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CIF/FOB margins: Insights on global transport and insurance costs of merchandise trade

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Abstract / Résumé

This paper presents the 2024 version of the OECD International Transport and Insurance Cost of Merchandise Trade (ITIC) database, offering insights into bilateral international transport and insurance costs across more than 200 countries and their trading partners. Covering over 1 200 products from 1995 to 2022, the database combines officially reported information with estimates based on a gravity model. The model operates at a detailed six-digit Harmonised System (HS) product code level, subsequently aggregated into four-digit HS product code categories for analysis. The findings of ITIC 2024 indicate that the COVID-19 pandemic had a more significant impact on international transport and insurance costs for trade between countries located in different continents compared to trade between partners within the same continent. Additionally, they confirm that trade costs have exhibited a declining trend during the study period, and that the CIF/FOB margins vary among different reporting entities, trading partners, and products.

Keywords: International trade, transport and insurance costs, CIF-FOB margin, gravity model.

JEL codes: F14, L91, C23.

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Cet article présente la version 2024 de la base de données du Coût des Transports Internationaux et de l'Assurance des Échanges de Marchandises (ITIC) de l'OCDE, offrant des perspectives sur les coûts bilatéraux de transport international et d'assurance de plus de 200 pays et leurs partenaires commerciaux. Couvrant plus de 1 200 produits de 1995 à 2022, la base de données combine des informations officiellement déclarées avec des estimations dérivées sur un modèle de gravité. Le modèle opère au niveau du code produit détaillé à six chiffres du Système Harmonisé (SH), ensuite agrégé dans des catégories de code produit SH à quatre chiffres pour l'analyse. Les conclusions du ITIC 2024 indiquent que la pandémie de COVID-19 a eu un impact plus significatif sur les coûts de transport et d'assurance internationaux pour le commerce entre des pays situés sur différents continents par rapport au commerce entre partenaires au sein du même continent. De plus, elles confirment que les coûts commerciaux ont présenté une tendance à la baisse de 1995 à 2022, et que les marges CIF/FOB varient selon les entités déclarantes, les partenaires commerciaux et les produits.

Mots-clés : Commerce international, coûts de transport et d'assurance, marge CIF-FOB, modèle de gravité.

Codes JEL : F14, L91, C23.

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CIF/FOB margins: Insights on global transport and insurance costs of merchandise trade

By Andrés Fiallos, Antonella Liberatore and Steven Cassimon[1]

1. Introduction

1. Measuring international transport and insurance costs is critical to understand the dynamics of merchandise trade. While numerous factors influence the volume and geography of international merchandise trade, transport costs and the related insurance charges have a direct and material impact on trade patterns and on a country's competitiveness. According to Hummels (1999[1]), transport and insurance costs can pose barriers similar in size and effect to import tariffs. Anderson and van Wincoop (2004[2]), estimated that transport costs represent around 30% of total trade costs. While technological advances and better infrastructure are generally acknowledged as drivers of the long-term decline in transport costs, these costs are still far from negligeable, especially in light of the surge in maritime and air freight rates witnessed during the COVID-19 pandemic (Daudin, Héricourt and Patureau, 2022[3]).

2. Quantitative information on transport and insurance costs associated with international merchandise trade is limited. Transaction-level data on these costs in monetary terms are generally not available to statistical offices, and even if they were, many different delivery terms would make aggregations by product and partner hardly feasible. An approach to compute these costs, consistent with the measurement of merchandise trade statistics, is to evaluate international transport and insurance costs in relative terms by looking at CIF/FOB margins, which correspond to the difference between the Cost, Insurance and Freight (CIF) and the Free-On-Board (FOB) valuation for the same import flow.

3. Although data availability on transport and insurance costs is gradually improving, as of today only around thirty economies make this information available with the required level of product and partner breakdown. The OECD has been working to fill this data gap since 2016, when the OECD International Transport and Insurance Costs of merchandise trade (ITIC) database was published for the first time (Miao and Fortanier, 2017[4]). ITIC provides information on international trade costs measured as CIF/FOB

[1] The authors were affiliated with the Trade and Productivity Division of the OECD Statistics and Data Directorate during the drafting of this paper. They thank Katia Sarrazin for her valuable input in the update of the database and Paul Schreyer, Asa Johansson, Annabelle Mourougane, Catherine Macleod, Minsu Park, Nohiriko Yamano, Colin Webb, and Silvia Sorescu for their insights and suggestions. Thanks to Ilda Duarte-Meyer from the German Central Bank (Deutsche Bundesbank), Andrea Carboni from the Italian Central Bank (Banca d'Italia), the French National Statistics office (Institut national de la statistique et des études économiques, INSEE), EUROSTAT, and the Joint Research Centre (European Commission) for the valuable exchanges. Special appreciation is extended to Virginie Elgrably for the editorial support.

margins at bilateral level, covering virtually all economies in the world and over a thousand products. Following the first publication, ITIC has seen two updates, each of them building on a larger and more detailed cross-country sample of official national statistics on observed CIF/FOB margins.

4. This paper accompanies the 2024 release of ITIC,[2] which provides estimates on international transport and insurance costs for over 200 reporters and partners, covering more than 1 200 products (at a HS four-digit product code level), and spanning 27 years (from 1995 to 2022), facilitating the analysis of international trade dynamics and costs at a granular level. In addition to incorporating a larger sample of explicit data, this update refines the existing methodology, notably to control for the effects of the COVID-19 pandemic on transport and insurance costs. It is worth stressing that ITIC is an analytical dataset, and as such it combines official information with estimations for non-reported data. As more countries report their imports according to both CIF and FOB, the quality of ITIC will gradually improve.

5. Key insights from the 2024 ITIC database are as follows:

- The global CIF-weighted average of CIF/FOB margins reached 4.9% in 2022, compared to an average of 4.3% in the years immediately preceding the pandemic.
- All regions experienced an increase in CIF/FOB margins after 2020, with the Pacific standing out with the most significant rise.
- In general, intracontinental trade shows lower international transport and insurance costs compared to intercontinental trade.
- An analysis of margins at the individual country level unveils significant heterogeneity. Strong heterogeneity is also observed at the product level.

6. The remainder of this paper is structured as follows: Section 2 provides definitions related to the measurement of international transport and insurance costs. Section 3 presents a descriptive analysis of observed CIF/FOB margins. Section 4 discusses the methodology employed to predict CIF/FOB margins for cases where they are not directly observed. Section 5 presents the key insights from the database. Finally, Section 6 concludes and discusses avenues for future research.

2. Definitions and related literature

What CIF/FOB margins measure and how they relate to international transport and insurance costs

7. A number of different arrangements, or terms of delivery, underpin international merchandise trade transactions. For instance, the invoice value for a given transaction may (or may not) include, in addition to the price of the good, domestic and/or international transportation costs, as well as different types of insurance coverage. Incoterms®,[3] or International Commercial Terms, define the terms of delivery and the responsibilities of exporters and importers in a standardised way (International Chamber of Commerce, 2020[5]).

8. Merchandise trade statistics are not valued, however, based on actual invoice values. To ensure that customs duties are calculated on a comparable basis across countries, the 'uniform point of valuation'

[2] Available in the OECD Data Explorer under the name **International transport and insurance costs of merchandise trade (ITIC)**.

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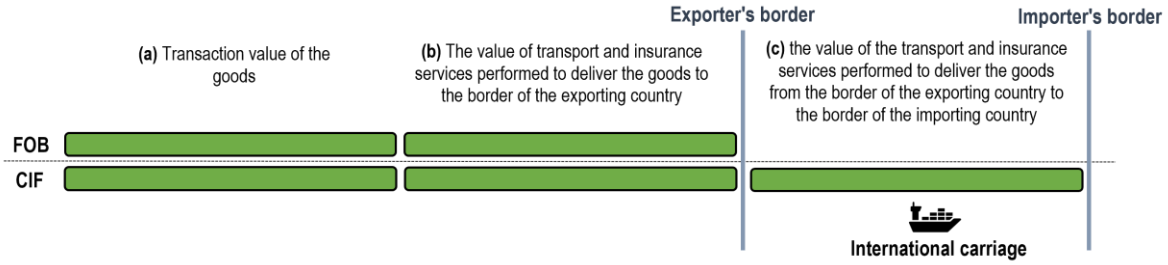
principle is used when measuring international merchandise trade. The statistical value[4] is defined in terms of three components: (a) the transaction value of the goods; (b) the value of transport and insurance services performed to deliver the goods to the border of the exporting country; and (c) the value of the transport and insurance services performed to deliver the goods from the border of the exporting country to the border of the importing country. The FOB-type value, where FOB stands for Free on Board, comprises components (a) and (b); the CIF-type value, where CIF stands for Cost, Insurance, and Freight, comprises the sum of (a), (b) and (c) (IMTS, 2010[6]).

9. Imports are traditionally recorded at CIF value in merchandise trade statistics, although international standards recommend publishing import data according to both CIF and FOB valuation (IMTS, 2010[6]). When both valuations are available for the same import flow, international transport and insurance costs can be measured in relative terms by looking at the difference between the CIF and the FOB valuation (Figure 1 and Section 3).

Figure 1. Illustration of the FOB and CIF valuation



Note: Although "FOB-type" and "CIF-type" terminology would technically be more appropriate, this paper uses CIF and FOB for brevity.
Source: Authors' own elaboration based on IMTS (2010[6]).

