Intra-Industry Trade and Development: Revisiting Theory, Measurement and New Evidences.

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Revisiting Old Issues on Intra-Industry Trade for Development: Theory, Measurement and New Evidences

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ABSTRACT

In this paper, role of international trade in economic development is discussed, both from the perspective of theoretical development and empiricism. In particular, it revisits theories pertaining to intra-industry and inter-industry trade and presents evidences of resilience in intra-industry trade. With globalization, trade in technology-intensive and manufactured products has increased intra-industry trade. Review of the theoretical and empirical literature reveals that this kind of trade is explained by variations in taste patterns, diversified preference structure, scale economies, technological change, and income level, amongst other things. After discussing computational issues related to level of aggregation of industry for measuring the extent of such trade, using Global Trade Analysis Project's (GTAP) database, we provide recent measures of Grubel-Lloyd Intra-industry trade indexes for the world economies. It shows that a country's intra-industry trade is growing in volume especially with fragmentation of production process. Also, we observe that burgeoning volume of intra-industry trade is positively correlated with: (i) per capita GNP; (ii) trade integration; (iii) share of manufacturing exports in total exports; (iv) technology intensiveness of the production process; (v) variety-seeking demand patterns.

Keywords: Intra-industry trade, Manufactures, Trade openness, Development, Grubel-Lloyd index, GTAP Database. ***JEL Classification:*** O1, F02, F15

"...our interests are to a considerable extent explorative in a more intrinsic sense; the motive of action is in part curiosity as to what the result will be, and hence depends on partial ignorance of the result when the action is performed."

-Frank Knight, What is Truth in Economics? Journal of Political Economy, 1940, Vol. XLVIII.

"The notion that trade, free trade, unencumbered by government restrictions–is welfare-enhancing -is one of the most fundamental doctrines in modern economics, dating back at least to Adam Smith (1776) and David Ricardo (1816). But the subject has always been marked by controversy because the issue facing most countries is not a binary choice of autarky (no trade) or free trade, but rather a choice among a spectrum of trade regimes with varying degrees of liberalizations."

–Joseph E. Stiglitz and Andrew Charlton, in Fair Trade for All, pg. 12, Chapter 2,

[1] I owe debts to many. With the usual caveat, I, therefore, acknowledge the intellectual debts to Professors Deepak Nayyar, Sugata Marjit, Ranajoy Bhattacharyya, and Charan Wadhva for comments and encouragements at formative stages. Discussions with Xiaokai Yang, Christis Tombazos, Jayant Menon, and Peter Dixon were useful.

1. Foreign Trade, Economic Development and Trade Theory: Exploring Many Facets

Since the days of Adam Smith, who pointed out the fallacies of mercantilism, economists have been concerned with the role of foreign trade in the development process, either as proponents of trade as a leading sector (`the engine of growth') or of a follower sector (`the handmaiden of growth'). Historically, there has been a strong empirical association between periods of rapid growth of trade and rate of growth of GDP. However, the interpretation of the direction of causality is problematic. In principle, the expansion of production and investment possibilities through foreign trade and capital flows should enable the home economy to achieve higher levels of real income and possibly, though not necessarily, a faster rate of growth as well. According to the "engine of growth", a causal connection is running from the growth of trade to the growth of income i.e., trade is the *connecting link* between the rate of growth of industrial production in the developed countries (DCs) and that of developing or less developed economies (LDCs). This Keynesian demand side view is in contrast to the idea that trade is the "handmaiden of growth" (Riedel, 1991), where trade is regarded as *facilitating* rather than the driving force in the development process and where both supply and demand side factors are operating without any one-way causality. As Riedel (1984) demonstrates, the demand side explanation works sufficiently well in the aggregate when LDCs are highly specialized in primary commodity exports, but the hypothesis breaks down when their exports are disaggregated and when supply side changes lead to the growth of manufactured exports. The following table shows that the volume of world trade continued to show remarkable resilience in 1992.

Table 1: Global Indicators of External Conditions Affecting Growth in the LDCs (Average annual % change)

Indicator	Trend		
	1965-90	1990-92	1992-2002
Real GDP in G7	3.4	1.1	2.7
Inflation	6.2	3.5	3.2
World trade	4.5	3.3	5.8

Source: Table 6-3, Global Economic Prospects and the Developing Countries, 1993, World Bank.

Looking toward the second half of the present decade, the trade of the non-OECD countries is increasing substantially faster than the trade of OECD countries. A large part of this difference is accounted far by the dynamism of countries in East Asia and South East Asia. Starting from a base line involving a certain international division of labor, most LDCs were engaged in international exchange during the colonial period. Accordingly, trade pattern was molded to achieve combinations of outcomes, which may be called a `development strategy'. There are four alternative *development strategies* in the literature viz., balanced growth, big push, traditional exports, non-traditional exports and import substitution. The essential idea behind Rosenstein-Rodan's (1943, 1961) and Nurkse's (1953) advocacy of balanced expansion was that widespread development affecting a large number of sectors of the economy will be *self-reinforcing* whereas the attempt to concentrate on isolated expansion of one or two industries too narrowly would not generate adequate demand as there would be lack in purchasing power.

Most of the literature which deals with extensions of the HO model and the investigation of its testable implications is not especially concerned with the LDCs. Increasing Returns to Scale (IRS) are a central component of new trade theories, especially based on the empirical phenomenon of intra industry trade (IIT). This has recently generated a large theoretical literature on models of trade in differentiated goods under imperfectly competitive conditions (Kierzkowski, 1984; Grubel and Lloyd, 1975; Greenaway and Milner, 1983, 1984). While IIT is predominantly observed among high income countries, it appears to be of growing importance in the trade of developing countries, especially in their trade in manufactured goods. Although increased variety of goods and consumer choice may not be an important factor in many developing economies and it may be socially undesirable, and although endowment and country size factors may hinder IIT in manufactured trade of a `North-South' nature, thus ability to `exchange' the benefits or gains of scale economies may be of increasing importance in non-Heckscher-Ohlin type trade of a `South-South' variety and/or, `North-South' variety.[2] The current conventional wisdom is that

[2]James, J. and Stewart, F; 1981: A Discussion of the Welfare Effects of the Introduction of New Products in Developing Countries, Oxford Economic Papers, 33, pp. 81-107.

'North-North' trade is predominantly of IIT variety whereas 'North-South' trade is inter-industry in nature. Chenery and Keesing (1981) have presented a more complex view of the manufacturing export patterns of LDCs. They have differentiated f*our types of countries* viz., those specializing early in their development process in the exports of manufactures (Hong Kong, Singapore, Korea, Portugal, Greece, Israel, Taiwan); the second group comprising of semi-industrialized nations (Spain, Yugoslavia, Argentina, Brazil, Mexico and Turkey) having a substantial industrial base created in the stage of import substitution; large poor nations (India, Pakistan, Indonesia and Egypt) and those emerging from primary specialization, exporting mainly standardized intermediate goods (textiles, cement, etc.) with widely recognized standards, and known channels of trade. Some of these products (textiles, for example, as opposed to clothing) may not be typical labour-intensive commodities. There is a second generation of successful LDC exporters, which, starting from natural resource based exports, have moved into textiles, clothing and similar products and then into engineering goods, following a pattern similar to the NICs, and selling in similar markets. [4]

The structure of world trade has, in fact, changed considerably over the past few decades. This changing pattern of comparative advantage is noteworthy and gives some empirical evidence to Balassa's "*stages"* approach to comparative advantage (1988) according to which, the export structure alters in line with the accumulation of physical and human capital. Over recent decades, developing countries have fairly consistently substituted manufactures for primary products in their exports. The studies demonstrate, however, that shares of IIT in total trade are systematically related (positively) to country characteristics (e.g., stages of development, market or country size, and degree of taste similarity between trading partner, etc.). Lower per capita incomes have restricted the scope for South-South IIT. The NICs climbed the ladder of development as they built up their physical and human capital, and their structure of trade has changed in the process; in the past decade they have moved into more capital-intensive goods and skill intensive engineering and industrial goods. Other non-NIC developing countries appear to be broadly following the same pattern of evolution.

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[4]Havrylyshyn, Oli and Iradi Alikhani, 1982, `Is there Cause for Export Optimism? An Inquiry Into the Existence of a

Next two sections survey the literature. Section 4 deals with empirical and methodological issues of measuring IIT. In Section 5, current empirical patterns are presented and section 6 takes stock of the new theories of IIT with special reference to the developing world. Section 7 concludes.

2. Trade and Specialization in Theories of Trade: Shifts in Comparative Advantage

The theory of International trade from Adam Smith to Ricardo until Heckscher-Ohlin had concentrated on the structural differences between countries as the basis of trade. To a certain extent, it is logically consistent with the flow between two interconnected water-container, where flow was a necessary outcome of differences in levels (tastes, technologies and endowments) and consequentially, leading to some kind of equality (of factor and commodity prices). Traditional trade theory takes it as axiomatic that countries trade in order to take advantage of their differences based on natural pattern of specialization and underlying characteristics. This is a "*homeostatic view*" of international trade.[6]

The first theoretical explanation of how trade can be mutually beneficial was by David Ricardo (1817) where he showed that so long as the relative unit costs of the two commodities differed between the two partner countries trade would occur, each country exporting the commodity that it could produce relatively more cheaply. Several of the major assumptions of the classical theory such as perfectly competitive markets, the absence of transport costs, the complete intersectoral mobility of factors and immobility between countries are still made in the basic formulations of the "modern" theory. While Ricardo considered the constant cost case, the modern theory is able to treat quite easily the more general case of increasing cost. The decreasing cost case, which is of considerable interest for underdeveloped countries beginning industrialization has been studied. The pertinent point to note is that the generalization of the cost structure assumptions by the modern theory has brought with it a shift from the comparative cost ratios to their more basic determinants viz., national endowment of factors, technology and taste pattern.

Contrary to the classical opinion that trade can occur only when technologies are different between

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Second Generation of Successful Exporters', Review of World Economies, 188, pp. 651-663.
[6]P.R. Krugman, "The Narrow Moving Band, the Dutch Disease, and the Competitive Consequences of Mrs. Thatcher, Notes on trade in the presence of Dynamic Scale Economies, Journal of Development Economics, 27, 1987, pp. 41-55.

countries (amounting to a change in relative prices), the H-O theory contends that trade can occur between countries with identical technologies if they differ in factor proportions. Modern mainstream literature on international trade developed trade models on the basis of the assumptions of perfect competition in product as well as factor markets, constant returns to scale technology, factor endowment differentials and dealt with the questions concerning the effect of exogenous or policy changes on the real income (aggregate) level and alternative rankings of policy instruments i.e. normative issues and also the effect of it on the output composition, relative prices, trade flows and determinants of trade pattern and on the internal income distribution i.e., "positive" aspects. While the principle of comparative advantage is put forward as a basic explanation of trade patterns, the comparative cost doctrine is *not* a "primitive explanation" since it assumes rather than explains inter-country differences in autarkic prices".[7]

The traditional answer to the question of why a particular country exports a particular commodity is simply that it is because it can produce it at a lower comparative cost. Hence the fundamental causes of international specialization and trade must be sought in intercountry differences in factor endowments, tastes or technology. For countries with identical tastes, endowments and technology the difference in the income elasticities of demand at the same price ratio (in a two good world) in two countries will generate trade; or, in other words, the income elasticities (referring to national aggregates) differential will induce trade with the pattern of trade being discerned by the absolute magnitude of the income-elasticities in the partner countries. This is the trade caused by difference in scale.

Even if two countries are identical in technologies, endowments, the difference in tastes will induce trade in spite of both having the same transformation curve. When trade opens up, the country will import goods for which there is greater preferences in consumption since in autarky there would be comparative cost disadvantage of producing the goods at home. Demand determines the composition of output here i.e.,

[7] R.W. Jones and P. Neary (1984), The Positive Theory of International Trade, Handbook of International Economics.

the pattern of production. It does not determine the relative price or the pre-trade prices.[8]

In the traditional two dimensional trade models, the analysis of two countries trading two commodities, each produced with one or possibly two factors of production eschews the partial equilibrium one thing at a time approach. But "two" is the smallest number that can be used to describe international trade.[10] It fails to explain clearly the role of trade in allowing countries to concentrate on production activities and actually produce different commodities from each other.[11] Since we are not discussing such models and their extensions, it is not analyzed here.

The first step towards a breach from the H.O. model is the Specific Factor Model following Jones (1971)[12] where only one factor is mobile intersectorally and others are specific to sectors. The crucial feature of the model is that with more factors than commodities, trade does not lead to factor price equalization in the model although Samuelson (1971) talked in favour of partial factor price equalization i.e., a reduction in the intercountry differences in factor price. As Jones argues, that specificity of factors can be conceived of as "temporarily immobile" within sectors and gradually mobile within sectors in response to intersectoral differences in rentals. The discussion of specific factor model necessitates the consideration of higher dimensions of standard two dimensional models.

