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MEASURING TRADE REGIONALISATION: THE CASE OF ASIA

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Abstract

This paper takes stock of the literature on the measurement of regional trade integration, showing that traditional indicators, based on bilateral trade intensity indices, are biased by some statistical problems and fail to take properly into account the geographic diversification of intra- and extra-regional trade relationships, as well as the role of distance among trading partners.

The paper suggests how to solve these problems through simple descriptive indicators of 'revealed trade preferences' and relative geographic diversification, that can be adjusted for differences in bilateral distances, and could be used also to better specify gravity models of trade.

Moreover, the paper builds on recent statistical techniques based on network analysis, in order to understand to what extent they can be useful to better describe the topology of regional trade networks.

The empirical section of the paper applies all these indicators to the case of Asia, where an increasing number of bilateral free trade agreements overlaps the growth of market-driven preferential commercial relationships. The paper confirms that the development of these processes is leading to a regionalisation of trade patterns, particularly in the ASEAN region.

Measuring Trade Regionalisation: The Case of Asia

1. Introduction

In the last few decades the international economic system has been experiencing a phase of rapid growth in trade flows, which has translated into a wide-spread increase in market integration. Many technical and socio-economic factors have favoured this process, by reducing obstacles to international transactions. Moreover, trade policies have generally been characterised by an open approach, which has led to a gradual fall in tariffs and other trade barriers. This line has been adopted either unilaterally or in the context of international agreements. Given the problems faced by multilateral negotiations in the World Trade Organization, many governments have tried to pursue trade liberalisation on a preferential basis, through bilateral and regional free trade agreements.

Asia is often presented as an area where the intensification of trade among neighbouring countries has been driven more by economic factors, such as international production fragmentation, than by regional integration policies (market-driven regionalisation). In particular, the development of regional production networks centred on large multinational corporations,[1] but involving an increasing number of small and medium-sized local enterprises, has brought about a growth of trade in intermediates, both intra-firm and intra-industry. On the other hand, policies aimed at removing trade barriers in the context of regional integration organisations have long remained weak, and the impetus to trade liberalisation in Asia has come more from unilateral outward-oriented policies than from regionally co-ordinated initiatives.

However, in the last two decades something has gradually been changing. In particular, countries belonging to the Association of East Asian Nations (ASEAN) gave birth to a free-trade area (AFTA) in 1992, which was the starting point of a more ambitious process aimed at

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[1] The tendency of multinational corporations to operate on a regional scale more than at the global level has been documented, among others, by Rugman and Verbeke (2004) and Rugman (2005).

establishing an Asean Economic Community (AEC) by 2015 (Plummer, 2006). Even in South Asia, where the South Asian Association for Regional Cooperation (SAARC), although creating important opportunities of dialogue in a region plagued by strong security problems, had not produced significant results in terms of trade liberalisation, some progress has recently been achieved in the view to establish a South Asian Free Trade Area (SAFTA). Moreover, the entire East and South Asia (ESA) has been involved in a proliferation of intra- and extra-regional bilateral free-trade agreements (Bonapace and Mikic, 2007; ADB, 2008) that, although creating some worries about their compatibility with the WTO system and the complexity of their effects on business environment, are helping reduce trade barriers, going beyond the limited progress achieved so far in the context of the Asia-Pacific Economic Co-operation (APEC) agreement.

In Asia, even more than elsewhere, it is therefore particularly important to assess correctly the welfare and growth effects of preferential integration agreements. The first step in this direction lies in estimating their impact on trade prices and volumes, which is the most important transmission channel of their policy impulses. This, in turn, requires reliable measurement tools to assess the intensity of regional trade.

This paper reviews the main statistical indicators used to measure the process of trade regionalisation, considering not only traditional and new formulations of trade intensity indices (section 2), but also indicators of geographic diversification of trade and statistical tools aimed at adjusting trade intensity indices by taking the role of distance into account (section 3). Section 4 presents an overview of indicators derived from the application of 'network analysis' to the world trade web, and shows how to adapt them to the study of regional trade networks. All the above indicators are used in section 5 to describe the process of trade regionalisation in three Asian regions. Some concluding remarks are offered in section 6.

2. Trade intensity indices[2]

The dominant approach to the measurement of trade intensity between two countries is based on a comparison between actual bilateral trade flows and their potential level, estimated through a gravity model as a function of the economic size of the two countries and the relative importance of bilateral trade barriers, including distance, protectionist policies, and other factors segmenting international markets. Gravity models have also been widely applied to study the effects of preferential trade agreements, such as those related to regional integration policies. However, model specification and econometric methods are still very controversial and the estimates obtained vary widely across different studies (Adams et al., 2003; Cardamone, 2007; Fontagné and Zignago, 2007).

In most specifications of the gravity model the dependent variable is the value of bilateral trade, at current or constant prices. An alternative and simpler approach is based on the idea that, before making any econometric estimate, the intensity of trade can be measured by comparing the actual value of trade to a properly defined benchmark. This implies that one or more of the variables used as regressors in gravity models is included in the intensity benchmark, so that the subsequent econometric estimates can focus on a more limited set of exogenous variables.[3]

Trade intensity indices are based on a comparison between actual bilateral trade flows and the hypothetical value they would reach in a situation of 'geographic neutrality', namely if the reciprocal importance of each country were equal to its weight in world trade (Kunimoto, 1977). In other words, given the *trade* size of the two countries, which depends on both their economic size, and their degree of international openness, bilateral trade intensity indices aim at capturing the degree of reciprocal *preference* between two trading partners, which can be the result of geographic nearness, common borders, the use of a common language, discriminatory integration policies and other proximity factors. Referring to a geographic neutrality threshold

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[2] This section is partly drawn from Iapadre (2006).
[3] The relationship between trade intensity indices and gravity models of international trade is analysed in Leamer and Stern (1970), Drysdale and Garnaut (1982) and Frankel (1997). Gaulier (2003) shows how trade intensity indices can be related to the gravity model proposed by Deardorff (1998). Trade intensity indices are used in the context of gravity models by Gaulier, Jean and Ünal-Kesenci (2004) and by Zhang and van Witteloostuijn (2004).

implies that proximity is implicitly defined in relative terms, that is as the ratio between bilateral distance and the average distance from the other countries.

Analogous indicators, called bilateral trade propensity indices, can be obtained starting from an alternative specification of the geographic neutrality threshold, in terms of GDP rather than of total trade.[4] In other words, geographic neutrality can be defined as a situation in which the reciprocal importance of each country in bilateral trade is equal to its weight in world GDP. This benchmark looks more consistent with the logic of gravity models,[5] but is implicitly based on the arbitrary assumption that the trade-to-GDP ratio is constant across countries. On the contrary, it is easy to show that this traditional measure of trade openness is negatively related to country size for a variety of reasons, including the simple fact that, by definition, large countries face a lower ratio between foreign and domestic markets.[6]

The usefulness of intensity indices to study trade relations in the context of regional integration agreements is highlighted by Anderson and Norheim (1993), who show that they are immune from the limitations of simpler indicators, such as the intra-regional share of a region's total trade. However, traditional specifications of intra-regional trade intensity indices, similar to the Balassa (1965) index of revealed comparative advantage, raise additional problems, because their range is not homogeneous across regions and is asymmetric around the geographic neutrality threshold, as well as because the interpretation of their changes across time can be ambiguous. In order to solve these problems, Iapadre (2006) presents a regional 'trade introversion' index, which can be seen as an indicator of *revealed trade preference (RTP)* among the member countries of a region.

