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SUMMARY

International trade, including regional integration, is seen as pro-convergence. Lagging countries could benefit from technology developed in more advanced countries they trade with. More generally, poorer countries could be the main beneficiaries of economic integration.

However, as pointed out in the theoretical literature, countries lacking a minimum industrial basis could suffer from economic integration and be caught in poverty traps[1]. More generally the economic theory gives an ambiguous answer to the question of the role of economic integration for convergence.

The answer may come from empirical research. In a well-known contribution, Ben-David (1996) observes that trade-based groups of countries (groups comprising major trade partners) are more likely to exhibit convergence than groups of randomly selected countries (or groupings according to other criteria).

In this study, after a brief survey of the theoretical and empirical literature about the link between trade (more generally economic integration) and convergence, we replicate the methodology used by Ben-David and we evaluate the robustness of his results.

First, we show that the finding of absolute convergence within trade-based groups does not imply a significant reduction of standard of living differences. The beta-convergence is not sufficient to imply sigma-convergence (reduction of cross-section dispersion of per capita GDP).

Second, and it is the main contribution of this research, we show that trade intensity *per se* does not bring about convergence. The finding of convergence within trade-based groups is due to a bias toward selecting big countries in those groups. A group of big traders (or big countries more generally) tends to be a group (club) of convergence, but it is not true for a group a smaller countries trading intensively.

Convergence may still be favoured by access to technologies developed in rich countries, especially in big countries who benefit from various externalities. However there is no robust evidence that the trade channel is the main channel of this diffusion.

[1] However, in a growing world, divergence is compatible with growth for the lagging countries: the gap between poor and rich countries widen in spite of positive growth rates in both groups.

ABSTRACT

Ben-David (1996) observes that trade-based groups of countries (groups comprising major trade partners) are more likely to exhibit convergence than groups of randomly selected countries. In this study, the robustness of this result is assessed. We show that trade intensity *per se* does not bring about convergence. Trade and beta-convergence are robustly linked but there is no evidence that trade induces sigma-convergence. Furthermore finding of beta-convergence within trade-based groups is due to a bias toward selecting big countries in those groups. Even if trading with big countries may be beneficial, the evidence for trade as a channel for convergence is weak.

JEL Classification: F15, O40.

Key Words: Trade, Convergence.

RESUME

Le commerce international, y compris au sein de régions intégrées, est souvent présenté comme favorable à la réduction des écarts de niveaux de vie entre pays. Les pays en retard accèdent en effet à moindre coût aux technologies produites dans les pays plus avancés. On peut aussi penser que les bénéfices de l'intégration économique se répartissent à l'avantage des pays les plus pauvres.

Cependant à côté de mécanismes de diffusion technologique conditionnels on peut envisager des processus d'intégration défavorables aux pays ne disposant pas d'une base industrielle suffisante. La théorie économique ne vient pas appuyer la thèse d'une intégration systématiquement ou généralement porteuse de convergence.

Les travaux empiriques doivent alors trancher. Dans une contribution importante, Ben-David (1996) constate que la convergence est le plus souvent présente dans des groupes de pays constitués sur la base de leurs relations commerciales, alors qu'elle n'apparaît pas significativement dans des groupes constitués aléatoirement ou sur la base de variables non commerciales.

Dans cette étude après un examen rapide de la littérature théorique et empirique sur le lien commerce-convergence, nous reprenons la méthodologie de Ben-David pour juger de la robustesse des résultats obtenus. Nous proposons un réexamen de la méthode et des conclusions sur deux points essentiels. D'abord, nous montrons que la convergence absolue mise en évidence pour les groupes de commerce par Ben-David n'implique pas de diminution significative des écarts de niveaux de richesse, autrement dit la beta-convergence (existence d'une force de rattrapage) ne débouche pas sur de la sigma-convergence (réduction de la dispersion en coupe des PIB par tête). Ensuite, et il s'agit de l'apport principal de cette recherche, nous montrons qu'il n'est pas possible, sur la base des statistiques d'échanges et en particulier de l'intensité bilatérale du commerce, d'établir une relation solide entre commerce et convergence, les groupes de commerce exhibent cette propriété de convergence seulement du fait de la taille des pays qui les composent. Autrement dit un groupe constitué (au moins pour partie) de grands pays tend à être un groupe (club) de convergence mais cela n'est pas vrai d'un groupe de pays plus petits commerçant intensément.

A partir des travaux de Ben-David «revisités » ici on peut au plus affirmer que le commerce, à condition qu'il soit dirigé vers des grands pays, favorise (ou est favorisé par) l'existence d'une force de rattrapage (la beta-convergence), force toutefois insuffisante pour provoquer la réduction des écarts de niveaux de vie (la sigma-convergence).

RESUME COURT

Ben-David (1996) propose une étude empirique du lien entre commerce et convergence (des PIB par tête). Il constate que la convergence est le plus souvent présente dans des groupes de pays constitués sur la base de leurs relations commerciales bilatérales, alors qu'elle n'apparaît pas significativement dans des groupes constitués aléatoirement. Nous montrons que ce résultat doit beaucoup à la présence fréquente des grands pays dans les groupes de commerce. L'intensité bilatérale du commerce ne conduit pas généralement à la convergence, en particulier à la sigma-convergence. Même si le fait de commercer avec des grand pays peut favoriser la convergence, le lien entre commerce et convergence apparaît faible.

Classification *JEL* : F15, O40.

Mots-clefs : Commerce, convergence.

TRADE AND CONVERGENCE: REVISITING BEN-DAVID

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1. INTRODUCTION

Great pressure is currently put on developing countries to adopt reforms promoting trade and investment. Proponents of liberalization depict international trade as a strong factor favoring growth and thus convergence and catching-up with developed countries. Theoretical as well as empirical economic research is said to give strong support to the trade and growth thesis. However recent papers give weight to a more skeptical view (Rodriguez and Rodrik, 1999, Baldwin, 2000, Lutz, 2001).

