Measuring International Economic Integration: Theory and Evidence of Globalization

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MEASURING INTERNATIONAL ECONOMIC INTEGRATION: THEORY AND EVIDENCE OF GLOBALIZATION*

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ABSTRACT

This article features a set of indicators designed to measure international economic integration and globalization. We analyze the degree of openness and the respective networks of connections---both direct and indirect---for each economy in our sample. Our indicators are based on network analysis techniques and the exchange of flows among world economies. Starting from four basic axioms of international economic integration, we define the Standard of Perfect International Integration, along with the set of indicators for degree of openness and connectedness, both for each specific economy and for the world economy as a whole. We apply our indicators to data on trade flows for 59 countries---accounting for 96.7% of world output---for the 1967--2004 period. According to our results, international economic integration is higher than what traditional degree of openness indicators suggest. The advance of globalization is unequal among countries because of the differing trends in their degree of openness and the differences in the intensity with which economies are connected to each other. Several economies now appear to be internationally integrated; however, the relatively low degree of openness in some of the largest economies jeopardizes the progress of globalization. We also perform some simulations which suggest that, should technological progress lead to an increase in indirect connections, the move towards greater international economic integration would accelerate.

Keywords: International Economic Integration, Globalization, International Trade, Network Analysis

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RESUMEN

Este trabajo propone indicadores para medir el grado de globalización e integración económica internacional. Para ello, se presta atención a la combinación de apertura de las economías y sus conexiones (tanto directas como indirectas) con el resto de países que constituyen la muestra. Los indicadores propuestos se basan en el análisis de redes (*network analysis*) y en los flujos de cantidades intercambiadas entre países. Partiendo de cuatro axiomas básicos de integración económica internacional se caracteriza un *Standard of Perfect International Integration*, así como un conjunto de indicadores de apertura, conexión e integración, tanto para cada economía como para el conjunto de la economía mundial. Aplicamos nuestros indicadores a una base de datos de comercio internacional entre 59 países (que supone el 96.7% de la producción mundial en 2004) durante el periodo 1967-2004. De acuerdo con nuestros resultados, la integración económica internacional es mayor de lo que indican los indicadores tradicionales de apertura. El avance de la globalización es desigual entre países debido a sus diferentes tendencias en los grados de apertura y la intensidad con la que se conectan entre sí. Muchas economías están muy integradas, pero los relativamente bajos grados de apertura de algunas de las más importantes suponen un freno al progreso de la globalización. Asimismo, llevamos a cabo simulaciones que sugieren que, en caso de que el progreso técnico lleve a un incremento en el número de relaciones indirectas, el proceso hacia una mayor integración económica internacional se aceleraría.

Palabras clave: Integración económica internacional, globalización, comercio internacional, análisis de redes.

1. Introduction

International economic integration (*IEI*) indicators can be classified into two broad categories, namely, those focusing on prices and those focusing on quantities. Other indirect approaches also take into account the importance of barriers to integration. However, these are not true indicators of international economic integration, but explanatory variables for their limits, i.e., explanatory variables for home-country bias, or for other biases such as geographical and flow-orientation biases. Some examples of this type of barrier thoroughly analyzed in the literature relate to distance and other nature-related hindrances, language, colonial, military or political relations, currencies, or trade agreements on trade tariffs (Brahmbhatt, 1998; Frankel, 2000; Knetter an Slaughter, 1999).

Measures of integration based on prices are preferred by many scholars to consider an axiomatic criterion, i.e., the compliance with the law of one price (*LOP*), in different geographical markets. The assumption of the *LOP* enables us to measure ability for integration by eliminating price differentials for commodities and assets in different territories in perfectly competitive markets. However, a unique price would only exist for homogeneous goods, yet not for others that can be differentiated. Since imperfect competition is now at the core of the new theories of international trade (Krugman and Obstfeld, 2002), and differentiated commodities account for two thirds of world trade (Rauch 1999), a set of criteria is required to establish international economic integration measures under conditions of imperfect competition. To date, this type of measure is unavailable,[1] and therefore international economic integration indicators based on prices turn out to be misleading, and present difficulties if they are intended to be used as a general measure of the degree of international economic integration. In fact, several empirical studies that attempt to measure how far we are from complying with the rule based on the *LOP* include integration objectives that have not necessarily been attained.

[1]Econometric estimations on the ability to explain deviations from the *LOP* are manifold (Knetter and Slaughter, 1999), yet they do not solve the key problem: the lack of a benchmark to measure integration that does not depend on perfect competition.

The most commonly used integration measure based on quantities is the degree of openness defined as exports plus imports divided by *GDP* (*XM*/*GDP*). While it provides a straightforward approach, it is not free from disadvantages. The first of these —although easily overcome— is its traditional disregard for differing sizes of economies, in spite of the fact that a large country such as the U.S. devotes higher shares of its output to satisfying internal demand than a small country such as the Netherlands, since the former's share of world demand is much higher.

Other limitations of the degree of openness become stricter when the number and importance of the trade connections each country has with the rest of the world are relevant aspects of integration, since the openness indicator completely disregards this issue. Indeed, the architecture of the network of world trade flows turns out to be very important when assessing integration from a globalization perspective, since some of its more relevant features are the multiplicity of flows (trade flows, capital flows, and human flows) in many directions, the adherence to the process of all countries, and the establishment of many other connection paths —both direct and indirect, and physical or virtual— between agents and economies. If these aspects are to be detected, international economic indicators must be given a higher degree of complexity.

Nowadays the world economy is regarded as a field in which the progress of globalization plays a major part. According to the process of globalization —introduced in the sixties by communications theorists such as Marshall McLuhan— technology alters both social and economic ties, turning the world into a *village* in which national spaces are partly abolished, and individuals must learn to live in close relation to formerly distant agents. Any attempt to analyze economic integration in these circumstances must uncover what occurs when borders vanish, and the connections among individuals and economies proliferate. When measuring globalization we must identify the type of international economic integration that would be attained in a true *world village*, and calculate how far we are from that scenario.

There is a remarkable consensus on what the main drivers of this process are. However, to date no consensus has been reached on the level of globalization attained, or its effects. Accordingly, many scholars share the opinion that the main drivers of international economic integration in the private sphere are technological change and the decline in transportation and communication costs, whereas in the public sphere they are associated with the gradual removal of political barriers to trade and investment and capital and human flows (Frankel and Rose, 2000). In turn, debate continues on the consequences of globalization, its effects on growth and income distribution, as well as

the changes to brings to competitiveness in firms and countries, the intensity of crises, or the governability of the international financial system (Rodrik 1998 a,b; Salvatore 2004; Bhagwati 2004 a,b; Stiglitz 2002).

One of the main difficulties in obtaining conclusive empirical evidence on the consequences of globalization is the shortage of convincing measures. In recent years, some aspiring indicators of globalization have been developed, which take into account economic, political, technological and personal dimensions, aggregating several variables following *ad hoc* (nonparametric) and statistical (parametric, based on principal components or factor analysis) criteria (Dreher, 2005; Heshmati, 2006). Constructing this type of indicators consists simply of mixing up different traditional openness indicators (both on international trade and financial flows), yet letting unsolved the aforementioned difficulties. The validity of these indicators is justified by its ability to (statistically) explain certain international economic differences (especially on growth), yet it does not imply they apprehend the nature of the globalization process.

The main aim of our study is to introduce measures for international economic integration and globalization starting from a set of basic axioms and the definition of a set of indicators conceived to achieve two objectives: to uncover the role of the network and to define a *Standard of Perfect International Integration*.

1) *Uncovering the role of the network implies accepting that the advance of international economic integration operates through both higher openness and higher connectedness to other economies, following both direct and indirect paths.*

The latest wave of technological change and the removal of a series of barriers to international trade has boosted openness, but at the same time has produced a secondary effect, namely, economic agents in different parts of the world now have more links, through both direct and indirect paths. This increased number of connections may be efficient because of the development of information technology and the dramatic fall in transaction costs. Measuring international economic integration in the age of globalization must take into account that connections thrive by different means. When indirect relations are accounted for, we are able to verify whether the attained level of integration is higher than what other traditional openness and direct connection indicators might only suggest. At this point, it is pertinent to ask how important the two components —namely, increased openness and increased connectedness— are to the progress of international economic integration.

The available statistical information does not allow us to give a precise answer because of the lack of accurate data on indirect links between countries. However, some trends-such as the development of e-commerce networks, or the increasing policy of outsourcing stages in the production process, representing a breakdown in the vertically-integrated mode of production (Feenstra, 1998; Feenstra and Hanson 1996, 1997 and 1999) —suggest that indirect connections are important and can contribute to the acceleration of the globalization process, thanks to the reduction in transport and transaction costs and greater reliance on international markets as a mechanism of resource allocation (Coase, 1937; Williamson, 1975; Grossman and Helpman, 2002, 2005).

2) *Any attempt to characterize a scenario in which economies are entirely integrated/globalized (Standard of Perfect International Integration) is to describe the conditions under which the world economy would operate as a global village.*

This approach allows us to assess the distance that separates the current level of international economic integration from the scenario of complete globalization. In that ideal situation, not yet attained, both borders and distances (of whatever kind) are irrelevant. This situation not only requires countries to be more open, but also a full and unbiased development of the network of connections that link economies. A further step would be to measure biases in both directions (through the domestic economy or by prioritizing some connections over others), which would help to identify the factors that hinder the advance of globalization. While some of these obstacles may always be with us, others that might previously have been considered unmovable have now been eliminated by technical and/or technological progress.

To achieve these two objectives, and to uncover the structure of the trade network that economies forge, we can contemplate the relations, or flows between them as the vectors of a graph in which the nodes represent the countries, and then analyze the degree of connectedness in the network using network analysis techniques.[2] Although these techniques are somewhat underused by economists, especially in comparison with other social sciences (Rauch, 2001), this approach is not new in international economics, and has attracted recent interest. In particular, several studies

[2]See, for instance, Carrington et al. (2005), Wasserman and Faust (1992), Hanneman and Riddle (2005), among many others.

highlight the importance of information flowing through cultural, political or economic ties in order to explain both the intensity and the evolution of economic relations between countries (Rauch, 1999, 2001; Rauch and Trindade, 2002; Rauch and Casella, 2003; Greaney, 2003; Pandey and Whalley, 2004; Combes et al., 2005). Other works suggest applying formal network analysis concepts and instruments developed in other social sciences such as sociology to the study of the structure and dynamics of international trade.[3] Smith and White (1992) rearrange old ideas such as blocks, center and periphery, that are relatively popular in debates on the evolution of world economy. Kali and Reyes (2007, 2005) transpose several concepts of network analysis (centrality, network, density, clustering, assortative mixing, maximum flow) to international economic integration.

To analyze integration from the perspective outlined above, the main contents of the article are structured into two sections, one theoretical and the other empirical. The theoretical section (Section 2) sets out the methodological contents of our approach to measure international economic integration. First, it takes a series of axioms to establish the approach and then uses them to define openness, connectedness and integration indicators together with their properties, and the Standard of Perfect International Integration. Section 3 contains the empirical application by considering data on exports of goods for a set of countries which account for virtually all world output, and for a relatively long sample period (1967--2004). Section 4 presents evidence on the power of our indicators as explanatory variables for some traditional competitiveness indicators. Once the most important features of the globalization process have been analyzed from the results obtained, Section 5 concludes.

2. Integration indicators: definitions and properties

The international integration process starts with the openness of economies, but its effects and scope also depend on the structure of current relations between these economies. Relevant aspects of this structure include the number of economies each one

[3]International trade is not the only case. Other recent examples of network analysis applications can be seen in the field of labor economics (Calvo-Armengol and Jackson 2004; Calvo-Armengol 2004; Calvo-Armengol and Zenou 2005), growth (Pérez et al., 2006), or bank efficiency (Pastor and Tortosa-Ausina 2006).

is in contact with; whether the relationships are direct or indirect; the number of flows between them and the proportionality of these flows to the size of the economies.[4]

When producers exist in the global village, the level of integration is such that there is no difference in intensity (bias) that reinforces the exchanges inside the countries or from one specific economy to other. In other words, the economies, represented by countries, are not relevant except for their relative size, and they do not imply differences in trading time costs.

To analyze the evolution of integration from this perspective we start with the following axioms on global village economies that must be verified by an integration index:

Axiom 1. Openness: The more open an economy is, the more integrated it will be.

Axiom 2. Balanced relationships: An economy that balances its direct relationships with other economies, in proportion to their size, will have a higher level of integration.

Axiom 3. Indirect relationships: An economy that reinforces its relationships with other economies through indirect relationships across third economies will have a higher level of integration.

Axiom 4. Size: The bigger an economy is, the more relevant its integration will be for the world economy globalization (global level of integration).

To determine the degree of integration we proceed in four stages, each one of which defines different indicators:

1. In the first stage we characterize the *degree of openness*. We start with the usual definition found in the literature but corrected for domestic bias to take into account the different sizes of the economies compared.

[4]This approach has several links with the literature on social networks. See, for instance, Annen (2003), Hanneman and Riddle (2005), Karlin and Taylor (1975), Wasserman and Faust (1992), or Wellman and Berkovitz (1988).

2. In the second stage we analyze whether the connection of one economy with others is proportional to their sizes in terms of *GDP* (gross deep product),[5] or whether this connection shows geographical bias which moves the situation away from that corresponding to a perfectly integrated world. Thus, we define the *degree of direct connection* to measure the discrepancy between the trade volumes in the real world and trade volumes corresponding to a perfectly integrated world.

3. Indirect relations between economies and the importance of these relations are considered in the third stage. To extend the analysis of economic integration in this direction we define the *degree of total connection*, which evaluates the importance of all direct and indirect relationships that economies establish with each other.

4. From the above concepts, we define the *degree of integration*. This combines degrees of openness and total connection, provided that both set limits to the integration level achieved. We show that the degree of integration verifies the four axioms presented above.

The analysis of the four indicators is conducted on two levels, namely, the individual level, which focuses on each economy, and the global level, which corresponds to the analysis of all economies. In the second level the weight of each economy enters the aggregation analysis.

2.1. Notation

The geometry defined by the relationships among economies can be modeled as a network, where countries are nodes and there exists a vertix between two of them, say i and j, if there exists a flow from i to j. Thus, flow not only defines links among countries but also measures the intensity of the relationships. Thus, given a specific flow (for example, an export flow), we have the network associated to a global village economy, which is an ideal network and the network associated to reality. Our

[5]The dependence of exchanges on economy size is the focus of international trade analyses based on gravity models and widely used in the literature (Hummels and Levinsohn, 1995; Feenstra et al., 1998, 2001; Rauch, 1999).

integration index is a measure of the distance between these two networks, the ideal one and the real one.

Let $N = \{1,\ldots,g\}$ be the set of nodes or economies and let i and j be typical members of this set. Let g be the number of elements in N, i.e., the number of countries in the analyses. Let Y_i be the size (activity volume) of economy $i \in N$, for example its GDP. We define a_i as the economy i's relative weight with respect to the world economy, i.e., $a_i = Y_i / \sum_{j \in N} Y_j$.

Given a measurable relationship among countries we define the flow X_{ij} as the intensity of this relationship from economy i to economy j, for all $i, j \in N$. The flow among economies can be evaluated through either the imports or the exports of goods or capital, and in general it can be evaluated through any other flow measured in the same units as Y_i. Moreover, in general the flow between two economies will be asymmetric, so that X_{ij} will not necessarily be equal to X_{ji}, for all $i, j \in N$. We also assume that $X_{ii} = 0$ for all economy $i \in N$. All definitions in this paper depends on the flow considered to measure the international integration.

If the orientation of production towards domestic demand is not biased, then its volume will not be the same in each economy since it depends on its size. In order to remove domestic bias we define $\hat{Y}_i$ as the production destined for export taking into account the weight in the world economy of the economy considered: $\hat{Y}_i = Y_i - a_i Y_i$.

2.2. Degree of openness

We define the relative flow or **degree of openness** between economies i and j as $DO_{ij} = X_{ij} / \hat{Y}_i$ Given that $X_{ii} = 0$, it follows that $DO_{ii} = 0$ for all $i \in N$.

