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SUMMARY

One of the most important empirical finding of the 1960s concerning international trade has been that European integration was not leading to increased inter-industry specialisation but to two-way trade within industries. This intra-industry nature of trade has been repeatedly attested since then and justified on the grounds of the new approaches to international trade based on imperfect competition and differentiated products.

The shortcomings of the initial empirical approaches have been very rapidly corrected. More fundamentally, the evidence of two-way trade in qualitatively differentiated products has profoundly changed our views regarding the determinants, measurement and consequences of intra-industry trade (IIT), since this empirical evidence was contrary to the classical trade theory associating trade integration with specialisation of countries, as well as theories of IIT in similar products.

Besides bringing about sizeable gains in variety, this evidence suggested that trade integration would not lead to potentially important adjustment costs associated with the displacement of resources from comparatively disadvantaged industries towards export-oriented industries. This "smooth adjustment" hypothesis very much welcomed by policy makers has only recently been challenged on the basis of selection effects associated with trade within industries.

In the same way, contrasting with the simplistic opposition between inter-industry trade (based on differences in prices leading to specialisation) and IIT (seen as two-way trade of differentiated products with similar prices), both empirical evidence and theoretical arguments pointed to the importance of two-way trade of qualitatively differentiated products. Accordingly, IIT itself had to be divided divided into two parts: IIT in horizontally differentiated (i.e. similar) products and IIT in vertically differentiated products (i.e. differing by quality), accounting for specialisation along ranges of quality within industries. The purpose of this article is to take stock of this second departure from the initial results and to provide a sound and exhaustive assessment of such phenomenon.

Contrasting with the partial assessments we were relying on up to now, we provide here a systematic decomposition of world trade using harmonised bilateral flows at the most available detail (some 5,000 product categories), into three trade types: inter-industry, intra-industry in horizontally versus vertically differentiated products. The analysis is diachronic and considers country pairs such as France-Germany, United States-China, Malaysia-Singapore, or India-Nigeria.

We show that the increase in IIT at the world level is due to two-way trade of vertically differentiated products. At the two opposite of the spectrum, we find France and Germany having the highest share of IIT in their bilateral trade among all country-pairs in the world, and Algeria-Brazil the weakest. In value terms, the most important bilateral IIT is between the United States and Canada.

Recently, specialisation according to the classical theories of international trade (inter-industry trade), has recovered, due to the increasing participation of emerging economies in world trade.

ABSTRACT

Intra-Industry Trade has been repeatedly attested since the 1960s and justified on the grounds of the new approaches to international trade based on imperfect competition and differentiated products. Up to now however, scholars were relying on partial assessments of this phenomenon. We provide here a systematic decomposition of world trade using harmonised bilateral flows for some 5,000 products, into three trade types: inter-industry, intra-industry in horizontally versus vertically differentiated products, over the period 1989-2002. We show that the increase in IIT at the world level is due to two-way trade of vertically differentiated products. However inter-industry trade has recently recovered, due to the increasing participation of emerging economies in world trade.

Keywords: Intra-Industry Trade, International Trade.
JEL classification: F14, F15

UNE DÉCOMPOSITION DU COMMERCE INTRA-BRANCHE HORIZONTAL ET VERTICAL

RÉSUMÉ

L'existence d'un commerce intra-branche, attestée de façon répétée depuis les années soixante a trouvé une explication dans les nouvelles approches du commerce international fondées sur la concurrence imparfaite et la différenciation des produits.

Les insuffisances des premiers travaux empiriques ont été rapidement corrigées. Plus fondamentalement, l'existence de commerce intra-branche pour des produits différant par leur qualité a profondément modifié notre compréhension des déterminants, de la mesure et des conséquences du commerce intra-branche, alors que ni les approches classiques en termes de spécialisation des économies s'intégrant, ni les approches en termes d'intra-branche de produits similaires, ne permettaient d'en rendre compte.

L'intégration économique via le commerce intra-branche n'apporte pas que des gains de variété. Elle est surtout un garant d'ajustements "amortis" dans lesquels les déplacements de ressources entre emplois, et les coûts associés sont limités. Cette vision harmoniste appréciée des responsables de la politique économique a toutefois été récemment remise en cause par la mise en évidence de processus de sélection à l'intérieur des industries.

De même, contrastant avec les approches simplistes opposant le commerce inter-branches (fondé sur les différences de prix entraînant la spécialisation) au commerce intra-branche (compris au sens d'échanges croisés de produits similaires), les nouvelles preuves empiriques comme les développements théoriques ont souligné l'importance des échanges croisés de produits différenciés par leur qualité. C'est ainsi que le commerce intra-branche a dû être divisé en deux parties, le commerce intra-branche en différenciation verticale rendant compte d'un phénomène de spécialisation sur les gammes de qualité au sein des industries. L'objet de cet article est de faire le point sur cette nouvelle approche et de fournir une mesure satisfaisante et exhaustive de ce phénomène.

A l'inverse des approches partielles auxquelles les statistiques disponibles contraignaient jusqu'ici les travaux empiriques sur le sujet, nous proposons ici une décomposition systématique du commerce mondial à partir de données harmonisées de commerce bilatéral pour quelque 5 000 produits, sur la période 1989-2002. Cette décomposition se fait en trois types de commerce: inter-branches, intra-branche en différenciation horizontale, enfin intra-branche en différenciation verticale. L'analyse s'intéresse à la dimension bilatérale des échanges et permet de considérer des couples de pays aussi divers que France-Allemagne, Etats-Unis-Chine, Malaysie-Singapour ou encore Inde-Nigéria.

Nous montrons que la progression du commerce intra-branche s'explique par la progression du dernier type d'échanges. Aux deux extrémités du spectre, on trouve la France et l'Allemagne, qui ont, au niveau mondial, la part d'intra-branche la plus élevée dans leur commerce bilatéral, et l'Algérie et le Brésil, pour lesquels cette part est la plus faible. En valeur, les Etats-Unis et le Canada réalisent le flux de commerce intra-branche bilatéral le plus élevé du monde.

Toutefois, on note une reprise du commerce inter-branches en fin de période en raison de la participation accrue des pays émergents au commerce mondial.

RÉSUMÉ COURT

L'existence d'un commerce intra-branche, attestée de façon répétée depuis les années soixante a trouvé une explication dans les nouvelles approches du commerce international fondées sur la concurrence imparfaite et la différenciation des produits. Toutefois, les preuves empiriques à la disposition des chercheurs restaient partielles. Le présent article propose une décomposition systématique du commerce mondial à partir de données harmonisées de commerce bilatéral pour quelque 5 000 produits, sur la période 1989-2002. Cette décomposition se fait en trois types de commerce: inter-branches, intra-branche en différenciation horizontale, enfin intra-branche en différenciation verticale. Nous montrons que la progression du commerce intra-branche s'explique par la progression du dernier type d'échanges. Toutefois, on note une reprise du commerce inter-branches en fin de période en raison de la participation accrue des pays émergents au commerce mondial.