If the number of goods and/or factors is increased beyond two, the propositions might fail to hold.[13]. If there are more factors than goods, proposition (a) will fail as there will be more unknowns (factor prices) than equations that could help to solve them and factor prices will just be undetermined. However, proposition (b) may survive generalization to a many factor many good world if there are at least as many traded goods as factors. What is needed in addition to common technology available to each country and perfect competition is sufficient similarity in the country's factor endowments. Endowments do not need to

[8] See Caves, Jones and Frenkel, World Trade and Payments: An Introduction, 5th ed., Chapters. 2,3.
[10] R.W. Jones, "Two-ness in Trade Theory: Costs and Benefits", in International Trade: Essays in Theory, (1977), Ch. 18.
[11] R.W. Jones (1974), "The Small Country in a Many Commodity World", in International Trade: Essays in Theory.
[12] R.W. Jones (1971) "A Three-factor Model in Theory, Trade and History" in International Trade: Essays in Theory.
[13] W.J. Ethier, "Higher Dimensional Issues in Trade Theory", Ch. 3, in Handbook of International Economics, ed. by Jones and Kenen, 1984.

be identical except at a point of factor intensity reversal. The proposition of factor price equalization, in effect, says that "factor price equalization results if the two countries have `sufficiently similar' factor endowments: widely divergent endowments preclude equalization regardless of the global nature of the technology". Any country with an endowment of the factors outside the cone will have factor prices that are different from world levels, essentially because its production will be too specialized to confirm to the other countries values of wages, capital rental and rent on land. If number of factors is greater than the number of goods, the pattern of production and hence exports becomes arbitrary (Ethier 1984).

Thus it is evident that the `*elaborate and extensive structure'* of modern trade theory is based on several extreme assumptions including that of dimensionality. A large volume of theoretical work in recent decades has exposed the sensitivity of the models of these restrictive assumptions. The above models are the basic building blocks of positive international trade theory on the foundation of which some extensions have been made. International trade, in all these models, is *arbitrage*, a response to price discrepancies. In the limit, international trade eliminates them. In the "*arbitrage*" theory of trade, autarkic price differences are only an immediate explanation. Something has to underlie them, be it differences in technology, factor endowments, or tastes. Using the input-output tables (developed by him) and data on the commodity composition of exports, Leontief (1953) showed that in 1947 the exports of the U.S.A., the most capital abundant country were more labor-intensive than the import substitutes, contrary to the H.O. theorem.

An obvious possible explanation of the Leontief paradox is that the H.O. theorem is wrong in the sense that its emphasis on factor endowment differentials as the basis of trade is misdirected in determining the pattern of trade. Another strand of empirical studies by Linneman (1966) showed the importance of international transport costs in predicting trade flows in terms of a "**gravitational hypothesi**s" that geographical propinquity encourages bilateral trade flows. Thus the traditional theory of comparative advantage has empirical "irrelevance" and some inadequacies like restrictiveness in its assumptions of perfect competition, constant returns to scale technology, full employment. One aspect of trade not explained by the Ricardian and/or the H.O. models is the large amount of "Two way trade" i.e., the simultaneous exports and imports of some goods at some chosen level of aggregation. Empirically, however, such trade persists down to at least the eight digit level of disaggregation and cannot be dismissed as only border or seasonal trade. Apparent empirical evidence of "*Two way trade*" (TWT, hereafter) or "*Intra-industry trade*" (IIT, henceforth) is provided by the published data in trade classification usually SITC (Standard International Trade Classification), different revisions. The identification and measurement of IIT depends upon the degree and kind of homogeneity of the commodities included in each statistical grouping. There are *three important* ***stylized facts*** about world trade which appear `unexplainable' in the H.O. framework:

1. Contrary to the H.O. propositions there has been evidence of intense and rapidly expanding trade between countries with similar resource endowments, such as the members of the European Economic Community (EEC).

2. The exchange of large quantities of identical products with nearly similar factor content and

3. The `minimal social conflict' in postwar trade liberalization among the industrial countries as opposed to the Stolper-Samuelson theorem postulating decline in real reward to one factor of production after trade liberalization.

The problems of orthodox theory have prompted several new theories of trade:

1. ***"Availability" theory:*** Kravis (1956) states that a country tends to import products that are not available at home; `availability' is determined by natural resources, technological progress and product differentiation.

2. New commodities and the "***Imitation Gap" theory*** postulates that the emergence of new products as the result of scientific research can create a temporary monopoly for the innovating country resulting in exports. Trade is thus created for the duration of the "imitation gap". Findlay calls this theory `Schumpeterian' since it inherits the concepts of `innovation and imitation' from Schumpeter.

Kravis's original incorporation of technological progress was more fully analyzed by Posner (1961) where he defines the `dynamism' of a country in international trade as a function of the rate of innovation i.e., the number of new commodities introduced per unit of time and the speed of imitation of innovations. Posner decomposes the imitation lag into *three components* viz., the <u>foreign reaction lag</u> (time taken for the first foreign firms to start producing new product), the <u>domestic reaction lag</u> (time required for other domestic produces to follow suit), and the <u>learning period</u> for mastering the `new' techniques of production. Posner showed that for similar degree of dynamism, trade can stimulate a process of all round development due to quicker rate of imitations. Posner has the credit for introducing this sort of "learning by doing" into recent trade theory. Although it might appear that the source of modern innovations being the deliberate and systematic R and D activities, it is dependent on relatively large capital endowment, it is not true in the sense that rate of innovation depend on several factors of *random nature*.

3. Dollar (1986)[14] and Krugman (1979)[15] formalized the ***innovation and technology factor*** in a model where the pressure to innovate comes from the need to pay higher wages in the DCs.

4. North-South trade has a popular explanation in the ***product cycle hypothesis*** (Vernon, 1966) formalized in Dollar (1986) and Markusen (1990). The idea behind the product cycle is that `New goods' are developed in the advanced countries (North) and are exported to the less developed countries (South). Later, when goods become old, production location changes and the comparative advantage ranking is reversed. The South starts exporting old goods to the North, and the North starts selling some other new goods to the South. Thus the product-mix of trade alters overtime as new goods become old. Krugman (1979) assumes an exogenous diffusion function which determines the rate at which new goods are transferred to the South.

5. ***The demand theories of Dreze (1960) and Linder (1961):*** These are, in fact, about the effect of domestic demand factors in influencing the comparative advantage in supply. Dreze (1960) argues that economies of scale and trade barriers across national boundaries will cause economically large countries to specialize in nationally differentiated goods when it comes to international trade, while small countries will specialize in internationally standardized products. This is related to Linder's arguments (1961).

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[14]Dollar, D. (1986) "Technological Innovation, Capital Mobility and the Product Life Cycle in North-South Trade, American Economic Review 76, pp. 177-190.

[15]Krugman, P. (1979) "A Model of Innovation, Technology Transfer and the World Distribution of Income", Journal of Political Economy, 87.

6. The idea that consumer demand for diversity leads to the production of differentiated products and the idea that the typical product line is not produced on a sufficient scale to exhaust all available economies of scale explain the phenomena of IIT and some of the increase in trade in manufacturers. On the supply side, ***increasing returns to scale in the production*** of products will give an added advantage to the firms. It takes time and large investments of resources to get production levels to the optimum scale, and substantial increasing returns can act as an effective `barrier to entry'. Applied to international trade this provides a further explanation of comparative advantage. ***Scale economies*** create potential gains from trade. In fact, the large volume of IIT estimated at 50% of world trade by Grubel and Lloyd (1975)[16] can be understood in the context of product differentiation and scale economies.

Ethier (1979) has tied ***the scale economies/IRS to the scale of world demand and output*** as opposed to the above models where it is linked to national levels of output. As world output of a good increases, greater degrees of specialization are allowed giving rise to IRS even with unaltered national output. In a later paper, Ethier (1982)[17] combines world increasing returns with more traditional national increasing returns. The gradual shifts in comparative advantage with the specific purpose of explaining different trade flows gave rise to the new theories.

3. Models of Intra-Industry Trade: Basic Theoretical Underpinnings

So far as the historical source is concerned, IIT was identified while trying to find what culminated into the formation of European Economic Community (EEC). Early research by Dreze (1961) and Balassa (1965) found evidence of increasing intra-industry specialization in the decade following the customs union formation. This led to the work of Grubel and Lloyd (1975) where detailed documentary evidence of IIT at the 2 and 3 digit levels of the SITC for all the major industrialized countries have been provided. Although by the mid-1970s some theorizing has been done [for example, Gray (1973), Grubel (1970), Pelzman (1978)], there was no formal theoretical model. In addition, by the mid-1970s there were few serious

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[16]Grubel, H.G. and P.J. Lloyd (1975), "Intra Industry Trade: The Theory and Measurement of International Trade in Differentiated Products (Macmillan, London).
[17]Ethier, W.J. "National and International Returns to Scale in the Modern Theory of International Trade, American Economic Review, 72.

attempts at econometric explanation [Pagoulatos and Sorensen (1975), McAleese (1979)-to mention a few]. In particular, theoretical work has become fashionable following some of the theoretical formulations by Dixit and Stiglitz (1977) and Lancaster (1979).

3.1 Demand and its importance in the determination of trade structure: Linder hypothesis

As mentioned, according to the Linder hypothesis (Linder, 1961), while the composition of trade in primary products may be explained by the factor proportions theory, the pattern of trade in manufactured goods is mainly determined by the demand characteristics of a country. Specifically, Linder argues that the structure of relative prices of industrial goods in each country is determined by the "*representative demand*", and that income per capita is the most important single factor influencing the representative demand. Linder (1961)[18] claims that "the production functions of goods demanded at home are relatively more advantageous" and he justifies this assertion on the reasons based on the unfamiliarity of the producers with foreign markets as compared with the domestic market and on the existence of scale effects (Linder, 1961, pp. 88-91).

Many empirical studies have been done to analyse the empirical links between the structure of industrial exports and the level of income per capita.[19] Hufbauer (1970) tested the relationship between income per capita and the composition of trade. In Linder's version, exports of manufactures are an outgrowth of a home production satisfying the home consumption demand. Thus, it is the reverse of the conclusion suggested by the H.O. model. The story of Linder is a controversial alternative to factor proportions theory.[20] As regards the bilateral trade intensity, Linnemann (1966) has made explicit reference to *distance variable* which is absent in Linder. Johnson (1964) suggested that the positive relationship between trade intensity and "*Linder variable*" (international similarity in per capita GNP) could be the result of the reality of geographical proximity among countries with similar wealth levels.[21] Thus, Linder variable is

[18]Linder, Staffan B. "An Essay on Trade and Transformation" (New York and Uppsala: Almqvist and Wiksell, 1961), p. 90.

[19]Leser (1963) has done it for Ireland; Japan; Shinohara (1967); Scandinania, Wold and Jurun (1952); U.K., Prais and Houthakker (1971); U.S., Houthakker and Taylor (1966). These are individual country studies. The studies referring to groups of countries are Balassa (1964), Chenery and Taylor (1968), Kuznets (1962), Maizels (1963).

[20]Hanink, D.M. (1990), "Linder, Again", Review of World Economics, Vol. 126.

[21]Johnson, H.G. "Review of An Essay on Trade and Transformation", Economica, Vol. 31, 1964, pp. 86-90.

a surrogate for distance and distance between partners is deterrent to trade. Following Bergstrand (1985) & Linneman (1986), Hanink has developed a gravity model [Bergstrand (1985)] and analyzed Linder's theme as a "spatial interaction model" i.e., model based on mutual attraction between places.[22]

So far as the empirical testing of Linder corollary relating to the commodity composition of trade in manufactured goods is concerned, the statements is "Potential exports and imports are - when they are manufactured - the same products. An *actual* import product *today* is a *potential* export product *today* and may be an *actual* export product *tomorrow*." (Linder 1961, p. 138). This means that there would be a similarity between a country's *export vector* of manufactures and its *import vector* of manufactures - irrespective of its level of development. This export-import similarity is measured by either, Finger and Kreinin (1979) Export-Import Similarity (*EIS*) index or, by Allen's Cosine measure (*COS*) [see Appendix].

A study by Linnemann and Beers (1988) on the commodity composition of exports of a country and of imports of another country shows that Linder thesis of a potentially relatively stronger trade in manufactures between countries of similar level of per capita income is rejected. On the other hand, the potential intensity of trade would generally seem to increase with increasing per capita income of the trading partners. Gray (1980; 1988) notes the applicability of Linder's proposition to the explanation of IIT and relates it to the theory of differentiated markets in international trade. Gray (1980) calls these goods as `*Linder Goods*' and these goods are the primary component of the large volume of trade between countries.

Overlapping demands also arise in the context of product variety i.e., the number of goods in a country's basket of imports/exports. Overlapping demands among rich countries can cover both income elastic and income inelastic goods (Hunter and Markusen 1986).

