MARGINAL INTRA-INDUSTRY TRADE: TOWARDS A MEASURE OF NON-DISRUPTIVE TRADE EXPANSION

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1. Introduction

When Verdoorn (1960) found that the formation of a customs union among the Benelux countries had stimulated large two-way trade flows of similar products, and Drèze (1961) discovered the same phenomenon in the fledgling six-nation EEC, economists took note because of one main reason: adjustment costs. Instead of inter-sectoral specialisation according to countries' comparative advantage, the national economies seemed to preserve their broad industrial structures and to specialise predominantly at the intra-sectoral level. A "smooth adjustment hypothesis" (SAH) soon became firmly rooted in economic thinking, according to which intra-industry trade (IIT) expansion generally entails lower adjustment costs than inter-industry trade.

In time, the early conjectures on the shape of emerging trade patterns were confirmed by a number of high-profile studies such as those of Grubel and Lloyd (1975), Greenaway and Milner (1986), Greenaway and Hine (1991) and OECD (1994). These empirical studies have without exception uncovered a secular increase in the share of intra-industry flows in trade among developing as well as developed economies, and many scholars have cited this fact as a powerful force for attenuating trade-induced economic frictions within and between countries during the past half-century.

The choice of IIT measure used in empirical work, however, has until recently been guided not so much by its relevance for factor-market adjustment but rather by its significance for the theory of international trade. Since trade theory consists to the most part of static models, the static Grubel-Lloyd index of IIT has been by far the most widely employed measure. High static IIT is difficult to reconcile with the predictions of neoclassical trade theory, and its discovery has therefore driven the development of the "new trade theory", which can accommodate the existence of IIT. For that reason, measures of static IIT can be a useful gauge of the determinants of trade flows.

However, Hamilton and Kniest (1991) have pointed out in a seminal contribution that, in the context of adjustment, dynamic measures of IIT may be more informative than static measures. They proposed an index of "marginal IIT" (MIIT) to be used in studies of the SAH. A number of authors have since proposed different measures of MIIT, and some empirical tests of the SAH have been carried out. This contribution provides a survey of that growing literature.

The survey is organised as follows. Section 2 provides some theoretical background to the SAH. In Section 3 I briefly review the properties of the most widely used measure of IIT, the Grubel-Lloyd index. Section 4 presents some alternative measures which capture changes in IIT but not MIIT in the strict sense. An overview of MIIT measures is given in Section 5. Section 6 is dedicated to a special class of MIIT measures, namely those that combine information on the symmetry of trade changes with information on a country's sectoral trade performance. In Section 7 I conclude with some generalisations and suggestions for future research.

2. The Smooth Adjustment Hypothesis

Adjustment costs arise from temporary inefficiencies when markets fail to clear instantaneously in the wake of a change of demand or supply conditions. More specifically, the adjustment costs that are normally studied in the context of trade expansion are those welfare losses that arise in labour markets from temporary unemployment due to factor-price rigidity or from costs incurred through job search, re-location and re-training.

Trade *per se* cannot be called a cause for adjustment costs. The size and pattern of trade flows are not exogenous. Rather, they are shaped by underlying factor endowments, demand patterns, technologies, income levels and policy regimes of the trading countries. The concept of "trade-induced" changes therefore implicitly alludes to ulterior causes which are manifested in the structure of trade flows. This conception is easiest to grasp in a setting of trade liberalisation. There, any change that can be tracked to the change in the trade-policy regime is defined as "trade-induced".

The models of the new trade theory are consistent with the smooth adjustment hypothesis. Krugman (1981, p. 970), in a general equilibrium model considering only price adjustments (changes in relative wages), found "a one-for-one relationship between similarity of factor endowments and intra-industry trade", which he interpreted as "a vindication [...] that intra-industry trade poses fewer adjustment problems than inter-industry trade". This result effectively stems from the fact that all the influential models explaining IIT through scale economies and monopolistic competition assume the products of an industry to be perfectly homogenous in terms of quantitative and qualitative factor requirements. Intra-industry adjustment costs are thus eliminated simply by assumption.

Unfortunately, the industry concept which underlies the empirical measurement of IIT does not contain only goods with perfectly identical production requirements. For the analysis of empirically observed IIT, there are three conceivable reasons why IIT might entail smaller labour-market adjustment costs than inter-industry trade:

1. the mobility of labour across firms and occupations might be greater within industries than between industries,
2. relative wages might be more flexible within industries than between industries, or
3. other production factors might be more mobile within than between industries.

The first hypothesis has much intuitive appeal. If one defines IIT as the exchange of goods with similar production requirements, then it is implied that labour requirements are more similar within industries than between industries. If the skills acquired by the workers and managers of a contracting firm can be applied without much re-training in an expanding firm of the same industry, then labour mobility may well be higher within industries than between them. If specialisation occurs inside firms, then workers can simply be transferred from one department to another. Where industries are spatially concentrated, labour is likely more mobile within than between industries. The problem is that one cannot assume *a priori* that the statistical product categories underlying empirical calculations of IIT actually correspond to this definition of industries.

The second hypothesis relates to intra-industry specific-factors model where asymmetric trade shocks across producers in one industry, combined with short-term immobility of workers, will result in temporary unemployment if wages are not flexible across producers. The main impediments to wage flexibility are minimum-wage legislation and contractual wage agreements at the industry level. Since such constraints generally apply at the level of the entire economy or of individual industries, they might actually be expected to allow greater wage flexibility between industries than within them. If wage inflexibility through industry-wide centralised bargaining is the dominant cause of adjustment problems, then adjustment would be greater when trade shocks are intra-industry than when trade alters the relative competitiveness among industries.

The third hypothesis, like the first, is plausible if we assume that "industries" are delineated according to supply-side substitutability of goods. In the specific-factors model it is normally assumed that all production factors except labour are non-transferable among products. If we relax this assumption and allow for increasing mobility of the complementary factors(s), then smaller wage adjustments will be needed to restore labour-market equilibrium. Hence, the third hypothesis offsets to some extent the caveat provided by the second hypothesis.

In sum, while the SAH has not yet been rigorously embedded in a fully specified theoretical model, existing trade theory does supply some arguments in its favour.[1] Ultimately, however, the homogeneity and adaptability of industries defined in trade statistics can only be determined through empirical investigation.

