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Data users' viewpoint to global production

Closing the gaps between trade theories, trade policies and global production statistics: a practitioner's perspective

Prepared by the World Trade Organization[1]

Summary

The paper presents how the geographical fragmentation of industrial production alters many of the stylized facts on which trade models are based, with profound economic and social implications at home. The coexistence of three interconnected dimensions – product, income and finance – has important consequences for understanding the dynamics of globalized economies, the micro-macro interaction of national economies and the accumulation of imbalances. To guide policy makers, theory and statistics should go hand in hand: it is important to develop the right empirical tools to back academic research, guide analysts and decision makers and identify knowledge gaps that require further attention.

[1] The paper is an unedited draft for discussion, prepared by Hubert Escaith. It builds on previous works, one of them co-authored with A. Jara. The author also thanks thank N. Ahmad and A. Maurer for their comments on previous drafts; he also wishes to show his recognition to his colleagues at WTO, IDE-JETRO, OECD, UN, USITC, WIOD and the other researchers he worked with on "trade in value-added" in the past few years. Possible errors and omissions, as well as any opinions expressed remain with the author and do not reflect any position of the WTO or its Members.

I. Introduction

1. For many years, merchandise trade statistics was considered a "mature" subject, where progress meant introducing better administrative procedures at custom offices or refining the Harmonised System to track new products. Things began to change when our profession realised that the nature of trade itself had changed dramatically and that what national custom statistics measured was insufficient to fully understand this alteration.

2. This mutation –some analysts even advanced the term "paradigm shift" (Grossman and Rossi-Hansberg. 2006) – was caused by two parallel but complementary trends. The first was the emergence of the "*firm*" as the main focus for analysing international trade, as opposed to the '*Nation-State*' which was the explicit or implicit reference of both trade theories and official statistics. The second was the globalization of production networks, giving raise to global value chains (GVCs) that closely knit firms from many different countries, blurring not only national borders, but also the frontier between goods and services, as most of the business to business trade along GVCs is in activities or "*tasks*".

3. For trade statisticians, it became increasingly clear that the old approach of measuring trade from a country's balance of payments perspective was obsolete: in the new global economy, enterprises trade and not countries. Moreover, firms are heterogeneous and trade in varieties. This has practical implications for trade analytics: in Ricardian times, export structures were closely associated with a country's natural resources endowments and its level of development; implicitly, all firms in a given country and industrial sector are similar and there is a "representative firm". In technical jargon, export specialization and Revealed Comparative Advantages provided a good picture of national structural and development factors. Moreover, export specialization could also provide information on a country's underlying development potential (Hausmann, Hwang and Rodrik, 2007). With the rise of GVCs, inter-industrial trade in intermediate inputs has taken on much more importance as GVCs allow less advanced countries to import technology, industrial norms and market access from the lead-firms. Firms in low-income countries can leap-frog the industrialization ladder by specializing in some of the tasks required for the manufacturing and exports of sophisticated products.[2] As a result, the export structure may not reflect anymore the relative situation of the exporting country with respect to the technology frontier (Ferrarini and Scaramozzino, 2011).

4. The value-added generated by each differentiated task along GVCs is embedded in a buoyant intra-industry exchange of intermediate goods, such as "parts and components" and other "goods for processing". Indeed, trade in intermediate goods amounts to more than half of world trade, excluding oil (WTO and IDE-JETRO, 2011). For first and second tier suppliers, the globalization of production means getting access to technology, patents, industrial norms and best practices, insiders' privileged market access in business to business (B2B) markets and financing: GVC trade has a strong "trade-investment" nexus.

5. This new phase of globalization was made possible by the convergence of significant changes in the technological as well as in institutional and political domains, which were "flattening the world" (Friedman, 2005). It also brought together analysts and trade statisticians who had comfortably lived more or less separately since the late fifties.

[2] In less than two decades, Costa Rica moved from being an exporter of coffee to competing with Brazil for the second place in the ranking of Latin American exporters of electronics. GVCs were also the drivers of the East Asian "miracle", and the jobs created in the process are one of the main reasons this region will overshoot in 2015 its Millennium Development Goals in terms of poverty reduction.

GVCs are also an obligatory reference when looking at future global trade scenari (Hoekman, 2015).

6. Adequately measuring international trade in the 21st Century is still a work in progress. Mapping GVCs, identifying where value-added is created, how much and by whom are the challenges that trade statisticians face. Ordinary concepts of country of origin or country of (final) destination do not fully apply anymore: if we look at the national origin of the value-added incorporated in the final product, we realize that significant shares of the value may come from other countries than from the country of origin as ascribed by customs records. Similarly, the domestic value added embodied in the exports of intermediate products may end being consumed as final goods in unsuspected countries. [3] Rising to this statistical challenge and producing the right numbers is important for decision making in todays' world: not only are business models and strategies changing, but so too also is the way public policy makers should understand their "home" country and their defensive and offensive interest in trade negotiations.

7. The purpose of this essay is to build on the compact between trade theory and trade statistics in order to provide a road map for empirical work. It analyses the challenge posed to trade statisticians by looking in the first place for guidance from some relevant theoretical frameworks suggested by trade and development models or business practices. Then, it reviews some of the approaches that have been used by trade statisticians to map the various dimensions of trade taking place within GVCs. The conclusion explores the possibility of developing an integrated framework for official statistics.

II. There is Nothing More Practical than a Good Theory[4] *(Thou should not measure without a theoretical framework)*

8. The "new" trade model, where individual firms, their interaction and their specialization take a central role, has been around for years. Examples of processing trade date back to the 1970s and Japanese firms started offshoring part of their manufacturing processes after the revaluation of the yen in 1985. More recently, fostering regional value chains was one of the driving forces behind the signature of the North American Free Trade Agreement in the mid-1990s. Yet it was the accession of the People's Republic of China to the WTO in 2001 that led to a quantum leap. In the process, the B2B relationship between lead firms and offshore suppliers seemed to disregard the national borders that were the organizing criterion of trade statistics, balance of payments and national accounts. From the B2B trade perspective, the World is (almost) flat, creating *en passant* a series of accounting issues as goods in process of finalization criss-crossed several international borders and inflated traditional trade statistics based on custom values. While anecdotal data were available through cases studies, aggregate level analysis were more limited. An off-shoring index for the USA was calculated by Feenstra and Hanson in 1996, but it was not before the 2000s that more systemic efforts were put in place. The first world-wide estimates of trade in value-added were largely produced by scholars (eg, Daudin et al., 2006, building on Hummels et al., 2001). Although the OECD produced estimates of the import content of exports in its first Handbook on Economic Globalisation Indicators in 2005 and WTO and IDE-JETRO an analysis of trade in tasks in East Asia in 2011, the measurement of '*trade in*

[3] The OECD-TiVA database provides the countries of origin of the foreign value-added content of final demand. This foreign value-added, embodied into intermediate inputs through multi-stager transformation process, may have transited through numerous countries before being finally "absorbed".