3.2 Increasing returns and scale economies

Increasing returns to scale provide an additional factor motivating trade where both countries benefit from trade *even when they are identical* with respect to tastes and technology. This is supply side explanation

[22]Bergstrand, J. (1985), "The Gravity Equation in International Trade: Some Micro Economic Foundations and Empirical Evidence", The Review of Economics and Statistics, Vol. 67, pp. 474-481.

of models. Such trade *cannot* be carried on in conditions of perfect competition and equilibrium will require that the firms involved have some degree of market power. The role of scale economies is of particular interest because of their importance to theoretical models. Most genuine IIT consists of two way trade in differentiated products, since with the exception of strategic trade in oligopoly market situations, homogenous goods IIT is believed to represent border or seasonal trade (Deardorff, 1984, pp. 506-7).

The first departure from the standard competitive model is the Marshallian approach in which increasing returns are assumed to be *external to the firm* and internal to the industry, allowing perfect competition to remain. According to Krugman, the literature did not seem to offer the interaction of increasing returns and comparative advantage as explanations of trade. Ethier (1979) cast his approach to the problem in terms of the two-way trade in intermediate goods, providing a formal basis for relating IIT to external economies linked to the world market size. Subsequently in Ethier (1982), he produced a model in which external and internal economies of scale interact to generate IIT starting from the allocation of resources to production and trade. According to a simplistic version of the scale economy thesis, the large nation because of an assured home market will specialize in goods produced with increasing returns to industry size. A small nation might occasionally develop a scale economy industry; rely on export sales to justify production.[Hufbauer (1970)]. So difference in the sizes of economy could have provided the inducement for trade. We would have seen the largest economy exporting the increasing return good. If, instead of that, a small economy which concentrated on producing and exporting the good subject to increasing returns, could export the IRS goods, the larger economy which specializes on constant return goods could end up, after trade, with a consumption bundle yielding lower utility than in autarky.[23]

Increasing return *internal to the firm* in industry gives a different situation incompatible with competitive model. For increasing returns external to the firm, costs fall with the size of the industry not with the size of firms comprising it and hence marginal cost pricing would not lead to losses. External economies are *not incompatible* with the perfectly competitive structure as it will merely lead to distortions leading to net

[23]Helpman and Krugman (1985): Market Structure and Foreign Trade, Cambridge, MA: MIT press.

welfare loss from trade and can be corrected by appropriate government intervention (i.e. taxes and subsidies). It is only when the firms are alone enjoying economies of scale (internal to the firms) that the firms realize the advantage of being alone in the market. It is this hostility to the new entrants and/or a tendency towards merger that threatens the validity of traditional trade theories. Empirical evidence, however, shows that most firms experience internal economies of scale as production expands. This prepares the ground for discussing the third approach to modeling.

3.3 Imperfect competition

The 1970s were marked by substantial progress in the theoretical modeling of imperfect competition. Several trade theorists developed models of trade incorporating non-perfectly competitive market structure. The literature divides itself into *two distinct categories* in their approach: one strand models the role of scale economies as a cause of trade and keeps the issue of market structure out of the way by assuming Chamberlinian monopolistic competition in market structure.[24] The second strand takes imperfect competition as the base and investigates IRS as a cause of imperfect competition. This falls under the purview of `oligopoly and trade'.

3.3.1 Monopolistic competition models

Intuitively it would seem that scale economies would increase the payoff to intra-industry specialization and two way trade in any type of commodity and therefore would be positively associated with the degree of importance of scale effects in an industry. However, as discussed by Greenaway and Milner (1985, pp. 111-2), even though these models all rely on some type of scale effects to generate IIT, it is not necessarily the case that intensity of such effects determine its share of an industry's trade. For example, Helpman and Krugman (1985), in an alternative to the Chamberlinian framework, modeled IIT by monopolistically competitive producers of single varieties who are constrained to average cost pricing by freedom of entry. In the 1970s, however, two approaches to this problem were developed. The first, identified

[24] E.H. Chamberlin's, `The Theory of Monopolistic Competition', Cambridge, MA: Harvard University Press, 1933.

with the work of Dixit and Stiglitz (1977) and Spence (1976), made the assumption that each consumer has a taste for many different varieties of a product. As there are alternative approaches, Lancaster (1979), for example, assumed a primary demand for `*attributes*' of varieties, with consumers differing in their *preferred mix of attributes*. Product differentiation here takes the form of offering a variety having attributes that differ from those of existing varieties. Since all these models assume different types of differentiation, *a brief taxonomy of terms for product differentiation* is given below:

i. Horizontal differentiation: It refers to differentiation by attributes or characteristic and every consumer has his most preferred "package" of characteristics. Within a given "group" (e.g., in automobiles category as compared to apparels) all products will share certain core characteristics the combination of which determines the products' *specifications*. It is often called locational differentiation (Hotelling 1919, Lancaster (1980), Helpman (1981)). **Pseudo differentiation** occurs when the core characteristics of all products in the group are identical, but differentiated by brand image.

ii. Vertical differentiation: It is broadly *consistent with quality differences* i.e. availability of alternative quality grades unlike the earlier case of availability of alternative specifications of a product in a given quality grade.

Despite divergences in the treatment of consumers' preferences and production conditions, there is some consensus that preference diversity and decreasing costs over a relevant output range give rise to IIT and in a general equilibrium set up, importance of intra vis-a-vis inter-industry trade depends upon initial factor endowments. In other cases, Krugman (1979, 1980) and Venables (1984) assume consumers having Dixit Stiglitz type utility function:[26]

$$U = \left(\sum_{K=1}^{n} C_K^{\beta} \right)^{\alpha / \beta} C_0^{1-\alpha}$$

where Co and Ck (k = 1,2.....) denote quantities of the numeraire and differentiated goods respectively. "Numeraire" good embodies all kind of goods other than the products of the differentiated industry and any new variety entering the market can be assumed to be finding its place in the consumer's budget. Elasticity of substitution (σ, henceforth) between any pair of k-differentiated products is [1/ (1-β)], where O<β<1 is a

[26]Dixit, A.K. and V. Norman (1980), Theory of International Trade, Cambridge: CUP.

parameter and σ between C_o and C_k is unity in this Cobb-Douglas specification. $O<\beta<1$ ensures concavity of the utility function. However, Xiaokai Yang and Ben Heijdra (1993) suggest an alternative solution method to DS taking into account price index effect and extending the range of applicability of the DS model where more general production structures can be incorporated. The crucial assumption of DS model is that each producer ignores the cross price elasticity of demand for a variety of goods and σ is constant. Assuming very large number of goods and σ as a positive function of number of goods varieties and utility is Cobb-Douglas, the authors have shown that their solution method reverses some of the conclusions of Krugman (1980).[27] We now consider three different modeling approaches:

3.3.1a. Neo-Hotelling approach: In this approach, the modelling of the preference structure is horizontal differentiation type. Hotelling looked at `spatial duopoly' where two firms chose where to produce and sell otherwise identical products in a market represented by a straight line between two points.[28] This approach is based upon Lancaster's analysis of consumers behavior (1966, 1980). The products all have different proportions of the same range of characteristics. All products can, then, have identical cost functions. Combined with the assumption of scale economies and the even distribution of demand across the range of differentiation, the equality of costs allow a determinate solution with reference to both the number of products (firms) and the level of costs for each product. Gains from trade (GFT) result from the ability of both countries to benefit from the exploitation of scale economies, which results in lower product prices for manufactures, as well as from greater product diversity. Since production of differentiated goods is subject to initial scale economies, in autarky the larger country will clearly produce a given variety of it at a lower unit cost and "false comparative advantage" occurs. Thus in equilibrium, the smaller country (larger country) imports more than (less than) half the total number of varieties available. GFT are uneven, with the smaller country reaping the greater per capita gains from trade (in contrast to the identical country case where these gains are same for two countries). Lancaster has also extended it into an H-O. framework.

[27] Yang, K. and B.J. Heijdra, "Monopolistic Competition and Optimum Product Diversity, Comment", American Economic Review, March 1993, Vol.83, No. 1. See for details Chapter Notes 2.

[28] See for details Hotelling, H. (1929) `Stability in Competition', Economic Journal, 30, pp. 41-57.

3.3.1b. Neo-Chamberlinian models: This approach builds upon the Dixit Stiglitz (DS) variety seeking utility function. Here trade is independent of relative factor endowments. But Lawrence and Spiller (1983) developed a model of economies of scale, product diversity and international trade where factor endowments have a causal role. In their model, they explore "how plant size, the number of plants, the degree of excess capacity, and prices in the monopolistically competitive sector depend upon the relative size of domestic and foreign markets and relative factor endowment differentials" (ibid. p. 63). In their paper, several empirically testable hypotheses for industrial studies in open economies have been derived. If capital is the principal fixed cost, and labour is the major variable cost, then the capital (labour) abundant country will experience lower (higher) domestic industrial concentration. In their model, they argue that less developed economies of small size can be accommodated because they have reversed their policy of infant industry protection in past few years and their framework suggests that those countries will experience an increase in the degree of excess capacity in the manufacturing sector. This model is different from Krugman (1979, 1981) and similar to Helpman (1981) - in presenting a general equilibrium model of a 2 sector economy (one sector is competitive, other is monopolistically competitive) with 2 factors of production and perfect intersectoral factor mobility.

We now turn to the Chamberlinian trade models by Dixit and Norman (1980), Ethier (1982), Helpman (1981), Krugman (1979, 1981) and Lancaster (discussed earlier) - that are essentially very similar. Krugman uses a DS model of differentiated goods to explain IIT. Primary emphasis is on the importance of scale economies. Three points are worth mentioning: economies of scale for existing firms could be small; scale economies show the desirability of a strong home market for the product' and the assumption of costless product differentiation allows him to assume zero profits for firms making differentiated goods in long run equilibrium so that `inter firm dynamics' and the costs of product development are omitted.

Krugman's production function for all goods involves only one factor, labour, and his cost function is:

$$Ci = (\alpha + \beta xi). Wi$$

where total production x_i units of the i^{th} goods (C_i) comprises a fixed component of so much labour (αW_i), W_i

being the wage rate paid in the industry and $\beta W_i X_i$ is the variable cost. Thus, average costs declines with output. Scale economies will protect against new entrants into the industry unless a new firm can establish itself and its sales at a high level of output. Scale economies support the notion, originally conceived by Linder (1961) that countries will export goods for which there is a strong home country market demand.

There is, however, no reason to suppose that this feature of a good will not be dependent on "idiosyncratic" home tastes. The home market (satisfying its domestic customers want) provides the firm with the economies of scale which allow it to offer its own differentiated products in foreign markets at a price competitive with foreign products. Differentiation reflects national tastes and endowments and a foreign market for the product exists if tastes are diffused across a range of differentiation. This type of model combining tastes and scale economies reflect Bhagwati's "Biological" theorizing (Bhagwati, 1988) in which environment and genetic factors interact.[29] Venables shows that Krugman (1979, 1980) model and Dixit-Norman (1980) are special cases in a broad category of such models. In Venables' model, there is potential for multiplicity of equilibria (not necessarily all stable) due to parametric variations unlike the unique equilibrium case of Krugman.

As Greenaway and Milner (1986) points out, there are limitations in this approach like product variety determined solely by factor supply and production conditions irrespective of demand; process of variety selection by firm is ignored and assumption of costless adjustment to trade expansion where variety can be altered without additional costs (unlike Lawrence and Spiller, 1983 where fixed capital outlays are required as a prerequisite to introducing new variety). In these models, symmetry in consumption rules out the elimination of certain varieties when trade opens up and direction of trade is indeterminate in the absence of initial factor endowment differences.

**3.3.1c.`Integrated economy' approach:** Krugman (1988) has given a basic monopolistic competition models of trade where an `integrated equilibrium' is established in a world economy in which all countries share a common technology and produce two goods `Manufactures' and `Food' with two factors of

[29] See Chapter Notes 3.

production Capital and Labour. This model is based on Helpman and Krugman (1985, Chs. 1,2). In this model, food is produced with CRS technology and manufactures is subject to product specific economies of scale. The world economy becomes perfectly integrated due to international trade depending on the allocation of the integrated economy's production among the trading countries so that full employments of all factors are generated while `non-negative' amount of every good is produced. This means the world economy could achieve the same outcome that would occur if all factors of production could work with each other freely. By geometric exposition, it has been shown that as long as resources are not divided too unequally it is possible to reproduce the production of the integrated economy without inter-country distribution of resources. The traditional inter-industry trade flows occur according to the conventional comparative advantage as, the capital abundant country is a net exporter of capital-intensive manufactures.

So far as the GFT argument is concerned, with DS preferences, the elasticity of substitution in demand for varieties is constant and trade offers greater variety but not greater scale whereas in Lancastrian preferences, trade is likely to lead to more elastic demand facing firms to move down their average cost curves. Both increased scale of production and increased diversity of available products are gains from scale in a more concrete form in Helpman and Krugman (1985). Thus trade is beneficial if the global production of manufactures is larger than our national output would have been in the absence of trade.

