuel protectionist pressures for the years to come.[29] Analysts are also concerned about longer term developments, fearing that the West-to-East repositioning of the world trade gravity centre may spur a series of "buy domestic" and "produce where you sell" pressures, leading to renewed trade and investment confrontations and an increase in protectionism.

This outcome would have dire consequences on global value chains, and the related international production networks. [30] Indeed, supply chains are very sensitive to even small increase in transaction costs, be they caused by higher tariffs or oil prices. A series of not-so-anecdotic evidences tend to support this hypothesis. In August 2009, the head of Ernst & Young's supply chains department declared that regulatory changes and also the downturn are forcing many organizations to consider restructuring their supply chains, leading to smaller and more regional supply chains (Financial Times 9 August 2009).

This deglobalization is not only linked to the present crisis situation, but may be more structurally caused by the difficulties of decentralizing increasingly complex industrial procedures. For example, after an

[29] "Report on G20: Trade and Investment Measures", 14 September 2009.

[30] Global value chains include the conception and marketing aspects of the products, and are sensitive to risk of breaches in intellectual property and patents; their production component (the supply chains) are also highly sensitive to international and cross-border transaction costs as the goods for processing typically cross several border during production.

accumulation of delays, and confronted with a series of difficulties in the production of its latest model, Boeing decided to abandon the original fragmented chain and repatriate key production processes in its main establishments. Differentiated regional markets, as well as political pressure to voluntarily restrict exports and "build where they sell" have also encourage automobile constructers to relocate their final assembly closer to their final markets, keeping only the heavy engineering work truly global (Sturgeon, and van Biesebroeck 2009).

Other structural factors are also at work, which may increase transaction costs and push global firms to reconsider their production networks. Since 2003, oil price has been increasing, reflecting, *inter alia*, the additional demand coming from large emerging countries. This trend is probably installed for some time now, and production mangers will have to adapt to a future where energy is more expensive and less plentifully available. The same structural factors that led to an increase in the consumption of fossil fuels are also causing a change in the perception of businesses, consumers, and policy makers. Indeed, carbon footprints (accumulated CO_2 emissions) calculated through the life-cycle of a product has become increasingly associated with transportation of goods within the supply chain. Using input-output matrices, Hertwich and Glenp (2009) calculates that trade margins "representing the accumulated emissions from distribution between the producer and final consume" account for 5.5% of greenhouse gases emissions. As concerns about global warming increases, purchasing managers are concerned about the carbon footprint of their supply chains, while consumers are increasingly offered carbon-labelled products and economists talk about internalizing environment costs through ad hoc consumption taxes. As these trends accentuate, there will be a natural tendency to shorten global supply rely more on regional or domestic networks.

If this trend is confirmed, these underlying deglobalization forces would hinder the medium-term possibilities of recovery for international trade at its pre-crisis level. Because the most dynamic markets are in emerging countries, a regionalization or a repatriation of global supply chain would negatively affect developed countries' exports of intermediate goods, slowing down their recovery and augmenting the risk for an L shaped exit pattern. But because global supply chains are a source of efficiency gains and technical progress diffusion (*see* Box 1 again), even emerging countries would see their potential growth reduced in the process.

More importantly, it may also deprive the poorest developing countries, located far from established or emerging markets, of the opportunities of following the industrialization path taken by China or Mexico, a powerful strategy for frog-leaping through the Rostovian take-off model by attracting foreign direct investment, creating large volume of manufacturing jobs and transferring technologies (Box 2). Thus the micro-economic debate on the future of global supply chains spills over very critical trade and development issues.

Yet, against this pessimistic outcome, many considerations militate in favour of productive network continuing to extend their global reach. In the short run, abandoning the present global network of suppliers carries a heavy cost for the multinational firms. Off-shoring has been a central objective of many key industries, which heavily invested in their international network. Often, the new plants build off-shore are more modern and efficient than the older domestic ones, and selling them to a competitor would create a comparative disadvantage (remember the dilemma of GM with the sale of Opel).

In the longer run, the constant flow of innovations and the extension of the technological frontier are lowering the cost of communication, creating new opportunities for redesigning the international division of labour.

Box 2. Global Supply Chains, Industrialization and Development

There is a heated debate, reminiscent of the 1970s controversies about the role of trans-national corporations, between the liberal and the heterodox schools on the role of global supply chains in fostering industrialization or, at the contrary, causing "inmisering growth", low labour standards and more informality.