A bilateral version of the RTP index is used in this paper, in order to measure the intensity of trade relations in the Asian region. The starting point is a 'homogeneous' bilateral trade intensity index (HI_{ij}), given by the ratio between a partner country's share of the reporting country's total trade (S_{ij}) and its weight in total trade of the *rest* of the world (V_{ij}):

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[4] These indices are discussed by Anderson and Norheim (1993: 84) and Frankel (1997: 27).
[5] Applying the Kunimoto (1977) framework to intra-regional trade propensity indices, (Iapadre, 2006: 73-4) shows their strong relationship with the logic of gravity models.
[6] Indicators based on a mixture of trade and GDP data raise additional problems, related to the fact that trade flows are measured in terms of gross output (including the value of intermediate goods), whereas GDP is expressed in terms of value added. Moreover, since GDP includes the services sector, bilateral trade in goods and services should be used in the numerator of the indices, but this is often precluded by data availability problems.

$HI_{ij} = S_{ij} / V_{ij} = (T_{ij} / T_{iw}) / (T_{oj} / T_{ow})$

[1]

where:

T_{ij} : trade (exports plus imports) between reporting country i and partner country j;

T_{iw} : trade between reporting country i and the world;

T_{oj} : trade between the rest of the world (excluding country i) and country j;

T_{ow} : trade between the rest of the world and the world.

The range of HI_{ij} goes from zero (no bilateral trade) to infinity (only bilateral trade) with a geographic neutrality threshold of one, when the importance of country j for country i is equal to its weight in world trade. Unlike the traditional Balassa index, HI_{ij} is homogeneous in the sense that its maximum value does not depend on the size of the partner country. However, HI_{ij} is not bilaterally symmetric, in the sense that is not necessarily equal to HI_{ji}, unless the two partner countries are equal.

Another problem of HI_{ij} is that, under certain conditions[7], its changes across time can have the same sign as the changes of the complementary 'extra-bilateral' trade intensity index HE_{ij}, which measures the intensity of trade relations between country i and all the other countries except country j:

$HE_{ij} = (1 - S_{ij}) / (1 - V_{ij})$

[2]

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[7] See Iapadre (2006: 70-1).

When this problem occurs, interpreting the indices becomes difficult and confusing, because they convey the ambiguous information that trade intensity is increasing (or decreasing) simultaneously with country j and with the rest of the world, which would be an oxymoron.

A simple solution for this problem is to consider the ratio between HI_{ij} and HE_{ij} as an indicator of *relative* bilateral trade intensity. Since the range of this ratio would be disproportionately larger above than below its geographic neutrality threshold of one, giving rise to difficulties in descriptive analysis, as well as in econometric estimates, the ratio between the difference and the sum of HI_{ij} and HE_{ij} can be used to define the bilateral *revealed trade preference index (RTP$_{ij}$)*:

$$RTP_{ij} = (HI_{ij} - HE_{ij}) / (HI_{ij} + HE_{ij})$$
[3]

This index ranges from minus one (no bilateral trade) to one (only bilateral trade) and is equal to zero in the case of geographic neutrality. Unlike trade intensity indices, the bilateral *RTP* index is perfectly symmetric, in the sense that:

$$RTP_{ij} = RTP_{ji}$$
[4]

independently of country size.

The above indices can also be used to map the intensity of trade within a region r. For each of its member countries, intra-regional revealed trade preferences can be computed simply

by applying the above formulas to the country's trade with the rest of the region, treated as a single partner.

$$RTP_{ir} = RTP_{ri} = (HI_{ir} - HE_{ir}) / (HI_{ir} + HE_{ir}) \qquad\qquad [5]$$

It can be shown that HI_{ir} is the weighted average of the corresponding bilateral indices between country i and its regional partners, with weights given by the relative trade size of country i's partners for the rest of the world ($V_{ij} / \Sigma_{j \neq i} V_{ij}$).

An intra-regional RTP index (RTP_{rr}) can be computed also for the region as a whole, but its relationship with the underlying bilateral indices is less straightforward. When a region's intra-regional RTP is computed as a weighted average of the member countries' RTP indices, the result is quite different than what could be obtained by applying the same formulas to a matrix of world trade by region.[8] This is essentially due to the fact that countries, unlike regions, cannot trade with themselves.[9]

3. Geographic diversification and distance[10]

Aggregate measures of trade regionalisation, such as those described in the previous section, although useful as a relatively simple starting point, neglect important aspects of the process. In particular, no attention is paid to the geographic distribution of trade flows within the region. A country with very intense linkages with only one neighbouring partner can in principle

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[8] The latter solution is used in Iapadre (2006) under the name of regional 'trade introversion' index.

[9] This problem, raised by Savage and Deutsch (1960), requires some adjustments in the formulas, similar to those described by Anderson and Norheim (1993: 82, footnote 6). A more rigorous correction procedure can be found in Freudenberg, Gaulier and Ünal-Kesenci (1998).

[10] This section is partly drawn from De Lombaerde and Iapadre (2008).

be considered as regionalised as another country with moderate linkages with every possible partner.[11] Even gravity models of international trade, although taking distance and other barriers to trade into account, do not control for the number of bilateral flows, which limits their usefulness for measuring the regionalization of trade patterns.

A possible solution is to combine intensity indices with a measure of the geographic diversification of bilateral intra-regional trade. The simplest way to do so is by computing the ratio between the number of a country's actual partners and the total number of its potential partners (the total number of countries in the region). As we will see in section 4, this is the approach followed by the so-called binary analysis of the trade network, where the above ratio is called *node density index*.

However this index would not account for the differences in the intensity of bilateral trade across partners, so that, for any given level of aggregate trade regionalisation and number of partners, a country having intense links with only one of them and marginal flows with the others would be treated in the same way as a country trading with all of them at the same level of intensity. In order to solve this problem, more precise indices of diversification are available, drawn from the literature on the measurement of inequality. For example, an *intra-regional geographic diversification index* ($IGDI_i$) can be derived from the normalised Herfindahl concentration index (NHI_i):

$$IGDI_i = (1 - NHI_i) = (1 - \Sigma_{j \neq i} IS_{ij}^2)/(1 - 1/p)$$
[6]

where *p* is the number of possible regional partners, which is equal to *n – 1* for each country, but is equal to *n* for the region, and IS_{ij} denotes their share of country's *i* intra-regional trade. Thanks to its normalisation, $IGDI_i$ ranges from 0, when intra-regional trade is concentrated with only one

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[11] The recently flourishing literature about extensive and intensive margins of trade refers to a similar problem, i.e. the decomposition of world trade growth into the increase in the number of bilateral relationships (extensive margins) and the growth in the volume of trade per relationship (intensive margins). See Helpman, Melitz and Rubinstein (2007).

partner, to 1, when it is equally distributed across all the possible regional partners. Similar diversification indices could be built starting from other measures of concentration, such as the Gini index.[12]

All these indices compare the actual geographic distribution of trade flows with an equidistribution benchmark, that is a distribution where all units have the same weight. This is an obvious choice for studies about income distribution among individuals, but in our case it is unreasonable to assume that trade values should be equally distributed across partner countries of largely different size. A more appropriate benchmark could be an *intra-regional neutrality* criterion, similar to that used for intensity indices. We will assume that the maximum level of *relative* diversification is reached if a country's geographic distribution of bilateral intra-regional trade values is proportional to partner countries' weights in total extra-regional trade. The underlying idea is that if the geographic distribution of intra-regional trade is neutral, it depends only on differences in the trade size of partners, and is not affected by bilateral proximity factors, so that the intra-regional integration process can be said to have reached its maximum level in removing the influence of distance-related barriers to trade. We will then measure to what extent the actual distribution of a country's intra-regional trade is similar to our intra-regional neutrality benchmark. This can be done through a Finger-Kreinin index of similarity, which we will name as *intra-regional relative geographic diversification index* (*IRGDI$_i$*):

$$IRGDI_i = 1 - \Sigma_{j \neq i} |IS_{ij} - IV_{ij}| \, /2$$
$$[7]$$

where *IV$_{ij}$* denotes each possible regional partner's share of the region's total extra-regional trade, net of country *i*'s extra-regional trade. This index ranges from 0, when country *i*'s intra-regional trade is concentrated with partners having no extra-regional trade, to 1, when it is neutrally distributed across all its possible regional partners.