3.4. Oligopolistic markets and IIT

Because a variety of assumptions can be made regarding conjectural variations, equilibrium outcomes can be generated in a wide range of contexts. Scale economies have also been associated with IIT models in their role as a source of barriers to entry. Strategic interaction among oligopolists whose market share is related to internal economies may result in two way trade as in Brander (1981). Further, with regard to "home market effects" of Helpman and Krugman which leads the monopolies to specialise geographically, Rauch (1989) suggests that a monopolist could internalize Ethier's international external effects by organising as a multinational and engaging in intra-firm IIT. This possibility means that unless the externalities are tied to non-tradable inputs, IIT would not necessary be reduced in the presence of increasing returns. Furthermore, Rauch points out those internal economies linked to a specific location by non-traded inputs or transport costs effects must be strong enough to offset the diseconomies of metropolitan agglomeration before they have the effect of reducing IIT. Because these diseconomies rise steeply with city size he argues that it is difficult to envision large countries as having a comparative advantage capable of affecting the international location of manufacturing simply because they are large.Everything depends on assumption regarding basic structural features of the market concerned and the conjectural variation.

Some important insights into international trade have been gained by adopting the Cournot (1838) assumption that imperfectly competitive firms take each others output as given. Papers by Brander (1981), Brander and Krugman (1983), Neven and Phlips (1984) and Krugman (1984) have made this assumption. The Cournot approach has led to the possibility of trade arising purely because imperfectly competitive firms have an incentive to try to gain incremental sales by "reciprocal dumping" in each others home markets.

The model of Brander (1981) envisages an industry consisting of two firms, each in a different country and each acting as a monopolist in autarky. They take the other firm's deliveries to each market as given. There would be an incentive for each firm to sell a little bit in the others home market as long as the price there exceeds marginal cost and it will continue until, with symmetric firms, each firm has a 50% share of each market. This theory of "reciprocal dumping" is related in important ways to the traditional Industrial Organization literature on basing point pricing and cross hauling. What the new models make clear, however, is that despite the waste involved in transporting the same good in two directions, trade can still be beneficial. The major importance of the Cournot approach, however, lies in its versatility and flexibility of discussion of trade policy. The assumption of Cournot behaviour is robust in the sense that the prediction of the model hold for a variety of demand and cost conditions, e.g., Brander (1981) assumed linear demand and Brander and Krugman (1983) argued the central predictions hold for any type of demand. As Greenaway and Milner (1986) points out, the assumption of output as a strategic variable and zero conjectural variation is questionable. Eaton and Grossman (1983) have got totally different results taking price as the decision variable.

As opposed to this model, different models have been developed where products are vertically differentiated and entry considerations are important. Unlike the Falvey Kurzkowski model, product quality is exogenously given. These models are based fundamentally on the work of Gabszewicz, Shaked, Sulton and Thisse (GSST) in a natural oligopoly framework as the number of firms in the market is limited.

The mathematical complexity of the model is beyond the scope of this review. The above theoretical models have empirical basis and much of the intra-industry trade literature is based upon empirical studies relating to the degree of intra industry trade and the associated country and industry features explaining it. The empirical analyses of IIT requires some discussion regarding problems of measurement and the methodological issues to which we turn in the next section. Assessing the importance of these theories in explaining the pattern of trade is essentially an empirical matter.

4. Measurement and Empirical Analysis of IIT: Methodological Issues

4.1 Measurement of IIT

There are, however, two unresolved problems which seriously undermine the empirical results on this subject. The first is the very existence of IIT and the `objective difficulty' of finding a suitable quantitative measure of IIT and the second concerns the definition of "industry" and the level of data disaggregation at which the phenomenon is best observed. Both are linked together.

While measures of IIT appeared in the literature long before the seventies [Verdoom, 1960; Kojima, 1964; Balassa, 1966], it was only in 1971 and 1975, with two contributions from Grubel and Lloyd, that the measurement problems were explicitly raised and discussed. The solution proposed by Grubel and Lloyd (hereafter GL) was subsequently disputed by Aquino (1978), who was later criticized by Greenaway and Milner (1981; 1983). Grubel and Lloyd (1975) reviewed the indices used in previous works and then proposed one of their own which was a modification of the one Balassa had used to assess the effects of the formation of the Common Market on the international specialization of the EEC countries involved, with special reference to the question whether the EEC led to inter - or to intra-industry specialization.

Balassa's indices (1966) of the measure of trade matching viz., the extent to which the absolute amount (by value) of commodity exports (Xi) is matched by imports (Mi) are given, at a particular level of aggregation, by

$$B_i = \frac{|X_i - M_i|}{|X_i + M_i|} = \frac{\text{Net trade}}{\text{Gross trade}} \qquad (1)$$

where $0 \le B_i \le 1$.

Summing across industries and taking the arithmetic mean lead to a measure (B) of the degree of a country's inter-industry specialization. The degree of intra-industry specialization is measured by:.

Thus,

$$B = \frac{1}{n}\sum_{i=1}^{n} B_i \qquad (2)$$

and (1-B) measures the degree of intra-industry specialization.

Grubel and Lloyd criticized this index both because it is a simple arithmetic mean of each industry's index (failing to reflect the different weight of each industry) and because it does not take into account the correction for aggregate trade imbalances. They introduced a simple transformation of Bi such that

$$GL_i = (1 - B_i) \times 100 \qquad (3)$$

i.e., $$GL_i = \frac{(X_i + M_i) - |X_i - M_i|}{(X_i + M_i)} \qquad (4)$$

and at the aggregate level, the summary measure is,

$$GL = \frac{\sum_{i=1}^{n}(X_i + M_i) - \sum_{i=1}^{n}|X_i - M_i|}{\sum_{i=1}^{n}(X_i + M_i)} \qquad (5)$$

Grubel-Lloyd (1971, p. 497) observe with respect to GL that it is "a biased downward measure of intra-industry trade... (in case of) an imbalance between exports and imports....". In this case, GL cannot attain its maximum value 1 because exports and imports cannot match in every industry. This is an undesirable feature of this measure of aggregate IIT. Grubel and Lloyd (1971; 1975) proposed the adjusted measure:

$$\overline{GL} = \frac{\sum_{i=1}^{n}(X_i + M_i) - \sum_{i=1}^{n}|X_i - M_i|}{\sum_{i=1}^{n}(X_i + M_i) - \left|\sum_{i=1}^{n} X_i - \sum_{i=1}^{n} M_i\right|} \tag{6}$$

and they comment that for trade with individual countries, "this adjustment makes a substantial difference if the bilateral trade imbalances are large relative to the combined total export and import trade" (1971, p. 498).

GL and $\overline{GL}$ are related by

$$\overline{GL} = \frac{GL}{1-k} \tag{7}$$

where
$$k = \frac{\left|\sum_{i=1}^{n} X_i - \sum_{i=1}^{n} M_i\right|}{\sum_{i=1}^{n}(X_i + M_i)}$$

In other words, IIT is now measured with respect to total balanced trade and not to total trade; thus $\overline{GL}$is supposed to have corrected the downward bias of the GL measure. The measure GL applies to aggregate trade flows only and does not have a counterpart at the level of an individual industry. Moreover, when for all i either Xi exceeds Mi or falls short of it, GL = 1 regardless of the size of these trade imbalances.

The subsequent literature generally accepts the GL arguments for adjusting trade imbalances and the correction procedures. Aquino (1978), made another correction and criticizes that the elementary measure GLi, at the most disaggregated level, is also downward biased as GL is also downward biased. He proposes an index for measuring IIT for "correcting for the overall imbalance at the elementary level". He simulates balanced trade by calculating "theoretical values" of exports and imports at the industry level i.e., values of Xi and Mi, for all i, if total exports had been equal to total imports. These are given by

$$X_i^e = X_i \frac{\sum_{i=1}^{n}(X_i + M_i)}{2\sum_{i=1}^{n} X_i} \tag{8a}$$

$$M_i^e = M_i \frac{\sum_{i=1}^{n}(X_i + M_i)}{2\sum_{i=1}^{n} M_i} \qquad (8b)$$

These values are applied to GLi in (4) and GL in (5) to arrive at the corresponding measures Qi at the level of industry and Q for total trade. The procedures in (8) equation may lead to a decline in trade overlap in industries where Xi=Mi. With Xi=Mi and overall trade imbalance, it follows that Qi < GLi and this contradicts the remark in Aquino (1978, p. 280) that GL is a downward summary measure of IIT just because GLi is a downward biased measure of IIT in each industry. Greenaway and Milner (1981) object to the `equiproportionality' because "it is extremely difficult to identify a macro-economic effect at the more micro level with any confidence" and "industry specific" factors are to be observed rather than eliminated.

Aquino takes the imbalance in multilateral manufactured trade as the basis for correction. Greenaway argue that there "can be no a priori justification for approximating "equilibrium" with multilateral balance on manufactured trade" (1981, pp. 757-8).

The Aquino measure for country j

$$Q_j = \frac{\sum_{i=1}^{n}(X_{ij} + M_{ij}) - \sum_{i=1}^{n}\left|X_{ij}^e - M_{ij}^e\right|}{\sum_{i=1}^{n}(X_{ij} + M_{ij})}.100 \qquad (9)$$

can be simplified to get Michaely index (1962) “F” presented in Grubel and Lloyd (1975).

$$F = 1 - \frac{1}{2}\sum_i \left| \frac{X_i}{\sum X_i} - \frac{M_i}{\sum M_i} \right| \qquad (10)$$

“F” calculates similarity of trade shares rather than overlap in trade flows. The Aquino-measure will have the same value as long as the shares of industrial exports in total exports and the shares of industrial imports in total imports do not change, regardless the size of the industrial trade flows.

Balassa (1979; 1986) applied this type of correction, but allows for inter industry specialization between primary and manufactured goods unlike Aquino where balanced manufactured trade is achieved with Aquino-correction. Thus Balassa (1979) concludes that with the Aquino adjustment IIT is overestimated.

Balassa Correction is given by multiplying Xi and Mi i.e., value of exports and imports at the industry level with all commodity exports and imports, X and M respectively. Balassa defines

$$X_i^b = X_i \frac{(X+M)}{2X} \qquad (11a)$$

$$M_i^b = M_i \frac{(X+M)}{2M} \qquad (11b)$$

The properties of Balassa correction is such that it does not balance primary or manufactured trade and after correction resulting trade balances for primary and manufactured product categories end up to be of equal size with opposite sign.

Bergstrand (1983) is in favour of correcting for a country's trade imbalance, provided that the imbalance to correct for relates to multilateral, all commodity trade, like in the Balassa correction. Bergstrand ignores Aquino's index and proposes an iterative procedure for adjusting bilateral disaggregated trade flows in order to make them consistent with the multilateral aggregate trade balance. The index for measuring IIT is given by

$$IIT_{ij}^{k*} = 1 - (\left| X_{ij}^{k*} - X_{ji}^{k*} \right|)/(X_{ij}^{k*} + X_{ji}^{k*}) \qquad (12)$$

where

$X_{ij}^k =$ Exports from country i to j of industry k

$X_i = \sum_k \sum_j X_{ij}^k$ i.e., exports from all i to all j in goods k.

$M_i = \sum_k \sum_j X_{ji}^k$ i.e imports by country i from all origins j in all k.

and similarly

$X_j = \sum_k \sum_i X_{ji}^k$ i.e export from j to all i in all industries k

$M_j = \sum_k \sum_i X_{ij}^k$ i.e imports from all origins i by j in all industries k.

The asterix indicates that trade flows are corrected for trade imbalance where

$$X_{ij}^{k*} = \tfrac{1}{2}[(X_i + M_i)/2X_i + (X_j + M_j)/2M_j]X_{ij}^{k} \qquad (13)$$

and

$$X_{ji}^{k*} = \tfrac{1}{2}[(X_j + M_j)/2X_j + (X_i + M_i)/2M_i]X_{ji}^{k} \qquad (14)$$

The correction factor is

$$\tfrac{1}{2}[(X_i + M_i)/2X_i + (X_j + M_j)/2M_j] \qquad (15)$$

where $(X_i + M_i)/2X_i$ is total trade of country i relative to two times its exports so that for trade deficit of country i, it contains an impulse to increase country i's exports. The factor $(X_j + M_j)/2M_j$ means that in case of a trade surplus of country j, the correction factor contains an impulse to increase its imports from county i. It is interesting to note that both elements work in the same direction of increasing the exports from country i to country j. For both countries having either a trade deficit or surplus, two elements would work in the opposite direction. Looking at the correction factors without any double country index one can infer that bilateral trade flows for the industry k are simulated to reflect multilateral aggregate trade balance. X_{ij}^{k*} and X_{ji}^{k*} are computed iteratively until some convergence criterion is metade which he formulates that the difference between the values in two successive rounds of the correction procedure for each of the bilateral trade flows for each industry k has become less than some preset small figure (0.001 in his study, ibid, p. 209).