CIF/FOB margins in literature

10. CIF/FOB margins have been studied in the literature with various objectives. In exploring the determinants and dynamics of trade costs, these margins, which encompass transportation expenses, insurance costs, and other related factors, have been used to understand how trade costs contribute to the variation in trade patterns. Similarly, CIF/FOB margins have been used to develop estimates for transport and insurance costs as supplementary indicators for international trade. These efforts provide insights into trade dynamics and patterns, with examples including Pomfret and Sourdin (2010[7]), Sourdin and Pomfret (2012[8]), Streicher and Stehrer (2013[9]), Brown, Englert and Hoofmann (2021[10]) and Hoffmeister et al. (2022[11])

11. When it comes to measuring CIF/FOB margins, two distinct approaches are commonly employed. The first approach, followed in the OECD-ITIC database, relies on explicit margins reported by statistical offices, as demonstrated in studies by Hummels and Skiba (2004[12]), Clark, Dollar and Micco (2011[13]), Brown, Englert and Hoofmann (2021[10]) and Hoffmeister et al. (2022[11]). In contrast, the second approach seeks to infer transport and insurance costs implicitly by examining the disparities between import and mirror export flows, where imports are valued at CIF and exports at FOB, as explored by Gehlhar (1996[14]), Gaulier et al. (2008[15]) and Gaulier and Zignago (2010[16]).

[4] The customs value depends on national legislation and may differ from the statistical value (IMTS, 2010[6]).

3. The observed (explicit) CIF/FOB margins

12. The explicitly reported import data on CIF/FOB margins are the backbone of the computation and predictions of the international transport and insurance costs in merchandise trade. The observed margins are obtained by looking at the ratio between the CIF and the FOB values for the same transaction. Specifically, they are computed as follows:

$$CIF/FOB\ Margin_{ijkt} = \frac{CIF_{ijkt} - FOB_{ijkt}}{CIF_{ijkt}}$$

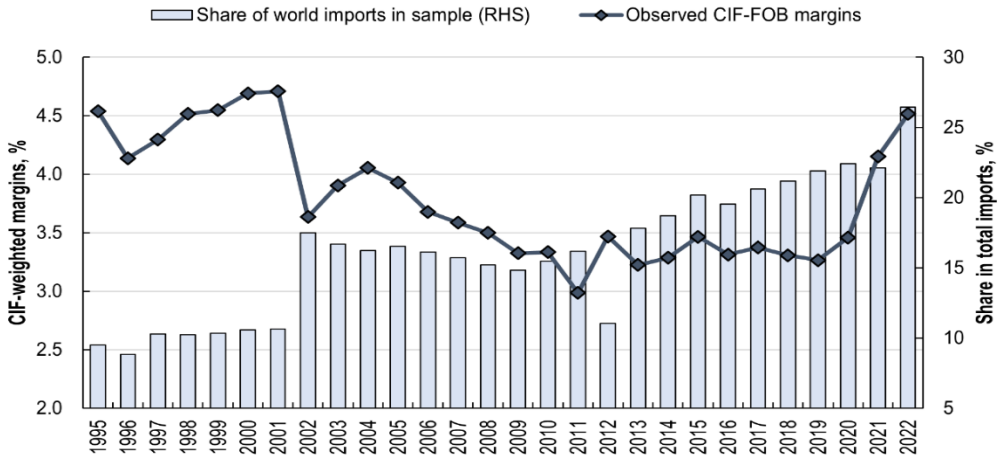
Where i identifies the reporter country (importer), j the partner country (exporter or country of origin of the imports), k the product, and t the year. The resulting margin is interpreted as the proportion of the CIF value of imports that corresponds to international transport and insurance costs.

13. The observed data used in ITIC is the largest and most detailed cross-country sample of official national statistics on explicit CIF/FOB margins to date. For the 2024 version of ITIC, the observed margins cover 34 countries, of which 13 are located in the Americas, 10 in Africa, 6 in Europe, 3 in the Pacific and 2 in Asia. The observed data are imports sourced from the UN COMTRADE database, by United Nations (2023[17]), and from the US Census Bureau (2023[18]). Some of the data from older vintages of UN COMTRADE are not available online anymore and were retrieved from the legacy data files used in previous updates of ITIC. This is the case for all data points from before 2000. Annex A shows the source of the observed CIF/FOB margins by country and year. A new feature in UN COMTRADE (2023[17]) is the availability of mode of transport data. However, currently, only a handful of countries for which we have observed margins are reporting this information and for a limited number of (mostly recent) years. Therefore, the mode of transport data was not used for this iteration of ITIC.

CIF/FOB margins over time

14. The observed data used in ITIC cover the period 1995-2022, with increasing coverage in terms of world trade (Figure 2). In 1995, the import value reported with both CIF and FOB valuations corresponded to 9.5% of the total available imports. By 2022, this figure represented 26.5% of total reported imports.

Figure 2. Observed CIF/FOB margins and share of world imports in sample by year



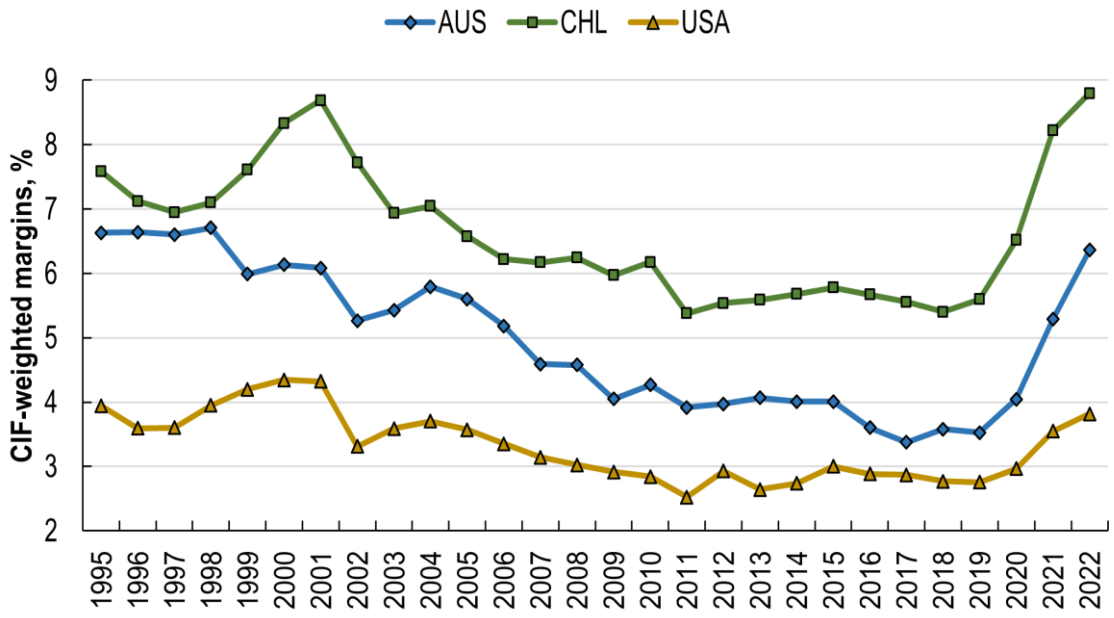
Note: The figure refers to total merchandise trade. Product-level margins (at six digits of the Harmonised System) are aggregated using the CIF value of imports as weights (CIF-weighted margins = sum (CIF value * observed margin) / sum (CIF value)).
Source: Authors' calculation based on data from United Nations (2023[17]) and US Census Bureau (2023[18]).

15. The number of reporting countries (and therefore their partner and product composition), and the completeness of the reported information for each country, show large variation over time (Annex A). At the start of the series, countries with high observed margins and relatively low trade participation comprise most of the sample. The increase in coverage observed in 2002, as well as the temporary drop in 2012, largely reflects variations in data availability for the United States.

16. The aggregated CIF/FOB margins by all countries and all products show an overall declining trend during 1995 to 2019, followed by a sharp increase since 2020. For the entire period the observed CIF/FOB margins have been fluctuating between 3 and 5%, the highest being in 2001 and the lowest in 2011. The data also shows substantial cross-country variation, with countries like the United States, Czechia, and Slovak Republic with a CIF-weighted average margin of around 3%, and others such as Mozambique, Madagascar, and Dominican Republic with a CIF-weighted average margin of around 10%.

17. In the sample, only three countries have observed CIF/FOB margins for the complete period (1995-2022): Australia, Chile, and the United States. Of these, the United States consistently presents the lowest margins (Figure 3). Despite Australia's remote geographical location, its observed CIF/FOB margins are lower than those observed in Chile. This South American country experienced a peak in its costs of international transport and insurance in the year 2000 when its CIF-weighted average margin reached 8.7%. After this peak, the margin gradually decreased until 2019, and then reached 8.8% in 2022. In Australia, while the margins were 3.5% in 2019, they increased to 6.4% in 2022. For the United States, the increase is evident but appears to be less steep, with margins growing by around one percentage point from 2019 to 2022.

