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**OECD ROUNDTABLE ON IMPACTS OF THE ECONOMIC CRISIS  
ON GLOBALIZATION AND GLOBAL VALUE CHAINS  
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CONFERENCE PAPER**

**Trade Collapse, Trade Relapse and Global Production  
Networks:  
Supply Chains in the Great Recession**

Hubert Escaith,<sup>1</sup>

The nature of international trade and the very nature of globalization have changed dramatically in recent years, with the emergence of new global players and a radically different competitive landscape. This new landscape 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 adapt 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 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.

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### **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 Heckscher-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 linked 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).

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 will 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. But because the total size of the market does not increase, 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. If trade is free, it does not matter where the production of intermediaries is located, and the firm producing the final good uses a mix of outsourcing and offshoring.

**Source:** Based on WTO (2008) World Trade Report

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 were of macroeconomic nature. The present crisis has also a systemic micro-economic dimension, because of the geographical segmentation of the productive chains. 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 (Box1).

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 essay explores the particular role of supply chains in transmitting external shocks initiating in the financial sector. In the process, the analysis highlights some procyclical implications of financial prudential regulation and re-considers the issue of the global imbalances.

## **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, 56 and 51 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.

In previous occurrences of global turmoil, shocks were mainly 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 modeling. 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-Q2/09**

(Year-on-year percentage change in current dollar values)

Quarter/Sectors	Q1/08	Q2/08	Q3/08	Q4/08	Q1/09	Q2/09
Manufactures	16	19	14	-11	-29	-30
Office and telecom equipment	9	13	8	-14	-28	-23
Automotive products	17	18	5	-24	-49	-45
Iron and steel	17	29	51	-5	-41	-56
Ores and other minerals	29	40	44	-7	-42	-48

**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. 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).

Escaith and Gonguet (2009) (E-G09 thereafter) jointly models the financial and real supply-side effects from a complementary viewpoint of monetary circuit and international Input-Output matrices. 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 behavior of the sector of activity in the business cycle, and the specific situation of the firm (credit rating, soundness of the management).

Money created by the bank when according the loan 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. 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 blocks <sup>2</sup> a late XX<sup>th</sup> century feature: the capital-asset adequacy ratio, a prudential mechanism –such as in Basel I and 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. Bank can modulate their assets to accommodate new credits, and client firms can shift to alternative partners when faced with the unexpected failure of one of their suppliers. But shifting to an alternative supplier, when decision results from an unexpected event (a shock), always carries a cost. The transmission across sectors and countries of the increased cost of production is modelled by E-G09 using an international input-output matrix (a set of interlinked national I-O matrices), rearranged to track forward linkages.<sup>3</sup>

E-G09 computes an indicator, called "*imported real supply-driven impact coefficient*" (IRSIC), defined as:

$$IRSIC = \Delta Q \cdot (I-B)^{-1} \bullet 1/Q \quad \text{Eq. 1}$$

<sup>2</sup> 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.

<sup>3</sup> 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.

Where, for "n" countries and "s" sectors:

Q: line vector of initial sectoral output (n.s x 1)

B : matrix of technical coefficients (ns x 1)<sup>4</sup>

(I-B)<sup>-1</sup>: Ghosh-inverse matrix, i.e. the sum of direct and indirect forward effects

ΔQ: line vector of supply shocks (initial increases in sectoral production costs emanating from the shock-exporter country) (1 x s)

● : Hadomard (entry wise) product

Results based on an international I-O matrix based on updated IDE-Jetro (2006) data, covering the USA, Japan, Korea and selected emerging Asian countries, indicate that:

1. In 2000 and 2006, Japan is the largest potential exporter of 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 used to compute the coefficients are based on nationwide samples of enterprises. For these 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 firms, causing serious disruptions at microeconomic level. Because these outward oriented firms are also the most dynamic and innovative ones in a given sector, these microeconomic disruptions would have significant negative systemic effects.

The accumulation of micro-disruptions in the productive chain, typical of a recession, disturbs the monetary circuit: production plans take longer to be completed, leading to an accumulation of outstanding loans and a reduction of the credit worthiness of firms. Under Basel II, banks have to adjust their asset holding in order to compensate for the higher risk of their loan portfolio. 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 be 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: banks run 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.