The correction procedure stops when all countries are in multilateral trade balance and this, however, implies that in order to carry out the Bergstrand correction, trade data are required for the focus country i, its trade partners; and even for the latter's' trade partners other than i and j. For bilateral IIT of i and j, the other countries can be taken together in a third group "rest of the world" and the way in which such a group of other countries is represented in the analysis will influence the outcomes of the Bergstrand correction. In the Bergstrand correction, the amount of bilateral IIT depends on the way in which third countries are aggregated and in the Balassa correction, it depends on the use of trade data of either country. Now for a country with overall Balance of Payments equilibrium, the individual subaccounts may not be in balance. Krugman and Obstfield (1988) observe that, if all countries are in current account equilibrium, no allowance for the possible important gains from trade over time is made. For countries where investment is relatively unproductive, they are net exporters of current output and have a trade surplus. Moreover, there are determinants and adjustments of imbalances in the current account, which do not have equiproportional impacts over product groups e.g., external factors like oil price hike and rising protection in export markets and domestic factors like demand pressures and inadequate supply, etc. Greenaway and Milner (1981) suggests that transitory influences are to be excluded by judicial selection of years to avoid periods of disequilibrium or taking average of the indices for IIT over a cautiously selected time period.

So long we have considered only `need for correction argument' for trade imbalances. Of greater significance is the problem of `Categorical Aggregation" i.e. inappropriate grouping of activkities within a particular statistical category with the result that the measured IIT (at a given level of aggregation) provides an erroneous indication of actual IIT. But since there is no single level of aggregation in the SITC or country specific standard industrial classificcation which ideally corresponds to the industry level, categorical aggregation complicates the measurement of IIT. Some have suggested that at the 3 digit level categorical aggregation may be pervassive and Finger (1975) described IIT as a "statistical artifact".

More constructive analysis have endeavoured to establish the extent of categorical aggregation and/or adjustment the Grubel Lloyd index to take some account of the influence. Greenaway and Milner (1985) proposed an adjusted GL index.

Grubel Lloyd index of IIT for the jth of inudstries at a given level of statistical aggregation is given by

$$GL_j = [1 - \frac{|X_j - M_j|}{(X_j + M_j)}] \times 100$$

where $0 \leq GL_j \leq 100$

GLj is recorded at 3 digit of the SITC on the assumption that at this level consistent differences in input requirements between statistical group is observed. `If, however, j, is defined in such a way that the component subgroups at the (j-1) level of aggregation have differing factor ratios then GLj will be distorted as a result of categorical aggregation (Greenaway and Milner, 1985, p. 901). Finger (1975) and Rayment (1976) suggested that there might be a great deal of variability in factor input ratios between subgroups in a given 3rd digit category. In this case, measurement of GLj is meaningless because a `high' index would be quite consistent with Heckscher-Ohlin trade. However, the 3 digit of the SITC and its equivalent in other classifications nevertheless remains the most popular level of statistical aggregation for estimating GLj, and for cross section econometric analysis directed at explaining at variations in GLj. As Gray (1979) noted aggregation bias can occur due to an `opposite sign effect' and a `weighting effect' depending upon subgroup trade imbalances and its magnitude. Example can be constructed where it can be shown that misclassification may manifest itself in opposite signed subgroup imbalances and they can work against each other.[30]

`Regrouping' faces the problem of absence of any unique criteria for doing this and also ambiguity about allocation of trade in parts and components in any reclassified scheme. Thus the option remains problematic due to lack of consensus on some "systematic economic criteria".

Greenaway and Milner (1985) have given an adjusted index of IIT to shed new light on Categorical Aggregation. Since value of GL as measured by (5) is

$$GL = \frac{\sum_{j=1}^{n}\left[(X_j + M_j) - \left|X_j - M_j\right|\right]}{\sum_{j=1}^{n}\left(X_j + M_j\right)}.100$$

value of GL depends on the aggregation level. For narrowly defined industries, $(X_j + M_j)$ is unchanged but

$$\sum_{j=1}^{n}\left|X_j - M_j\right| \geq \sum\left|X_i - M_i\right|$$

where i refers to subcategory i and the *sufficient condition for strong inequality* is the existence of `*opposite signed imbalances'*. Under this condition, a smaller measure of IIT is obtained with a narrower definition of industries.

Greenaway and Milner (GM) calculated IIT for each subcategory and divided this by subcategory's total trade to get GLi. It is the equal weight assigned to all subcategories that creates problem and GM propose as superior a trade weighted average of Bj:

[30] See chapter notes 4 for examples of this problem.

Thus, $$C = [1 - \frac{\sum \left| X_{ij} - M_{ij} \right|}{\sum \left(X_{ij} + M_{ij} \right)}] \times 100$$

is the Greenaway and Milner *adjusted index*. C is closely related to (5) and if the normalization procedure of dividing by total trade is done in the final step then GL=C.[31]

However, this issue remains unsettled due to *lack of criteria* to interpret the numbers and no consensus on definition of `industry'. Moreover, it is not mentioned what values of C are significant. Measured IIT is always likely to exceed zero unless industries are defined by individual transactions. Greenaway and Milner (1985) suggest several empirical procedures for evaluating the impact of aggregation effects in the measurement of IIT; these are: measurement at a lower level of aggregation, measurement according to alternative classification system and computation of an adjusted GLj index i.e., computation of C. Pomfret (1985) claims that GLj and C indices are alike $\left(0 \leq C \leq GL_j \leq 100\right)$.[32]

Thus we see that although greater degree of professional consensus exists in regarding the 3rd digit as being a reasonable approximation to industry, for analysing the evidence of IIT and econometric analysis of its determinants, 2 digit level i.e., lesser disaggregation can serve the purpose at hand. Spotting activities where any level of disaggregation may be inappropriate could be repeated ad infinitum at any digit without any positive analysis of its evidence. From the above discussion, it is clear that Aquino solved the problem of the GL index by dropping the term $\sum_i \left| X_i - M_i \right|$ from his measure Qj. As Vona (1990) comments, the link between the theoretical concept of IIT and the empirical one of trade overlaps is broken; or, in other words, the `new' index is a measure of the trade composition similarity. This Michachy-Aquino measure solves the problem of the GL index i.e., its dependence on the level of data aggregation, but as Vona (1990) shows, this measure is totally unrelated to the pattern of trade flows which actually take place at that specific level, but depends on the intersectoral composition of trade flows. These shortcomings suggest that it is not a suitable

[31]See chapter note 4.

[32]Pomfret, R., `Categorical Aggregation and International Trade: A Comment', The Economic Journal, 95 (June 1985), pp. 483-485.

measure of IIT rather uncorrected GL index i.e., GL(U) is a suitable measure. It is given by:

$$GL(U)=\frac{\sum_{i=1}^{n}\left(X_i+M_i\right)-\sum_{i=1}^{n}\left|X_i-M_i\right|}{\sum_{i=1}^{n}\left(X_i+M_i\right)}.100$$

Vona (1991) has pointed out its important features viz., first, it does not suffer from the problem of reaching the maximum which arises with GL (vide equation 6) because *in some cases*

$$\sum_i\left|X_i-M_i\right| \quad \text{is equal to} \quad \left|\sum_i X_i-\sum_i M_i\right|$$

Second, it performs better than other indices Vona (1991) constructs an example and shows that correcting for trade imbalance leads to an index which gives overestimation than the uncorrected index, and also behaves differently indicating an increase in the degree of IIT.[33] Thus, uncorrected GL index is the best suitable measure and posses desirable features. Finger (1975) preferred an `uncorrected' index giving support to `non-correction' argument by saying that "if the results are to be used to evaluate the validity of the factor proportions theory or any other theory, the unadjusted measure is prefereable. Any adjustment contains implicit assumptions about the effect on trade patterns of eliminating the phenomenon being adjusted for, hence the `adjusted' figures could be misleading because of the invalidity of these implicit assumptions" (Finger, 1975, p. 586). Vona (1991) proposed a `New Index' of IIT but according to him "it is premature to state that the new index is definitely superior to the existing ones" (ibid, p. 698). This index is linked to theoretical premises and is not linked to trade overlap but directly reflects the concept of IIT.[34] From our analysis, it may be inferred that GL(U) is the best suitable measure of IIT in spite of its responsiveness to the level of data disaggregation `whose optimal level is difficult to determine empirically' and this depends on operationalizing the concept of `industry'.

4.2 Empirical Analysis and Methodological Issues

The above review suggests that given the diversity of models of IIT, it is not easy, or even possible, to formalize a simple and universal test in the fashion of the factor-intensities based H-O. trade or of the

[33] See chapter notes 6.

wage-productivity relationship of Ricardian trade theory. In this subsection we will mention the problem confronted by any attempts to `test' specific `new theories' of IIT and the difficulties involved in testing hypothesis based upon theories *without going into details* of the set of empirical analysis.

The diversity of types of IIT (i.e., in homogenous, horizontally and vertically differentiated goods) and under alternative market structures (competitive, monopolistically competitive and oligopolistic) makes the testing difficult. There have been empirical `tests' of trade models of hypotheses of international trade which may play role in generating certain types of IIT or in creating conditions conducive to IIT. Hufbauer (1970); Katrak (1973) has separately investigated a positive correlation between scale economies in export industries and measures of country size. But these are not tests of specific models of IIT; rather, they are either implications drawn for non-IIT theories or ones that cannot be inferred from specific models of IIT. An attempt to derive testable implications from a specific model of monopolistic competition has been made by Helpman (1984) and Helpman and Krugman (1985). Helpman shows that a gravity-type equation can be derived from such a model and hypotheses about the composition of bilateral trade flows.

For arresting the effect of market structure variables, concentration ratio measures and Herfindahl index, Linder index, entropy coefficients are used. We are not going into the details but the basic point to note is the fact that superior productivity and dominance in market as well as high industry concentration implies rise in exports as well as imports and hence a positive relationship with IIT could be postulated. We now turn to the ***econometric analysis of IIT***. Most of them attempt to explain observed inter-country or inter-indstury variation in IIT. The range of studies so far completed encompasses developed market economies [e.g. Aquino (1978), McAleese (1979); Greenaway (1983)], developing countries [Balassa (1979); Havrylyshyn and Civan (1983); Tharakan (1984, 1986)] and centrally planned economies [e.g., Pelzman (1978)]. These analyses provide sufficient comprehensive information on a number of "***stylized facts***".

Pagoulatos, Sorensen (1975); Finger, DeRosa (1979); Loertscher, Wolter (1980); Caves (1981); Lundberg (1982); Toh (1982); Bergstrand (1983); Greenaway and Miher (1984); Tharakan (1984, 1986);

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[34] Vide Chapter Notes 7 for the `New index' of Vona (1991).

Mac Charles (1986); Balassa and Bauwens (1987) - all have done econometric analysis incorporating industry characteristics. These studies differ markedly in their country and industry coverage, the time period, model specifications, the proxies used for product differentiation and scale economies and measurement of IIT. Taste similarity, product differentiation, decreasing costs and market concentration appear to be deterministically related to IIT and all these studies support the fact that, recorded IIT is not a `statistical artifact', or the outcome of random measurement problems. There have been a few econometric studies which have concentrated on country hypothesis regarding country size, stages of development, per capita income, etc. The cross country analysis shows intercountry differences in IIT in manufactured goods and examine determinants of IIT in manufactured goods *either* in bilateral trade (IIT between pairs of countries and explanations with respect to general country characteristics and specific country characteristics) *or* in multilateral trade (i.e., IIT between a country with a group of countries specified by level of development, geographical concentration-aggregate over countries of origin and destination for exports and imports).

Cross industry analysis investigates the inter industry variations in terms of industry characteristics as it is done by Toh (1982) for U.S. manufacturing, Greenaway and Milner (1984) for the U.K.; Lundberg (1982) for Swedish Manufacturing; MacCharles (1986) for Canada; Messerlin and Becuwe (1986) for France; Sazanarin (1986) for Japan. Cross-country analysis incorporating ***both industry and country characteristics*** have been carried out by Lee (1988) for IIT among Pacific Basin Countries; Balassa and Bauwens (1987, 1988); Bergstrand (1983), etc. A detailed account of all these studies is beyond the scope. A closer look into and deeper analysis of the empirical studies relevant to our purpose is described in the following section.

5. Intra-Industry Trade: Recent Empirical Evidences using a Global Database

We measure the extent of IIT in manufactures for a set of countries and study the country characteristics and interrelationships between the degree of IIT and some country features. The analysis to be carried out will help explaining the source of generation of IIT in developing countries and the relevance of analysis of IIT, both theoretical and empirically, in the context of developing countries. We use Global Trade Analysis Project's (GTAP) Version 6 Database (2004) to compute extent of such trade. GTAP is a Computable General Equilibrium (CGE) trade model with large database suitable for policy analysis (Hertel ed. 1997).[1] This model divides the world economy into several countries and composite regions. The model and database are widely used for analyzing the effects of issues such as trade liberalization and technological changes. The original Version 6 database consists of 57 commodities and 87 regions expressed in U.S. billion dollars. Typically, the database comprises bilateral trade flows between all the regions. Each set of transactions is recorded at both market prices and agent's prices. GTAP model belongs to the class of computable general equilibrium models (CGE) based on the Australian ORANI model (Dixon et al. 1982). Following discussions in section 4, we use Equations (4) and (5) to calculate Grubel-Lloyd index (GL (U). The rationale has already been spelt out in section 4.1. Table 2 presents the measures of IIT at sectoral level for the GTAP sectors and regions based on GTAP Sectoral Classification (GSC2).