Figure 3. Observed CIF/FOB margins in Australia, Chile and the United States

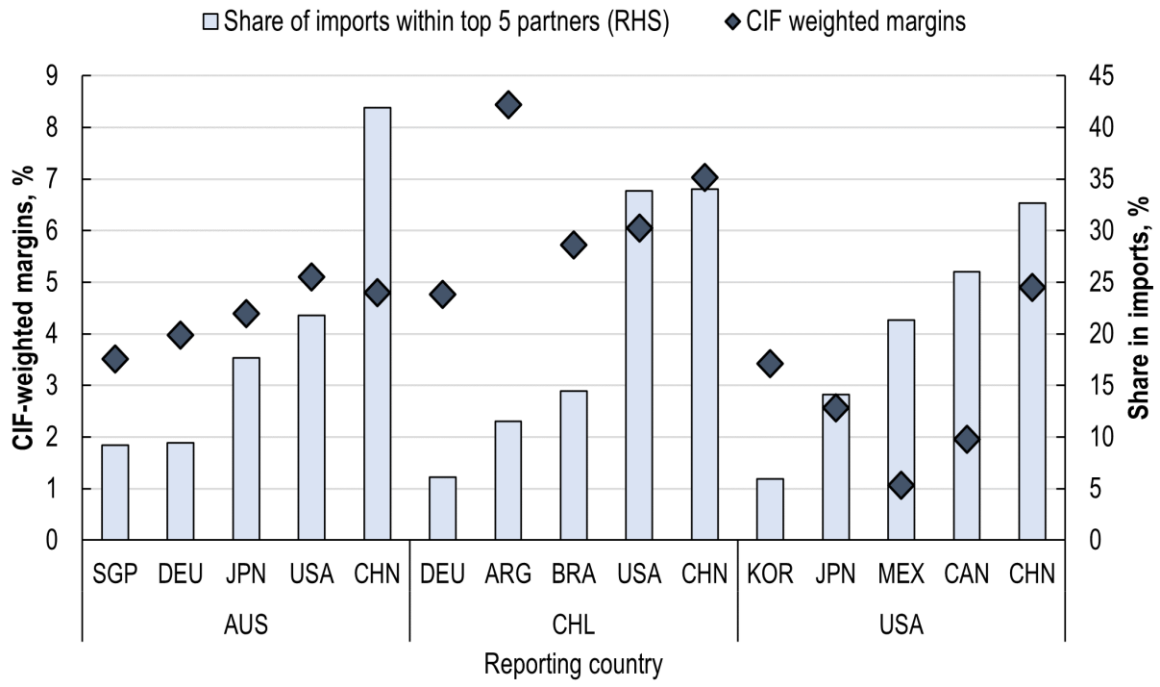


Note: The figure refers to total merchandise trade as reported, reflecting varying partner and product compositions. Product-level margins (at six digits of the Harmonised System) are aggregated using the CIF value of imports as weights (CIF-weighted margins = sum (CIF value * observed margin) / sum (CIF value)).
Source: Authors' calculation based on data from United Nations (2023[17]) and US Census Bureau (2023[18]).

CIF/FOB margins by trade partners

18. Cross-country variation also occurs when analysing the partner dimension, as margins in general increase proportionally with the geographical distance between the two trading partners. To continue with the countries with full coverage for 1995-2022, in the case of the United States the lowest margins are associated, as expected, with its geographical neighbours (Figure 4): Canada with an average CIF/FOB margin of 2% across 1995 to 2022, and Mexico with an associated margin of 1.1%. However, for Chile, trade with Argentina (one of its neighbours) has the largest margin associated within its top five partners. Chile's lowest margin is associated with trade with Germany, while countries in the same continent such as the United States, Brazil, and Argentina present higher margins. For all three countries, China is the largest source of imports from 1995 to 2022, accounting for more than 40% of Australian imports and around 33% of imports of the United States and Chile. The trade costs associated with imports from China are around 5% for the United States and Australia, and 7% for Chile.

Figure 4. Observed margins and share of import value across top five trading partners, 1995-2022



Note: The figure refers to total merchandise trade as reported, reflecting varying product compositions. Product-level margins (at six digits of the Harmonised System) are aggregated using the CIF value of imports as weights (CIF-weighted margins = sum (CIF value * observed margin) / sum (CIF value)).
Source: Authors' calculation based on data from United Nations (2023[17]) and US Census Bureau (2023[18]).

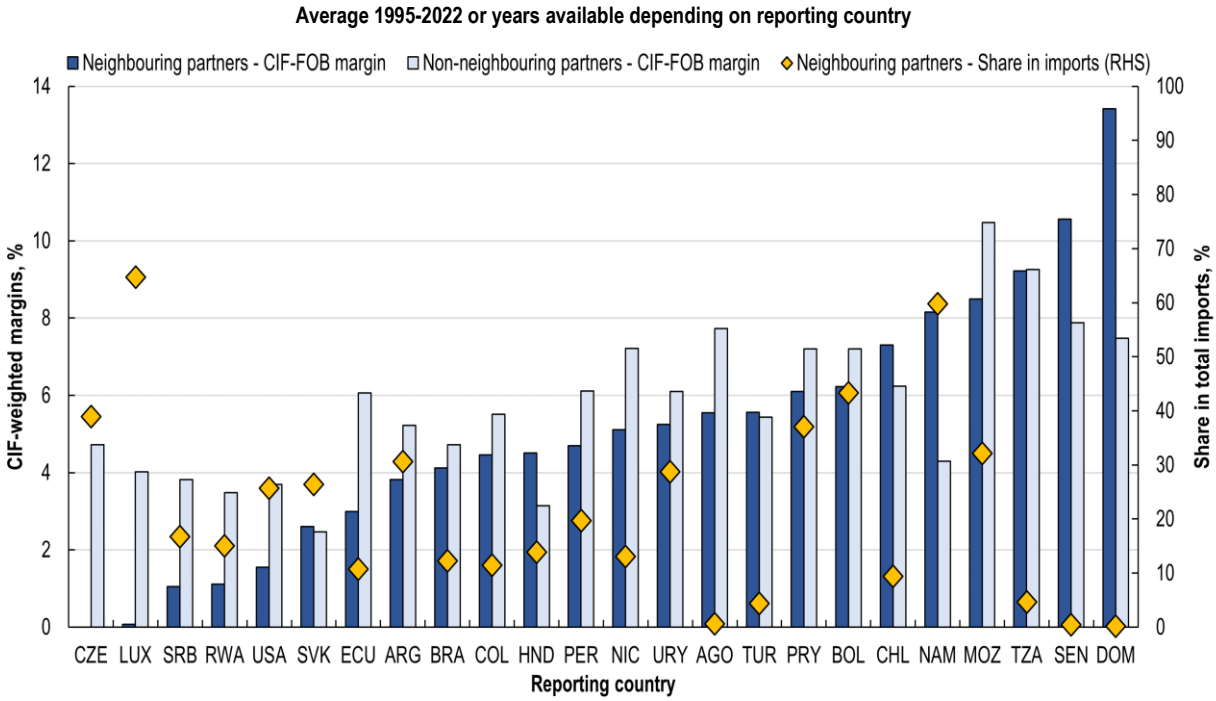
CIF/FOB margins for neighbouring trade partners

19. The theoretical model behind the CIF and FOB valuation implies that the CIF/FOB margin between two contiguous countries should be zero, as the FOB price is equivalent to the CIF price at the (common) border (see Figure 1). In practice, this may not always be the case, due to factors such as the mode of transport (the uniform point of valuation model is based on maritime transport) or the trade route taken (trade between two contiguous countries may transit through a third economy, e.g. in presence of physical barriers). In South America, for example, the Andes affect the trade routes and hence weigh on the

international transport and insurance costs, even when trading partners are neighbours (Miao and Fortanier, 2017[4]). Another situation that challenges this assumption is when the country of consignment differs from the country of origin. In such cases, the traded merchandise arrives at the importer's country being dispatched from a third country, distinct from the exporter's country. If the importer and exporter countries are physically neighbouring each other, but the country of consignment is not neighbouring the importing country, then there may be costs of international transport and insurance associated with the transaction.

20. The observed CIF/FOB margins indicate that, for most countries in the sample, the margin for imports from neighbouring partners is lower than those from non-neighbouring countries, though not necessarily equal to zero. Only Czechia and Luxembourg report CIF/FOB margins of zero for imports originating from neighbouring countries (Figure 5). Czechia, shares borders with four countries (Germany, Poland, Austria, and Slovak Republic), which collectively account for approximately 40% of Czechia's total imports. Luxembourg has an even higher proportion of its total imports sourced from neighbouring countries, observed at around 65%. In contrast, countries such as the Dominican Republic, Senegal, and Angola report minimal imports from contiguous partners, with associated margins sometimes exceeding those from non-contiguous partners, as observed in the cases of the Dominican Republic and Senegal. Namibia, despite having more than 60% of its imports coming from neighbouring countries, has an observed CIF/FOB margin for these countries of around 8%, whereas imports from non-contiguous countries have a lower margin, of around 4%.

Figure 5. Imports from neighbouring and non-neighbouring partners: Observed CIF/FOB margins and share in total imports

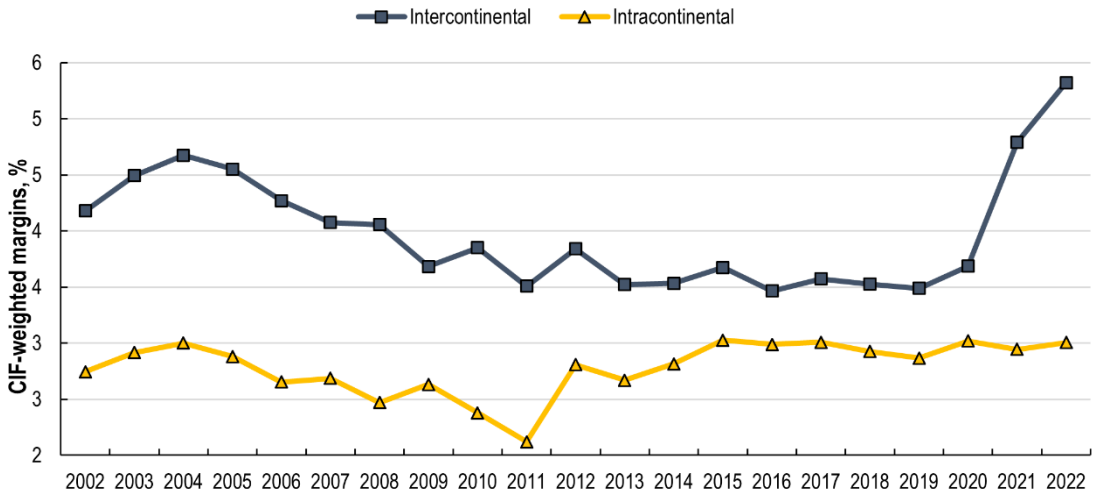


Note: The figure refers to total merchandise trade as reported, reflecting varying partner and product compositions. Product-level margins (at six digits of the Harmonised System) are aggregated using the CIF value of imports as weights (CIF-weighted margins = sum (CIF value * observed margin) / sum (CIF value)). Reporting countries vary across years. The average for each country may represent some years between 1995 and 2022, not the complete period.
Source: Authors' calculation based on data from United Nations (2023[17]) and US Census Bureau (2023[18]).

