# Trade, (de)globalization and the distance puzzle

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***Abstract**: Talks of deglobalization after the global financial crisis of 2008–2009 intensified in recent years due to bilateral trade wars and the disruption of supply chains during the COVID-19 pandemic. Deglobalization is often associated to a shortening of the supply chains through reshoring and nearshoring, entailing smaller geographical distance travelled by traded goods. This paper proposes a new methodology to analyse the evolution of distance through time, while controlling for the effect of the geographical distribution of exporters and importers linked, inter alia, with the growing weight of large emerging countries in the world economy and the expansion of South-South trade. The new indicator, rooted in trade empirics, operational research and information theory, allows to isolate the endogenous effect of changes in the geographical distribution of supply and demand (a structural effect) to estimate changes in the appetite to trade with distant countries (the globalization effect). It also provides information on geographical diversification that is not captured through more traditional trade indicators. Taking into consideration the rise of Global Value Chains, the analysis is applied to both gross and value-added trade data for a selection of goods and services sectors between 1995 and 2020. We find that it is premature to conclude that global trade has been suffering a deglobalization trend, at least up to 2018. Nonetheless, the situation is heterogeneous between small and large countries and across sectors and regions.*

*Keywords: Entropy; non-parametric gravity; index number; structural decomposition; trade slowdown and nearshoring*

*JEL codes: C14, C43, C60, F14, F60*

**Contents:**



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TRADE, (DE)GLOBALIZATION AND THE DISTANCE PUZZLE

H. Escaith

# 1. Introduction

Globalization is often associated with an increase in the distance travelled by traded goods. This results from the geographical diversification of import and export markets, itself a consequence of lower trade costs. It was the case for the previous episodes of globalization (17th and 19th century), and also for the hyper-globalization phase which began in the late 1980s.

Geographic distance has historically played a key role in international trade. The effect of distance as a trade barrier has been extensively analysed since the 1950s (Eaton and Kortum, 2002). Trade between countries diminishes with distance: A transaction cannot occur without a contractual relationship, and the involved parties must overcome the distance between them. The large-scale reduction in the cost of travel that occurred over our sample period (Feyrer, 2019) had differentiated impacts, some bilateral partners benefit more from the reduction in the cost of air travel than others. Since modern Information and communication technologies (ICT) decrease the coordination and transaction costs in international commerce (Malone et al. 1987), trade flows should also have increased proportionally more for countries separated by large geographical distance, although this effect may vary between different trading partners.

The geographical broadening of trade is a topic that received special interest in the past. It is often associated with welfare gains, thanks mainly to market/varieties diversification and gains in efficiency. More recently, the larger distance travelled by traded goods has also been associated with a negative environmental effect, especially through the CO2 emitted by cargo ships and planes during international transit. After the global crisis of 2008-2009, distance travelled by trade goods has been used as one of the many indicators of globalization attempting at measuring the extent of a reversal in the post-1990 hyper-globalization trend. After the China-USA trade war of 2018-19, the COVID-19 pandemics and the Ukraine-Russia conflict, the contemporaneous discussion on globalization focuses on geo-political risks and GVC decoupling.

The diversification or, conversely, the concentration of global value chains (GVCs) are likely indicators of globalization or deglobalization. GVC decoupling is often associated to a shortening of the supply chains through reshoring and nearshoring. In case nearshoring, decoupling should entail shorter geographical distance travelled by internationally traded goods. It must not be always the case, as when decoupling means “de-risking” by diversifying the geographical source of critical inputs. In the latter case, we should not refer to “deglobalization” in the stricter sense, as it is just a reorganization of the supply chains to mitigate disruption risks without having an aversion to further geographical diversification.

Focusing on the extent of nearshoring, this paper looks at analysing the evolution of distance travelled by traded products through time. The issue is not as simple as it appears, because it does not depend only on monetary and non-monetary trade costs (which are reduced by technological progress but also by bilateral trade policies and other soft infrastructures such as better global governance). It depends also of the geographical distribution of supply and demand. For example, geographical distribution of imports for any given industry may entail a lower distance covered if new production capacity is created in a neighbouring country, even if there is no change in its aversion to globalization. This distribution has changed significantly since the late 1980s, with the fragmentation of industrial production through global value chains. In the process, new players emerged in the 1990s, some of them becoming dominant traders either at regional or global levels. Developing countries have been an increasing source of demand for imports as well as exporters of differentiated industrial products (Horner and Nadvi, 2018). South-South trade has increased, in particular within the same geographical region. It is something to take into account in the discussion: a more poly-centric world is not necessarily a less globalised one.

After reviewing the current literature, the paper proposes a new indicator rooted in trade empirics, operational research and information theory to control for the multiplication of import and export markets and their increasing geographical diversification. The methodology is applied to bilateral trade flows for selected sectors of activity between 1995 and 2020, differentiating between physical and value-added trade flows. An annex relates our measure of globalization with more traditional diversification indicators and look at regional patterns. These results are then synthetised in view of the deglobalization debate; a conclusion highlights some of the limitations and potentials of the new methodology.

## 2. Positioning the problem

"Globalization is in retreat for the first time since World War II" asserts Irwin (2020). This comes after a long period of trade liberalization after the end of the Cold War until the financial crisis of 2008, when economic integration through trade and investment rose to a historically unprecedented global scale. Irwin builds his diagnostic on the evolution of the Trade/GDP ratio (the sum of imports and exports divided by World GDP in current USD). After reaching a maximum of 61.1, the indicators fell to 54.4 in 2016, to reach a new low with the COVID-19 pandemics (51.6) in 2020. The increase in the trade/GDP indicator in often credited to the rise of global value chains (GVC), particularly during the 1995-2005 period. GVC trade results from the geographical fragmentation across several countries of the production of a product through international outsourcing and offshoring. The international fragmentation of production processes, called "vertical integration", acts as a "trade magnifier" (Escaith, Lindenberg and Miroudot, 2010). Trade is inflated because intermediate products originating from different suppliers are being exported to contractors in other countries to be further transformed, leading to double-counting bias. [1] This chain of imports-transformation-exports of intermediate parts and components continues until their assembly as final goods, themselves exported to their markets of final destination. The trade magnifier effect was augmented during 1995–2005 by a shift in global demand towards goods and services whose production processes are highly fragmented such as consumer durables and investment products (Timmer, Los, Stehrer and de Vries, 2016).

The speed of trade globalization is often measured as the relationship between trade growth rate (in volume) and the variation in World real GDP. The globalization momentum is far from being stable over the long period (Table 1).

*Table 1 World Trade/GDP elasticity, 1950-2023*

| Period | Trade/GDP elasticity |
|---|---|
| 1950–2023(f) | 1.7 |
| - 1950–1989 | 1.4 |
| - 1990–2013 | 2.2 |
| - o/w 1995–2005 | 2.4 |
| - 2014–2023(f) | 1.4 |

Note: Elasticity based on 5-year rolling periods. Trade in merchandises only.
All variables in real terms. (f) denotes forecasted data.
Source: Author, based on WTO data and forecasts.

[1] This bias is eliminated when measuring trade in terms of value-added (as it is already the case for measuring GDP).

After years of what if often referred to as the era of "hyper-globalization" (1995–2005), trade collapsed during the 2008–2009 global financial crisis. Since then, the pace of globalization has noticeably slowed ("slowbalization").

Since 2015, policy-driven forces aimed at reducing geopolitical and systemic risks pointed to a more cautious approach of global economic integration by firms and governments (IMF, 2022). Yet, it is perhaps wrong (or too early) to speak about "deglobalization": the Trade/GDP elasticity is now about 1.4, same as during the Cold War era (1950-1989). This "slowbalization" may not be the sign of a "deglobalization", but only that the World economy has now settled at a new steady-state at a higher level of global integration. [2]

Indeed, elasticity is only one of various possible measures of the strength of globalization. Other possible indicators can be devised, such as the geographical diversification of trade partners or the average distance travelled by traded goods. For example, data on maritime shipping from UNCTAD (2022) shed important additional light on changes in distance travelled by merchandises. From 2000 to 2008, average distance travelled by containerships fluctuated narrowly around an average of 5 030 nautical miles; from 2009 to 2021 it decreased by 275 nautical miles (−5.5%). Interestingly, all other types of ships report an increase after 2009 (the average for all cargo ships rose 4.4% by 204 miles).