The establishment of export processing zones (EPZs) in developing countries and their success in attracting foreign direct investment have usually been balanced by a bias towards a low qualification and low salary profile for their employees. Because the establishments in EPzs in least advanced countries are predominantly labour intensive and foot-loose industries (e.g., apparel and garments), critics to an industrial strategy based on processing industries point to **1.** their lack of backward and forward linkages with other domestic industries; **2.** their reliance on informal markets to lower labour costs; and **3.** their sensitivity to conjunctural downturns. Partial field data from Asian countries on the impact of the crisis show declines in both average working hours and average earnings, especially in footwear and furniture industries. In addition, it seems that the crisis hurts more the formal sector, while the informal sector saw increases in average working hours (Hurst, Buttle, and Sandars 2009).

The controversy is partially based on an erroneous supposition that inward oriented (domestically integrated) and outward oriented (globally connected to supply chains) industrialization processes are mutually exclusive forms of industrialization for developing countries. It needs not being

so because capital and skill requirements are quite different, especially at the earliest stages of the export-processing industrialization. Milberg (2007) provides a survey of the pros and cons of industrial up-grading through export processing, and identifies potential spill-over. Using the tools of structural economics, Escaith (2007) shows that outward-oriented Asian economies, which inserted themselves actively in global supply chains, were able to successfully absorb their growing active population, while the more domestic based manufactures in Latin American countries could not provide enough formal jobs in the manufacturing sectors to the new entrants, pushing them instead into a growing urban informal service sector. Bacchetta, Bustamente, and Ernst (2009, 111) indicates also that EPZs actually compete more with informal activities than established national industries, "offering better, more stable employment opportunities for those previously working in the informal economy".

This logic of transferring more and more labour-intensive manufacture processing in developing countries applies easily when low-income economies export to high-income economies, because of the strong complementarities in comparative advantages. However, such complementarities are eroded when low-income economies trade with other low-income economies, because comparative advantages, cost structure and industrial specialization are rather similar. With the gravity centre of international trade moving from Developed West to Emerging East, it should be feared that, as long as these variable factors remain similar, South-South trade be driven more by absolute rather than comparative advantages, i.e., by differences in natural resource endowments rather than by efficiency opportunities.

- **Supply Chain in Global Rebalancing**

During the 1990s, large trade imbalances developed in several regions of the world; with the US running persistent deficits while Japan, Germany and later China, running surpluses. Many trust that these imbalances, financed by an increase in US liabilities, created a persistent situation of financial distortion that led to the September 2008 crisis. Rebalancing is therefore a key objective in the exit strategy, while many fears that such a rebalancing might lead to a secondary demand shock, fragilizing further the international financial system as such correction could only be possible thanks to a large correction in the bilateral exchange rates of concerned countries. From a macroeconomic perspective, the rebalancing can be analysed from several angles; the present section will focus on two particular aspects: balance of payments and global effective demand.

- **Balance of Payments**

The role of supply chains in amplifying trade flows should prove some kind of blessing when it comes to redress the "global imbalances", particularly the large trade deficit of the US economy. A back-of-the envelope calculation shows that the bilateral deficit of the USA vis-à-vis China measured with conventional trade statistics over-estimates the imbalances measured in value added content by about 60% (Table 2). This estimate, derived from an indirect measurement of value added content estimated from international input-output matrices, is based on the hypothesis of homogeneous production on the US side (i.e., the US production of final goods is similar for exports and for domestic use) and heterogeneity for China (technological dichotomy between firms producing for the domestic market and firms producing for exports, with higher import contents for the latter).

Table 2. Bilateral trade balance China-USA, Gross vs. Value Added measurement.

Billion USD	2000	2008
1. US exports to China	19	77
2. Chinese exports to USA	80	305
Balance (1-2)	(61)	(228)
3. US-VA exports to China	18	70
4. Chinese VA exports to USA	40	152
Balance (3-4)	(22)	(83)
5. Ratio (3-4)/(1-2)	0.4	0.4

Note: Asymmetric trade flows were averaged, and may differ from balance of payments values. Value added content for US exports is about 0.9, based on input-output coefficients; the respective value for China was 0.8, and adjusted to 0.5, accounting for re-exports and Export Processing Zones.

Source: Author's estimate based on COMTRADE and IDE-Jetro data

Because the domestic value added content of trade is lower than the gross commercial value recorded in

the balance of payments, closing the gap between China and the USA will be faster and, more importantly, cheaper in terms of lost welfare. This said, measuring trade in value added may, as in this case, reduce bilateral imbalances, but in other instances it will increase it, or even change its sign (Daudin *et al.* 2009; Johnson, and Noguera 2009). From a balance of payments perspective, the overall imbalance of an economy *vis-à-vis* the rest of the world will remain the same.