Although improving with respect to the previous option, indicators of diversification fail to inform properly on the geographic reach of the integration process, because they treat every partner in the same way, independently of its distance, so that a country linked exclusively with neighbouring partners would not be distinguished from a country trading with an equal number of partners (of the same trade size as the former country's partners) scattered all over the region. Of course, the severity of this shortcoming is negatively related to the total number of partners, but still the problem cannot be neglected, also because of its interaction with the issue of diversification. Indeed, other things being equal, bilateral trade tends to be relatively less intense with distant partners, as it is shown by gravity models.

A possible solution lies in giving higher weights to more distant partners when computing the indices. This can be done in several ways. The approach followed in this paper is based on a simple correction of bilateral trade values, which have been multiplied by the corresponding normalised relative distances. To this purpose, we have used the CEPII matrix of distances, which includes also measures of internal distance for each country. Each bilateral trade value has been multiplied by the ratio between the corresponding bilateral distance and the sum of the region's countries' internal distances.[13] The resulting adjusted values have been normalised so that their total remains equal to the unadjusted total value of intra-regional trade. Having done so, *distance-adjusted revealed trade preferences* ($DARTP_{ij}$) have been computed on these values using the same formulas of the unadjusted indices.

4. Network analysis

The indicators described in the previous sections aim at measuring the intensity of intra-regional trade or, in other words, to what extent bilateral trade between countries belonging to

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[13] A partly similar approach is adopted by Arribas, Pérez and Tortosa-Ausina (2008).

the same region is higher than expected on the basis of a geographic neutrality assumption (revealed trade preferences). Their standpoint can be either a single member country, in its relationships with partner countries of the region, or the region as a whole, in comparison with other regions.

A different and complementary approach is based on the idea that trade relationships within a region, as well as in the world economy, can be studied as a system of linkages among a set of countries. The topological features of this trade network can be studied through the analytical and statistical tools developed by *network analysis* in other contexts, mainly in the study of social relationships.[14]

Most of this literature refers to the world trade network as a whole, trying to understand its systemic structure in terms of connectivity among its nodes (countries), or in order to detect possible core-periphery patterns and their evolution across time.[15] However, recently network analysis has been applied also to the study of regional trade (Kali and Reyes, 2007), with the aim to assess to what extent belonging to the same region affects the intensity of trade linkages among countries.[16]

Network analysis techniques can be classified according to the way in which linkages among the nodes (vertices) of the network are represented. In *binary-network analysis* (BNA) what matters is only the number of existing or missing linkages, whereas in *weighted-network analysis* (WNA) each linkage is weighted according to some variable defining its intensity. In other words, in BNA the network is represented as an adjacency matrix (A) where each of the a_{ij} elements is equal to one if there is a linkage between nodes i and j, or zero otherwise. Thus, in BNA all existing linkages have the same weight, regardless of their strength, whereas in WNA the adjacency matrix is replaced by a matrix of weights (W), whose elements w_{ij} measure the

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[14] The literature on network analysis has been surveyed by Scott (2000), Barabàsi (2003), Watts (2003), Carrington, Scott, and Wasserman (2005). Recent books presenting economic applications of network analysis include Goyal (2007) and Vega Redondo (2007).

[15] See Smith and White (1992), Li, Jin and Chen (2003), Serrano and Boguñá (2003), Garlaschelli and Loffredo (2004, 2005), Fagiolo, Reyes and Schiavo (2007, 2008), Kali and Reyes (2007), Serrano, Boguñá and Vespignani (2007), De Benedictis and Tajoli (2008).

[16] An application of network analysis to trade in continental groupings is offered by De Benedictis and Tajoli (2008). An earlier attempt to use network analysis at the regional level, in order to identify the most attractive regional member countries for FDI, is due to Roth and Dakhli (2000). A different question underlies a paper by Reyes, Schiavo and Fagiolo (2008), who study the relative degree of integration into the world economy of two different regions (East Asia and Latin America).

intensity of bilateral linkages.[17] A further distinction concerns the direction of linkages. They can be represented either as directed links (arcs) from one node to another, or as undirected links (edges) between two nodes.

In many contexts of network analysis the number of linkages among the nodes of the network is the only available information, but this is not the case for trade, where we have detailed statistics on the value of bilateral flows. However, most of the literature is based on BNA, and studies the structure of the trade network considering only the number of partners. We will here review the main statistical indicators used in this literature, showing how they can be adapted to study a regional trade network.

Since we are interested in assessing the intensity of bilateral trade flows independently of their degree of balance, we will neglect the distinction between exports and imports and consider their sum as an undirected trade flow (t_{ij}) between two countries i and j belonging to the same region r made of n countries. This makes our trade matrix symmetric by definition ($t_{ij} \equiv t_{ji}$). Since no country can trade with itself, $t_{ii} \equiv 0$ for all countries. However, at the region level, t_{rr} defines intra-regional trade and is equal to $\Sigma_i t_{ij}$ and to $\Sigma_j t_{ij}$.

The simplest indicator than can be used to analyse the structure of a regional trade network is the *intra-regional node degree (IND_i)*[18], that is the number of regional partner countries of each country i, which can be expressed in absolute terms, or as an *intra-regional density index* (IDI_i), that is as a ratio of the total number of possible regional partner countries ($n − 1$):

$IDI_i = IND_i / (n − 1)$

[8]

As mentioned in section 3, the intra-regional density index can be seen as a measure of the geographic diversification of bilateral trade relationships and can be computed also for the entire

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[17] The notation used in this section is mostly drawn from Fagiolo, Reyes and Schiavo (2007).
[18] In the network analysis literature node degree is sometimes called *neighbourhood degree*.

region, where it measures to what extent the actual number of trade linkages corresponds to its maximum potential level:

$$IDI_r = \Sigma_i IND_i / [n(n-1)]$$
[9]

The density of a regional trade network can be compared with a pre-defined external benchmark area o, that can be a set of other regions or the rest of the world, made of m countries. Denoting with END_i the *extra-regional node degree*, that is the number of country i's trading partners located in the external benchmark, a *relative intra-regional density index* ($RIDI_i$) can be defined as:

$$RIDI_i = (IDI_i - EDI_i) / (IDI_i + EDI_i)$$
[10]

where: $EDI_i = END_i / m$

$RIDI_i$ ranges between -1 and 1 and is equal to zero if $IDI_i = EDI_i$ (geographic neutrality). At the regional level:

$$RIDI_r = (IDI_r - EDI_r) / (IDI_r + EDI_r)$$
[11]

where: $EDI_r = \Sigma_i END_i / (n \cdot m)$

Another indicator frequently used in the BNA of the world trade network is the *average nearest neighbour degree* ($ANND_i$), which is simply the average node degree of country i's partners. In our context, to reduce the complexity of notation, we will replace the phrase *nearest neighbour* with *partner*, and define an *intra-regional average partner degree* ($IAPD_i$) as follows:

$$IAPD_i = (\mathbf{A}_{(i)} \cdot \mathbf{A} \cdot \mathbf{1})/IND_i$$
[12]

where $\mathbf{A}_{(i)}$ is the ith row of the adjacency matrix $\mathbf{A}$ describing the network and $\mathbf{1}$ is a unitary vector. The maximum level of $IAPD_i$ is reached when all country i's regional partners' IDI_j are equal to one, that is when all the possible $n(n-1)$ trade linkages exist. This allows us to define an average *intra-regional partner density index* ($IPDI_i$) as follows:

$$IPDI_i = IAPD_i /(n-1)$$
[13]

At the regional level $IAPD_r$ and $IPDI_r$ can simply be computed as the averages of the corresponding country indicators.