These results indicate that "slowbalization" affects only trade within Global Value Chains (GVC), containerships being mainly used by GVC trade to transport inputs (parts and components) as well as finished manufactured products. In this perspective, deglobalization means lesser vertical integration (reshoring) or shorter GVCs (nearshoring).

Several authors have looked at the evolution of GVC indices to provide an answer to this deglobalization question. Mancini, Montalbano, Nenci and Vurchio (2023) use the concepts of upstreamness and downstreamness distances to calculate an indicator of GVC positioning. In this approach, the "distance" corresponds to the average number of production stages of a production sector before its product reaches final consumers and the number of steps its inputs took before being procured and transformed. Their results show that the phenomenon of production fragmentation has been losing ground after 2011. This confirms the diagnostic made earlier by Timmer et al. (2016), who concluded that the process of GVC fragmentation has stalled since 2011. They added, nevertheless, that the downside trend was also due to the fact that global demand had shifted towards services for which production processes are much less trade intensive.

Miroudot and Nordström (2019) find also that the general trend is a steady increase in the international fragmentation of production until 2008 followed by a drop with the 2008–2009 financial crisis and a structural decrease since 2012. They observe that GVCs have been shrinking after 2012, with fewer foreign production stages. Turning to the geographic length of supply chains, they find that it increased by more than 500 kilometres between 1995 and 2008, with a decline after the 2008–2009 crisis. After 2012, the average distance has decreased, being lower in 2016 by about 10% compared to 2012. They estimate the 'speed' of deglobalization or the 'erosion in globalization' between 2016 and 2016 at about 52 kilometres per year. They also observe that distance matter more for imports than for exports.

The Global Value Chain Development Report (2021) presents the average number of stages in the GVC component of a given sector between 2000 and 2019. A general lengthening of GVCs occurred across sectors from 2000 to 2010. On average, the number of stages separating primary inputs and final consumption in GVCs

[2] Escaith et al. (2010) concluded "[…] the pattern observed from the data is compatible with a structural change from one steady state (a "Ricardian" economy where countries trade final goods) to another one (a "trade in tasks" economy, where countries trade also intermediate goods in a global supply chain).

globally was 7.9 in 2000 and 8.5 in 2010. Stagnation followed, consistent with slowbalization rather than deglobalization, with stages remaining at about 8.5 from 2010 to 2019.

From this brief review of the literature, we can conclude that most authors coincide in saying that the structural slowdown in globalization (discarding the 2008–2009 global crisis) occurred after 2011–2012. Both the hyper-globalization and slowbalization phases can also be attributed to changes in the composition of final demand, in particular manufactures and services. We now present our own approach to this discussion.

# 3. The Methodology

Our approach is related to Miroudot and Nordström (2019), in the sense that we focus on the geographical distance as the main source of information to analyse globalization and decompose its main drivers.

## a. Distance: physical and economic measurements

*Geographic Distance.* The simplest measure is the geographic distance in kilometres between two places. When applied to international trade between large countries, distance must take into consideration the main places of origin and destination, as in the CEPII Geodist database (Mayer and Zignago, 2011). In truth, *Travel time and transportation costs* are probably better suited to analyse the economic influence of distance on trade. A more general approach consists in considering all *monetary and non-monetary trade costs.* Monetary costs include, inter alia, freight and insurance, tariff duties and other cross-border costs. Many non-monetary costs are intangibles linked to the perception of risk (longer time to delivery and numerous manipulations of the cargo; different legal system, differences in languages complicate communication, etc…).

Because our purpose is not to explain changes in bilateral trade flows due to variations in trade costs but to measure how changes in trade patterns have influenced the distance travelled by traded products, our option is to use geographical distance. It is time invariant, at the difference of other measures that will be affected by changes in modes of transport, in communication technology or in trade policy. Furthermore, the geographic distance between two countries is generally well correlated with many of the economic trade frictions.

## b. Modelling trade

### 1) A probabilistic approach

Our main methodological building block derives from the probabilistic approach to information theory. More precisely, we compare the actual trade patterns to some benchmarks corresponding to different levels of entropy. Entropy in our perspective measures the degree of (dis)organization of the world trade network; it is maximum when the system defined by bilateral trade flows is totally random.

Denoting country "i" total exports by $X_i$ and total world exports by $X_w$, let's assume a homogeneous commodity "k" that is randomly traded in a frictionless free trade world. Without any prior knowledge of country "i" production capabilities, the uninformed probability to observe that product "k" is exported by any country picked at random is:

$$\mu(X_w^k) = \left(\frac{X_w^k}{X_w}\right), \quad \mu(X_w^k) \in ]0,1[ \qquad [1]$$

Where $X_w^k$ represents the value of world exports of product "k". The theoretical literature usually restricts "k" to being a commodity in order to satisfy the condition of homogeneity. In practice, the analysis is extended to more diversified products, including services.

In absence of special factors affecting country "i" ability to export, the probability to observe that "i" exports product "k" (noted here: $X_i^k$) is given by combining the marginal distributions of $X_i$ and $X_w^k$:

$$\mu(X_i^k) = \mu(X_i) \cdot \mu(X_w^k) = \left(\frac{X_i}{X_w}\right) \cdot \left(\frac{X_w^k}{X_w}\right), \quad \mu(X_i^k) \in ]0,1[ \qquad [2]$$

Without prior information about country "i" production capabilities, we assume statistical independence: $\mu(X_i^k)$, the probability of the joint event {country "i" exports product "k"} is equal to the product of the individual probabilities. Moving from probability [2] to the value of expected gross trade flow, we obtain the statistical expectation of the value of exports on "k" product by country "i" in the neutral situation [3]:

$$E(X_i^k) = \left(\frac{X_i}{X_w}\right) \cdot X_w^k \qquad [3]$$

A similar exercise can be conducted for imports $M_i$ and $M_i^k$. In the next section, we combine both approaches to build a "neutral" distribution of bilateral trade flows using a statistical formulation of the gravity model.

## 2) Gravity model

The maximum entropy configuration of World trade is derived from the gravity model, introduced by Walter Isard (1954) in both its bilateral and multilateral specifications. The model closely follows Newton and only includes a limited number of covariates that proxy for distance and economic mass. Initially conceived from an intra-regional perspective, the model was applied by Timbergen in 1962 to econometrically specify the gravity equation of international bilateral trade flows.

By analogy with Newton's Law of Universal Gravitation, the model predicts that trade between two countries is proportional to their economic mass and inversely proportional to the 'distance' separating them. In economic terms, this distance refers to all the 'frictions' impeding trade, as discussed above page 4.

For two countries $a$ and $b$, for any traded product k (superscript ignored in the notation, for simplicity) we can express the Newtonian gravity equation as:

$$X_{ab} = \frac{X_a M_b}{W d_{ab}^2} \qquad [4]$$

where $X_{ab}$ are exports from $a$ to $b$, $X_a$ is $a$'s economic size from the supply-side perspective (the total value of this product exported at origin *a)*, $M_b$ is $b$'s market size for this product (the mass of products imported at destination b), $W$ is total world trade in this product and $d_{ab}$ is the economic distance between $a$ and $b$ (a measure of the trade frictions that impede pure free trade). [4]

Discussing Isard (1954), Capoani (2022) mentions that his model was already taking into consideration the attraction –known today as "multilateral resistance"– resulting from other countries, which may compete for the same trade opportunities.[5] This specification was explicated by the first theoretical micro-foundation of the gravity equation of trade, attributed to Anderson (1979). This new approach, called structural gravity, has been the workhorse model in international trade to predict, for example, the effect of changes in tariff duties. For our more descriptive purpose, the statistical approach embodied into Isard (1954) is sufficient (see Box 1).

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[3] This formulation is central to the empirical measure of comparative advantages. Most applied RCA indices derive from the following rule: if the observed ($X_k^j$) is higher than the expected neutral one E($X_k^j$), then we conclude that country "i" has special characteristics, other than its sheer economic size, that bestow it with special advantages in exporting the product "k" (Escaith, 2020).

[4] Statisticians interpret these frictions as the 'distance' that separates the trade system from the maximum entropy state when trade is determined only by the relative size of the trade partners.

[5] "According to the theory, trade between more isolated but close to each other countries, like New Zealand and Australia, is supposed to be more consistent in comparison to a pair of countries like Austria and Portugal."