This section has been concerned with the effect on an asymmetric demand shock between or within industries on labour-market adjustment. The main focus of this survey, however, is on how to measure the relevant degree of (a)symmetry of trade-induced shocks in empirical work.

3. Static IIT: The Grubel-Lloyd Index

By far the most widely used measure of IIT is due to Grubel and Lloyd (1975), who suggested the following formula:

$$GL_i = 1 - \frac{|X_i - M_i|}{(X_i + M_i)}, \qquad \textbf{(1)}$$

where X_i and M_i refer to a country's exports and imports of goods contained in industry i in one particular year. This measure takes values between zero and one and increases in IIT.

Furthermore, Grubel and Lloyd (1975) have represented the summary IIT index calculated over several industries as a trade-weighted (rather than simple arithmetic) average of the industry indices:

$$GL = \sum_{i=1}^{n} w_i GL_i = \sum_{i=1}^{n} \left(\frac{X_i + M_i}{\sum_{i=1}^{n}(X_i + M_i)}\right) GL_i = 1 - \frac{\sum_{i=1}^{n}|X_i - M_i|}{\sum_{i=1}^{n}(X_i + M_i)}. \qquad \textbf{(2)}$$

Equivalent to this definition is the following formula:

$$GL = \frac{\sum_{i=1}^{n} 2*(\min X_i, M_i)}{\sum_{i=1}^{n}(X_i + M_i)}. \qquad \textbf{(3)}$$

The GL index can be calculated for a country's world-wide trade or for a subset of trade partners, as well as for total merchandise trade or for a subset of industries. The statistical properties and limitations of the GL index have been carefully scrutinised in the literature. An authoritative survey can be found in Greenaway and Milner (1986). I will therefore give only a brief summary of the four main measurement issues.

1. **Categorical aggregation**. As seen above, the definition of an "industry" central to the SAH and probably the most contentious issue in applied IIT research. Grubel and Lloyd (1975, p. 86), have defined IIT as "trade in differentiated products which are close substitutes". Over

time, it has become generally accepted that the relevant criterion is substitutability in production (rather than in consumption), since this is the aspect of industries that (a) distinguishes IIT from comparative-advantage based trade and (b) lies at the heart of the link between IIT and factor-market adjustment. Whilst statistical product classifications are inevitably imperfect in this respect, they are nevertheless largely guided by the correct criterion, i.e. an effort to group together goods with similar input requirements.[2] This still leaves open the question about the most appropriate level of statistical aggregation for the calculation of IIT indices. Whilst the majority of empirical studies use data at the 3-digit level, this choice is mostly motivated by expediency rather than any *a priori* reason for favouring that level of aggregation.

2. **Adjustment for overall trade imbalance**. The upper bound of a country's mean GL index is negatively related to the share of the overall trade surplus or deficit in total trade. Hence, imbalance in the trade account will tend to bias the GL index downwards. Adjustment methods have therefore been suggested, with the one brought forward by Aquino (1978) having been most widely used. The Aquino index is defined as follows:

$$GL_i^A = 1 - \frac{\left|\hat{X}_i - \hat{M}_i\right|}{(\hat{X}_i + \hat{M}_i)}, \qquad \textbf{(4)}$$

where $\hat{M}_i = M_i * \left(\left\{\sum X_i + M_i\right\} / 2\sum M_i\right)$ = "expected imports",

and $\hat{X}_i = X_i * \left(\left\{\sum X_i + M_i\right\} / 2\sum X_i\right)$ = "expected exports".

The rationale for such adjustment measures has been questioned on the grounds that visible trade imbalances, both bilateral and multilateral, may well be compatible with balance of payments equilibrium (Greenaway and Milner, 1986; Kol and Mennes, 1989; Vona, 1991). Given the difficulty in estimating equilibrium trade imbalances, the professional consensus has been to work with unadjusted GL indices.

3. **Scale invariance**. The GL index for an individual industry is not related to the absolute size of imports and exports in that sector, nor indeed to the size of the industry in terms of domestic production or consumption. What matters for studies of trade-induced adjustment is not only the structure of trade flows, which is captured by the GL index, but also the degree

of openness of individual sectors. In regression analysis it is therefore advisable to interact the GL index with a measure of sectoral trade openness or simple trade volumes.

4. **Static nature**. The GL index refers to the pattern of trade in one year. In the context of structural adjustment, however, it is the structure of *changes* in trade patterns which is important. This insight, attributable to Hamilton and Kniest (1991), has motivated the development of measures of *marginal* IIT (MIIT) and thus provides the key issue for this survey.[3]

4. Quasi-Dynamic Measures: Changes in IIT

Some measures have been developed that are neither static nor measures of MIIT in the strict sense. These "quasi-dynamic" measures take account of trade flows in two different years, but, as I shall argue below, they may not present the most appropriate gauge of trade patterns in the adjustment context.

First-Differenced GL Indices

Prior to the introduction of the MIIT concept, the evaluation of IIT changes over time was confined to the comparison of GL indices for different time periods, where

$$\Delta GL = GL_t - GL_{t-n} = \left(1 - \frac{|M-X|}{(M+X)}\right)_t - \left(1 - \frac{|M-X|}{(M+X)}\right)_{t-n}, \qquad \textbf{(5)}$$

Δ is the first-difference operator, t is the end year, and n is the number of years separating the base and end years.[4]

The nature and limitations of this approach to measuring IIT are best illustrated in a simple diagram. Figure 1A plots one country's imports and exports of one particular industry (i).[5] All points along any ray from the origin share the same GL index, since they represent equal sectoral import-export proportions. The GL index equals 1 along the 45 degree line, and zero along either of the axes.