Classement JEL : F14, F15
Mots Clés : Commerce intra-branche, commerce international.

DISENTANGLING HORIZONTAL AND VERTICAL INTRA-INDUSTRY TRADE

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INTRODUCTION

The revelation of simultaneous exports and imports within industries between countries of similar development levels is one of the most important empirical finding of the 1960s concerning international trade. Initially observed for the Benelux customs union and thereafter for the 6 founding members of the European Economic Community (Verdoorn, 1960, Drèze, 1960, Balassa, 1966, Grubel, 1967), the concentration of trade flows within industries rather than between industries has been since its discovery a recurrent pattern of the process of European integration[1].

This evidence of *intra*-industry trade (IIT) was contrary to the classical trade theory associating trade integration with specialisation of countries (Viner, 1950). Although challenging the conventional view, the evidence of IIT suggested that trade integration would not lead to potentially important adjustment costs associated with the displacement of resources from comparatively disadvantaged industries towards a limited number of export-oriented industries (*inter*-industry trade). This "smooth adjustment" hypothesis very much welcomed by policy makers has only recently been challenged on the basis of selection effects associated with trade within industries (Jean, 2002; Mélitz, 2003). In addition to limiting adjustment costs, international trade may also bring about sizeable gains in variety: A recent study estimated that the number of varieties offered to the US consumer have been multiplied by a factor of four over the last three decades, leading to a welfare gain for the US economy corresponding to 3% of GDP (Broda and Weinstein, 2004).

Consequently, the revelation of IIT may be seen as the starting point of the renewal of international trade theory, the theoretical base in understanding this phenomenon being considerably enlarged since then. Originally, this empirical evidence has given support to a rejection of classical theories of international trade based on the concept of comparative advantage: if countries export and import products belonging to the same industry, the specialisation process will no longer be the core phenomenon associated with trade integration. Given the methodology used in pioneering studies, the bulk of trade among industrial countries was considered of an intra-industry nature, leading to a rejection of traditional approaches in terms of specialisation (of countries) and differences (in prices).

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Since these pioneering studies, a huge literature has replicated the initial results and clarified methodological issues: Grubel & Lloyd (1975), Greenaway & Milner (1986) and Lloyd & Lee (2002) are the main steps leading from the initial understanding to our current appraisal of the phenomenon of IIT. Two main departures from the initial understanding in the 1960s of the phenomenon have been made by the literature.

Firstly, as a result of a debate addressing measurement issues as well as progress made regarding the determinants of the phenomenon, the original opposition between specialisation and IIT has vanished:

- On the empirical front, more recent papers have addressed the shortcomings of the original methods. One of them concerns the sensitivity of measured IIT on the level of analysis: the more products are grouped together into an "industry", the higher the probability of overlap between exports and imports of that industry (sectoral aggregation bias). Consequently, studies using more detailed industry breakdowns have indeed found lower shares of measured IIT. A related issue concerns the geographic aggregation bias, where examining a country's trade with aggregates of its partners, such as "regions" or the "world" creates an artificially high measured IIT. In fact, overlapping trade flows may simply be the result of a "triangular" trade relationship, in which a country exports a given product to one partner and imports it from another one. Such a "multilateral" intra-industry trade is perfectly compatible with traditional theories incorporating the concept of the "chain of comparative advantages" (Deardorff, 1979; Lassudrie-Duchêne and Muchielli, 1979). The solution is to examine bilateral trade flows, which again yields in lower shares of IIT in total trade.

- On the theoretical front, a synthetic view of the determinants of international trade has emerged: According to the view popularised by Helpman & Krugman (1985), monopolistic competition and (internal) economies of scale drive IIT in (horizontally) differentiated products, whereas the old comparative advantage affects trade patterns for countries strongly differing in factor endowments.2 IIT is thus understood as a peculiar kind of (complete) specialisation (of firms, hence of countries) in differentiated products (Feenstra, 2004). However, this theoretical synthesis was itself missing an important dimension of the problem, namely the vertical differentiation of products.

Accordingly, the second departure from this initial understanding refers to prices. In contrast to the simplistic opposition between inter-industry trade (based on differences in prices leading to specialisation) and IIT (seen as two-way trade of differentiated products with similar prices), there are both empirical evidence and theoretical arguments in favour of two-way trade of qualitatively differentiated products. Accordingly, IIT itself has been divided into two parts: IIT in horizontally differentiated (i.e. similar) products and IIT in vertically differentiated products (i.e. differing by quality), accounting for specialisation along ranges of quality within industries. Numerous empirical papers have echoed the

[2] "*To use a terminology that has been widely accepted, we can have a Heckscher-Ohlin view of interindustry specialisation but a scale economy view of intraindustry trade*" (Helpman and Krugman, 1985).

seminal theoretical article of Falvey (1980), including Abd-el Rahman (1986, 1991), Greenaway et al (1994 and 1995), Fontagné et al. (1997 and 1998).

The purpose of this article is to take stock of this second departure from the initial results. After having briefly reviewed the literature in section 1, we point out the differences and similarities between the two alternative methods proposed to empirically address this issue in section 2. Section 3 proposes an adaptation of one of these methods aiming at addressing the issue at stake not only on a single country level (as done by numerous studies), not only at the European level (see for instance Fontagné et al., 1998), but also at the world level. For the first time, to the best of our knowledge, a database allows to realise an assessment of IIT breaking down between horizontal and vertical IIT for all countries in the world[3]. Section 4 highlights the main results of this new approach.

1. IIT IS *NOT* ONLY ABOUT TRADING SIMILAR PRODUCTS

The seminal papers by Krugman (1979) and Lancaster (1980) have promoted a theoretical framework associating IIT with economies of scale and trade in varieties of (horizontally) differentiated products. In such a monopolistic competition framework, similarities are the very determinant of trade flows: similarities in tastes, in factor endowments, in economic size and in specialisation are powerful predictors of bilateral trade flows. This is why the predictions of the gravity equation do hold easily (Helpman, 1987).

The problem with this approach is that it hardly fits empirical evidence. There has been very early and repeated evidence of two-way trade within product categories with very different prices (in practice: unit values, as will be discussed below). Finger (1975) is certainly the seminal reference: despite the fact that his paper was not directly addressing the measurement of IIT, he pointed out that the variability of factor intensities is larger within industries than between industries. Hence, even if trade is based on differences in production patterns, one should indeed observe much IIT. Torstensson (1991) provided evidence of Sweden's vertical specialisation with countries at different levels of per capita incomes. More recently, Schott (2003) is echoing Finger's assessment: the US sources similar products from both high-wage exporters and low-wage one, but unit values associated with the corresponding trade flows vary according to the exporting countries' supply characteristics. Hence the current interpretation of IIT in terms of specialisation of countries within products referred to in the introduction.