Measuring bilateral trade flows according to their domestic content modifies also the responses to bilateral exchange rates adjustments. In the previous example (Table 2), an appreciation of the Chinese Yuan *vis-à-vis* the US dollar will only be transmitted to the price of Chinese exports in proportion to their domestic content (50% in average). Thus, a revaluation of the Yuan would influence only moderately the bilateral balance with the USA, albeit it still may lead to a lower overall trade surplus for China, especially by increasing its total demand for imports.

- **Global Effective Demand**

Even if some bilateral imbalances may prove easier to resolve, it remains that the rebalancing will imply for the deficit countries higher national savings, to be obtained through a relative decrease in final demand and an improved competitiveness to generate net exports. These forces will lead to fundamental changes in the source of global effective demand, from "old industrialized West" to "emerging East"[31]. The implications for the industrialization prospects of other developing countries may depend more strongly on their geographical situation (distance from the emerging markets) and their existing production potential. As mentioned in Box 2, for developing countries that will remain outside regional production networks, it may be feared that rebalancing from North-South to South-South trade will be determined largely by absolute comparative advantages. Such an exit scenario implies, at least for the medium term, a relative reduction in the international demand for labour intensive manufactured consumer goods (clothing, textile and consumer electronics) and an increase in demand for commodities (agricultural, fuels and minerals) and investment goods.

Adjusting to this trend will prove especially difficult for the less-advantaged countries (i.e. resource-constrained small developing countries, especially the least-developed countries). According to WTO (2010) developed economies remain largely the dominant LDCs' export destination for manufactured articles such as clothing (95%) and some high value-added agricultural and food products (between 60 and 70%). For these developing countries suffering usually from high trade deficit, the external situation may worsen as the potential for exporting labour intensive products to the North would decline in the same time as their import bill in oil and food will increase.

Even for resource-rich less-advantaged countries, which have been benefiting from the increase in commodity prices during the 2000s, the long term impact on development is not clear, as exporting non-renewable commodities does not have the same social benefits than exporting labour-intensive merchandises and is non-sustainable in the long term. For these countries, the challenge is to manage their natural resource bonanza in a sustainable way, but it is not an easy course of action, considering the pressing needs of their population.

Confronted to such a perspective, there are basically two trade-related options opened to less-advantaged countries. One is to lower the costs of exporting. These costs are part of the supply constraints that frequently reduce the international competitiveness of LDCs and limit their trade potential. Based on World Bank estimates (Doing Business, 2009), time for exporting a standardized cargo of goods by ocean transport was 37 days for LDCs, against a world average of 25 (less than 12 days in the case of developed countries). According to Djankov *et al.* (2006), a one-day reduction in delays before a cargo sails to its export destination is equivalent to reducing the distance to trading partners by about 70 km. The issue is even made more pressing by the "distance puzzle" or "missing globalization puzzle" (the negative effect of distance on international trade is not shrinking as expected, despite technological changes) for poor countries. Carrère *et al.* (2010) estimates that low income countries exhibit a significant rising distance effect on their trade, around 18 percent between 1970 and 2006. While part of the effect could be attributed to the impact of regional trade agreements, the growing importance of vertical specialization and tightly managed global supply chains under just-in-time production increase the opportunity cost of time and distance. In this case, low–income countries that face relatively larger costs could be marginalized from global trends.

[31] "Emerging East" is an illustrative concept which includes some western hemisphere countries, like Brazil or Mexico. The concept of effective demand refers to a demand-driven model, where production responds to final demand and where some large importing countries (typically the USA and the EU in the pre-crisis scenario) play the role of world locomotive.

Because distance and transaction costs is becoming a critical factor in shaping international supply chains, all efforts should be done to decrease the economic distance with the main destination markets in developed and emerging countries. Efforts to reduce delays and domestic transaction costs in order to facilitate trade in developing countries focus principally on upgrading infrastructure and reforming administrative procedures. For the poorer countries, these efforts need to be supported by international assistance, in particular aid for trade.

The other direction for trade-policy is to secure preferential market access in emerging markets for the labour-intensive exports of less-advanced countries. Traditionally, LDCs have benefited from non-reciprocal preferences for their merchandise exports in developed country markets. More recently, a number of developing countries have granted preferences to LDCs, under a series of multilateral, bilateral and regional preferential market-access schemes. The (weighted) average tariff faced by LDCs when exporting to developing countries, nearly 12 per cent in 2006, is much higher than in developed countries (ranging from 3% for agriculture to 6.5% for clothing). Albeit 73% of the total value of LDC exports was granted duty-free status by other developing countries (90% in developed countries), it resulted principally from the favourable treatment of their exports of fuel and non-fuel minerals: only 30 per cent of their agricultural exports was accepted free of duty (93% in the case of developed countries), while the remaining agricultural exports faced an average tariff of 26 per cent (WTO 2010). This situation illustrates the wide dispersion of tariffs facing South-South trade, and the need for improving LDCs' market access in developing countries. Moreover, while the conclusion of the Doha Round (DDA) would certainly benefit LDCs trade with developed countries by removing some of the trade-distorting agricultural subsidies and consolidating the unilateral preferential treatment, it will also lead to preference erosion. The margin of preference granted to LDCs by developed countries will be reduced because their applied Most Favoured Nation tariffs, in particular tariff peaks, will be lowered under the DDA. At the contrary, there should remain an important potential for fostering preferential treatment for LDCs with most income developing countries, because the DDA cuts will principally affect their bound rates (the maximum tariff authorized under the WTO agreement) rather than the applied duties.