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<sup>4</sup> In a typical supply-use table, horizontal lines show the use of goods and services to supply other firms, final consumers and rest of the world (exports). The vertical columns describe the requirements by sector j: purchases from suppliers (domestic and rest of the world) needed to produce the goods, value added and taxes. Inter-sectoral relationships are represented by the coefficients Q<sub>ij</sub>. The technical coefficients conforming the input-output matrix (I-O) are derived by normalizing the intermediate coefficients Q<sub>ij</sub> by the value of total production (a<sub>ij</sub>= Q<sub>ij</sub>/Q<sub>i</sub>). These I-O coefficients present the direct requirements of inputs from "i" for producing one unit of output of industry "j". As in the Leontief case, the Ghosh matrix B is build using the inter-sectoral transaction matrix Q<sub>ij</sub>, but the allocation coefficients are normalized in line (destination of output) by the value of production, and not in column as for technical coefficients (origin of productive factors used in the production). The Ghosh matrices are similar to the Leontief demand-driven model, but their theoretical robustness for modeling supply shock is much weaker. For this reason, E-G09 uses them only as a tracking mechanism.

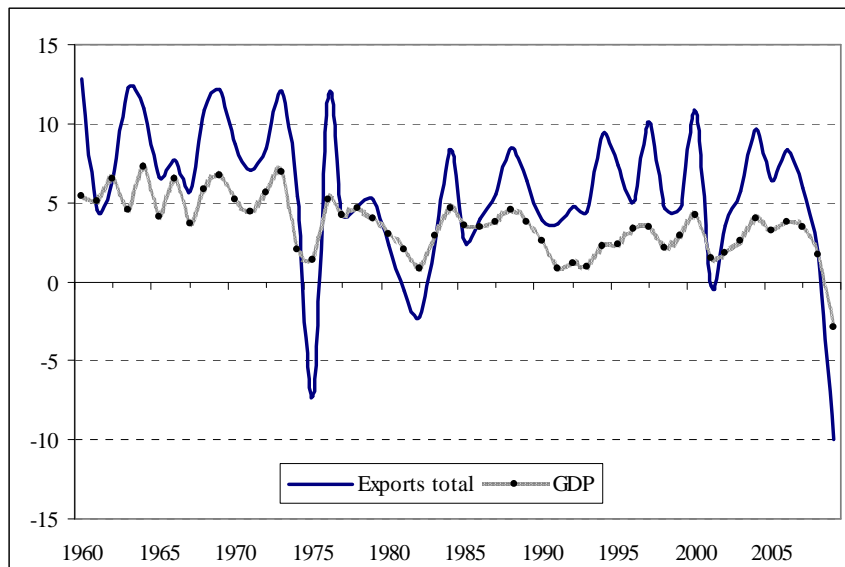
Moreover, the accumulation of supply shocks leads to secondary demand-driven adjustments, either through a price effect (increasing production costs translate into higher retail prices and lower demand) or income effect (lower activity leading to unemployment). The succession of micro waves followed by secondary macro shocks leads to a "W" crisis pattern and can be jointly modelled through international I-O. IRSIC is well suited to model the secondary demand effects created by an increase in prices: after adjusting the price effect by their respective demand elasticity, E-G09 applies a traditional Leontief model to the international input-output matrix. But a similar reasoning can be applied to a demand shock caused by unemployment and lower income.

## 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 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.

### *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*

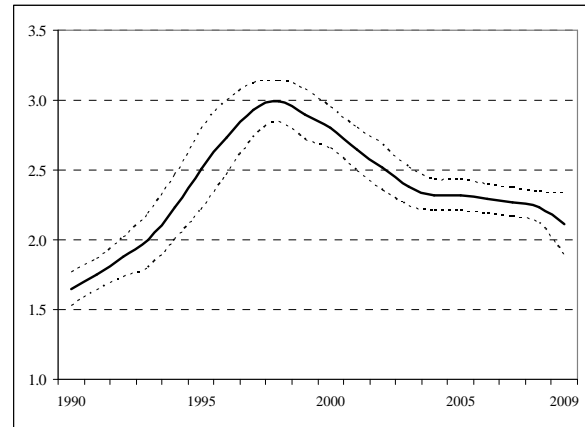
Various authors attribute the large drop in trade registered since the end of 2008, with an apparent trade-GDP elasticity close to 5, to the leverage effect induced by the geographical fragmentation of production (Tanaka, 2009; Yi, 2009). Others contest the hypothesis of higher demand elasticity due 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 inverted "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.