CIF/FOB margins during COVID-19

21. The observed data on CIF/FOB margins suggest a significant increase in overall margins from 2020-2022 (Figure 2). Additionally, during the COVID-19 pandemic international trade costs varied depending on whether both trade partners are within the same continent or located on different continents (Figure 6). Historically, intra-continental trade has exhibited lower margins than inter-continental trade, likely due to the prevalence of road transport over sea transport, which is typically more cost-effective. However, while intra-continental trade maintained its level during and after the pandemic, inter-continental trade experienced a significant increase in that period, suggesting a potential amplification of the pandemic's effect on international transport and insurance costs for trade between countries located on different continents compared to those located on the same continent.

Figure 6. Observed CIF/FOB margins: Inter- vs. intracontinental trade, 2002-2022



Note: The figure refers to total merchandise trade as reported, reflecting varying partner and product compositions. Product-level margins (at six digits of the Harmonised System) are aggregated using the CIF value of imports as weights (CIF-weighted margins = sum (CIF value * observed margin) / sum (CIF value)).
Source: Authors' calculation based on data from United Nations (2023[17]) and US Census Bureau (2023[18]).

4. Estimating non-observed CIF/FOB margins

22. Since only 34 countries currently report both CIF and FOB valuations for their import data, estimations are produced for the remaining countries in order to achieve global coverage. The estimations are based on a gravity model, building on Miao and Fortanier (2017[4]) and Miao and Wegner (2022[19]), with several refinements. These refinements, explained in more detail below, include changes to the gravity model to consider the COVID-shock, special treatment of EU neighbouring trade, inclusion of margins for countries reporting exclusively FOB for imports and an updated procedure to deal with missing values and time series calibration.

23. The methodology underlying the OECD ITIC database consists of a three-step process:

- **Step 1:** all available official statistics on imports with both CIF and FOB prices are gathered, broken down by partner country and by commodity at the six-digit level of the Harmonised System (HS) classification, and pre-processed for the analysis.

- **Step 2:** a gravity model is estimated and used to predict the CIF/FOB margins for countries lacking explicit data.
- **Step 3:** explicit data and estimates are aggregated from six digits HS codes to four digits codes, calibrated to fit the observed data, and validated to produce the final ITIC.

The next subsections are dedicated to developing each of these steps.

Step 1: Cleaning and pre-processing the data

24. After having collected all available official statistics on imports with both CIF and FOB prices, a data cleaning process is performed before estimating the model with the objective of removing outliers, implausible or incomplete data that could potentially distort the estimated coefficients:

- **Filtering outliers:** data points with explicit margins higher than 40% are removed from the dataset. This process results in filtering out approximately 5% of the initial sample (1 040 889 observations).
- **Elimination of cases lacking quantity information:** observations lacking quantity unit and quantity (necessary to compute unit values) are omitted from the training dataset. A total of 218 470 observations (1,1% of the sample after filtering for outliers) were dropped because of missing quantity information.
- **Removal of cases with CIF less than FOB:** instances where the CIF values are lower than FOB values are excluded from the sample, assuming misreporting. These cases accounted to 69 226 observations.
- **Identification and removal of year-specific inconsistencies**: implausible jumps in time series were eliminated for Bolivia, Madagascar, and Rwanda, amounting to 200 418 observations being filtered out (Annex B).

Harmonisation of quantity units

25. To ensure the comparability of unit values, concordances were established between national quantity units and international standards in a simplified manner. This process impacts the computation of the median unit values, used as explanatory variable in the model, since they vary by quantity units. The outcomes of this harmonisation effort are presented in Table 1. The units of weight in kilogrammes and number of items emerged as the two most prevalent quantity units, accounting for around 95% of total observations. In this process, country and product-specific quantity unit classifications were transformed to their closest possible match after a meticulous examination of diverse quantity units. Certain units in the data, such as Gross Lines, Jewel, Megabecquerels, and Ozone Depletion Equivalent, used for very few transactions, proved challenging to align with any standard quantity unit and were therefore excluded from the analysis.

Table 1. Harmonised quantity units

Quantity unit	Number of observations	Percentage of total number of observations
Weight in kilogrammes	13 746 226	69.71%
Number of items	5 068 087	25.70%
Number of pairs	193 047	0.98%
Volume in litres	163 123	0.83%
Area in square meters	416 384	2.11%
Volume in cubic meters	62 350	0.32%
Length in meters	37 322	0.19%
Number of packages	3 564	0.02%
Thousands of items	16 151	0.08%
Weight in carats	11 365	0.06%
Electrical energy in thousands of kilowatt-hours	420	0.00%
Total	**19 718 039**	**100%**

Source: Authors' own elaboration.

Creation of auxiliary product codes to maintain consistency across HS versions

26. The import data used in ITIC follow the version of the Harmonised System (HS) classification as reported by countries. Given this, two related but distinct issues need to be tackled: first, the evolution of the HS classification over time, as the period of study covers six HS versions. Second, countries may switch to the updated HS with a lag of a few years, meaning that multiple versions of the HS classification may coexist in the dataset for the same year. For this study, it is necessary to identify identical products over time, even if they may be associated to different product codes. Rather than converting all data to the same HS version, auxiliary product codes are used to maintain consistency across different HS versions and facilitate the tracking of products over time. The use of these auxiliary product codes preserves the panel structure of codes across HS versions, facilitating the simultaneous estimation of all HS versions in the gravity model. The auxiliary codes are also used when creating the groups for the computation of the median unit values, improving their accuracy.

27. To create the auxiliary codes, a correlation table provided by the UNSD (2023[20]) is used. The process replicates that by Miao and Fortanier (2017[4]) and entails mapping and assigning codes from previous HS versions to new codes in subsequent ones. The method ensures that each code has a consistent meaning. Some HS six-digit codes remain unchanged-across versions, and thus do not require the creation of auxiliary codes.

Step 2: Estimating the gravity model and predicting the margins

Model selection

28. The COVID-19 pandemic has caused significant disruptions in international transport and insurance costs. According to the reported data, the discrepancy in margins between intra-continental and inter-continental trade increased significantly after 2020 (Figure 6). To ensure a better fit of the model during the affected years, it was deemed necessary to control for this effect in the gravity model. To achieve this, alternative models were tested, and a cross-validation procedure based on Miao and Wegner (2022[19]) was used to select the most appropriate specification.

29. The cross-validation procedure involved iterating through all countries with explicitly observed CIF/FOB margins, by removing from the training set the reported data for one country at a time. The training data, which included explicit data from all other countries, were then used to estimate different model

specifications. In the final stage, the estimated coefficients were used to predict margins for the excluded country.

30. This iterative process allowed for the validation of model performance out of sample, ensuring the selection of the best model for predictions. To assess the performance of each model, the difference between the predicted and explicitly reported margins were evaluated using standard accuracy measures (Root Mean Square Error (RMSE) and Mean Squared Error (MSE).

31. The specifications tested are as follows:[5]

- Model 1 **(baseline model)**: which corresponds to that estimated by Miao and Wegner (2022):

$$\boldsymbol{y}_{ijkt} = \beta_0 + \beta_1 \boldsymbol{distw}_{ij} + \beta_2 \boldsymbol{distw}_{ij}^2 + \beta_3 \boldsymbol{gdppc}_{it} + \beta_4 \boldsymbol{gdppc}_{jt} + \beta_5 \boldsymbol{poil}_t + \beta_6 \boldsymbol{yrt}_t + \beta_7 \boldsymbol{same\_continent}_{ij} + \beta_8 \boldsymbol{contiguity}_{ij} + \beta_9 (\boldsymbol{distw}_{ij} \times \boldsymbol{same\_continent}_{ij}) + \beta_{10} (\boldsymbol{distw}_{ij}^2 \times \boldsymbol{same\_continent}_{ij}) + \beta_{11} \boldsymbol{uvmdn}_{kt} + \delta_{k4} + \delta_j + \varepsilon_{ijkt}$$

Where:

- $\boldsymbol{y}_{ijkt}$ corresponds to the log of the CIF/FOB margin[6] of a specific product k imported by country i from country j at year t.
- $\boldsymbol{distw}_{ij}$ is the log of the population-weighted distance between countries i and j.
- $\boldsymbol{gdppc}_{it}$ and $\boldsymbol{gdppc}_{jt}$ are the log of GDP per capita of country i and j in year t.
- $\boldsymbol{poil}_t$ is the log of the average annual price of crude oil (in USD per barrel).
- $\boldsymbol{yrt}_t$ corresponds to a linear time trend.
- $\boldsymbol{same\_continent}_{ij}$ and $\boldsymbol{contiguity}_{ij}$ correspond to the geographical situation of country i relative to country j – if they are in the same continent, and if they share common borders, respectively.
- $\boldsymbol{uvmdn}_{kt}$ is the log of the median unit value of each HS six-digit product k in year t.
- δ_{k4} are product fixed effects (at HS four-digits product level,) and δ_j partner fixed effects.
- $\boldsymbol{\varepsilon}_{ijkt}$ is the error term.