How such empirical finding impacts the assessment of the consequences of economic integration deserves further comments: how quality is produced is a matter of factor content. High quality varieties embody larger contents of capital (Falvey, 1981; Falvey and Kierzkowski, 1987), qualified labour (Gabszewicz and Turrini, 1997), or R&D (Gabszewicz, Thisse, Shaked and Sutton, 1981). In simple words, the production function for different qualities of the same category of products differs in the line of Finger's findings. Hence, even balanced two-way trade within the same categories of products may

[3] Ecochard et al. (2004) provide another exploitation of this database.

be associated to a net factor content impacting factor markets in the same way as inter-industry trade flows. The specialisation of countries on products differentiated by their quality may lead to adjustment costs, invalidating the smooth adjustment hypothesis.

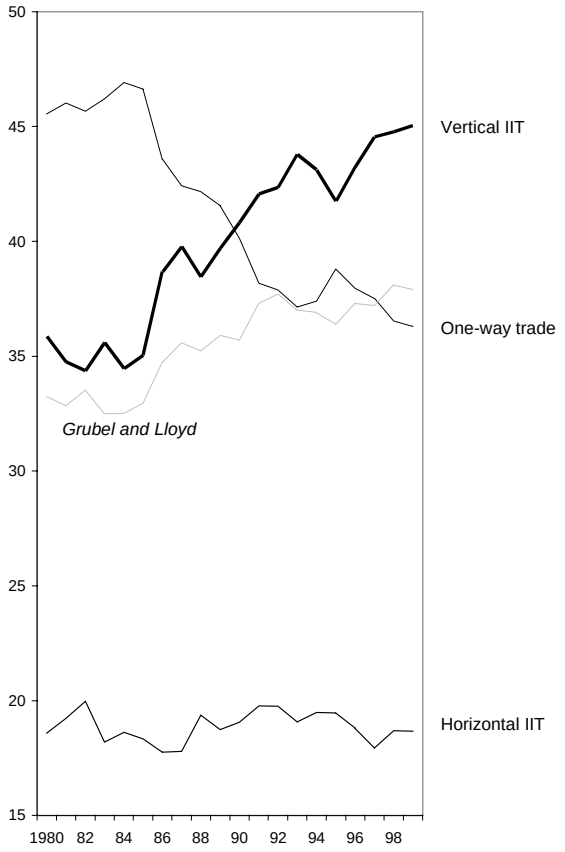
The first studies to tackle empirically the measurement of vertical IIT are Abd-el Rahman (1986, 1991) in the case of France, Freudenberg et al. (1992) for Germany, Greenaway et al. (1995) for the United Kingdom. They all find that vertical IIT is all but a negligible phenomenon: Greenaway et al. (1995) for example estimated that about half of British IIT is of a vertical nature. Many subsequent studies have found similar results, including Hellvin (1996) and Hu & Ma (1999) for China, Freudenberg and Lemoine (1999) and Aturupane et al. (1999) on Eastern European Countries trading with EU members, Blanes & Martin (1999) on Spain, Andressen et al. (2001) on US-Canada bilateral trade, Gullstrand (2001) on 8 EU members trading with 52 developing countries.

These studies have in common that they measure the relative importance of vertical IIT at one point in time. As a result, the extent of vertical IIT is strictly speaking not comparable across studies that are based on different methodologies to measure IIT, different levels of product and partner detail and different thresholds to distinguish horizontal from vertical product differentiation. In addition, any cross-sectional analysis can be criticised on the basis of assumptions they rely on: for instance, less disaggregated nomenclatures will lead to higher shares of IIT.

To our knowledge, the first longitudinal multi-country study on horizontal and vertical IIT –which should a priori isolate any bias due to the thresholds-- was done by the CEPII (1997) within the European Commission's *ex post* appraisal of the impact of the completion of the Single European market on trade patterns in Europe.[4] This study found that the rise of IIT in Europe (and the consequent reduction in inter-industry trade) is entirely due to IIT in vertically differentiated products, whereas IIT in horizontal differentiation remains stable over time (Figure 1, which includes an update by Fontagné & Freudenberg, 2002). This unexpected result influenced the policy debate, as policy makers were accustomed to the scheme associating economic integration with the development of IIT, and accordingly confident that European integration would match the smooth adjustment hypothesis referred to above.

[4] Other studies addressing the longitudinal dimensions of the problem were available at this time, but they did not disentangle the two types of IIT (e.g. Stone & Lee, 1995).

Figure 1 - Trade types in intra-EU12 trade, 1980-99 (%)



Source: Fontagné & Freudenberg (2002), updating CEPII (1997).

An analysis of the determinants of the share of trade types in bilateral trade between EU-12 member countries, based on a panel of 14 industries and 11 countries covering the 1980-94 period (Fontagné & Freudenberg, 2002) confirms the theoretical interpretation suggested by Falvey. Differences in income per capita (proxying economic distance) as well as difference in economic sizes (indicating the potential of economies of scale to be realised by the largest country) both promote specialisation of countries in qualities or in industries.

Last but not least, disentangling IIT by type of product differentiation provides useful insight regarding the impact of exchange rate volatility on trade flows. Whereas the literature remains inconclusive as far as the impact of exchange rate volatility on trade volumes is concerned, disagreggated data points out to a very differentiated impact across industries and products. The reason for this lies in the underlying market structures. Broda & Romalis (2003) show that exchange rate volatility is impacting trade in products

differently according to their degree of differentiation. Homogenous products are less affected by exchange rate volatility than more highly differentiated products. Consequently, exchange rate volatility should enhance the share of inter-industry trade in total trade, detrimental to intra-industry trade. This is confirmed by Fontagné and Freudenberg (1999); disentangling IIT in horizontally and vertically differentiated products moreover points out that the former type of trade is the most affected.

2. TWO METHODS FOR DISENTANGLING IIT IN VERTICALLY/HORIZONTALLY DIFFERENTIATED PRODUCTS

Two methods have basically been proposed to disentangle horizontal and vertical intra-industry trade. Greenaway, Hine and Milner (GHM 1994, 1995) further decompose a Grubel and Lloyd index, while Fontagné and Freudenberg (FF 1997, 1998) categorize trade flows and compute the share of each category in total trade. If they diverge on the definition of IIT, both methods rely on the same assumption regarding the association of price, unit values and the quality of traded products.

Accordingly, the starting point is prices: one makes the assumption that differences in prices within one product category mirror differences in quality. Three comments have to be made regarding such assumption.

- This assumption is only acceptable with the most detailed trade data, where aggregation of different products within one product category is minimised. Since relying on tariff line level data would hamper international comparisons one must use HS 6-digit trade data[5].

- Second, though there are good reasons leading to slight departures from a strict association of prices with quality, trade economists are accustomed to this simplification.

- Third, prices of traded products are not known: what is the price of "men's or boys' shirts of cotton, knitted or crocheted"? It is impossible to give a general answer, as each transaction has its own characteristics (such as time, place, volume, partners, and special conditions) and thus price. This is why average unit values are used instead of prices, namely the value of one ton of men's or boys' shirts of cotton, in this example.