[4] Kurt Lewin (1890-1947)

value-added' (the statistical equivalent of economists' '*trade in tasks*') challenge did not enter the official statistics mainstream until more recently , 2012 (WIOD) and 2013 (TiVA) providing the first serious international attempt at creating worldwide "official" databases.[5]

9. Trade theory was also submitted to an accelerated obsolescence process. In less than 10 years, trade in intermediate products supplanted the old "Ricardian" trade in finished goods in explaining emerging trade patterns. Theory reacted by producing new trade theories, where geography and industrial logic were taking an increasing role. The present essay explores these underlying models with a view to understand them and their empirical requirements for guiding official statisticians in their mission of fostering "*evidence-based decision making*". As Koopmans (1947) once commented, without a model, no practical inference for decision making is possible: "the rejection of the help that economic theorizing might give leaves a void. … Without resort to theory, in the sense indicated, conclusions relevant to the guidance of economic policies cannot be drawn." Oxley et al (2008) go as far as calling most attempts to measure complex socio-economic developments without some proper understanding or a theoretical definition, as movies where "*Mr Bean(counter) Measures the Economy*".

A. Trade Network Economics and Business Models

10. A production network is, at its core, the nexus of interconnected functions, operations and transactions through which a specific product or service is produced, distributed and consumed (Coe et al., 2008). GVCs result from lead firms arbitraging between "make or buy" decisions. The chemically pure example of the new model of globalized manufacturers is perhaps the so called "factoryless" firm, which creates networks of workshops and manages its production lines in the cyberspace. Who you are connected with is important: those networks determine and organise the production, distribution and use of knowledge and information. In this framework, trade between two parties is not only a function of the characteristics specific to each partner (what they produce and their cost) but also the result of their business environment (who they are in business with).

11. Besides looking at pairwise connections, network analysis is also interested in describing what kind of other third party relationships two participants have in common. This analytical approach fits perfectly the developments in trade theory introduced by Ethier and Krugman in the 1970s (see below, p. 6). In a trade and production network, what happens is the result of a series of long term business decisions, such as investment decisions. They will also involve a series of other partners downstream, or can take place only after another upstream partner has done its part of the contract and delivered the parts. Trade takes place among pre-determined partners glued together by arm's length contracts or intra-firm relationship: trade patterns tend to reproduce themselves identically through time.

1. Trade, finance and corporate ownership

12. This kind of long term contractual relationship sheds new lights on the notion of "ownership" (one of the guiding principles for BPM6 recording of trade, which now diverges from merchandise trade statistics). The 2008 SNA follows the BPM6 recommendations for recording international trade flows under a change of ownership

[5] OECD and WTO, which launched TiVA in January 2013, worked in close collaboration with IDE-JETRO, US-ITC and the WIOD project.

principle ("the time of recording of the acquisition of goods is the moment when the economic ownership changes hands") bringing all cross-border transactions into line with the underlying concept of economic owner ("the economic owner of goods and services, natural resources....is the institutional unit entitled to claim the benefits associated with the use of the entity in question in the course of an economic activity by virtue of accepting the associated risks"). [6] Whilst this change has brought the accounts closer to the way businesses operate within GVCs, it is not without challenges, as can be seen in UN-ECE (2015), which considered the thorny issue of risks and rewards in the context of intellectual property transactions and where opinions in the statistics community remain split. Moreover, as we shall see, the conceptual improvement may translate into a statistical deficit by creating a gap between the national accounts concepts, on the one hand, and, on the other hand, the practice and analytical requirements of trade and economic statistics.

13. The reality of business today differs significantly from the environment in the 1980s. In a global market place where manufacturing companies rely on outside suppliers for critical parts and components, the notion of risk, ownership and legal responsibilities of the suppliers include the consequences of defects and malfunctions in the end-product and the impact on its users. Conversely, the lead-firm becomes exposed when critical suppliers encounter financial difficulties and are unable to make deliveries of the promised parts. Indeed, a new body of laws under commercial and bankruptcy codes to deal with these cross-border matters is developing in parallel to regional trade agreements. The first international initiative to reform national insolvency laws for the express purpose of facilitating international trade emerged in the mid-1990s when the United Nations Commission on International Trade Laws (UNCITRAL) proposed the Model Law on Cross-Border Insolvency. It was adopted by the UN General Assembly in 1997 (Mears et al, 2012).

14. This in turn means that increasingly one has to begin consider a broader notion of trade that looks through the classic goods and services prism and instead also embraces the income flow which runs parallel to the physical product circuit (at least up to the SNA93 when production and trade were also always recorded on the basis of their physical dimension). Cross-border income flows largely reflect dividends, royalties or interest payments. [7] Monetary income is created in one industry but can be transferred to households or firms that are resident in other countries. This secondary circuit makes possible the financial viability of the product circuit (its reproduction) when the final products are eventually purchased, consumed or invested in one country thanks –in part– to t income generated in another country. It is possible (Escaith and Gonget, 2011) to superpose a monetary circuit to the product space defined by intra-industry international trade. Eventually, the trade and production network relates also to the corporate networks, as in a globalised world, international trade is dominated by a subset of large multinational enterprises (MNEs). According to UNCTAD (2013), MNEs-coordinated GVCs account for some 80 per cent of global trade; many cross-border transactions take place within related firms and establishments..

15. Thus, for the same global business network, cross border physical flows are often likely to differ from financial ones for a series of reasons, ranging from supply-chain

[6] SNA 2008 paragraphs 3.26 and 3.169. Similarly, UN-ECE paragraph 6 (2013) states, that the controlling entity and economic owner is the firm who is exposed to the risks and benefits from the returns

[7] Although changes to EBOPS (2010) have helped to separately identify royalty payments that should be recorded as services transactions and those that should remain as income flows, in practice the distinction remains blurred.

governance (e.g., intra-firm trade may not entail change of ownership and actual payments for inputs purchased) or tax planning.[8] As we shall see later, physical flows between two partners may not provide anymore an adequate picture of the trade relationship between those countries. It is, in particular, the case when trade flows are intermediated by a third country which plays the role of a "hub". As Maurer and Degain (2010) highlight, what you see (through traditional trade statistics) is not always what you get.[9] On the other hand, mapping the physical flows and studying them with the help of network analysis puts in evidence the competitive advantages of this trade hub in facilitating trade, even in absence of financial transactions.