In the absence of any trade friction, similar goods and services have the same price everywhere. Under the hypothesis of homothetic preferences, consumers in $a$ and in $b$ are expected to buy products in the same proportion based on their share of world income (entropy is maximised). We thus obtain a gravity equation where distance does not play any role. Exports from $a$ to $b$ are simply (Escaith and Miroudot, 2015):

$$\tilde{X}_{ab} = s_a s_b W \,, \forall a \neq b; \quad \tilde{X}_{aa} = 0 \,, \forall a \qquad [5]$$

Denoting $s_a = X_a/W$ the share of country $a$ exports; $s_b = M_b/W$ the share of country $b$ imports in world trade for a given product and $\tilde{X}_{ab}$ the exports from a to b under frictionless trade. [6]

Estimated trade flows add-up to the value of products actually exported or imported by countries in the observed situation.

$$\sum_{b=1}^{N} \tilde{X}_{a,b} = \sum_{b=1}^{N} (X_a \cdot M_b/W) = X_a$$
$$\sum_{a=1}^{N} \tilde{X}_{a,b} = \sum_{a=1}^{N} (M_b \cdot X_a/W) = M_b \qquad [6]$$

From a statistical perspective, Equation [5] provides the expected value of trade flows between "a" and "b" in absence of any prior information on the attractive or repulsive forces affecting bilateral trade, besides the size of their total exports and imports. It coincides with the case of maximum entropy (maximum randomness). From an economic perspective, it reflects a situation of pure free trade, without any influence of trade frictions or trade preferences. Comparing actual (observed) trade flows with the hypothetical situation of maximum entropy provide information on the strength of the various factors affecting (positively or negatively) actual trade between two countries.

**Box 1. Statistical vs. Structural Gravity Models**

In practice, the influence of these factors (geographic distance, other trade costs, common historical and cultural heritage, etc.) are estimated today through the structural specification suggested by Anderson and van Wincoop (2003), where the attractive force between two countries reflects the profit maximizing arbitrage done by cost minimizing buyers. Nevertheless, Anderson (2023 proposes also a non-parametric alternative that boils down to bi-lateral distance, "reconnecting economic gravity to its physical origin" (p.2). In non-parametric specifications, gravity properties reduce to dependence on pairwise relative resistances.

In Anderson (2023), the CES trade elasticity of structural gravity model is estimated with a minimum distance method consistent with the perspective of non-parametric gravity. We use a simplified approach here, that does not consider producers' prices or trade barriers. Moreover, we consider that transportation costs are fully represented by geographical distance. This simplification is consistent with the main objective of the paper, which is to measure if the global trade universe has been expanding or contracting in recent years. Implicitly, those economic factors are being considered when we take into consideration the observed changes in the geographical distribution of suppliers: new comers are expected to enter the market because they offer competitive price and trade cost alternative.

[6] In canonical gravity model, $Y_i$ denotes supply and demand of tradable goods, usually approximated by GDP. In our case, we restrict the relationship to goods that are actually exported or imported (i.e., excluding domestic transactions).

From the hypothetical World trade network defined by equation [5], we can now calculate the average distance that would be travelled by one unit value of product "k" in the maximum entropy situation (superscript not included for simplicity)

$$\tilde{D}_w = \frac{1}{N}(\sum_{a=1}^{N}[\sum_{b=1}^{N}(\tilde{X}_{a,b}d_{a,b})]/X_a) \quad [7]$$

### c. Distance Minimization

The total distance travelled by products in equation [7] constitutes one of the characteristics of the world trade situation at a given time. Conceptually, it corresponds to a situation of perfect globalization where distance is no more an obstacle to trade. Another characteristic will be provided by the situation where importers (or exporters) want, at contrary, to minimize trade costs (represented here by distance) and to concentrate all their transaction on near-shoring criterion. Distance minimization by each importer for each product is constrained by the geographical distribution of exporters and the demand from other importers. In other words, it takes into consideration the attraction (or "multilateral resistance") resulting from other countries.

While frictionless gravity takes its source in trade economics, distance minimization is a topic belonging to operational research and management science. Facility location problems locate a set of facilities (exporters, in our case) to minimize the cost of satisfying some set of demands (importers) with respect to some set of constraints. Reaching a solution may demand complex algorithms, depending on the objective and constraints imposed (see Farahani and Hekmatfar, 2009). In the present case where supply and demand are fixed, the solution is straightforward, and obtained using linear programming. For the same reason, there is no need to distinguish the exporters from the importers' perspective, because we look for a "World" optimum, which may deviate from what would be optimal from a single country's perspective. [7]

The standard linear programming solution implies that there is only one objective function defining a social optimum where total travelled distance by traded goods is minimized. Imagine, for example, that the social objective is to reduce CO2 emissions due to transnational transportation. The solution measured by the total distance travelled by world trade under maximum resistance to trade is efficient and there are no unused arbitrage gains that would provide a shorter global distance. The solution may not be unique as there may be several trade patterns satisfying the optimality conditions, but the end result in terms of distance travelled should be the same.

Formally, for any product "k" (superscript ignored in the notation, for simplicity) the program can be specified as follows: Find a set of bilateral trade patterns $\{X^*{}_{a,b}\}$ $(a, b\colon 1\ to\ N)$ where $X^*{}_{a,b}$ are exports from $a$ to $b$ and N is the number of countries that minimizes:

$$D_w^* = \frac{1}{N}(\sum_{a=1}^{N}[\sum_{b=1}^{N} X_{a,b}^* d_{a,b})]/X_a) \quad [8]$$

Subject to the following constraints:

$X^*{}_{a,a} = 0$ , ∀a = 1, …,N (no domestic trade)

$X^*{}_{a,b} \geq 0$ , ∀a, b = 1, …,N (no negative trade flows)

$\sum_{b=1}^{N} X_{a,b}^* = \sum_{b=1}^{N} X_{a,b}$ (total exports are equal to observed ones)

[7] Note that the distance calculated under maximum entropy is not the opposite of the minimum distance. Maximum entropy maximises randomness, not distance.

$$\sum_{a=1}^{N} X_{a,b}^{*} \ = \ \sum_{a=1}^{N} X_{a,b} \text{ (same thing for total imports)}$$

The social solution $D_w^*$ may not be a Pareto optimum with respect to the observed conditions, in the sense that some countries may have to source their imports or transport their exports on longer distances than in the actual situation. In this case, we are confronted to a more complex "multi-objective problem". In theory, the new functions are easy to specify by adding as many constraints as we have importers and exporters (the new distances travelled by imports and exports should not exceed the observed one). In practice, it leads to adding 2N constraints that render the programming cumbersome.[8] More importantly, it implies that the optimization process is path-dependent, because historical patterns may restrict the search for an optimum. We eventually discarded this option due to its sensibility to the choice of initial conditions, while recognizing it may bring interesting information on some existing tight trade relationships.

From the hypothetical World trade network defined by the minimization program [8], we calculate the average minimum distance travelled by one unit value of product k (superscript not mentioned for simplicity):

$$\dot{D}_w \ = \ \frac{1}{N}(\textstyle\sum_{a=1}^{N}[\sum_{b=1}^{N}(X_{a,b}^{*} d_{a,b})]/\, X_a) \qquad [9]$$

Both as-if-frictionless maximum entropy and maximum trade frictions situations are comparable only if consider that all products classified as "k" are perfect substitutes. From an importer's perspective located in country *a*, the sole difference in a product "k" procured from country *b* or country *c* is the respective distance d(a,b) and d(a,c).

### d. The globalization indicator (GI)

We can now introduce our new globalization indicator (GI). GI measures the strength of globalization forces, understood as the relative distance between the observed situation and the two theoretical World trade network defined under maximum entropy and minimum distance.

$$GI \ = \ (D_w \ - \ \dot{D}_w)/(\tilde{D}_w \ - \ \dot{D}_w) \qquad [10]$$

With $D_w$ measuring the average distance travelled by one unit value of product in the actual (observed) situation:

$$D_w \ = \ \frac{1}{N}(\textstyle\sum_{a=1}^{N}[\sum_{b=1}^{N}(X_{a,b} d_{a,b})]/\, X_a) \qquad [11]$$

GI has two important properties. First, and at the difference of the average distance travelled by one unit value, it is dimensionless. For any given product "k", $GI^k$ varies between 0 and 1.[9] The larger GI stands, the closer (i) actual distance is to frictionless free trade (the maximum entropy situation) and (ii) the more globalized is World trade for this product.