The principles common to both methods (GHM and FF) is as follows:

1) The analysis shall be based on bilateral trade data (in order to avoid the assimilation of trade reversal to IIT), at the product level;

[5] Studies limited to a sub-group of countries (e.g. the EU) can rely on a further decomposition of the HS-6 (e.g. the Combined Nomenclature).

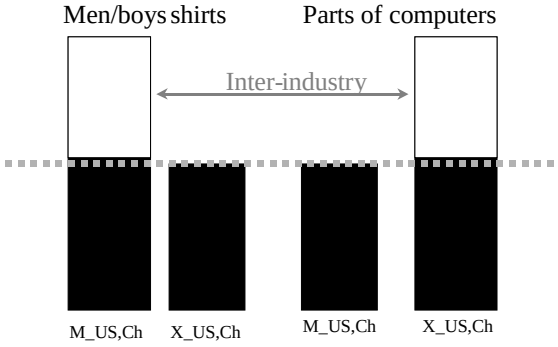
2) To calculate the unit value (value/quantity) for each elementary flow (Chinese exports of "men's or boys' shirts of cotton, knitted or crocheted" to the U.S.) at the most detailed level;

3) To check whether unit values are similar for each reciprocal elementary flow (US exports of "men's or boys' shirts of cotton, knitted or crocheted" to China) in order to allocate the associated trade flow to a given category of product differentiation: horizontal in case of unit value similarity, otherwise vertical. FF rely on a 15% difference in unit value. GHM have used 15% and 25% thresholds. We will rely in what follows on the 25% threshold in order to take into account the large differences in "prices" in a panel of developing and developed economies.

4) All calculations are made at the product, declaring country and partner levels, and the results are aggregated thereafter only.

Notwithstanding these commonalities, the two methodologies differ in the measurement of the trade overlap. GHM derive an indicator from the classical Grubel and Lloyd (G&L) one. The balanced part of a bilateral trade flow is considered as intra-industry, whereas the trade imbalance is inter-industry. Assuming that trade between China and the US is limited to two industries[6] ("Shirts of cotton" referred to above and "Parts and accessories of automatic data processing machines and units thereof") the G&L index is simply one minus the ratio of the white area over total trade (Figure 2). When each pair of elementary/reciprocal trade flows is characterised as horizontally/vertically differentiated, there is an additional dimension to tackle.

Figure 2 - Grubel & Lloyd-type trade decomposition

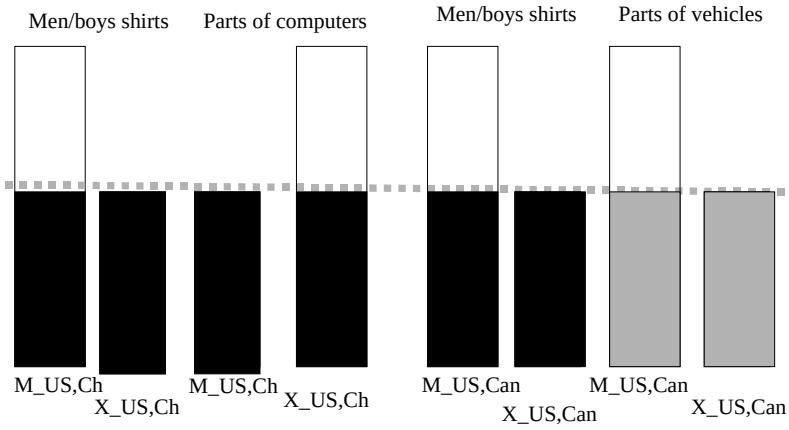


If one adds one category of product (parts of vehicles) and one trading partner (Canada) to the previous example, one will have reciprocal trade flows of similar unit values (grey area in Figure 3) or of different unit values (resp. black areas). The share of intra-industry trade in horizontally differentiated products in total US trade is the ratio of the grey areas over

[6] We assume balanced trade by sake of simplification.

total trade, the share of intra-industry trade in vertically differentiated products in total US trade is the ratio of the black areas over total trade. The two shares (respectively defined as GHM-H and GHM-V) sum up to the G&L ratio as previously defined. Notice that each share is not a "true" G&L index but a mix of the intra-industry nature of trade in each category of differentiation and of the weight of each category of differentiation in total trade.

Figure 3 - Decomposition of the G&L according to GHM



Grey: similarity in unit values
Black: differences in unit values

In contrast, the approach adopted by FF does no longer rely on the trade overlap. It is based on a simple algorithm: First, test whether reciprocal trade flows are of an intra-industry nature (imports represent at least *x* % of exports or reciprocally); Second, if the answer is positive, test whether unit values of elementary trade flows are similar or not (up to a *y* % difference in unit values is allowed).

Does it make such a difference to rely on one methodology or the other one? Azahr and Elliott (2004) compare precisely the two approaches and rely on numerical examples, while FF(1997) rely on EU12 trade data for 1995. Table 1 is reproducing the latter results in order to show the differences. The values of *x* and *y* are respectively 10% overlap and 15% unit value difference in this example. Not surprisingly the percentage of IIT differs according to the two methods differs, since the definition differs.

Table 1 - Comparison of GHM and FF methods (EU12, total trade)

		Value 1995 (Euro bn)	Percent
Value of trade types			
Two-way trade in horizontal differentiation	TWTh	374	
Two-way trade in vertical differentiation	TWTv	885	
One-way trade	OWT	1,365	
Total trade	TT	2,624	
Share of trade types (%)			
Two-way trade in horizontal differentiation	TWTh/TT		14.2
Two-way trade in vertical differentiation	TWTv/TT		33.7
One-way trade (Inter-industry trade	OWT/TT		52.0
Value of balanced trade			
Horizontal differentiation	BTh	229	
Vertical differentiation	BTv	540	
Total	BT	770	
Value of total trade			
Horizontal differentiation	TTh	579	
Vertical differentiation	TTv	2,045	
Total	TT	2,624	
Greenaway, Hine and Milner (%)			
Horizontal differentiation	BTh/TT		8.7
Vertical differentiation	BTv/TT		20.6
Inter-industry trade	100-(BT/TT)		70.7
Modified Grubel and Lloyd (%)			
Horizontal differentiation	BTh/TTh		39.6
Vertical differentiation	BTv/TTv		26.4
Total IIT	BT/TT		29.3

Source: Adapted from Fontagné & Freudenberg (1997), COMEXT data;