16. Analysing trade through business practices may also help identifying other issues in micro-data collection. Many exporting or importing firms may trade through trade agents or wholesalers. Some estimates put at about 20% the value of international trade done by agents. In practice, this means that customs registers will not reflect the true industrial origin of the exported goods.

17. Besides their theoretical and statistical implications, the coexistence of three interconnected spaces – product, income and finance circuits – has important consequences for understanding the dynamics of globalized economies, the micro-macro interaction of national economies and the accumulation of imbalances. But the statistical system that we currently have is arguably not well suited to viewing these three circuits as one, the product circuit being largely compiled on the basis of industries and products, whilst income and finance are typically built around institutional sectors. Tackling global production networks in their multiple productive, commercial, financial or legal dimensions arguably requires both diversified measurements and a more joined-up view.

B. Trade theory and development policy implications

18. The natural theoretical framework of reference for identifying gaps in trade statistics is the advances in trade theory and how statistics respond to their demand for data. The new trends in trade theory put much emphasis on the micro-economic dimension of firm heterogeneity.

19. The new trade theory is strongly associated with, inter alia, Wilfred Ethier and Paul Krugman who, in the late 1970s, incorporated increasing returns to scale into previous models. Increasing returns are a deviation from the neo-classical hypothesis and tend to generate specialised and localised topological patterns. In particular, external benefits such as agglomeration effects facilitate the creation of localised industrial networks, such as those discussed in the previous section. These clusters are self-reinforcing, thanks to the benefits provided by their size (economies of agglomeration) and the scope of specialization for participating firms. Thus, connectedness within networks is, once again, an important dimension to measure.

20. Reductions in trade costs are even more important in the new trade theories. Not only do transaction costs explain the agglomeration of production in a specific location, but their reduction has been a prerequisite in facilitating the international fragmentation of production processes (WTO, 2008). More generally, gravity models that use some measure

[8] Vitali at al. (2011) present an analysis of intra-firm transaction within large corporation, illustrating how graph and network theories can help in mapping a hierarchy across these relationships.

[9] This said, tracking the monetary flows (fees, royalties) instead of the physical ones may not provide a much better image, as payments may be issued from and received in countries that differ from the manufacturing and the end-use locations.

of distance between trade partners as explanatory variables are standard features of the trade-economist's tool-box; a current topic of research is measuring the effect of distance on trade in intermediate products (typical of GVCs) and trade in final goods. Therefore, measuring these trade costs should be an important item on the trade statistician's agenda. Transaction costs include border aspects (tariff and non-tariff measures) as well as logistics and freight cost by mode of transport. Those transport modes are also relevant for the environmental implication of international trade.

21. The "new" new trade theory, by putting the emphasis on firm heterogeneity (Melitz , 2003) is another source of guidance on the relevant dimensions to take into account in our attempt at measuring modern trade today. This new school, which has a clear empirical foundation, has thrived on the increasing availability of firm level data tracking trade operations by firm characteristics. [10]

22. Firms typically differ in terms of their productivity; some of them find it profitable to sell only on the domestic market while only the most productive will usually export. [11]Further empirical investigation shows that firm heterogeneity is closely related to ownership and governance structure, including global supply chain linkages. What the statistician should retain here are two things. Firstly, that the "representative firm" approach adopted in input-output models is not necessarily precise enough for providing an adequate representation of modern trade. Secondly, as noted in the previous section, that foreign direct investment flows have to be part of the picture, because foreign ownership is often a key factor explaining trade patterns.

23. As part of the larger trend of "new" new trade theory, a growing strand is dedicated to analysing trade as "trade in tasks" along international supply chains. The management of international supply chains is now-a-days a profession and is taught as a subject-matter in engineering and business schools. Park et al. (2013) offer a commented review of the literature covering most, if not all, its relevant strands.

24. Through GVCs, technology proper to lead firms (typically installed in developed countries) can be used effectively by first-tier providers and affiliates located in developing countries. This is analytically similar to a virtual migration of workers from cheap labour locations to high productivity locations, without actually paying the full increase in labour cost. In more technical terms, trade in tasks is assimilated to a technological shock that changes a country's labour endowments measured in productivity-equivalent units. This shock may allow firms in high labour cost countries to remain competitive *vis à vis* the increasing competition from emerging countries. Similarly, it may also help supplier firms in developing countries to close their technological gap and gain competitive advantages. Trade in tasks is also trade in skills, as the difference in wages across countries is determined not only by the average wage level, but also by the relative abundance of skilled labour. In practical terms, this has important effect on wages and income distribution in both developed and developing countries. This theoretical branch of trade policy signals, therefore, that any attempt to "map" international trade in its new dimensions should include a measure of labour by skills and industries.

25. GVCs offer new options to developing countries. Gereffi and Sturgeon (2013) review the situation and policy options of emerging countries, but the potential is also high for small developing countries that were not able to find a niche in the older (pre-GVC)

[10] As pointed out by Feenstra (2004), recent work in trade economics has been more empirical than theoretical, and about accounting for global trade flows than about testing hypotheses related to trade.
[11] This is linked to fixed transaction costs that reduce the profitability of exports for the least productive firms and act as a barrier to trade.

world of international division of labour. What Grossman and Rossi-Hansberg (2006) and Baldwin (2006) tell us is that globalisation today differs from the old approach in that the opportunities for jobs and value creation it is occurring at a much finer level of disaggregation. GVCs enable a finer degree of specialization, allowing the production process to be fragmented into narrowly defined segments or "tasks". Recently, development theory has borrowed from network sciences to define the concept of "Product Space". This is a network approach to trade by product grouping, similar to the idea of revealed comparative advantages (Hidalgo et al., 2007). Countries export products for which they have comparative advantages, but not all products have the same potential for export diversification at the extensive margin. Being able to diversify into new product depends not only of the relative situation of the developing country from the production frontier, but also the ease of moving to other products (connectedness). Some areas of the product space are denser than others, and transition is easier.

26. Because national accountants are principally interested in the macroeconomic perspective, it is relevant to mention also that the macro-economics of open economies – be they developing or developed – is also interested in the outcome of the statistical research agenda on trade in value-added. Box 1 presents some of the arguments.