It is therefore possible to compare the globalization strength of two different products (k1 and k2) at the same period of time. If $GI_t^{k1} > GI_t^{k2}$, one may conclude that trade in product k1 is more globalized (less sensitive to distance) than trade in product k2. Similarly, one may compare the situation of the same product at two different time periods. $GI_{t+1}^{k1} > GI_t^{k1}$ indicates that trade in product k1 is more globalized in time t+1.

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[8] In addition, the optimization may not converge. We experimented with only N constraints on the importers' distance. The programming was done using the package 'lpSolve' (M. Berkelaar et al., 2023), implemented in R language and environment (R Foundation for Statistical Computing, Vienna).

[9] The negative values $(D_a \ - \ \dot{D}_a)^k$ for country "a" and product "k" (non-Pareto optimum) are too few to influence the world average.

An important property of *GI* is that it controls for the changes in the geographic distribution of demand and supply through time. This is a crucial feature when studying the 1995−2020 period that witnessed the emergence of large developing countries, first as a major source of exports, then as major destinations of imports. It was also the time of sever shocks (the Global Financial Crisis, the COVID-19) that affected supply and demand between countries for different categories of product. This property is further developed in the following section, taking the example of the positive feed-backs existing between exports and imports through time.

### e. Endogeneity of supply and demand

Endogeneity in our case is understood as the existence of a positive dynamic feed-back between demand for imports and the creation of new export capacities, which in turn generate additional income in the exporting country leading to an increase in demand for imports. This positive relation is one of the main arguments for export-led growth strategy.

The interaction is quite complex, in particular from a trade and development perspective. Demand from developed consumers, associated with a lower reluctance to source from foreign suppliers (the globalization effect), may generate new exports in emerging countries. Exports expand production and employment, which in turn will increase demand for imports of final and intermediate goods. This is particularly relevant in the recent phase of globalization, based on the fragmentation of industrial production through international outsourcing and off-shoring. Not only jobs were created in previously un-industrialised countries, but knowledge-intensive capital and know-how was transferred from more advanced countries. The "unbundling" of productive capacity (Baldwin, 2016) led to a growing demand for imports from these peripheral countries, first for intermediate and investment goods required by the new factories, then for final consumer goods demanded by a growing middle class.

This long-term coevolution of supply and demand means that the geographical distribution of imports and exports is endogenously changing through a process of accelerating economic catch-up. From a measurement perspective, it means also that one cannot estimate the extent of globalization simply by measuring changes through time in the distance travelled by trade products. One needs to take into consideration also the changes in the geographical distribution of supply and demand.

Our new approach allows to take into consideration theses structural considerations because the two benchmarks (maximum entropy and minimum distances) are constructed on the basis of actual changes in the geographical distribution of exports and imports. *GI* controls also for another issue in times series comparison: the change in product prices through time. It can be shown that the globalization indicator is unaffected by a change in price.

### f. Separating the structural and globalization effects

The variation of the total distance travelled by traded goods is the result of two effects: a change in the geographical distribution of supply (a structural effect) and demand, and a change in the aversion to travel long distance (the "globalization effect"). Separating both effects can be analysed as an index number problem, where one wants to decompose the change in the value of the aggregate "Total Distance" ($D^k_w$) into the product of a part that is due to changes in the respective quantities exported and imported by each country (the structural effect) and the change in trade frictions (the globalization effect).

Index number theory has been developed mainly in the context of price statistics to find out what part of a price index variation corresponds to price developments for each product and what part corresponds to movements in the composition of demand. Huerga and Steklacova (2008) review a number of possible alternatives in view of a set of axiomatic properties that would be desirable to have in the decomposition. They conclude that possibly the most useful decomposition is the Marshall-Edgeworth-type decomposition (with or without extended weight effect).

In our case, “price” is the average distance travelled by one unit value of a given product and “quantity” is the marginal distribution of total countries imports and exports, at different periods of time. The Marshall-Edgeworth-type decomposition without extended weight effect uses the simple average of the previous and present period weights to calculate the globalization effect (variation in travelled distance or in the GI indicator; first element on the right-hand side of [12]). The structural effect (changes in the relative weight of importers and exporters in World trade, second element) is calculated in the same way, resulting in a decomposition with only two terms. In this decomposition, the composite effect is distributed equally between the globalization effect and the structural effect. [10]

$$\Delta D_{t,t-1} = \sum_k \Delta D(k)_{t,t-1} \left(\frac{w(k)_t + w(k)_{t+1}}{2}\right) + \sum_k \Delta w(k)_{t,t-1} \left(\frac{D(k)_t + D(k)_{t+1}}{2}\right) \quad [12]$$

With: $\Delta D_{t,t-1}$ variation in average distance travelled by traded products between time t and (t-1); $\Delta D(k)_{t,t-1}$ change in average distance travelled by on unit of product k); $\Delta w(k)_{t,t-1}$ the change in the geographical distribution of countries exports and imports for product k. Finally, the average distance travelled by one unit value of product k were normalized at $D(k)_{1995} = 100$ in order to facilitate the comparison across products.

# 4. The data

## a. Trade

With the aim of investigating the role of GVC trade in the process of globalization, we used the OECD TiVA database, comparing the evolution of trade as measured by traditional trade statistics, and the evolution of trade in value-added, representative of the trade in tasks along global value chains. The first timeseries (gross values) is made of bilateral trade in nominal US dollar measured by merchandise or services trade statistics. The second one reflects the country/sector origin of value added embodied in the consumption of the country of final demand. At the difference of traditional trade statistics, the TiVA data are organised by industries and not by product. The data, covering the 1995–2020, was released in November 2022 but remained preliminary at the time of undertaking our analysis. [11] We also used contextual data based on a wider GVC index analysis by Mancini, Montalbano, Nenci and Vurchio (2023), which used also the same preliminary TiVA data.

*Table 2 Selected sectors included in the analysis*

| Sector | Code |
|---|---|
| Agriculture, hunting, forestry | D01T02 |
| Textiles, textile products, leather and footwear | D13T15 |
| Chemical and chemical products | D20 |
| Pharmaceuticals, medicinal chemical and botanical products | D21 |
| Fabricated metal products | D25 |
| Computer, electronic and optical equipment | D26 |
| Electrical equipment | D27 |
| Motor vehicles, trailers and semi-trailers | D29 |
| Publishing, audiovisual and broadcasting activities | D58T60 |
| IT and other information services | D62T63 |
| Financial and insurance activities | D64T66 |

[10] A similar decomposition is often found in shift-share analysis (SSA) used in regional science or international trade. SSA attempts to identify the sources of regional or global economic changes (employment, production, trade, etc.).

[11] The revised data were expected to be officially released end-2023.

We restricted the analysis to a selection of 11 industries covering distinctive goods and services sectors presenting different levels of globalization (Table 2). Considering the volume of data to be processed, only some years of particular interest were taken into consideration. First, the years terminating by 0 or 5, that are usually used as benchmark by national accounts and are therefore expected of being of better quality. [12] Second, we isolated 2012 as a possible inflexion point, following Miroudot and Nordström (2019), and the three individual years starting in 2018 to spot possible impact of the China-USA trade conflict or the effect of COVID-19.

### b. Geographic distances

We used the CEPII Geodist database (Mayer and Zignago, 2011). Bilateral geodesic distances between two countries are calculated following the great circle formula, based on the localization of the most important cities in terms of population. The main hypothesis is that the geographical distribution of production and consumption is closely correlated with population. It means that distance is not from and to international borders and a part of it takes place within the exporting and importing countries. The bias is expected to be negligible, except perhaps for countries that share a common border, and does not affect the end results.

## 5. Findings

We first analyse distance from the traditional approach of bilateral trade, before looking at trade in value-added. As we are privileging the demand side, the main focus when looking at individual countries will be on imports, with only additional references to exports.[13]

### a. Gross trade statistics

#### 1) Distance to import and export

In average of all sectors, the distance to import increased by average of 0.36% per year between 1995 and 2020. This increase was equally distributed between the structural and the globalization effects (Table 3). But a closer look shows heterogenous variations between sub-periods of time.

The first phase of hyper globalization (1995–2000) is particularly interesting from this perspective. While the geographical dispersion of supply and demand contributed positively to the increase in distance, when given the opportunity, countries tended to source their imports closer to Home, resulting in a negative contribution (−0.31% per year) of the globalization effect. One explanation for this negative effect is the impact of several deep regional agreements that took effect in 1995 in North America and Europe. The positive structural effect was mainly linked to a global imbalance between the geographical distribution of supply and demand, leading to a strong increase in the minimum distance (1.51% per year).