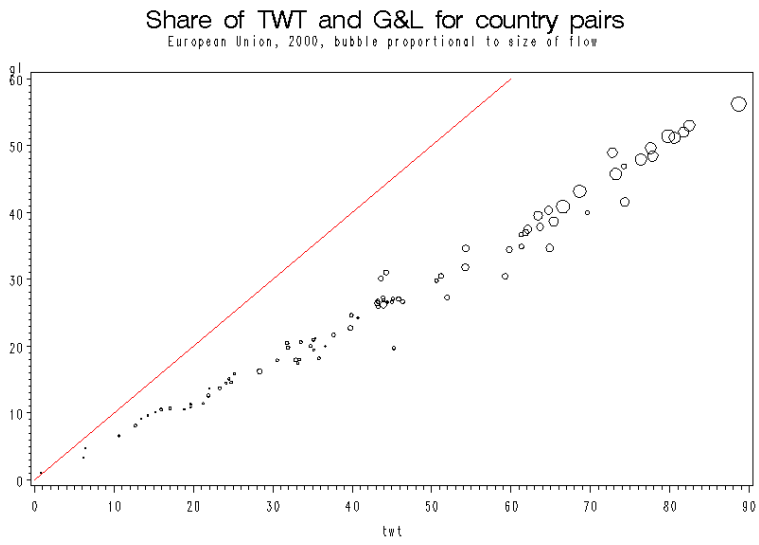
In this example, the GL indicator – which is the share of balanced trade (BT) in total trade (TT) – stands at 29.3% with the world. The method according to GHM (1994, 1995) would calculate separately the share of horizontal IIT in total trade (8.7%), and the share of vertical IIT in total trade (20.6%), the sum of the two being identical to the GL indicator (29.3%).

This solution departs from the traditional calculation of the GL, which consists in dividing balanced trade by total trade, what could be done for each category of product differentiation: horizontal and vertical. To our knowledge, this solution has not yet been used in the literature, but yields an interesting result. The degree of overlap is more

important in horizontal differentiation (39.6%) than in vertical differentiation (26.4%). But since the share of IIT in vertical differentiation is almost four times as important as IIT in horizontal differentiation (77% as compared to 22%), the GHM indicator shows values much more important for vertical differentiation than for horizontal differentiation.

A more systematic comparison can be done[7]. Figure 4 plots the percentage of IIT for each European country pairs according to the two alternative methods in 2000. There are two striking results. First, the results of the two methods are highly correlated. Second, the intra-industry nature of trade is increasing with the value of bilateral trade flows (which are proportional to the size of the bubbles). Since the value of bilateral trade is proportional to the economic size of trading partners, as a result of gravity principles, we have here an illustration of the theoretical result according to which IIT is increasing with the economic size of the countries. The extreme bubble on the right refers to Germany-France, a specific case to which we will come back later.

Figure 4 - Comparison between G&L and FF: EU15, 2000

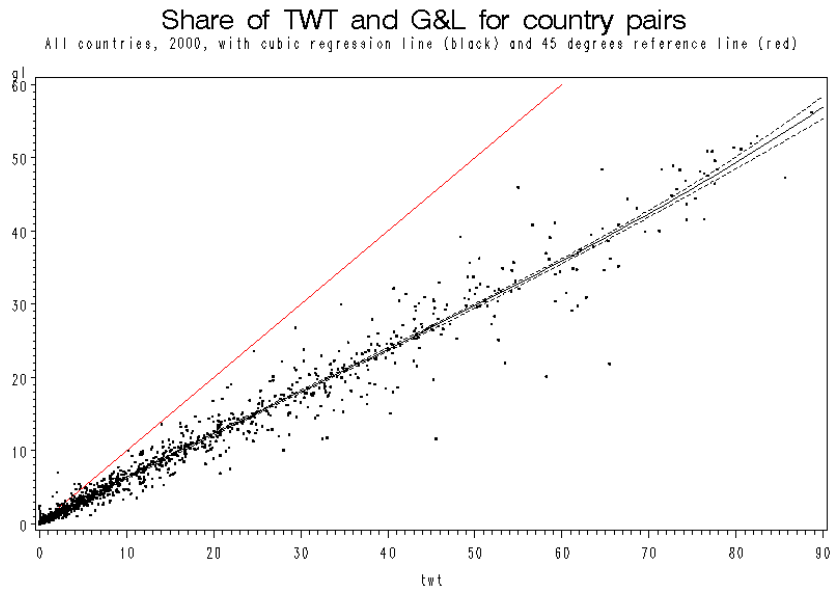


Sum of IIT-V and IIT-H as in GHM on the vertical axis.
Sum of TWT-V and TWT-H as in FF on the horizontal axis.

Leaving the European example to address the same issue of comparison at the world level, Figure 5 regresses one method on the other one for all country pairs in the world in 2000. The fit is good, despite some outliers, illustrating on an exhaustive basis that there is no much difference in the aggregate outcome of GHM and FF.

[7] See the methodological details in the next section.

Figure 5 - Comparison between G&L and FF: world, 2000



Sum of IIT-V and IIT-H as in GHM on the vertical axis.

Sum of TWT-V and TWT-H as in FF on the horizontal axis.

45-degree line in red ; quadratic adjustment in black (dashed lines indicate 95% confidence interval).

3. AN AMENDED FF METHODOLOGY AIMING AT EXHAUSTIVITY

Our aim in this article is to extend previous work limited to European countries to a systematic appraisal of intra-industry trade at the world level, while disentangling horizontal and vertical differentiation cases. This means relying on trade data at the HS6 digit level, the most disaggregated level available internationally. Compared to the studies centred on European countries and based on Eurostat's database COMEXT, a worldwide study encounters a number of difficulties.

- Concerning COMEXT, all European countries without exception declare their trade statistics to Eurostat: this means that every flow is declared twice, by the exporter in FOB (free on board) and by the importer in CIF (cost, insurance and freight). All countries do so in the same nomenclature (combined nomenclature, representing about 10,000 products at the 8-digit level), and differences between CIF and FOB due to insurance and transport costs are limited. It is thus relatively straightforward to harmonise European trade statistics to have a single figure for bilateral trade flows at the product level: the declarations of the importing country generally being more reliable, they are weighted twice as compared to those of the exporter that have a weight of one.

- In contrast, the United Nations' COMTRADE database is more incomplete, more heterogeneous and less detailed. Not all countries in the world do report their trade statistics to the UN Statistical Division, and those that report may do so in different nomenclatures (e.g. different revisions of the Harmonised System (HS) or the Standard International Trade Classification (SITC). At the 6-digit level, HS covers about 5,000 products.

The CEPII has recently developed a database (BACI) based on COMTRADE, aimed at constructing a harmonised world trade matrix for values as well as quantities at the 6-digit level of the HS. Currently, due to data constraints, the full data set is limited to 1995-2002. Trade flows in value and quantity stemming from COMTRADE are harmonised as described in Gaulier et al. (2004). The initial data show huge discrepancies between reported mirror flows: at the 6-digit level, the gap between mirror flows exceeds 100% for half of the observations in COMTRADE. One of the differences is of course due to the fact that import values are reported CIF and exports are reported FOB. In order to convert CIF to FOB figures, costs for insurance and freight have to be estimated and excluded. However, due to large measurement errors, the differences between flows and mirror flows (mirror flow ratios) cannot be directly identified with freight costs. In BACI, *predicted* mirror flows ratios from a gravity-type equation are used to convert CIF to FOB figures.