Table 2: Grubel-Lloyd Intra-Industry Trade Indexes for Selected Regions and Sectors

	GSC2 Regions and GTAP Codes	Australia	New Zealand	China	Hong Kong	Japan	Korea	Taiwan
GSC2 Sector and codes		1 aus	2 nzl	4 chn	5 hkg	6 jpn	7 kor	8 twn
27 tex	Textiles	0.35	0.56	0.84	0.74	0.99	0.45	0.23
28 wap	Wearing apparel	0.25	0.65	0.14	0.77	0.06	0.68	0.60
29 lea	Leather products	0.61	0.75	0.14	0.02	0.09	0.69	0.52
30 lum	Wood products	0.78	0.36	0.36	0.06	0.08	0.40	0.69
31 ppp	Paper products, publishing	0.48	0.90	0.67	0.66	0.73	0.98	0.68
32 p_c	Petroleum, coal products	0.69	0.26	0.84	0.00	0.22	0.87	0.61
33 crp	Chemical, rubber, plastic products	0.54	0.90	0.80	0.24	0.81	0.88	0.96
34 nmm	Mineral products nec	0.58	0.33	0.58	0.06	0.85	0.68	0.85
35 i_s	Ferrous metals	0.79	0.78	0.45	0.11	0.34	0.95	0.88
36 nfm	Metals nec	0.29	0.63	0.61	0.50	0.75	0.68	0.39
37 fmp	Metal products	0.50	0.87	0.39	0.31	0.83	0.58	0.36
38 mvh	Motor vehicles and parts	0.55	0.17	0.62	0.01	0.21	0.29	0.92
39 otn	Transport equipment nec	0.59	0.22	0.95	0.00	0.47	0.58	0.95
40 ele	Electronic equipment	0.23	0.28	0.87	0.23	0.75	0.70	0.71
41 ome	Machinery and equipment nec	0.43	0.59	0.91	0.37	0.53	0.96	0.94
42 omf	Manufactures nec	0.64	0.89	0.12	0.37	0.90	0.73	0.54
43 ely	Electricity	0.07	0.09	0.54	0.47	0.46	0.08	0.56
46 cns	Construction	0.77	0.98	0.73	0.43	0.96	0.75	0.98
47 trd	Trade	0.91	0.73	0.51	0.08	0.68	0.72	0.75
48 otp	Transport nec	0.94	0.98	0.84	0.36	0.43	0.64	0.88
49 wtp	Water transport	0.80	0.51	0.17	0.22	0.35	0.50	0.45
50 atp	Air transport	0.77	0.71	0.95	0.41	0.87	0.88	0.81
51 cmn	Communication	0.89	0.84	0.93	0.77	0.72	0.75	0.99

Source: Author's calculation using GTAP Database Version 6 using Gempack simulation software.

[1] It is developed at the Centre for Global Trade Analysis, Purdue University, USA (www.gtap.org) and with the collaboration of international organizations such as the World Bank, WTO, ILO, Productivity Commission, to name a few. It is based on the CGE model developed in Centre of Policy Studies, Monash University, Melbourne, Australia.

Table 2 (Continued)

	GSC2 Regions												
	Indonesia	Malaysia	Philippines	Singapore	Thailand	Viet Nam	Bangladesh	India	Sri Lanka	Canada	USA	Mexico	Venezuela
GSC2 Sectors	10 idn	11 mys	12 phl	13 sgp	14 tha	15 vn	17 bgd	18 ind	19 lka	21 can	22 usa	23 mex	27 ven
27 tex	0.63	0.84	0.67	0.75	0.66	0.51	0.98	0.24	0.67	0.72	0.58	0.94	0.25
28 wap	0.06	0.34	0.11	0.66	0.08	0.13	0.04	0.03	0.09	0.65	0.18	0.48	0.06
29 lea	0.18	0.87	0.48	0.75	0.30	0.26	0.13	0.24	0.31	0.25	0.16	0.82	0.26
30 lum	0.05	0.16	0.57	0.51	0.36	0.27	0.53	0.57	0.60	0.42	0.35	0.66	0.09
31 ppp	0.45	0.61	0.41	0.95	0.97	0.22	0.02	0.48	0.23	0.55	0.91	0.41	0.21
32 p_c	0.62	0.93	0.49	0.63	0.12	0.00	0.01	0.89	0.08	0.76	0.63	0.31	0.00
33 crp	0.91	0.92	0.32	0.90	0.99	0.30	0.40	0.96	0.68	0.87	0.98	0.54	0.60
34 nmm	0.75	0.89	0.60	0.77	0.73	0.78	0.53	0.93	0.65	0.79	0.82	0.99	0.84
35 i_s	0.48	0.49	0.13	0.42	0.40	0.06	0.01	0.96	0.07	0.83	0.60	0.71	0.79
36 nfm	0.49	0.58	0.85	0.61	0.33	0.16	0.01	0.34	0.14	0.62	0.64	0.75	0.34
37 fmp	0.93	0.89	0.46	0.60	0.88	0.51	0.06	0.46	0.30	0.86	0.76	0.79	0.60
38 mvh	0.40	0.64	0.59	0.32	0.90	0.03	0.03	0.87	0.07	0.90	0.54	0.79	0.18
39 otn	0.29	0.61	0.61	0.48	0.50	0.20	0.09	0.62	0.40	0.81	0.83	0.71	0.05
40 ele	0.51	0.57	0.85	0.96	0.80	0.62	0.04	0.43	0.45	0.78	0.79	0.83	0.03
41 ome	0.74	0.75	0.77	0.77	0.96	0.43	0.10	0.66	0.34	0.83	0.91	0.85	0.11
42 omf	0.53	0.51	0.80	0.78	0.65	0.72	0.35	0.76	0.84	0.71	0.41	0.99	0.26
43 ely	0.80	0.28	0.15	0.01	0.22	0.42	0.29	0.28	0.22	0.64	0.68	0.61	0.16
46 cns	0.20	0.67	0.29	0.76	0.68	0.32	0.31	0.83	0.11	0.89	0.44	0.17	0.49
47 trd	0.30	0.29	0.51	0.87	0.89	0.29	0.16	0.96	0.51	0.63	0.81	0.52	0.31
48 otp	0.96	0.66	0.73	0.61	0.48	0.43	0.70	0.64	0.69	0.56	0.88	0.61	0.87
49 wtp	0.91	0.19	0.55	0.41	0.38	0.83	0.16	0.73	0.54	0.44	0.36	0.31	0.73
50 atp	0.92	0.73	0.98	0.70	0.37	0.45	0.19	0.82	0.77	0.80	0.93	0.90	0.73
51 cmn	0.71	0.62	0.82	0.84	0.95	0.42	0.89	0.72	0.21	0.95	0.99	0.73	0.25

Table 2 (Continued)

	GSC2 Regions							
	Netherlands	Portugal	Sweden	Switzerland	Romania	Turkey	Botswana	South Africa
GSC2 Sectors	48 nld	49 prt	51 swe	52 che	63 ror	71 tur	76 bwa	77 zaf
27 tex	0.67	0.86	0.64	0.86	0.58	0.49	0.86	0.81
28 wap	0.16	0.60	0.39	0.27	0.36	0.12	0.73	0.94
29 lea	0.15	0.71	0.41	0.39	0.92	0.96	0.44	0.84
30 lum	0.27	0.76	0.61	0.50	0.30	0.77	0.19	0.54
31 ppp	0.83	0.91	0.32	0.78	0.42	0.49	0.13	0.84
32 p_c	0.69	0.37	0.78	0.02	0.97	0.32	0.03	0.09
33 crp	0.87	0.57	0.91	0.79	0.56	0.48	0.31	0.87
34 nmm	0.69	0.92	0.94	0.72	0.87	0.71	0.02	0.81
35 i_s	0.99	0.44	0.73	0.73	0.71	0.99	0.16	0.24
36 nfm	0.95	0.40	0.99	0.93	0.62	0.37	0.16	0.19
37 fmp	0.93	0.80	0.86	0.94	0.72	0.91	0.07	0.74
38 mvh	0.64	0.78	0.74	0.32	0.45	0.91	0.43	0.87
39 otn	0.97	0.66	0.87	0.58	0.82	0.68	0.20	0.50
40 ele	0.70	0.77	0.86	0.68	0.72	0.61	0.10	0.35
41 ome	0.91	0.65	0.86	0.68	0.62	0.64	0.19	0.75
42 omf	0.61	0.70	0.76	0.87	0.93	0.77	0.04	0.56
43 ely	0.32	0.76	0.87	0.45	0.45	0.18	0.20	0.88
46 cns	0.66	0.60	0.83	0.85	0.58	0.15	0.48	0.62
47 trd	0.56	0.77	0.89	0.75	0.67	0.66	0.91	0.78
48 otp	0.69	0.44	0.99	0.93	0.29	0.21	0.72	0.75
49 wtp	0.07	0.44	0.20	0.57	0.28	0.33	0.36	0.50
50 atp	0.64	0.75	0.84	0.86	0.68	0.55	0.76	0.86
51 cmn	0.96	0.89	0.99	0.97	0.65	0.41	0.68	0.83

We retain the region and sector's identifier number so as to keep it convenient to refer to the GSC classification by mentioning the numbers corresponding to the large database. Typically, there are two concordances of GSC2, one with the Commodity Product Classification (CPC) and the other one with the ISIC Revision 3 (UN).[2] In our empirical analysis, from Table 2 it is seen that the share of IIT in total trade is not a negligible percentage for the developing countries at more advanced level of development. Compared to the developed economies, the share is, no doubt, small. But the interesting picture that comes out from our analysis is that the share is substantial as they diversify their production structure to hi-tech goods especially, with the advent of information and communications technology. Manufactures exports were the developing countries most dynamic part of export sectors in the 1970s and 1980s and also in recent decade. With the rapid growth and economic development of the East Asian newly industrializing countries (NICs), Latin American NICs and the South and South East Asian Countries, there has been a significant increase in intra-industry trade (IIT) in the developing economies. A substantial proportion of these countries IIT has been with their major trading partners e.g., the United States, Japan, the EEC, the U.K., i.e. the developed world. The figures for intra-trade suggest that any presumption that LDCs are more likely to have a comparative disadvantage in advanced manufactures relative to industrial countries and advantage relative to developing countries less developed than them is too simple. Some commodities are too widely produced (e.g., clothing, steel, machinery and transport equipment, etc.) to offer scope for such intra-trade. Countries' whole trading patterns are developing although there has been little change in the composition of manufactured goods' imports. The Asian countries are no longer net importers of manufactures, and in Latin America the ratio of exports to imports is approaching a half. It is clear that the diversification into manufactures, and then into different sectors, has gone well beyond early stages of industrialization or exporting for the major exporters. Table 3 shows commodity-wise patterns of comparative advantage as revealed through their direction and composition of global trade.

[2] The complete list of 57 sectors-by-87 regions and their mappings to components are not reported for parsimony. However, they are readily available from the GTAP website, as noted above. This 6th Version is the latest release while Version 7 is under preparation and is scheduled to release by the end of 2008.

Table 3: Revealed Comparative Advantage indexes for GTAP Sectors and Regions (%)

	GSC2 Regions and GTAP Codes	1 aus	2 nzl	4 chn	5 hkg	6 jpn	7 kor	8 twn	10 idn
GSC2 Sector and codes									
1 pdr	Paddy rice	1.03	0.00	0.43	0.00	6.70	0.00	0.00	0.03
2 wht	Wheat	9.96	0.05	0.06	0.00	0.00	0.00	0.00	0.07
12 wol	Wool, silk-worm cocoons	55.32	51.25	1.63	0.00	0.01	0.01	0.38	0.05
13 frs	Forestry	0.57	18.42	0.20	0.00	0.01	0.02	0.02	3.24
15 coa	Coal	29.16	1.42	2.56	0.00	0.00	0.00	0.00	10.17
16 oil	Oil	0.59	0.07	0.06	0.00	0.00	0.00	0.00	1.55
18 omn	Minerals nec	13.92	0.24	0.50	0.00	0.06	0.04	0.04	6.37
27 tex	Textiles	0.19	0.32	2.25	1.22	0.69	2.57	2.90	2.33
28 wap	Wearing apparel	0.13	0.34	4.27	2.98	0.05	0.79	0.59	3.01
29 lea	Leather products	0.40	0.90	6.55	0.10	0.05	0.94	0.88	3.39
30 lum	Wood products	0.62	2.38	1.85	0.02	0.06	0.11	0.82	5.00
31 ppp	Paper products, publishing	0.43	1.85	0.41	0.38	0.26	0.54	0.32	2.30
32 p_c	Petroleum, coal products	0.55	0.17	0.59	0.00	0.15	1.62	0.33	0.81
33 crp	Chemical, rubber, plastic products	0.45	0.81	0.63	0.09	0.89	0.96	1.03	0.76
35 i_s	Ferrous metals	0.86	0.41	0.39	0.05	1.54	1.53	1.01	0.35
37 fmp	Metal products	0.34	0.56	1.71	0.10	0.74	0.94	2.20	0.49
38 mvh	Motor vehicles and parts	0.45	0.08	0.09	0.00	2.29	1.10	0.20	0.08
39 otn	Transport equipment nec	0.41	0.22	0.53	0.00	1.22	1.75	0.67	0.14
40 ele	Electronic equipment	0.13	0.08	1.53	0.26	1.73	2.28	3.22	1.08
41 ome	Machinery and equipment nec	0.34	0.36	1.04	0.17	1.73	0.75	1.01	0.38
42 omf	Manufactures nec	0.45	0.54	4.25	0.40	0.70	0.55	0.98	0.71

Source: Author's calculation using GTAP Database Version 6 using Gempack simulation software.