An *extra-regional average partner degree* ($EAPD_i$) and an *extra-regional partner density index* ($EPDI_i$) can be defined as follows:

$$EAPD_i = (\mathbf{EA}_{(i)} \cdot \mathbf{OA} \cdot \mathbf{1})/END_i$$
[14]

$$EPDI_i = EAPD_i /(m-1)$$
[15]

where **EA** is the *n* x *m* adjacency matrix of linkages between the region's members and the benchmark area's countries, and **OA** is the *m* x *m* adjacency matrix of linkages among the benchmark area's countries.

Finally, a *relative intra-regional partner density index* ($RIPDI_i$), ranging from − 1 to 1 with a neutrality threshold of zero, can be computed as:

$$RIPDI_i = (IPDI_i - EPDI_i)/(IPDI_i + EPDI_i)$$

[16]

The fact that a country has a certain average partner degree does not necessarily imply that all its partners are connected between each other. In order to capture this feature of the network, a third indicator has been developed, named *binary clustering coefficient* (BCC_i), aimed at measuring to what extent a country's partners tend to cluster into triangles, that is to trade between each other. *BCC* has also been used to detect a possible hierarchic structure of the network.

The *intra-regional binary clustering coefficient* ($IBCC_i$) can be defined as:

$$IBCC_i = (A^3)_{ii}/[IND_i(IND_i - 1)]$$

[17]

where $(A^3)_{ii}$ is the *i-th* entry on the main diagonal of $A \cdot A \cdot A$. Given IND_i, $IBCC_i$ measures the actual number of bilateral linkages between country *i's* regional partners, relative to its potential.[19]

When geography and distance matter, as in the case of trade, clustering coefficients tend to be high, because countries tend to trade more intensely with neighbouring partners.

An *extra-regional binary clustering coefficient* (*EBCC_i*) can be used to measure to what extent the extra-regional partners of a region's country tend to trade between each other. Its formula can be defined as follows:

$$EBCC_i = (E{\cdot}O{\cdot}E')_{ii}/[END_i(END_i - 1)]$$
[18]

where E is the *n x m* adjacency matrix between countries of the region and of the benchmark area, and O is the *m x m* adjacency matrix describing trade linkages within the benchmark area. Similarly to *IBCC_i*, *EBCC_i* measures the actual number of bilateral linkages between country *i's* extra-regional partners, relative to its potential.[20]

As for the previous indicators, a *relative intra-regional binary clustering coefficient* (*RIBCC_i*), ranging from -1 to 1 with a neutrality threshold of zero, can be computed as:

$$RIBCC_i = (IBCC_i - EBCC_i)/(IBCC_i + EBCC_i)$$
[19]

This indicator shows if trade clustering within the region is more or less intense than in extra-regional trade.

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[19] *IBCC_i* can be computed only if *IND_i* >1.
[20] *EBCC_i* can be computed only if *END_i* >1.

Another useful concept is the *degree of centrality*, which is used to assess to what extent trade linkages tend to concentrate towards one or more *hub* countries. The maximum degree of centralisation is reached in a *star network*, where only one country is connected with all the others, whereas each of the others is connected only with the centre of the network.[21]

Several indicators have been proposed to measure the centrality of a node and the centralisation of a network. At the country level, *intra-regional node centrality* (INC_i) can simply be measured as:

$$INC_i = (1 - IBCC_i)$$

[20]

INC_i measures to what extent a country is connected to regional partners that are not connected between each other.

At the network level, an *intra-regional centralisation index* (ICI_r) can be defined as:

$$ICI_r = max[INC_i] = \Sigma_i(max[IND_i] - IND_i)/[(n-1)(n-2)]$$

[21]

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[21] A similar image is sometimes used to describe the network of preferential trade relationship between the European Union and its partner countries, particularly in developing regions, which is depicted as a *hub-and-spoke* system. The lack of preferential agreements among the spokes of the system is sometimes considered as a factor than can inhibit their ability to reap the benefits of their integration with the EU.

This indicator measures the network's actual centralisation as a proportion of its theoretical maximum, defined by the number of missing linkages in the corresponding star network, which is equal to $(n – 1)(n – 2)$.[22]

As argued above, BNA is based only on the number of trading partners and neglects the intensity of their linkages. The simplest way to study the geographic distribution of trade flows considering jointly the number of partner countries and the value of bilateral trade is through one of the many measures of diversification already mentioned in section 3. The world trade network appears to be concentrated in a relatively small number of significant bilateral flows.[23] In BNA, this feature is the justification for the common practice of reducing the size of the network, by limiting the analysis to the most significant flows, selected through arbitrary thresholds, and comparing the resulting indicators to those obtained for the entire network.

Going beyond measures of concentration, the WNA of international trade represents the intensity of linkages among the network nodes through the actual matrix of their bilateral trade flows (W) expressed in absolute or relative terms.[24]

Apart from the difference between the respective matrices, indicators used in WNA are similar to those used in BNA. In our context, node degree is replaced by *intra-regional node value* (INV_i), which is the value of a country's total trade with its region. However, since there is no given maximum value for trade, a density index similar to that used in BNA cannot be easily defined, and there are several options to build a normalised INV_i.

If we refer to the geographic neutrality criterion used in section 2, we can introduce intensity and revealed trade preference indices into the context of WNA. Since INV_i refers to intra-regional trade, we can define *extra-regional node value* (ENV_i) as the total value of country i's trade with the benchmark area, and the density index of BNA can be replaced by an homogeneous trade intensity index HI_{ir} similar to that defined in section 2. More precisely:

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[22] See Kali and Reyes (2007).
[23] See Serrano, Boguña and Vespignani (2007).
[24] Fagiolo, Reyes and Schiavo (2007) show why WNA is more informative than BNA in describing the world trade network.

$HI_{ir} = S_{ir} / V_{or}$

[22]

where: $S_{ir} = INV_i / (INV_i + ENV_i)$

$V_{or} = \Sigma_k ENV_k / \Sigma_k (ENV_k + INV_k)$

and $k = 1, \ldots, m$ refers to countries of the benchmark area o.

HI_{ir} is higher (lower) than one if country i's intra-regional trade share is higher (lower) that the share of region r in the benchmark area's trade.

In a similar way, an *homogeneous extra-regional trade intensity index* (HE_{ir}) can be defined as:

$HE_{ir} = (1 - S_{ir}) / (1 - V_{or})$

[23]

and finally the *relative intra-regional revealed trade preference index* ($RIRTP_{ir}$) can be computed as:

$RIRTP_{ir} = (HI_{ir} - HE_{ir})(HI_{ir} + HE_{ir})$

[24]

As shown in section 2, this index measures unambiguously if intra-regional trade is more or less intense than what implied by the geographic neutrality criterion.

So far, it could be argued that the simplest indicators based on WNA have no significant value added with respect to trade intensity indices and/or traditional concentration measures. However, other WNA indicators can be used to better illustrate the topology of regional trade networks in terms of connectivity and centralisation, taking into account not only direct bilateral linkages between a country and its partners, but also linkages among the latter.

Reminding that the importance of a node in a network depends not only on its own degree, but also on the degree of its partners, we can adapt the binary indicator of $IAPD_i$ to WNA in several ways.

The first possibility is to compute an *intra-regional weighted average partner degree* ($IWAPD_i$) through the following formula:

$$IWAPD_i = (W_{(i)}A1)/INV_i \qquad [25]$$

where $W_{(i)}$ is the $i\text{-}^{th}$ row of the weight matrix W.

A similar indicator could be built for extra-regional partners and the two indicators could be compared as for the previous ones. However, $IWAPD_i$, although weighting each partner with its trade value, is still to be considered as a binary indicator, since its unit of measurement remains the number of partners.