*Table 3 Distance to import: Average annual growth and decomposition, 1995–2020*

| Annual growth and effects | | 1995-2020 of which: | 1995-2000 | 2000-2005 | 2005-2010 | 2010-2012 | 2012-2015 | 2015-2018 | 2018-2019 | 2019-2020 |
|---|---|---|---|---|---|---|---|---|---|---|
| Observed | Average | 0.36 | 0.33 | -0.43 | 1.37 | 1.41 | 0.44 | -0.70 | 0.07 | 0.68 |
| of which: | - Structure | 0.18 | 0.64 | -0.62 | 0.59 | 0.96 | 0.05 | -0.73 | -0.12 | -0.19 |
| | - Globalization | 0.18 | -0.31 | 0.19 | 0.78 | 0.45 | 0.39 | 0.02 | 0.19 | 0.87 |
| Memo item: theoretical cases: | | | | | | | | | | |
| Minimum | Average | 0.48 | 1.51 | -0.56 | 1.14 | 1.42 | 0.97 | -1.67 | -0.66 | 1.97 |
| Entropy | Average | 0.18 | 0.69 | -0.71 | 0.80 | 0.88 | 0.09 | -0.48 | 0.04 | -0.04 |

Note: Based on a simple average of sectoral results.
Source: Author, based on OECD TiVA and CEPII data

[12] OECD TiVA calibrates bilateral trade data using national accounts and not trade statistics.

[13] At world trade level, there is symmetry between imports and exports and the distance is the same. The difference appears at country level.

This geographical distribution of supply and demand is more equilibrated in the second sub-period (2000-2005), when the structural effect becomes negative. Even if the globalization effect turned positive, the net effect was a decrease (−0.43 in annual average) of the distance to import.

After accelerating between 2005–2012, this distance continued increasing up to 2015, but at a slower pace. The global financial crisis of 2008–2009, if it had a strong impact on the volume of trade, did not modify significantly the dynamic of globalization. It is only after 2015 that the distance travelled by imports stagnates, indicating a possible break in trend. But this this only due to a better geographical distribution of supply and demand, and not for less appetite for sourcing imports from far-away suppliers. The globalization effect remains positive after 2018 (the start of the China-US bilateral trade war) and reach its maximum in 2020, an exceptional year marked by the CIVID-19 pandemic and the disruption of several supply chains: if trade volumes decreased, globalization endured.

In most sectors (see Table 4), the main drop in distance to import is registered after 2015. Generally, a decrease in average observed distance to import coincides with a decrease in both Minimum and Maximum Entropy distances. Thus, it seems that the structure effect (better geographical repartition of supply and demand) explains the variations, with some exceptions. [14]

*Table 4 Distance to import: Average annual growth of products classified by sector, selected periods*

| Sector [a] | 1995-2020 | 2015-2018 | 2018-2019 | 2019-2020 |
|---|---|---|---|---|
| D13T15 | 1.09 | -0.68 | 1.53 | 2.63 |
| D21 | 0.72 | -0.13 | 2.46 | -0.79 |
| D27 | 0.68 | -0.30 | 0.37 | 1.62 |
| D01T02 | 0.66 | 0.47 | -2.45 | 1.78 |
| D25 | 0.56 | -1.15 | 1.11 | 0.04 |
| **Average [b]** | **0.36** | **-0.70** | **0.07** | **0.68** |
| D20 | 0.27 | -0.24 | 0.73 | 1.04 |
| D62T63 | 0.22 | -1.27 | -1.2 | -0.81 |
| D29 | 0.19 | -1.67 | -1.68 | 1.37 |
| D64T66 | 0.09 | -0.95 | -0.23 | 1.08 |
| D58T60 | -0.16 | -1.41 | -0.34 | 0.19 |
| D26 | -0.36 | -0.42 | 0.50 | -0.66 |

Note: a/ Include imports of intermediate and final products, distance ranked by variation over the 1995-2020 period; b/ simple average of sectoral results, may not correspond to the average calculated on all individual trade flows.

The COVID-19 effect is not perceptible as far as distance is concerned. We find only three sectors that registered a year-on-year decrease in average distance in 2020: Pharmaceuticals (D21, −0.8%); Computer equipment (D26, −0.7%); Financial activities (D62T63, −0.8%). At the same time, some sectors recorded large increases; this was particularly the case of Textiles (D13T15, 2.6%) and Agriculture (D01T02, 1.8%). Agricultural products registered the largest increase in the globalization effect over the 1995–2020 period (see Figure 1), and the second largest during the post-2015 subperiod (8 percentage points, based on the 1995 distance).

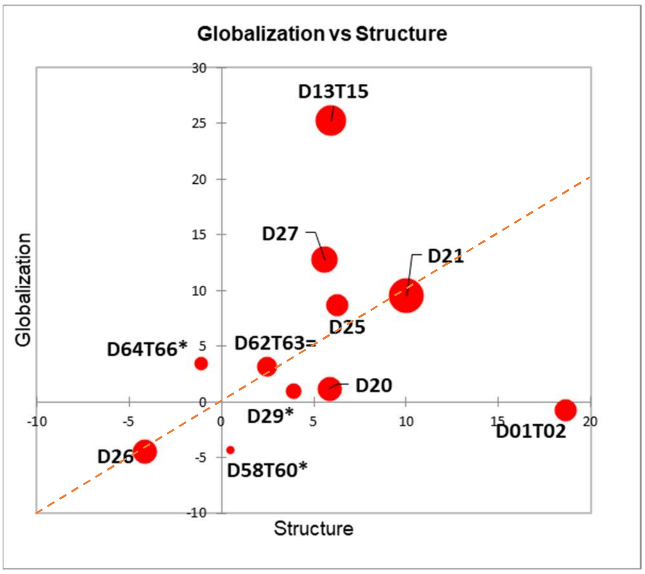
Similar situation is observed for Electrical equipment (D27), where the increase in actual distance (0.7% per year) was probably driven by supply-demand geographical imbalance, reflected in a 1.7% annual variation in the minimum distance. The Globalization effect dominates over the whole period (see Figure 1 again), and remained positive (4 percentage points) between 2015 and 2020.

Three sectors in Figure 1 −Agriculture (D01T02), Computer equipment (D26) and Publishing services (D58T60)− return negative globalization effects over the 1995–2020 period, but for very different reasons.

[14] Chemicals (D20) and Motor vehicles (D29) register an increase of distance to import over the period, and tend to follow the evolution of the Entropy benchmarks while the Minimum ones decrease; at the contrary, Computer equipment (D26) observed distance decreased over the period, as did the Entropy one, while the Minimum increased.

- *Agriculture*: The distance covered by agricultural imports increased over the period (0.7% per year in average), only thanks to the structural effect (the Globalization component is slightly negative). This indicates the emergence of new importers located away from prevailing exporters (often determined by pre-existing natural comparative advantages), and is compatible with the rise of demand for food products by emerging and developing countries. This said, the Globalization effect became positive for this type of product after 2015.
- *Computer*: The average distance required to import computer equipment dropped over the period (−0.4% on an annual basis), driven almost equally by the structural and the globalization effects. During the post-2015 period, the structural component increased its negative effect while the globalization one turned positive.
- *Publishing services* is another outlier, with a large decline in its globalization component. This decline accelerated during the post-2015 period, and was reinforced by a negative structural effect (−8 and −5 percentage points, respectively). The digitalization of this type of creative and cultural services has dramatically changed its business model, and interpreting these results would require a dedicated analysis.

*Figure 1 Globalization and Structural Effects by Sector, 1995–2020 [a]*




Notes: a/ In percentage of the respective distance to import observed in 1995; the size of the disc indicates the strength of the globalization effect during the 2015−2020 period, with additional information in superscript: (=) about nihil, (*) negative (3 occurrences), none: positive effect.
Source: Author, based on OECD TiVA and CEPII data. The points above (alt. below) the dotted line registered a higher (lower) Globalization effect over the whole period compared to the structural effect.

## b. Globalization indicator

What is the end-result as far as our Globalization indicator (GI) is concerned?

Remember that GI takes into consideration the actual distance travelled by traded products and the distance they would have journeyed under two hypothetical situations: Frictionless free trade (maximum entropy case) and high reluctance to procure goods from far-away locations (minimum distance situation). It is somewhat affected by the two effects we observed in the previous section: the geographical distribution of supply and demand (our structural effect) and the appetite to travel long distance (the globalization effect). It is therefore natural to find some convergence between the two approaches, which are complementary rather than substitute.