International trade, including regional integration, is usually seen as pro-convergence [3]. Lagging countries could benefit from technology developed in more advanced countries with whom they trade. Poorer countries (partly because there are initially more protected) could be the main beneficiaries of economic integration.

In spite of this common belief, the economic theory gives an ambiguous answer to the question of the role of economic integration for convergence (Lutz, 2001). The convergence hypothesis in the Solow model is an autarky result. It stems from decreasing marginal productivity of capital. When several countries are considered in the same time, each one is supposed to converge toward its own trajectory defined by its fundamentals (investment rate in physical and human capital, etc). As soon as technology is an international public good (or diffusion is easy) countries will ultimately grow at a same rate, but inequalities stemming from national specificities will persist (convergence is conditional). However, opening up to international capital flows should foster the convergence process, as differences in capital productivities will be arbitraged away.

The expectation that trade liberalization might lead to income convergence is grounded on the factor price equalization theorem (Samuelson, 1948). According to trade theory, free trade in goods leads to the equalization of factor prices under certain conditions (including identical technologies, absence of transport costs and same specialization cone). As

[2] Guillaume Gaulier is economist at the CEPII. The author is grateful to Isabelle Bensidoun, Lionel Fontagné, Michel Fouquin, Pierre-Yves Hénin, Laurence Nayman and Soledad Zignago for helpful comments. This work also benefited from comments of participants to the congress of the *Association Tiers-Monde* (Tunis , May 2001) and *GDR Economie et Finances Internationales* (Bordeaux, June 2002). Usual disclaimers apply.

[3] In this article we focus on trade as a factor of convergence rather than trade as a factor of growth. However, if leading countries grow at a positive rate, convergence will be synonymous with growth. For a critical view of the trade (policy) and growth relation see Rodriguez and Rodrik (1999).

barriers to trade are relaxed, a tendency towards factor price equalization can be set into motion, resulting in convergence in per capita incomes. However, as pointed out by Slaughter (1998) this assumes that differences in capital-labor ratios and labor-force participation ratios do not countervail (diverging labor-force participation can offset convergence in productivity) .

More recent research, elaborating on old ideas, show that countries lacking a minimum industrial basis could suffer from economic integration and be caught in poverty traps (Young, 1991, Grossman and Helpman 1991, Redding, 1999). For instance, a country weakly specialized in a growth-engine sector, *i.e.* a sector that has plenty of potential for technological progress, or in goods with a great potential for learning, can with openness be excluded from this sector and therefore be subject to low growth.

The diffusion of technology or knowledge *via* trade flows is usually seen as a strong argument for the trade and convergence hypothesis (Grossman and Helpman, 1991; Ben-David and Loewy, 1998). The strength and geographical extent of the diffusion process is especially important in the endogenous growth model. In Ventura (1997), Mountford (1998), Chuang (1998) and Ben-David and Loewy (2000), global rather than local externalities allow the emergence of convergence, even in endogenous growth frameworks.

What is the message of empirical research?

Following Coe and Helpman (1995), several papers have measured the extent to which technology spills over between industrialized countries through the particular channel of trade flows. Although they sometimes outline flaws in Coe and Helpman's methodology (Lichtenberg and Van Pottelsberghe de la Poterie, 1998), most of them favor the idea of trade flows as a vehicle for diffusion. However, Keller (1998) casts doubts on the claim that patterns of international trade are important in driving R&D spillovers: he shows that randomly created trade patterns give rise to the same amount of spillovers than observed trade patterns.

For analyzing trade's contribution to the convergence process, a non-parametric and not regression-based approach can be found in Ben-David (1993). The author focuses on groups of countries that formally liberalized trade (EEC, EFTA, etc.) and shows that the timing of the convergence process of per capita GDP (decrease of an annual cross-country dispersion measure) is related to the timing of the liberalization process. Ben-David tries to show that trade liberalization caused the observed decrease in dispersion free trade areas. To discard other plausible alternatives, he argues: (i) that the observed convergence was not simply a continuation of a long-term convergence trend unrelated to postwar economic integration; (ii) and that the European countries that chose not to enter a free-trade agreement did not experience the same levels of convergence; (iii) and that other subsets of economies in the world which were not economically integrated did not experience convergence. Rodriguez and Rodrik (1999) argue that the exclusion of Germany (which is supposed to bias the result toward convergence in the EEC) has the effect of understating the fall in dispersion before the creation of the EEC. On the two others points, Rodriguez and Rodrik give counter-examples that stress the limited robustness of Ben-David's

finding. For instance, as for Latin America, there has been a steady decrease in dispersion during the period of import substitution that contrasts with a sharp rise since the late 1980s, just at the time when those countries liberalized their trade regimes.

More generally, Rodriguez and Rodrik (1999) highlight the fact that most liberalization episodes since the 19th century are divergence episodes (see also Bairoch, 1996).

Using an econometric methodology, Ben-David (1996) observes that trade-based groups of countries (groups comprising major trade partners) are more likely to exhibit convergence than groups of randomly selected countries (or groupings according to other criteria).

Slaughter (1998) investigates the link between trade and convergence in a systematic way with a more demanding methodology. He compares convergence patterns among liberalizing countries before and after liberalization with the convergence pattern among randomly chosen control countries before and after liberalization. This difference-in-differences approach avoids the pitfalls of before-and-after comparisons (non-liberalizing countries may exhibit the same pattern before and after) or of comparing liberalizing countries to non-liberalizing ones (the liberalizing countries may have been converging prior to the liberalization as well). He concludes that there is no systematic link between trade liberalization and convergence. In case where a link is found, it is negative.