* FIGURE 1 ABOUT HERE *

Assume that *P* represents the sectoral trade balance in the base year (*t-n*). In this initial year, home-country imports in industry *i* exceed exports by a ratio of 3:1. The industry thus exhibits a GL index of 0.5.[6] Assume further that the GL index is higher in the end year (*t*). In Figure 1A, both points *Q1* and *Q2*, fit this scenario, since they both correspond to a sectoral GL index of 0.8. Both a move from *P* to *Q1* and a move from *P* to *Q2* would thus show up as an increase in the GL index from 0.5 to 0.8. However, the pattern of trade change is quite different between the two scenarios. Consider, first, a shift from *P* to *Q1*. *Q1* lies in a 45-degree angle to the north-east of *P*. Exports and imports of *i* have thus increased at the same absolute rate, and both countries (assuming there are only two) have captured an equal share of the increased volume of trade in this sector. If this pattern appears for other industries as well, then the adjustment process is *intra*-industry, since all countries share equally in the growth (or decline) of all these sectors. Now consider a move from *P* to *Q2*. In this scenario, the amount of home country exports has declined while imports have increased. If this pattern appears also in other industries - with the home country not necessarily always on the 'losing' side - the adjustment process is *inter*-industry. A rise in the GL index can thus hide both a process of *intra*- and *inter*-industry trade change. Thus, the juxtaposition of corresponding GL indices for different periods conveys some information on the structure of trade in each of these time periods, but it does not allow conclusions on the structure of the *change* in trade flows.[7]

This, however, is not to say that intertemporal analysis of corresponding GL indices is useless or misleading in itself. If the aim of the analysis is "comparative static", meaning that what is sought is a comparison of the structure of trade at different points (years) in time, then the comparison of GL indices may well be adequate. It is only when the aim of the analysis is "dynamic" in nature, meaning that the structure of the change in trading patterns is to be scrutinised, that the comparison of GL indices is inadequate. Since simple logic suggests that the costs of adjustment depend on the latter rather than on the former, an alternative measurement method is warranted.

The Greenaway-Hine-Milner-Elliott Measure

Greenaway *et al*. (1994) have suggested the following measure:

$$GHME = [(X+M)-|X-M|]_t - [(X+M)-|X-M|]_{t-n}, \quad \textbf{(6)}$$

or:

$$GHME = \Delta[(X+M)-|X-M|] \; . \quad \textbf{(7)}$$

The GHME measure fundamentally differs from the GL index in that it reports IIT in absolute values rather than as a ratio. This feature can be desirable because it facilitates the scaling of IIT relative to gross trade levels, production or sales in a particular industry; which in turn is useful for the econometric analysis of the forces that determine structural adjustment. The drawback in this is that the unscaled GHME measure says nothing about the proportion of (marginal) intra- relative to inter-industry trade and it lacks the presentational appeal of a simple bounded index. Hence, its *raison d'être* rests upon the fact that "it can be related to corresponding levels of gross trade or real output" (Greenaway *et al*., 1994, p. 424).[8]

The GHME measure belongs to the "quasi-dynamic" class, since it corresponds to the difference in the amounts of IIT in two periods, and it therefore shares limitations of the GL index for the assessment of the structure of *change* in trading patterns. Hamilton and Kniest's (1991) insight on the GL index thus also applies to the GHME measure. Assume, for instance, that over the period of investigation a particular sector experiences a shift from a trade deficit to balanced trade while exports remain unchanged. The GHME measure will show a positive value of twice the increase in exports, even though this is an obvious case of *inter*-industry adjustment, because the increase in exports is not matched by any corresponding increase in imports. This can be seen in Figure 1B, which gives a mapping of iso-GHME contours: the inter-industry trade change represented by a change from *P* to *Q2* in Figure 1A would yield a positive value of the GHME measure.

The Dixon-Menon Measures

Dixon and Menon (1997) have developed two alternative "quasi-dynamic" measures. The first measure captures base-year weighted percentage growth of IIT:

$$DM^{IIT} = GL_{t-n}\left(\frac{\Delta[(X+M)-|X-M|]}{[(X+M)-|X-M|]_{t-n}}*100\right), \qquad \textbf{(8)}$$

and the second measure captures the base-year weighted percentage growth of net trade:

$$DM^{NT} = (1-GL_{t-n})\left(\frac{\Delta|X-M|}{|X-M|_{t-n}}*100\right). \qquad \textbf{(9)}$$

These measures can take values from –100 to infinity. An appealing feature is that these two measures add up to the percentage growth in total trade of the relevant industry. However, the Dixon-Menon measures belong to the "quasi-dynamic" class, because they cannot consistently separate MIIT from marginal inter-industry trade. For illustration, suppose again that over the period of investigation a particular sector experiences a shift from a trade deficit to balanced trade while exports remain unchanged. DM^{IIT} (DM^{NT}) will yield a positive (negative) value, even though this is an obvious case of *inter*-industry adjustment. A mapping of iso-DM^{IIT} contours looks identical to the one derived from the GHME measure (Figure 1B): the inter-industry trade change represented by a change from *P* to *Q2* in Figure 1A would yield a positive value of the DM^{IIT}.[9]

To summarise, the "quasi-dynamic" measures are representations of the change in the share or the amount of matched trade between two years, using different scaling yardsticks. They can thus be useful for an analysis of the evolution of IIT over time. However, these measures do not consistently relate to the degree of "matchedness" in trade changes, i.e. they do not capture MIIT in the strict sense.

5. Marginal IIT: Matched Trade Changes

Measures of MIIT quantify the degree of intra-sectoral symmetry of trade *changes*. Hence, they are computed from first differences in exports and imports, ΔX and ΔM, that is they can be unrelated to the level of trade or of IIT in either the base of end period. In a nutshell, MIIT is about the importance of IIT in trade changes, and not about the change in IIT.

The Hamilton-Kniest Index

The first measure of MIIT was proposed by Hamilton and Kniest (1991):

$$HK = \begin{cases} \dfrac{\Delta X}{\Delta M} & \text{for } \Delta M > \Delta X = 0 \\[2ex] \dfrac{\Delta M}{\Delta X} & \text{for } \Delta X > \Delta M = 0 \\[2ex] 1 & \text{for } \Delta X = \Delta M > 0 \\ \text{undefined} & \text{for } \Delta M < 0 \text{ or } \Delta X < 0. \end{cases} \qquad \textbf{(10)}$$

This measure is related strictly to the structure of the *change* in trading patterns – information on levels of exports or imports is not required. Hence, the HK index can be mapped onto a plane that is defined by ΔX and ΔM (Figure 2A). The possibility of such a mapping is what distinguishes MIIT measures from IIT and quasi-MIIT.