Notwithstanding these efforts, there are still some reliability issues raised by remaining trade flows in the database. Consequently, the sample is restricted to those 6-digit products for which data reliability can be considered sufficient. We first exclude notoriously unreliable products (energy, HS chapter 27) and diamonds (HS code 7102) and all products for which there are less than 50 bilateral relations. We then exclude those with an unusual dispersion of unit values, the assumption being that a very large dispersion signals a high probability of classification failure due to the heterogeneity of the HS 6-digit heading (heterogeneous products are grouped together) or due to measurement error. For each product and year, the standard deviation and kurtosis of unit values (logarithm) is calculated. All observations for a particular product and year are excluded if *at least one* of the following conditions is fulfilled:

- The standard deviation falls within the 5% largest values (extreme dispersion of unit values), unless the kurtosis is also within the 5% largest values;

- The kurtosis falls within the 5% lowest values (very flat distribution of unit values), unless the standard deviation is also within the 5% lowest values;

- The value-weighted standard deviation falls within the 5% largest values;

- The difference between the average and the median value-weighted unit value exceeds 30%.

These conditions eliminate 17% of the number of observations and 18% of the value of trade compared to the unrestricted sample.

For longitudinal comparisons, we further restrict the sample to those that pass the filter in every single year. This restriction avoids breaks in time series due to products entering or leaving the sample. In total, the longitudinal sample eliminates 31% of the number of observations and 56% of the value of trade compared to the unrestricted sample. The longitudinal sample may suffer from selection bias, however selected observation seem globally quite representative of the whole sample.

As can be expected, the results with the restricted sample tend to be more stable[8], and large divergences arise only for some specific countries that are usually known as poor declaring countries.

Since for a large number of observations quantity data is missing, in particular in North America, unit values cannot be systematically calculated. Missing unit values are not a problem for one-way trade: if there is no or no significant overlap between trade flows, the second condition of unit value differences is not even examined. In contrast, they are for two-way trade. In this case, if unit value differences cannot be calculated, the original FF method needs to be modified to include a fourth "type of trade": non-allocated two-way trade (Figure 6).

Figure 6 - Our new methodology at a glance

<table>
<tr><td>Degree of overlap between export and import values</td><td colspan="3">Similarity of export and import unit values</td></tr>
<tr><td rowspan="2">Does the minority flow represent at least 10% of the majority flow?</td><td colspan="2">Do export and import unit values differ less than 25%?</td><td rowspan="2">Unit value not available</td></tr>
<tr><td>Yes</td><td>No</td></tr>
<tr><td>Yes</td><td>Two-way trade in horizontally differentiated products</td><td>Two-way trade in vertically differentiated products</td><td>Two-way trade non-allocated</td></tr>
<tr><td>No</td><td colspan="3">One way trade</td></tr>
</table>

[8] With the restricted sample we obtain better correlations between total IIT share and Grubel and Lloyd index (weighted average of the product level GL indexes) for some important country pairs: for US-Canada trade (1991-2002) the correlation increases from 0.86 on the full sample to 0.99 on the restricted sample.

4. RESULTS

The very existence of IIT and its rise over time was discovered in pioneering studies examining trade flows during the early phase of the European integration in the 1960s. A further step of our understanding of IIT has been the identification of the contribution of two-way trade in vertically differentiated products in this phenomenon; extensive evidence has been provided by studies devoted to the impact of the completion of the Single market. Not surprisingly, we find here that the most important bilateral IIT intensities are observed in Europe. And since the share of IIT is increasing in the size of the trading partners, it is natural to find that Germany and France are the two trading partners in the world having the highest share of IIT in their trade: 88% according to our calculations (Table 2). Belgium-France, Belgium-Germany, Germany-United-Kingdom or Austria-Germany were also expected as countries prominently trading within industries.

What is more interesting here is that the second pair of countries trading the most within industries is Malaysia-Singapore. We also find Taiwan-Singapore in this top ten. This confirms the high level of trade integration among Asian countries, as well as the important role of geography. At the opposite of the spectrum, pairs of countries mostly trading on an inter-industry basis systematically contain an oil exporter, and are generally remote trading partners, as is the case for example in trade between Algeria and Brazil and between Saudi Arabia and Brazil.

Table 2 - The worldwide top ten bilateral IIT shares (TWT-H+TWT-V), %, 2000

Germany	France	88.70
Malaysia	Singapore	85.69
France	Belgium and Luxembourg	82.47
Netherlands	Belgium and Luxembourg	81.73
Germany	Belgium and Luxembourg	80.60
Germany	United Kingdom	79.78
Germany	Austria	77.86
France	Spain	77.62
United States	Canada	77.55
Taiwan	Singapore	77.29

Concerning the value of IIT, the largest flows of bilateral IIT are recorded outside Europe (Table 3). US-Canada and US-Mexico are the most prominent values observed. For both pair of countries, more than 70% of trade is on an intra-industry nature according to our definition. But the third pair of countries (US-Japan), as far as values are concerned, corresponds to a limited intra-industry share in total trade (45%). Germany-France are only in the 4th position, followed by US-China. In the latter case, the share of IIT flows is very limited (23%) but the values are of course huge.

Table 3 - The top ten bilateral IIT values (TWT-H+TWT-V), %, 2000

United States	Canada	77.55
United States	Mexico	71.21
United States	Japan	45.29
Germany	France	88.70
United States	Germany	67.57
United States	China	23.25
Japan	China	34.30
United States	United Kingdom	73.59
Germany	Italy	66.53
Germany	United Kingdom	79.78

Lastly, if we disentangle the two types of product differentiation (Table 4), we observe that in addition to European country pairs (Germany-France, Germany-Belgium, Belgium-Netherlands, France-Spain, Belgium-France, Finland-Sweden) IIT in horizontally differentiated products is very much developed in Asia: Korea-Singapore, Malaysia-Philippines, Singapore-Thailand, Korea-Philippines. For each of these country-pairs, IIT in horizontally differentiated products accounts for between one third and almost half of total bilateral trade.

How these trade shares change over time is an important issue: it is no longer regional integration that we are contemplating with such database, but globalisation since the late 1980s. The first information obtained is that inter-industry trade still dominates world trade, even if its share has been reduced over time (Figure 7). During the decade of the 1990s, its share has been reduced from two-thirds to 60%. This has been associated exclusively with an increase of IIT in vertically differentiated products. Accordingly, the phenomenon observed within the EU is also observed at the world level. Interestingly however, a recent come-back of inter-industry trade is to be noticed in the 2000s, in line with the increasing role of emerging countries in international trade flows.

