Intra-Industry Trade: A Statistical Artefact or a Real Phenomenon?

1. Introduction

It is rather frustrating that after at least fifteen years of developments, both on the theoretical and the empirical aspects, the studies concerning intra-industry trade (IIT) have still to deal with a couple of unsolved issues which tend to undermine most of the conclusions of the empirical studies: (i) the definition of "industry" and the associated problem of the proper level of trade data disaggregation; (ii) the choice of a suitable index for measuring the extent of IIT. These issues are strictly interwoven, but for the sake of clearness may be dealt with separately.

In the literature on IIT most attention has been paid to the latter issue. On the contrary, in this article the focus will be put upon the first one, with reference to the second only when strictly needed.

This article is organised as follows. The second section is devoted to a brief presentation of the main issue: the problem of industry definition at the empirical level and its importance for the assessment of the practical relevance of IIT. The third section presents the arguments in favour of the position according to which IIT is mainly a statistical artefact. In the fourth section, the opposite arguments which support the idea that IIT is a true economic phenomenon are discussed. In section five, some conclusions are drawn from the analysis conducted before. In section six, some

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Stefano Vona died on November 27, while this article was in the press. He did not allow a prolonged illness to interrupt his economic research and courageously continued to work, as this article testifies. We regret the loss of both a friend and a dedicated scholar.

* Comments from Silvia Vori, of the Research Department of the Banca d'Italia, and from an anonimous referee are gratefully acknowledged. In an early stage the work also benefited from interesting remarks by Terry Barker of Cambridge University. However, the responsibility for the content of the article is esclusively the author's.

original empirical results are presented, which give support to the conclusions of the discussion in the previous section. Finally, section seven summarizes the main findings.

2. The debate on the empirical relevance of intra-industry trade

The very existence of intra-industry trade (IIT) has generally proved difficult to explain in terms of the neoclassical theory of international trade. As a matter of fact, the Heckscher-Ohlin-Samuelson (H-O-S) theory cannot explain the existence of simultaneous imports and exports of very similar products, produced with the same factor proportions, between pairs of countries, or between one country and the rest of the world. As is well known, according to this theory the pattern of international trade is determined by comparative advantage due to differences in factor endowments among countries and to the relative intensities of factor inputs in production. Consequently, international trade brings about the exchange of goods produced under different combinations of factor inputs. According to the hypotheses of the model, whereby each industry produces a homogeneous product, international trade consists of goods belonging to different industries. Thus, if the H-O-S model represents a reasonable abstraction from reality, we should observe the establishment of a trade pattern of the inter-industry trade type in the real world.

If IIT exists it must be caused by other factors than those considered by the H-O-S model. The theoretical literature on IIT – which is founded upon the seminal works of Krugman (1979, 1980, 1981), Lancaster (1980), Helpman (1981) – has developed rigorous models which are able to explain this phenomenon in terms of product differentiation, economies of scale and monopolistic competition, *i.e.* including some crucial feature of the real world. Moreover, these models have also been able to complement the H-O-S approach. In such a situation IIT can no longer be considered as an empirical phenomenon searching for a theoretical explanation in a world where one theory, namely the H-O-S model, is predominant.

Although the early studies on IIT arrived at strong anti-H-O-S conclusions, more recent contributions are, correctly, much more cautious in denying the relevance of traditional theory in the explanation of the patterns of trade. The following judgment by Helpman and Krugman (1985) appears to be well grounded: "the theory of comparative advantage is alive and well, but it has lost some of its monopoly position... In a world where increasing returns are present, however, comparative advantage resulting from differences between countries is not the only reason for trade. Economies of scale provide an additional incentive and will give rise to trade even if countries are identical in tastes, technologies, and factor endowments" (p. 261).

Consequently, one of the most important problems in the study of IIT is that of assessing its empirical relevance so as to evaluate the relative importance of economies of scale and product differentiation, as opposed to factor endowments and relative factor prices, in shaping trade patterns among countries.

Following this approach the first problem to solve is that of measuring IIT on the basis of international trade data, disaggregated at an appropriate level in order to single out "industries", *i.e.* a group of production units producing, with the same factor proportions, goods which are similar in end-use thus satisfying similar consumers' needs (demands). If an "industry" is incorrectly defined as a group of firms producing a bundle of goods with widely different factor input mixes, then it is not surprising, also within the H-O-S framework, that they export these goods in exchange for imports of goods produced abroad by the same "industry", but with a different factor mix. More precisely, let us consider a situation in which the capital-rich country exports a subset of goods, within the "industry" bundle, which has a relatively higher K/L ratio than the subset of its imports; while the other labour rich country exports goods with a relatively higher L/K ratio. This situation can be revealed only if appropriate statistical information on trade flows and supply characteristics in the two countries are available. If they are not, the exchange might have the appearance of intra-industry trade, but it would in fact be simply "trade". Following Gray (1973) we could term this kind of IIT, due to inappropriate categorical statistical aggregation, as "spurious IIT".

Therefore, the proper definition of industry and the accurate use of trade and production data are required in order to avoid

confusing trade with IIT (or spurious IIT with true IIT). Strongly anti-factor proportion conclusions have often been drawn from prior empirical studies on IIT (*e.g.* Pagoulatos and Sorensen, 1975) which do not consider the factor proportions of the goods traded within each industry. These conclusions must consequently be viewed with caution.

It was precisely the anti-factor proportions argument put forward by many students of IIT that led to a reaction from defenders of this theory. This reaction first questioned the empirical relevance of IIT. In fact, at the present stage of the study of IIT, this issue cannot be considered resolved (Greenaway and Milner, 1987), although empirical studies on this subject have used very detailed data on international trade. Unfortunately, there is a lack of suitable statistical information on the conditions of production at such a level of disaggregation, and the results obtained by Finger (1975), Pomfret (1976, 1979) and Lipsey (1976) – to which I shall refer in the next section – suggest that at least some of the measured IIT result from inappropriate statistical information.

However, the debate on the "existence" or the "empirical relevance" of IIT presents some peculiar features: in particular, it seems rather polarized, both by those who maintain the anti-factor proportions argument and by those who view intra-industry trade as a statistical artefact. Some rapprochement seems necessary in order to avoid misunderstandings and waste of resources.