Definition 1 *Given an economy $i \in N$, we define its **degree of openness**, DO_i, as*

$$DO_i = \sum_{j \in N} DO_{ij} = \frac{\sum_{j \in N} X_{ij}}{\hat{Y}_i}. \qquad (1)$$

By definition the above expression verifies Axiom 1. Degree of openness yields results (in general) within the interval $(0,1)$, where a value of 0 indicates that the economy is closed (compared to the measure of flow chosen) and a value of 1 indicates a lack of domestic bias in the economy (total openness). Although the degree of openness in an economy is, in general, lower than 1, some particular economies may exceed this value.

DO is a relative indicator that takes into account economy size: domestic bias has been corrected, removing the effect of the size of economy i on DO. Differences in DO among economies can be attributable to different obstacles to integration (transport costs, political factors, etc.), one of which is scale, but differences cannot be due to bias in the measure of openness.[6]

2.3. Degree of connection

In the economic network, the relative flow from economy i to economy j in terms of the total flow of economy i, α_{ij}, is given by

$$\alpha_{ij} = \frac{X_{ij}}{\sum_{j \in N} X_{ij}} \tag{2}$$

(recall that we are assuming $X_{ii} = 0$.) Let $A = (\alpha_{ij})$ be the square matrix of relative flows: the component ij of matrix A is α_{ij}.

We consider that an economic network (the world economy) is perfectly connected if the flow between two economies is proportional to their relative weights. An economy that is part of a perfectly connected network will emit flows to all other economies which must be proportional to the size of the recipient economy.

Definition 2 *A world economy is perfectly connected if the flow from economy i to economy j is equal to $\beta_{ij}\hat{Y}_i$ where*

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[6]We write DO instead of DO_i when general statements on the degree of openness are being made, or references to the variable itself, which do not hang on any specific country. The same rule will be applied to the other indicators.

$$\beta_{ij} = \frac{Y_j}{\sum_{k \in N \setminus i} Y_k} \tag{3}$$

is the relative weight of economy j in a world where economy i is not considered.

Note that $\sum_{j \in N \setminus i} \beta_{ij} = 1$ and that β_{ij} is the degree of openness between economies i and j in the perfectly connected world, with $\beta_{ii} = 0$. Let $B = (\beta_{ij})$ be square matrix of degrees of openness in the perfectly connected world, where the component ij of B is β_{ij}.

Remark 1 *By definition we verify that* $\sum_{j \in N} \alpha_{ij} = \sum_{j \in N} \beta_{ij} = 1$, *thus both matrixes* A *and* B *define Markov chains and it can be proved that they are recurrent irreducible aperiodic Markov chains.*

Degree of direct connection

Starting from the previously defined matrices, we can define the indicators that measure the distance between the real distribution of flows and those that correspond to a perfectly connected world. One of these indicators is the cosine of the angle of the vector of relative flows with the vector of the flows in a perfectly connected world.

Definition 3 *Given an economy* $i \in N$ *we define the* ***degree of direct connection*** *of* i, DDC_i, *as*

$$DDC_i = \frac{\sum_{j \in N} \alpha_{ij} \beta_{ij}}{\sqrt{\sum_{j \in N} (\alpha_{ij})^2} \sqrt{\sum_{j \in N} (\beta_{ij})^2}}. \tag{4}$$

Although the cosine of two vectors oscillates between -1 and 1, the degree of direct connections always takes nonnegative values given that both vectors have only nonnegative components. DDC verifies Axiom 2 and provides a single number that should be close to 1 if the economy i is perfectly connected, and close to zero for an economy i whose flows are directed towards the smallest world economies.

Degree of total connection

Both the real world matrix A and the perfectly connected world matrix B consider *direct* relative flows between economies. However, part of the flow moving from economy i to economy j may pass through other economies and those *indirect* flows also contribute to integration.

Let $A^n = A \cdot A \cdot \overset{n}{\ldots} \cdot A$ be the n-times product matrix of matrix A and let α_{ij}^n be the element ij of A^n. It is not difficult to show that α_{ij}^n is the relative flow that goes from i to j passing through $n-1$ intermediate economies. Moreover, we verify that $0 \leq \alpha_{ij}^n \leq 1$ for all $n \geq 1$. In the same way we define B^n, the elements of which evaluate the flow passing through all economies in a perfectly connected world.

Let $\gamma_i \in (0,1)$ be the proportion of flow that economy i emits to another economy where it remains for internal consumption by this economy, while $1-\gamma_i$ is the proportion of flow that the destination economy sells, possibly after some transformation. Alternatively, we can interpret the inverse of γ_i as the number of transactions (on average) that take place when a good is initially emitted by economy i until the time it arrives to the destination economy. Thus, $\gamma = 0.5$ is consistent with the assumption that goods receive a single intermediate transaction, i.e., between economies i and j there is only one other intermediate economy and two transformations are made. An alternative case is $\gamma = 0.25$, which corresponds to a run with five economies taking part and four transformations.

Let Γ be the square diagonal matrix of direct flow proportions, so that the element ii of Γ is γ_i and the element ij, for $i \neq j$, is zero. The matrix of total flows an economy sends to another economy is the sum of the direct and indirect flows and can be estimated as

$$A^{\Gamma} = \sum_{n=1}^{\infty} \Gamma (I - \Gamma)^{n-1} A^n, \tag{5}$$

$$B^{\Gamma} = \sum_{n=1}^{\infty} \Gamma (I - \Gamma)^{n-1} B^n \tag{6}$$

where I is the identity matrix of order g. Both expressions depends on matrix Γ and they can be simplified if we assume that the direct flow proportion is independent of the economy, so that $\gamma_i = \gamma$ for all $i \in N$. Under this assumption the above expressions become

$$A^{\gamma} = \sum_{n=1}^{\infty} \gamma(1-\gamma)^{n-1} A^n, \tag{7}$$

$$B^{\gamma} = \sum_{n=1}^{\infty} \gamma(1-\gamma)^{n-1} B^n. \tag{8}$$

Let α_{ij}^{γ} be the element ij of the matrix A^{γ} and β_{ij}^{γ} be the element ij of the matrix B^{γ}. Each element of these matrices is the weighted sum of the direct and indirect flows through any possible number of intermediate economies. Moreover, the weight used is consistent with the average number of transactions that take part in the world. It can be checked that the above two series are convergent and than an alternative way to compute A^{γ} and B^{γ} is given by the following expressions (see appendix),

$$A^{\gamma} = \frac{\gamma}{1-\gamma}\left(\left[I-(1-\gamma)A\right]^{-1} - I\right), \tag{9}$$

$$B^{\gamma} = \frac{\gamma}{1-\gamma}\left(\left[I-(1-\gamma)B\right]^{-1} - I\right). \tag{10}$$

Note that if there are no indirect flows, $\gamma = 1$, then expressions (7) and (8) yield $A^{\gamma} = A$ and $B^{\gamma} = B$. The limit case $\gamma = 0$ (goods receive infinite number of transformations before arriving to their final destinations) cannot be derived directly from the above expressions. The basic limit theorem of Markov chains (see appendix) is needed to show that in the limit case, where $\gamma = 0$, the proportion of flow an economy j receives from an economy i is independent of i, i.e., all economies send the same proportion of flow to economy j.

Definition 4 *Given an economy* $i \in N$ *we define the* ***degree of total connection*** *of* i*,* DTC_i^γ*, as*

$$DTC_i^\gamma = \frac{\sum_{j \in N} \alpha_{ij}^\gamma \beta_{ij}^\gamma}{\sqrt{\sum_{j \in N} \left(\alpha_{ij}^\gamma\right)^2} \sqrt{\sum_{j \in N} \left(\beta_{ij}^\gamma\right)^2}}. \tag{11}$$

The degree of total connection, which verifies Axiom 3, belongs to the interval $(0,1)$ and measures the distance of the flows of an economy from what its flows would be in a perfectly connected world. Similarly to the degree of direct connection, it should be close to 1 when the flows of an economy are proportional to the size of the receiver economies and close to zero if the largest economies do not receive any commodities and the smallest receive all the goods.

However, DTC^γ depends on parameter γ which measures the incidence of indirect flows in the connections between economies. Thus, the degree of total connection for any economy i is a decreasing function of γ, so that the larger the weight of the indirect flows, the larger the DTC^γ will be. In the limit case, $\gamma = 0$, we assume that there are no transaction costs of any kind and in their passage around the world goods are potentially subject to an infinite number of transformations before arriving at their final destination. This case corresponds with the maximum possible degree of connection that is independent of the economy.

If α_{ij}^γ is the element ij of A^γ, then for all $i, j \in N$ it follows from proposition 2 (see Appendix) that there exists the limit $\lim_{\gamma \to 0} \alpha_{ij}^\gamma$ and that it is equal to the component j of the ergodic distribution of the Markovian process defined by matrix A. Hence $\lim_{\gamma \to 0} \alpha_{ij}^\gamma = \lim_{n \to \infty} \alpha_{ij}^n = \overline{\alpha}_{jj}$ and, equivalently, we have that $\overline{\beta}_{jj} = \lim_{\gamma \to 0} \beta_{ij}^\gamma$ where β_{ij}^γ is the element ij of B^γ. Thus, $\overline{\alpha}_{jj}$ is the proportion of goods that arrive to economy j from any other economy assuming that there are no transaction costs of any kind and $\overline{\beta}_{jj}$ is that proportion in a global village.

Definition 5 *We define the* ***maximum degree of connection*** *of the world (maximum global degree of connection), MDC, as*

$$MDC = \frac{\sum_{i \in N} \overline{\alpha}_{ii} \overline{\beta}_{ii}}{\sqrt{\sum_{i \in N} \left(\overline{\alpha}_{ii}\right)^2} \sqrt{\sum_{i \in N} \left(\overline{\beta}_{ii}\right)^2}}. \tag{12}$$

The difference between MDC and DDC_i can be interpreted as a measure of the potential that indirect connections represent for economy i, in order to improve its connectedness.

2.4. Degree of integration

Definition 6 *Given an economy* $i \in N$ *we define its* ***degree of integration****,* DI_i^{γ}*, as*

$$DI_i^{\gamma} = \sqrt{DO_i DTC_i^{\gamma}} \tag{13}$$

The degree of integration of an economy is the geometric average of its degrees of openness and total connection, thus DI depends on both, the openness of the economy and the balance in its direct and indirect flows. Moreover, DI verifies Axioms 1 to 3, given that it is an increasing function of both DO and DTC.

If $DI_i^{\gamma} = \sqrt{DO_i DTC_i^{\gamma}}$, then

$$1 = \sqrt{\frac{DO_i}{DI_i^{\gamma}}} \sqrt{\frac{DTC_i^{\gamma}}{DI_i^{\gamma}}} \tag{14}$$

and we can interpret each of these two factors as the weight that the degrees of openness and total connection have over the degree of integration. In a given economy, this can be useful to analyze changes over time in the weight of the factors.

2.5. Global indicators

In the previous subsections we defined several indicators that characterize the integration of each individual economy. These can be summarized to characterize the integration of the whole economic network. To this end, we should consider the share of

each economy in the network to define the global indicators as follows (recall that $a_i = Y_i / \sum_{j \in N} Y_j$):

Degree of global openness:

$$DGO = \sum_{i \in N} a_i DO_i. \tag{15}$$

Degree of global direct connection:

$$DGDC = \sum_{i \in N} a_i DDC_i. \tag{16}$$

Degree of global total connection:

$$DGTC^{\gamma} = \sum_{i \in N} a_i DTC_i^{\gamma}. \tag{17}$$

Degree of globalization (Degree of global integration):

$$DGI^{\gamma} = \sum_{i \in N} a_i DI_i^{\gamma}. \tag{18}$$

The DGI indicator is the most general quantitative approximation to the international integration of economies, as it considers not only the degree of openness, but also the distribution and size of the direct and indirect flows between economies. In light of the different concepts included in this definition, the indicator will be considered as a Globalization Index for the world economy, which verifies Axioms 1 to 4 (the first three axioms because DGI is an increasing function of DI for all economy i; Axiom 4 is verified because DGI is a weighted average of the economies' degree of integration, where the weight of each economy depends directly on its size.) The index is included in the $[0,1]$ interval, where the maximum value is obtained when all economies are perfectly integrated, i.e., they have optimal degrees of openness (taking into account domestic demand) and the flows between economies are proportional to the share of each economy in the economic network.

3. On the evolution of international economic integration: empirical evidence

The international economic integration indicators defined above may well be used to study the evolution of international trade and international capital markets. In this section, we apply our indicators to trade flows, which requires information on the volume of activity for each country together with their flow exchanges with the rest of the world.

The first subsection details the problems related to information sources and the decisions taken to overcome them. The remaining subsections present results on degrees of openness, connection, and integration.

3.1. Statistical sources and selected variables

The data were taken from the CHELEM database[7] and correspond to 59 countries that together account for 96.7% of world output and 86.5% of international trade. The variable selected to measure flows between countries is the volume of exports.[8]

The available information covers a relatively long period of time, from 1967 to 2004, uncovering entirely what some authors have termed the second wave of globalization (O'Rourke and Williamson, 1999, 2002; Maddison, 2001). Although the database also contained information for other countries, it was not available for all our sample years, and we therefore disregarded it.

The first three columns in Table 1 report data on *GDP* shares for each country in our sample. For the sake of simplicity, and also for reasons of space, tables containing individual information for each country in our sample constrain the reported information to three years, namely, the initial year (1967), the final year (2004) and an

[7]Information on CHELEM (*Comptes Harmonisés sur les Echanges et l'Economie Mondiale*, or Harmonised Accounts on Trade and The World Economy) database is available at URL http://www.cepii.fr/anglaisgraph/bdd/chelem.htm.

[8]The computations for indicators based on imports do not alter the general results, although they may differ for some specific countries. These results are not reported due to space limitations, but are available from the authors upon request.

Table 1. GDP shares of world GDP (*a*) and degree of openness (*DO*) (%)

	a_i			DO_i		
	1967	1985	2004	1967	1985	2004
Albania	NA	0.02	0.02	NA	7.26	7.36
Algeria	0.15	0.49	0.20	19.46	21.77	40.47
Argentina	1.07	0.75	0.38	5.44	8.38	20.61
Australia	1.35	1.41	1.55	10.00	10.97	13.22
Austria	0.52	0.58	0.73	14.29	23.61	35.20
BLEU	0.90	0.73	0.96	33.07	58.61	82.00
Brazil	1.36	1.88	1.43	5.89	10.37	15.53
Brunei Darussalam	0.01	0.03	0.01	58.50	71.40	84.36
Bulgaria	0.31	0.27	0.06	2.92	2.95	38.44
Canada	2.89	3.01	2.50	16.36	24.22	33.12
Chile	0.31	0.14	0.23	11.10	21.16	32.48
China, People's Rep.	3.20	2.58	4.13	1.54	6.64	36.40
Colombia	0.26	0.30	0.24	7.80	8.96	16.48
Czechoslovakia (former)	0.63	0.40	0.37	4.63	6.92	63.76
Denmark	0.56	0.51	0.61	18.70	25.25	28.43
Ecuador	0.07	0.14	0.07	13.68	18.42	22.94
Egypt	0.26	0.40	0.17	9.52	9.76	7.58
Finland	0.41	0.46	0.46	15.42	24.10	31.37
France	5.33	4.50	5.11	8.68	17.14	20.58
Gabon	0.01	0.03	0.02	30.90	52.00	37.62
Germany	5.61	5.37	6.87	17.30	29.61	34.60
Greece	0.36	0.35	0.51	5.81	9.50	6.85
Hong Kong	0.12	0.30	0.43	39.50	45.09	11.79
Hungary	0.20	0.18	0.25	8.92	14.61	54.45
Iceland	0.03	0.02	0.03	17.86	33.73	28.16
India	2.17	1.90	1.72	2.62	3.74	9.28
Indonesia	0.27	0.74	0.57	14.65	21.52	28.40
Ireland	0.15	0.17	0.45	21.84	48.53	58.46
Israel	0.17	0.20	0.29	12.86	22.56	31.88
Italy	3.56	3.61	4.24	10.18	16.81	20.83
Japan	5.56	11.48	11.90	7.36	13.00	13.12
Malaysia	0.16	0.27	0.29	32.63	46.06	112.95
Mexico	1.21	1.64	1.71	4.24	14.37	28.32
Morocco	0.14	0.11	0.13	12.24	17.44	19.30
Netherlands	1.11	1.12	1.46	24.95	55.21	50.05
New Zealand	0.27	0.19	0.24	16.64	20.65	18.86
Nigeria	0.23	0.24	0.16	13.89	45.41	43.41
Norway	0.42	0.54	0.63	15.92	31.43	32.92
Pakistan	0.33	0.25	0.20	5.59	6.28	12.95
Peru	0.27	0.14	0.17	10.87	16.33	17.83

Table 1. GDP shares of world GDP (*a*) and degree of openness (*DO*) (%)

	a_i			DO_i		
	1967	1985	2004	1967	1985	2004
Philippines	0.33	0.26	0.22	10.06	16.45	51.36
Poland	0.80	0.64	0.59	4.61	5.87	31.00
Portugal	0.24	0.21	0.42	9.29	21.16	20.77
Romania	0.48	0.40	0.18	4.01	8.19	31.67
Singapore	0.05	0.15	0.27	37.91	76.50	92.44
South Korea	0.22	0.84	1.72	6.15	26.05	34.87
Southafrican Union	0.61	0.51	0.49	9.02	15.87	20.68
Spain	1.39	1.45	2.48	4.11	12.36	18.14
Sweden	1.19	0.89	0.87	15.82	27.92	35.50
Switzerland	0.77	0.83	0.91	19.45	25.90	32.43
Taiwan	0.16	0.52	0.79	16.77	47.24	53.59
Thailand	0.25	0.33	0.43	8.83	14.93	58.48
Tunisia	0.05	0.07	0.07	9.80	17.17	31.65
Turkey	0.71	0.57	0.80	3.14	7.63	16.98
United Kingdom	4.94	3.86	5.47	11.24	21.83	16.41
United States	37.11	35.72	30.26	5.24	7.26	8.34
USSR (former)	7.78	4.43	2.00	1.48	5.17	31.70
Venezuela	0.48	0.52	0.27	13.43	18.59	7.40
Yugoslavia (former)	0.51	0.34	0.26	10.33	25.60	28.98
Mean	1.69	1.69	1.69	13.30	22.77	32.62
Standard deviation	4.98	4.87	4.29	10.66	16.80	21.71
Coefficient of variation	2.94	2.87	2.53	0.80	0.74	0.67

intermediate year (1985).[9] In both the tables with aggregated data and in the figures (referring to the world economy as a whole, and to each of the largest economies) the annual evolution is reported. All indicators are reported as percentages.