In this study, we step back from Slaughter (1998) since we stick to Ben-David-1996's methodology. We aim at evaluating the robustness of his results without departing too much from his methodology[4].

Our results are twofold. First, we show that the finding of absolute convergence within trade-based groups does not imply a significant reduction of standard of living differences. The beta-convergence is not sufficient to imply sigma-convergence (reduction of cross-section dispersion of per capita GDP). Second, and it is the main contribution of this research, we show that trade intensity *per se* does not bring about convergence. The finding of convergence within trade-based groups is due to a bias toward selecting big countries in those groups. A group of big traders (or big countries more generally) tends to be a group (club) of convergence, but it is not true for a group of smaller countries trading intensively.

In a first time we replicate Ben-David's study using a different database. Our database expands Ben-David's on both time and geographical dimension. We check that groupings of countries according to trade criteria exhibit convergence contrary to random groupings. We also check that groupings according to geographical proximity or similarity of specialization do not converge.

[4] Consequently some potential drawbacks of Ben-David's methodology are voluntary ignored. However in the first chapter of Gaulier (2002) some improvements are considered (concerning the measure of trade within groups for instance).

Trade groups exhibit convergence in the sense of a tendency for deviations to the mean to vanish in the long run (*i.e.* beta convergence) but there is no evidence of a significant decrease in standard of leaving dispersion in those groups (*i.e.* no sigma convergence).

As we noticed, the over-frequency of USA, Germany or Japan in the trading groups, we suggest two alternative modifications of the Ben-David's methodology. We aim at eliminating a possible size effect in order to focus on the intensity of trade relationship as a factor of convergence.

This paper has three additional sections. Section 2 presents the Ben-David's methodology and applies it to a wider database. Section 3 tests for the hypothesis of a size-bias in trade-based groups of countries. Section 4 concludes.

2. REPLICATING BEN-DAVID'S METHODOLOGY

2.1. Trade groups

Ben-David (1996) considers what he calls trade groups, that is groups of countries composed of one source country and its major trade partners. Source countries are selected according to their per capita income level in 1960: Ben-David excludes countries that do not reach 25% of the US per capita income level of 1960 (the initial year of the study). Countries that are primarily oil producers and formerly Communist countries are excluded. There are two lists of source countries: major exporters and major importers. For each source country, those partners contributing to more than 4% in trade flows (exports or imports) are selected in a trade group. The groups resulting from the 4% threshold ranged in size from a minimum of three countries per group to a maximum of nine. There are 50 groups: 25 export groups and 25 import groups.

In a first time we replicate Ben-David's methodology with only minor changes. As concerns as the building of trade groups we drop the threshold of 25% of the US per capita GDP and we combine exports and imports. The first change stems from the idea that the generality of the results is reduced when developing countries are not taken into account (as source countries). This results in 48 groups[5], the number of (non former-Communists or oil producers) countries for which we have got trade data on a bilateral basis for the whole time span (1967-1997). As the distinction between export and import groups does not appear to matter a lot in Ben-David (1996) we prefer to keep the examination within manageable proportions by working on exports plus imports. The mean group size is 7. To avoid the creation of too small groups we also consider fixing *a priori* the size to x: in that case we simply select in the groups the x biggest partners of each source country.

In Ben-David, groups are built with 1985 trade data. We take the year 1997 as our final year. Given the high inertia in geographical trade patterns, our trade groups usually do not differ a lot from Ben-David's ones.

The groups composition is given in Table 1. For each source country (line) we indicate by '1' partner countries (columns) that belong to its group and '0' for other countries.

2.2. The data

Trade and income data are from CEPII's database CHELEM (Harmonized Accounts on the World Economy). Per capita GDP and bilateral trade flows are from 1967 to 1997 for 48 countries. GDP are in purchasing power parity (base year for PPP is 1990). Trade data are in current dollars. We checked that our results are robust to changes in the database (sample of countries and years, PPP measure for GDP, etc.).

[5] Those 48 countries make up more than 90% of world trade in 1997.

2.3. Convergence tests

Ben-David (1996) performs panel data beta-convergence tests. Equations as follows are estimated (for each group):

$$y_{i,t} - \bar{y}_t = \rho \cdot (y_{i,t-1} - \bar{y}_{t-1}) + \varepsilon_{i,t} \qquad (1)$$

where $y_{i,t}$ is country *i* (logarithm of) per capita GDP at time *t* and $\bar{y}_t$ is the average of logarithm of per capita GDP at time *t* within the group.

Data are pooled and the model is estimated with OLS. Variables are taken as deviations from period averages in order to remove any aggregate effects (common time effect).

The (absolute) convergence hypothesis consists in ρ being (significantly) negative.

Levin and Lin (1992) show that it is possible to use the standard t-statistic for testing the unit root null since, in the presence of pooling, the t-statistic will have an asymptotically normal distribution. Given the absence of country fixed effects there is no dynamic panel bias to deal with. However this kind of model is not free from the problem of heterogeneity of coefficients as stressed in Pesaran, Smith and Im (1995). If the assumption of a common ρ in equation 1 is false then Pooled OLS estimates will underestimate the true (mean) value of ρ. However, as we checked using a bootstrap method, the size of the bias should be small for the typical trade group[6].

Ben-David (1996) re-writes equation (1) as an Augmented-Dickey-Fuller test by adding lagged growth rate of per capita GDP on the right hand side. This deals with the autocorrelation issue. For simplicity and as it does not affect the results we keep equation (1) without ADF terms.

As in Bernard and Jones (1996) or Ben-David and Kimhi (2000), beside beta-convergence we consider sigma-convergence. Beta-convergence (the existence of mean-reversion process) is a necessary but not sufficient condition of sigma-convergence: in case of large asymmetric shocks, beta-convergence may not be sufficient to obtain a reduction of the dispersion of per capita income (see Barro and Sala-i-Martin, 1995, or Hénin and Le Pen, 1995). The concept of sigma-convergence is more intuitive, it corresponds to the common-sense notion of convergence.