Table 5 shows that in 2020, all indicators remained above the 1995–2020 average and did not show decrease after 2018, at the contrary. Again, individual sectoral situation varies a lot when considering the GI for both imports and exports trade (GI_All). Some sectors, such as Pharmaceuticals (D21, GI_All=0.78) or IT services (D62T63) and Financial services (D64T66) (GI_All equal to 0.66 and 0.64, respectively) show high degree of globalization in average of the 1995−2020 period for the Total trade indicator, which covers both importers and exporters.

*Table 5 Globalization indicator, average of sectoral results, 1995–2020 and selected years [a]*

| Years | Total trade [b] | Imports [c] | Exports [d] |
|---|---|---|---|
| 1995-2020 [e] | 0.59 | 0.60 | 0.50 |
| 2015 | 0.60 | 0.60 | 0.48 |
| 2018 | 0.60 | 0.61 | 0.51 |
| 2019 | 0.61 | 0.62 | 0.52 |
| 2020 | 0.61 | 0.63 | 0.52 |

Note: a/ Based on a simple average of sectoral results; b/ Total world trade (imports and exports); c/ and d/ Median of country results; e/ annual average.

This contrasts with the relatively low mark observed for Motor vehicles (D29, GI_All=0.42) and Metal products (D25, 0.49). With the exception of IT services, all of them scored higher in 2020 than what was their respective period average. Moreover, most report an increase between 2015 and 2020, IT services being an exception as its GI for total trade went down from a relatively high 0.69 in 2015 to a still respectable 0.64 in 2020. Pharmaceutical, already a highly globalized sector according to our indicator, increased its GI_All mark from 0.83 to 0.84 between 2015 and 2020, consolidating its status of most globalized industry as far as trade is concerned.

- ***Imports***

When looking at the median GI indicator calculated for imports only (GI_Imp), which is −in our opinion− more representative of the behaviour of small and medium countries from a demand-driven perspective, the overall picture does not change much. Over the 1995–2020 period, high GI_Imp are found in Financial services (GI_Imp=0.75), Publishing (0.70) or IT services and Pharmaceutical (0.69, both). Lowest marks are found for Chemicals and Motor vehicles (0.45), and for Agriculture and Metal products (0.46). All sectors registered higher globalization indicator in 2020 compared to 2015.

Comparing Pharmaceutical with Chemicals gives us a clue about these differences: relatively un-processed products are more easily found closer to Home country, while at the contrary fewer countries specialise in producing and exporting complex products. An exception is found in the case of Vehicles, a complex product but that is usually sourced regionally. This is specific to the industry's business model and is often strongly affected by regional trade agreements (See Annex for more information).

- ***Exports***

From the median exporter's perspective, the globalization indicators tend to be smaller than importers' ones, but with exceptions (similar results hold when looking at the simple average). This result diverges from Miroudot and Nordström (2019) who observe that distance matter more for imports than for exports. But the methodology differs. In our case GI compares actual distance with the two benchmark distances taking also into consideration the influence of the geographical distribution of exports and imports.

Services in general show higher marks for this indicator than goods producing sectors: Financial services (D64T66; GI_Exp=0.70), IT services (D62T63; 0.61) and D58T60 (0.60). On the other side of the spectrum, we find sectors with exports that are more geographically concentrated: Motor vehicles (D29; 0.37), Agriculture (D01T02; 0.40), Textiles (D13T15; 0.41) or Fabricated metal (D25) and Electrical equipment (D27) at about 0.43.

Agriculture, in particular, concludes the 1995–2020 period with lower-than-average globalization indicator (GI_Exp=0.37 in 2020 compared with an average of 0.40). With the exception of this sector, all exporting industries registered higher globalization indicator between 2015 and 2020.

### c. Trade in Value-Added

Thanks to the geographic fragmentation of global production, many industrial products are "Made in World" with several countries contributing to their final value. For each country of final demand, OECD TiVA allows to identify the foreign origin of value-added embodied in the products that are absorbed.

Applying as such the GI methodology to trade in value-added presents a series of issues. The main issue relates to the minimum distance (high aversion to import from far-away suppliers). Because we consider here only the distance between the country of final destination and the various countries that contributed to the value of the final product consumed, we may misrepresent some complex supply-chain configurations.

The methodology applies perfectly to hub-and-spike supply chains optimizing transport along bilateral trade routes from a series of "spokes" that connect to a central "hub" where the final product is assembled (sometimes called "spider-type" configurations). When the value-chain is linear (a "snake"), each firm contributes its own task by adding value to processing goods. In this case, the optimum suppliers of the most upstream manufacturers may not be those that are closer to the country of last destination at the end of the value-chain. In other words, when applying the minimal distance criterium, we also impose that GVC arrangements be of the "hub and spoke" type, the "hub" being also the country of final destination.

A rigorous application of the minimum criteria would require decomposing the various steps (or tasks) involved in the production of the final good. It is achievable using international input-output matrices but would be require some specific data processing. [15] We therefore do not refer to "distance to import tasks" but to "distance to foreign source of value-added (embodied in domestic final demand).

*Table 6 Distance to foreign source of Value-Added: Average annual growth and decomposition, 1995-2020*

| Distance to import | | 1995 – 2020 of which: | 1995-2000 | 2000-2005 | 2005-2010 | 2010-2012 | 2012-2015 | 2015-2018 | 2018-2019 | 2019-2020 |
|---|---|---|---|---|---|---|---|---|---|---|
| Observed | Average | 0.45 | 0.72 | -0.29 | 1.35 | 1.39 | 0.50 | -0.74 | 0.18 | 0.24 |
| of which : | - Structure | 0.20 | 0.77 | -0.53 | 0.42 | 1.06 | 0.26 | -0.66 | -0.11 | -0.45 |
| | - Globalization | 0.26 | -0.05 | 0.24 | 0.94 | 0.32 | 0.24 | -0.08 | 0.30 | 0.69 |
| Memo item: | | | | | | | | | | |
| Minimum | Average | 0.46 | 1.86 | -0.86 | 0.89 | 0.69 | 1.50 | -10.58 | -0.36 | 1.29 |
| Entropy | Average | 0.23 | 0.76 | -0.57 | 0.81 | 0.96 | 0.23 | -0.55 | 0.13 | -0.22 |

Note: Based on a simple average of sectoral results.

The distance from the country of final demand to the countries that contributed to the value-chain increased more rapidly than the bilateral distance obtained previously in Table 3 (0.45% annually over the whole 1995–2020 period, compared to 0.36%). Most of this difference was obtained at the beginning of the period, between 1995 and 2000. As for bilateral trade in physical products, the highest distance was reached in 2015, with a drop in 2015–2018 and anaemic growth afterwards.

The globalization indicator (GI) for the origin of foreign value added in domestic final demand does not indicate a reversion of the geographical diversification of inputs embodied in final demand. In average of all bilateral

[15] The solution would require to use the decomposition of the Leontief matrix and optimise the distance travelled at each step the distance required to procure imported inputs. We refer the interested reader to Miroudot and Nordström (2019) for an application of the Leontief decomposition in the case of observed trade data.

flows, the indicator concludes the post-2015 period with higher marks than its historical average. It is particularly true when we consider the median of "importing" countries (based on the origin of foreign value-added embodied in domestic final demand). The COVID-19 induced a wider geographical diversification, resulting in a 3% increase of GI_Imp in 2020.

Table 7 Distance to foreign source of Value-Added Distance to import: Average annual growth by sector of origin, selected periods [a]

| Sector | 1995-2020 | 2015-2018 | 2018-2019 | 2019-2020 |
|---|---|---|---|---|
| D13T15 | 1.11 | -0.39 | 1.30 | 1.91 |
| D01T02 | 0.83 | -0.47 | -0.81 | 1.94 |
| D21 | 0.63 | -0.64 | 3.43 | -0.64 |
| D27 | 0.54 | -0.29 | 0.18 | 0.52 |
| D20 | 0.53 | -0.13 | 0.54 | 0.3 |
| All sectors [b] | 0.45 | -0.74 | 0.18 | 0.24 |
| D64T66 | 0.44 | -0.47 | -0.19 | 0.42 |
| D25 | 0.42 | -0.89 | 0.59 | -0.53 |
| D62T63 | 0.35 | -1.07 | -0.90 | -1.38 |
| D29 | 0.16 | -1.92 | -1.60 | 1.42 |
| D58T60 | 0.03 | -0.96 | -0.66 | -0.75 |
| D26 | -0.07 | -0.90 | 0.13 | -0.58 |

Note: a/ ranked by variation over the 1995-2020 period; b/ simple average of sectors.