* FIGURE 2 ABOUT HERE *

This index, however, has some important limitations. Greenaway *et al.* (1994) have highlighted that the fact of the HK index being undefined when either X or M has decreased can lead to a non-random omission of a significant number of statistical observations and therefore to potentially misleading results. Furthermore, Hamilton and Kniest (1991) have interpreted any situation where their index is undefined as representing “an increase in exports and a decrease in imports (or vice versa), which indicates inter-industry trade”. Yet, the HK index is also undefined where both imports and exports have decreased (the bottom left quadrant of Figure 2A), a situation in which the matched decreases should be recorded as MIIT.

A Grubel-Lloyd Style Measure of MIIT

The following index is derived in Brülhart (1994):

$$B^A = 1 - \frac{|\Delta X - \Delta M|}{|\Delta X| + |\Delta M|}. \qquad \textbf{(11)}$$

This index, like the GL coefficient, varies between 0 and 1, where 0 indicates marginal trade in the particular industry to be completely of the *inter*-industry type, and 1 represents marginal trade to be entirely of the *intra*-industry type. The main appeal of the B^A index lies in the fact that it reveals the structure of the *change* in import and export flows, similar to the HK index. Yet, unlike the latter measure, the B^A coefficient is defined in all cases and shares many familiar statistical properties of the GL index. This can be seen in the mapping given in Figure 2B.

Oliveras and Terra (1997) have shown that the statistical properties of the B^A index differ from those of the GL index in two particular respects. First, this index is not subject to an rising downward bias as the level of statistical disaggregation is increased. Second, there is no functional relationship between the B^A index for a certain period and the B^A indices of constituent sub-periods.

Note that B^A can be summed, like the GL index, across industries of the same level of statistical disaggregation by applying the following formula for a weighted average:

$$B^A{}_{tot} = \sum_{i=1}^{k} w_i B^A{}_i \,, \qquad \text{where} \quad w_i = \frac{|\Delta X|_i + |\Delta M|_i}{\sum_{i=1}^{k} (|\Delta X|_i + |\Delta M|_i)} \qquad \textbf{(12)}$$

and where $B^A{}_{tot}$ is the weighted average of MIIT over all industries of the economy or over all the sub-industries of an industry, denoted by *i...k*.

Extensions to the MIIT Index

Several authors have put forward amended versions of the B^A index, which are tailored to particular underlying assumptions on the nature of the adjustment problem.

Lloyd (1998) has argued that it may be useful in certain contexts to incorporate local sales of foreign affiliates ("international production") in an analysis of trade flows. He suggested that the B^A index could be computed for $\hat{X}_i = \sum_{j=1,2} X_i^j$ and $\hat{M}_i = \sum_{j=1,2} M_i^j$, where *i* again denotes the industry, and *j* stands for the "mode of supply". If a particular flow is a cross-border import or export in the traditional sense then j=1; and when we look at local sales of foreign affiliates then j=2. This index could be useful for a study of the adjustment implications of globalisation in a broader sense, since it can be decomposed into the separate contributions to MIIT of changes in international goods trade and of changes in the pattern of international production.[10]

Another variant of the MIIT index was developed by Thom and McDowell (1999) to take account of the increasing fragmentation of international production:

$$TM_i = 1 - \frac{\left|\Delta X_i - \Delta M_i\right|}{\sum_{l=1}^{L}\left|\Delta X_l\right| + \sum_{l=1}^{L}\left|\Delta M_l\right|}, \qquad \textbf{(13)}$$

where *l* denotes sub-industries of *i*. The TM index is bounded between zero and one, but it differs from B^A_{tot} aggregated over sub-industries *j* of *i* (equation 12).

The rationale underlying the TM index is that offsetting net trade changes across subsectors should be counted as MIIT if those subsectors are vertically linked. This is best illustrated with a simple example. Assume that country A increases its exports and reduces its imports of finished watches vis-à-vis country B, and that A simultaneously reduces its exports and increases its imports of watch components. Furthermore, suppose that the two trade changes are of equal size. If we apply the B^A index to the industries "finished watches" and "components" separately, we diagnose zero MIIT. On the other hand, if we define finished watches plus components as an industry, then the B^A index is undefined, since we observe zero aggregate trade change. The TM index, however, will return a value of 1, i.e. perfect MIIT, since the two net changes at sub-industry level offset each other perfectly. In an application to data on trade between the EU and some Eastern European countries, Thom and McDowell (1999) have found their index to return significantly higher values on average than B^A.

The validity of the TA index hinges on the appropriate definition of industries and sub-industries. If one had a classification with sub-industries defined according to the stages of production of the industry's final product, then the TA index provides an elegant measure of the international fragmentation process of production. In the face of the untidy existing statistical classification schemes, however, it is difficult to state *a priori* which might be the appropriate level of aggregation, and whether one should prefer the TM or B^A indices.

Annicchiarico and Quintieri (2000) have suggested a third extension of the MIIT index. They propose that the index should take a negative sign when the matched trade change is negative, so that the index would range from –1 to 1:

$$AQ = \begin{cases} -B^A & \text{if } \Delta M < 0 \text{ and } \Delta X < 0, \\ B^A & \text{otherwise.} \end{cases} \qquad \textbf{(14)}$$

This touches on an important point. Underlying the B^A index is the implicit assumption that the quantity of production factors displaced by a one unit increase in imports (decrease in imports) is identical to the quantity of production factors required for a one unit increase in exports (decrease in imports). One corollary is that a matched increase in imports and exports has a zero net effect on factor demand at the industry level, and likewise for a matched decrease in imports and exports.[11] Unless we are in the context of multiple regression, where one can control for trade-independent changes in sectoral demand and productivity, we may plausibly assume that matched expansion of trade will be associated with growing sectors, whilst matched contraction of trade would be indicative of sectors that are in general decline. Hence, unless we can control for non-trade determinants of structural change, it appears plausible that the adjustment implications of matched trade expansion differ from those entailed by matched trade contraction, and the transformed index suggested by Annicchiarico and Quintieri (2000) may well be informative in descriptive studies.