For a group of *N* countries we compute $s_t^2 = \frac{1}{N}\sum_i (y_{i,t} - \bar{y}_t)^2$, then estimate with OLS:

[6] Simulations results (using bootstrap) are not reported here but are available upon request. See also Gaulier (2002), Chapter 1 and Annex 4.

$$s_t^2 = j \cdot T_t + u_t \qquad (2)$$

where T_t is a linear time-trend.

Sigma-convergence consists in a negative slope (j negative and significant).

2.4. Control groups

Ben-David wonders if convergence properties in trade groups are indicative of trade-related convergence, or if any random grouping of these same countries might produce similar results. To test this conjecture, he groups its source countries into their many different possible subgroupings, estimate their convergence coefficients, and get adequate distributions of coefficients with which it is possible to test for the specificity in terms of convergence properties of any trade-based group. Indeed, what we are interested in is not the evidence of convergence in trade-based groups but the hypothetical quicker convergence speed in trade-based group.

As in Ben-David (1996) we estimate the distributions of convergence coefficients (r and j) under the null hypothesis of "normal" convergence. A different distribution must be estimated for each group size. Given a size N and a sample of S countries, it is possible to get $\frac{S!}{N!(S-N)!}$ subgroupings. For instance, with S=48 and N=7, there are 73629072 possibilities. We thus have to select subsamples of more tractable sizes. We verify that 5000 random draws for each size are sufficient. For each "simulated" group, the *ex ante* probability for a country to be selected is N/S. Drawings are made without replacement.

The cumulative distribution of the r's and j's for groups of 7 countries is plotted in Figure 1. Critical values are taken from these distributions: for example, in the case of beta-convergence and for 7 countries the critical value at 10% is nearly 0.988. These critical values are used for testing the hypothesis of a significant convergence process in excess of the common convergence in a group of countries of a given size.

2.5. Results

In Tables 2 and 3, from the coefficient estimate columns (r or j) we see that there is convergence in most cases (46 out of 48 groups for beta-convergence, 42 out of 48 for sigma-convergence). Let us recall that beta-convergence implies r <1 and sigma-convergence implies j <0. Using standard critical values, it appears that those cases of convergence are significant at the usual level. Out of the 46 r below unity, 31 are significant. Sigma-convergence is also highly significant: 40 out of the 42 negative j .

However we have to take into account the control groups to properly test our hypothesis on trade and convergence. Columns *Proba-1* in Tables 2 and 3 present the p-value for the "over-convergence"-tests for each trade-based group, respectively for beta and sigma

convergence. To illustrate that point we can consider the case of the trade group with Denmark as source country. It contains 9 countries so we have to use the critical values obtained for that particular size[7]. Denmark r estimate is 0.9799 which is below the critical value for a risk of 1% (0.983). Consequently the p-value for Denmark's group is 1%[8].

Corroborating Ben-David's results, we find that beta-convergence is still significant for the majority of trade-based groups (30 out of 48). The replacement of the null hypothesis when we consider control groups does not change the results: trade-based groups appear to be convergence groups. The use of a larger database than Ben-David's has no consequences with regards to his main finding.

However, as far as sigma-convergence is concerned, the convergence hypothesis is rejected: it remains significant only for 12 groups when the critical values are taken from random control groups. We can conclude that trading, in the sense of belonging to a same Ben-David's trade group, leads to (or is the result of) a beta-convergence process, that is a mean-reversion process, but not to a reduction in the dispersion of per capita GDP. An hypothesis for this important result, is the presence of asymmetric shocks in trade groups that overcome the beta-convergence force. However, beta-convergence groups are not the same as sigma-convergence groups: significant beta-convergence is found in European groups and sigma-convergence in Asian groups.

2.6. Alternative grouping of countries

As in Ben-David (1996) we have to make sure that the (beta-)convergence finding is robust to a change in the base year of the trade groups. The use of the end-of-period year (1985 for Ben-David, 1997 for us) possibly increases the likelihood of convergence. Indeed, converging countries (for any non-trade reason) may have evolved over time into major trade partners. Building trade groups at the beginning-of-period year is therefore a first attempt to control for an inverse causality in the trade-convergence story (from convergence to trade). Contrary to Ben-David the evidence on that point is mixed. In Table 4, we see that the average r coefficient when 1967 is used as a base-year remains significant but the p-value is 10% (compared to 5% with 1997). Sigma-convergence remains non-significant.

Countries in trade groups share other features than trade links of some magnitude (with the source country). Those characteristics that can matter are geographical or cultural proximity. Ben-David considers the possibility of the convergence not being produced by trade but by other common features. Here we check for this possibility by introducing two proximity variables. One is common to Ben-David: geographical proximity[9], the other is

[7] Critical values were tabulated for size 3 to 12.

[8] Alternatively we can say that the likelihood of drawing a randomly constructed group of 7 countries out of the original 48 and getting a r of 0.9799 is less than 1%.

[9] We use geodesic distances calculated between the capitals of 48 countries.

more original. It is the similarity of specialization patterns. This variable is likely to favor convergence (or convergence may produce similarity) because it is a proxy for factor endowment. Similarity is computed as one minus the sum of absolute differences in (trade-revealed) comparative advantages of two countries. As comparative advantage indicators, we use the contribution to the trade balance (Lafay, 1992). This indicator is detailed in the Annex.

It appears that the convergence finding is neither driven by geographical proximity nor by specialization proximity. Indeed, the p-values for groups built according to these two variables are clearly above significance level.

At this stage we can say that Ben-David's conclusion (if restricted to beta-convergence) is rather robust.