A more appropriate WNA equivalent of the binary $IAPD_i$ is the *intra-regional average partner value* ($IAPV_i$), which is the average value of a country's regional partners' intra-regional trade:

$$IAPV_i = (A_{(i)}W1)/ IND_i$$

[26]

The maximum level of $IAPV_i$ can be defined as follows:

$$Max(IAPV)_i = \Sigma_k INV_k /IND_i$$

[27]

where $k = 1, ... IND_i$ are the *possible* regional partners of country i ranked according to their total trade value. This implies that $\Sigma_k INV_k$ necessarily grows less than proportionally than IND_i. It is also important to note that, for any given *IND*, the list of possible partners changes across countries, because it cannot include country i. As a consequence, $Max(IAPV)_i$ is negatively related to INV_i and will be reached only if the *actual* regional trade partners of country i happen to be those with the highest total trade value.

This definition allow us to build an *intra-regional normalised average partner value* ($INAPV_i$) as the ratio between $IAPV_i$ and its maximum.

At the regional level $IAPV_r$ and $INAPV_r$ can simply be computed as the weighted averages of the corresponding country indicators.

An *extra-regional average partner value* ($EAPV_i$) and a corresponding normalised index ($ENAPV_i$) can be defined as follows:

$$ENAPV_i = (EA_{(i)} \cdot OW \cdot 1)/END_i$$

[28]

$$ENAPV_i = EAPV_i /Max(EAPV)_i = EAPV_i / (\Sigma_q ONV_q /END_i)$$

[29]

where OW is the m x m matrix of trade flows among the benchmark area's countries, ONV_q is the total value of trade of country q with the other benchmark area's countries, and $q = 1, ... END_i$ is the number of *possible* extra-regional trade partners of country i ranked according to the total value of their trade with the rest of the benchmark area. By definition, $Max(EAPV)_i$ is negatively related to END_i.[25]

Finally, a relative *normalised intra-regional average partner value* ($RINAPV_i$), ranging from -1 to 1 with a neutrality threshold of zero, can be computed as:

$$RINAPV_i = (INAPV_i - ENAPV_i)/(INAPV_i + ENAPV_i)$$
[30]

The binary concept of clustering into triangles can easily be adapted to WNA. The *intra-regional weighted clustering coefficient* ($IWCC_i$) is defined as follows:

$$IWCC_i = (W^{[1/3]})^3{}_{ii}/[IND_i(IND_i - 1)]$$
[31]

where $W^{[1/3]}$ is the matrix obtained by raising each element of the W matrix to 1/3 and $(W^{[1/3]})^3{}_{ii}$ is the $i\text{-}th$ entry on the main diagonal of $W^{[1/3]} \cdot W^{[1/3]} \cdot W^{[1/3]}$. $IWCC_i$ measures the intensity of trade among country i's regional partners relative to the total number of their potential

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[25] In a fully connected network, where all possible linkages exist ($IDI_r = 1$), $IAPV_i$ necessarily equals its maximum and is negatively related to country size, as measured by its total trade value. This results from the fact that no country can trade with itself. On the other hand, if the network of extra-regional trade is fully connected ($EDI_r = 1$), $EAPV_i$, although being equal to its maximum, is also equal across the region's countries.

connections. So, it is positively related to the actual density of these connections (*IBCC*) and to their intensity.

For any given IND_i, the maximum level of $IWCC_i$ is not scale-independent. This problem can be solved by dividing each element in the **W** matrix by their maximum, which results into an *intra-regional normalised weighted clustering coefficient* (*INWCC$_i$*), ranging from 0 to 1:

$$INWCC_i = (NW^{[1/3]})^3{}_{ii}/[IND_i(IND_i - 1)]$$
[32]

where **NW** is the matrix of trade flows within region *r* normalised with respect to their maximum.

An *extra-regional weighted clustering coefficient* (*EWCC$_i$*) can be defined as:

$$EWCC_i = (EW^{[1/3]} \cdot OW^{[1/3]} \cdot EW'^{[1/3]})_{ii}/[END_i(END_i - 1)]$$
[33]

where **EW** is the *n* x *m* matrix of bilateral trade flows between the member countries of region *r* and countries of the benchmark area. Its normalised version is:

$$ENWCC_i = (NEW^{[1/3]} \cdot NOW^{[1/3]} \cdot NEW'^{[1/3]})_{ii}/[END_i(END_i - 1)]$$
[34]

where **NEW** and **NOW** are obtained from the matrices **EW** and **OW** by dividing each of their elements by their respective maximum.

Finally, the *relative intra-regional normalised weighted clustering coefficient* ($RINWCC_i$) is given by:

$$RINWCC_i = (INWCC_i - ENWCC_i)/ (INWCC_i + ENWCC_i)$$
[35]

As in the previous similar cases, this index ranges from -1 to 1 around a geographic neutrality threshold of zero.

Trade regionalisation can be seen as a process leading a region's member countries to trade more intensely among each other than with countries in other regions. Stated differently, this process implies that countries characterised by a certain qualitative feature (belonging to region *r*) tend to trade more intensely with countries sharing the same feature. This pattern of selective linking has been characterised in network analysis as *assortative mixing* or *homophily* and a number of indicators have been devised to measure its intensity. Unlike previous indicators, that can be computed at country and region levels, homophily can be measured only with reference to the entire network of trade flows, including both the target region and the other regions in the benchmark area.

In a binary context Newman (2003a,b) suggests an *assortativity coefficient*, which can be easily adapted to a weighted matrix of trade flows. The resulting *intra-regional assortativity coefficient* (*IAC*) is:

$$IAC = (Tr(\mathbf{R}) - ||\mathbf{R^2}||) / (1 - ||\mathbf{R^2}||)$$
[36]

where R is the matrix of intra- and inter-regional trade flows, divided by their total, Tr is the trace operator, and $\|R^2\|$ is the sum of all the elements of matrix R^2.

IAC is equal to zero in the case of geographic neutrality, that is when regions trade among each other in proportion to their total trade values, and reaches a maximum value of one in the limiting case of no inter-regional trade. On the other hand, in the limiting case of no intra-regional trade, the minimum (negative) value of IAC is equal to $-\|R^2\| / (1 - \|R^2\|)$.[26]

Assortativity of a network can also be measured with reference to a scalar variable, such as the node degree or its value. In other words, it can be of interest to assess to what extent high-degree or high-value nodes tend to trade among themselves more than with low-degree or low-value nodes. In the world trade network, this concept of assortativity has normally been measured with the Pearson correlation coefficient between ND_i and APD_i or between NV_i and APV_i.[27] These correlation coefficients can be computed also for regional networks, although their statistical significance is not high, given the relatively low number of observations.

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[26] The minimum IAC of -1 (perfect disassortativity) is reached when $Tr(R) = 0$ (no intra-regional trade) and $\|R^2\| = 0.5$. The latter parameter depends on the distribution of extra-regional flows and on the number of regions. It can be shown that $\|R^2\|$ is equal to 0.5 only for a two-region world with no intra-regional trade. For a symmetric matrix with a number of regions larger than 2, the minimum IAC is higher than -1 and grows with the number of regions.

[27] Garlaschelli and Loffredo (2004) show that the world trade network is disassortative, meaning that countries with many partners tend to trade with countries with few partners. Given the high density of the trade network, degree disassortativity seems to be a rather obvious consequence of the unequal distribution of the node degree. In other words, since only few countries have a high degree, the APD results a decreasing function of the degree even if all high-degree countries are connected between each other.

5.   Trade Regionalisation in East and South Asia

We apply the indicators described in the previous sections to study trade regionalisation in the ESA area in the 1990-2005 period.

In order to measure the intensity of trade regionalisation, we consider separately the two regions (ASEAN and SAFTA) where formal trade agreements are more developed, grouping the rest of the area into a third region "other East and South Asian countries" (OESA), comprising countries that are more or less involved in preferential trade agreements at different levels, including APEC.

At this stage of the research, our aim is only descriptive. We want to measure the intensity of trade in the three regions, without any ambition to establish causal links.

Data have been drawn from the IMF Direction of Trade Statistics (DOTS) for years 1990, 2000 and 2005. They are expressed in US dollars at current prices.