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:

**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 (2009)

$$\Delta M^{IC} = u \cdot M^o \cdot (I-A)^{-1} \cdot \Delta D \quad \text{Eq. 2}$$

Where, in the case of a single country with "s" sectors): <sup>5</sup>

$\Delta M^{IC}$  : variation in total imported inputs (scalar)

u: summation vector (1 x s)

$M^o$ : 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)

$\Delta D$  : initial final demand shock (s x 1) <sup>6</sup>

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

$$\Delta Q = u \cdot A \cdot \Delta Q + \Delta D \quad \text{Eq. 3}$$

Solving for  $\Delta Q$  yields the traditional result:

$$\Delta Q = u \cdot (I-A)^{-1} \cdot \Delta D \quad \text{Eq. 4}$$

The comparison between equations 2 and 4 is illustrative. Since  $[M^o \cdot (I-A)^{-1}]$  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  $\Delta D$  is not a scalar, but a vector (s x 1), and the individual shocks affecting each sector do not need to be always in the same proportion from one year to another one. As the sectoral import requirements  $[M^o_s]$  differ from sector to sector, then the apparent import elasticity will change according to the sectoral distribution of the shock. <sup>7</sup>

<sup>5</sup> The model can be extended easily to the case of "n" countries, as in E-G09 by modifying accordingly the summation vector "u".

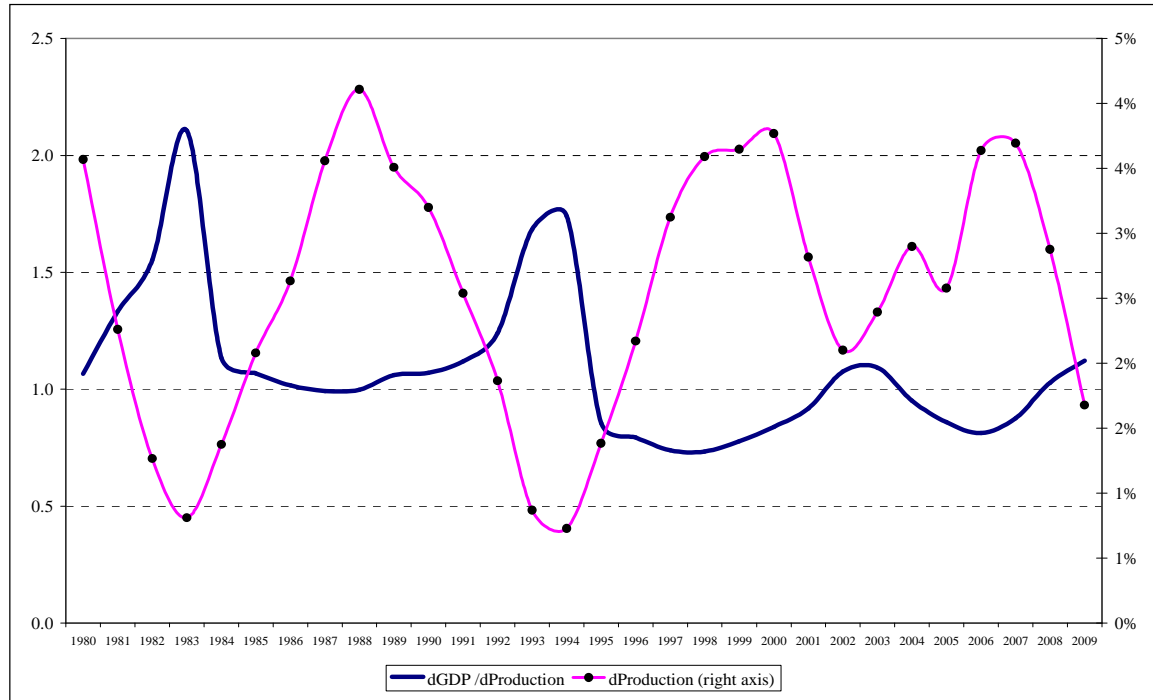
<sup>6</sup> In this traditional IO framework considering one country and the rest of the world, exports of intermediate goods are considered as being part of the final demand. The situation differs when extending the IO relationship to include international transactions of intermediate consumptions, as in equation 1.

<sup>7</sup> 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) shows 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'



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 approximately 5.

Figure 3 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.