3. DOES THE SIZE OF COUNTRIES BELONGING TO TRADE GROUPS BIAS THE RESULTS?

The main motivation behind this paper comes from questioning the way countries are grouped. The 4% (of source country) threshold implies that large countries have a much higher probability to belong to a typical trade group.

Ben-David is, in some way, aware of this problem. Indeed he wonders whether it could be that all the convergence within trade groups is towards one country common to all groups or nearly all. United-States is an obvious candidate; Germany and Japan also appear as major trade partners in a number of groups. Ben-David tackles this issue by excluding those big countries one by one. Results appear robust to these exclusions.

In our opinion, removing countries one by one may not be sufficient to address the problem with size. Indeed it may be the simultaneous presence of two (or more) countries in a group that produces the convergence. It is a well known fact that during most of the post-second-world-war period (this convergence period ended up in the early nineties) Germany and Japan caught up with United-States. Japan's take-off imply a strong bias toward convergence when this country belongs to a group that includes the US, Germany or any other old industrialized country.

Evaluating convergence within the biggest-countries-group can be a crude test of this bias. We put together the 7 biggest countries in terms of GDP (in 1997) and see if those countries converged. The result is given in Table 4. Beta but also sigma convergence are indeed significant in this group: p-values are respectively 7% and 2% for beta and sigma-convergence.

We now suggest two methods to evaluate the role of big countries presence in Ben-David's trade groups. The first one implies a change in the criterion used to select partners countries in a group. The idea is to remove the size effect by considering trade intensity instead of trade levels. The second method keeps the countries selection criterion

unchanged but introduces the size bias into the procedure by which countries are selected in the random control groups.

Let us notice that our two methods do not imply systematically removing countries from trade groups. In fact their is no justification in not considering USA, or Japan for instance. We only aim at removing the over-probability of getting these countries in trade groups.

3.1. Trade intensity-based groups

The way countries are selected into trade-based groups in Ben-David is problematic. To illustrate this, let's consider Greece's group: it includes the United-States (as in all groups except Portugal's and Tunisia's) although if we control for the two countries size by taking bilateral trade intensity it appears that Greece-USA trade link is approximately 70% below the level that would reflect the overall capacity of the two countries to trade (see below for a definition of the trade intensity ratio). It is therefore questionable to put together those two countries in a trade group. Conversely, Macedonia does not reach the 4% share of Greece's trade threshold and cannot enter the Greece's group although the two countries trade intensively on a relative basis (given their capacities to trade).

The concept of bilateral trade intensity used above is one of the numerous possible measures of trade flows besides that in Ben-David. We consider here three alternative indicators of trade intensity.

Relative trade intensities (*RTI*) are the ratios of the observed trade flows to "natural" flows (Deutsch and Savage, 1960). The latter are determined by the geographical distribution of world trade according to the relative importance of exporters and importers respectively.

$$RTI = \frac{\frac{V_{ij}}{V_{..}}}{\frac{V_{i.} \times V_{.j}}{V_{..}^{2}}}$$

with V_{ij} the trade between country *i* and country *j*. A dot stands for total on the omitted dimension. $V_{i.}$ is total trade of country *i*. $V_{..}$ is total world trade.

Rather than controlling for total trade flows it is possible to control for GDP. Two indicators do it: *ATI* and *MTI*. The first one considers the sum of GDP at the denominator, the second one uses their product instead. Gravity models usually specify bilateral flows as

a function of the product of GDP (and distance). In that case, *ATI* is biased in the sense that it will increase with GDP. *MTI* is not sensible to changes in GDP[10,11].

$$ATI = \frac{V_{i,j}}{GDP_i + GDP_j}$$

$$MTI = \frac{V_{i,j}}{GDP_i \cdot GDP_j}$$

To sum up: with the usual (gravitational) specification for trade, ATI increases with GDP and openness (Vi./GDPi); MTI increases only with openness; RTI is "pure" intensity: it measures (or "reveals") trade preferences notwithstanding size or openness of the two partners. Let's exemplify this with Germany: in 1997 its main trade partner was France. Taking into account GDP of countries in an additive way (ATI), the most intense trade link is with Netherlands; then, if we consider GDP in a multiplicative way (MTI), the most intense link is with Belgium, a smaller country; finally, if RTI is taken, we find a higher trade intensity with Austria, also a small country but less open to trade.

We replace the 4% threshold used in Ben-David (1996) by a value for each trade intensity measure taken so as to obtain the same average number of countries in groups, that is 7.

In the case of RTI the threshold is 1.75: a country is grouped together with a source country when the trade flow with the source country is 75% or more higher than would predict their respective weights in world trade. The median size of groups is 7. Results for trade intensity-based groups are given in Table 4.

For RTI based-groups, beta-convergence is (on average) non-significant (p-value of 30%) and the sigma-convergence coefficient is positive, denoting divergence. The results are similar for MTI with non-significant beta-convergence (p-value of 55%) and sigma-divergence. Concerning ATI, beta-convergence is closer to significance level, with a p-value of 12%. We still find sigma-divergence.

On average, there is no convergence within trade groups based on trade intensity measures. This is true whatever the measure. The result the most favorable to (beta-) convergence is obtained with ATI, which is a measure sensitive to the size of trading countries.

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[10] With a specification of trade flow: $V = d_{i,j} \cdot GDP_i \cdot GDP_j$, where $d_{i,j}$ stands for all factors except GDP, by differentiating *ATI* we get: $\frac{dATI}{ATI} = \frac{dGDP}{GDP}$ when the two GDPs grow at the same rate and $dd_{i,j} = 0$. On the other hand $dMTI = 0$. Details of calculations are available upon request.