- Model 2: **baseline model** + $\boldsymbol{covid}_t$, which corresponds to a dummy variable that identifies the years 2020, 2021 and 2022.
- Model 3: **baseline model** + $\boldsymbol{covid}_t$ + ($\boldsymbol{covid}_t \times \boldsymbol{same\_continent}_{ij}$). The interaction term aims to capture the different effects of the pandemic depending on whether trade partners are in the same continent or not (intracontinental trade vs. intercontinental trade).

[5] A version of the baseline model that incorporated the log of the Baltic Freight Index was also considered, yet it was omitted from the final cross-validation process as it produced implausible outcomes, particularly around the periods of the financial crisis of 2008 and the COVID-19 pandemic.

[6] In the model data, the dependent variable (CIF/FOB margin) is always greater than zero, which is required to introduce the log-linear transformation.

32. Results from the cross-validation show that, although the differences are rather small, model 3 exhibits the lower RMSE and MSE than the other models (Table 2).

Table 2. Accuracy measures by model

	Average across countries and time	
Model	**RMSE**	**MSE**
Model 1	0.066369	0.004405
Model 2	0.066299	0.004395
Model 3	**0.066275**	**0.004392**

Note: Lowest error in **bold**.
Source: Authors' calculations.

33. Upon examining the frequency with which each model was selected as the best fit by different countries, model 1 showed the best results for 13 countries, while model 2 and model 3 did for 9 and 12 countries, respectively. Consequently, a secondary comparison between model 1 and model 3 was conducted, revealing that model 3 is preferred over model 1. Specifically, model 3 showed the best results for 21 countries, whereas model 1 did for 13 countries.

34. Focusing on the years 2020, 2021, and 2022, model 3 consistently outperformed the other two models. In 2020 and 2021, out of 20 countries that reported explicit CIF/FOB margins in those years, model 3 exhibited the lowest RMSE and MSE for 9 and 13 countries, respectively. Furthermore, in 2022, with 22 countries reporting observed margins, the RMSE for 16 of them was lower for model 3 compared to model 1. Based on these findings, model 3 was selected and used in the 2024 ITIC update.

Estimating the gravity model

Model specification

35. In line with the results of the cross-validation exercise, the model estimated in the 2024 version of ITIC corresponds to the following:[7]

$$\boldsymbol{y}_{ijkt} = \beta_0 + \beta_1 \boldsymbol{distw}_{ij} + \beta_2 \boldsymbol{distw}_{ij}^2 + \beta_3 \boldsymbol{gdppc}_{it} + \beta_4 \boldsymbol{gdppc}_{jt} + \beta_5 \boldsymbol{poil}_t + \beta_6 \boldsymbol{yrt}_t + \beta_7 \boldsymbol{same\_continent}_{ij} + \beta_8 \boldsymbol{contiguity}_{ij} + \beta_9 (\boldsymbol{distw}_{ij} \times \boldsymbol{same\_continent}_{ij}) + \beta_{10} (\boldsymbol{distw}_{ij}^2 \times \boldsymbol{same\_continent}_{ij}) + \beta_{11} \boldsymbol{uvmdn}_{kt} + \beta_{12} \boldsymbol{covid}_t + \beta_{13} (\boldsymbol{covid}_t \times \boldsymbol{same\_continent}_{ij}) + \delta_{k4} + \delta_j + \boldsymbol{\varepsilon}_{ijkt}$$

Data sources for explanatory variables

36. The explanatory variables used to estimate the CIF/FOB margins are extracted from the following data sources:

- The population-weighted distances are sourced from the CEPII Gravity Database (Conte, Cotterlaz and Mayer, 2022[21])
- GDP per capita is obtained from various sources depending on availability. The preferred source is the World Economic Outlook by the International Monetary Fund (2023[22]). Gaps were filled using data from the World Development Indicators by The World Bank (2023[23]), GDP per capita by the United Nations (2023[24]), the Series of Gross Domestic Products by the French National

[7] Variables are defined in the *Model Selection* section.

Institute of Statistics and Economic Studies INSEE (2023[25]), and data from the US Bureau of Economic Analysis (2023[26]).

- The oil prices correspond to the Crude Oil Prices: West Texas Intermediate (WTI) dataset, sourced from the Reserve Bank of St. Louis (2023[27]).
- The information on the same continent and contiguity of a country is sourced from the CEPII-GeoDist Database (Mayer and Zignago, 2011[28]).
- The computation of the median unit value ($\boldsymbol{uvmdn}_{kt}$) involves a two-stage process. Firstly, the unit value is calculated for each observation, taking the trade value, and dividing it by the quantity for every reporter i partner j, product k and year t available in the data set. In the second phase, the previously calculated unit values are grouped by year t, and product k. This grouping is performed to obtain the median of all unit values for a specific product at world level.

Estimates

37. The gravity model was fitted on the (cleaned) training dataset using OLS. The results of the estimation in general confirm a priori expectations (Table 3). For comparison, the table also shows the coefficients estimated in the 2022 ITIC update (Miao and Wegner, 2022[19]).

Table 3. Gravity model coefficients and comparison with the previous version of ITIC

	2024 ITIC		2022 ITIC	
Term	**Coefficient**	**t statistic**	**Coefficient**	**t statistic**
(Intercept)	0.986***	65.21	0.640***	73.7
distw	-0.051***	-54.27	-0.055***	-46.86
distw_sq	0.003***	68.48	0.003***	54.85
contiguity	-0.012***	-153.23	-0.013***	-155.28
GDP per capita partner country	-0.006***	-104.81	-0.006***	-104.95
GDP per capita reporting country	-0.005***	-430.62	-0.004***	-295.2
Price of oil	0.008***	225.67	0.005***	146.78
year	-0.0003***	-102.69	-0.0001***	-37.31
same_continent	-0.405***	-91.31	-0.705***	-124.01
distw_same_continent	0.089***	90.51	0.168***	132.01
distw_sq_same_continent	-0.004***	-84.85	-0.009***	-137.47
covid	0.011***	234.21	n/a	n/a
covid_same_continent	-0.010***	-141.25	n/a	n/a
Number of observations		19 718 039		14 745 201
R-square		0.1275		0.1139
Root MSE		0.06113		0.0577

Note: For presentation purposes, some regressors are omitted from this table (median unit values, product, and partner fixed effects).
*** p-value < 0.01.
Source: Authors' calculation.

38. The COVID-19 pandemic has a positive relationship with CIF/FOB margins, but this effect is lower when trading partners are located in the same continent. Intracontinental trade, or trade that happens between partners located in the same continent, is associated with lower margins, as suggested by the *same_continent variable*. This effect is estimated to be smaller than in previous update. Additionally, a negative linear time trend points to a slight decline in international insurance and transport costs over the period. Moreover, neighbouring trade partners experience a reduction in margins compared to non-neighbouring partners, as suggested by the coefficient associated with the *contiguity* variable.

Predicting the margins

39. The next stage is to use the estimated model to predict the margins for the rest of the world, by partner and product at HS six-digit code level.

Ensuring a full dataset: Expansion of test set

40. The test dataset (for which the predictions are made) comprises all the annual import data as reported by countries. For most countries, import data are reported under a CIF valuation. However, a handful of countries report imports under a FOB price for all or some years. UN COMTRADE (United Nations, 2023[17]) serves as the exclusive data source for the test dataset. Since all the import data available is retrieved, predictions will be made even for cases with observed CIF/FOB margins. The harmonisation of quantity codes and the creation of auxiliary product codes to maintain consistency across HS versions are also applied to the test dataset in the same way they were applied to the training set.

41. In the test dataset, all records where imports are recorded (in CIF) are treated as 'observed trade'. However, note that the observed trade data are often incomplete. To address this, a complete matrix spanning from 1995 to 2022 is created for each reporter-partner-product-quantity unit group at a six-digit HS code level. For the newly generated cases, a CIF value of 0 is assigned, treated as 'unobserved trade'. Predictions are produced for both observed and unobserved trade, resulting in a full matrix of nearly one billion observations at HS six-digit level.

Step 3: Aggregation and validation

Aggregating the margins from six-digits to four-digits HS codes

42. Once the predictions for the margins are obtained at a six-digit HS classification codes level, they are aggregated into four-digit HS codes using either a CIF-weighted average (the preferred option), or a simple average if there is no observed trade for that specific transaction (across the six-digit codes corresponding to the same four-digit code). More details on this process are available in Annex C.

Handling negative predictions

43. Negative CIF/FOB margins are considered implausible. To address this issue, the positive minimum CIF/FOB margin is extracted from each specific reporter-partner-year group, representing the minimum across all products. When a negative value is encountered within a reporter-partner-product-year group, the corresponding positive minimum is imputed as a replacement.

Imputation of margins equal to zero for trade between neighbouring countries in the European Union, Norway, and Switzerland

44. An important methodological change introduced in this version of ITIC concerns how CIF/FOB margins between neighbouring countries are handled. As discussed in Section 3, margins are theoretically zero for countries that share a border, while the explicit data contains instances of both zero and non-zero margins for countries that share a border. To acknowledge the prevalence of land transportation and, more generally, deep trade integration, margins between neighbouring countries were set to zero for member countries of the European Union, as well as Norway and Switzerland. In all other cases, the model estimates were not constrained.

Predicting margins for countries which report FOB imports[8]

45. A handful of countries in the sample provide only FOB prices for some of their import data. In these cases, model-based estimates are produced at HS six-digits level, subsequently aggregated to four digits via simple averages (i.e. they are treated as unobserved trade). This treatment differs from the previous releases of ITIC, as margins were not provided for countries that reported their imports in FOB valuation.

Imputation of margins for non-predicted cases due to lack of regressors

46. The test data includes some partners, in general very small economies, that are not reported by any of the countries with observed CIF/FOB margins. For these partners, direct prediction of margins by the model is not possible, as there are not partner effects coefficients. Additionally, other regressors such as GDP per capita, distance, and other trade cost variables included in the model may not be available for the entirety of the test data. Annex D contains the details of countries that cannot be estimated due to missing regressors.