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 Figure 3, 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 lag effect between goods and services. It is thus normal to expect a regression to normality of the trade elasticity for 2010.

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).

- *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 (Stadler, 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.

Because the reactivation of the supply chain is only gradual, and final demand (household consumption and firm's investment) has been reduced because of higher unemployment and increased risk aversion, the road to recovery can be a slow and bumpy one. This leads us to the last section of this article: the future of global supply chains in the post-crisis scenarios.

## ***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.<sup>8</sup> 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.<sup>9</sup> 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-anecdotal 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 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 constructors 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 managers 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<sub>2</sub> emissions) have become increasingly associated with supply chain or through the life-cycle of a product. Using input-output matrices, Hertwich and Glen (2009) calculates that trade margins—representing the accumulated emissions from distribution between the producer and final consumer—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,

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<sup>8</sup> "Report on G20: Trade and Investment Measures", 14 September 2009.

<sup>9</sup> 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.

there will be a natural tendency to shorten global supply rely more on regional or domestic networks.

If this trend is confirmed, this underlying deglobalization process 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 when selling Opel).

In the longer run, the constant flow of innovations and the extension of the technological frontier are lowering the cost of communication and 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 "inmiserizing 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 (i) their lack of backward and forward linkages with other domestic industries; (ii) their reliance on informal markets to lower labour costs; and (iii) 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 as capital and skill requirements are quite different, especially at the earliest stages of the export-processing industrialization.

Bacchetta, Bustamante and Ernst (2009) indicates 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" (p.111). Using the tools of structural economics, Escaith (2007) shows also 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.

## 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). From a balance of payments perspective, the overall imbalance of an economy vis-à-vis the rest of the world will remain the same; but because its actual composition differs, the implications in terms of effective bilateral exchange rates are also different.

- *Global Effective Demand*

Even if some bilateral imbalances may prove easier to resolve, it remains that the rebalancing will imply for the deficit countries a relative decrease in the final demand and an exacerbated competition to generate net exports. These forces will lead to fundamental changes in the source of global effective demand, from an "older industrialized West" to an "emerging East".<sup>10</sup> Because of the difference in

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<sup>10</sup> The term "emerging East" may include 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.

consumer behaviour between these two groups of countries, such an exit scenario implies, at least for the medium term, a relative reduction in the international demand for labour intensive manufactured consumer goods (from clothing to consumer electronics) and an increase in demand for commodities (agricultural, fuels and minerals) and investment goods.

Adjusting to this trend will prove difficult for non-emerging countries, both in the North and the South. Even if resource rich developing and least developed countries are already benefiting from the increase in commodity prices (see box 3), the long term impact is not clear. From both the effective demand and the sustainable development perspective, exporting non-renewable commodities does not have the same benefits than exporting labour-intensive merchandises. For the poor deficit developing countries, the situation will be worst as the potential for exporting labour intensive products to the North will decline in the same time as their import bill in oil and food will increase.

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.

### **Box 3: Least Developed Countries Exports: Products and Markets**

Export concentration has been a structural characteristic of LDC economies. Almost three quarters of LDC total merchandise exports depends upon only three main products (which change from country to country), accounting sometimes for more than 95 per cent of export receipts. The recent trends in commodity prices reinforce this tendency, not only by increasing the weight of those commodities, but also for discouraging diversification efforts.

The value of fuels and mineral exports between 2000 and 2007 rose annually by more than 27 per cent and represent now 67 per cent of total LDC exports. For commodity exporters, the non-traditional (labour intensive) activities appear less lucrative to domestic investors due to their lower relative prices. In addition, exchange rate appreciation linked to commodity booms – the so-called Dutch Disease – reduces the international competitiveness of labour intensive activities, such as light manufacture. This increased concentration on commodities reduced the weight of clothing, the second product in importance, to below 13 per cent for the LDC group. All other product groups, including agriculture, are now contributing less than 10 per cent to the total export value.

The market for LDC exports have increasingly become diversified, with developing economies, such as China, India and Thailand having a greater weight in LDC exports than one would expect from their share in world total imports. As a result developing economies have become the major destination for LDC exports of mineral fuels (56 per cent in 2006), copper (83 per cent), wood products (87 per cent), cotton (89 per cent) or some food products like vegetables and oil seeds (84 and 73 per cent). On the contrary, developed economies remain largely a dominant export destination for manufactured articles such as clothing (95 per cent) and some high value-added agricultural and food products such as fish and crustaceans, beverages or tobacco, with 67, 73 and 57 per cent, respectively.