Table 4 - The top 10 bilateral IIT shares, %, 2000. Breakdown by type of differentiation

			TWT-H	TWT-V
Top ten IIT-H	Belgium and Luxembourg	Netherlands	42.97	41.28
	France	Germany	40.27	42.94
	Belgium and Luxembourg	France	37.43	40.94
	Belgium and Luxembourg	Germany	36.39	36.87
	France	Spain	36.13	34.08
	Austria	Germany	34.34	44.14
	Germany	Netherlands	33.52	38.59
	France	United Kingdom	32.43	40.93
	France	Italy	30.87	37.42
	Germany	United Kingdom	30.68	44.12
Top ten IIT-V	Czech Republic	Germany	52.32	19.87
	Germany	Switzerland	50.96	27.73
	United Kingdom	United States of America	50.19	17.65
	Mexico	United States of America	46.34	12.07
	Germany	United States of America	45.95	18.28
	Austria	Germany	44.14	34.34
	Germany	United Kingdom	44.12	30.68
	Ireland	United Kingdom	43.9	24.71
	Austria	Switzerland	42.99	21.86
	France	Germany	42.94	40.27

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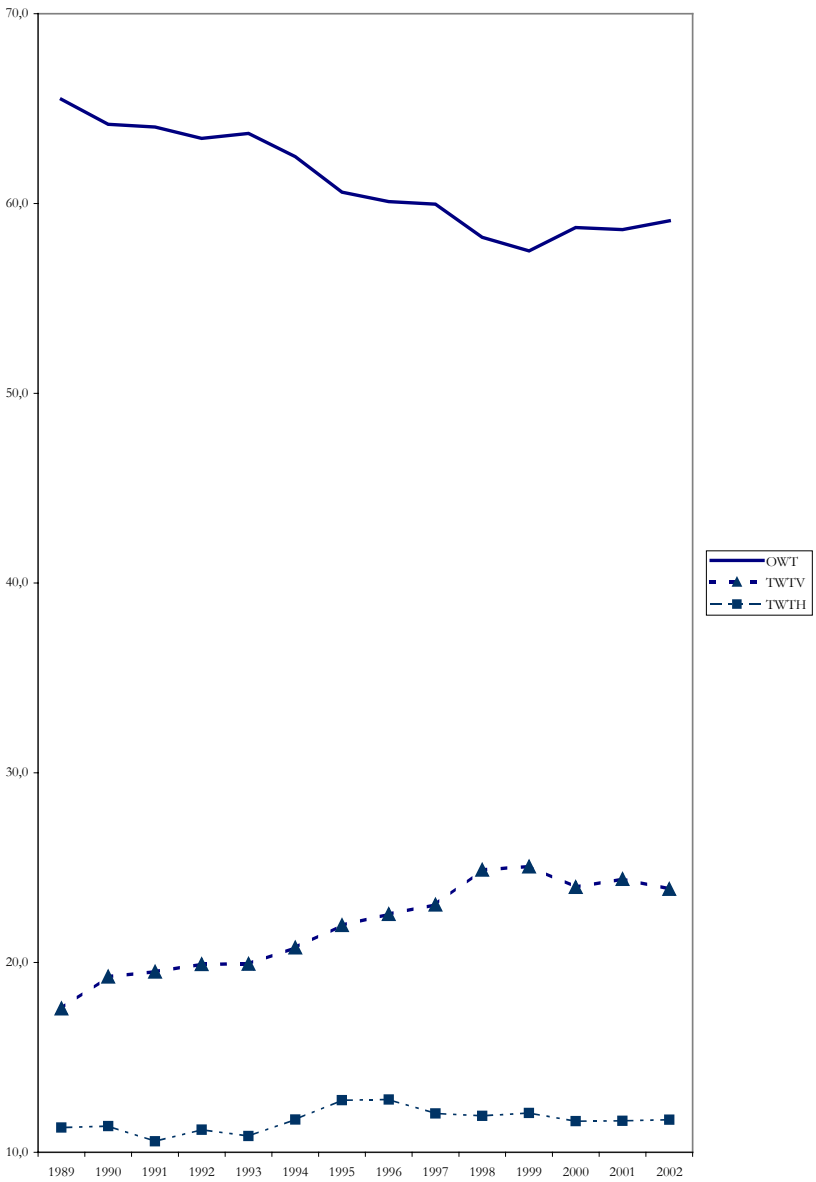
Figure 7 - Evolution 1989-2002 of the 3 trade types (% of world trade)



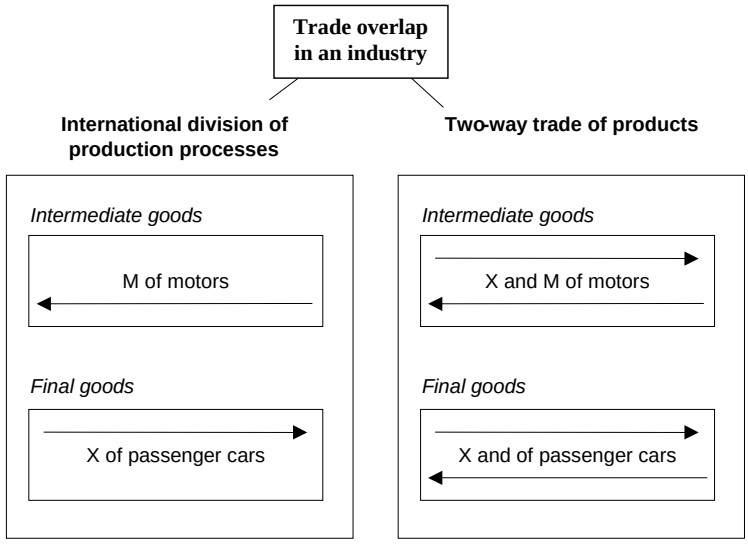
Note: non-allocated trade flows have not been plotted. They account for roughly 3% of total trade flows each year. We rely on a sub-sample of data passing the filters in every year, as explained in the core of the text.

It is now crucial to stress that simultaneous exports and imports within a same industry ("intra-industry trade") may hide two distinct concepts whose characteristics and implications clearly differ (Figure 8):

- The *international division of production processes* (i.e. the international splitting-up of the value added chain) allows multinational firms to specialise their affiliates in those stages of the value-added chain within a same industry for which they are advantaged. The United Nation's classification of Broad Economic categories (BEC), which defines the main end-use of products (primary, intermediate, capital or consumption goods), is particularly useful for empirical studies. An alternative empirical strategy is to rely on the import content of intermediate consumption, using input-output tables. When nomenclatures used are aggregated enough, the vertical splitting-up of the production process may lead to intra-industry trade: Hence the misleading association of imported intra-consumption (motor parts traded against passenger cars) with IIT.

- T*wo-way trade of products* concerns simultaneous exports and imports of products having the same main technical characteristics. It can concern horizontally differentiated goods (two-way trade of varieties) or vertically differentiated goods (two-way trade of qualities).

Figure 8 - The two faces of "trade within industries" (or "intra-industry trade")



The difference between the "international division of production processes" and "two-way trade" can only be detected empirically if trade flows are examined at a disaggregated i.e. the product level, rather than at the industry level (Fontagné et al. 1996).