The median "exporter" (domestic value-added embodied in foreign final demand), at the contrary, reversed part of the geographical diversification gained in previous year to conclude 2020 with a GI_Exp score close to the historical 1995-2020 average. This reversal affects mainly small countries and did not weight much on the overall GI_All indicator.[16]

*Table 8 TiVA globalization indicator, average of sectoral results, selected periods [a]*

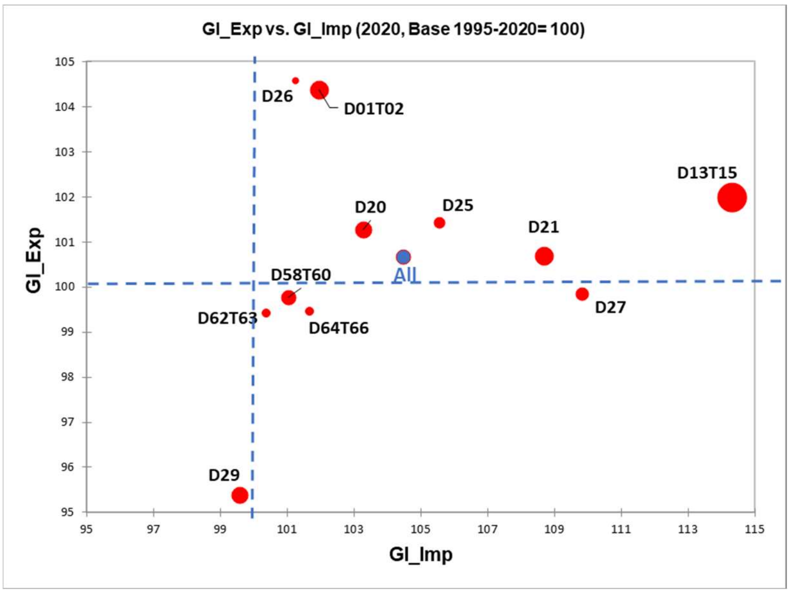
| Years | Total trade [b] | Imports [c] | Exports [d] |
|---|---|---|---|
| 1995-2020 | 0.66 | 0.64 | 0.57 |
| 2015 | 0.68 | 0.65 | 0.57 |
| 2018 | 0.69 | 0.65 | 0.60 |
| 2019 | 0.68 | 0.65 | 0.59 |
| 2020 | 0.69 | 0.67 | 0.58 |

Note: a/ Based on a simple average of sectoral results; b/ Total world trade of selected sectors (imports and exports); c/ and d/ Median of country results.

Only one sector, Motor vehicles (D29), registered a shortening of its median value-chain, especially for its export component (Figure 2). Nevertheless, the average, weighted by the value of trade flows (GI_All), shows an expansion driven by main traders (5% in 2020, compared to the 1995–2020 average). An opposite situation is observed for Computer equipment (D26) which remained stable over the period for the GI_All indicator but registered the highest expansion when considering the smaller median exporters (104.6 in 2020). Textiles value chain (D13T15) concluded the period of analysis with the highest geographical expansion both for the median importers (GI_Imp= 114.3) and total trade flows (GI_All= 112.1), compared to the corresponding period average.

[16] Considering that GI_All is based on the total trade in value added flows, the large "importers" and "exporters" of inputs embodied in final products weight more than in the separate calculation median importers and exporters.

*Figure 2 Median TiVA GI for Imports and Exports by Sector, 2020 (100=1995-2020) [a]*

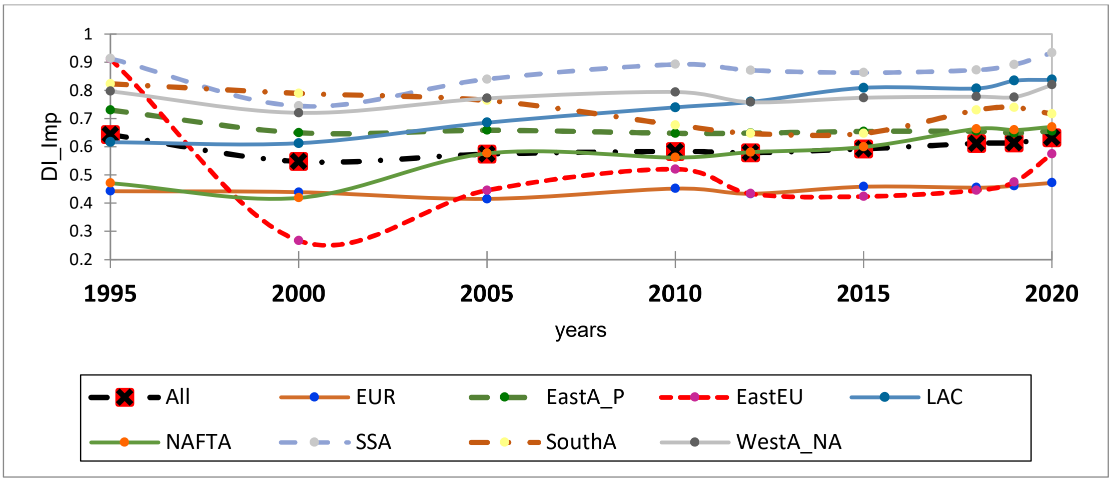



Note: The size of the disc represents the value of GI for all sectoral trade flows in 2020, base 100= 1995-2020; values range from a minimum of 100.3 (D26) to a maximum of 112.1 (D13T15).

## 6. Post Data on regional specificities

The TiVA data cover 76 countries in various regions of the world; it includes all OECD countries plus several emerging and developing countries. While the preliminary 2022 release extended the coverage to several developing countries, the regional distribution remains unbalanced. In particular, some regional results may be strongly affected by a single outlier (as has been the case with Eastern Europe). [17] For this reason, we refer only to the median results. Even so, the following results should be considered with precaution.

*Figure 3 Median GI for Imports by Region, All Sectors, 1995-2020*




When considering the median Globalization Indicator for imports (GI_Imp), we do not see a drop after 2015 nor after the COVID-19 (Figure 3). The sole exception is Sub-Sahara Africa, but if its GI_Imp indicator

[17] Eastern Asia and Pacific: 15 members; Eastern Europe: 4; Western and Central Europe: 31; South America: 5; North and Central America: 4; Southern Asia: 5; Sub-Sahara Africa: 5: Western Asia and North Africa: 7.

decreased in 2020 (0.72) it was after a significant recuperation from a low 0.65 in 2012–2015. Thus, we cannot exclude here a simple correction resulting from a regression to trend.

## 7. Deglobalization?

Despite talks of globalization's demise through trade wars and a pandemic, we could not see any clear signal of deglobalization between 2015 and 2020, the latest year for which data were available in OECD TiVA. Even if we identified a slow-down after 2015, our results do not show signs of near-shoring for the majority of importers. On the other hand, we should not conclude that it was "business as usual".

China's exports in computer and electronic equipment appears to have been affected by the China-US trade war of 2018-2019. Its GI indicator for Computer equipment exports dropped by −14% in 2019 and another −3% in 2020, against regional averages of 4% and 8%, respectively. China's GI_Exp indicator for Electrical equipment dropped also in 2019 (−9% year on year, compared to a positive 9% for the Eastern Asia and Pacific region); it continues to decrease in 2020 (−13%), but less than the substantial −25% observed in its region. This trend may also have resulted from more regionalised trade. Indeed, UNCTAD (2022) relates the 2009−2021 decline in average distance travelled by containerships to higher growth rates recorded on intra-Asian routes serving intraregional supply chains.

When looking at distance travelled by imports and differentiating between the Structural and the Globalization effects, the latter dominates over the whole period and remains positive (4 percentage points) between 2015 and 2020. On the export side, with the exception of Agriculture, all exporting industries registered higher globalization indicator between 2015 and 2020.