Service exports are of particular importance to some LDCs. Travel, a close proxy of tourism receipts, is the dominant sector, representing 52 per cent of their services exports in 2008. This activity grew steadily since the beginning of 2000, at an average annual rate of 15 per cent, and was particularly dynamic during the last three years. This promising sector is vulnerable in the present economic cycle, because a large part of these revenues originate from tourists arriving from developed countries, where the economic impact of the crisis has been primarily felt.

**Source:** WTO "Market Access for Products and Services of Export Interest to Least-Developed Countries" WT/COMTD/LDC/W/46, October 2009.

## 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 remodeled 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 favored economic development.

Off-shoring 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.

The role of global supply chains 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.

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.

On the other hand, 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 crisis is 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.

## Bibliography

- Baldwin, Richard (2006) "Globalisation: the great unbundling(s)" Economic Council of Finland, 20 September.
- Bénassy-Quéré, A., Y. Decreux, L. Fontagné and D. Khoudour-Castéras (2009) "Economic Crisis and Global Supply Chains" CEPII No 2009-15, July.
- Daudin, Guillaume, Paola Monperrus-Veroni, Christine Riffart et Danielle Schweisguth (2006) "Le commerce extérieur en valeur ajoutée" Revue de l'OFCE 98 pp. 129-165.
- Dvorak, Phred (2009) "Clarity is missing in Supply Chain" The Wall Street Journal, 18 May
- Escaith, Hubert (2007) "Old and New Dualisms in Latin America and Asia: Labour Productivity, International Competitiveness and Income Distribution" Revista Trabajo, No.5, ILO-UAM.
- Escaith, Hubert (2008) "Measuring trade in value added in the new industrial economy: statistical implications," 12<sup>th</sup> Meeting of the Association française de Comptabilité nationale and MPRA Paper 14454, Munich.
- Escaith, Hubert and Fabien Gonguet (2009) "International Trade and Real Transmission Channels of Financial Shocks in Globalized Production Networks", WTO Staff Working Paper, May.
- Escaith, Hubert, Nannette Lindenberg and Sébastien Miroudot (2009) "International Supply Chains and Trade Elasticity in Times of Global Crisis" WTO Staff Working Papers (forthcoming).
- Grossman, Gene and Esteban Rossi-Hansberg (2006) "The rise of offshoring: it's not wine for cloth anymore", Proceedings, Federal Reserve Bank of Kansas City.
- Hertwich, Edgarg and Glenp Peters (2009) "Carbon Footprint of Nations: A Global, Trade-Linked Analysis" Environ. Sciences and Technology, Vo. 43 No 16, pp. 6414-6420.
- Hurst, Rosey, Martin Buttle and Jonathan Sandars (2009) "The Impact of the Global Economic Slowdown on Value Chain Labour Markets in Asia", September.
- IDE-JETRO (2006) "How to make Asian Input-Output Tables", March.
- Krugman, Paul (1995) "Growing World Trade: Causes and Consequences" Brookings Paper on Economic Activity 1:327-377
- Lynn, Barry (2009) "How Detroit Went Bottom-Up", The American Prospect, October.
- Miroudot, Sébastien and Alexandros Ragoussis (2009) "Vertical Trade, Trade Costs And FDI" OECD Trade Policy Working Paper No. 89.
- Stadtler, Hartmut (2008) "Supply Chain Management – An overview" in Hartmut Stadtler and Christoph Kigler "Supply Chain Management and Advanced Planning", Springer-Verlag, 4<sup>th</sup> Edition.
- Sturgeon, Timothy and Johannes Van Biesebroeck (2009) "Crisis and Protection in the Automotive Industry: A Global Value Chain Perspective", World Bank Policy Research Working Paper 5060.
- Tanaka Kiyoyasu (2009) "Trade collapse and international supply chains: Evidence from Japan" VoxEU.org, 7 May.
- Uchida, Yoko and Satoshi Inomata (2009) "Vertical Specialization in the Time of the Economic Crisis" IDE-Jetro (forthcoming).
- Yi, Kei-Mu (2009). "The collapse of global trade: The role of vertical specialisation," in R. Baldwin and S. Evenett (eds), "The collapse of global trade, murky protectionism, and the crisis: Recommendations for the G20", VoxEU publication.