Table *1* shows the RTP index for the three regions and for the rest of the world (ROW), taken as a unique region and as a benchmark of trade intensity. The index for intra-ROW trade confirms the great progress achieved by international economic integration in the 1990-2005 period, and particularly in the last five years. It is also evident that all the three regions in the ESA area have been trading more intensely intra-regionally and with other regions in the same area than with the rest of the world. The RTP indices of the three ESA regions towards ROW were strongly negative already in 1990, particularly for ASEAN and OESA, and have further declined in the following years. In 1990 the intensity of intra-regional trade was marginally higher than the ROW benchmark only in the ASEAN region, confirming its relatively stronger degree of integration, but has been increasing in all the three regions, and particularly in SAFTA. It is interesting to note that in each region the intensity of intra-regional trade has heightened not only at the expense of trade with ROW, but also with the other ESA regions. The only partial exception is the ASEAN-SAFTA index, which rose in the last five years. It is also noteworthy

that the SAFTA-OESA index has remained only marginally higher than the geographic neutrality threshold.

Index of revealed trade preferences

1990		ASEAN	SAFTA	OESA	ROW
	ASEAN	0.66	0.29	0.52	-0.68
	SAFTA	0.29	0.62	0.10	-0.21
	OESA	0.52	0.10	0.49	-0.57
	ROW	-0.68	-0.21	-0.57	0.65

2000		ASEAN	SAFTA	OESA	ROW
	ASEAN	0.67	0.28	0.42	-0.67
	SAFTA	0.28	0.73	0.01	-0.19
	OESA	0.42	0.01	0.49	-0.59
	ROW	-0.67	-0.19	-0.59	0.68

2005		ASEAN	SAFTA	OESA	ROW
	ASEAN	0.73	0.36	0.41	-0.70
	SAFTA	0.36	0.76	0.06	-0.26
	OESA	0.41	0.06	0.54	-0.63
	ROW	-0.70	-0.26	-0.63	0.72

Table 1

The intensification of intra-regional trade has not involved all the countries at the same rate. Figure 1 shows changes in intra-regional RTP in each of the ASEAN countries between 1990 and 2005. Overall, there was a process of convergence. Countries starting with relative low levels of intra-regional RTP, namely Indonesia, Philippines and Vietnam, recorded the highest increases, whereas countries that in 1990 were already strongly oriented towards intra-regional trade (Cambodia, Laos, Malaysia) underwent a fall in the index. The coefficient of variation fell from 0.27 to 0.12.
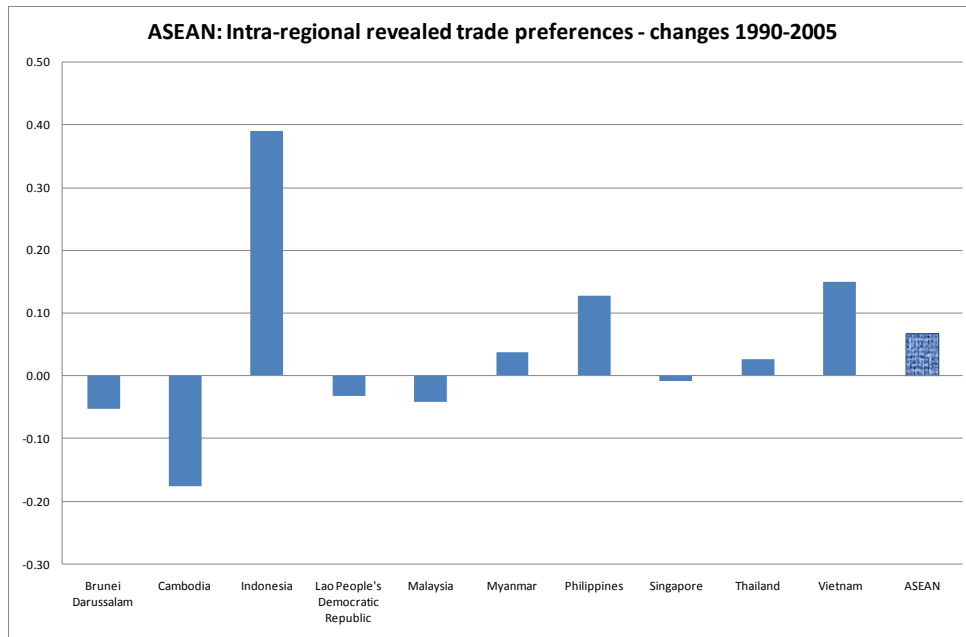
Figure 1

The same cannot be said for the SAFTA region, where the increase in intra-regional RTP was driven by India, and only Bangladesh recorded a significant fall (figure 2).
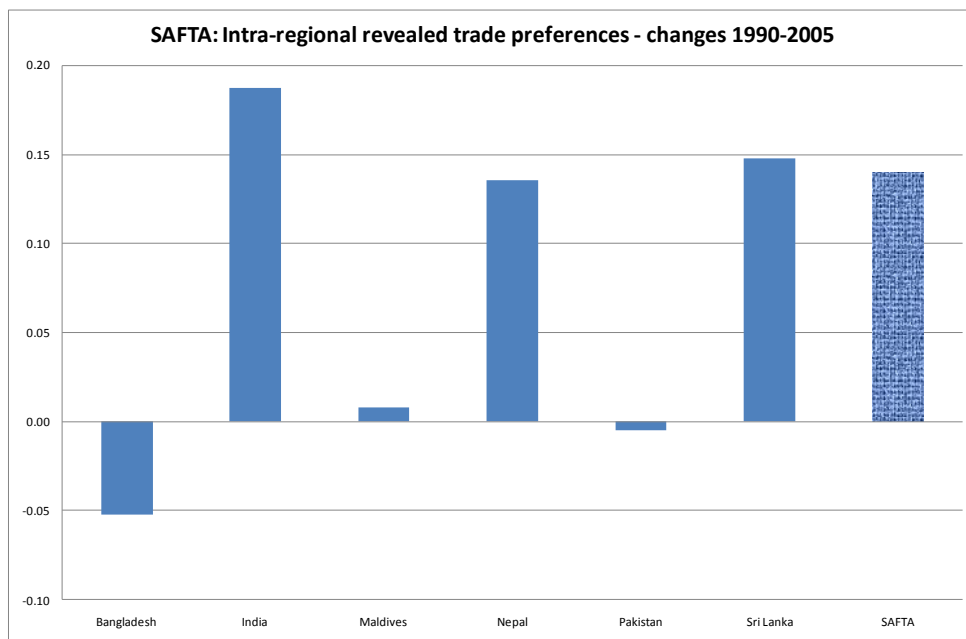
Figure 2

Among the OESA countries, only Hong Kong and Japan increased their intra-regional RTP (figure 3), whereas Australia, China and New Zealand reduced their orientation towards this group. A composition effect explains why the average increase at regional level was higher than at country level: the relative weight of countries with the highest RTP indices (China and Hong Kong) increased between 1990 and 2005.

Figure 3

The convergence in intra-regional RTP indices is confirmed at the level of the entire ESA area. Countries starting from high levels tended to reduce their index and viceversa. The Pearson correlation coefficient between the 1990 levels and the 1990-2005 changes, computed on all the 24 countries considered in this study is − 0.35.