An early problem arose as the consequence of the choice made by Grubel (1967) when he defined the exchange of highly substitutable or very similar goods as IIT, without exploring the implications of this definition for empirical applications. Indeed, the term "industry" was also used in a rather loose sense in later works of Grubel and Lloyd (G-L); it is often associated with groups of commodities as defined by the Standard International Trade Classification (SITC), with little attention to the nature of these data. In fact G-L acknowledged their unusual way of using the term industry: "We decided that it serves the purposes of our study best if we cease to search for an unambiguous definition of an industry at some level of aggregation and instead call each statistical class of internationally traded goods, regardless of the level of aggregation, an 'industry'... Our unconventional use of the term 'industry' may cause initial difficulty for readers accustomed to considering an industry as a group of firms producing a fixed range of products, but this pragmatic definition allows us, without further terminological preliminaries, to examine the pattern of export and import trade of countries at several different levels of aggregation. In fact, however, most of the empirical analysis concentrates on the 3-digit and, if that is not possible, the 2-digit level of the trade statistics, which correspond most closely to the conventional definition of an industry as a set of producers competing in the production of the same set of commodities" (1975, pp. 4-5).

This approach to the problem of the definition of an industry, together with the term (IIT) chosen to describe the phenomenon of the exchange of similar commodities in international trade, has produced some confusion in later discussions. In particular, the adaptability of the G-L definition to various degrees of international trade data aggregation (though G-L tend to favour the 3-digit level as the most appropriate) may lead to classifications where large differences among the production functions of the commodities produced within the same "industry" do exist. This is a likely outcome when the level of disaggregation is not sufficiently detailed.[1]

In fact, the possibility of working with industries producing bundles of commodities within which production conditions may vary considerably has simply not been taken into account by G-L. As we have seen before, however, if the production functions of the commodities produced by each industry do have large differences, the measured IIT is largely spurious IIT and the empirical results are not reliable.

In the literature two approaches to the problem of the empirical relevance of IIT have generally been adopted: one is motivated by the attempts to use it either to criticise orthodox theory (Pagoulatos and Sorensen, 1975; Gray, 1973; G-L, 1975) or to support it (Finger, 1975; Lipsey, 1976; Pomfret, 1979); the other simply tends to undervalue or even neglect the problem, as is especially evident in some recent studies (Globerman and Dean, 1990; Siriwardana, 1990).

A third and, in my opinion, more correct way of approaching the problem, is to realize that the definition of an industry according to the H-O-S model, *i.e.* a group of firms producing a homogeneous good, is operationally almost irrelevant not only because the available

[1] Notwithstanding these drawbacks of the G-L definition it has been widely accepted in the literature so that I have decided to use "intra-industry trade" instead of one of the other two which are sometimes adopted: "trade overlap" and "two-way trade", even if the last one presents, in my view, some advantage over the others.

statistics are not collected following H-O-S criteria but also, and more importantly, because modern industrial firms produce bundles of differentiated goods rather than one simple homogeneous product. Therefore, the students of IIT should not pursue the unattainable target of adapting reality to the hypothesis of a theoretical model and, consequently, should stop looking for data which fit perfectly into such hypothesis. Whatever the quality and detail of the data employed in empirical studies of IIT, some factor input variation within commodity groups could be never ruled out.[2] Hence one could well try to explain some IIT in terms of the H-O-S model or in terms of its more recent developments (notably the neo-factor proportion approach). Nonetheless if, as it seems more plausible, one regards IIT as the empirical evidence of the importance of product differentiation, economies of scale and imperfect competition in international trade it becomes immediately clear that other theories competing with the H-O-S model are more suitable to explain it. This is not to say that the search for an appropriate data classification is no more an objective that must be followed but rather that it must not be confused with the search of the "homogeneous product industry" of the ethereal H-O-S world.

The problem of choosing the most appropriate disaggregation of international trade data is not easy to solve, as has been clearly revealed by the literature on this subject that developed after Grubel and Lloyd's book (1975) was published. One must also be cautious in criticizing the G-L approach because there is no ready-made solution to propose. In any case, in my opinion, the limitation of G-L's work, as far as the problem of definition is concerned, is not their failure to provide a convincing solution – the present state of statistical information probably makes this outcome almost impossible – but that they disregard the problem and prefer a quick short-cut to a full discussion of it.

However, quite apart from the G-L approach, the empirical studies on IIT all suffer from the lack of international trade data which are suitable for testing the homogeneity of the condition of production in the classified goods. In fact the SITC adopts criteria of classification based upon similarity of material inputs and/or end-use;

[2] I wish to stress here that LANCASTER showed in his 1980 model of the Heckscher-Ohlin-Chamberlin type that even if some factor intensity variation exists within groups of differentiated goods their effect may be small in comparison with that of economies of scale, which bring about IIT in such model (p. 172).

the factor content of the various commodities or commodity groups is simply not taken into account. Therefore one can only rely upon subjective judgement and reasonable assumptions. This is not an approach confined to the empirical studies on IIT: it is indeed widely adopted in almost every field of applied economics. It is a great merit of the debate on the empirical relevance of IIT to have led researchers to examine the implications of these assumptions in more detail, and to try to work with the most suitable data at their disposal.

In what follows we shall comment on the most important contributions to the debate, and then draw some conclusions relevant for future works.

3. Intra-industry trade as a statistical artefact: the supporting arguments

The most radical anti-intra-industry trade propositions were put forward by Finger (1975). They have aroused great interest among scholars studying IIT because they were based upon an empirical test of the extent of variation in factor contents among and within disaggregated international trade data categories, which is unique in the literature.[3]

Finger introduced the concept of trade overlap, as linked to the level of IIT measured according to actual international trade data, as opposed to the level of IIT which is purely theoretical in nature and cannot be properly verified in the empirical world, because of the limits of available data which I referred to above. Then Finger observed that only IIT is inconsistent with the factor proportions theory, whereas trade overlap is not, because the degree of variation of factor input requirements is higher within product groups than between them.