Box 1

Why is Trade in Value Added important? A macro-policy perspective

Rifflart and Schweisguth (2013) mention several areas where measuring trade in value-added brings a new perspective and is likely to impact policy choices:

a- Using accurate value-added trade data would improve exchange rate assessments. Real effective exchange rates based on value-added trade weights would reveal more accurate measures of competitiveness of a country than those based on gross trade weights.

b- Real effective exchange rates based on value-added trade would improve estimates of the impact of changes in relative prices, including that on global rebalancing. This reflects the higher foreign content in the downstream country's exports, which mitigates the impact of exchange rate changes.

c- Decomposing foreign value added in exports by source country would help understand how disruptions to supply chains can have spillover effects. Disruptions of trade flows could be either policy induced, such as preferential/regional trade agreements, or naturally caused, such as the 2011 earthquake in Japan.

d- Bilateral balances, if discussed for political economy considerations, are better measured with value-added, rather than gross, trade data. Accounting for trade in intermediate parts and components, and taking into account "trade in tasks", does not change the overall trade balance of a country with the rest of the world but it redistributes the surpluses and deficits across partner countries.

e- Measuring trade in value added sheds new light on today's trade reality, where competition is not between nations, but between firms. Competitiveness in a world of global value chains means access to competitive inputs and technology. Optimum tariff structure in such a situation is flat (little or no escalation) and reliable (contractual arrangements within supply chains, especially between affiliated establishments, tend to be long term). As a consequence, tariffs, non-tariff barriers and trade measures –such as anti-dumping rights– are likely to impact domestic producers in addition to foreign producers.

f- The impact of macro-economic shocks would be better assessed. The 2008-2009 financial crisis was characterised by a synchronised trade collapse in all economies. What role did global supply chains play in the transmission of a demand shock in markets affected by a credit shortage? A better understanding of value-added trade flows would provide tools for policymakers to anticipate the impact of macro-economic shocks and adopt the right policy responses.

III. What should be counted?

27. The review of underlying theories and their main topics of interest should help us advancing more rapidly with the next question: what? We saw that global production networks operate in many dimensions: trade in intermediate goods, trade in factors of production, trade in tasks, financial and income transfers, etc. Some of these dimensions may be more difficult to measure as they are hidden below several layers of superficial information. Moreover, trade in tasks (or the value-added content of trade, following the statisticians' terminology) can only be measured indirectly: strictly speaking therefore, we cannot measure it, only provide an estimate.

28. A proper mapping of global value chains requires collecting information on operational, financial and governance aspects. Those are fruits that hang at different heights of the tree, operational aspects being low-hanging while governance ones staying unseen at the top. It is also important to compile the information keeping the systemic dimension which relates all those bounties within a comprehensive and analytically relevant statistical model.

29. Our review of the relevant analytical models identified the following points of interest, which are either flows (visible or invisible; physical or financial) or actors (firms, households, markets):

- Trade in intermediate inputs, including goods and services. This is the glue connecting the firms participating in international supply chains and, at the same time, the belt that keeps them moving together. Trade flows are classified (according to the relevant classification for goods and services) and divided as incoming (inputs) or outgoing (output) for each relevant actor (firm or sector).

- Transaction costs: freight and insurance by modes of transport, border and "behind the border" costs (tariff duties and cost of complying with non-tariff measures).

- Balance between incoming and outgoing trade flows. This provides the measure of the value-added created by each firm in the value chain. Value-added should be disaggregated into its main components (wages, profit and taxes, to use common language). [12]

- Jobs and skills, if possible related within broader business functions.

- Capital and its ownership (tangible, intangible, technological content and intellectual property, as it relates to trade in income through royalties and fees).

- Non-reproducible capital or inputs (natural resources, land, water) used and consumed, as well as other environmental variables (trade and production related CO2 emissions, etc.).

IV. How to map and measure?

30. This section will review some of the approaches that have been used by trade statisticians to map the various dimensions of trade taking place within global value chains and estimate its value.

[12] National accounts would prefer to say compensation of employees and operating surplus (or labour and capital compensations) and net indirect taxes, after subsidies.

A. Milking the Traditional Trade Statistics Databases

31. "Traditional" trade statistics can still bring a lot of information on the new modalities of international trade modalities. As mentioned by Sturgeon and Memedovic (2010), re-visiting existing trade data sets with a new angle leads to considerable benefits, rapidly available and at relatively little cost. The potential of trade statistics such as UNSD COMTRADE or other similar databases is enhanced when the data are mapped using algorithms derived from social network analysis.

32. A good starting point for mapping trade among value-chains is to look at the intermediate inputs which are used for the production of final (finished) products. [13] Trade in intermediate inputs, including goods and services, is the glue connecting the firms participating in international supply chains and, at the same time, the belt that keeps them moving together. Mapping those flows, using available trade statistics, is therefore an intuitive way of describing the network. One early example in the specialised literature is Yeats (2001). Moreover, recent advances in the analysis of social networks provide a series of quantitative indicators (and dedicated software) that go beyond the simple mapping of trade patterns to compute synthetic indicators.[14]

33. Trade flows are classified according to the relevant classification for goods and services and divided as incoming (inputs) or outgoing (output) for each relevant actor (firm or sector). Trade in goods is relatively well mapped and detailed information by products and partners is available at dedicated databases like COMTRADE, maintained by the United Nations Statistical Division. Differentiating between intermediate and final goods can be solved relatively easily by doing a secondary classification on the UN Broad Economic Categories Classification (BEC), which splits the Standard International Trade Classification (SITC) or, alternatively, the Harmonized System (HS) of merchandises in terms of their final use (intermediate, capital or consumer goods). Crossing BEC and SITC has the advantage of classifying each good by stage of production and by industry (OECD, 2005).

34. The case of services is much more complex. Despite recent advances in international recommendations (UNSC, 2012, and EBOPS classifications) most existing statistics are compiled for balance of payments purpose rather than for analytical purpose. Moreover, only the most advanced countries publish bilateral flows of trade in services. When only the most aggregate values are available (total imports and total exports of transport, travel and "other services"), imputing bilateral flows remains almost a matter of guesswork (Miroudot et al., 2009; Timmer, 2012). The good news is that the task may become easier in the future, as work is under way to develop a correspondence table between EBOPS 2010 and CPC Version 2.0 which may help in the future.

35. Trade in intermediate goods and services within GVCs is often seen as a statistical nuisance because it creates double-counting. The value of parts and components that compose goods in process of elaboration are counted each time they (or the product in which they are embedded) cross a border. This double counting tends to artificially inflate the importance of trade and was probably one of the factors that led to a gradual increase in

[13] Final goods are purchased for consumption or investment purposes. In practice, the boundaries are not clear. Gross investment includes changes in inventories, while final demand in national accounts covers total exports (of final and intermediate goods). International IO accountants separate exports of intermediate products from final demand, but the treatment of inventories remains an empirical issue.
[14] See, for a relatively un-technical example, Hansen *et al.* (2011); Goyal (2007) develops a more formal approach of the economic theory of networks.

the world trade-GDP ratio up to 1995 (WTR, 2013). Yet, far from being a double counting nuisance, trade in intermediate products can, on the contrary, provide invaluable information on the topology of value chains. Because the information on trade in intermediate inputs, at least in the domain of merchandise, is very detailed (the HS classification at its 6 digit level, distinguishes some 5,000 different categories of goods), the mapping can be very precise and provides information on the pattern of specialization of each country within regional or international productive clusters (Goyal, 2007; Flores and Vaillant, 2011). As we shall see later, mapping physical flows based on custom data and the Harmonised System has some clear advantages over more holistic accounting approaches such as income flows (processing fees) and input-output models, because the mapping of trade in intermediate products provides statistical and analytical perspectives on very detailed inter-industrial interactions.