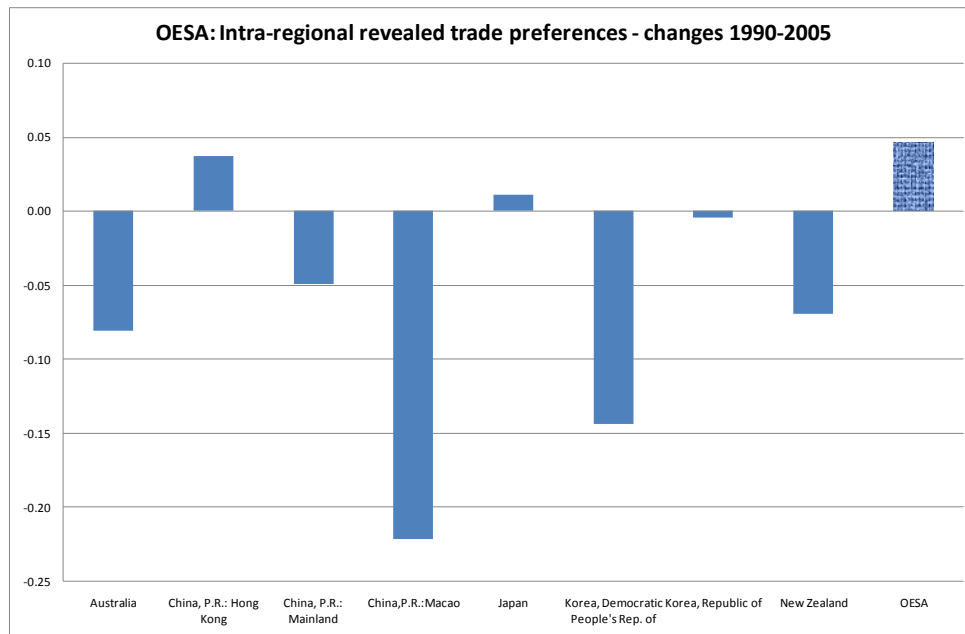As argued in section 2, a high level of intra-regional RTP does not necessarily imply a high level of trade regionalisation, if it is not accompanied by an adequate degree of geographic diversification of bilateral trade flows within the region.

Table 2 shows the *intra-regional relative geographic diversification indices* (IRGDI), based on the Finger-Kreinin formula [7]. The three regions show different patterns. In ASEAN the wide-spread increase in intra-regional RTP has come with a further rise in the already high aggregate level of relative geographic diversification, but with large differences across countries. In particular, relatively peripheral countries (Brunei, Cambodia, Indonesia and Myanmar) have recorded a fall in their IRGDI. SAFTA and OESA started from the same level of aggregate relative geographic diversification in 1990, but have followed different paths since then. Most OESA countries have significantly increased their IRGDI, the only exceptions being again relatively peripheral countries (Australia, New Zealand and North Korea). On the contrary, SAFTA's intra-regional geographic diversification has remained virtually unchanged on aggregate, even if some individual countries have recorded large increases, starting from relatively low levels.

As for intra-regional RTP, a clear process of convergence has emerged in intra-regional geographic diversification, with a fall in cross-country disparities. The correlation coefficient between the 1990 levels and the 1990-2005 changes of the IRGDI index is – 0.57.

Intra-regional relative geographic diversification index				
	1990	**2000**	**2005**	**2005-1990**
Brunei Darussalam	0.74	0.70	0.66	-0.08
Cambodia	0.56	0.65	0.53	-0.03
Indonesia	0.83	0.90	0.73	-0.10
Lao People's Democratic Republic	0.21	0.26	0.30	0.09
Malaysia	0.61	0.66	0.75	0.14
Myanmar	0.73	0.73	0.53	-0.20
Philippines	0.85	0.88	0.92	0.07
Singapore	0.64	0.71	0.76	0.12
Thailand	0.76	0.87	0.88	0.12
Vietnam	0.75	0.83	0.86	0.11
ASEAN	**0.79**	**0.85**	**0.91**	**0.12**
Bangladesh	0.95	0.90	0.93	-0.02
India	0.58	0.67	0.61	0.03
Maldives	0.34	0.26	0.65	0.32
Nepal	0.75	0.68	0.73	-0.01
Pakistan	0.47	0.65	0.81	0.34
Sri Lanka	0.77	0.87	0.84	0.07
SAFTA	**0.68**	**0.71**	**0.69**	**0.01**
Australia	0.88	0.87	0.83	-0.06
China, P.R.: Hong Kong	0.43	0.54	0.64	0.21
China, P.R.: Mainland	0.40	0.67	0.71	0.30
China,P.R.:Macao	0.29	0.39	0.52	0.23
Japan	0.89	0.92	0.97	0.08
Korea, Democratic People's Rep. of	0.64	0.70	0.49	-0.15
Korea, Republic of	0.92	0.91	0.93	0.01
New Zealand	0.57	0.52	0.51	-0.06
OESA	**0.68**	**0.78**	**0.88**	**0.20**

Table 2

As argued in section 3, a thorough assessment of regional trade integration should take distance properly into account. For any given value of bilateral trade, flows with more distant regional partners imply higher trade costs and should therefore be weighed more than flows with neighbouring countries, when measuring the intensity of intra-regional integration.

As a first step in this direction, we have adjusted bilateral trade values proportionally to relative bilateral distances, as explained in section 3, and used the new values to compute *distance-adjusted RTP indices* ($DARTP_{ij}$). At regional level there are no significant changes, but at country level, DARTP indices are quite different than the unadjusted ones. The DARTP of countries located at the periphery of their regions, such as Australia, New Zealand and Philippines result much higher than the unadjusted indices (the average difference is about 0.2). On the other hand, relatively central countries, such as Malaysia and Korea, show DARTP indices that are significantly lower than the corresponding unadjusted values. Within SAFTA the corrections are lower, due to the fact that India borders almost every country in the region.

Progress in international integration, driven by technical progress and other factors, is expected to reduce the importance of distance-related trade barriers across time. This should translate into lower differences between adjusted and unadjusted RTP indices. To check this hypothesis we have computed the Pearson correlation coefficient between the two indices across all the 24 countries of our study. This index rose from 0.67 in 1990 to 0.82 in 2005, confirming that the role of distance in limiting trade flows has become less important, at least in regional contexts.

We will now present the results obtained by applying network analysis indicators to the data on trade in the ESA area, which we have already analysed through more traditional techniques.

In this sub-section we have focussed on the three ESA regions, excluding the rest of the world from the analysis, in order to better understand the relative dynamics of trade regionalisation in the Asian area.

Table *3* presents the main network indicators for the ASEAN region, in comparison with the rest of ESA (SAFTA plus OESA).

Overall, network analysis confirms the increase in regional trade integration which was already evident from the previous indicators. Both the regional network and its extra-regional benchmark were very densely connected already in 1990. Density indices have risen more

intensely in intra- than in extra-regional trade. The same can be said for the average partner density indices. Binary clustering has grown only intra-regionally. All these indicators are only marginally lower than their theoretical maximum, which does not come as a surprise, given the high degree of integration in the Asian region.[28] As a result, already in the nineties, the network's centralisation index fell sharply. At country level, Indonesia, Malaysia, Philippines and Thailand had a relatively high (0.25) intra-regional node centrality in 1990, whereas in 2000 INC became extremely low (0.06) in every country, with Brunei, Laos and Myanmar at zero.

Relative intra-regional RTP has risen strongly, even more than what appeared in the world context. Average partner value was at its maximum, both intra- and extra-regionally, already in 1990 and remained there. As we will see, this is a common feature of the three regions, which stems from the high density of their networks. Weighted clustering coefficients are very low,[29] and have increased less in intra-regional trade than in trade with the benchmark area.

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[28] Different results could be obtained by conducting the analysis at the product level, where international trade networks are still characterised by a large number of missing linkages.

[29] The low levels of WCC indicators can be explained with the normalisation benchmark, which is the maximum value of bilateral trade. WCC indicators would reach their maximum level of 1 only if all bilateral trade flows in the network's triangles were equal to their maximum, which is clearly implausible given the large disparities in country size.