In order to support this view, he performed a test for US trade in 1963, calculating the total variation of input requirements within 3-digit SITC groups. Finger considered economies of scale as well as

[3] A similar test with UK data was also performed by RAYMENT (1976) who got similar results. However, the level of data aggregation in Rayment's study is much higher than that required to consider such results as a decisive contribution to the problem of the empirical relevance of IIT.

physical and human capital intensities. The main interest for our discussion, however, is in the last two variables, as they are directly linked to the controversy about the relevance of the IIT phenomenon.

The most important result of this test, according to Finger, is that "nearly 40% of the variation among 4-digit SIC categories in physical and in human capital intensity is within 3-digit SITC groups" (p. 584). Furthermore, comparing the amount of variation of factor intensities with the measured level of trade overlap, Finger finds that "the proportion of variation in the US production characteristics which is within SITC groups is at least as large as the proportion of US trade which is within these groups. Thus it is difficult to agree with Grubel and Lloyd's and Gray's presumption that the observation of exports and imports in the same data category is reason to reject the factor proportions approach to trade theory" (p. 586).

Also Lipsey and Pomfret have argued against intra-industry trade as a relevant empirical phenomenon. However, their judgements appear less extreme than that of Finger.

The position of Pomfret (1979) seems somewhat ambiguous. At the beginning of his study he states that "The central proposition of the present paper is that IIT is a significant empirical phenomenon, but it is impossible to separate the extent to which IIT requires a new analytical concept from the extent to which it is a statistical artefact" (p. 115). In fact, as in a musical "crescendo", the paper develops a certain number of arguments against the empirical relevance of IIT.

Firstly, Pomfret criticizes the results obtained by G-L in their measurement of IIT for the Australian economy, and in their test for sensitivity to data aggregation (this test is performed using trade data from the 3-digit to the 7-digit level of disaggregation) both because the 7-digit level still includes some heterogeneous goods, and because the resulting amount of IIT (6% as opposed to 20% when measured at the 3-digit level) is too low to establish it convincingly as a relevant phenomenon. Secondly, Pomfret performs a test similar to that used by G-L with Israeli foreign trade data, moving from a level of disaggregation of 100 industries to one of more than 2000.

There is a sharp reduction of measured IIT[4] when one passes from more to less aggregated data. The characteristics of the industries

[4] Intra-industry trade was measured by means of the G-L indices, both that corrected and that uncorrected for total trade imbalance.

still presenting fairly high IIT at the most detailed classification level, together with a close and convincing argument against some results obtained by Pagoulatos and Sorensen (1975), lead Pomfret to conclude that "... it is impossible to identify whether the characteristics of observed IIT provide support for IIT theories, so long as doubts remain about whether the industry classes are sufficiently disaggregated" (p. 122).

Finally, Lipsey (1976) criticizes Grubel and Lloyd (1975) on the grounds that they do not succeed in separating statistical from economic aspects of IIT. In particular, Lipsey convincingly shows the inadequacy of the G-L definition of an industry and of their choice of the 3-digit SITC data for measuring IIT. The results of the empirical test performed by G-L with the data on Australian trade is also questioned by Lipsey, along the same lines of argument described before in connection with Pomfret's paper. "I conclude from these results, and from my own impressions as to the heterogeneity of 3-digit groups, that much, although not all, of intra-industry trade is a statistical phenomenon" (Lipsey, 1976, pp. 313-14).

Both general and specific objections can be raised to the three studies described above.

From a general point of view, it is quite evident that what emerges from these studies is much more a criticism of the G-L choice of the 3-digit disaggregation of international trade data than a criticism of the concept of IIT and, more important, of its general empirical relevance. In fact, although Finger admittedly put forward a little evidence (not fully convincing in some respects as we shall see later on) that at the 3-digit level IIT may largely be of the spurious type, no evidence is provided that intra-industry trade cannot be correctly measured at a more detailed degree of disaggregation. Moreover, one must reject Pomfret's attempt to suggest that even at the 7-digit level of disaggregation the data may not be reliable for measuring IIT because "some degree of heterogeneity" exists within such narrowly defined "industries", so that the very low level of measured IIT can be explained by means of the traditional factor proportions theory. Indeed, if we accepted Pomfret's way of stating the problem, we could equally well argue that together with "some" heterogeneity there is also "a lot" of homogeneity within 7-digit categories:[5] consequently the G-L indices used in Pomfret's study can be considered as downward biased measures of IIT.

[5] It is hard to believe that in 1972 the Israeli economy was composed of more than 2,130 different "H-O-S industries"!

At an elementary "industry" or better "commodity" level, where the degree of homogeneity is very high, total trade in those statistical categories where two-way trade does exist must be considered as intra-industry trade, whereas it should be regarded as inter-industry trade whenever there is only a one-way flow. Adopting this measure,[6] which is more directly derived from theoretical assumptions, would result in a larger share of IIT in total Israeli trade than when using the G-L indices. This would considerably weaken the conclusions drawn by Pomfret.

Moreover, the criticism of the empirical relevance of IIT based upon such tests as those performed by Pomfret and G-L[7] is not convincing because the economies of Israel and Australia are far from representative of the "average" industrial economy.

Then we are left with the anti-intra-industry trade arguments put forward by Finger and Lipsey, who both attack the reliability of IIT calculated by means of 3-digit trade data. While Lipsey uses some suggestive examples and his own experience to criticize G-L, Finger is more effective because he manages to perform a rigorous test.

However, this test must be viewed with caution because it refers only to one country, the United States, and to one year, 1963. Furthermore, there are some obscure aspects of the test which deserve further discussion. First of all, it has no link with the theoretical considerations which Finger prefaces to the empirical part of his work. There he uses some simple propositions derivable from the factor proportions theory to show that when ordering products and product varieties according to their capital-labour ratios, one country trading with another would export only those varieties which have factor ratios above a certain dividing value, or below that value, according to whether that country is relatively capital or labour endowed. This serves to show that, even when factor intensity reversals do occur, intra-industry trade involves only the product (the variety) which lies on the boundary between imports and exports.

From this kind of theoretical presentation one expects an empirical test which relies on some ordinal criterion. With the very valuable data set which Finger constructs from both industrial and trade data, he could have ranked the 3-digit commodity groups of the

[6] For the presentation and discussion of this measure of IIT, see VONA (1990).

[7] The latter test, as we have seen before, is considered as confuting the practical relevance of IIT by Lipsey and by Pomfret but not by G-L themselves.