3.2. Degree of openness

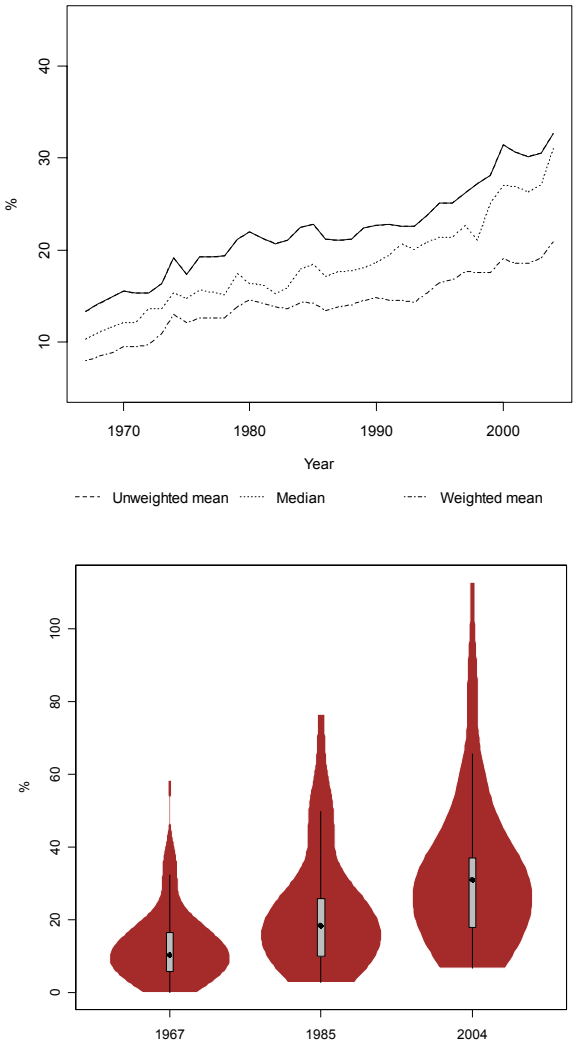
The degree of openness defined by considering both exports and *GDP* in Equation ((1)) is presented in Table 1, and in Figures 1 and 2. In addition to each country's share of world output, Table 1 also reports each country's degree of openness for the selected years, considering information on exports of goods for years 1967, 1985 and 2004 (columns 4, 5 and 6).[10] Figure 1 shows the evolution of both indicators for all

[9] Results on all indicators for the remaining sample years are available from the authors upon request.

[10] Our results have been performed by analyzing flows of goods only, not goods and services, since

countries in our sample, reporting information on weighted mean, unweighted mean, and the median. The lower panels in the Figure represent the entire distribution using box plots and violin plots[11] corresponding to the three selected years, which enables the features of the distributions to be detected more thoroughly.

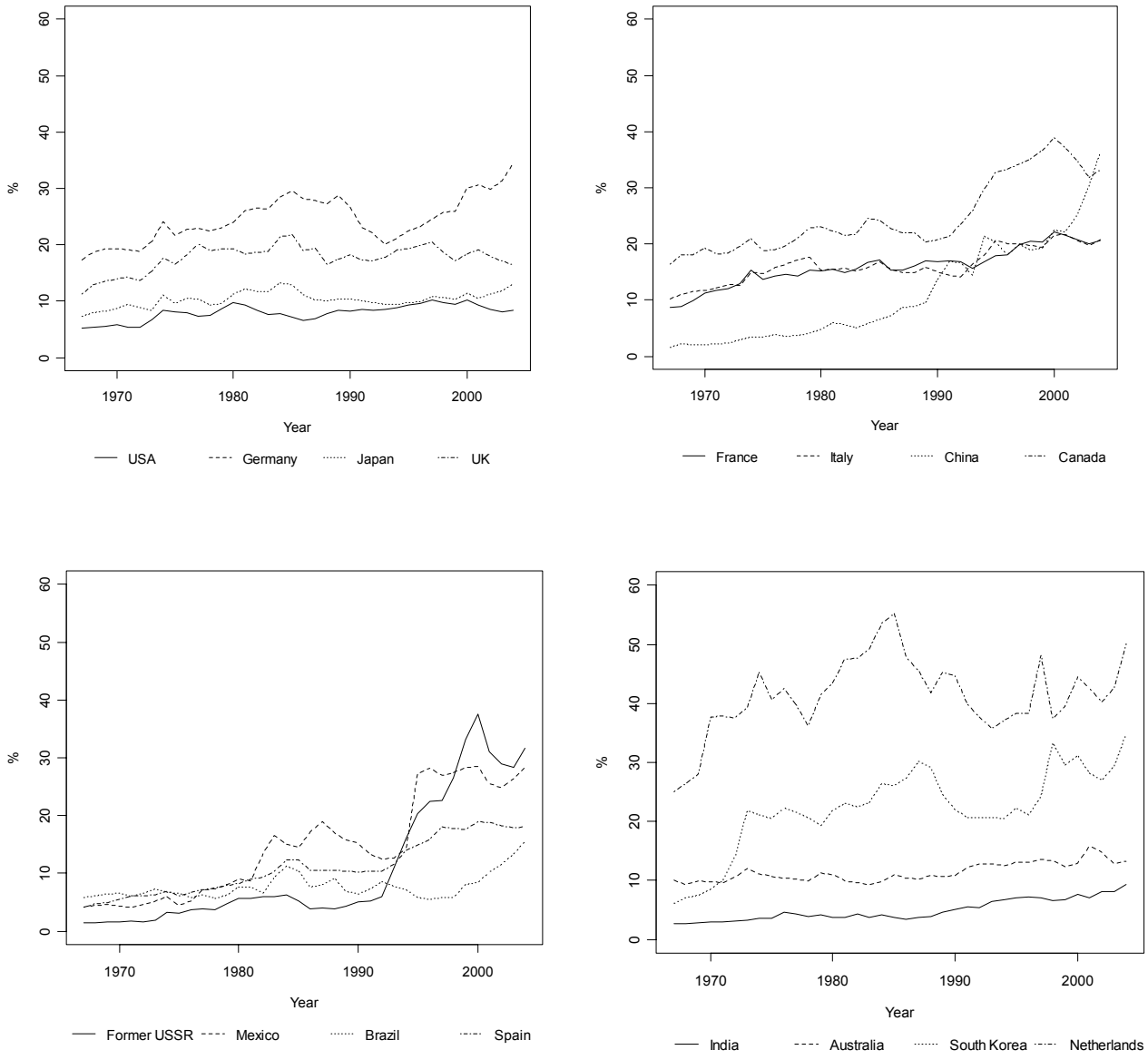
Figure 1. Degree of openness (*DO*), 1967-2004



information on the destination of exports is unavailable in the case of services. In addition, the literature deals with the trade of goods and services differently. See, for instance, Mirza and Nicoletti (2004).

[11] Violin plots are a mix between box plots and density functions estimated nonparametrically via kernel smoothing, to reveal structure found within the data. Box plots show four main features of a variable: center, spread, asymmetry and outliers. The density trace, which in the case of violin plots is duplicated for illustrating purposes, supplements this information by graphically showing the distributional characteristics of batches of data such as multi-modality. See Hintze and Nelson (1998).

Figure 2. Degree of openness (*DO*), selected countries, 1967-2004



For the entire world economy, considering the degree of global openness as defined in Equation (15), and the corresponding results in Table 2, the case of exported goods increased from 8% in 1967 to 20.9% in 2004 —i.e., the indicator multiplied by 2.6.

Over time, the increase in the degree of openness is not smooth; stagnant periods (from 1985 to 1995), and even brief periods of reversal are observed. The unevenness is accentuated at country level. Although positive annual growth rates dominate, some exceptions also exist, especially in the second part of the period (1986--2004).

Table 2. Degree of global openness (*DGO*), 1967-2004 (%)

	DGO
1967	7.94
1968	8.35
1969	8.81
1970	9.45
1971	9.46
1972	9.67
1973	10.86
1974	13.02
1975	12.16
1976	12.62
1977	12.66
1978	12.59
1979	13.81
1980	14.64
1981	14.25
1982	13.85
1983	13.62
1984	14.36
1985	14.21
1986	13.47
1987	13.85
1988	14.00
1989	14.48
1990	14.84
1991	14.55
1992	14.54
1993	14.31
1994	15.30
1995	16.46
1996	16.71
1997	17.67
1998	17.55
1999	17.54
2000	19.10
2001	18.55
2002	18.51
2003	19.14
2004	20.85

The unweighted mean is always higher than the weighted mean (see Figure 1), due to the fact that the degree of openness for the largest economies is lower, even after including the bias correction as suggested in Equation ((1)). The gap between the mean and the median suggests there are countries with quite an extreme degree of openness, especially in the upper tail. The violin plots reinforce this finding, which is stressed over time, showing that some countries have expanded their openness much more than average. Thus, dispersion in the openness indicators for all countries increases; however, due to the increase in the average, the variation coefficient declines.

Each sub-figure in Figure 2 describes the evolution of the degree of openness for the 16 largest world economies (accounting for 81.7% of world output and 65.5% of world trade). Since the definition of the indicator controls for domestic bias, the differences in openness are not directly attributable to this variable, although this does not necessarily imply that the size effect is negligible.

As shown by Figure 2, the values obtained differ a great deal across countries. By the end of the period, the high levels achieved by Canada, China, Germany, the former USSR, the Netherlands and South Korea should be noted, together with the low levels shown by India, Australia, the USA and Japan. High degrees of openness in the fastest growing countries are noted for China, Canada, the former USSR, Germany and Mexico.

3.3. Degree of connection

Information on the degree of connection indicators is reported in Tables 3 and 4 and Figures 3-6. The value for the degree of direct connection indicator (DDC, Equation ((4))) matches the degree of total connection indicator (DTC, Equation (11)) under the hypothesis of $\gamma = 1$. Computations are also performed for indicators based on two additional hypotheses: (i) for cases in which a single indirect connection exists, i.e., two transactions between the producer and the consumer of the traded commodity ($\gamma = 0.5$); (ii) and for four indirect connections, i.e., a total of five transactions ($\gamma = 0.2$). Because of the lack of information on the actual number of transactions, the two hypotheses will help us study the importance of indirect connections for the degree of connection and, in a subsequent stage, for the degree of integration.

Table 3. Degree of total connection (*DTC*) for γ = 1, γ = 0.5 and γ = 0.2, individual countries, 1967-2004 (%)

	DTC_i (γ = 1)			DTC_i (γ = 0.5)			DTC_i (γ = 0.2)		
	1967	**1985**	**2004**	**1967**	**1985**	**2004**	**1967**	**1985**	**2004**
Albania	NA	21.88	13.95	NA	54.79	34.67	NA	79.80	68.83
Algeria	20.70	66.84	75.53	42.13	76.34	84.80	68.49	85.16	90.61
Argentina	54.85	70.92	52.27	74.59	86.84	80.63	82.87	91.10	91.81
Australia	59.69	60.07	62.90	79.18	86.50	84.64	86.79	94.92	93.74
Austria	35.95	32.43	43.58	58.22	56.57	63.17	75.69	77.79	81.40
BLEU	41.42	38.94	48.38	58.62	59.90	66.97	74.90	78.51	82.80
Brazil	91.61	97.61	88.30	89.92	96.35	92.65	88.07	94.16	93.88
Brunei Darussalam	0.40	29.07	47.83	21.59	64.99	73.47	60.84	90.13	92.16
Bulgaria	25.70	32.63	39.31	55.16	60.95	61.93	75.31	80.48	81.44
Canada	95.67	93.93	88.36	95.61	95.20	90.35	94.49	96.58	94.26
Chile	63.30	85.86	84.55	77.87	92.97	93.16	83.99	93.35	94.69
China, People's Rep.	15.13	71.46	81.32	59.59	90.24	90.32	82.19	95.60	93.89
Colombia	92.72	93.78	87.28	92.84	94.03	91.35	90.84	93.20	94.66
Czechoslovakia (former)	30.08	24.18	32.60	59.94	52.66	53.51	77.46	76.90	76.79
Denmark	41.04	53.16	49.33	61.37	70.37	70.34	77.03	83.25	85.01
Ecuador	86.75	89.66	88.31	91.20	93.11	92.48	91.72	95.65	95.08
Egypt	38.19	28.80	58.88	65.99	61.04	77.64	82.72	81.92	88.21
Finland	44.92	38.01	50.25	65.13	63.72	71.06	79.07	82.08	85.47
France	41.61	52.05	54.90	61.18	68.99	71.46	76.40	82.37	84.64
Gabon	27.99	70.40	88.89	48.25	81.54	92.76	71.53	89.02	95.10
Germany	54.24	58.16	62.58	69.07	72.66	75.66	79.54	83.77	86.06
Greece	66.22	46.84	48.77	74.07	64.67	67.42	81.43	80.53	83.23
Hong Kong	92.50	93.99	70.51	92.56	95.94	84.35	91.23	95.65	91.72
Hungary	24.37	38.69	35.33	53.61	60.69	56.53	74.62	79.49	78.31
Iceland	66.22	83.44	52.83	75.08	86.59	70.86	82.35	89.29	84.83
India	71.08	86.96	87.87	84.35	93.44	91.62	88.36	93.92	93.19
Indonesia	44.29	66.36	75.12	69.85	86.14	87.67	85.41	95.61	93.57
Ireland	26.86	40.33	78.03	46.70	62.76	84.36	70.90	80.66	89.55
Israel	77.94	94.86	91.54	81.91	94.53	94.03	84.50	93.33	94.50
Italy	58.59	62.92	62.05	70.41	74.59	75.17	79.93	84.42	85.93
Japan	94.72	96.68	82.25	94.92	97.49	89.00	93.00	96.58	93.35
Malaysia	64.75	62.28	75.74	81.50	86.12	86.56	88.17	94.42	92.80
Mexico	95.04	94.38	87.01	95.49	95.69	89.20	95.17	96.50	93.65
Morocco	28.64	29.57	32.74	53.05	59.17	57.71	74.16	80.14	80.69
Netherlands	33.61	33.66	42.19	55.75	56.34	63.31	74.03	77.09	81.42
New Zealand	44.73	69.97	67.55	64.52	88.04	85.55	80.03	93.84	93.69
Nigeria	37.97	78.56	89.22	60.03	82.97	93.79	76.27	87.64	95.18
Norway	43.85	35.25	53.02	63.35	59.77	72.71	77.80	79.43	85.61
Pakistan	70.57	76.82	93.06	82.50	90.46	94.08	86.59	92.85	93.87
Peru	90.33	98.05	92.11	92.09	98.07	94.64	90.77	95.88	94.98
Philippines	76.19	95.30	73.03	85.24	97.35	85.63	91.11	96.84	92.78
Poland	52.46	36.70	34.56	69.41	60.77	56.19	79.98	79.48	78.20