[11] Formalized by Deardorff (1998) under assumptions of homothetic preferences, the indicator only depends on barriers to trade (transport costs, tariff barriers). Hence, it provides a more accurate picture of the extent of integration among countries, independently of their size.

3.2. Putting a size-bias into control groups

Our second method to tackle the size-bias is to introduce the same bias as in the procedure of selection of countries within trade-based groups in random drawing used to get distributions of convergence coefficients. We substitute the uniform random drawing for a size-proportional drawing. In the former, ex post probability to draw a country was 1/48 (for 48 countries in the sample). In the latter, this ratio is replaced with the share of countries in world GDP or world trade. So we get new benchmarks to evaluate significance of convergence coefficients of trade groups built with Ben-David's method. The drawing method we use[12] imposes that country weight (probability of drawing) does not exceed the inverse of the number of countries in the group (20% for 5 countries groups). This limit is easily reached for big groups given that the US makes up nearly 30% of world GDP in 1997 (even more in our 48 countries sample; breackdown of world trade is more egalitarian). Consequently we transform country weights with the function square root (30% is replaced with $\sqrt{30\%}$).[13]

The columns Proba-2 in Tables 2 and 3 give the significance level for each convergence test when the benchmark is convergence in groups of countries selected by taking into account size as defined above. Calculations have been made with country shares in world trade and (square root of) shares in world GDP. As there is little difference we only report results with square root of shares in world GDP. P-values tend to be very high. Sigma-convergence remains non significant: only 8 out of 48 groups exhibit sigma-convergence significant at the 10% level. Beta-convergence is still significant (at the 10% level) only in 20 out of 48 groups. Significance levels for the mean and median r coefficients are 20%. When we use shares in world trade to build the benchmark (detailed results are not reported here), the significance level is still higher: significance levels lie at 50% (for sigma-convergence it is respectively 50 and 70% for the mean and median).

With these new benchmarks there is no evidence of convergence in trade-based group.

It means that a group consisting of one source country and its major trade partners (as in Ben-David) has no more chance to be a convergence group than a group of randomly selected countries representative of countries in the world.

Results with trade intensity measures or with size-biased control groups suggest that Ben-David's finding of a strong correlation between trade and convergence need to be reassessed. The finding of convergence within trade-based groups is due to a bias toward selecting big countries in those groups. In Ben-David's testing procedure, a group of big

[12] PROC SURVEYSELECT in SAS 8.01 software is used.

[13] More generally the new ex post weight in the drawing is (for GDP): $\frac{\sqrt{PIB_j / PIB_.}}{\sum_j \sqrt{PIB_j / PIB_.}}$.

traders (or big countries more generally) tends to be a group (club) of convergence, but it is not true for a group a smaller countries trading intensively.

One can conclude from our results that being big favors convergence. This conclusion is dubious: big countries can benefit from increasing returns to scale and various size-related externalities but this has no reason to induce convergence between big countries. Divergence is more likely to take place if increasing returns are important.

What can be saved from Ben-David conclusion? The fact that trading intensively with big countries is correlated to convergence is not rejected by our results. However convergence is limited to beta-convergence, that is the weakest form of convergence. Also, it is still to examine to what extent a (lagging) country can use that lever (via trade agreements with big countries). Indeed, the benefit could be very limited for countries not having big countries as natural trade partners, particularly because of their geographical location.

4. CONCLUSION

In this paper we stick to Ben-David (1996)'s approach as it is an influential paper as concerns the link between trade and convergence. Our scope is thus limited to a careful examination of his findings. There are obvious shortcomings in the methodology we use. For instance, the way trade groups are built is questionable. It could be better to take into account all bilateral trade intensities within groups instead of the sole relations between a source country and its partners (with the selection procedure used above, two non-source countries do not necessarily trade intensively, this is true whatever measure of trade is taken). Apart from this (non-) transitivity problem it may also be useful to take into account changes in trade intensity instead of levels (as in Slaughter, 1998). The question is thus: was there more convergence within groups of countries that increased their trade links? This is suggested by Ben-David and Kimhi (2000), groups being replaced with pairs of countries in their paper. Crude attempts to deal with theses issues globally confirm the results above[14]. The positive correlation between trade and convergence (even if the causality issue is ignored) is at best very weak. When the size-bias is taken off, trade (or increase in trade) is rather correlated with divergence.

Our skeptical view about trade and convergence does not sustain a recommendation of closing up frontiers. It calls policy-makers for more cautious expectations and economists for more research in this field. Promising research directions may consist in taking into account non-linearity (see Baldwin and Sbergami, 2000) and taking into account trade types and nature of traded goods: two-way trade in intermediate or capital goods may be a better vector for externalities than other types of trade. There is also scope for more research about the benefit from trading with big countries or countries being on the technological frontier.

[14] See Gaulier (2002), Chapter 1, Section 5. One difficulty is the huge number of control (random) groups to consider when all the bilateral trade links within groups are to be taken into account.

TABLES AND FIGURES

Table 1: Composition of trade groups

Source country	USA	CAN	FRA	BEL	GER	ITA	NLD	UK	IRL	DNK	FIN	NOR	SWE	AUT	SWI	SPA	GRE	POR	TUR	ISR	YUG	JAP	AUS	N-Z
United-states	1	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Canada	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
France	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Belgium	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Germany	1	0	1	1	1	1	1	1	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0
Italy	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Netherlands	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
United-kingdom	1	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ireland	1	0	1	0	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Denmark	1	0	1	0	1	1	1	1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0
Finland	1	0	1	0	1	1	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
Norway	1	0	1	0	1	0	1	1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0
Sweden	1	0	1	1	1	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
Austria	1	0	1	0	1	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
Switzerland	1	0	1	0	1	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Spain	1	0	1	0	1	1	1	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
Greece	1	0	1	0	1	1	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
Portugal	0	0	1	0	1	1	1	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
Turkey	1	0	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Israel	1	0	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0
Former Yugoslavia	1	0	1	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0
Japan	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Australia	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
New zealand	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
South africa	1	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Ecuador	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Mexico	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brazil	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Argentina	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Chile	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Colombia	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Peru	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Morocco	1	0	1	0	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Tunisia	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Egypt	1	0	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Non OPEC Middle East	1	0	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0
Africa nes	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Indonesia	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
India	1	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
South korea	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Hong kong	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Singapore	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Taiwan	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Malaysia	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Philippines	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Thailand	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Pakistan	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
China	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Total	46	2	24	11	42	25	15	29	2	4	2	4	4	3	3	9	1	2	2	1	1	27	3	2