ASEAN: Regional trade network indicators				
	1990	**2000**	**2005**	**2005-1990**
IDI	0.80	0.96	0.96	0.16
EDI	0.85	0.95	0.91	0.06
RIDI	-0.03	0.00	0.02	0.05
IPDI	0.87	0.96	0.96	0.09
EPDI	0.94	0.94	0.94	0.00
RIPDI	-0.04	0.01	0.01	0.05
IBCC	0.87	0.96	0.95	0.08
EBCC	0.96	0.95	0.95	-0.01
RIBCC	-0.05	0.01	0.00	0.05
ICI	0.25	0.06	0.06	-0.19
HI	1.44	1.70	2.04	0.60
HE	0.86	0.77	0.72	-0.14
RIRTP	0.25	0.38	0.48	0.22
INAPV	0.998	1.000	1.000	0.001
ENAPV	1.000	1.000	1.000	0.000
RINAPV	0.000	0.000	0.000	0.000
INWCC	0.04	0.04	0.06	0.02
ENWCC	0.03	0.04	0.05	0.02
RINWCC	0.08	-0.02	0.05	-0.03

Table 3

The network analysis of the SAFTA region shows partly different results (*Table 4*). Intra-regional trade density remained stable in the 1990-2005 period, at a level which has become the lowest in the ESA area, whereas in 1990 it was higher than in ASEAN. This is in line with what already emerged above, where SAFTA's index of intra-regional relative geographic diversification remained stable, in contrast with the rest of the area. The other intra-regional binary indicators have remained stable too, so that overall relative trade regionalisation has

slightly receded with respect to the rest of the ESA area. Even the centralization of the network has remained at the relatively high level of 1990 (0.2), with India, Pakistan and Sri-Lanka playing the role of central countries.

RTP indicators point to different results, but the increase in intra-regional trade intensity achieved in the nineties, relative to the rest of the ESA area, was partly reversed in the following years. Even the decline in intra-regional weighted clustering coefficients seems to show that the SAFTA trade network has not developed at the pace of the other regions.

SAFTA: Regional trade network indicators				
	1990	**2000**	**2005**	**2005-1990**
IDI	0.87	0.87	0.87	0.00
EDI	0.83	0.92	0.88	0.05
RIDI	0.02	-0.03	-0.01	-0.03
IPDI	0.90	0.90	0.90	0.00
EPDI	0.92	0.98	0.97	0.06
RIPDI	-0.01	-0.04	-0.04	-0.03
IBCC	0.90	0.90	0.90	0.00
EBCC	0.93	0.98	0.98	0.05
RIBCC	-0.02	-0.05	-0.04	-0.02
ICI	0.20	0.20	0.20	0.00
HI	3.47	5.02	4.34	0.87
HE	0.93	0.90	0.89	-0.04
RIRTP	0.58	0.70	0.66	0.08
INAPV	0.998	0.997	1.000	0.001
ENAPV	0.999	1.000	1.000	0.001
RINAPV	0.000	-0.002	0.000	0.000
INWCC	0.14	0.11	0.10	-0.04
ENWCC	0.04	0.07	0.06	0.03
RINWCC	0.59	0.18	0.22	-0.37

Table 4

The OESA group differs from the other two regions because it was characterised by extremely high binary indicators already in 1990. Starting from such levels, the density of the intra-regional network, its average partner degree and its clustering coefficient have remained stable throughout the period, whereas the corresponding extra-regional indicators have reduced their relative gap. As a result, the network's centralisation has remained extremely low in every country, with New Zealand and North Korea at zero in 2000 and 2005.

Relative intra-regional RTP was almost equal to that of ASEAN and has followed the same upward path. Weighted clustering coefficients have remained higher intra-regionally than with the rest of the area, but have fallen in relative terms.

OESA: Regional trade network indicators			
	1990	**2000**	**2005**	**2005-1990**
IDI	0.96	0.96	0.96	0.00
EDI	0.90	0.97	0.95	0.05
RIDI	0.04	0.00	0.01	-0.03
IPDI	0.97	0.97	0.97	0.00
EPDI	0.83	0.92	0.91	0.07
RIPDI	0.08	0.02	0.03	-0.04
IBCC	0.96	0.96	0.96	0.00
EBCC	0.86	0.93	0.92	0.06
RIBCC	0.06	0.02	0.03	-0.03
ICI	0.05	0.05	0.05	0.00
HI	1.18	1.34	1.44	0.27
HE	0.71	0.59	0.50	-0.21
RIRTP	0.25	0.39	0.49	0.24
INAPV	0.9995	1.0000	1.0000	0.0005
ENAPV	1.0000	1.0000	1.0000	0.0000
RINAPV	-0.0002	0.0000	0.0000	0.0002
INWCC	0.08	0.09	0.07	-0.01
ENWCC	0.04	0.04	0.06	0.02
RINWCC	0.32	0.33	0.13	-0.19

Table 5

Overall, network analysis seems to confirm some of the trends shown by more traditional indicators. However, the intensification of intra-regional trade appears particularly strong in the ASEAN region (according to both BNA and WNA) and, to a slightly lesser extent, in the OESA group. The process looks weaker in the SAFTA region, where the density of the network has not changed significantly in the 1990-2005 period.

The above network indicators, as mentioned, have been computed with reference to each of the three ESA regions with respect to the other two, excluding the rest of the world. A more general perspective can be regained through the *intra-regional assortativity coefficient* defined in equation [36]. By definition, this index must be applied to a multi-region trade matrix, and shows to what extent international trade tends to follow a "homophilic" pattern. In other words, this index measures globally the tendency of countries to trade more intensely with intra-regional partners than with partners in other regions. The IAC index, computed on the data of *Table* 1, was 0.23 in 1990, already showing a significant degree of regionalisation in world trade, and further rose to 0.27 in 2000 and 0.31 in 2005. The same trend, although at lower levels, emerges if the IAC index is computed only on the matrix of OESA intra- and inter-regional trade, excluding the rest of the world. Its levels were respectively 0.11, 0.18 and 0.22. This confirms that, even in the smaller context of the ESA area, intra-regional trade has intensified more than trade among different regions.

6.   Conclusions

This paper has shown how simple statistical indicators of trade can be improved to better assess the process of regional integration. This requires the use of a particular specification of trade intensity measures (the 'revealed trade preference' index), which is immune from the problems encountered by traditional formulations, and ensures perfect bilateral symmetry between trading partners.

However, when applied at the regional level, even RTP indices fail to measure correctly the intensity of trade regionalisation, because they neglect two important dimensions of the process, namely the degree of geographic diversification of intra-regional trade and differences in bilateral distances across member countries.

The latter problem is present even at country level, and can be solved by adjusting the indicators, so that trade with distant partners is given a higher weight than trade with neighbouring countries. Geographic diversification can easily be measured through additional indicators, derived from measures of similarity with respect to a geographically neutral distribution.

A recent strand of literature has applied statistical indicators drawn from social network analysis to the study of the international trade web. This paper has shown how to adapt these indicators to describe the topological features of regional networks, considering both binary and weighted network analysis.

All the above indicators have been applied to the case of East and South Asia, divided into three regions (ASEAN, SAFTA and OESA). Overall, the results obtained tend to confirm the strong increase in trade regionalisation that has characterised the Asian area in the last decades. The process has involved all the three regions, although at different rates, and has entailed a wide-spread increase in the relative geographic diversification of intra-regional trade, with the exception of SAFTA. It can also be argued that in the ESA area the process of trade integration has been accompanied by a reduction in the limiting role of distance, as detected by adjusted RTP indices.

Network indicators tend to confirm the above conclusions. Regional trade networks were intensely connected already in 1990, and their density has further increased in ASEAN. Their levels of centralisation are, or have become, extremely low, with the partial exception of SAFTA, where India, Pakistan and Sri-Lanka have continued to play the role of regional hubs. Relative intra-regional RTP indices rose in all the three regions in the nineties, and declined only in SAFTA between 2000 and 2005.

Overall, the assortativity coefficient confirms that intra-regional trade has intensified more than inter-regional trade, both in the global trade network and in the more limited context of the Asian area.

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