Table 3. Degree of total connection (*DTC*) for γ = 1, γ = 0.5 and γ = 0.2, individual countries, 1967-2004 (%)

	DTC_i (γ = 1)			DTC_i (γ = 0.5)			DTC_i (γ = 0.2)		
	1967	**1985**	**2004**	**1967**	**1985**	**2004**	**1967**	**1985**	**2004**
Portugal	54.00	51.82	42.14	69.71	67.42	62.25	80.41	81.36	81.19
Romania	28.41	73.34	37.31	54.50	81.25	59.91	74.63	87.49	80.33
Singapore	22.39	78.57	60.42	59.00	91.21	80.60	82.25	95.31	91.05
South Korea	84.26	96.62	73.42	89.50	97.36	86.03	92.30	96.70	92.69
Southafrican Union	60.36	76.08	76.66	76.69	87.26	88.56	84.08	90.95	92.47
Spain	74.36	60.25	43.42	79.90	74.19	65.65	83.69	84.51	82.86
Sweden	46.99	61.92	68.72	65.64	74.87	79.99	78.61	84.82	87.96
Switzerland	65.09	57.39	64.16	75.24	73.47	78.23	81.89	84.37	87.54
Taiwan	95.08	97.23	65.70	94.98	97.60	81.62	93.97	96.87	91.32
Thailand	52.24	87.37	86.32	76.00	93.48	91.88	86.96	94.49	94.51
Tunisia	27.88	23.42	27.65	51.52	53.15	50.47	73.36	77.15	76.33
Turkey	80.60	50.33	59.92	82.74	66.73	73.26	84.79	81.20	85.02
United Kingdom	76.27	71.69	77.25	82.35	79.52	83.77	84.86	86.26	89.12
United States	56.92	63.62	56.97	78.06	84.28	80.08	86.72	92.18	91.44
USSR (former)	34.45	30.07	24.42	65.38	58.87	53.89	81.09	79.60	80.22
Venezuela	92.41	94.85	82.96	92.43	95.43	89.44	92.31	95.35	94.05
Yugoslavia (former)	45.33	30.70	28.51	65.58	55.63	50.88	80.02	79.30	76.50
Mean	54.83	63.33	62.71	71.26	78.02	77.12	82.20	87.75	88.07
Standard deviation	24.96	24.41	20.84	15.59	15.02	14.17	7.14	6.88	6.37
Coefficient of variation	45.53	38.53	33.24	21.88	19.26	18.37	86.81	7.84	7.23

Table 3 reports information on the degree of connection for each country (DTC), while Table 4 reports the same information for all countries as a whole ($DGTC$). In both cases, the differences between the two indicators (DTC and $DGTC$) are remarkable, even when the number of indirect connections is assumed to be very low. Differences are far more important if the number of indirect connections increases, as shown by the estimation for $\gamma = 0.2$. This would imply that the full potential for indirect connections is remarkable: for a country in which the degree of direct connection with the rest of the world is high, the degree of total connection could also be high as a result of the itineraries offered by the world trade network.

The mean values for the degree of direct connection (DDC , or DTC for $\gamma = 1$) are higher than those for the degree of openness (DO), and they are especially high for some countries, many of which exhibit values of over 80%. When we consider the possible existence of indirect connections, the degree of connection increases noticeably. Table 4 reveals this effect for our set of economies: in 2004, the degree of

direct connection is 64.6%, whereas the degree of total connection is considerably higher (89.7%) for $\gamma = 0.2$.

Table 4. Degree of global total connection (*DGTC*) (%), 1967-2004

	DGTC (γ=1)	*DGTC* (γ=0.5)	*DGTC* (γ=0.2)
1967	57.86	75.55	84.55
1968	59.16	76.90	85.98
1969	58.45	75.95	84.93
1970	60.62	76.54	84.34
1971	59.59	76.39	85.05
1972	61.28	77.71	86.47
1973	64.01	79.03	86.85
1974	64.26	79.48	87.72
1975	62.73	78.58	87.01
1976	63.20	78.47	86.29
1977	62.91	78.50	86.75
1978	65.18	79.75	87.48
1979	65.54	79.95	87.47
1980	66.17	80.04	86.90
1981	66.76	80.93	88.29
1982	67.55	81.07	87.76
1983	66.92	80.89	87.98
1984	67.74	82.21	89.72
1985	67.36	82.25	90.01
1986	67.20	81.28	89.02
1987	68.26	81.46	88.83
1988	69.63	81.97	88.83
1989	70.44	82.50	89.12
1990	70.32	82.31	89.02
1991	69.66	81.13	87.43
1992	68.96	80.96	87.95
1993	67.24	79.89	88.01
1994	66.98	79.67	88.02
1995	67.13	79.54	87.87
1996	67.42	80.55	89.25
1997	66.82	80.62	89.44
1998	66.98	81.00	89.50
1999	67.14	80.96	89.29
2000	67.54	81.33	89.55
2001	67.48	81.83	90.20
2002	66.67	81.64	90.56
2003	65.47	80.62	89.98
2004	64.60	80.01	89.69

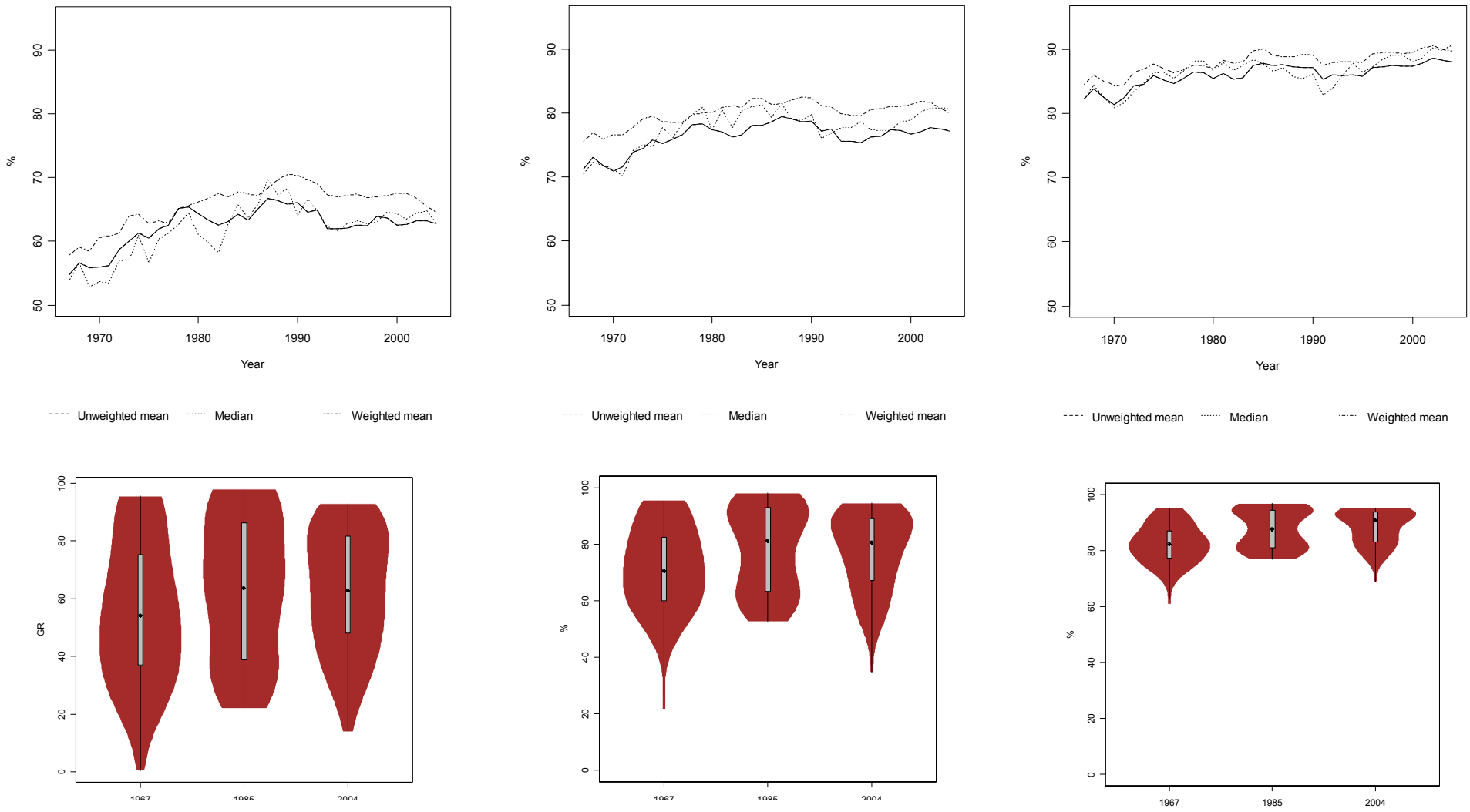
If we consider that γ is constant, the time trend for the degree of connection indicators is of moderate growth, i.e., countries widen their trade networks with the rest of the world, and attempt to balance them according to the size of their export markets. However, by weighing in not only time but also the number of transactions (γ)---by looking at Table 4 diagonally---we perceive a far larger increase, from 57.9% in 1967 (for $\gamma = 1$) to 89.7% by 2004 (for $\gamma = 0.2$). Although γ is difficult to measure and might vary greatly depending on the commodity considered, the evidence suggests that it has decreased substantially over the past forty years due to current trends in offshore outsourcing and delocalization. See, for instance, Feenstra (1998), Feenstra and Hanson (1996, 1999), or Grossman and Helpman (2005).

As a whole, dispersion in the degree of connection tends to diminish over time, in both absolute and relative terms. It is important to realize that when indirect connections are taken into account, and these increase in number, economies become much more similar in their degrees of total connection, as suggested by the sharp decline of dispersion indicators (Table 3).

Figure 3 shows that the values for the weighted degree of total connection ($DGTC$) are slightly higher than those corresponding to the unweighted mean. In contrast to what occurs with the degree of openness, large economies tend to connect with the rest in a more balanced way than smaller economies do. A further difference in the degree of openness is that now both the mean and the median are very close, suggesting that both tails of the distribution are not very important for the degree of connection. However, the violin plots in Figure 3 indicate that the distribution of the degree of connection shows a fairly stable dispersion over time, and it is bimodal. Therefore, there are two groups of economies with different degrees of connection: the first group is concentrated around high degree of connection values, higher than 80%, which is equivalent to being connected in a balanced way with all other countries; in contrast, the mode of the second group is located around lower values, close to 40%. For countries in the second group, what occurs to the indirect connections will be more relevant. It is also interesting to note that the second group has ostensibly been losing weight over time.

The degree of connection (DTC) also varies greatly among the largest economies (see Figure 4). Some examples of countries with high degrees of connection by 2004 are Canada, most Asian economies (China, South Korea, India, Japan), Brazil,

Figure 3. Degree of total connection (*DTC*), for γ = 1, γ = 0.5 and γ = 0.2, 1967-2004



γ = 1 **γ = 0.5** **γ = 0.2**

and Mexico. Some large economies also have low degrees of connection, among which we find several European countries such as the former USSR, the Netherlands, or Spain.

The general tendency for the degree of direct connection is to increase, yet not all countries follow the same pattern, and for some of them the balance in their external connections is declining, as they export only to specific trade partners. This is the case of Canada and, notably, of some European countries (Iceland, Spain, Greece, Portugal, former Yugoslavia, former Czechoslovakia, Poland, Romania), some Latin American countries (Argentina, Colombia), and some Asian countries (Thailand, Hong Kong). The decline in the degree of direct connection indicates that these countries trade more with economies whose weight in the exporter countries' exports is larger than that corresponding to the importing countries according to their share of world output. The list of countries showing this behavior enables us to establish a hypothesis, the testing of which would require an additional investigation, namely, that the current international economic integration processes in different parts of the world have an impact on the structure of trade connections. In the European case, the effect seems particularly strong, especially for most of the countries that joined the European Union in its various enlargements; in most of these cases, the value of the degree of direct connection not only declines, but is also low (below 0.5 in 2004), whereas the world average is higher and has also increased.

These ideas might partly explain why Spain or Netherlands have low degrees of connection. Appropriate answers could relate therefore to the existence of regional agreements with pernicious collateral effects, given that although trade intensity increases with members of the agreement, it may decline with respect to non-members. That would explain why in Spain, although the degree of openness has increased steadily throughout the sample period, the degree of total connection has been declining---suggesting that, although Spain exports more, it does not do it in a ``balanced'' way, i.e., it exports much more to countries whose share of the world economy is not proportional to the imports they receive from Spain, or to areas whose growth rates are relatively low.

Comparison of Figures 4, 5, and 6 show the relevance of indirect connections in increasing and homogenizing the degree of total connections between economies. For economies with low degrees of direct connection, indirect connections are more relevant, since they can considerably improve the degree of total connection. In addition, when we also consider the indirect itineraries, some economies that showed a

Figure 4. Degree of total connection (*DTC*) (γ = 1), selected countries, 1967-2004

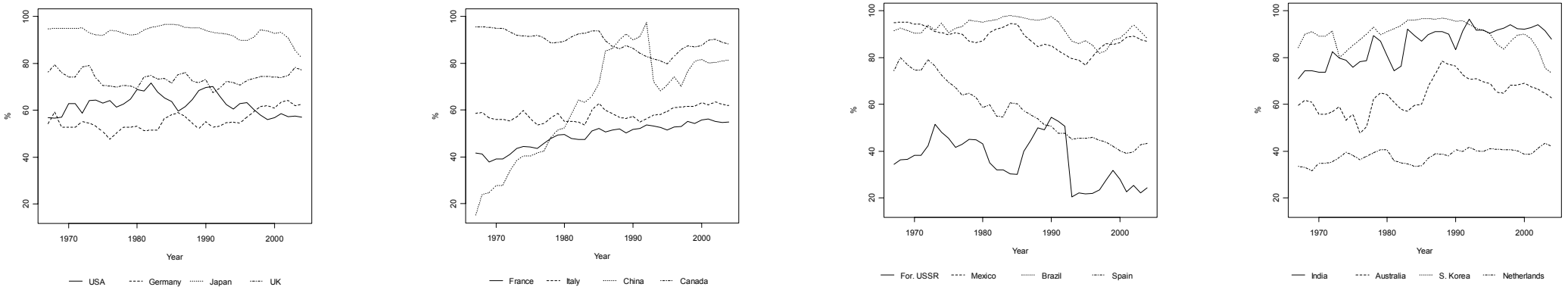


Figure 5. Degree of total connection (DTC_i) (γ = 0.5), selected countries, 1967-2004

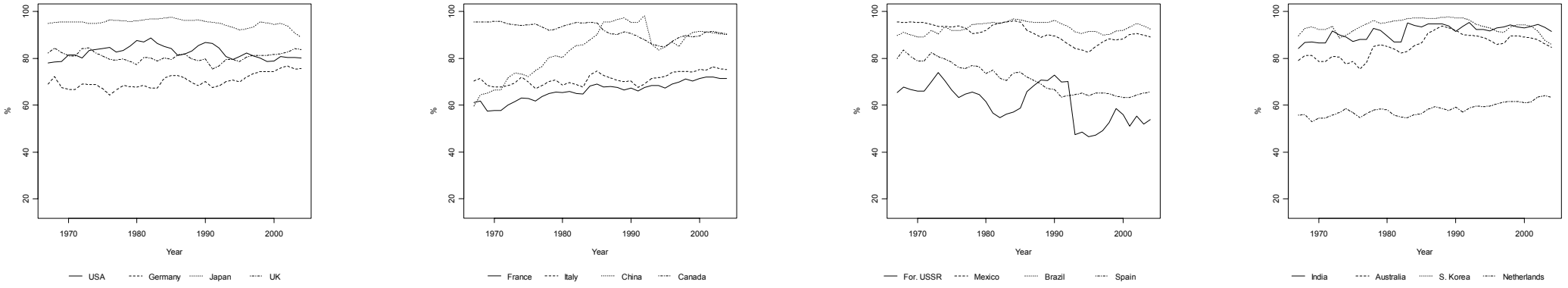
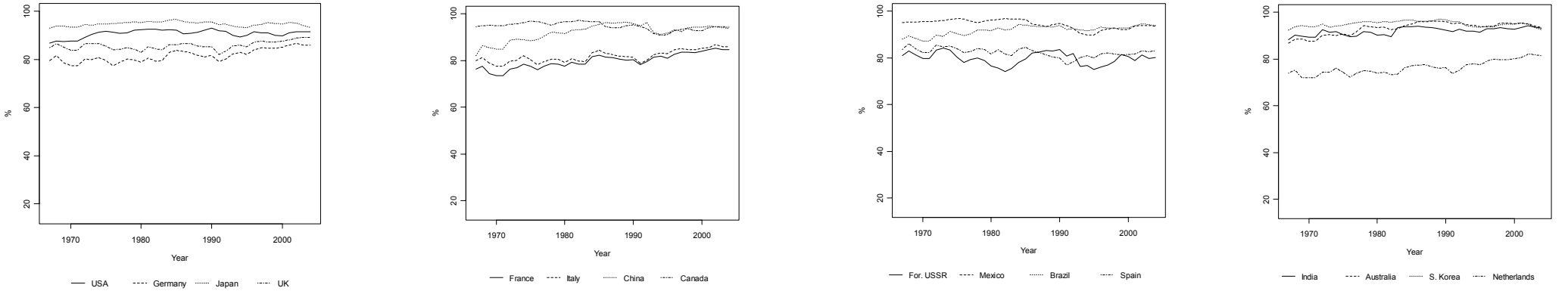


Figure 6. Degree of total connection (DTC_i) (γ = 0.2), selected countries, 1967-2004



tendency towards disconnection —such as Spain— now show a more stable evolution due to their strong links to economies that are much better connected to the rest.