SITC according to their K/L ratios and checked to see whether IIT only occurs near the dividing line above (below) which US trade was constituted only by exports (imports). If this hypothesis were contradicted, as seems likely in view of the outcome of the actual test performed by Finger, he could have proved that much of the measured IIT at the 3-digit level is explained by the very fact that 4-digit categories are highly heterogeneous.

On the contrary, he prefers to rely upon a measure of variation of the factor input ratios. This test is in fact very weak because there is no plausible link between the measured variation of factor ratios and measured IIT. It is only the simple observation that the orders of magnitude of these two phenomena resemble each other which leads Finger to conclude that much of the measured level of IIT at the 3-digit level of data aggregation is due to improper categorical aggregation.

Finger's conclusion would be much more convincing if he had taken into account the different importance of the various 4-digit commodities within each 3-digit industry, with respect to trade and to intra-industry trade, in calculating factor input variations. This could be done in several ways: for instance, by calculating a measure of variation weighted with the amount of trade in each 4-digit commodity relative to total trade (*i.e* to total 3-digit trade), or, alternatively, by taking into account the amount of IIT in each 4-digit category, in order to show exactly how much IIT at the 3-digit level is due to 4-digit commodities having factor ratios different from the average of the 3-digit category to which they belong. As he did not perform such a test, Finger fails even to fully prove that the 3-digit SITC level of data disaggregation is inadequate for the measurement of IIT. Therefore, the main merit of Finger's work, often neglected, rests in having shown that variation among 3-digit categories of the SITC in factor input ratios is much larger than variation within each one, because the former account for 61% and the latter for only 39% of the total 4-digit variation. This is an important result for the empirical analysis of IIT; it supports the hypothesis, indeed highly plausible, that variation of factor input ratios substantially diminishes when the level of data disaggregation increases. Several empirical studies on IIT have in fact implicitly adopted such a hypothesis.

4. Intra-industry trade as an economic phenomenon: the supporting arguments

It was not until the second half of the '70s that the empirical evidence supporting the relevance of the IIT phenomenon, produced among others by Balassa (1966), Grubel and Lloyd (1971, 1975) and Hesse (1974), was widely accepted. All these studies measure significant levels of IIT by means of international trade data disaggregated at a very detailed level.

In particular, Grubel and Lloyd carried out an impressive number of calculations using data at the 3-digit level of the SITC. These calculations, which include 163 "industries", and consider ten industrial countries, seem to constitute an irreproachable body of evidence in favour of the empirical relevance of IIT. It is measured as fairly significant in almost every industry and in most of the countries considered.

Hesse provides further and even more powerful evidence of the empirical relevance of IIT in manufactures among 14 industrial countries. These results are particularly impressive both because they focus on dynamic inter-temporal comparisons and because the degree of data disaggregation is deepened to the 4-digit SITC level. Focusing upon the period 1953-1970, Hesse shows that IIT in a sample of 52 manufacturing 3-digit industries generally increased during that period, and that it is fairly significant in 1970, when 42 out of the 52 industries considered recorded IIT in excess of 50%. Furthermore, Hesse shows that using 4-digit data leads to some reduction in the measured IIT, but it remains "remarkably high", and between 1962 and 1969 it increased in almost 75% of cases among the 32 4-digit sub-groups considered. Because of the very fine level of data disaggregation in Hesse's study, this evidence has often been quoted as a proof that IIT is not a purely statistical phenomenon.

Nonetheless, Finger's results shook the conviction even of the proponents of the empirical relevance of IIT and led to a more careful treatment of the data selection. However, no real test of the homogeneity of the industries or commodity groups considered in the measurement of IIT has been performed by any of these authors. It was only in 1979 that Gray undertook an extensive study which sought to clarify the most relevant empirical aspects of the IIT

phenomenon. He recognized that "The crux of the matter lies in the degree to which compiled trade data include goods with different production functions within a single trade category. Only if categorical aggregation can be shown to be substantially less than the reported amount of trade overlap can IIT be said to exist. The burden of proof must be on those who would innovate and argue in support of the hypothesis that intra-industry trade exists at a level that requires emendation of the factor proportions theory" (p. 89).

In order to solve this problem, Gray tried to answer the following two questions: first, what is the most suitable level of international trade data disaggregation for representing an "industry"; and, second, what is the extent of IIT at that level of disaggregation. Using data covering the whole range of the SITC from 1-digit to 4-5-digit, and considering the trade of France (1971) and Germany (1973) with selected partner countries, Gray performed a test designed to bring out the relative importance of the two factors which contribute to the reduction of the measured level of IIT when trade data become more detailed. These factors are categorical aggregation and the weighting system.

This test, based on a wide set of Balassa's indices[8] calculated with 4-digit trade data, showed that these two causes are of similar importance. From this result, Gray concluded that "the four-digit level of aggregation may frequently constitute a workable definition of industry for the purposes of measuring intra-industry trade" (p. 99). However, commenting later on further empirical evidence from his own data, Gray seems to contradict himself when he states that this evidence supported the idea "that substantial intra-industry trade exists at high levels of disaggregation but that it is not possible arbitrarily to define an industry as a three-digit or a four-digit classification" (p. 99). In any case, his final conclusion was that "Certainly enough intra-industry trade exists to warrant its consideration as a qualification of the factor-proportions theory narrowly defined and as a special case for various dimensions of international economic policy" (p. 102).

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[8] BALASSA (1966) proposed the following indices to measure the effects of the formation of the EEC on the patterns of specialization of the countries concerned:

$$(1) \qquad C_i = \frac{|X_i - M_i|}{X_i + M_i}; \qquad C = \frac{1}{n} \Sigma_i C_i.$$

The indices calculated at the elementary items level, C_i, were aggregated using simple means, thus producing the "industry" index C.