3. Concluding remarks

The geographical segmentation of industrial production has played a major role in shaping international economy in the past 15 years. It was at the root of the emergence of new global players, such as China or Malaysia, and the correlated dramatic reduction in absolute poverty levels. It allowed also some old industrial economies like Germany or the USA, to regain international competitiveness through increased productivity and efficiency. In the same time, the content of merchandise statistics and the economic significance of trade balances became more and more difficult to interpret.

Supply chains reshaped international trade and changed the relationship between trade and development: the surge of trade in intermediate commodities remodelled regional and international networks through a bottom-up angle and forced governments to reconsider the previous identification of industrial development with protectionism; developing countries were able to leap-frog the traditional industrialization phases by inserting themselves into complex industrial networks; the criss-crossing of manufacture networks led to large investments in transportation equipment and infrastructure in order to accommodate the huge transit of goods for processing that removed bottlenecks and favoured economic development.

Offshoring altered also the social panorama. If global economic and welfare benefits have been substantial, their distribution remains contentious. While creating numerous jobs in emerging countries, outsourcing and offshoring increased wage disparity in both developed and developing economies, fuelling an active political debate on the pro and cons of globalization.

Even if global supply chains did not alter dramatically the long run Trade-to-GDP elasticity, their role in explaining the trade collapse that followed the financial crisis of September 2008 has been determinant. And determinant is also their role in shaping the alternative exit scenarios from the Great Recession, as is their future contribution in any post-crisis scenario. The reactivation of the global supply chains is still largely dependent on the rebound of final demand in developed countries, i.e household consumption and firm's investments, which have been reduced because of higher unemployment and increased risk aversion. The road to recovery can be a slow and bumpy one for the developed economies, many of them suffering from internal or external macroeconomic deficits. It is therefore expected that the gravity centre of demand for imports will continue shifting from West to East.

The reshaping of global effective demand in any future scenario is of particular importance for the labour abundant developing countries that where relying on the strength of the global supply chain movement to attract

productive investments. Global Supply Chains are based on comparative advantages derived from costs and specialization. Complementarities based on cost differential between countries arise naturally when factors endowments are very different. This explains the specialization in trade in tasks between industrialised economies and labour abundant developing countries. Complementarities based on specialization are, at the contrary, the domain of intra-sectoral trade between complex industries, typical of the developed economies (for example, intra-EU trade in manufacture). The capacity of LDCs and least-advanced developing countries to successfully insert themselves into supply chains led by and for emerging economies is still unclear. The difference in factor endowments and production costs is not large (as in the case of mature industrialised countries), and most emerging countries still count with a large reservoir of labour.

An increase in objective and subjective transaction costs, from higher oil prices to "buy local" campaigns and murky protectionism, indicates that in the future, supply chains will probably be smaller and more regional. Let unchecked, these centripetal forces may well cause a deglobalization process which will directly affect less advanced developing economies but, in the end, will also be detrimental to both developed and emerging countries. For less advanced countries, closing the gap with the closer-knitted regional value chains means reducing transaction costs. Resource-constraint less advanced countries need more aid for trade to engage vigorously in trade facilitation programs to reduce their transaction costs, while they rely on emerging countries to provide more preferential treatments to their non-traditional exports.

On the other hand, the deglobalization outcome as a result of the present crisis is far from being certain. The technical factors that made possible the internationalization of production, from the IT revolution to innovations in engineering and business management, still promote further "flattening of the Earth". Large emerging countries are becoming new markets for final goods that reshape existing production networks, while new actors are emerging from the "not-so-emerging" countries. Thus deglobalization is probably a distant menace on objective grounds, even if it is a new global effective demand that will drive the world economy, forcing some difficult adjustments. Indeed, the 2008-2009 crises are a structural break, and the world economy will certainly not return to "business as usual". Old giants' tumbled, new global players emerged. Public opinion is also changing and the citizens' concerns on the lack of governance of the previous phase of globalization will have to be addressed, while the present gains in opening trade opportunities will have to be preserved.

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