3.4. Degree of integration

Integration indicators uncover the combined effect of openness and balance of connection, and are presented in Tables 5 and 6 and Figure 7.

In general, the degree of integration (DI) for all economies has increased, with few exceptions. When considering only direct connections, the average increased from 20.3% in 1967 to 34.5% by 2004 (see first column in Table 6). If we take into account indirect connections, the degree of integration also rises, although the increase is more modest (from 24.4% in 1967 to 40.9% in 2004, for $\gamma = 0.2$).

Figure 7 indicates that integration for large economies is lower, as shown by lower values for the weighted as compared to the unweighted mean. In addition, the progress of integration is slightly less intense among large economies, since the rate of growth of the weighted indicator is slightly lower.

The dispersion shown by the degrees of integration is remarkable, although it tends to diminish when the coefficient of variation is considered, which controls for the growing average effect. Integration for some countries is quite high, as revealed by the violin plots, which show that the most advanced countries have values over 60%, whereas for the most backward economies it hardly reaches 40%.

The degree of integration has also grown in most cases because of its driving factors: the degree of openness and the balance in the connection. The importance of each factor can be seen from Equation (14) and is shown in Table 7 and Figure 8. In general, the contribution of the degree of connection is larger, although its weight decreases over time, whereas the opposite holds for the degree of openness. In Table 7 we note that for nine very open countries, by 2004 openness surpasses the degree of connection, within the limits of the degree of integration.

Table 8 reports the relative positions for each country with respect to the global average for the three indicators (DI/DGI , DO/DGO and $DTC/DGTC$) and for year 2004. BLEU (Belgium and Luxembourg), Brunei Darussalam, Malaysia, Singapore and Thailand are placed in the top positions, while Albania, Egypt, Greece and the USA are at the lower end. In both extreme cases, the effect of the degree of openness is crucial,

Table 5. Degree of integration for individual countries (*DI*) (%), 1967-2004

	DI_i ($\gamma = 1$)			DI_i ($\gamma = 0.5$)			DI_i ($\gamma = 0.2$)		
	1967	**1985**	**2004**	**1967**	**1985**	**2004**	**1967**	**1985**	**2004**
Albania	NA	12.61	10.13	NA	19.95	15.97	NA	24.07	22.50
Algeria	20.07	38.15	55.29	28.63	40.77	58.58	36.51	43.06	60.56
Argentina	17.28	24.38	32.82	20.15	26.98	40.76	21.24	27.63	43.49
Australia	24.43	25.67	28.84	28.14	30.80	33.46	29.46	32.27	35.21
Austria	22.66	27.67	39.17	28.84	36.54	47.16	32.89	42.85	53.53
BLEU	37.01	47.77	62.99	44.03	59.25	74.11	49.77	67.83	82.40
Brazil	23.24	31.82	37.04	23.02	31.61	37.94	22.78	31.25	38.19
Brunei Darussalam	4.83	45.56	63.52	35.54	68.12	78.73	59.66	80.22	88.17
Bulgaria	8.67	9.80	38.87	12.70	13.40	48.79	14.84	15.40	55.95
Canada	39.56	47.70	54.10	39.55	48.02	54.70	39.32	48.37	55.87
Chile	26.51	42.63	52.40	29.41	44.36	55.01	30.54	44.45	55.46
China, People's Rep.	4.83	21.78	54.41	9.59	24.47	57.34	11.26	25.19	58.46
Colombia	26.90	28.99	37.92	26.92	29.03	38.80	26.63	28.90	39.49
Czechoslovakia (former)	11.81	12.94	45.59	16.67	19.09	58.41	18.95	23.07	69.98
Denmark	27.70	36.64	37.45	33.88	42.15	44.72	37.96	45.85	49.16
Ecuador	34.45	40.64	45.01	35.32	41.41	46.06	35.42	41.97	46.70
Egypt	19.07	16.76	21.12	25.07	24.40	24.26	28.07	28.27	25.86
Finland	26.32	30.27	39.70	31.69	39.19	47.21	34.92	44.48	51.78
France	19.00	29.87	33.61	23.04	34.39	38.34	25.75	37.58	41.73
Gabon	29.41	60.50	57.83	38.61	65.11	59.08	47.02	68.03	59.81
Germany	30.63	41.50	46.53	34.57	46.39	51.16	37.09	49.81	54.57
Greece	19.62	21.10	18.28	20.75	24.79	21.49	21.76	27.66	23.88
Hong Kong	60.45	65.10	28.83	60.47	65.77	31.53	60.03	65.67	32.88
Hungary	14.74	23.77	43.86	21.86	29.77	55.48	25.79	34.07	65.30
Iceland	34.40	53.05	38.57	36.62	54.04	44.67	38.36	54.87	48.88
India	13.64	18.05	28.56	14.85	18.71	29.16	15.20	18.75	29.41
Indonesia	25.48	37.79	46.19	31.99	43.05	49.90	35.38	45.36	51.55
Ireland	24.22	44.24	67.54	31.94	55.19	70.22	39.35	62.56	72.35
Israel	31.66	46.26	54.02	32.46	46.18	54.75	32.97	45.89	54.89
Italy	24.42	32.52	35.96	26.77	35.41	39.57	28.52	37.67	42.31
Japan	26.40	35.45	32.85	26.42	35.59	34.17	26.16	35.43	34.99
Malaysia	45.97	53.56	92.49	51.57	62.98	98.88	53.64	65.95	102.38
Mexico	20.07	36.83	49.64	20.12	37.09	50.26	20.09	37.24	51.50
Morocco	18.73	22.71	25.14	25.48	32.12	33.37	30.13	37.38	39.46
Netherlands	28.96	43.11	45.96	37.29	55.78	56.29	42.97	65.24	63.84
New Zealand	27.28	38.01	35.69	32.76	42.64	40.17	36.49	44.02	42.04
Nigeria	22.96	59.72	62.23	28.87	61.38	63.81	32.55	63.08	64.28
Norway	26.42	33.28	41.78	31.75	43.34	48.92	35.19	49.96	53.09
Pakistan	19.87	21.97	34.71	21.48	23.84	34.90	22.01	24.15	34.87
Peru	31.34	40.01	40.53	31.64	40.01	41.08	31.41	39.56	41.15
Philippines	27.69	39.59	61.25	29.29	40.01	66.32	30.28	39.91	69.03
Poland	15.56	14.68	32.73	17.90	18.89	41.74	19.21	21.60	49.23

Table 5. Degree of integration for individual countries (*DI*) (%), 1967-2004

	DI_i (γ = 1)			DI_i (γ = 0.5)			DI_i (γ = 0.2)		
	1967	**1985**	**2004**	**1967**	**1985**	**2004**	**1967**	**1985**	**2004**
Portugal	22.40	33.11	29.58	25.45	37.77	35.96	27.33	41.49	41.06
Romania	10.67	24.51	34.37	14.78	25.80	43.56	17.30	26.77	50.44
Singapore	29.13	77.53	74.73	47.29	83.53	86.32	55.84	85.39	91.74
South Korea	22.76	50.17	50.60	23.46	50.37	54.77	23.82	50.19	56.85
Southafrican Union	23.34	34.75	39.81	26.31	37.21	42.79	27.54	37.99	43.72
Spain	17.48	27.29	28.06	18.12	30.28	34.51	18.55	32.32	38.77
Sweden	27.26	41.58	49.39	32.22	45.72	53.29	35.26	48.67	55.88
Switzerland	35.58	38.55	45.61	38.25	43.62	50.37	39.91	46.74	53.28
Taiwan	39.93	67.77	59.34	39.91	67.90	66.14	39.70	67.65	69.96
Thailand	21.48	36.12	71.05	25.90	37.36	73.30	27.71	37.57	74.34
Tunisia	16.53	20.05	29.58	22.47	30.21	39.97	26.81	36.40	49.15
Turkey	15.90	19.60	31.89	16.11	22.57	35.27	16.31	24.90	37.99
United Kingdom	29.28	39.56	35.60	30.42	41.67	37.08	30.88	43.40	38.24
United States	17.28	21.49	21.79	20.23	24.73	25.84	21.33	25.87	27.61
USSR (former)	7.14	12.47	27.82	9.83	17.45	41.33	10.95	20.29	50.43
Venezuela	35.23	41.99	24.77	35.23	42.12	25.72	35.21	42.10	26.37
Yugoslavia (former)	21.64	28.03	28.75	26.03	37.74	38.40	28.75	45.06	47.09
Mean	24.26	35.07	42.27	28.44	39.46	47.49	31.05	42.02	51.00
Standard deviation	9.79	14.51	15.27	9.69	14.81	15.89	11.04	15.52	16.64
Coefficient of variation	40.36	41.36	36.13	34.05	37.53	33.45	35.56	36.93	32.62

and the ranking barely changes when indirect effects enter the analysis ($\gamma = 0.5$, $\gamma = 0.2$).

3.5. How do the different indicators relate?

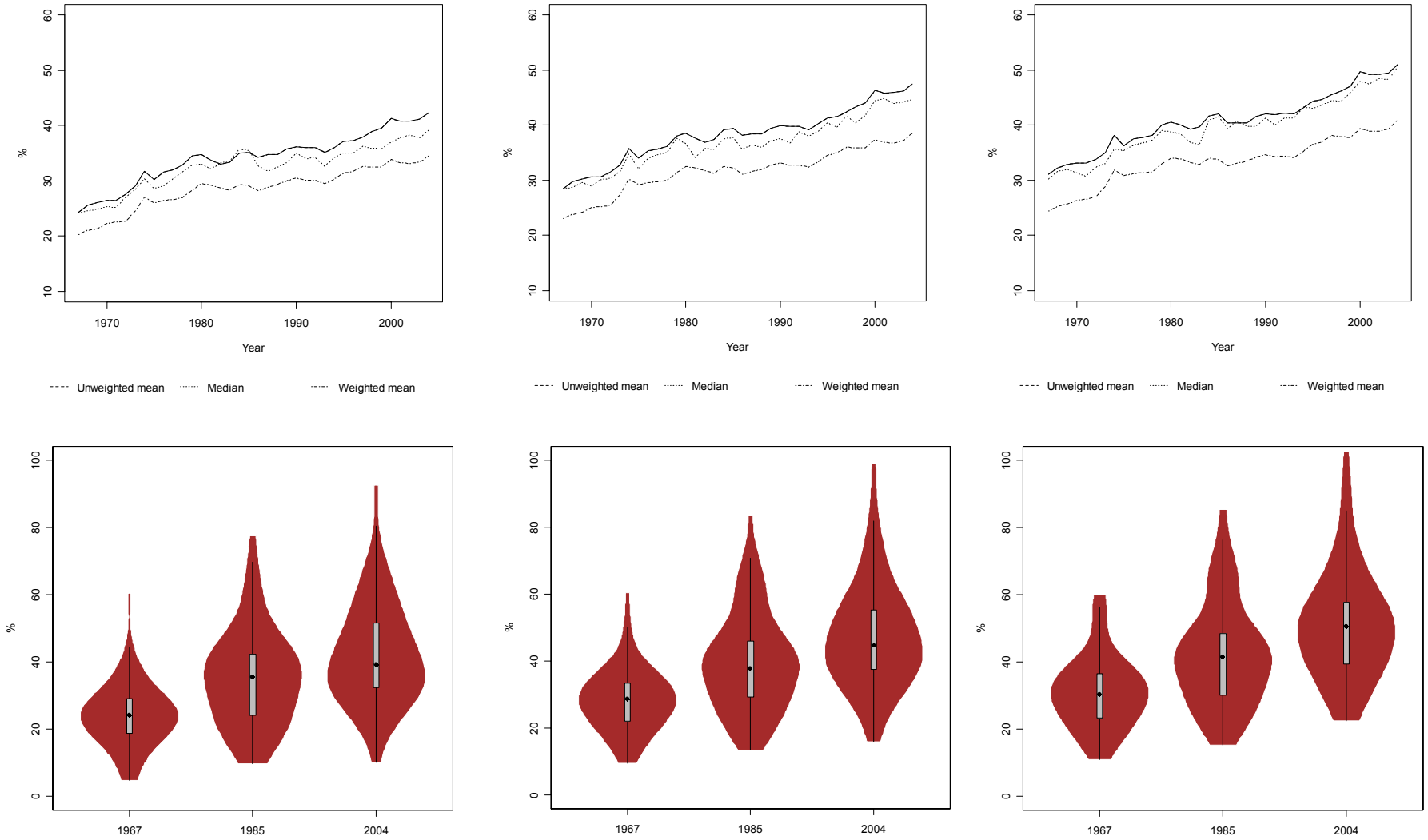
Table 9 presents Spearman correlation matrices between different indicators for the three selected years. Notable among these results is the low (negative) correlation between DO and DTC, regardless of its type ($\gamma = 1$, $\gamma = 0.5$, $\gamma = 0.2$), which shows their independence from each other.

In addition, Table 9 shows that the correlations between DO and DI are also high, indicating that the degree of openness is quite relevant in explaining the degree of integration distribution. The correlation between DO and $(X + M)/GDP$ is also high, as we might expect. Correlation between DO and $(X - M)/GDP$, or $(X - M)/(X + M)$ is also high, yet far less important than in the case mentioned above.