Table 3 (Continued):

	GSC2 Regions										
GSC2 Sectors	11 mys	12 phl	13 sgp	14 tha	15 vnm	17 bgd	18 ind	19 lka	21 can	22 usa	23 mex	27 ven
1 pdr	0.24	0.03	0.01	3.34	2.26	0.03	8.21	1.34	0.01	1.09	0.00	0.11
2 wht	0.00	0.00	0.01	0.00	0.00	0.00	2.91	0.00	4.63	1.86	0.21	0.00
12 wol	0.01	0.00	0.04	0.01	0.13	0.10	0.77	0.00	0.01	0.03	0.01	0.00
13 frs	3.89	0.15	0.14	0.09	0.43	0.11	0.45	0.59	1.03	1.01	0.06	0.05
15 coa	0.00	0.00	0.00	0.00	2.60	0.00	0.23	0.00	1.17	0.68	0.00	4.04
16 oil	0.55	0.00	0.00	0.01	4.23	0.00	0.00	0.00	0.56	0.00	2.04	15.46
18 omn	0.10	1.28	0.18	0.13	0.61	0.00	3.63	0.17	1.64	0.34	0.46	3.45
27 tex	0.45	0.70	0.30	1.46	1.04	9.01	4.26	3.66	0.36	0.50	0.98	0.11
28 wap	0.43	2.66	0.18	1.76	4.49	20.81	3.89	15.60	0.26	0.25	1.71	0.02
29 lea	0.14	0.94	0.17	1.85	13.69	3.51	2.11	1.98	0.07	0.17	0.30	0.12
30 lum	1.91	0.91	0.12	1.20	2.19	0.07	0.34	0.14	3.66	0.53	1.32	0.03
31 ppp	0.20	0.20	0.52	0.49	0.15	0.02	0.24	0.18	3.28	1.05	0.30	0.17
32 p_c	0.46	0.30	2.25	0.85	0.00	0.02	1.32	0.14	0.70	0.61	0.23	12.70
33 crp	0.58	0.19	0.91	0.89	0.32	0.37	1.03	0.55	0.78	1.08	0.43	0.56
35 i_s	0.29	0.09	0.20	0.42	0.09	0.02	1.17	0.04	0.58	0.38	0.51	1.93
37 fmp	0.39	0.28	0.38	0.78	0.34	0.04	1.33	0.17	1.07	0.90	0.95	0.37
38 mvh	0.09	0.13	0.04	0.30	0.01	0.00	0.13	0.01	2.35	0.86	2.06	0.14
39 otn	0.11	0.20	0.50	0.21	0.21	0.10	0.30	0.20	1.48	2.01	0.21	0.02
40 ele	4.25	4.96	3.74	2.08	0.25	0.01	0.12	0.09	0.44	1.08	1.81	0.01
41 ome	0.42	0.66	0.75	0.85	0.35	0.06	0.36	0.16	0.87	1.29	1.66	0.07
42 omf	0.61	0.53	0.39	1.64	0.97	0.14	4.60	2.08	0.36	0.63	0.48	0.09

Table 3 (Continued):

GSC2 Sectors	**GSC2 Regions** 29 arg	30 bra	31 chl	32 ury	37 au	38 bel	39 dnk	40 fin	41 fra	42 deu	43 gbr	44 grc	45 irl
1 pdr	3.48	0.11	0.01	56.03	0.01	0.11	0.02	0.00	0.19	0.02	0.05	0.76	0.02
2 wht	24.43	0.01	0.01	0.08	0.40	0.16	0.56	0.01	2.50	0.68	0.29	1.14	0.08
12 wol	4.50	1.23	0.61	18.64	0.02	0.16	0.03	0.00	0.18	0.14	0.41	0.31	0.37
13 frs	0.46	0.43	1.72	13.63	0.87	0.37	0.44	1.03	0.65	0.54	0.05	0.07	0.11
15 coa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.00
16 oil	1.81	0.22	0.00	0.00	0.00	0.00	0.59	0.00	0.00	0.00	0.74	0.00	0.00
18 omn	2.29	10.37	21.98	0.22	0.30	0.46	0.16	0.38	0.20	0.26	0.12	0.66	0.40
27 tex	0.36	0.49	0.20	0.73	0.72	1.08	0.61	0.24	0.68	0.68	0.50	1.52	0.27
28 wap	0.19	0.17	0.10	1.20	0.32	0.52	0.58	0.24	0.49	0.39	0.32	1.27	0.12
29 lea	2.42	3.00	0.16	6.54	0.64	0.79	0.27	0.15	0.62	0.29	0.29	0.38	0.11
30 lum	0.59	1.89	3.20	0.59	1.72	0.67	1.70	2.79	0.62	0.74	0.27	0.34	0.23
31 ppp	0.61	1.76	2.77	1.12	1.89	0.93	0.61	9.20	1.05	1.21	0.89	0.41	0.25
32 p_c	2.68	1.32	0.66	1.35	0.13	1.05	0.41	0.98	0.52	0.23	0.58	2.17	0.04
33 crp	0.79	0.63	0.58	0.88	0.77	1.84	1.00	0.63	1.45	1.31	1.27	0.47	3.25
35 i_s	1.54	2.35	0.14	0.22	1.53	1.79	0.43	1.94	1.27	1.15	0.71	0.70	0.07
37 fmp	0.30	0.60	0.32	0.07	1.40	0.95	0.94	0.92	0.90	1.46	0.87	0.59	0.28
38 mvh	0.70	1.02	0.07	0.35	1.09	1.53	0.18	0.30	1.41	2.30	0.82	0.07	0.08
39 otn	0.28	1.83	0.17	0.13	0.49	0.26	0.30	1.26	2.29	1.22	1.36	0.15	0.13
40 ele	0.03	0.33	0.01	0.04	0.47	0.34	0.34	1.82	0.60	0.64	1.07	0.13	1.73
41 ome	0.35	0.53	0.10	0.10	1.11	0.67	1.07	1.20	1.00	1.61	1.00	0.20	0.75
42 omf	0.11	0.379	0.095	0.256	0.63	2.666	0.354	0.19	0.624	0.49	1.28	0.40	0.38

Table 3 (Continued):

GSC2 Sectors	**GSC2 Regions** 46 ita	47 lux	48 nld	51 swe	57 hrv	60 hun	61 mlt	62 pol	63 rom	71 tur	76 bw	77 zaf
1 pdr	0.31	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.01	0.03	0.07	0.12
2 wht	0.08	0.12	0.06	0.46	2.60	1.96	0.03	0.00	1.87	1.84	0.00	0.45
12 wol	0.14	0.03	0.01	0.01	4.22	0.18	0.02	0.03	0.65	0.50	0.00	2.94
13 frs	0.06	0.89	0.01	0.68	3.31	1.37	0.09	0.78	1.36	0.17	0.18	1.40
15 coa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.09	0.00	0.00	0.00	19.18
16 oil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.55	0.00
18 omn	0.26	0.28	0.46	1.12	0.67	0.05	0.04	0.38	0.55	1.45	0.48	9.60
27 tex	1.92	1.18	0.33	0.26	0.85	0.64	0.42	0.86	1.93	4.80	0.35	0.48
28 wap	1.49	0.26	0.09	0.17	2.07	1.21	2.34	1.95	8.49	4.45	0.29	0.34
29 lea	3.67	0.14	0.07	0.12	1.88	0.94	0.90	0.82	6.01	0.41	0.17	0.42
30 lum	1.88	0.67	0.12	2.24	1.91	1.17	0.13	4.58	4.22	0.48	0.12	1.27
31 ppp	0.89	0.79	1.23	4.31	1.07	0.56	0.70	1.44	0.31	0.29	0.12	1.30
32 p_c	0.68	0.00	3.13	0.86	1.58	0.57	0.00	0.69	2.00	0.34	0.04	2.09
33 crp	1.05	1.16	1.60	1.02	0.75	0.93	0.35	0.77	0.51	0.45	0.12	0.73
35 i_s	1.17	7.64	1.01	1.79	0.38	0.54	0.12	1.43	3.37	2.80	0.06	3.24
37 fmp	1.58	1.39	1.49	1.49	0.78	1.02	0.30	2.42	0.90	0.77	0.07	1.35
38 mvh	0.71	0.27	0.46	1.34	0.11	2.08	0.16	1.25	0.22	0.64	0.20	0.82
39 otn	0.87	0.33	0.47	0.44	1.83	0.31	2.21	1.19	0.89	0.66	0.04	0.29
40 ele	0.29	0.67	0.41	0.87	0.13	1.52	3.11	0.29	0.33	0.21	0.01	0.12
41 ome	1.57	0.70	0.37	1.27	0.46	1.02	0.57	0.83	0.67	0.48	0.09	0.55
42 omf	1.15	0.21	0.86	0.26	0.48	0.47	1.23	0.48	0.48	0.58	29.01	1.52

The `stylized' picture that comes out from the empirical analysis is that the considerable two way trade of developing economies with the developed economies and also with the world can be explained by the level of development, market size, share of manufacturing value added in GDP and/or share of manufacturing exports in total exports and some trade orientation variable measuring, as a proxy, trade policy intervention. These are all country features. The specific products which have the highest levels of IIT are organic chemicals, glass, leather, iron and steel forms, textile yarn, fabrics, in addition to various types of machinery and equipment including vehicles. Goods with high IIT are more `sophisticated' and these are, mostly, capital intensive and/or investment goods. Changes in the specialization of certain manufactures towards intra-industry production and exchange is a reflection of the growing similarities between the developing economies and the developed counterpart in terms of relative factor endowments, consumers' preference structure, level of development. It may be reasonably expected that the LDCs will continue to evolve up the ladder of comparative advantage and specialize through international division of labour. As the developing economies diversify their export through increased IIT, the DCs will have opportunities to export to these countries the products of the industries e.g., textiles, leather, etc. This, however, depends on the LDCs ability to identify and adopt new technologies for achieving such competitiveness. Here, the "vertical specialization" becomes important. This means that quality differentiation rather than attribute differentiation is the appropriate product dimension. Consequently, IIT indices may be expected to be lower and more stable where the goods are vertically differentiated rather than horizontally. One, thus, enjoys a comparative advantage in specialized product lines and slight variations in product specification in response to diverse choice pattern have a limited effect on demand. Furthermore, it can be inferred from our findings that as industrialization led growth and development in the developing economies proceeds, pushing these countries along the development path towards the matured industrial country stage, intra-industry specialization in production and trade in certain manufacturing commodities will play an increasingly important role in manufacturing production and trade.

6. Intra-industry Trade Theory and Developing Economies

As we have seen from our previous discussions that the first generation models in this new literature have been shown to be applicable for explaining trade between countries at similar levels of per capita income or development viz., North-North trade. Krugman argues that this exclusion of "poor nations" is due to "a bias in the research agenda". The trade analysis of LDCs requires taking account of increasing returns and imperfect competition. The `new theory' is essentially based on "arbitrary" specialization to realise economies of scale. The specific characteristics of LDCs require a different emphasis for adopting the theories to the developing world. Certain features of Southern economies are of relevance that bear on appropriate choice of models of trade. One pertinent point to note is that most of the theories are applicable to manufactures trade not the `climatic' primary products. It is widely recognized that the simple H-O. theory is capable of explaining N-S trade in terms of the differences in factor endowment and mutual gains from this exchange are assured. But the remaining theories that have been mentioned above need some qualifications both as descriptions of actual trade flows and in terms of policy conclusion. The preference similarity theory, for example, is primarily applicable to N-N trade with tastes being determined by income level. The South having substantially lower income levels, on average, and having different tastes from the North would not participate in this form of trade. Marked income inequalities among the South economies imply that having skewed income distribution, the rich in these economies have incomes and hence tastes similar to those in the North. South could gain from preference-similarity trade with other Southern economies only if the South innovates and produces its own products. In these types of models, Southern focus is left ignored because the South has a comparative disadvantage in the production of these goods. International trade in these products permits Southern consumers a wide choice of products produced in the North but these goods have main market among high income consumers.