Table 1: Composition of trade groups (continued)

Source country	SA	ECU	MEX	BRA	ARG	CHL	COL	PER	MOR	TUN	EGY	M-E	AFR	INDO	INDE	KOR	HON	SIN	TAI	MAL	PHI	THA	PAK	CHI	Size
United-states	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7
Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
Belgium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Germany	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
Italy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
United-kingdom	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
Ireland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Denmark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
Finland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
Norway	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
Sweden	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
Austria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Switzerland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
Spain	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
Greece	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
Portugal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Turkey	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
Israel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
Former yugoslavia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
Japan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	6
Australia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	8
New zealand	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
South africa	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	8
Ecuador	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	7
Mexico	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Brazil	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
Argentina	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Chile	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	8
Colombia	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Peru	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7
Morocco	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Tunisia	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
Egypt	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Non OPEC Middle East	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	10
Africa nes	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	10
Indonesia	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	1	0	0	0	0	0	8
India	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	7
South korea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	5
Hong kong	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	1	9
Singapore	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	0	1	0	0	9
Taiwan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	5
Malaysia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	0	0	0	0	6
Philippines	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	0	0	0	7
Thailand	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	7
Pakistan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	1	8
China	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	1	7
Total	2	1	3	4	3	3	3	1	1	1	1	1	2	2	1	14	3	6	10	4	1	2	1	10	344

Table 2: Beta-convergence for trade-based groups

Group	*Size*	*Rho*	*Proba-1*	*Proba-2*
Canada	3	0.9360	5%	5%
Israel	8	0.9648	1%	5%
Austria	7	0.9685	5%	5%
New Zealand	5	0.9708	5%	5%
Ireland	7	0.9729	1%	5%
Switzerland	6	0.9733	5%	10%
Sweden	10	0.9739	1%	5%
Finland	10	0.9743	1%	5%
United-Kingdom	8	0.9751	1%	10%
Belgium	7	0.9752	5%	10%
Netherlands	7	0.9752	5%	10%
Germany	10	0.9767	1%	10%
Malaysia	6	0.9773	5%	10%
Portugal	7	0.9774	5%	10%
Spain	8	0.9790	1%	10%
Danemark	9	0.9799	1%	10%
Australia	8	0.9820	5%	10%
France	8	0.9824	5%	10%
Italy	8	0.9824	5%	10%
Thailand	7	0.9828	5%	10%
Indonesia	8	0.9835	5%	20%
Norway	8	0.9839	5%	20%
Japan	6	0.9845	10%	20%
Hongkong	9	0.9847	5%	30%
Greece	8	0.9850	5%	20%
Non OPEC Middle East	10	0.9882	5%	30%
South Korea	5	0.9849	10%	30%
China	7	0.9852	10%	20%
Taiwan	5	0.9857	20%	30%
Chile	8	0.9870	10%	30%
United-States	7	0.9871	10%	30%
Pakistan	8	0.9902	20%	40%
Singapore	9	0.9905	20%	40%
Peru	7	0.9909	20%	40%
Ecuador	7	0.9926	30%	40%
Tunisia	6	0.9932	30%	40%
Argentina	7	0.9936	30%	40%
Turkey	6	0.9942	40%	50%
Egypt	7	0.9944	40%	50%
Brazil	6	0.9967	50%	50%
Colombia	4	0.9976	50%	50%
Phillipines	7	0.9977	50%	60%
India	7	0.9985	60%	70%
Morocco	7	0.9987	60%	70%
Mexico	2	0.9992	60%	50%
Former Yugoslavia	6	1.0034	80%	80%
South Africa	8	1.0056	90%	90%
Africa nes	10	1.0093	99%	99%
Mean	7.1667	0.9847	5%	20%
Median	7	0.9848	5%	20%