47. Gaps are filled by imputing CIF-weighted averages across different groups on an iterative basis until all gaps are filled. The groups considered for the computation of CIF-weighted averages are as follows (in order of preference):

- Group 1: same reporter - all partners – four-digits product code - year
- Group 2: same reporter - all partners – two-digits product code - year
- Group 3: all reporters - same partner – four-digits product code - year
- Group 4: all reporters - same partner – two-digits product code - year
- Group 5: all reporters - all partners – four-digits product code - all years.

Calibration

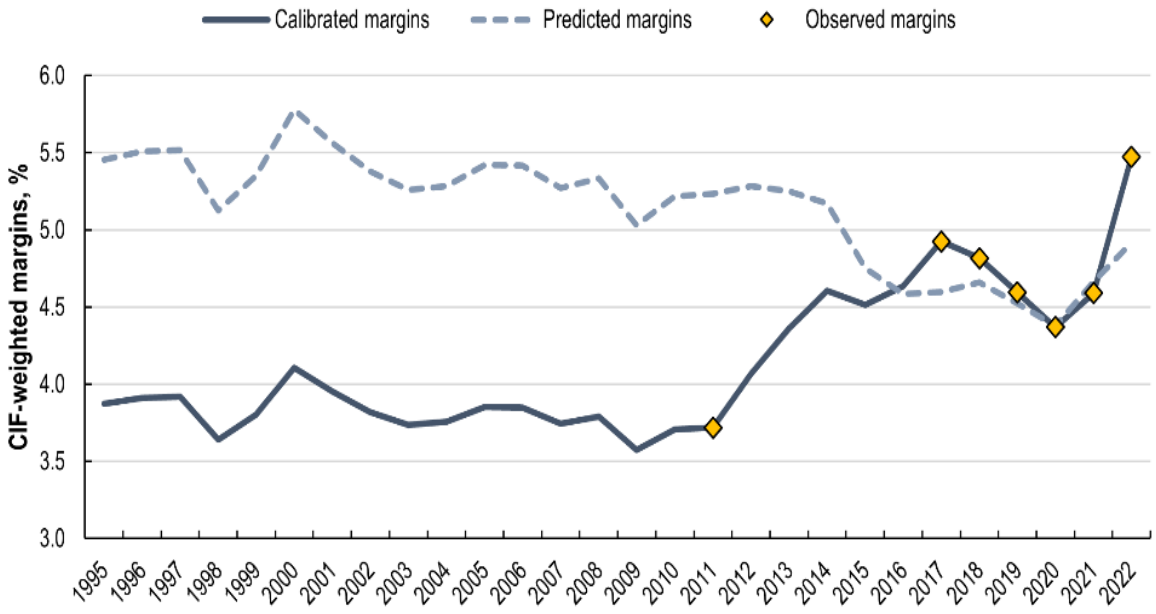
48. The final ITIC dataset comprises a blend of observed and estimated CIF/FOB margins. As complete observed margins are unavailable for the entire period spanning 1995 to 2022, model estimates are used to fill these gaps in the time series. To ensure broad coherence between observed and estimated margins, model-based estimates are calibrated to the explicit data.

49. Since predictions were generated for all observations, including cases with observed margins, comparing the observed data with the estimated values is the first step of the calibration process. The ratio between the observed and estimated margins is calculated at the reporter-partner-product-year level, and then used as a basis for calibration for years lacking observed margins. Every observation available for a country with observed data needs a ratio for the calibration process. In cases where new products and partners are introduced in the test data but not included in the observed data, a more generalised ratio is computed based on reporter-year groups. The ratios are then applied to adjust estimated CIF margins, which results in calibrated series.

50. Figure 7 presents an example of the calibration process. In the case of imports of *Children's picture, drawing or colouring books,* under HS code 4903, from France and reported by importing country Czechia, observed data on CIF/FOB margins are available for 2011 and from 2017 to 2022. Using the model predictions, it is possible to calibrate the predicted margins so that they fit the level of the observed data.

[8] The eight countries reporting only FOB values in some of their import data are Canada, Dominican Republic, Mexico, Mozambique, Palau, Bermuda, Bolivia, and South Africa.

Figure 7. Calibration procedure: adjusting the estimated margins to fit the observed series



Note: The calibrated series corresponds to the final series. Product-level margins (at six digits of the Harmonised System) are aggregated using the CIF value of imports as weights (CIF-weighted margins = sum (CIF value * observed margin) / sum (CIF value)).
Source: Authors' calculation.

51. In the final dataset, specific methodological codes are used to distinguish reported from estimated data, and to flag other adjustments and aggregations (Annex E).

Validation using 2022 ITIC and external sources

52. The validation of the results of this ITIC update was conducted in multiple stages. The initial stage involved a detailed analysis at the level of reporter-partner-product groups, wherein a coefficient of variation was computed for each group. This step aimed to identify any significant deviations, inconsistencies within the dataset or implausible values.

53. The second stage compares the aggregated margins with those from the previous iteration of the database (Miao and Wegner, 2022[19]). This comparison was performed at the reporter country level, aggregating across all products, and at the product level, aggregating across all reporters and partners. The analysis revealed that, while the projected margins exhibit similar trends, the methodology changes implemented in this version of ITIC have resulted (in general) in lower margins compared to those published in the previous edition of the database. At the aggregate level, the 2024 margins are about half a percentage point lower than those estimated in 2022, largely because of the different treatment of trade between neighbouring economies.

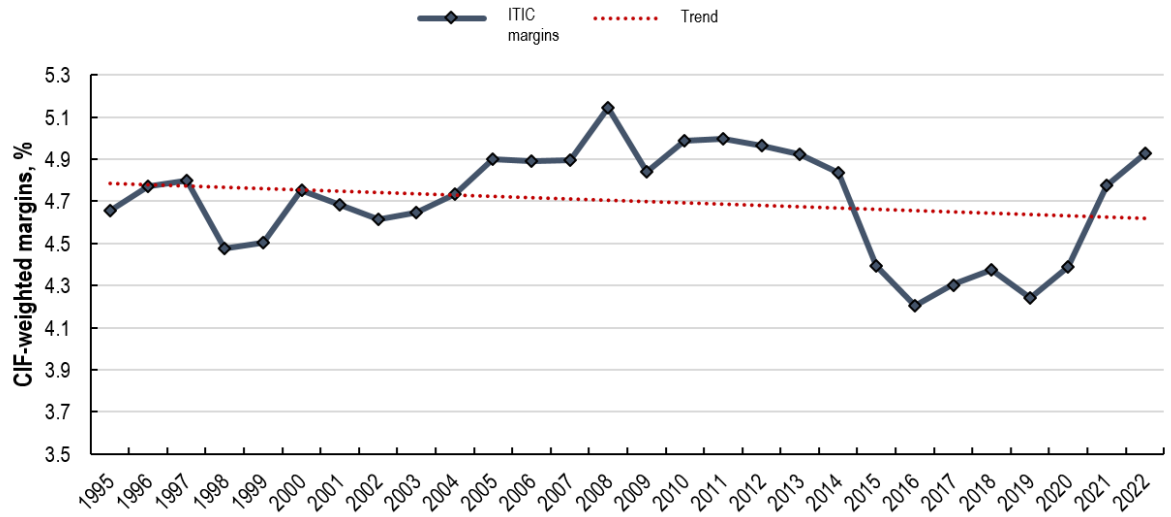
54. The third stage of validation involved consultations with experts in the field, particularly from EUROSTAT, the Joint Research Centre (European Commission), and the French National Statistics office (Institut national de la statistique et des études économiques, INSEE). Experts from these institutions validated the methodological changes implemented in this version, and the estimated margins were further validated by the Department of International Trade Statistics (DSECE) of INSEE through a comparison of the ITIC margins estimated for France with the aggregated margins estimated by DSECE. Additionally, the aggregated predicted margins were found to be broadly consistent with the official data from the central banks of Germany (Deutsche Bundesbank) and Italy (Banca d'Italia).

5. Main insights from the database

55. The ITIC database contains information on 1 223 products (according to the HS 2017 classification) for around 200 individual reporters and partners, for the years 1995-2022. Additionally, data are aggregated by partner and product so that country-specific CIF-weighted averages with partner world and for total merchandise trade are presented.

56. ITIC reveals that, at the global level, the CIF-weighted average of international transport and insurance margins is 4.7% over the period from 1995 to 2022. Following several years of decline after the global financial crisis, margins picked up again with the COVID-19 pandemic and reached 4.9% in 2022, slightly below the maximum of 5.1% observed in 2008 (Figure 8). Although global merchandise trade significantly increased between 1995 and 2022, transport and insurance costs remained relatively stable. The overall trend has diminished over time but at a slow pace.