Table 6. Degree of integration (globalization degree) (*DGI*) (%), 1967-2004

	DGI ($\gamma = 1$)	*DGI* ($\gamma = 0.5$)	*DGI* ($\gamma = 0.2$)
1967	20.26	23.06	24.40
1968	20.98	23.81	25.18
1969	21.28	24.18	25.62
1970	22.30	25.04	26.37
1971	22.17	25.04	26.49
1972	22.67	25.49	26.97
1973	24.56	27.34	28.81
1974	27.07	30.19	31.87
1975	25.96	29.17	30.83
1976	26.47	29.65	31.26
1977	26.52	29.71	31.36
1978	26.94	29.91	31.46
1979	28.32	31.38	32.98
1980	29.45	32.48	34.00
1981	29.18	32.29	33.88
1982	28.76	31.71	33.19
1983	28.30	31.28	32.80
1984	29.39	32.46	34.04
1985	29.07	32.18	33.79
1986	28.20	31.08	32.64
1987	28.80	31.58	33.11
1988	29.35	32.03	33.52
1989	29.97	32.67	34.17
1990	30.43	33.13	34.67
1991	30.13	32.73	34.18
1992	30.09	32.79	34.36
1993	29.48	32.39	34.17
1994	30.32	33.36	35.27
1995	31.39	34.48	36.47
1996	31.78	35.01	37.06
1997	32.55	36.01	38.12
1998	32.43	35.86	37.86
1999	32.47	35.83	37.77
2000	33.88	37.38	39.37
2001	33.28	36.85	38.86
2002	33.14	36.79	38.88
2003	33.37	37.11	39.33
2004	34.52	38.48	40.87

Figure 7. Degree of integration (*DI*), 1967-2004



γ = 1 **γ = 0.5** **γ = 0.2**

Table 7. Degree of integration for individual countries (*DI*), and its decomposition into degree of openness (*DO*) and degree of total connection (*DTC*)[a] (%), 1967-2004

	$\sqrt{DTC_i / DI_i}\,(\gamma = 1)$			$\sqrt{DTC_i / DI_i}\,(\gamma = 0.5)$			$\sqrt{DTC_i / DI_i}\,(\gamma = 0.2)$		
	1967	**1985**	**2004**	**1967**	**1985**	**2004**	**1967**	**1985**	**2004**
Albania	NA	131.75	117.34	NA	165.73	147.34	NA	182.07	174.89
Algeria	101.56	132.37	116.88	121.30	136.84	120.31	136.97	140.63	122.32
Argentina	178.17	170.57	126.21	192.40	179.42	140.65	197.53	181.58	145.29
Australia	156.31	152.97	147.68	167.75	167.57	159.06	171.64	171.51	163.17
Austria	125.94	108.26	105.48	142.08	124.42	115.74	151.71	134.73	123.31
BLEU	105.79	90.28	87.64	115.38	100.55	95.07	122.68	107.58	100.24
Brazil	198.55	175.15	154.41	197.63	174.58	156.28	196.61	173.58	156.79
Brunei Darussalam	28.72	79.88	86.77	77.94	97.68	96.60	100.98	106.00	102.24
Bulgaria	172.19	182.43	100.56	208.41	213.27	112.66	225.29	228.62	120.64
Canada	155.50	140.33	127.80	155.48	140.80	128.52	155.02	141.31	129.89
Chile	154.51	141.92	127.02	162.73	144.77	130.14	165.84	144.92	130.67
China, People's Rep.	176.96	181.15	122.26	249.27	192.04	125.51	270.13	194.82	126.73
Colombia	185.66	179.87	151.71	185.71	179.98	153.45	184.71	179.59	154.82
Czechoslovakia (former)	159.62	136.72	84.56	189.64	166.08	95.71	202.20	182.58	104.76
Denmark	121.71	120.46	114.77	134.59	129.21	125.41	142.46	134.75	131.50
Ecuador	158.70	148.54	140.07	160.69	149.95	141.70	160.92	150.96	142.68
Egypt	141.52	131.07	166.96	162.25	158.16	178.91	171.67	170.23	184.71
Finland	130.64	112.06	112.50	143.35	127.51	122.68	150.48	135.84	128.48
France	147.99	132.00	127.81	162.96	141.64	136.51	172.26	148.05	142.42
Gabon	97.56	107.87	123.98	111.78	111.90	125.31	123.35	114.39	126.09
Germany	133.06	118.38	115.97	141.36	125.15	121.60	146.43	129.69	125.58
Greece	183.70	149.01	163.36	188.92	161.52	177.13	193.45	170.62	186.71
Hong Kong	123.70	120.16	156.39	123.72	120.78	163.56	123.28	120.68	167.02
Hungary	128.58	127.58	89.75	156.59	142.78	100.94	170.09	152.74	109.51
Iceland	138.76	125.42	117.03	143.18	126.58	125.95	146.53	127.56	131.74
India	228.32	219.52	175.40	238.30	223.50	177.24	241.08	223.79	178.00
Indonesia	131.85	132.52	127.53	147.76	141.45	132.55	155.37	145.19	134.73
Ireland	105.30	95.48	107.49	120.93	106.64	109.60	134.23	113.54	111.25
Israel	156.90	143.20	130.17	158.86	143.07	131.05	160.10	142.62	131.21
Italy	154.90	139.09	131.37	162.18	145.14	137.82	167.40	149.70	142.51
Japan	189.43	165.15	158.24	189.53	165.50	161.39	188.57	165.11	163.33
Malaysia	118.69	107.84	90.49	125.71	116.94	93.57	128.21	119.66	95.21
Mexico	217.60	160.08	132.39	217.86	160.63	133.22	217.68	160.97	134.85
Morocco	123.68	114.11	114.12	144.29	135.72	131.50	156.89	146.41	142.99
Netherlands	107.74	88.36	95.82	122.27	100.51	106.05	131.25	108.70	112.94
New Zealand	128.06	135.67	137.57	140.34	143.69	145.94	148.10	146.00	149.29
Nigeria	128.58	114.69	119.73	144.18	116.26	121.24	153.08	117.87	121.68
Norway	128.84	102.91	112.66	141.25	117.43	121.91	148.69	126.09	126.99
Pakistan	188.47	187.01	163.73	195.97	194.80	164.18	198.36	196.08	164.09
Peru	169.78	156.55	150.76	170.60	156.56	151.79	169.98	155.67	151.92

Table 7. Degree of integration for individual countries (*DI*), and its decomposition into degree of openness (*DO*) and degree of total connection (*DTC*)[a] (%), 1967-2004

	$\sqrt{DTC_i / DI_i}\,(\gamma = 1)$			$\sqrt{DTC_i / DI_i}\,(\gamma = 0.5)$			$\sqrt{DTC_i / DI_i}\,(\gamma = 0.2)$		
	1967	**1985**	**2004**	**1967**	**1985**	**2004**	**1967**	**1985**	**2004**
Philippines	165.88	155.15	109.20	170.60	155.98	113.63	173.46	155.78	115.93
Poland	183.62	158.12	102.76	196.94	179.36	116.03	204.04	191.81	126.02
Portugal	155.27	125.10	119.35	165.50	133.60	131.58	171.52	140.04	140.62
Romania	163.16	172.97	104.18	192.01	177.45	117.28	207.71	180.77	126.20
Singapore	87.66	100.67	89.91	111.69	104.49	96.63	121.37	105.65	99.62
South Korea	192.39	138.77	120.46	195.32	139.04	125.33	196.83	138.80	127.69
Southafrican Union	160.82	147.97	138.76	170.74	153.13	143.86	174.72	154.73	145.42
Spain	206.24	148.58	124.38	209.98	156.52	137.93	212.43	161.70	146.20
Sweden	131.28	122.03	117.96	142.72	127.97	122.52	149.31	132.02	125.46
Switzerland	135.25	122.01	118.60	140.25	129.78	124.62	143.25	134.35	128.18
Taiwan	154.30	119.78	105.22	154.26	119.89	111.09	153.85	119.66	114.25
Thailand	155.96	155.52	110.23	171.29	158.17	111.96	177.16	158.60	112.75
Tunisia	129.88	108.07	96.67	151.42	132.64	112.37	165.41	145.60	124.62
Turkey	225.13	160.24	137.07	226.61	171.94	144.13	228.00	180.59	149.59
United Kingdom	161.40	134.61	147.30	164.53	138.15	150.31	165.77	140.98	152.66
United States	181.51	172.06	161.68	196.42	184.59	176.05	201.65	188.77	181.98
USSR (former)	219.72	155.27	93.68	257.88	183.67	114.18	272.15	198.06	126.13
Venezuela	161.96	150.29	183.01	161.98	150.52	186.48	161.92	150.49	188.84
Yugoslavia (former)	144.72	104.64	99.59	158.73	121.41	115.11	166.82	132.66	127.46
Mean	151.72	137.46	123.94	164.72	146.87	131.64	171.18	151.75	136.49
Standard deviation	36.38	27.92	24.08	35.23	27.90	22.96	34.80	28.43	22.83
Coefficient variation	23.98	20.31	19.43	21.39	19.00	17.43	20.33	18.73	16.73

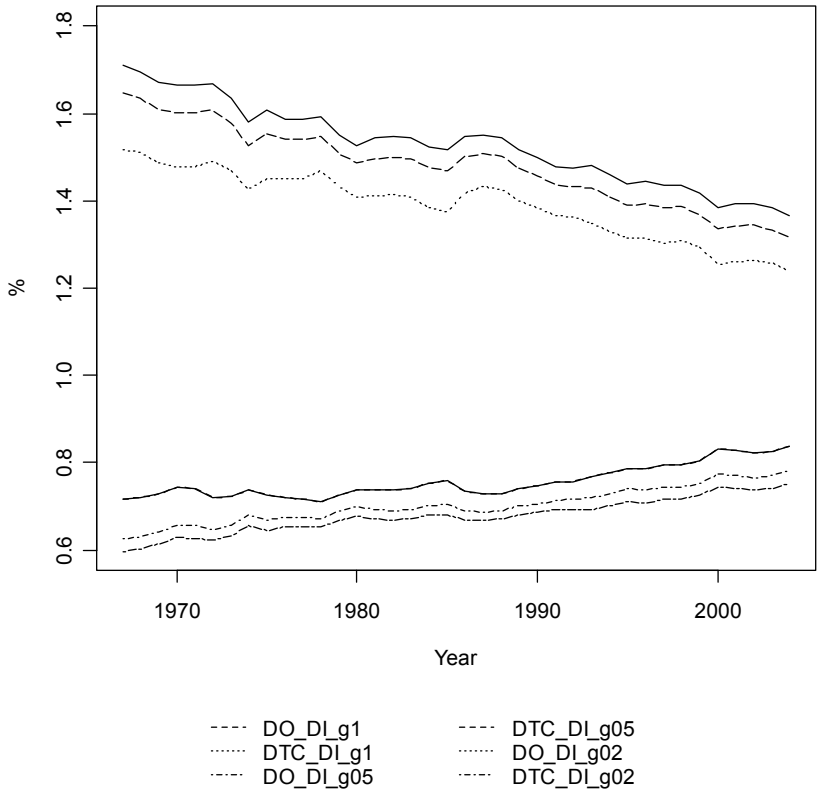
[a] Expresión $\sqrt{DTC_i / DI_i}$ is derived from the decomposition $1 = \sqrt{\frac{DO_i}{DI_i}}\sqrt{\frac{DTC_i}{DI_i}}$

The degree of connection (DTC) presents low correlations with the degree of integration, and is negative with $(X+M)/GDP$. In turn, its correlations both with the trade balance and the comparative advantage are positive and higher.

The degree of integration shows similar relatively high correlations with $(X+M)/GDP$, the trade balance ($(X-M)/GDP$), and the comparative advantage ($(X-M)/(X+M)$). The latter two indicators are also strongly correlated with each other, but not with the traditional degree of openness ($(X+M)/GDP$).

The featured indicators can be compared with each other, and with other traditional indicators of economy internationalization, such as the traditionally defined

Figure 8. Evolution of $\sqrt{DO_i / DI_i}$ vs. $\sqrt{DTC_i / DI_i}$ (means), 1967-2004



degree of openness (i.e., $(X+M)/GDP$), trade balance ($(X-M)/GDP$), and the comparative advantage index ($(X-M)/(X+M)$), to analyze their similarities and the ability of our indicators to contribute new yardsticks to interpret the evolution of integration.

More detailed information is reported in Table 10, which provides the distribution of DTC conditional on the distribution of DO. Specifically, we estimate conditional probability matrices for each value of γ.

This type of matrix involves dividing the space of indicators into different classes. The matrices track changes in the distribution of one indicator (say, DTC) as the other (say, DO) moves from one class to other. The class limits, or grid, are chosen in accordance with a certain criterion. We consider five classes each encompassing 20% of the values of an indicator, arranged in increasing order, i.e., class 1 covers lowest, and class 5 covers highest openness. The conditioned probability then uses an

Table 8. Degree of integration with respect to the degree of global integration (*DI/DGI*) and its decomposition[a], 2004

	DI_i/DGI			DO_i/DGO	$DTC_i/DGTC$		
	(γ=1)	(γ=0.5)	(γ=0.2)		(γ=1)	(γ=0.5)	(γ=0.2)
Albania	29.34	41.50	55.07	35.29	21.59	43.33	76.74
Algeria	160.14	152.23	148.18	194.09	116.92	106.00	101.02
Argentina	95.06	105.92	106.43	98.82	80.93	100.79	102.36
Australia	83.53	86.93	86.15	63.42	97.37	105.80	104.52
Austria	113.45	122.53	130.98	168.82	67.47	78.96	90.75
BLEU	182.44	192.56	201.63	393.26	74.90	83.71	92.32
Brazil	107.27	98.58	93.44	74.50	136.70	115.81	104.67
Brunei Darussalam	183.98	204.57	215.75	404.57	74.04	91.83	102.75
Bulgaria	112.59	126.79	136.91	184.37	60.85	77.41	90.80
Canada	156.69	142.14	136.72	158.84	136.78	112.93	105.10
Chile	151.78	142.94	135.70	155.77	130.89	116.45	105.57
China, People's Rep.	157.59	148.99	143.05	174.56	125.89	112.90	104.68
Colombia	109.85	100.81	96.64	79.02	135.12	114.18	105.54
Czechoslovakia (former)	132.06	151.79	171.23	305.80	50.47	66.89	85.62
Denmark	108.48	116.21	120.30	136.36	76.37	87.92	94.78
Ecuador	130.37	119.68	114.28	110.02	136.72	115.59	106.01
Egypt	61.19	63.03	63.27	36.34	91.16	97.04	98.35
Finland	115.00	122.68	126.70	150.44	77.80	88.81	95.29
France	97.35	99.64	102.12	98.68	85.00	89.32	94.37
Gabon	167.51	153.51	146.36	180.43	137.62	115.95	106.03
Germany	134.78	132.95	133.53	165.94	96.88	94.57	95.95
Greece	52.94	55.84	58.42	32.85	75.50	84.27	92.79
Hong Kong	83.50	81.93	80.45	56.52	109.16	105.43	102.26
Hungary	127.05	144.16	159.78	261.15	54.70	70.65	87.31
Iceland	111.73	116.07	119.60	135.06	81.79	88.56	94.57
India	82.73	75.78	71.97	44.52	136.03	114.52	103.90
Indonesia	133.79	129.66	126.15	136.21	116.30	109.58	104.33
Ireland	195.62	182.47	177.04	280.35	120.80	105.44	99.84
Israel	156.48	142.27	134.31	152.90	141.72	117.53	105.35
Italy	104.15	102.83	103.53	99.92	96.06	93.95	95.80
Japan	95.14	88.78	85.63	62.91	127.33	111.24	104.08
Malaysia	267.91	256.93	250.51	541.68	117.26	108.20	103.46
Mexico	143.78	130.61	126.02	135.83	134.70	111.50	104.42
Morocco	72.81	86.72	96.56	92.56	50.68	72.13	89.96
Netherlands	133.11	146.28	156.21	240.05	65.32	79.14	90.78
New Zealand	103.38	104.38	102.86	90.46	104.57	106.93	104.46
Nigeria	180.26	165.81	157.29	208.20	138.12	117.23	106.12
Norway	121.01	127.13	129.90	157.87	82.09	90.89	95.45
Pakistan	100.55	90.69	85.31	62.10	144.06	117.59	104.66
Peru	117.38	106.75	100.70	85.51	142.59	118.30	105.90
Philippines	177.40	172.33	168.92	246.33	113.06	107.03	103.44
Poland	94.81	108.45	120.48	148.67	53.51	70.23	87.18

Table 8. Degree of integration with respect to the degree of global integration (*DI/DGI*) and its decomposition[a], 2004

	DI_i/DGI			DO_i/DGO	$DTC_i/DGTC$		
	(γ=1)	(γ=0.5)	(γ=0.2)		(γ=1)	(γ=0.5)	(γ=0.2)
Portugal	85.68	93.43	100.48	99.60	65.23	77.81	90.52
Romania	99.57	113.19	123.42	151.89	57.76	74.89	89.57
Singapore	216.47	224.30	224.49	443.34	93.53	100.75	101.51
South Korea	146.56	142.32	139.12	167.24	113.67	107.53	103.35
Southafrican Union	115.32	111.19	106.99	99.16	118.68	110.69	103.09
Spain	81.29	89.67	94.87	86.99	67.22	82.05	92.39
Sweden	143.06	138.46	136.74	170.25	106.38	99.98	98.07
Switzerland	132.12	130.88	130.37	155.53	99.33	97.78	97.59
Taiwan	171.88	171.86	171.19	257.04	101.71	102.02	101.82
Thailand	205.79	190.47	181.91	280.45	133.64	114.85	105.37
Tunisia	85.68	103.85	120.27	151.79	42.80	63.08	85.10
Turkey	92.38	91.64	92.96	81.42	92.76	91.57	94.79
United Kingdom	103.13	96.34	93.57	78.70	119.59	104.71	99.36
United States	63.12	67.14	67.56	39.98	88.19	100.09	101.94
USSR (former)	80.59	107.40	123.40	152.04	37.81	67.35	89.44
Venezuela	71.75	66.83	64.53	35.47	128.44	111.79	104.86
Yugoslavia (former)	83.26	99.78	115.22	139.00	44.14	63.60	85.29
Mean	122.43	123.40	124.80	156.46	97.08	96.39	98.19
Standard deviation	44.23	41.28	40.71	104.11	32.27	17.71	7.10
Coefficient variation	23.98	20.31	19.43	66.54	33.24	18.37	7.23

[a] Despite the correct relationship among the magnitudes in the table is $DI_i / DGI = \sqrt{DO_i / DGO}\sqrt{DTC_i / DGTC}$, where $DGI = \sqrt{DGO}\sqrt{DGTC}$, we have decided to present the above expressions so as to ease interpretations. In addition, the DI_i / DGI ratio has been computed according to the simplest expression for DGI, i.e., $DGI = \sum_{i=1}^{N} a_i DI_i$.