Table 3: Sigma-convergence for trade-based groups

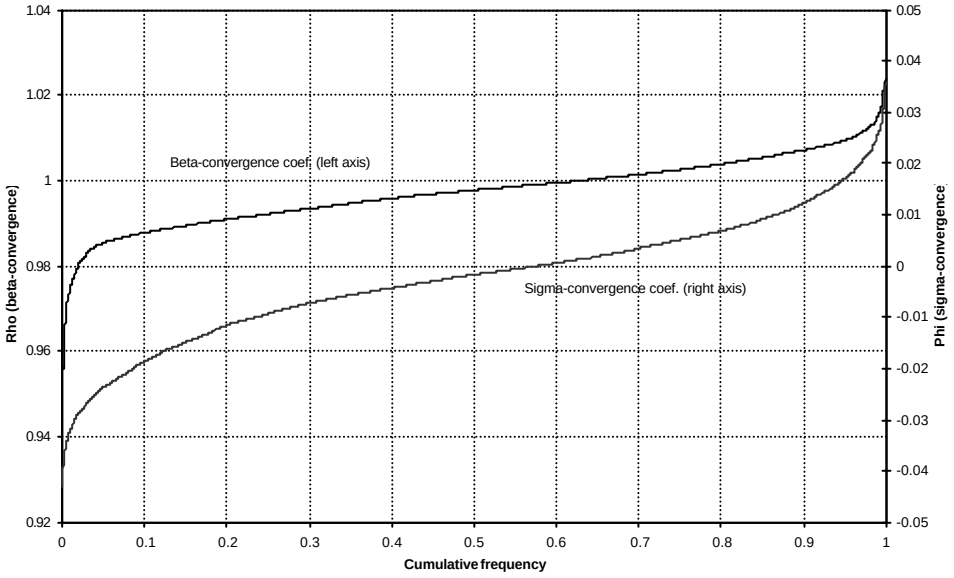
Group	*Size*	*Phi*	*Proba-1*	*Proba-2*
South Korea	5	-0.0483	1%	5%
Taiwan	5	-0.0448	1%	5%
Japan	6	-0.0397	1%	5%
Australia	8	-0.0352	1%	5%
China	7	-0.0317	5%	10%
United-States	7	-0.0294	5%	10%
Pakistan	8	-0.0284	5%	10%
Hongkong	9	-0.0259	5%	10%
Indonesia	8	-0.0217	5%	20%
Non OPEC Middle East	10	-0.0210	5%	20%
Peru	7	-0.0199	10%	20%
Thailand	7	-0.0184	10%	30%
Malaysia	6	-0.0168	20%	30%
Singapore	9	-0.0116	20%	40%
Ecuador	7	-0.0064	40%	50%
Egypt	7	-0.0058	40%	50%
Chile	8	-0.0055	40%	50%
India	7	-0.0036	40%	60%
Canada	3	-0.0030	60%	50%
Ireland	7	-0.0025	50%	60%
Tunisia	6	-0.0025	50%	60%
Spain	8	-0.0024	50%	60%
United-Kingdom	8	-0.0021	50%	70%
Portugal	7	-0.0020	50%	70%
Colombia	4	-0.0015	60%	60%
Austria	7	-0.0014	60%	70%
Switzerland	6	-0.0013	60%	70%
Germany	10	-0.0013	50%	70%
Greece	8	-0.0010	60%	70%
Israel	8	-0.0010	60%	70%
Philippines	7	-0.0009	60%	80%
France	8	-0.0008	60%	80%
Italy	8	-0.0008	60%	80%
Morocco	7	-0.0007	60%	80%
New Zealand	5	-0.0006	60%	70%
Belgium	7	-0.0006	60%	80%
Netherlands	7	-0.0006	60%	80%
Finland	10	-0.0005	60%	80%
Sweden	10	-0.0004	60%	80%
Denmark	9	-0.0004	60%	80%
Norway	8	-0.0003	60%	80%
Argentina	7	0.0003	60%	80%
Mexico	2	0.0004	70%	80%
Brazil	6	0.0027	70%	80%
Former Yugoslavia	6	0.0051	80%	90%
South Africa	8	0.0144	95%	95%
Africa nes	10	0.0175	95%	95%
Mean	7.1667	-0.0084	30%	40%
Median	7	-0.0018	50%	70%

Table 4: Alternative groupings of countries

Groups formed with:	**Rho (beta convergence)**	**P-value**	**Phi (sigma convergence)**	**P-value**
Trade in 1967	0.9880	10%	-0.00109	25%
Geographical proximity	0.9927	25%	0.00260	(div)
Specialization similarity	0.9935	30%	0.00158	(div)
7 biggest countries	0.9861	7%	-0.03115	2%
Additive Trade Intensity (ATI)	0.9893	12%	0.00008	(div)
Multiplicative Trade Intensity (MTI)	0.9986	55%	0.00573	(div)
Relative Trade Intensity (RTI)	0.9939	30%	0.00159	(div)

Notes: (div)= divergence; Rho and Phi coefficients are average over groups, except for '7 biggest countries'

Figure 1: Distribution of convergence coefficients (groups of 7 countries)



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ANNEX: SIMILARITY OF SPECIALIZATION PATTERNS

International specialization of countries is measured by the "contribution to the trade balance" (CTB) indicator (Lafay, 1992). Unlike other indicators of specialization, the CTB is a symmetrical indicator in the sense that it focuses not only on exports but also on imports. CTB compares observed trade balance for a product to a theoretical trade balance corresponding to an absence of specialization. The latter is calculated so as to spread the global trade balance on the different products according to their respective weights in the country total trade.

$$CTB_i^k = \left(\frac{1000}{GDP_i}\right)\left[\left(X_i^k - M_i^k\right) - \sum_k \left(X_i^k - M_i^k\right)\left(\frac{X_i^k + M_i^k}{\sum_k \left(X_i^k + M_i^k\right)}\right)\right]$$

with *i* the country, *k* the product, *X* are the exports and *M* the imports.

A positive contribution is interpreted as a revealed comparative advantage. By definition, the sum over all products is zero. In CHELEM database we get 72 categories of products.

The "contribution to the trade balance" (*CTB*) indicator is used to evaluate the similarity of specialization patterns between pairs of countries.

Two steps are needed to transform the *CTB* indicator into a similarity index:

We first compute adjusted *CTB*, ($\tilde{CTB}$) , in order to get rid of the size effect (degree of specialization) included in the *CTB*: *CTB* are multiplied by a coefficient so that the sum of adjusted values equals 100 for positive contributions and –100 for negative contributions;

then, for each pair of countries, we add up absolute differences of adjusted CTB. The similarity will equal 100, if the two countries have the same specialization pattern (possibly with different intensities). If each comparative advantage for country i is matched by an equal disadvantage for country j then similarity will be 0.

The similarity of specialization patterns between country i and j, Sim_{ij}, is defined as follow:

$$Sim_{ij} = 100 - \frac{1}{4}\sum_k \left|\tilde{CTB}_{ik} - \tilde{CTB}_{jk}\right|$$

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