Unscaled MIIT Measures

There are undeniable advantages in a simple bounded index for presentation and interpretation. Yet, as pointed out by Greenaway *et al*. (1994), it can be useful in certain applications to have gross measures of MIIT, or to scale MIIT to production variables. For that reason, the following measure has been suggested by Brülhart (1994):

$$B^C = (|\Delta X| + |\Delta M|) - |\Delta X - \Delta M|, \quad \textbf{(15)}$$

which is strictly non-negative and can be scaled even at the disaggregated industry level, like the GHME measure:

$$B^C{}_V = \frac{B^C}{V}, \quad \textbf{(16)}$$

where *V* is any relevant scaling variable. Figure 2C presents a mapping of iso-B^C contours in the trade-change space.

Menon and Dixon (1997) have proposed a similar measure. Instead of capturing absolute values of sectorally matched trade changes, like B^C, theirs is a "measure of unmatched changes in trade":

$$MD^{UMCIT} = |\Delta X - \Delta M|. \quad \textbf{(17)}$$

MD^{UMCIT} and B^C are closely related, as B^C shows the absolute magnitude of MIIT and MD^{UMCIT} shows the absolute magnitude of marginal *inter*-industry trade. The relative properties of MD^{UMCIT} and B^C are easily grasped through a comparison of their respective mappings in Figures 2D and 2C.

Absolute values of MIIT, such as B^C and MD^{UMCIT}, are difficult to interpret in isolation, since they give no indication of the proportion between intra- and inter-industry trade, which, after all, is central to the definition of the very concept of IIT and MIIT. Therefore, it might be appropriate for studies investigating MIIT and adjustment to use a two-stage approach, where MIIT is expressed both in relation to marginal *inter*-industry trade and in relation to other scaling variables.

6. Marginal IIT and Sectoral Performance

As noted above, a latent assumption underlying the basic MIIT index is that the adjustment costs of a net improvement in a sectoral trade balance are identical to those of a net deterioration in that sectoral trade balance. In other words, an additional million dollars of net exports will create a number of jobs that is equal to the number of jobs that would have been destroyed by an additional million dollars of net imports in that industry, and the adjustment costs of a job lost and of a job created are equal. In a labour market with unemployment and on-the-job learning, the assumed symmetry of adjustment costs between job creation and job destruction is clearly unrealistic. MIIT indices have therefore been developed to take account of the asymmetry between net import growth and net export growth.

For those reasons, the following index was put forward in Brülhart (1994):

$$B^B = \frac{\Delta X - \Delta M}{|\Delta X| + |\Delta M|}, \qquad \textbf{(18)}$$

where

$$|B^B| = 1 - B^A. \qquad \textbf{(19)}$$

This coefficient can take values ranging between -1 and 1. It is two-dimensional, containing information about both the proportion of MIIT and country-specific sectoral performance. First, the closer B^B is to zero, the higher is MIIT. B^B is equal to zero where marginal trade in the particular industry is entirely of the *intra*-industry type, whereas at both -1 and 1 it represents marginal trade to be entirely of the *inter*-industry type. Second, sectoral performance is defined as the change in exports and imports in relation to each other, with exports representing good domestic performance and imports reflecting weak domestic performance in a particular sector. Thus defined, B^B is directly related to sectoral performance. When $B^B > 0$, ΔX was $> \Delta M$. The opposite holds for $B^B < 0$. A mapping of B^B into the trade-change plane is given in Figure 4A.

* FIGURE 4 ABOUT HERE *

Unlike the B^A index, B^B cannot be aggregated meaningfully across industries, except where the Bs of all sub-industries have the same sign. Since high marginal inter-industry trade is expressed by values close to either -1 or 1, the weighted average of two sub-industries might yield a value close to zero (high MIIT) even where high marginal *inter*-industry trade prevails in both of them. Therefore, B^B cannot be used for summary statistics resulting from calculations at a disaggregated level.

A related measure has been proposed by Azhar and Elliott (2001):

$$AE = \frac{\Delta X - \Delta M}{2(\max[|\Delta X|, |\Delta M|])}. \quad \textbf{(20)}$$

This index also ranges from –1 to 1, and it is negative (positive) if the sectoral trade balance has deteriorated (improved) over the relevant time interval. The difference lies in the data range where ΔX and ΔM have opposite signs, i.e. where there is no MIIT. The B^B index returns a value of –1 or 1 for all configurations within that data range. The AE index, however, differentiates between the relative sizes of opposing net trade changes. This means that the AE index provides further detail in a data range where B^B always returns one of its polar values. This additional information conveyed by the AE index does not come at a cost, since the information contained in $B^B \in (-1,1)$, which is the same data range as that for which $B^A \in (0,1]$, is fully contained in $AE \in (-0.5,0.5)$. Hence, the information conveyed by B^B is a subset of that given by the AE index. The apparent advantage of the AE index also presents its main difficulty: it is not clear how one should interpret different configurations of pure marginal inter-industry trade, i.e. what to infer from different index values in the ranges (-1,-0.5) and (0.5, 1). There is no ready interpretation for index values in those intervals.

7. Some Conjectures: Which Measure is Best?

The SAH has undeniable intuitive appeal and is firmly established in the canon of international economics.[12] As this survey of measurement issues shows, however, the seemingly straightforward hypothesis is mired in ambiguity once one tries to define it rigorously. I have argued that a measure of MIIT, i.e. one that reflects the degree of intra-sectoral (a)symmetry in trade *changes*, should be preferred to static or "quasi-dynamic" measures of IIT when one seeks information on the likely implications of trade changes for factor-market adjustment.

Unfortunately, the ambiguity does not stop here. There are now a number of different measures which capture different aspects of the structure of trade changes. The problem is, of course, that no one-dimensional measure can ever fully describe the three-dimensional distribution of adjustment costs over the trade-change plane. Take, for example, the hypothetical mapping of trade-induced adjustment costs given in Figure 5. That particular map of iso-adjustment contours assumes that adjustment costs rise monotonically as one moves away from the origin of the Cartesian space, i.e. as the combined size of trade changes increase; but that this rise does not occur at the same rate depending on the direction in which one departs from the origin. The debate about which MIIT measure to use boils down to the question about which is the most important direction of skewness in this distribution, departing from one that is symmetric around the origin.