36. Using traditional trade statistics for analysing global value chains is particularly effective when the researcher is interested in a certain type of product. For example, many researchers interested in the trade-development nexus and the issue of value-chain upgrading, are interested in analysing trade patterns according to the technological sophistication of the products. Lall et al. (2005) provide a detailed example of the calculation of sophistication scores for 237 exports at the 3-digit SITC level and 766 exports at the 4-digit level. This classification, while not pretending to be a world standard, has inspired analytical works in UN agencies such as ECLAC and UNCTAD. OECD and EUROSTAT have defined also a classification of high-technology sectors and products (Hatzichronoglou, 1997). The classification is based both on direct R&D intensity and R&D embodied in intermediate and investment goods. Interestingly, the latest revision of the classification includes services (OECD, 2011).

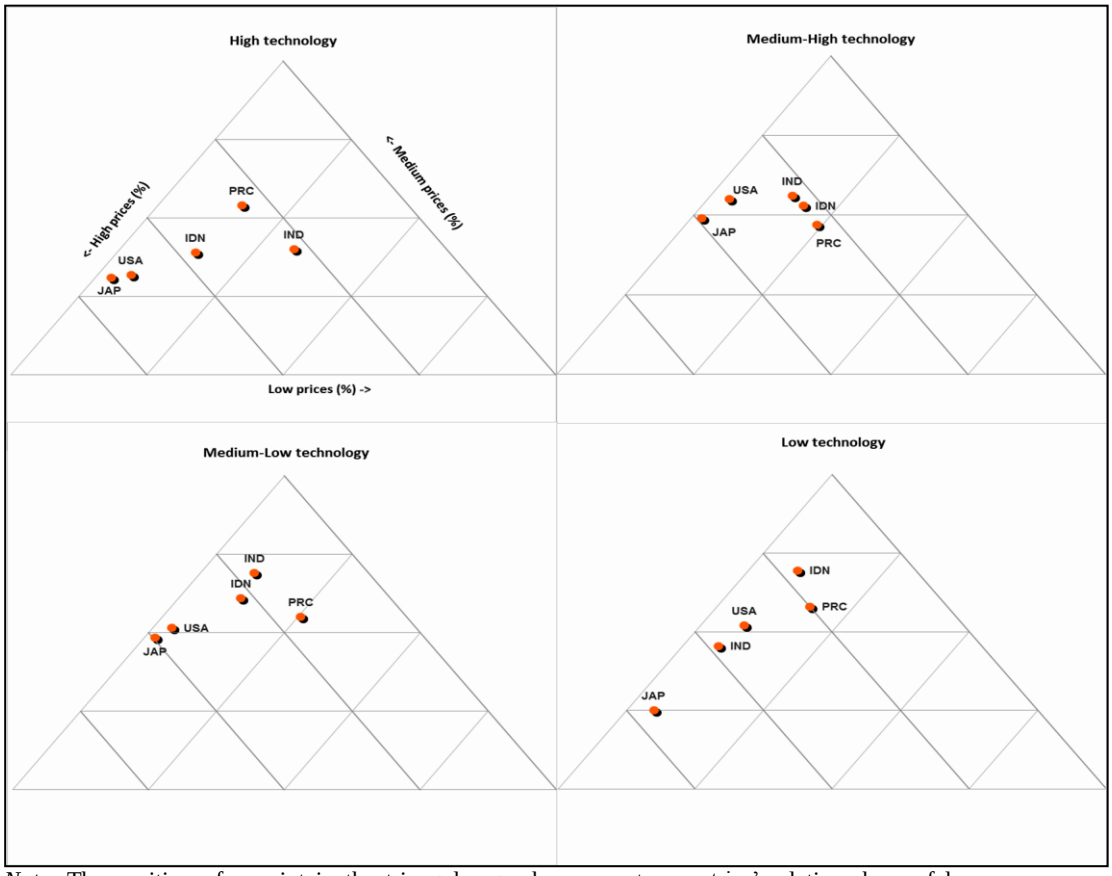
37. Nevertheless, it remains important to keep in mind that such classifications – based on imported and exported goods – can be greatly misleading when trade takes place in GVCs where what is actually traded are the ***tasks*** and not the ***products***. Relatively simple tasks (eg, assembly) can be incorporated into very sophisticated electronic equipment. This does not imply that the sector/country's production frontier has moved towards high-technology. Therefore, popular indicators such as revealed comparative advantages have to be treated carefully when trade in tasks is prevalent (Ferrarini and Scaramozzino, 2011).

38. Another aspect of interest for the researchers following the new "new" trade theory is product differentiation. Applying statistical filters to the raw data (eg., splitting HS categories by quality, using Unit Values) should help providing a better understanding of the industrial clusters participating in GVCs. Rauch (1999) looks into the issue and offers a classification of merchandises into three categories (homogeneous, reference priced, and differentiated). Products traded on an organized exchange (Chicago Board of Trade, New York Mercantile Exchange, etc.) as considered homogeneous goods. When manufactured goods are not sold on mercantile exchanges but are sufficiently standardised to be benchmarked for price and quality (chemicals, special types of steel), they are classified as reference priced; all other products were deemed differentiated. The latter category includes the inputs specifically tailored to the end-user's needs (eg, automobile parts).

39. Using OECD data, Figure 1 gives an example of trade indicators crossing technological content and quality differentiation for a selection. Industries are classified by technological content and, for each HS6 product they export, high, medium and low quality are determined –under the hypothesis that market are efficient and differences in prices reflect differences in quality– by looking at the relative position of their unit value compared to world trade in similar products (OCDE, 2013). Within each of the industry, the graph illustrates well the specialisation of high-income countries (Japan, USA) in high quality/high price products while developing countries export low or medium quality

varieties. The graph shows also that the USA is still an exporter of medium and low priced products in the low technology industrial sectors.