Where the South concentrates on production of differentiated consumer goods, it does it on a small scale and potential economies of scale remain partially, if not fully, unexploited. Stewart (1984) discusses this case in detail by pointing out that a lack of natural comparative advantage in their production at the primary stages when there are diseconomies of scale and no inefficiency (i.e., under employment of resources, etc.) compel most of them to produce under heavy protections. The market is confined to relatively small domestic market. The basic point to note is that for local production to take place on a sufficient scale to realize scale economies, given the small scale of the home market, very few varieties can be justified. As Stewart recognizes, there is a trade off between efficiency and variety, unless trade can perform the role of permitting specialization, scale economies and variety to be exploited.

As far as intra-industry specialization and exchange is concerned, it is solely a matter of more efficient deployment of resources within the South, and it should raise productivity and not direct resources. This is a form of trade creation. If countries in the South specialized on particular differentiated variety of final products and then exchanged them each country should be able to use its resources more efficiently, raising output without resource diversions. As the South moves into `manufactured exports, as we will see in the subsequent chapters, the need for analyzing this kind of specialization and gains from exchange is looming large. The most general conclusion, following Stewart, is that while the theories explain N-N trade, S-S trade offer a potential way for the South to gain from the trade in products for countries with identical demand structure, in differentiated products and in intermediate goods. All of the models discussed in Section II postulate an equivalence between scale economy and IIT in the sense that for individual product varieties within an industry (e.g., car) having a common technology there are scale economies (internal to the firm), giving rise to IIT or `non-comparative' advantage trade. This equivalence does not necessarily hold for the LDC because for small open economies the realization of it requires inter-industry trade. It is due to the fact that scale economies apply to large product lines and also a single scale efficient plant often exceeds the domestic market size of many LDCs. To take advantage, many industrial complexes will concentrate in a single country giving rise to IIT and specialization. Since the domestic markets for the South are so small that the range of goods for which minimum efficient scale of production is large enough compared to home markets is much broader than a fully integrated plant at efficient scale.

Krugman (1988) describes a situation (hypothetical) where scale economies in infrastructure (required for imports into agriculture) give the overall primary good a definite `non-comparative advantage' in trade pattern. In LDCs exports of manufacturers, there are elements of increasing returns as well as comparative advantage; hence, the phenomenon of IRS may be applicable to LDCs, even if primarily in the role of providing necessary infrastructure to get them to world or, in non-traded intermediate inputs to standard primary productive activity. The economic integration efforts in the developing world were always motivated more by the "swapping of production for import substituting industries' enjoying scale economies". Scale economies have mattered much in LDC trade policy. Since the market structure matters in international exchanges, it is necessary to analyze the imperfections in market characteristics in such `regulation-prone' setting for LDCs. Firms and government interact in arriving at regulations and controls which have a spillover effect on a region's trade pattern. Small number of private agents and relatively heavy intrusion of government regulation make the traditional assumption of large, competitive markets, *prima facie*, less relevant for LDCs than the developed countries (DCs). For many LDCs these gains do not accrue to the state. Brander and Speneer (1981) type strategic export subsidies may seem a little far fetched for LDCs as their bargaining ability and credibility of threats is small. Small size reduces the role for strategic trade policy a la Brander and Spencer. Even if the small country has some major share of the product, the government will face difficulty of becoming a credible first mover. Another interesting point to note is the fact that Krugman's 1984 paper "Import protection as export promotion": international competition in the presence of oligopoly and economies of scale' is a refurbished version of the `Infant Industry Argument' for protecting an industry in a small LDCs. Krugman's model is based on IRS - internal to the firm so that firms in protected domestic market will move down their marginal cost curves and market shares will go up. The argument was originally pioneered by Hamilton (1791), List (1841), Mill (1909) and Bastable (1921). Kemp's analysis (1960) makes uses of the distinction between dynamic internal and external economies. The result of his paper was a kind of an "impossibility theorem" i.e., in a world of perfect competition, perfect knowledge and foresight, no case for this protection can be established if the cause of the cost reduction through time is `dynamic internal economies'. This is the model that countries like China, India, Japan and South Korea adopted and achieved international competitiveness.

7. Conclusion

Over the last decade or so there has been a reappraisal by some economists of the ability of traditional trade theory to explain relatively recent developments in the pattern of world trade. The `new' views have largely focused on the economies of the DCs, newly industrialized countries (NICs), East Asian NICs and developing countries at higher stages of development. These countries are rapidly dismantling their highly protectionist trade regimes often initiated by major multilateral lending agencies, including the IMF and the World Bank. There has been constant effort to determine from a theoretical standpoint whether or not there is anything in this "new" theory for small developing economies. The new theories pay particular attention to two features of imperfect world markets, viz: (1) economies of scale; (2) external economies. The reorientation of trade from largely domestic consideration into the realm of international relationships and the shift in the character of trade such that motives other than comparative advantage now drive trade. These motives include the advantage of large scale production, technological advancement and innovation. As well, economic theorizing has improved, such that there is now a better understanding of industrial structure and the nature of oligopolistic markets. However, joint-ownership firms in small developing economies might engage in profit raising, especially on the foreign market. This might necessitate government support. Herein lies the relevance of `new view' for small open economies. Firms in these countries produce, nowadays, new high technology products of services for the export market, manufactures on a large scale by using high technology processes. This has got a strong empirical basis. Considerable dynamic benefits of the learning-by-doing type or `technological invitation' variety may be expected to evolve through different ex ante policies and also through the adoption of development strategies. Although empirical work incorporating more recent theoretical approaches is not lagging behind, the present analysis shows an evolution of new trade patterns for the developing economies participating and integrating themselves with the world.

Appendix

NOTE 1:

Linnemann and Van Beers (1988, p. 446) introduced two alternative measures which are measures of export-import similarity reflecting the expected intensity of a bilateral trade flow from an exporting to an importing country. This measures are *Cosine measure* (Cos)presented in Allen's "Mathematical Economics" (p. 381) and developed by Linnemann (1986, p. 141) and the other is Finger and Krienin's (1979) *Export Import Similarity measure* (EIS).

Thus for trade between countries i, j in k commodity class,

$$Cos_{ij} = \frac{\sum_k E_{ik} M_{jk}}{\sqrt{\sum_k E^2_{ik}} \sqrt{\sum_k M^2_{jk}}}$$

and

$$EIS_{ij} = \sum_k \min \left[\frac{E_{ik}}{\sum_k E_{ik}}, \frac{M_{jk}}{\sum_k M_{jk}} \right]$$

where

E_{ik} = exports of country i in k commodity class.
M_{jk} = imports of country j in k commodity class.
k = commodity class 1,.......,n

Both measures vary between zero (no similarity) and unity (perfect similarity). Cos_{ij} is the cosine of the angle between the vector of country i exports and the vector of country j imports in an n dimensional commodity space (Allen, 1987). “EIS” is the sum over all commodity class k in country i exports or in country j imports whichever of these two shares is lower measuring, thus, the "overlap" of trade. This is used by Hufbauer (1970, p. 199-202) and Linnemann (1988) as an index of trade similarity especially for trade in manufactures.

NOTE 2:

Bhagwati (1988) develops a model of trade in similar products assuming endogenously determined technologies (by tastes, research and development costs, other parameters) where unlike H.O.S. model all firms, and nations do not share identical know-how exante. According to him, "just as in biological theorizing the "environment" interacts with "genetic factors" to produce a 'phenotype', we can think of an economic process whereby a specific choice of a product type emerges within a nation-society". Different genetic histories and environmental pressures will cause phenotypic change among the members of a related group of organisms living under natural conditions.

NOTE 3:

Grubel-Lloyd indices though widely used as "good" measure of the extent of IIT, have very serious flaws. It cannot take care of the distribution of deficit and surplus subsectors within an economy. This does not pose a problem for calculating a single set of indices corresponding to a single level of disaggregation/aggregation. The problem becomes crucial for comparing the value of the indices at two separate levels of disaggregation as it depends on the number of deficit and/or surplus sectors. This is due to the existence of absolute term (modulus values of "net trade") in the numerator of the second term in the formula. The following example makes it clear.

Case a: Let 1, 2 and 3 be 3 industries where 1 and 2, at a more aggregated level, can be agglomerated into one sector so that we can have only two industries viz., (1+2) and 3. Suppose *1 and 2 are surplus* industries and *3 is deficit industry* so that we have the following scenario.

Sectors	**1**	**2**	**3**
Export (X)	X1=90	X2=70	X3=60
Import (M)	M1=40	M2=30	M3=65

The GL(U), calculated, is at the disaggregated level:

$$GL(U)_{disaggregated} = 1 - \frac{|90-40| + |70-30| + |60-65|}{(90+40) + (70+30) + (60+65)} = 0.73$$

At aggregated level,

$$GL(U)_{aggregated} = 1 - \frac{|160-70| + |60-65|}{[(90+70) + (40+30)] + (60+65)} = 0.73$$

Thus, $GL(U)_{aggregated} = GL(U)_{disaggregated}$.

Case b: Let *1 be surplus* and *2 and 3 be deficit sectors*. Thus, we have the numerical hypothetical scenario as below:

Sectors	**1**	**2**	**3**
Export (X)	X1=90	X2=50	X3=60
Import (M)	M1=40	M2=60	M3=65

Thus,

$$GL(U)_{disaggregated} = 1 - \frac{|90-40| + |50-60| + |60-65|}{(90+40) + (50+60) + (60+65)} = 0.82$$

and

$$GL(U)_{aggregated} = 1 - \frac{|140-100| + |60-65|}{(140+100) + (60+65)} = 0.87$$

Thus, $GL(U)_{aggregated} \succ GL(U)_{disaggregated}$

Case c: Let us assume a hypothetical case where *Sector 2 has trade balance*, *1 is surplus and 3 is deficit*. The scenario is:

Sectors	**1**	**2**	**3**
Export (X)	X1=90	X2=50	X3=60
Import (M)	M1=40	M2=50	M3=65

Thus,

$$GL(U)_{disaggregated} = 1 - \frac{|90-40| + |0| + |60-65|}{(90+40) + (50+50) + (60+65)} = 0.84$$

and

$$GL(U)_{aggregated} = 1 - \frac{|140-90| + |60-65|}{(140+90) + (60+65)} = 0.84$$

Thus, $GL(U)_{aggregated} = GL(U)_{disaggregated}$

Case d: In another hypothetical case, consider *Sector 3 having trade balance, Sectors 1 and 2 both have surpluses*. The new scenario is:

Sectors	**1**	**2**	**3**
Export (X)	X1=90	X2=50	X3=60
Import (M)	M1=40	M2=30	M3=60

Here,

$$GL(U)_{disaggregated} = 1 - \frac{|90-40| + |50-30| + |60-60|}{(90+40) + (50+30) + (60+60)} = 0.78$$

and

$$GL(U)_{aggregated} = 1 - \frac{|140-70| + |0|}{(140+70) + (60+60)} = 0.78$$

Thus, $GL(U)_{aggregated} = GL(U)_{disaggregated}$.

All the above numerical examples illustrate that comparison of GL (uncorrected) index *at different levels of aggregation* is problematic as it does not give the true picture. Following Greenaway and Milner, (1983), if a groups i comprising of 2 subsectors 1 and 2 have the situation such that $(X_1\text{-}M_1) > 0$ and $(X_2\text{-}M_2) < 0$, aggregation will cause mutual offsetting.

If, in the limit, $|X_1 - M_1| = |X_2 - M_2|$, a GL(U) index of 100 would be recorded suggesting that all trade in ith product category was of IIT variety. This inflated value indicator gives a wrong picture unless the subsector imbalances all have identical sign (in which case GL(U) will, be sum of "individual trade weighted" subgroup indices).

NOTE 4:

This has been shown by Pomfret (1985) in an example. IN his example, constructed in such a way that an aggregative product group has overall trade surplus although the subcategories have deficit in 1 subgroup and surpluses in 2 subgroups, GL = C was ensured.

NOTE 5:

The *New Index of Vona* is given (op.cit., p. 691) as below. Considering two types of industry one characterized by perfect competition and homogeneous products and another by economies of scale and product heterogeneity, the bilateral index for trade between country A and B in industry is:

$I_{A.B.i} = X_{B.A.i} + X_{A.B.i}$, if both are non-zero.

and

$I_{A.B.i} = 0$, if either $X_{B.A.i}$ or, $X_{A.B.i}$ is zero.

where $I_{A.B.i}$ is amount of inter industry trade in industry i.

The IIT index at 3 digit jth sector and ith 5 digit industries within jth sector for each given j is given by

$$IIT_{A.B.j} = \frac{\sum_i I_{A.B.i}}{X_{A.B.i} + X_{B.A.j}}.100, \forall i, I_{A.B.i} = 0$$

where $0 \le IIT_{A.B.j} \le 100$.

This reflects the theoretical approaches to both, Inter and intra-industry exchanges (see Vona 1991, p. 692-3).

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