* FIGURE 5 ABOUT HERE *

Figure 5 is based on the following linear model of adjustment costs (*AC*) in a certain industry (*i* subscripts implied):

$$AC = a\left|\Delta X - \Delta M\right| + b(\Delta X - \Delta M) + g\left(\left|\Delta X\right| + \left|\Delta M\right|\right), \text{ with} \qquad \textbf{(21a)}$$

$$a > 0, \qquad \textbf{(21b)}$$

$$b < 0, \qquad \textbf{(21c)}$$

$$\left|a\right| > \left|b\right|, \qquad \textbf{(21d)}$$

$$g > 0. \qquad \textbf{(21e)}$$

The model (21a) is fairly general, its main restriction being that of linearity - which could be easily relaxed by adding non-linear terms. The four restrictions that are then imposed on this model to generate the mapping of Figure 5 are rooted in assumptions that have been made, mostly implicitly, in the MIIT literature. Restriction (21b) reflects the assumption that adjustment costs increase in the absolute amount of unmatched trade change, (21c) that export expansion (contraction) causes lower (higher) adjustment costs than import expansion (contraction), (21d) that for given volumes of trade changes adjustment costs are minimised where changes in imports and exports are of equal size, and (21e) that a adjustment costs increase in the absolute amount of total trade change.

Estimation of a model like (21a) might shed some light on the debate about the most appropriate measure of low-adjustment-cost trade change. One could assess the validity of the SAH assumptions by testing restrictions (21b-e). In particular, the relevance of MIIT would be confirmed if the estimated a were significant, since this would indicate that the degree of "matchedness" of trade changes within sectors matters for adjustment costs, as the variable $\left|\Delta X - \Delta M\right|$ is the Menon-Dixon (1997) measure of marginal inter-industry trade (MD^{UMCIT}). The relevance of the Grubel-Lloyd-style MIIT index (B^A) would be confirmed if a were large relative to g. Similarly, a significant estimated b would indicate that sectoral trade performance matters for adjustment costs, and that indices such as B^B of Brülhart (1994) or the Azhar-Elliott (2001) index are important.

There is some empirical evidence to support the claim that MIIT is relevant to labour-market adjustment costs, derived from a specification that is similar that in equation (21a) (Brülhart, 2000).[13] However, this question still deserves to be explored further. Two major challenges need to be addressed. First, explicit estimation of factor-market adjustment *costs*, rather than measures of structural change that are merely assumed to relate to the adjustment costs, has only recently begun to be applied to this context (Haynes, Upward and Wright, 2000; and Wright, Haynes and Upward, 2001). Second, there still does not exist a formal theoretical model that can generate marginal intra- and inter-industry trade, and thus serve as a base for the specification of empirical models. The choice of control variables in such exercises therefore still lacks a coherent theoretical base.

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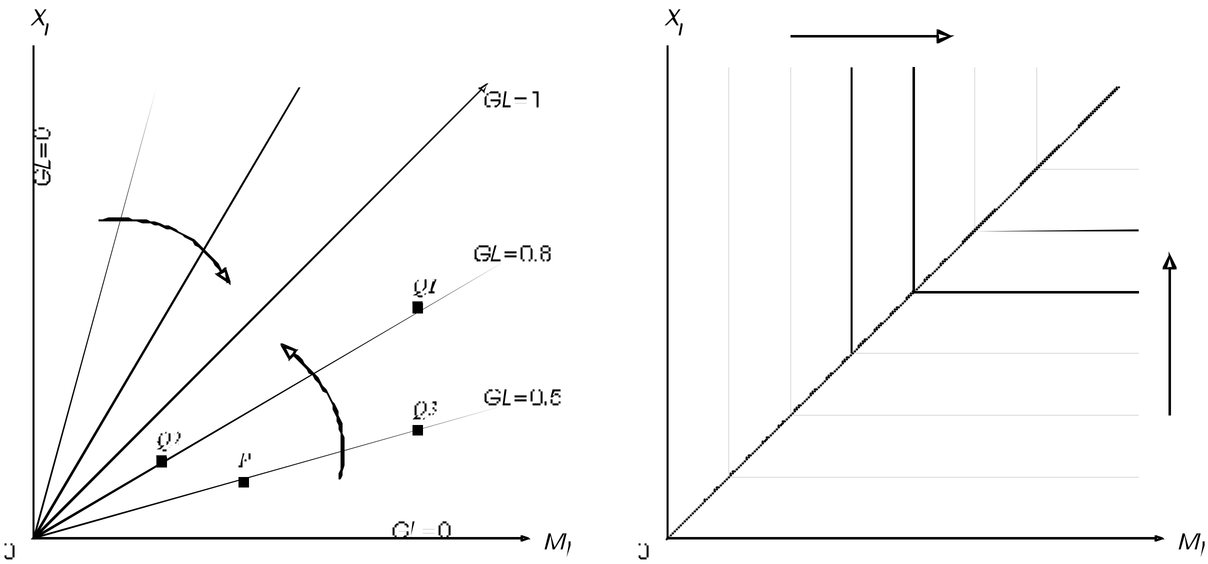
Figure 1: Measures of IIT and Quasi-MIIT

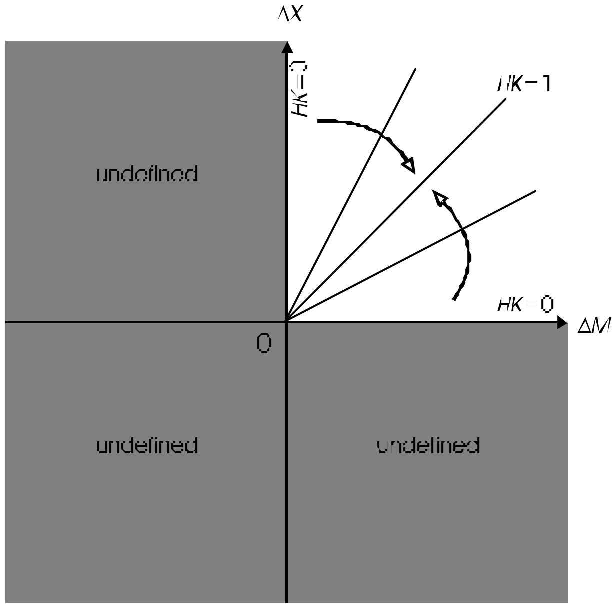


(A) Grubel-Lloyd (1975)