Table 9. Spearman correlation matrices among the different indicadtors, 1967, 1985 and 2004

	Year 1967									
	DO	***DTC(γ=1)***	***DTC(γ=0.5)***	***DTC(γ=0.2)***	***DI(γ=1)***	***DI(γ=0.5)***	***DI(γ=0.2)***	***(X+M)/GDP***	***(X-M)/GDP***	***(X-M)/(X+M)***
DO	1.0000	-0.0843	-0.1610	-0.1727	0.7290	0.9444	0.9905	0.9575	0.0784	0.2698
DTC(γ=1)		1.0000	0.9710	0.8787	0.4926	0.1706	0.0058	-0.1173	0.0326	0.0097
DTC(γ=0.5)			1.0000	0.9591	0.4259	0.1068	-0.0603	-0.2001	0.0431	-0.0007
DTC(γ=0.2)				1.0000	0.3823	0.0935	-0.0651	-0.2039	0.0421	-0.0188
DI(γ=1)					1.0000	0.8843	0.7851	0.6628	0.1067	0.2367
DI(γ=0.5)						1.0000	0.9746	0.8850	0.1478	0.3125
DI(γ=0.2)							1.0000	0.9403	0.1043	0.2875
(X+M)/GDP								1.0000	-0.1408	0.0402
(X-M)/GDP									1.0000	0.9492
(X-M)/(X+M)										1.0000
	Year 1985									
	DO	*DTC(γ=1)*	*DTC(γ=0.5)*	*DTC(γ=0.2)*	*DI(γ=1)*	*DI(γ=0.5)*	*DI(γ=0.2)*	*(X+M)/GDP*	*(X-M)/GDP*	*(X-M)/(X+M)*
DO	1.0000	0.0528	0.0104	0.0463	0.8602	0.9528	0.9881	0.9595	0.3394	0.4106
DTC(γ=1)		1.0000	0.9700	0.8807	0.5062	0.2971	0.1634	-0.0603	0.3027	0.3409
DTC(γ=0.5)			1.0000	0.9545	0.4649	0.2690	0.1307	-0.0951	0.2754	0.3029
DTC(γ=0.2)				1.0000	0.4669	0.3012	0.1681	-0.0738	0.3233	0.3362
DI(γ=1)					1.0000	0.9641	0.9127	0.7680	0.4723	0.5355
DI(γ=0.5)						1.0000	0.9827	0.8791	0.4419	0.5044
DI(γ=0.2)							1.0000	0.9331	0.3850	0.4521
(X+M)/GDP								1.0000	0.1213	0.1952
(X-M)/GDP									1.0000	0.9539
(X-M)/(X+M)										1.0000

Table 9. Spearman correlation matrices among the different indicadtors, 1967, 1985 and 2004

	Year 2004									
	DO	*DTC(γ=1)*	*DTC(γ=0.5)*	*DTC(γ=0.2)*	*DI(γ=1)*	*DI(γ=0.5)*	*DI(γ=0.2)*	*(X+M)/GDP*	*(X-M)/GDP*	*(X-M)/(X+M)*
DO	1.0000	-0.0834	-0.0833	-0.0626	0.8393	0.9525	0.9901	0.8482	0.5598	0.5369
DTC(γ=1)		1.0000	0.9778	0.9265	0.4056	0.1569	0.0092	-0.3023	0.4391	0.4392
DTC(γ=0.5)			1.0000	0.9728	0.3981	0.1633	0.0146	-0.3161	0.4601	0.4641
DTC(γ=0.2)				1.0000	0.3979	0.1796	0.0358	-0.3024	0.4718	0.4726
DI(γ=1)					1.0000	0.9517	0.8916	0.5969	0.7259	0.7006
DI(γ=0.5)						1.0000	0.9815	0.7458	0.6823	0.6566
DI(γ=0.2)							1.0000	0.8177	0.6143	0.5966
(X+M)/GDP								1.0000	0.1748	0.1732
(X-M)/GDP									1.0000	0.9567
(X-M)/(X+M)										1.0000

Table 10. Relative positions between degree of openness (*DO*) and the degree of total connection (*DTC*), 1967-2004

		Upper limit *DTC*					
		0,403	0,542	0,692	0,878	0,983	(Number)
Upper limit *DO*:	0,089	0,23	0,20	0,24	0,16	0,16	(449)
	0,151	0,16	0,17	0,22	0,19	0,27	(448)
	0,210	0,16	0,23	0,17	0,22	0,21	(448)
	0,311	0,22	0,21	0,23	0,17	0,17	(448)
	1,129	0,23	0,19	0,13	0,27	0,18	(449)
		a) γ=1					
		Upper limit *DTC*					
		0,617	0,714	0,837	0,918	0,984	(Number)
Upper limit *DO*:	0,089	0,18	0,25	0,24	0,16	0,17	(449)
	0,151	0,15	0,20	0,17	0,21	0,27	(448)
	0,210	0,18	0,23	0,19	0,19	0,21	(448)
	0,311	0,22	0,22	0,21	0,18	0,17	(448)
	1,129	0,27	0,10	0,19	0,26	0,18	(449)
		b) γ=0.5					
		Upper limit *DTC*					
		0,786	0,830	0,900	0,937	0,973	(Number)
Upper limit *DO*:	0,089	0,22	0,22	0,25	0,23	0,08	(449)
	0,151	0,17	0,18	0,17	0,26	0,23	(448)
	0,210	0,20	0,24	0,18	0,15	0,23	(448)
	0,311	0,19	0,25	0,23	0,11	0,22	(448)
	1,129	0,22	0,12	0,18	0,25	0,24	(449)
		c) γ=0.2					

unweighted average of observed frequencies to estimate the probability that a country in one class according to DO will be in another class according to DTC.[12] Hence, we have evidence on the different paths followed by different countries to achieve a certain degree of integration (DI), i.e., it might be due to either higher openness, or to a higher degree of connection, or to a combination of the two in similar proportions, etc.: the possible combinations are multiple.

[12] Put another way, entry l in each row k, p_{kl}, represents the probability that a country in class k according to DO will be in state l according to DTC_i. They are computed as $p_{kl} = N_{kl}/N_k$, where N_{kl} is the number of countries in class k and l for DO and DTC_i respectively, and N_k is the total number of countries in class k.

Results are shown in Tables 10.a, 10.b and 10.c. Given γ, if there is no difference in the values of any two rows we can conclude that the indicators DO and DTC are independent, i.e., a country's degree of openness does not give us any knowledge about its degree of connection and *vice versa*, as can be seen in reality. Moreover, each value in a fixed row is close to 20%. Given a class of DO it is equally likely to belong to any class of DTC. This is because the independence between these indicators as well as between classes. For instance, the upper-left cell in Table 10.a indicates that the 20% least open countries, with $DO_i < 0.089$, have a 0.23 probability of having a low degree of connection, $DTC_i < 0.403$, but in fact, the probability of their having a medium or a high degree of connection is 0.24 and 0.16 respectively, all probabilities lying close to 0.20.

These tendencies are similar for all γ, i.e., the general tendency is for any class of DO to have an equal probability of belonging to each class of DTC. Finally, the last column in Tables 10.a, 10.b and 10.c shows the number of country-year pairs in each DO class. For instance, the first row indicates that there were 449 country-year pairs with $DO_i < 0.089$.

Apart from the relations between our basic indicators of interest, we can also analyze how they relate to different country groupings. In particular, we find that it is difficult to identify any sort of clear association between the average values of the two dimensions of integration according to geographical areas (Table 11), according to economy size (GDP) (Table 12), or according to per capita GDP (Table 13), although this classification reveals distinctive features for some of the indicators. In particular, we note how the Eastern European economies stand out for their high levels of openness, but low levels of connectedness, whereas those in South and Southeast Asia excel in both variables. We can also point to low openness in North America, Australasia, and South America, although for this case DTC is the highest indicator. The highest DI levels are found in Asia (South and Southeast), whereas North America ranks lowest.

The impact of both economy size and per capita GDP on degree of openness presents an inverted-U shape, with the highest levels corresponding to intermediate stages. From this perspective, we do not note any particular pattern for either DTC or DI.

Table 11. Degree of openness, degree of total connection and degree of integration, weighted means, country groups according to geography, 2004

Region	*DO*	*DTC*			*DI*		
		(γ=1)	(γ=0.5)	(γ=0.2)	(γ=1)	(γ=0.5)	(γ=0.2)
Western Europe[a]	27.80	59.85	74.21	85.67	39.41	44.16	47.56
Eastern Europe[b]	32.64	37.68	60.02	81.05	33.24	43.14	50.52
North America[c]	11.12	60.73	81.28	91.75	25.51	29.14	30.84
South Americad[d]	17.26	82.73	90.76	93.85	37.06	39.04	39.72
Africa[e]	25.76	68.46	81.80	89.82	40.80	44.62	46.76
Asia (South and Southeastern)[f]	34.94	82.05	89.56	93.22	46.89	49.70	51.05
Asia (Eastern)[g]	21.82	80.29	88.60	93.29	40.16	42.35	43.50
Australasia[h]	13.98	63.52	84.76	93.74	29.76	34.35	36.12

[a] France, BLEU, Germany, Italy, Netherlands, United Kingdom, Ireland, Denmark, Finland, Norway, Sweden, Iceland, Austria, Switzerland, Spain, Greece, Portugal.

[b] Former Yugoslavia, Former USSR, Bulgaria, Former Czechoslovakia, Hungary, Poland, Romania, Albania, Turkey, Israel.

[c] United States, Canada, Mexico.

[d] Venezuela, Ecuador, Brazil, Argentina, Chile, Colombia, Peru.

[e] Southafrican Union, Algeria, Morocco, Tunisia, Egypt, Nigeria, Gabon.

[f] Indonesia, Singapore, Malaysia, Philippines, Thailand, Brunei Darussalam, India, Pakistan.

[g] Japan, South Korea, Hong Kong, Taiwan, China, People's Rep.

[h] Australia, New Zealand.

Table 12. Degree of openness, degree of total connection and degree of integration, weighted means, country groups according to GDP, 2004

Group	*DO*	*DTC*			*DI*		
		(γ=1)	(γ=0.5)	(γ=0.2)	(γ=1)	(γ=0.5)	(γ=0.2)
Group 1[a]	17.18	64.92	80.60	90.08	32.02	35.62	37.69
Group 2[b]	33.97	63.77	78.04	88.32	43.75	49.04	52.59
Group 3[c]	31.22	60.77	76.30	87.52	41.46	46.64	50.09
Group 4[d]	43.66	66.64	79.85	89.49	48.95	54.57	58.19
Group 5[e]	24.91	64.53	77.91	88.45	37.87	42.11	45.04

[a] United States, Japan, Germany, United Kingdom, France, Italy, China (People's Rep.), Canada, Spain, Former USSR, South Korea, India.

[b] Mexico, Australia, Netherlands, Brazil, BLEU, Switzerland, Sweden, Turkey, Taiwan, Austria, Norway, Denmark.

[c] Poland, Indonesia, Greece, Southafrican Union, Finland, Ireland, Thailand, Hong Kong, Portugal, Argentina, Former Czechoslovakia, Israel.

[d] Malaysia, Venezuela, Singapore, Former Yugoslavia, Hungary, New Zealand, Colombia, Chile, Philippines, Algeria, Pakistan, Romania.

[e] Peru, Egypt, Nigeria, Morocco, Ecuador, Tunisia, Bulgaria, Iceland, Albania, Gabon, Brunei Darussalam.

Table 13. Degree of openness, degree of total connection and degree of integration, weighted means, country groups according to per capita GDP, 2004

Group	*DO*	*DTC*			*DI*		
		(γ=1)	(γ=0.5)	(γ=0.2)	(γ=1)	(γ=0.5)	(γ=0.2)
Group 1[a]	14.76	64.17	81.30	90.78	28.86	32.47	34.40
Group 2[b]	25.69	61.60	76.00	86.98	39.19	43.46	46.44
Group 3[c]	37.54	66.29	78.58	88.81	47.83	52.64	56.18
Group 4[d]	26.86	57.48	74.47	87.51	36.00	42.77	47.09
Group 5[e]	27.91	81.33	89.53	93.33	45.87	48.31	49.37

[a] Norway, Switzerland, Ireland, Denmark, Iceland, United States, Sweden, Japan, United Kingdom, Austria, Netherlands, BLEU.

[b] Finland, France, Germany, Australia, Canada, Italy, Hong Kong, Spain, Singapore, New Zealand, Greece, Israel.

[c] Portugal, Brunei Darussalam, South Korea, Taiwan, Hungary, Former Czechoslovakia, Mexico, Poland, Chile, Malaysia, Gabon, Turkey.

[d] Former Yugoslavia, Venezuela, Argentina, Southafrican Union, Romania, Bulgaria, Brazil, Tunisia, Former USSR, Thailand, Algeria, Peru.

[e] Albania, Ecuador, Colombia, Morocco, China (People's Rep.), Philippines, Indonesia, Egypt, India, Nigeria, Pakistan.

4. Integration indicators: relevance of results

The correlations observed suggest that the new indicators provide relevant information to analyze the influence of integration on economies' international competitiveness. A thorough analysis of this issue goes beyond the scope of our study, but it is worth performing an initial analysis of the relations among the three degrees of integration indicators defined (DO, DTC, and DI), and the two indicators of international competitiveness considered (trade balance and comparative advantage, i.e., $(X-M)/GDP$ and $(X-M)/(X+M)$, respectively). To do this, we performed a regression analysis, the results of which are presented in Table 14.