Figure 1
Exports by technology content and price level, selected Asia-Pacific countries (2010)



Note: The position of a point in the triangular graph represents countries' relative share of low, medium and high priced traded products for each technological category.
Source: Based on an interpretation of data displayed in Figure 5.12 of OECD (2013)

40. This specialisation on different quality segment allows countries with different comparative advantage to trade in the same type of products, in apparent breach of the traditional trade theory which predicted a clear specialisation by type of activity. This type of information is also relevant for development economists, as it shows that lesser developed economies are not condemned to compete head-to-head with emerging and developed countries, but may find an entry niche in low quality segments, before up-grading by climbing up the quality ladder.

B. Measuring Trade in Value Added [15]

41. While mapping trade in intermediate inputs is important to understand the topology of the production process, a value added approach enables an assessment of the net economic contribution by each contributing sector/country and further disaggregates these flows into their main components (wages, profit and taxes). [16] Estimates of the value added content of trade rely typically on Leontief inverse matrices based on international input-output (I-IO) tables, which integrate national accounts and bilateral trade statistics. I-IO tables present the advantage to being able to capture in a cost-effective manner not only direct linkages and exchanges between countries and sectors but, after applying standard Leontief transformations, also the indirect sectoral linkages. The Asian Input-Output Tables produced by IDE-JETRO are the earliest examples of systematic compilation of I-IO with a clear statistical objective while most academic researchers have instead used non-official or ad-hoc data, such as GTAP or EORA databases. [17]

42. The most recent advances in compiling I-IO rely principally on the increasing availability of country supply-use tables, which –for each sector– provide a detailed picture of the supply of goods and services inputs by origin (domestic production and imports) and the use of output for intermediate consumption and final use (consumption, gross capital formation, exports). The supply-use tables also provide information on the value-added components (compensation of employees, other net taxes on production, consumption of fixed capital, net operating surplus). From 2010 to 2012, best practices in compiling such data were greatly enhanced by the experience gained through a EU-funded project, the World Input-Output Data Base (WIOD). The WIOD project developed also socio-economic satellite accounts that allow deriving employment or environmental impact from the models (Escaith and Timmer, 2012).

43. Once the I-IO table is available, a series of trade indicators can be produced, each one capturing a specific aspect of trade in value-added (see Box 1).

Box 2

Decomposition of Gross Exports into their Domestic and Foreign Components using International Input-Output Tables

Tracking the inter-industrial relationships behind the production of goods and services and measuring the value-added that is created in the process is made possible by using international input-output tables. The starting point is supply-use tables which reflect for each country the interrelationship between domestic industries and also between those industries and the final demand categories (households, government, investment and exports). They also reveal how imports of intermediate products are used in producing goods and services.

Extending those domestic input-output relationship to a world model (the basic idea behind trade in value-added) dates back from a V. Leontief in the 1960s. Compiling and harmonizing multiple sets of trade and national accounts data is a complex process and this project did not materialize up to very recently. IDE-JETRO built a Asian database in the

[15] The present section draws heavily on work done at OECD and WTO in co-operation with IDE_JETRO and USITC; see OECD-WTO (2012) and Degain *et al.* (2013) for the main technical conclusions of this research programme.

[16] Compensation of employees and operating surplus (primary factors' income), and net indirect taxes, after subsidies.

[17] An introduction on international input-output can be found in the 'Explanatory Notes' of Inomata and Uchida (2009); see also Ahmad (2013).

1980s which was used for a pilot study in measuring trade in value-added (WTO and IDE-JETRO, 2011) but it was only in 2012 that worldwide estimates based on official data were produced (WIOD, OECD-WTO). Previously, a similar exercise had been attempted, but on the non-official database GTAP (Daudin, 2006).

Once the underlying international input-output matrix is built (which is, as mentioned, a major endeavour), trade in value added is derived from the basic Leontief model. Starting from a single country perspective (OECD-WTO, 2012):

X= AX + Y [B1.1]

Often written (after rearranging terms): X= [I-A]-1 Y [B1.2]

where:

X: is an n*1 vector of the output of n industries within an economy.

A: is an n*n technical coefficients matrix; where aij is the ratio of inputs from domestic industry i used in the output of industry j.

I: is the diagonal n*n identity matrix

Y: is an n*1 vector of final demand for domestically produced goods and services (final demand includes consumption, investment and exports) and AX results in a vector of direct and indirect intermediate inputs required for producing Y.

A country's total value added can be split in two parts: one is the VA embodied in goods and services absorbed domestically (consumption and investment), the other is the VA embodied in its exports. Assuming the homogeneity of products made for the domestic market and products made for exports, total imports embodied directly and indirectly within exports are given by:

Import content of exports = M (1-A)-1 E [B1.3]

where:

M: is a 1*n vector with components mj (the ratio of imports to output in industry j)

E: is a n*1 vector of exports by industry to the rest of the world.

In the same way, one can estimate the total indirect and direct contribution of exports to value-added by replacing the import vector m above with an equivalent vector that shows the ratio of value-added to output (V), with $V_j = [1 - \sum_i a_{ij}]$. So, the contribution of exports to total economy value-added is equal to:

VAE: V (I-A)-1E [B1.4]

_____

Note: ‡ The estimation of trade in value-added goes beyond the BPM6 concept of measuring trade on the basis of the national ownership of inputs, as it reassigns inputs and value-added by country and sectors of origin. In order to do so, input-output matrix has to be compiled according to SNA93, all inter-industrial physical flows (be they domestic or international) being the support of the exchange of (embodied) sectoral value-added.

C. Linking Trade and Business Statistics

44. Input-output data, despite their great systemic value, are too aggregated to capture the business reality behind trade in global value chains. Sturgeon (2013) presents a state-of-the-art discussion on firm-level data requirements and data compilation strategies based on

EUROSTAT/OECD experiences. Some developing countries involved in GVCs have also developed appropriate statistical tools, be they large emerging economies such as China or Mexico, or smaller countries such as Cost Rica.

45. Obtaining firm-level data of global value chain insertion requires dedicated surveys, something official statisticians look at with caution, considering the implementation cost as well as the statistical fatigue of responding firms. Fortunately, there are cost-effective approaches at gathering relevant information without increasing the statistical burden on responding firms.

46. Data already collected by national administrations are able to provide a detailed view of the trade activity generated by each firm. Administrative registers gather a lot of information on firms' activity, their corporate structure, their labour force and productive characteristics. By linking those administrative data with custom statistics, it is therefore possible to cross –check several existing databases and build very detailed maps of trade activity by firm characteristic. EUROSTAT and the OECD have spearheaded a joint project called "Trade by Enterprise Characteristics" to understand the specific profile of firms that actively engage into trade. This institutional initiative mirrors other initiatives from the academia that burgeoned in response to the new "new" trade theory, which had a clear focus on empirical issues and micro -data. For example, Bernard et al. (2005) look at US data to provide an ID card of firms according to their trading activity. More recently, the Chinese Academy of Sciences (2013) has released detailed information on export activity by type of firms.