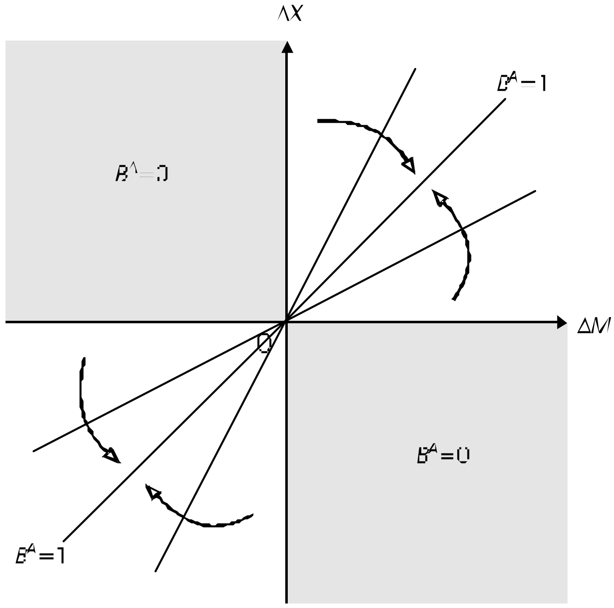
(B) Greenaway, Hine, Milner, Elliott (1994)
Dixon and Menon (1997): DM^{IIT}

Note: contour values depend on starting point

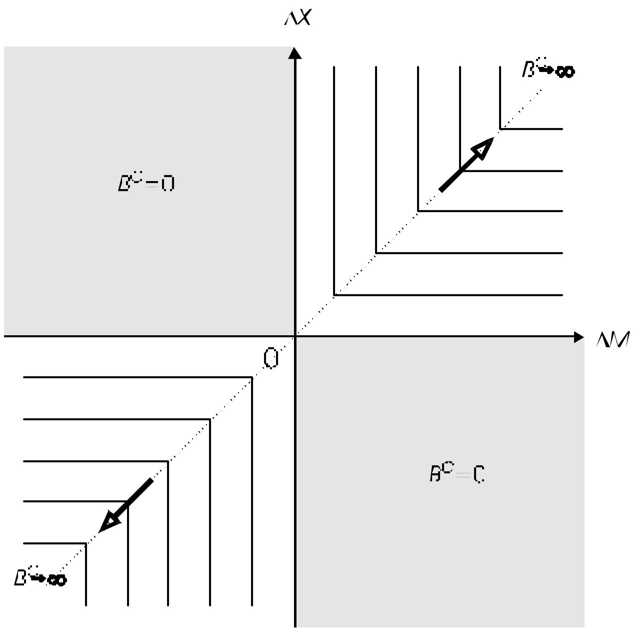
Figure 2: MIIT Measures



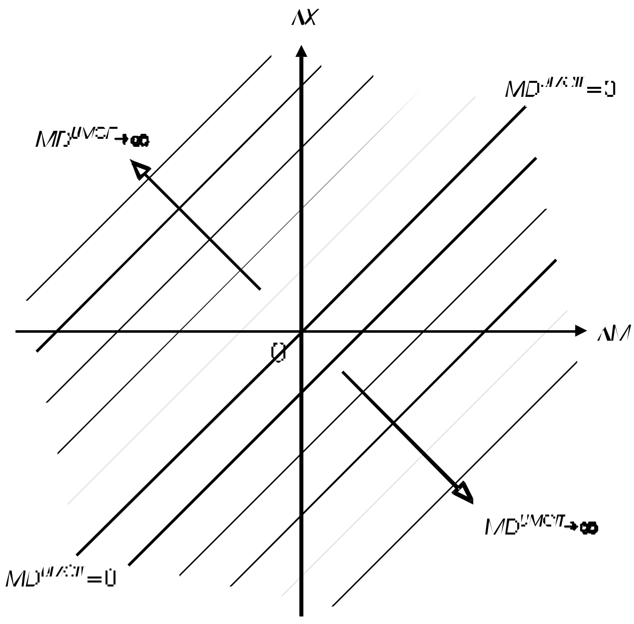
(A) Hamilton and Kniest (1991)



(B) Brülhart (1994): "*A* index"

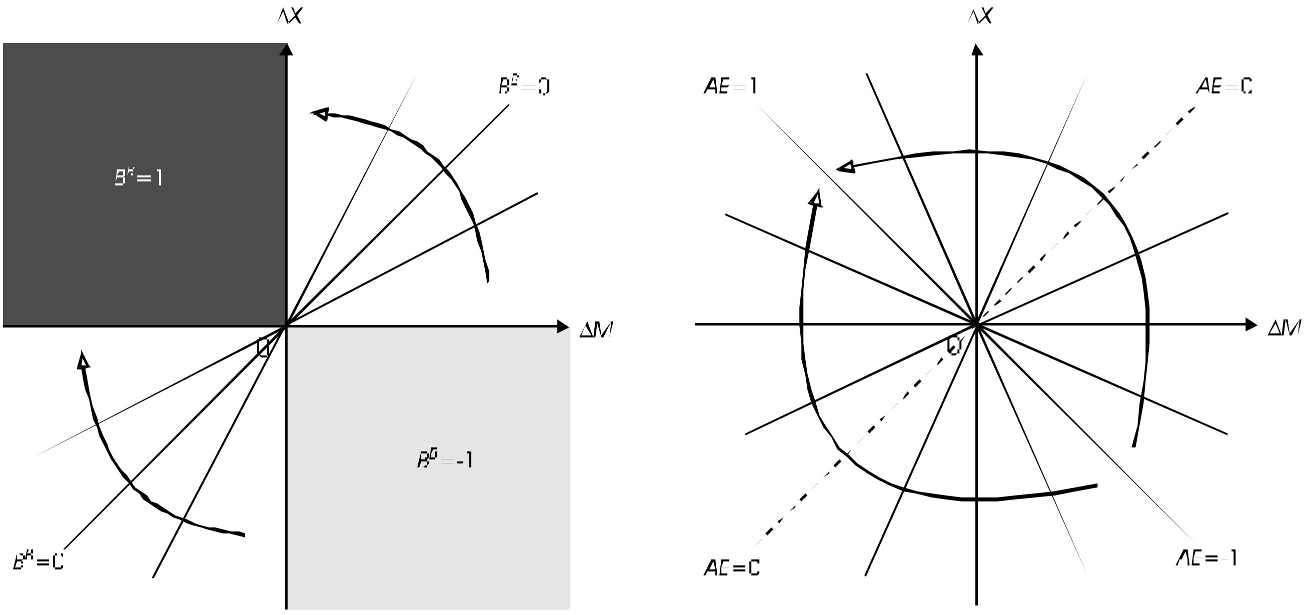


(C) Brülhart (1994): "*C* measure"