However, the typical vertical division of labour, corresponding to outsourcing, would lead to a situation in which products at different levels of the production process are traded. Hence, examining trade at the *product* level would suggest one-way trade (imports) of intermediate goods and one-way trade (exports) of final goods, or reciprocally, i.e. witnessing an international division of production processes rather than intra-industry trade. An exchange of motors for motors (of a certain cylinder capacity) represents two-way trade in intermediate goods; likewise, an exchange of cars for cars (of a certain cylinder capacity) represents two-way trade in final goods. Exporting motors and re-importing cars incorporating these motors corresponds to a vertical division of labour, not to IIT.

Table 5 explores the consequences of such distinction by relying on the BEC's grouping of products. It shows the importance of trade types in world trade in 1995 and 2002. As can be expected, primary goods are mainly traded in a one-way manner: they are either exported or imported for about 85% of their world trade in value. In contrast, roughly one-third of world trade in consumption goods is two-way trade. The share of two-way trade is even higher for processed goods, capital goods and parts and components. In all stages of production, measured two-way trade is higher in vertically than in horizontally differentiated products. Two-way trade increased in all stages between 1995 and 2002.

Table 5 - Trade Types by Stages of Production: World, 1995 and 2002

	1995				2002			
	OWT	TWTH	TWTV	TWT na	OWT	TWTH	TWTV	TWT na
Primary goods	87.1	5.7	6.8	0.4	86.5	6.2	6.4	0.9
Processed goods	64.7	15.3	18.9	1.1	64.1	13.7	20.7	1.5
Parts and components	43.1	14.9	33.7	8.2	40.1	14.5	36.7	8.7
Capital good	60.4	11.4	25.1	3.1	57.5	10.1	27.2	5.2
Consumption goods	68.8	12.0	17.7	1.4	67.1	12.5	18.5	2.0
Total	64.5	13.4	20.1	2.0	62.9	12.6	21.7	2.8

We must finally address the sensitivity of our results to the degree of overlap in trade and on differences in unit values chosen. Inevitably, the thresholds of 10% for trade overlap and 15% for unit value differences are to a large extent arbitrary. One of the possibilities would have been to apply e.g. different similarity criteria for different product groups, but applying one and the same criteria to all products leads to more understandable results. Sensitivity tests showing how trade types can be influenced by the choice of different thresholds will be presented below.

Table 6 shows the share of two-way trade flows according to the degree of overlap in trade (the minority flow in percentage of the majority flow), again calculated at the most detailed level. It shows that cases of extreme overlap between exports and imports are rare: for example, only 4% of all bilateral trade has an overlap of more than 90%, and about 17%

have an overlap of 50% or more. About 60% of world trade has an overlap of less than 10%, and these are eliminated with the 10% threshold. The reasoning behind this is that below 10%, minority flows cannot be considered significant, as they do not represent a structural feature of trade.

Table 6 - Sensitivity of trade types depending on the degree of overlap between exports and imports

Degree of overlap (%)	OWT (%)	TWT (%)	TWTH	TWTV	TWT na
5	50.6	49.4	19.2	26.3	3.9
10	*57.8*	*42.2*	16.7	22.2	3.3
15	62.7	37.3	15.0	19.5	2.8
20	67.1	32.9	13.0	17.2	2.6
25	70.8	29.2	11.6	15.3	2.4
30	73.9	26.1	10.5	13.4	2.1
35	76.9	23.1	9.3	12.1	1.7
40	79.5	20.5	8.2	10.8	1.5
45	81.5	18.5	7.5	9.6	1.4
50	83.5	16.5	6.7	8.5	1.3
55	85.5	14.5	5.9	7.6	1.0
60	87.6	12.4	5.1	6.4	0.9
65	89.6	10.4	4.3	5.3	0.8
70	91.5	8.5	3.4	4.4	0.6
75	93.0	7.0	2.8	3.6	0.5
80	94.5	5.5	2.2	2.9	0.4
85	96.0	4.0	1.5	2.2	0.3
90	97.4	2.6	1.0	1.5	0.2
95	98.6	1.4	0.5	0.8	0.1

Note: TWT= TWTH+TWTV+TWTna. All flows, unrestricted sample, year 2000.

Finally, Table 7 shows the sensitivity of the relative importance of horizontal two-way trade in total two-way trade to unit value differences. As expected, the share of horizontal two-way trade increases with the unit value ratios of bilateral trade flows (measured by dividing the larger unit value by the smaller one) to be considered horizontal. Less than 10% of two-way trade would be considered two-way in horizontal differentiation for unit value differences of 5%, as compared to more than 60% for unit value differences of more than 85%.

Table 7 - Sensitivity of the relative importance of horizontal and vertical two-way trade in total two-way trade

Univ value threshold (%)	TWTH%	TWTV%
5	8.8	91.2
10	14.9	85.1
15	21.1	78.9
20	26.7	73.3
25	*30.7*	*69.3*
30	34.1	65.9
35	38.0	62.0
40	41.7	58.3
45	45.0	55.0
50	47.4	52.6
55	49.8	50.2
60	51.6	48.4
65	53.8	46.2
70	55.3	44.7
75	57.7	42.3
80	59.0	41.0
85	60.9	39.1
90	62.1	37.9
95	63.4	36.6

Note: Share of type in TWT excluding NA**,** All flows, unrestricted sample, year 2000.

CONCLUSION

This article has taken stock of empirical as well as theoretical advances in the numerous studies addressing the inter-industry versus intra-industry nature of the specialisation of countries. The main departure of the current literature as regards the initial understanding of the phenomenon in the early 60's, is that IIT is not only about trading similar products. On the contrary, two-way trade in vertically differentiated products has been the main contribution to the growth of IIT among developed economies.

Two methods have accordingly been proposed to empirically disentangle horizontal and vertical intra-industry trade. Greenaway, Hine and Milner further decompose a Grubel and Lloyd index, while Fontagné and Freudenberg categorise trade flows and compute the share of each category in total trade. If they diverge on the definition of IIT, both methods rely on the same assumption regarding the association of price, unit values and the quality of traded

products, making the assumption that differences in prices within one product category mirror differences in quality.

Contrasting with the partial assessments we were relying on up to now, due to data limitation, we have provided here a systematic decomposition of world trade using harmonised bilateral flows at the most available detail (some 5,000 product categories), into three trade types: inter-industry, intra-industry in horizontally versus vertically differentiated products, for all countries in the world, based on extension of the method initially implemented by Fontagné and Freudenberg.

Our diachronic analysis shows that the increase in IIT at the world level is due to two-way trade of vertically differentiated products, echoing the observation made on the Single European market. We find France and Germany having the highest share of IIT in their bilateral trade among all country-pairs in the world, and Algeria-Brazil the weakest. In value terms, the most important bilateral IIT is between the United States and Canada.

The second important result is that specialisation according to the classical theories of international trade (inter-industry trade) has recently recovered, due to the increasing participation of emerging economies in world trade. Accordingly, the magnitude and the nature of internal adjustments induced by trade openness will change, as our economies will progressively go back to the traditional patterns of international specialisation.

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