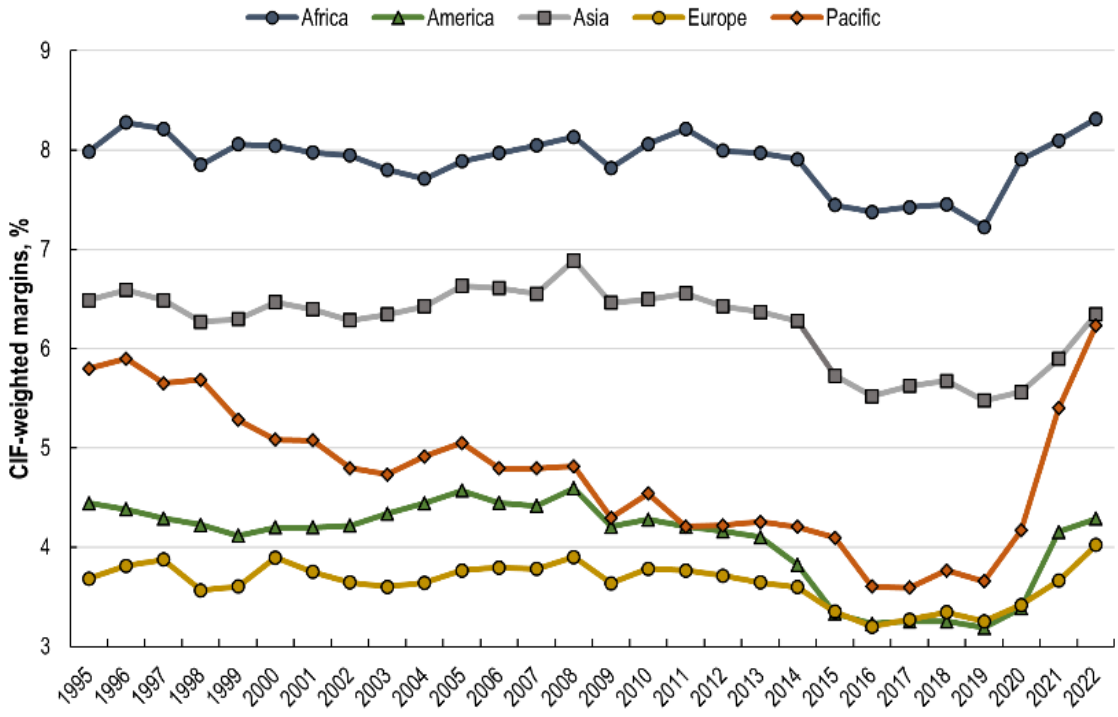
Figure 8. Global estimates of CIF/FOB margins



Note: The figure refers to total merchandise trade. Product-level margins (at six-digits of the Harmonised System) are aggregated using the CIF value of imports as weights (CIF-weighted margins = sum (CIF value * observed margin) / sum (CIF value)).
Source: Author's calculation.

57. Turning to estimates by importing region, Africa exhibits the highest CIF/FOB margins over 1995-2022, whereas Europe consistently shows the lowest margins (Figure 9). All regions experienced an increase in CIF/FOB margins after 2020, with the Pacific standing out with the most significant rise. Within just three years, the estimated CIF/FOB margins soared from 3.7% in 2019 to 6.2% in 2022. Notably, 2022 marks the year with the highest international transport and insurance costs for Africa, Europe, and the Pacific, while for both Asia and America a peak was registered in 2008, possibly reflecting the repercussions of the financial crisis on trade costs.

Figure 9. Estimates of CIF/FOB margins by region



Note: The chart shows the estimated margins for imports of each region from the rest of the world. The figure refers to total merchandise trade. Product-level margins (at six digits of the Harmonised System) are aggregated using the CIF value of imports as weights (CIF-weighted margins = sum (CIF value * observed margin) / sum (CIF value)). The data refer to total trade and reflects varying partner and product compositions.
Source: Authors' calculation.

58. The bilateral dimension in ITIC allows the analysis of inter and intracontinental margins. In general, intracontinental trade showed in 2022 lower international transport and insurance costs compared to inter-regional trade (Table 4). In 2022, African imports from the Americas exhibited the highest CIF/FOB margins. In contrast, intra-European imports showed the lowest CIF/FOB margins in 2022, slightly below those estimated for intra-American imports.

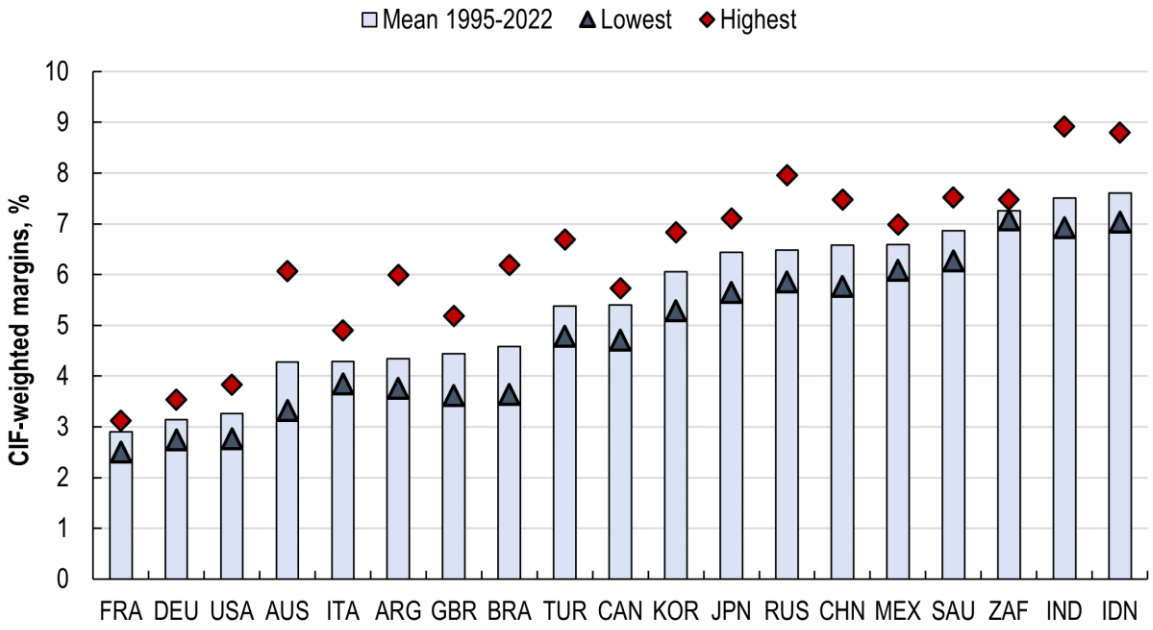
Table 4. Inter- and intra-regional CIF/FOB margins, 2022

Importer (reporter) \ Exporter (partner)	Africa	America	Asia	Europe	Pacific
Africa	6.4	10.1	8.7	7.9	9.2
America	4.0	2.6	6.0	3.3	3.9
Asia	8.1	8.4	5.3	6.9	9.7
Europe	6.8	6.4	6.2	2.6	8.5
Pacific	4.2	6.1	6.3	6.7	4.7

Note: The colour scale goes darker with higher CIF/FOB margins. Numbers in the matrix correspond to CIF-weighted averages. The figure refers to total merchandise trade. Product-level margins (at six digits of the Harmonised System) are aggregated using the CIF value of imports as weights (CIF-weighted margins = sum (CIF value * observed margin) / sum (CIF value)). The data includes varying partner and product compositions as reported.
Source: Authors' calculation.

59. An analysis of margins at the individual country level unveils significant heterogeneity (Figure 10). Among the G20 members, France and Germany emerge as the countries with the lowest margins, in part due to a high proportion of imports from neighbouring countries. Conversely, India and Indonesia consistently exhibit the highest average margins throughout the period.

Figure 10. CIF/FOB margins for G20 countries, average 1995 to 2022



Note: Covers only G20 individual economies (excluding the European Union and the African Union). The figure refers to total merchandise trade. Product-level margins (at six digits of the Harmonised System) are aggregated using the CIF value of imports as weights (CIF-weighted margins = sum (CIF value * observed margin) / sum (CIF value)). The data includes varying partner and product compositions as reported.
Source: Authors' calculation.

60. Similarly, margins reveal substantial heterogeneity in trade costs across products. In 2022, the products with the highest international transport and insurance costs are *Copra* (code 1203), and *Natural calcium phosphates, natural aluminium calcium phosphates, and phosphatic chalk* (code 2510), with an associated average margin of 14.2% and 13.7% respectively (Table 5). Conversely, *Coin* (code 7118) and *Electrical energy* (code 2716) appeared as the products with the lowest margins, estimated at 0.2% and 0.5%, respectively.

61. While Table 5 presents the results for 2022, these findings are more general and largely reflect the nature of the products traded. High-value products such as precious metals, railway coaches, aircraft or some chemical components show the lowest margins when expressed as a percentage of their CIF price. On the other side of the spectrum, bulky products such as aluminium, marble, and vegetable fibres show the highest margins.

Table 5. Products associated with the lowest and highest CIF/FOB margins at the world level, 2022

Products with lowest CIF/FOB margins			Products with highest CIF/FOB margins		
HS4	Description	CIF/FOB margin	HS4	Description	CIF/FOB margin
7118	Coin	0.2%	1203	Copra	14.2%
2716	Electrical energy	0.5%	2510	Natural calcium phosphates	13.7%
7115	Articles of precious metal	0.5%	2610	Chromium ores and concentrates	13.3%
2937	Hormones, prostaglandins, thromboxanes and leukotrienes	1.7%	2606	Aluminium ores and concentrates	13%
2934	Nucleic acids and their salts	1.7%	2528	Natural borates and concentrates	12.8%
8603	Railway or tramway coaches, …	1.9%	2524	Asbestos	12.6%
2935	Sulphonamides	2%	2515	Marble, travertine, ecaussine, …	12.5%
8802	Aircraft, spacecraft, and suborbital and spacecraft launch vehicles	2%	5305	Vegetable textile fibres	12.3%
0105	Poultry; live, fowls of the species Gallus domesticus, ducks, …	2%	2602	Manganese ores and concentrates	12.2%
7112	Waste and scrap of precious metal	2.2%	2503	Sulphur	12.1%

Note: Product-level margins (at six digits of the Harmonised System (HS)) are aggregated to the corresponding four digits codes of the HS using the CIF value of imports as weights (CIF/FOB margin = sum (CIF value * observed margin) / sum (CIF value)). Product code labels were simplified for illustration purposes.
Source: Authors' calculation.