The analysis of Trade in Value-Added, based on the geographical origin of industrial value-added embodied in final products, projects a similar picture. As with the bilateral trade in physical products, the highest distance was reached in 2015, with a drop between 2015-2018 and anaemic growth afterwards. Interestingly, the COVID-19 induced a wider geographical diversification of value chains, resulting in a 3% increase of the TiVA GI_Imp in 2020. All in all, it is therefore premature to conclude that global trade has been suffering a deglobalization trend, at least up to 2018. Nonetheless, the situation is heterogeneous between countries and across sectors.

The large volume of results obtained when processing the data along the proposed methodology offers a rich source of information for identifying patterns, convergences and divergences. We superficially touched this matter using exploratory data analysis in the Annex.

## 8. Conclusions

We applied a new set of indicators rooted in trade empirics, operational research and information theory to analyse the evolution of distance travelled by traded products and disentangle the contribution of structural and globalization effects. Building on recent Trade in Value Added data developed by OECD (76 countries from 1995 to 2020), the methodology was applied to a selection of 11 industries covering different goods and services sectors presenting different levels of globalization.

With the exception of Motor vehicles industries, which tend to be organised according to regional considerations, all sectors presented positive indicators of globalization. Even if this trend slowed-down after 2015, there is no indication of a reversal after 2018, even after the COVID-19 pandemic: while trade volumes decreased in 2020, globalization endured. If there was some near-shoring, it does not appear in the results. We are therefore more in a situation of slowbalization than deglobalization. [18]

In truth, the proposed methodology cannot identify two related aspects of deglobalization: reshoring and friend-shoring. Indeed, we dealt only with international trade and did not consider the contribution of reverting to domestic supply (reshoring). And because the methodology is based on geographical distance, it cannot capture friend-shoring if the new trade partners are not closer to the home country. These shortcomings could be easily remedied by extending the analysis to the use of domestic inputs in addition to imported ones and by using another type of bilateral distance taking into consideration the geopolitical affiliations.

Finally, by exposing significant differences between sectors and between regions, our analysis showed that one-size does not fit all. Country size appears also to be important, large economies being more willing to trade with far-away partners. This is consistent with the main tenets of the gravity model and with the new "new" trade theory stating that only large firms can easily assume the sunk-costs associated with intercontinental trade.

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[18] Obviously, the geo-political tensions in the Indo-Pacific region and the violent conflicts that erupted in Eastern Europe, then in the Near East after 2020 will possibly change this state of affairs.

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# Annex: Exploring the statistical relationships between Globalization and Diversification indicators.

The Herfindahl–Hirschman index (HHI) is a commonly accepted measure of market concentration. When normalised, it ranges from 0 (full diversification) to 100 (full concentration on a single market). A preliminary review shows that some results, especially when disaggregating them by region, are based on few observations and within each sub-group, the in-between variance is usually high.

## d. Descriptive approach

Table 9 compares the median of countries’ HH indices of the different products over the period of analysis. Trade in Chemicals, and to some extent in IT services and Fabricated metal products are relatively well diversified in both their import and export dimensions. At the contrary, trade in Vehicles is region-specific, presenting the highest HHI for both import and export dimensions. The case of Pharmaceutical is interesting: very diversified when it comes to imports, median country’s exports are at the contrary very regionalised. An opposite situation is observed for Publishing and audio-visual services, highly diversified in terms of exports while more regionalised when it comes to imports.

*Table 9 Median HHI by sector, 1995−2020 averages.*

| Sectors | | Imports | | Exports | |
|---|---|---|---|---|---|
| Short label | Code | HHI | (Rank) | HHI | (Rank) |
| Pharmaceuticals | D21 | 8.8 | 1.0 | 12.8 | 10.0 |
| Chemicals | D20 | 9.6 | 2.0 | 9.2 | 3.0 |
| Agriculture | D01T02 | 9.7 | 3.0 | 11.2 | 9.0 |
| IT services | D62T63 | 10.1 | 4.0 | 9.5 | 5.0 |
| Metal products | D25 | 10.9 | 5.0 | 9.5 | 6.0 |
| Publishing | D58T60 | 12.2 | 6.0 | 7.6 | 1.0 |
| Financial services | D64T66 | 12.4 | 7.0 | 8.9 | 2.0 |
| Electrical equipment | D27 | 12.8 | 8.0 | 9.3 | 4.0 |
| Computers | D26 | 13.2 | 9.0 | 10.2 | 7.0 |
| Textiles | D13T15 | 14.8 | 10.0 | 11.1 | 8.0 |
| Vehicles | D29 | 15.6 | 11.0 | 15.0 | 11.0 |

Note: ranked by increasing geographical concentration (HHI) of imports.
Source: Author, based on OECD TiVA data (Gross trade flows)

We conclude this descriptive section by looking at the profile of each region according to four indicators: HHI for imports and for exports; GI calculated on imports and on exports. For each indicator, the regions are ranked from 1 (highest value) to 1 (lowest). The scores are based on the median calculated at country level.

There are differences in regional ranking when they are based on an average of sectoral means (not shown here) rather than medians. This said, South America appears to have the largest distance to imports and exports for both indicators. Yet, this is not reflected in high Globalization indicators, which are about average (4th rank). It means that the high distance to trade is due to geographical considerations or product composition. Sub-Sahara Africa, another region of the Southern hemisphere, is also characterised by long distances travelled, but, at the difference of South America, they show relatively high GI indicators.

*Figure 4 Regional score-chart on selected indicators, all years*


Note: Based on median countries in each region; scores on reverse order, 1= highest.

The shortest distances by unit value are found in Europe (East and West). This translates for them in high HHI and low ranking on Globalization Indicators, especially for the median Eastern countries (6.5 for GI_Imp and 7.4 for GI_Exp). North and Central American countries show also high concentration of their imports and exports (HHI), with relatively low ranking on their GI score.

The Western Asia and North Africa region ranks relatively low in terms of distance and has a relatively well diversified source of imports (HHI_Imp rank is next to last). It reflects in a relatively high GI indicator for imports (about 3) while its GI_Exp ranks lower than average (at or above 5).

East Asia and Pacific are within the average for all indicators (its average score across indicators is 4.1, with a low 0.6 standard deviation). A similar situation is observed for Southern Asia, with some differences in terms of exports: it ranks relatively high in terms of the geographical diversification of its exports (low value of HHI_Exp, second only to Europe) and rank well for its export-based GI.

### e. Further results from exploratory data analysis

Contrary to expectations, for any given product, there is no correlation at country level (either Pearson or Spearman) between HHI, which reflects geographic distribution of bilateral trade and our Globalization indicator GI, which associates geographic distribution with geographic distance. This result is confirmed by a broader Principal Component analysis, with the possible exception of Metal products (D25) where DI_Imp is somewhat negatively correlated with HHI_Imp. Similar (lack of) result is found when looking at variations between periods, which keep bilateral geographic distance constant. This shows the complementarity of the

HHI and the GI indices, the former being based on a simple count of export and import markets, irrespective of their localization while GI takes also into account remoteness.

It is only when aggregating results at regional level and looking at rank correlation that some patterns emerge. When considering all regions and all sectors, the average distances to import and to export are relatively well correlated (0.67). Considering that the product composition of import and exports is different within regions, the result is considered not being biased by difference in unit values. The GI for export is also correlated with the distance to export (0.73), much more than in the corresponding case of imports (0.51).

At regional level, this relationship between distance to export and GI_Exports holds in most cases. An interesting case is found in East Asia and the Pacific, where in addition we find a negative correlation between GI for exports and the average distance to import, as if globalised exporters had a tendency to import regionally (a finding consistent with the notion of "Factory Asia"). Similarly, there is a high correlation in South America between the average distance to export and the HHI for imports, this may be explained by specialization in exporting commodities worldwide while procuring imports from a few countries. This translates into a negative correlation in South America between the globalization index for import and for exports. No such a correlation is found for Sub-Sahara Africa, the other Southern Hemisphere region. Here we find a close correlation between GI-Imports and GI-Exports, perhaps due to the remoteness of the region and the lack of complementarity between regional trade partners.

When comparing the changes in HHI and GI indicators before and after 2015 based on cluster analysis, we observe very heterogeneous results. Eastern Europe and North and Central America are singled out as outstanding when considering all sectors, while Western and Central Europe and Western Asia and North Africa cluster together, close to the world average. South America, Eastern Asia & Pacific, Southern Asia and Sub-Saharan Africa constitute another cluster sharing common characteristics. Finally, some sectors tend to have common behaviour across regions. It is the case of Publishing (D58_T60); Chemicals (D20) and Computer equipment (D26).