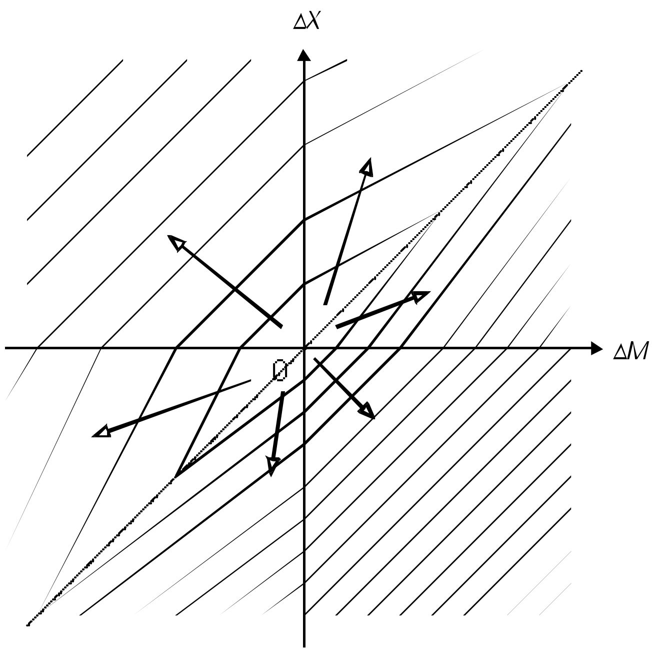
(D) Menon and Dixon (1997): "*UMCIT*"

Figure 3: Measures of MIIT and Sectoral Performance



(A) Brülhart (1994): "*B* index" **(B)** Azhar and Elliott (2001)

Figure 4: A Hypothetical Map of Adjustment Costs and Trade Changes



Abstract:

Economists conventionally assume that intra-industry trade (IIT) entails relatively smooth factor-market adjustment to trade liberalisation. However, the appropriate definition of IIT in the adjustment context continues to be a matter of debate. A consensus is emerging that, in the context of adjustment, one should use measures that are based on *marginal* IIT, and a range of measures have been developed. These measures capture the degree of symmetry of *changes* in exports and imports at the sector level. In this paper I give a critical overview of these measures.

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[1] Lovely and Nelson (2000) have explored changes in IIT in an Ethier (1982) trade model. In that model, trade liberalisation can yield both changes in countries' relative specialisation and changes in the size of industries at the world level. In the conventional understanding of the SAH, the latter effect is subsumed into the *ceteris paribus* assumption, but the Lovely-Nelson (2000) analysis highlights the importance of controlling for world-wide structural change - be it induced by trade liberalisation, technology or taste changes – in empirical analyses of the relationship between (M)IIT and factor-market adjustment.

[2] In the list of five similarity criteria used by the experts in charge of the third revision of the SITC code, for instance, the first principle was "the nature of the merchandise and the materials used in its production", while "the uses of the product" only ranked third (United Nations, 1986, p. viii). Evidence in favour of reasonable homogeneity of statistical sectors in terms of factor requirements has been found by Elliott, Greenaway and Hine (2000). Some researchers, including Aquino (1978), Balassa (1985), Balassa and Bauwens (1987) and Christodoulou (1992), have re-arranged trade data into groups that would seem more appropriate in the IIT context.

[3] A note on terminology. I refer to the GL index as a "static" measure, and to MIIT as a "dynamic" concept. The GL index is calculated on the basis of cross-border flows of goods and is thus not a static measure in the strictest sense. Yet, "static" IIT in the sense of the GL index contrasts with "dynamic" measures of MIIT since the latter relate to the change in these flows between two different years.

[4] Industry subscripts are implied. This will also be the case for all subsequent equations, unless stated otherwise.

[5] This graphical representation is originally due to Shelburne (1993) and has been developed as the "trade box" by Azhar, Milner and Elliott (1998).

[6] If the (constant) slope of a ray is defined as $S = M_i / X_i$, then the GL index on any point along a particular ray is given by: $GL = 1 - \left(\left|1 - S\right| / \left\{1 + S\right\}\right)$.

[7] These considerations are supported by empirical evidence in Little (1996, p. 16), who observed that "regions with rising IIT tended to experience a relatively large shift in the composition of their exports, imports, or both. By contrast, regions with declines in IIT faced somewhat less structural change. These results suggest the need to re-examine the conventional wisdom that increasing IIT automatically smoothes adjustment to trade liberalisation".

[8] Greenaway *et al*. (1994) also pointed out the importance of using deflated trade values for the calculation of ΔM and ΔX. This is true for all measures which use first differences of trade flows, hence it applies to all the MIIT measures discussed below.

[9] Note also that the first measure is undefined if base-year IIT is zero, and the second measure is undefined where base-year net trade is zero.

[10] Greenaway, Lloyd and Milner (1998) have applied this definition of "extended trade" to compute GL indices for the US and five of its major trading partners. They found that two-way foreign-owned production is significantly larger than arms-length IIT.

[11] Another implication is that the magnitude of adjustment costs is unaffected by whether net trade changes are positive or negative. This assumption is relaxed in Section 5.

[12] For a list of references to the SAH in the recent literature, see Brülhart (1999).

[13] The exercise of Brülhart (2000), which is conducted on Irish data and where adjustment costs are proxied by plant-level job turnover rates, includes among the independent variables the MIIT index (B^A) and a measure of trade intensity ((X+M)/output). It does not consider measures of sectoral trade performance.