Table 14. Regression results of trade balance and comparative advantage on degree of openness, degree of total connection and degree of integration, 1967-2004, 1967-1985 and 1986-2004

	(γ=1)											
	1967-2004				**1967-1985**				**1986-2004**			
	(1)		**(2)**		**(1)**		**(2)**		**(1)**		**(2)**	
Intercept	-0.0664***	-0.0575***	-0.1514***	-0.1629***	-0.0317**	-0.0442***	-0.1096***	-0.1220***	-0.1244**	-0.0750	0.1108	0.1868**
(s.e.)	(0.0143)	(0.0133)	(0.0262)	(0.0233)	(0.0136)	(0.0150)	(0.0342)	(0.0335)	(0.0544)	(0.0497)	(0.0864)	(0.0764)
OD	0.4396***	---	0.6253***	---	0.6342***	---	0.8244***	---	0.4592***	---	0.6740***	---
(s.e.)	(0.0159)	---	(0.0291)	---	(0.0198)	---	(0.0496)	---	(0.0234)	---	(0.0372)	---
DTC	0.1387***	---	0.1264***	---	0.0514***	---	0.0117	---	0.2945***	---	0.4707***	---
(s.e.)	(0.0135)	---	(0.0247)	---	(0.0135)	---	(0.0338)	---	(0.0287)	---	(0.0456)	---
DI	---	0.5184***	---	0.7901***	---	0.6146***	---	0.8798***	---	0.6758***	---	1.091***
(s.e.)	---	(0.0184)	---	(0.0322)	---	(0.0240)	---	(0.0536)	---	(0.0314)	---	(0.0482)
$\log(\frac{GDP}{POP})$	-0.0154***	-0.0157***	-0.0119***	-0.0171***	-0.0170	-0.0207***	-0.0128**	-0.0259***	-0.214***	-0.0212***	-0.0696***	-0.0712***
(s.e.)	(0.0018)	(0.0019)	(0.0033)	(0.0033)	(0.0021)	(0.0024)	(0.0052)	(0.0055)	(0.0058)	(0.0057)	(0.0091)	(0.0087)
R^2_{within}	0,3203	0,2768	0,2156	0,2336	0,5401	0,4118	0,2410	0,2293	0,3076	0,3072	0,3008	0,3454
F-statistic	341,94	416,72	199,49	331,98	413,44	369,95	111,78	157,21	156,80	234,99	151,84	279,67
#obs.	2.239	2.239	2.239	2.239	1.118	1.118	1.118	1.118	1.121	1.121	1.121	1.121

Table 14. Regression results of trade balance and comparative advantage on degree of openness, degree of total connection and degree of integration, 1967-2004, 1967-1985 and 1986-2004

	(γ=0.2)											
	1967-2004				1967-1985				1986-2004			
	(1)		(2)		(1)		(2)		(1)		(2)	
Intercept	-0.2081***	-0.0898***	-0.2842***	-0.2120***	-0.1494***	-0.1169***	-0.1500**	-0.2220***	-0.3888***	-0.0191	-0.5021***	0.2600***
(s.e.)	(0.0344)	(0.0138)	(0.0622)	(0.0231)	(0.0297)	(0.0139)	(0.0747)	(0.0307)	(0.0939)	(0.0534)	(0.1475)	(0.0809)
OD	0.4502***	---	0.6347***	---	0.6297***	---	0.8213***	---	0.4267***	---	0.6159***	---
(s.e.)	(0.0161)	---	(0.0291)	---	(0.0197)	---	(0.0496)	---	(0.0242)	---	(0.0380)	---
DTC	0.2800***	---	0.2603***	---	0.1982***	---	0.0660	---	0.6076***	---	1.1979***	---
(s.e.)	(0.0444)	---	(0.0802)	---	(0.0408)	---	(0.1027)	---	(0.0945)	---	(0.1485)	---
DI	---	0.4370***	---	0.7700***	---	0.7096***	---	1.1274***	---	0.4462***	---	0.7756***
(s.e.)	---	(0.0184)	---	(0.0309)	---	(0.0247)	---	(0.0547)	---	(0.0281)	---	(0.0425)
$\log(\frac{GDP}{POP})$	-0.0172***	-0.0118***	-0.0136***	-0.0165***	-0.0194***	-0.0208***	-0.0138**	-0.0321***	-0.0293***	-0.0213***	-0.0830***	-0.0723***
(s.e.)	(0.0019)	(0.0020)	(0.0035)	(0.0033)	(0.0022)	(0.0023)	(0.0055)	(0.0050)	(0.0059)	(0.0061)	(0.0093)	(0.0093)
R^2_{within}	0,3001	0,2158	0,2100	0,2393	0,5440	0,4643	0,2412	0,3097	0,2675	0,1956	0,2750	0,2608
F-statistic	311,21	299,64	192,88	342,65	419,92	458,13	111,91	237,10	128,88	128,89	133,89	187,02
#obs.	2.239	2.239	2.239	2.239	1.118	1.118	1.118	1.118	1.121	1.121	1.121	1.121

In light of the results achieved so far, we can now examine the impact of our indicators on the two variables that measure international competitiveness. We consider these two basic equations using a fixed effects panel data model for the periods 1967--2004, 1967--1985 and 1986--2004:

$$((X-M)/GDP)_{it} = \mathbf{X}_{it}\beta + c_i + \nu_{it} \tag{19}$$

and

$$((X-M)/(X+M))_{it} = \mathbf{X}_{it}\beta + c_i + \nu_{it} \tag{20}$$

Two separate sets of regressors are considered to estimate equations (19) and (20): the first considers the degree of openness, the degree of connection and the log of GDP divided by population, whereas the second set substitutes the degrees of openness and connection with the degree of integration. Although the ideal situation would be to have all three integration indicators in the same equation, the likely dependency between them advised us against that combination. Therefore, by combining the two equations outlined above with the two sets of regressors and the three periods considered, we estimate a total of twelve equations. In addition, we consider two alternative scenarios in accordance with the number of transactions considered (i.e., $\gamma = 1$ and $\gamma = 0.2$).

Results are displayed in Table 14, the panels of which report findings for $\gamma = 1$ (upper panel) and $\gamma = 0.2$ (lower panel). They suggest that the degree of openness (DO) impacts positively and significantly on both competitiveness indicators, although the impact is higher on the first period considered (1967--1985). The impact is also positive and significant for the degree of connection (DTC), except for the impact on comparative advantage on the 1967--1985 subperiod. However, the impact is much higher in the second period considered.

When the results of the two indicators are combined, we gain a better understanding of what drives the evolution of the degree of integration (DI). Again, the impact of the integration degree on the variables considered is always positive, and it is higher on the comparative advantage. The evolution shown by the degree of integration seems to have a greater impact on the two competitiveness indicators, i.e., the coefficients are higher for the 1986--2004 sub-period. Therefore, although the impact of the degree of openness seems to decline over time, it is sufficiently offset by the degree

of connection in such a way that the impact of the degree of integration on our competitiveness indicators increases.

Finally, the effect of per capita GDP (and probably production costs) is always negative, and also significant in virtually all instances. Therefore, the lower the per capita GDP in a given country, the higher its trade balance and its comparative advantage will be, as we might *a priori* expect.

We should also highlight the varying role of the degree of total connection (DTC), which depends heavily on the value of γ. A comparative analysis of the upper and lower panels in Table 14 reveals that its impact on the different variables considered doubles, and almost triples, in all instances---as shown by much larger coefficients. Again, the number of transactions, as measured by γ, turns out to be a key factor when assessing different issues on the degree of international economic integration achieved so far.

Therefore, this analysis could be regarded as temporary evidence that the progress made by economies in openness and integration contributes to increasing their competitiveness, especially for those whose lower per capita GDP provides them with a competitive advantage in costs.

5. Conclusions: is globalization advancing?

The aim of this study was to present international economic integration and globalization indicators that take into account both the growing degree of openness in economies and the development of direct and indirect network connections. To do this, we approached the characterization of the indicators and their properties from a network analysis perspective, and defined the distance separating each country's economy and the world economy from a Standard of Perfect International Integration. When we applied the indicator of integration presented to our set of countries, we obtained a measure of the level of globalization achieved. If integration reached the level of the Standard of Perfect International Integration, the relations between economic agents in different countries would not be biased or influenced by location, and we would have arrived at the stage known as the global village.

To illustrate its potential, we applied the proposed methodology to export flows, which provided us with some responses to the question of the distance that separates us from the situation of complete trade globalization. This distance is still considerable, since we have only reached the halfway point, yet the ground covered over the last forty years is quite remarkable, as it represents advances in international economic integration of more than 75% and, if we consider that the number of indirect connections has increased substantially over this period, this figure may be higher than 100%.

Results also indicate that differences between countries in this vein are notable, and leading positions may be observed for some, especially for some small European Union economies (Belgium and Luxembourg, Ireland) or Southeast Asia (Malaysia, Singapore, Thailand, or Brunei Darussalam), in which the total integration indicators are quite high, twice the average.

The methodology proposed therefore offers a starting point to assess the importance of the advance of globalization, and also the contribution made to it by the two components that either jointly constitute the integration process, or limit its scope, both for individual countries and for the world economy: the degree of openness (DO) and each economy's balance in the connections network with the other economies (DTC).

The results point firstly to the fact that domestic bias affecting trade (which limits the degree of openness) represents the highest limit to integration. Although its importance is declining, this hindrance is more important for large economies, which are proportionally much more closed than what might be justified by the size of their domestic markets. Due to the higher weight of large economies in the aggregate, the most relevant effect is that of the limits to openness on the globalization indicator.

Second, the effect of bias on trade among economies towards certain areas (which limits the direct connection balance) is, in general, more limited than the effect of the degree of openness. However, we have detected that some regional integration processes---especially in Europe---emphasize the orientation of many of its recent members' exports towards the internal market, to the detriment of developing more balanced trade networks with the rest of the regional world markets. Other forces are operating in this way to restrict the advance of globalization.

Third, the system of indicators suggested shows that the expansion of indirect trade —vigorously boosted by the reduction in transport costs and ITC development—

may well represent a relevant factor in increasing the degree of total connection for many economies and, as a result, their degree of integration. This factor is more relevant for economies that are less directly related to all the others, since they can be integrated in the world trade network through indirect connections. In the case of Europe, some southern economies may be reinforcing their integration through intense commercial relations with other European Union partners that have higher levels of total connection.

Finally, the patent heterogeneity of the degrees of openness and connection for different sized economies causes the globalization indicator to be affected by the lower degree of integration of some of the largest economies.

These results may lead us to pose other interesting questions. First, we may inquire into the likely causes for the differences between countries in terms of their degrees of integration, openness and connection. The literature on international economic integration has explored many factors, as pointed out in Section 1, but always under the assumption that openness and integration are one and the same thing. Once the role of the degree of connection has been introduced, we may reconsider the relevance of economy size, language, colonial or political relationships, currency, trade or tariff agreements, etc., and also other factors such as economic and technological development, specialization, or human capital endowments, reexamining their importance in relation to the degree of openness or connection, and their eventual impact on integration.

In addition, the analysis performed in this study suggests that the international economic integration indicators presented may be more useful than traditional indicators to study the international competitiveness of economies. According to the regression analysis performed, the advance of openness, connection and integration positively contribute to competitiveness, especially when the country's per capita GDP is lower. If these hypotheses were to be confirmed, we would have positive empirical evidence of the opportunities that globalization can offer emerging economies.

Finally, our study contemplated only some of the features of the trade network that are potentially relevant for integration, although there could be more. For instance, it may be of interest to analyze in greater depth whether integration and its effects are influenced by the central or peripheral position of countries with respect to all flows. It might also be important to analyze the existence of regional trade networks within the global network, with much more intense relationships in their interior, and their contribution to globalization. And it would clearly be worth exploring the role of

integration and international competitiveness on the dynamics of growth for different countries.

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Appendix

Propositions and proofs

Here we demonstrate that the series given in (6) and (7) are convergent, and provide an alternative way to compute them.

Proposition 1 *Given a matrix* $C = (c_{ij})$ *such that* $\sum_{j \in N} c_{ij} \leq 1$ *for all* $i \in N$ *we verify that*

i) The series $\sum_{n=1}^{\infty} \gamma (1-\gamma)^{n-1} C^n$ is convergent

ii) $C^{\gamma} = \sum_{n=1}^{\infty} \gamma (1-\gamma)^{n-1} C^n = \frac{\gamma}{1-\gamma} \left[I - (1-\gamma) C \right]^{-1} - I$, where I is the identity matrix of order g

iii) $0 \leq c_{ij}^{\gamma} \leq 1$

Proof. Let $\| \ \|_{\infty}$ be the matrix norm defined as $\|C\|_{\infty} = \max \{ |c_{ij}| : i, j \in N \}$. Clearly $\|C\|_{\infty} \leq 1$, which implies that $\|(1-\gamma)C\|_{\infty} \leq (1-\gamma)$ and the series $\sum_{n=1}^{\infty} \gamma (1-\gamma)^{n-1} C^n$ is convergent.

Moreover,

$$C^{\gamma} = \sum_{n \geq 1} \gamma (1-\gamma)^{n-1} C^n = \frac{\gamma}{1-\gamma} \left(\sum_{n \geq 0} \left[(1-\gamma) C \right]^n - I \right)$$
$$= \frac{\gamma}{1-\gamma} \left(\left[I - (1-\gamma) C \right]^{-1} - I \right).$$

To prove iii) we only need to recall that in general $0 \leq c_{ij}^n \leq 1$, hence $0 \leq \sum_{n \geq 1} \gamma (1-\gamma)^{n-1} c_{ij}^n \leq \sum_{n \geq 1} \gamma (1-\gamma)^{n-1} = 1$.

Next proposition follows from the basic limit theorem of Markov chains.

Proposition 2 *Given a matrix* $C = (c_{ij})$ *that is a recurrent irreducible aperiodic Markov chain we verify that*

i) $\lim_{n\to\infty} c_{ii}^n = \bar{c}_{ii}$ for all $i \in N$

ii) $\lim_{n\to\infty} c_{ji}^n = \lim_{n\to\infty} c_{ii}^n$ for all $i, j \in N$

iii) $\lim_{\gamma\to 0} \sum_{n=1}^{\infty} \gamma(1-\gamma)^{n-1} c_{ij}^n = \bar{c}_{jj}$.

Proof. i) and ii) are the results of the basic limit theorem of Markov chains. This states that at the limit, matrix C^n converges to matrix $\bar{C}$, which is also a Markov chain which verifies that all the elements of a column are equal: $\bar{c}_{ji} = \bar{c}_{ii}$ for all $i, j \in N$.

From i) and ii), given $\varepsilon > 0$, n_0 exists such that for all $n \geq n_0$ we verify that $| c_{ij}^n - \bar{c}_{jj} | < \varepsilon$ or equivalently

$$\bar{c}_{jj} - \varepsilon < c_{ij}^n < \bar{c}_{jj} + \varepsilon. \tag{21}$$

We also have

$$\begin{aligned}
\sum_{n=1}^{\infty} \gamma(1-\gamma)^{n-1} c_{ij}^n &= \sum_{n=1}^{n_0-1} \gamma(1-\gamma)^{n-1} c_{ij}^n + \sum_{n=n_0}^{\infty} \gamma(1-\gamma)^{n-1} c_{ij}^n \\
&\leq \sum_{n=1}^{n_0-1} \gamma(1-\gamma)^{n-1} c_{ij}^n + \sum_{n=n_0}^{\infty} \gamma(1-\gamma)^{n-1} (\bar{c}_{jj} + \varepsilon) \\
&= \sum_{n=1}^{n_0-1} \left[\gamma(1-\gamma)^{n-1} c_{ij}^n\right] + (\bar{c}_{jj} + \varepsilon)(1-\gamma)^{n_0-1}.
\end{aligned}$$

where the first inequality holds by (21) and the following equality results from applying the sum of a geometric series for the second series.

Taking limits, we have:

$$\lim_{\gamma\to 0}\sum_{n=1}^{\infty}\gamma(1-\gamma)^{n-1}c_{ij}^{n} \quad \leq \quad \lim_{\gamma\to 0}\left(\sum_{n=1}^{n_0-1}\left[\gamma(1-\gamma)^{n-1}c_{ij}^{n}\right]+(\bar{c}_{jj}+\varepsilon)(1-\gamma)^{n_0-1}\right)$$

$$= \quad \lim_{\gamma\to 0}\sum_{n=1}^{n_0-1}\left[\gamma(1-\gamma)^{n-1}c_{ij}^{n}\right]+\lim_{\gamma\to 0}(\bar{c}_{jj}+\varepsilon)(1-\gamma)^{n_0-1}$$

$$= \quad \bar{c}_{jj}+\varepsilon.$$

Repeating the argument, we find that

$$\lim_{\gamma\to 0}\sum_{n=1}^{\infty}\gamma(1-\gamma)^{n-1}c_{ij}^{n} \geq \bar{c}_{jj}-\varepsilon.$$

Therefore for any $\varepsilon > 0$ the following holds

$$\bar{c}_{jj}-\varepsilon \leq \lim_{\gamma\to 0}\sum_{n=1}^{\infty}\gamma(1-\gamma)^{n-1}c_{ij}^{n} \leq \bar{c}_{jj}+\varepsilon$$

which implies that $\lim_{\gamma\to 0}\sum_{n=1}^{\infty}\gamma(1-\gamma)^{n-1}c_{ij}^{n} = \bar{c}_{jj}$ and iii) is proved.