Extensive quotation from this article is aimed at revealing that Gray's work was not entirely free of contradictions and rather unconvincing in the way it arrived at the conclusion that the 4-digit SITC data can be considered as closely representing the concept of an industry, because unweighted indices (upon which Gray's conclusions rely), of whatever kind, lead to unreliable measures of IIT. Moreover, the conclusion which stresses that weighting may cause the same quantitative effect as categorical aggregation may be misleading. In fact, some weighting system must be adopted in any case, and Gray does not seem to criticize the one most used in the literature which is based on the relative importance of each sub-sector in total trade. Hence, the effect produced by weighting is an intrinsic property of every index of IIT, while categorical aggregation is not. The former is the consequence of a correct statistical choice; the latter follows from improper selection of the level of data aggregation. Although they produce quantitatively similar effects, weighting and categorical aggregation are very different in nature and require different consideration in empirical studies.

Reviewing the abundant empirical material produced in the Appendix of Gray's study, Hesse (1979) correctly stressed that one of the main results of that study was to show that in many cases the level of measured IIT actually increases with disaggregation. This, of course, is a valuable insight for those who maintain that IIT is not a purely statistical phenomenon.

Yet, Gray's test is not really more convincing than those performed by the critics of the importance of IIT. However, the evidence for the existence of significant amounts of IIT even when SITC data are disaggregated both geographically and categorically (at a very detailed level indeed) is a powerful argument in favour of the empirical relevance of IIT.

5. The empirical relevance of intra-industry trade: an unsolvable puzzle?

The poor results of the efforts to test scientifically for the empirical relevance (or irrelevance) of IIT support Gray's (1973) judgement that "the topic is not one that lends itself to confirmation or refutation in the scientific sense" (p. 102). Reviewing the literature on this problem, one gets the impression that the available body of data generally prevents a rigorous test of the empirical relevance of IIT from being performed. Some tests actually seem to raise more problems than they solve (see *e.g.* in Gray, 1988 the discussion on Chipman's work, 1986).

To find a solution, a different approach must be sought, based upon less powerful results, such as those obtained by Gray and stressed by Hesse, and the tests performed by Lundberg. In a study concerning Swedish intra-industry trade, Lundberg (1982) tested for the aggregation problem by measuring IIT both at the 3-digit and at the 4-digit level of the ISIC (Industrial Standard International Classification). The results show that (a) although IIT actually falls at the more disaggregated level, the extent of this phenomenon remains significant; (b) in many cases, the reduction of IIT is small; and (c) in Sweden's trade with other European industrial countries, in particular with the EEC members, no significant reduction appears.[9]

These results constitute a powerful evidence supporting the economic relevance of IIT although they cannot be used to definitely reject the hypothesis that a certain degree of factor proportions variation exists even at high levels of disaggregation. However, one has to consider if the very extreme position taken by Finger, which is even more clear from his exchange of views with Davies (1978), has some intellectual appeal. In fact, Finger argued that each variety of a product should be viewed as possessing a different production function. If this kind of approach is accepted, the positive value of every theory of international trade, including the factor proportions, would vanish. Moreover, one would have to regard most, if not all, past empirical studies in this field as irrelevant because they did not meet Finger's homogeneity criterion which implies that one has to work with data permitting several thousands of different varieties of products to be distinguished.

Another consideration supports the view that the evidence produced in favour of the empirical relevance of IIT would have to be accepted. It is the impressive increase in the measured level of IIT which, among others, has been singled out by Hesse even at the

[9] In a more recent study (1983), GREENAWAY reported results supporting the view that categorical aggregation is not a major reason for the emergence of high levels of measured IIT. However, this study refers to Switzerland only and does not perform any geographical disaggregation.

4-digit level of the SITC. To this evidence, I have to add what I myself have produced, which will be illustrated in the next section. The data employed are finely disaggregated both from the commodity and from the geographical point of view. As will be shown below, these results tend to give strong support to the idea that IIT is an important empirical phenomenon, at least for the international trade in manufacturing among industrial countries.

Indeed, only those who believe that the H-O-S model provides a complete representation of international trade in the real world are sceptical about the importance of empirical phenomena which tend to give more weight to those explanations of international trade based on reasons different from those which dominate in the factor proportions approach. Since modern industrial sectors in the advanced countries are often characterized by the presence of economies of scale and product differentiation, *i.e.* the major ingredients of imperfectly competitive markets, there is a general interest in the extension of the factor proportions theory to include such important features of the real world.

Corden expressed a well-balanced opinion when he stated (1979) that: "The empirical importance of intra-industry trade only affects the weight which is given to existing theories. Perhaps the main implication for trade theory is that less weight should be given to factor proportions theory and more weight to economies of scale" (p. 10).

The very rigorous discussion on the empirical relevance of IIT which has been undertaken in the last fifteen years may be seen as the high cost to be paid by the proponents of a new theory to convince that it is able to provide an explanation for an important empirical phenomenon, unexplained by the old approach.

All in all, I think the problem of the very existence of IIT has received sufficient attention to make it clear that IIT is an important phenomenon in the real world – even though lack of data makes it difficult to measure its importance scientifically.

6. The extent of intra-industry trade in a sample of fourteen industrial countries (1970-1987)

The discussion of the previous sections helped to clarify some methodological problems connected with the assessment of the empirical relevance of IIT. This section provides some evidence on the quantitative importance of IIT and on its development in the seventies and in the eighties.

The problems linked to the choice of a suitable measure of IIT are dealt with separately (see Vona, 1990). Here, without entering into a discussion of the related problems, Grubel-Lloyd's uncorrected index will be adopted as the main tool to measure IIT.[10]

In general, the empirical analysis is based on measures of bilateral IIT, because geographical disaggregation is important as well as product one. Fourteen industrial countries have been considered – Canada, United States, Japan, Belgium, Denmark, France, Germany, Ireland, Italy, Netherlands, United Kingdom, Greece, Portugal and Spain – so that for any industry and for each year chosen for the calculations 91 values of the IIT index have been computed on a bilateral basis. The most finely disaggregated trade data available on OECD magnetic tapes have been used. They refer to the 5-digit commodity sub-groups of the SITC.[11] As we have seen before, Gray (1979) provided some indication that the 4-5-digit level of the SITC data is the most appropriate breakdown for measuring IIT. I have chosen the 5-digit level to reduce as far as possible the danger of including heterogeneous products within each "industry".[12]

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[10] For the reader's convenience the formula of this index is reported below (symbols' meaning is self-evident):

$$(2) \qquad \bar{B}_i = \frac{\Sigma_i (X_i+M_i) - \Sigma_i |X_i - M_i|}{\Sigma_i (X_i+M_i)} \cdot 100.$$

[11] In 1977 the SITC Revision 1 which has been employed both by the UN and by the OECD for a long time has been replaced by the SITC Revision 2. This implies a more detailed level of disaggregation especially in Division 7 (Machinery and Transport Equipment). Consequently, in order to work with a homogeneous data-set covering the whole seventies I have been obliged to reconcile Revision 1 with Revision 2. This has been possible, apart from marginal unsolvable problems, by working with 5-digit data. The result of such an effort has been a classification which is much more similar to Revision 1 than to Revision 2. For the manufacturing sector, excluding the food industry, about 950 5-digit commodity sub-groups are included.