47. These "Trade by Enterprise Characteristics" (TEC) are so far restricted to national or well integrated custom union areas, because one needs to use a single identification for the firm across all administrative registers. In addition, confidentiality aspects do constrain their dissemination. A second-best solution, half-way between the detailed firm-level micro-data and the aggregated sectoral representative firm , is provided by disaggregating sectorial I-IO by firm characteristics. De la Cruz et al. (2011) undertake such an exercise on Mexico; Tang et al (2013) combine IO tables and firm census data to disaggregate Chinese GVC trade by firm size and type of ownership.

V. Conclusion: Searching for an integrating framework

48. Up to very recently, trade statistics was considered a mature field by the profession; this sleeping beauty has recently awakened to transform herself into a vibrant teenager, curious to explore new areas but yet uncertain of the best avenues. The objective of the present essay was to tentatively map what we needed to know, while recognising that there remain plenty of known unknowns and unknown unknowns. Despite significant advances since the early 2010s, we have so far scrapped only the surface of the issue.

49. A significant move took place in March 2015 when the Statistical Commission, in its forty-sixth session was presented with a report by the Friends of the Chair group on the measurement of international trade and economic globalization. [18] The report provided an overview and assessment of the conceptual, compilation and analytical issues that are to be addressed with the new modalities of trade today, in particular along global value chains (see Annex I). It called for a new multi-dimensional system of extended international and

[18] A previous report to the Statistical Commission (UNSC, 2013) provides a comprehensive review of the work undertaken so far at international level, proposing the development of an overreaching framework to ensure consistency in methodology, data compilation and data dissemination. UNSC (2015) results from this proposal.

global accounts in order to measure the economic, environmental and social interdependencies in global production and trade that impact sustainable development in both developed and developing countries.

50. The road ahead travels through the micro data territory and firm-level information. With a few exceptions, mainly in the EUROSAT and OECD regions, recent progress in linking trade with industrial activities has been done at macro-sectoral level. Having this information is already a great step in the right direction and helped demonstrate that understanding the economic relevance of trade in today's globalised economy required new instruments and new methodologies. Additional efforts, such as the TiVA database and WIOD's tables, have further helped to shed light on the big picture, resizing the relative weight of services and manufacture or the real size of bilateral trade imbalances and understanding better the complex relationship between trade and job creation. While they bring very valuable information on the relationship between international trade and economic development, these databases developed on official data still need to include more developing and least developed countries. Extending the coverage of developing and least developed countries using official data should therefore be a priority. This task will be made easier by new approaches that rely on SUT instead of full-fledged IO tables and the work of the OECD and WTO to expand the coverage of TiVA through regional partnerships.

51. But expanding country coverage is not a panacea. As demonstrated above, responding to the new realities of trade, and in particular the three circuits of production, income and finance, requires a more holistic approach. The existing databases on trade in value-added are not yet able to satisfy these demands. The new TiVA released in June 2015 goes one step into the right direction by splitting, for two countries (China and Mexico) the industries into two sub-samples: firms that specialize in exports and the other domestic firms. This was made possible because both countries developed adequate micro-data linking trade and enterprise characteristics.

52. The new statistical frontier lies in the development of micro-database to fully capture the heterogeneity of firms that are active in these global value chains and complement the trade data with information of the firm characteristics, including the financial and corporate dimensions. An increasing number of countries have undertaken projects to link trade statistics to business registers at the micro-level. Such integrated datasets can, for instance, indicate which firms, characterized by industry, size class, foreign ownership, and geographic location, are engaged in international trade as part of global value chains, and the importance of those firms for the overall economy. And this momentum has been consolidated with the creation of an OECD Expert Group on Extended Supply-Use tables, that has two primary objectives: (i) to improve the quality of current TiVA estimates through the better measurement of heterogeneity and (ii), to create an accounting framework bringing together the three circuits, plus socio-economic data on labour (see Annex II). Similarly, after the good reception of the Friends of the Chair report (UNSC, 2015), the UNSD plans to conduct a global survey on national practices on trade by firm characteristics.

53. The compilation of business data for international trade analysis calls also for a revision of the existing classifications. The Classification by Broad Economic Categories (BEC), used to distinguish trade in final and intermediate products, is undergoing a new revision (expected for 2016). Efforts are also taking place for a better understanding of what are the "business functions" which are subject to outsourcing and determine in fine what is "trade in value-added".

54. Without prejudging future developments in trade statistics, the trends point towards integrating micro-economic data, including business registers or labour and financial

information, using National Accounts as one of the main organizing and integrating frameworks. In a first step, the relevant data would ideally be interrelated into a "satellite account" of the external sector, linked to the national accounts as far as residents are concerned, but also interlinked with other trading partners using trade and income flows. A good example of such statistical framework is provided by the satellite accounts for tourism, a branch of trade in services with complex interactions between many different economic and social actors.

55. Installing such accounts in the routine of national statistical institutes will be challenging for most developing countries, as it is demanding in terms of quality of administrative data and dedicated business surveys. It is nevertheless in these countries that the need for developing such information system is the greatest, considering the relevance between global value chains, trade and development. On the other hand, the difficulty of the task should not be overstated, because most trade activity in developing countries is concentrated in a few firms, greatly simplifying the data compilation.

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ANNEX I: Schematic Classification for measuring international activities, internationalization and globalization *(adapted from UNSC Friend of the Chair Report, 2015)*

SCOPE	*STATISTICAL DIMENSION*	Existing and new aggregate statistics	Existing and new micro data based statistics and analysis (record linkages); confidentiality at NSOs
Existing core statistics and developments	*Domestic and cross-border (National Statistical System)*	Core national and international accounts, merchandise trade and related business statistics ─ Development, interpretation and implementation of core recommendations of international manuals, such as measurement of global production	Micro based estimates of domestic and cross-border processing in manufacturing
Enhancements to core statistics	*Domestic and cross-border (National Statistical Systems)*	Enhanced country bilateral data confrontation; implementation of selected *recommended items* in manuals, such as modes of supply for trade in services; additional details in SUTs, trade and FDI; FDI mergers and acquisitions; satellite accounts (KLEM -- employment, capital stock, environment)	Micro based estimates of value added, trade and investment, assets, etc.
Internationalization extensions	*Domestic and cross-border (National Statistical System)*	Country measures of TiVA; Inward FATS ─ employment, sales, trade, control, etc.; Foreign ownership and control statistics; Outward FATS ─ employment sales, trade, control, etc. (typically under NSOs); AMNE statistics; Details on mergers and acquisitions	Inward/outward FATS and AMNE statistics – Firm heterogeneity (export-intensities, firm size, productivity); international trade-investment-business statistics; Business Functions in- and outsourcing;
Globalization extensions ─ summation of country activities	*Beyond cross-border (International Statistical System)*	Trade flows symmetry, Harmonized and Global supply-use tables; OECD-WTO TiVA; IMF CDIS and CPIS; Aggregate tables built from country micro-data studies; Globally-consolidated MNEs – activities, financial statements and risk exposures	
Globalization extensions	*Beyond cross-border (International Statistical System)*	Aggregate global value chains analysis by researchers; Big Data (e-commerce, digital flows,…)	Micro data based global value chains analysis by researchers