[12] This choice has been taken after having evaluated the "revenues" associated with the attainment of the highest degree of homogeneity against the "costs" which could derive from excessive data disaggregation, *i.e.* biased downwards IIT measures.

TABLE 1

SHARES OF IIT IN MANUFACTURES TRADE WITH THE OECD COUNTRIES

(Grubel-Lloyd index, not corrected for disequilibrium in trade balances; percentage values)

	1970	1973	1977	1980	1983	1987
Canada	44.8	52.7	54.9	47.0	49.8	55.7
United States	45.4	51.2	51.6	52.5	51.6	51.0
Japan	23.6	27.1	19.6	23.6	21.9	22.2
Belgium	57.8	63.4	66.0	64.7	63.2	66.7
Denmark	50.2	51.3	52.8	55.2	53.9	56.9
France	65.5	67.2	69.8	71.6	71.7	72.3
Germany	58.9	59.0	64.2	67.1	66.0	65.5
Ireland	22.4	41.6	45.0	49.9	54.2	54.8
Italy	54.2	56.1	56.1	53.8	53.8	55.3
Netherlands	56.0	60.6	59.7	62.6	65.0	64.0
United Kingdom	57.8	60.3	64.5	66.8	66.3	68.8
Greece	8.5	11.3	10.8	13.6	14.7	19.2
Portugal	14.5	19.6	16.6	19.2	n.a.	n.a.
Spain	25.8	31.4	36.3	45.2	45.1	56.4

Source: OECD data on international trade on magnetic tapes at the 5-digit level of disaggregation (SITC 1).

The attention has been focused on the manufacturing sector (Divisions 5-8 of the SITC), which includes 950 elementary sectors ("industries"). Bilateral G-L indices for each industry have been aggregated according to the well-known G-L methodology to give a synthetic estimate of the extent of IIT in manufacturing as a whole (see formula 2 in footnote 10). Furthermore, IIT indices have also been computed for manufacturing trade with the whole OECD area for each of the countries taken into account.

An overview at the level of IIT in the seventies and in the eighties shows that the extent of the phenomenon has been remarkable for almost all the fourteen countries considered, when trade in manufactures with the OECD area as a whole is taken into account. According to the results based on the uncorrected G-L index (Table 1) the level of IIT in 1970 ranged from a low 8.5% of Greece to a high 65.5% of France; nine out of the fourteen countries show IIT in excess of 40%. These data also indicate that during the period under review the phenomenon has generally been on the increase. In fact, comparing IIT measured in 1987 with that recorded in 1970, an increase is evident in as much as 12 cases over 13 (Portugal is excluded because of data problems); only for Japan IIT declined slightly. In 1987 the extent of IIT ranged from 19.2% in the case of Greece to 72.3% in that of France; eleven countries showed values above 40%.

A close inspection of the trend in the course of the period reveals a steady pattern in most cases, the major exception being the Japanese IIT which jumped upward in 1973, fell even more sharply in 1977, in 1980 recouped the 1970 level but declined slightly in 1983. It is also worth noting the shrinkage of IIT in the cases of Canada and Italy between 1977 and 1980.

The results illustrated above confirm the idea that IIT is an important empirical phenomenon even when measured at a very detailed level of product disaggregation. Introducing geographical disaggregation into the scene gives even more support to this idea.

The extent of measured IIT in manufacturing, when geographically disaggregated data are employed, tends to fall; nonetheless its amount is still relevant in many of the cases considered (Tables 2-3-4). Figure 1 shows the frequencies of cases classified within intervals according to certain threshold values. In 1970 even at this very finely disaggregated level 55% of bilateral IIT indices were above or equal to 10%, 21% exceeded or equalled a value of 30%. Compar-

TABLE 2

INTRA-INDUSTRY TRADE INDICES (G-L UNADJUSTED) IN MANUFACTURING, 1970
(percentage values)

COUNTRIES	CAN	USA	JAP	BEL	DEN	FRA	GER	IRE	ITA	NETH	UK	GRE	POR	SPA	OECD
Canada	–	45.0	4.9	9.7	10.5	10.5	10.7	3.5	6.3	18.8	12.3	2.0	2.1	1.4	44.8
USA		–	17.7	15.4	20.0	25.2	25.6	16.3	24.1	18.9	36.0	8.9	14.8	8.1	45.3
Japan			–	7.3	11.9	21.8	23.6	0.5	19.3	9.4	19.4	0.1	1.0	5.3	23.6
Belgium				–	15.3	47.5	49.7	2.1	34.5	47.7	42.3	1.7	4.0	8.5	57.8
Denmark					–	17.8	31.8	4.2	19.2	36.0	33.1	1.4	5.6	10.6	50.1
France						–	55.6	2.6	51.4	41.6	45.2	3.9	3.7	24.6	65.5
Germany							–	9.7	45.3	51.2	51.6	6.1	7.8	16.5	58.9
Ireland								–	2.4	5.9	23.0	0.0	0.1	0.7	22.4
Italy									–	29.8	45.4	5.1	1.9	17.9	54.2
Netherlands										–	31.8	2.6	7.2	13.3	56.0
United Kingdom											–	0.9	10.5	13.1	57.8
Greece												–	2.9	0.6	8.4
Portugal													–	6.9	14.5
Spain														–	25.7

Source: OECD international trade data on magnetic tapes at 5-digit level of disaggregation (SITC 1).