ANNEX II: Extended Supply-Use Tables [19]

Over the past 30 years, the role and use of Input-Output framework has developed rapidly within NSOs. Supply Use tables, derived from firms surveys, are the building block required to bring together the different approaches to measuring Gross Domestic Product. While I-O tables are usually built only for benchmark years, SUTs are available at a higher frequency (annual and, sometime, quarterly). More recently, the measure of trade in value-added based on International I-O tables raised the attention for exploiting more intensively the SUTs from an international trade perspective. Deriving Trade in Value-Added estimates from SUTs rather than from I-O tables allows to increase the frequency of the hard data needed for the exercise, but also to provide a more detailed and intuitive statistics at the product and enterprise level. Such intuitive data facilitate the dialogue between analysts and stakeholders, at the difference of the I-O matrices and the Leontief models which stand at a higher level of conceptualization.

The OECD launched in 2014 an Extended SUT initiative with two primary objectives: (i) to improve the quality of current TiVA estimates through the better measurement of heterogeneity and –perhaps most importantly for our present concern– (ii) to create a holistic accounting framework that brings together the three circuits of production, income and finance whilst also providing the vehicle to analyse jobs (and subsequently skills and so tasks) within the same framework.

Importantly the development of this framework aim at bringing together existing data sources (TEC, FATS, BOP, National Accounts, Trade, Employment, structural business statistics). Capitalising on these sources highlights the potential of what can be achieved in many national statistics offices from available data, optimizing the use of already existing information.

The Asian Development Bank is also embarking in a fairly data-intensive research agenda on GVC building on the work they have been doing on SUTs with the NSOs. In Latin America, UN-ECLAC has also compiled those data in order to produce TiVA estimates for 9 South American countries, while developing KLEM satellite accounts on the underlying labour and investment dimensions.

The underlying principle is built around the idea that new aggregations of firms are required to better understand and respond to the GVC world (see Table II. 1)

Table II.1: ' *Ideal*' breakdown of columns and rows in Supply Use Tables

Foreign Owned												**Domestically owned MNE**												**Domestic Owned**											
With high Export orientation 'Exporters'						**With low Export orientation 'Non-Exporters'**						**With high Export orientation 'Exporters'**						**With low Export orientation 'Non-Exporters'**						**With high Export orientation 'Exporters'**						**With low Export orientation 'Non-Exporters'**					
Low import orientation			**High import orientation**			**Low import orientation**			**High import orientation**			**Low import orientation**			**High import orientation**			**Low import orientation**			**High import orientation**			**Low import orientation**			**High import orientation**			**Low import orientation**			**High import orientation**		
S	**M**	**L**	**S**	**M**	**L**	**S**	**M**	**L**	**S**	**M**	**L**	**S**	**M**	**L**	**S**	**M**	**L**	**S**	**M**	**L**	**S**	**M**	**L**	**S**	**M**	**L**	**S**	**M**	**L**	**S**	**M**	**L**	**S**	**M**	**L**

Source: OECD

But recognising that such a breakdown will create confidentiality problems in (particularly small) countries, the Expert Group is exploring different levels of aggregations – for example, aggregations built around ownership only, around export intensities only, and around size classes only, with countries encouraged to explore options most

[19] This section builds on inputs on the OECD project provided by N. Ahmad and discussions on SUT with S. Mahajan held at the 23rd Input-Output Conference in Mexico (June 2015).

relevant (and feasible) to them. Table II. 2 provides an illustrative template of the information being explored using the ownership criteria.

Table II. 2: Ownership focus: Domestic Use Table at Basic Prices

Reference Year	Year'	Domestic Use at Basic prices														
ISIC Code equivalent	Product	Industry 1			Industry 2			Total intermediate consumption	Household final consumption	*NPISH*	*GGFC*	*GFCF*	*Valuables*	*Changes in Inventories*	*Exports*	*of which non-residents expenditure*	*of which re-exports*	*of which intra-firm exports*	Total Demand
Product	Product produced by:	Foreign	Domestic MNE	Domestically owned	Foreign	Domestic MNE	Domestically owned												
Product (Industry) 1	Foreign																		
	Domestic MNE																		
	Domestic MNE																		
	Domestically owned																		
Product (Industry) 2	Foreign																		
	Domestic MNE																		
	Domestically owned																		
Total Imports																			
Taxes and Subsidies on Products																			
on imports																			
on domestic transactions																			
Gross Value added - Basic Prices																			
Gross Operating surplus																			
Mixed Income																			
Compensation of Employees																			
Other Taxes on Production																			
Other subidies on production																			
Total Output:Basic Prices																			
of which																			
own-account production of:																			
software																			
R&D																			
other																			

Source: OECD

Further, the Expert Group will be looking to further extend the tables via the integration of income flows, employment flows (for skills), indeed hours worked (for productivity) emissions datak, and even current tax information (to better respond to the Base Erosion Profit Shifting[20] agenda) with supplementary tables (Table 3, which shows for illusration a table with a split into ownerhsip and exporting criteria)

Table II. 3: Splitting Ownership and Exporting Criteria

	Industry 1				Industry 2			
	Foreign		Domestic		Foreign		Domestic	
	Exporter	Non-Exporter	Exporter	Non-Exporter	Exporter	Non-Exporter	Exporter	Non-Exporter
Property income payments - to abraod								
of which								
Interest								
Distributed Income of Corporations								
Reinvested Earnings on FDI								
Investment Income Disbursements								
Property Income payments - to abroad								
of which								
Interest								
Distributed Income of Corporations								
Reinvested Earnings on FDI								
Investment Income Disbursements								
Current taxes on income and wealth								
Employment								
Employees								
Hours worked								
Co2 emissions								

Source: OECD

[20] See http://www.oecd.org/ctp/beps.htm