TABLE 3

INTRA-INDUSTRY TRADE INDICES (G-L UNADJUSTED) IN MANUFACTURING, 1980
(percentage values)

COUNTRIES	CAN	USA	JAP	BEL	DEN	FRA	GER	IRE	ITA	NETH	UK	GRE	POR	SPA	OECD
Canada	–	48.2	4.7	12.2	12.0	15.0	14.8	7.6	10.8	9.2	19.9	3.2	1.1	5.3	46.9
USA		–	18.0	21.0	26.8	39.4	31.8	20.8	29.4	35.0	44.0	3.9	11.2	17.8	52.4
Japan			–	6.1	12.0	15.4	28.6	3.6	21.7	8.6	20.0	0.4	1.0	8.0	23.5
Belgium				–	21.9	52.8	59.9	18.3	34.1	58.6	49.8	7.4	6.6	28.8	64.7
Denmark					–	30.0	42.9	19.9	29.3	40.3	45.1	4.4	6.7	22.2	55.2
France						–	62.2	25.8	48.1	46.4	58.9	11.5	12.7	37.2	71.5
Germany							–	34.9	43.3	53.0	54.2	11.1	20.7	38.8	67.0
Ireland								–	22.9	22.4	49.0	3.0	3.9	12.6	49.9
Italy									–	30.7	50.5	11.2	6.3	31.7	53.7
Netherlands										–	49.3	7.2	7.8	23.9	62.5
United Kingdom											–	6.9	9.2	32.0	66.7
Greece												–	0.3	1.6	13.6
Portugal													–	8.8	19.2
Spain														–	45.1

Source: see Table 2.

TABLE 4

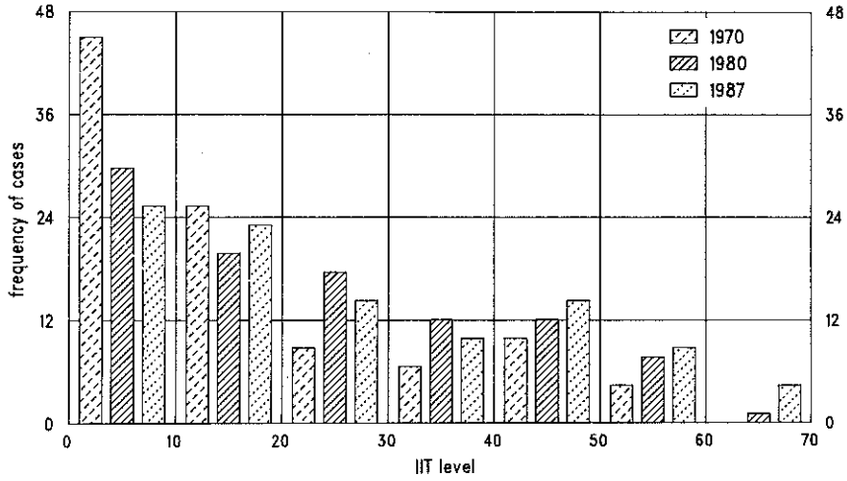
INTRA-INDUSTRY TRADE INDICES (G-L UNADJUSTED) IN MANUFACTURING, 1987
(percentage values)

COUNTRIES	CAN	USA	JAP	BEL	DEN	FRA	GER	IRE	ITA	NETH	UK	GRE	POR	SPA	OECD
Canada	–	53.5	4.8	19.3	16.9	13.9	15.2	30.7	10.6	16.6	19.3	21.3	0.3	5.7	55.7
USA		–	16.4	26.0	28.8	43.0	28.4	33.1	29.5	39.4	47.8	7.9	1.1	17.1	51.0
Japan			–	8.9	10.8	19.9	40.0	16.6	22.5	8.5	18.3	0.7	0.1	7.2	22.2
Belgium				–	28.4	54.9	63.1	18.1	37.1	62.8	49.5	14.7	1.8	37.8	66.7
Denmark					–	35.3	42.7	24.3	27.8	42.3	50.2	3.9	6.9	26.6	56.9
France						–	60.4	21.5	51.5	50.8	67.1	17.0	3.4	47.6	72.3
Germany							–	50.1	48.1	54.8	49.2	13.1	3.2	42.7	65.5
Ireland								–	20.4	20.4	49.7	7.9	0.9	12.4	54.8
Italy									–	35.0	46.5	16.4	2.2	42.0	55.3
Netherlands										–	54.2	8.6	1.4	32.6	64.0
United Kingdom											–	13.1	3.6	39.3	68.8
Greece												–	0.2	10.0	19.2
Portugal													–	8.5	n.a.
Spain														–	56.4

Source: see Table 2.

FIGURE 1

FREQUENCY DISTRIBUTIONS OF IIT IN MANUFACTURING; SELECTED YEARS
(G-L uncorrected indices for a sample of fourteen industrial countries)



Note: The fourteen countries considered are those which appear in Tables 2-4.

ing these value with those calculated for 1980 and for 1987 confirms the tendency towards an increase in IIT which has already been revealed by the data used in the previous section. As a matter of fact the measured levels of IIT in 1980 exceed in 74 cases over 91 (more than 80%) those measured for 1970. The new frequency distributions reveal even more clearly the extent and the characteristics of this phenomenon, showing an increase in the percentage of cases in the upper classes. These findings seem to suggest that IIT empirically matters. The results for 1987 (Table 4) reveal a further increase of IIT: in more than 60% of cases the value of the index is above that scored in 1980. Again, the percentage of cases falling in the upper classes increases so that more than one quarter of the bilateral IIT indices are above 40%.

Some new evidence on the "aggregation problem" in the measurement of IIT will be briefly discussed below. As it is well

known, the extent of the measured level of IIT is negatively related to the degree of data disaggregation: the more the elementary commodity group included in the calculation of an "industry" IIT, the lower would be the measured level. To my knowledge the extent of such a phenomenon has not yet been evaluated by means of a broad data set including geographical as well as categorical disaggregation.[13] Thus the following empirical results may be seen as a further important piece of evidence in evaluating the phenomenon.

The aggregation problem is here assessed by comparing the bilateral indices of IIT calculated in a previous study (Vona, 1979) for the manufacturing industry using 2-digit SITC data referring to a subset of ten of the fourteen countries considered here,[14] with the same indices elaborated both at a 4- and at a 5-digit level of disaggregation. In order to minimize calculations, the comparison has been based on the G-L adjusted indices used in Vona (1979); the characteristics of this index do not affect the conclusions of the empirical investigation on the problem. Thus the results may be viewed as general, although confined to one single year.

Tables 5-6-7 show IIT measures calculated at the three different levels of aggregation of the SITC data. As expected, the value of the IIT indices decline sharply when passing from the 2-digit to the 4-digit data: in many cases the reductions exceeded 40%. A different pattern emerges when comparing the 4-digit with the 5-digit figures. In 7 out of the 45 cases considered the measured level of IIT actually increased,[15] while in other 17 cases the reduction is smaller than 10%.

Overall, these outcomes seem to confirm those obtained by Gray (1979), with all the limitations discussed in section 4, and by Lundberg (1982): a level of international trade data disaggregation in the range of 4-5-digit level of the SITC may be the most appropriate for measuring IIT.

[13] Lundberg's (1982) study cited above considers some geographical disaggregation, but only for Sweden. In a very recent study Blomström, Lipsey and Ohlsson (1990) examine bilateral Sweden-US trade and find that "Their shifting comparative advantages seem to have increased the scope for trade on the basis of specialization within similar industries" (p. 231).

[14] Canada, United States, Japan, Belgium, Netherlands, France, Germany, Italy, United Kingdom and Spain.

[15] The increases are centred in Netherlands' bilateral IIT. However the fact that also the US-UK index rises excludes any restrictive explanation of such outcome.

Table 5

INTRA-INDUSTRY TRADE INDICES CALCULATED BY MEANS OF 2-DIGIT SITC DATA.
WHOLE MANUFACTURING SECTOR (G-L ADJUSTED) 1973
(percentage values)

COUNTRIES	CAN	USA	JAP	BEL	NETH	FRA	GER	ITA	UK	SPA
Canada	–	77.4	34.7	49.9	50.2	67.3	51.4	50.7	37.2	32.6
USA		–	82.5	44.1	80.2	61.8	91.7	66.0	77.9	26.4
Japan			–	33.6	78.2	59.7	60.4	48.7	57.5	80.3
Belgium				–	92.9	85.2	68.3	68.4	82.8	67.1
Netherlands					–	80.9	94.3	67.2	81.2	60.4
France						–	89.8	78.2	82.2	84.1
Germany							–	62.4	94.5	74.2
Italy								–	72.7	89.5
United Kingdom									–	78.5
Spain										–

Source: Vona (1979).

TABLE 6

INTRA-INDUSTRY TRADE INDICES CALCULATED BY MEANS OF 4-DIGIT SITC DATA.
WHOLE MANUFACTURING SECTOR (G-L ADJUSTED) 1973
(percentage values)

COUNTRIES	CAN	USA	JAP	BEL	NETH	FRA	GER	ITA	UK	SPA
Canada	–	61.2	18.4	17.3	22.8	28.1	30.0	18.5	21.5	9.7
USA		–	47.4	24.1	34.2	32.7	51.4	33.4	43.7	15.3
Japan			–	18.3	36.1	33.2	39.7	28.4	30.0	39.2
Belgium				–	70.1	66.1	60.2	44.4	61.8	34.9
Netherlands					–	49.2	73.9	37.9	47.0	20.9
France						–	74.1	59.6	58.8	54.4
Germany							–	50.5	74.7	51.1
Italy								–	49.5	60.9
United Kingdom									–	43.8
Spain										–

Source: see Table 2.

TABLE 7

INTRA-INDUSTRY TRADE INDICES CALCULATED BY MEANS OF 5-DIGIT SITC DATA.
WHOLE MANUFACTURING SECTOR (G-L ADJUSTED) 1973
(percentage values)

COUNTRIES	CAN	US	JAP	BEL	NETH	FRA	GER	ITA	UK	SPA
Canada	–	58.6	15.0	12.3	23.3	23.6	28.4	16.2	17.7	7.3
USA		–	42.0	20.4	36.2	29.6	45.1	33.0	44.6	13.1
Japan			–	14.4	37.3	23.6	34.0	21.8	24.6	30.2
Belgium				–	71.5	62.3	57.0	41.0	59.1	30.6
Netherlands					–	44.2	75.0	37.6	49.3	15.8
France						–	70.3	54.3	53.0	50.8
Germany							–	46.4	62.9	47.7
Italy								–	45.0	53.7
United Kingdom									–	40.4
Spain									–	–

Source: see Table 2.

It is also interesting that in this smaller sample, made up by countries more similar from the "stage of development" point of view than those included in the whole fourteen countries sample, the number of cases in which bilateral IIT exceeded 40%, at the 5-digit level of disaggregation, is more than half of the total number of cases, while only in 8 over 45 cases IIT is below 20%.

7. Conclusions

The conclusions that may be drawn from the review of the literature presented in this article on the empirical relevance of IIT are that neither the pro-IIT, nor the anti-IIT contributions have unequivocally proven their case. The central issue is to identify, at the empirical level, industries which produce bundles of goods under similar factor proportions and with the same final use. However, this cannot be done with the available data on international trade, which are classified according to totally different criteria. The only study that was able to calculate factor intensities for 3-digit SITC categories (Finger, 1975), used a questionable procedure to show that measured IIT at 3-digit level of trade data can be explained by the H-O-S theory. However, its findings were important because they showed that variation in factor intensities strongly declines when passing from the 3-digit to the 4-digit level of disaggregation.

Although even the most accurate empirical tests are inconclusive, personal judgement and the results obtained in other studies tend to give support to the idea that the 4-5-digit level of disaggregation is acceptable for measuring IIT in that it singles out "industries" which appear as fairly homogenous within themselves, even if some small degree of production factors variation cannot be ruled out.

Even at that fairly detailed level of product disaggregation, measured IIT remains quite significant, according to the empirical results of several previous studies as well as to those of the present one, which considers geografically disaggregated data (bilateral trade). Although IIT usually declines with data disaggregation, there are indications that approaching the 5-digit level the decline often becomes negligibile or even reverses.

Finally, IIT measured with this very finely disaggregated data is still a sizeable phenomenon in trade among advanced industrial countries, a result consistent with expectations derived from trade theories.

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