6. Conclusions

62. The OECD International Transport and Insurance Costs of merchandise trade (ITIC) dataset is the most comprehensive publicly available source of information on CIF/FOB margins associated with merchandise trade. It covers bilateral data for over 200 countries broken down by over 1 200 products. Since its first publication in 2016, the dataset has been gradually improved and has become a key resource for the analysis of international trade. It is currently used for a variety of analytical and statistical purposes, shedding light on the relationship between trade patterns and international transport and insurance costs. By allowing the conversion of exports and mirror imports into a common price basis, it is also a key source of information in the construction of balanced merchandise trade statistics and inter-country input-output tables and derived indicators (such as trade in value added, carbon footprints, or employment sustained by foreign demand). Finally, this data can provide empirical evidence on how trade facilitation policies could further reduce trade costs and enhance trade flows.[9]

63. The 2024 edition of ITIC features several enhancements in the methodology, notably to account for the effects of the COVID-19 pandemic on international transport and insurance costs. It estimates that global CIF/FOB margins (CIF-weighted) reached 4.9% in 2022, compared to an average of 4.3% in the years immediately preceding the pandemic. All regions experienced an increase in CIF/FOB margins after 2020, with the Pacific standing out with the most significant rise. An analysis of margins at the individual country level unveils significant heterogeneity. Strong heterogeneity is also observed at the product level.

64. Finally, there are opportunities to expand upon this research further:

- **Distinguishing among different modes of transport** (sea, air, road, other) would be a logical next step. The availability of such information in merchandise trade statistics is still quite limited, but improvements have been made recently and future versions of ITIC could envisage such extensions.
- **Considering the actual trade route taken**, notably for maritime trade, rather than an exogenous distance variable, is another possible avenue for future work. As recent events in the Red Sea and Panama Canal demonstrate, geopolitical tensions and climate-related events can have disruptive effects on trade routes and weigh on international transport costs (OECD, 2023[29]; Kamili et al., 2024[30]). Signals from the Automatic Identification System (AIS) can be used to monitor port activity and track trade routes (Pilgrim, Guidetti and Mourougane, 2024[31]). They could thus be used to derive a measure of actual 'distance travelled' and potentially improve estimations for non-reported data.
- Finally, information on CIF/FOB margins is produced by national statistical offices or central banks to adjust merchandise trade data to comply with Balance of Payment standards, albeit at a much less detailed level (typically for total goods, and with limited – if at all – partner breakdown). As this information becomes more widely available, it can be used to **validate or benchmark the estimated margins**, further improving the alignment of ITIC to officially reported statistics.

[9] See www.oecd.org/trade/topics/trade-facilitation/.

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Annex A.

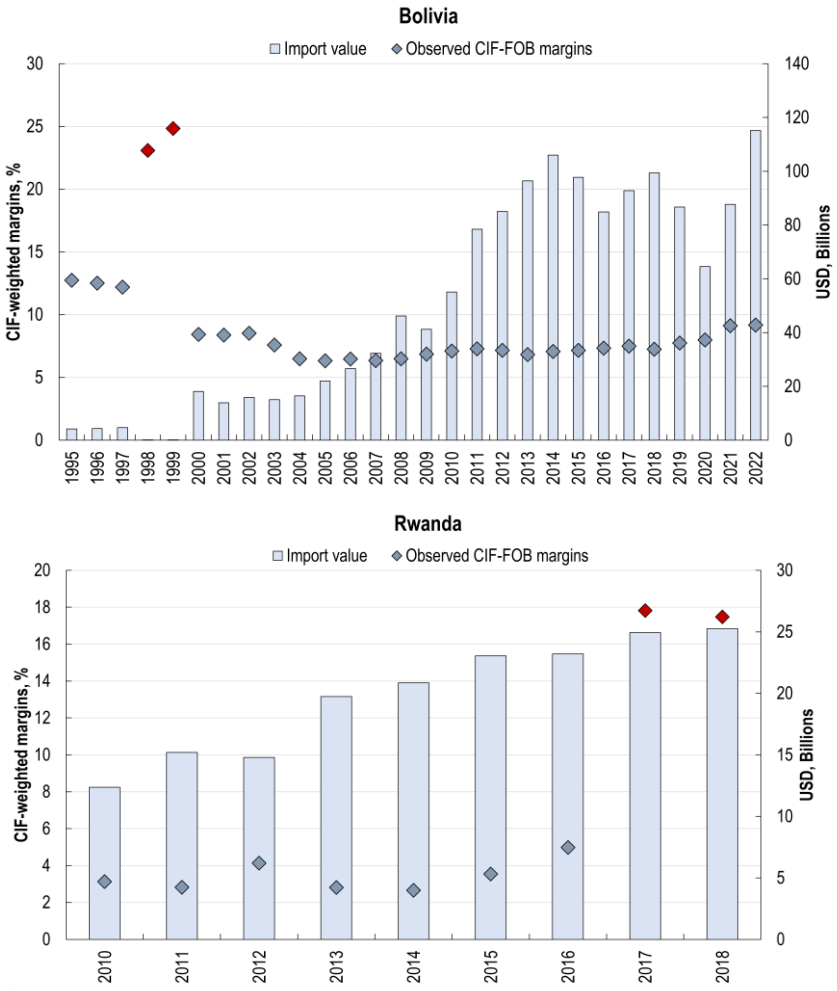
Figure A.1. Source of the observed CIF/FOB margins and share of imports reported with both CIF and FOB valuations by country and year

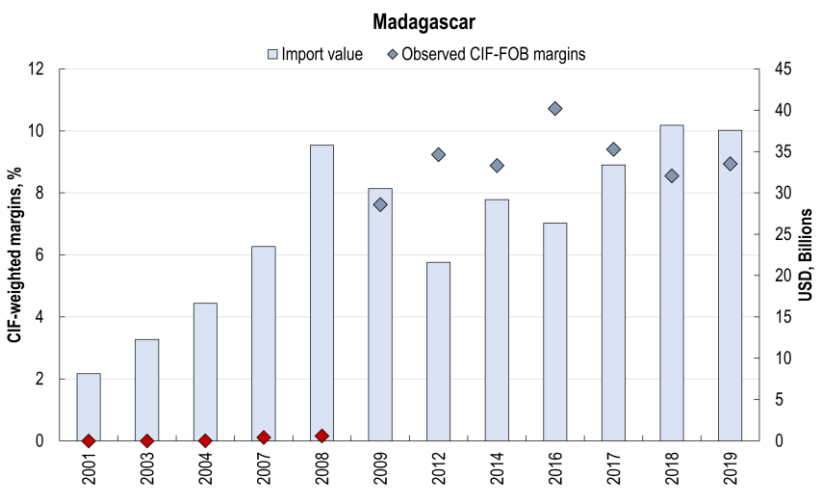
Reporter	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
AGO																					98.01	97.08	97.01					97.45
ARG	39.5	40.3	43.5	43.3	39.27	41.3	42.25	42.2	46.1	47.9	49.5	50	18.68							99.2	99.3	99.29	99.54	99.47	99.54	99.34	98.81	98.86
AUS	86.3	44.5	84.9	85.4	85.66	56.6	58.75	58.4	58.9	60.4	61.4	61.3	100	100	99.98	100	100	100	100	100	100	100	99.81	99.72	99.81	99.77	99.74	99.35
BOL	30.1	26.4	24.7			98.6	99.08	99.3	98.6	97.8	98.1	99.1	99	99.07	98.94	98.71	99.21	99.13	99.49	99.41	99.44	99.45	99.23	99.42	99.33	99.3	97.78	97.73
BRA			56	52.8	49.42	99.7	99.6	99.5	99.5	99.1	99.3	99.4	99.28	99.43	99.58	99.64	99.73	99.76	99.78	99.78	99.8	99.85	99.82	99.79	99.86	99.74	99.1	99.31
CHL	55.9	57.7	55.4	48.9	100	22.9	23.38	32.7	99.3	98.4	99	99	98.49	97.4	98.63	99.01	99.07	99.05	99.23	99.39	99.1	99.24	99.32	99.25	99.2	98.45	97.99	97.54
COL	47.2	51.6	51.8		52.59	54.8	51.54	52.9	55.1	56.1	56.3	58	62.43										99.68	99.73	99.54	99.44		
CPV																							96.56					
CZE																	100		28.92				99.99	100	100	100	100	100
DOM								98.4	98.8	98.8	98.1		99.35	99.21	98.73					96.24	95.64	96.92	98.87	99.38	99.45	99.18	93.04	95.54
ECU						67.8	64.92	67.6	70.5	69.5	74.5	70.7	73.36										99.76	99.74	99.83	99.76	98.61	
HND																							98.47					
ISL							96.94	97.2	97.8	97.7	96.9	98.2	97.43	92.82	97.88	97.71	98.23		93.13				99.11	98.82	97.81	99.01	99.02	98.94
KIR																				96.73	98.34							
LUX														100	100	100	100							34.12	43.36	99.95	99.86	99.96
MDG							100								97.56			95.75		95.82		95.81	95.22	96.54	97.22			
MDV																								90.37				
MOZ																							94.12	94.72				55.14
MUS																						98.86		98.7	98.8	98.46	96.05	96.24
NAM																									84.36		99.38	
NIC																							99.05					
NZL	97.5	99	61.7	68.4	63	99.3	98.86	98.7	98.6	98.9	98.8	98.9	99.13	98.39	98.18	100	58.8	100	100	100	100	100	99.72		96.64	99.26	99.13	98.29
PER	87.4	90.5	91.9	96.2	95.38	98.3	97.87	94.9	98.2	98.5	97.4	98.8	93.55	99.43	99.52	99.36	99.63	99.65	99.57	99.56	99.62	99.76	99.79	99.76	99.78			
PHL																								99.58	99.91	99.9	99.89	99.92
PRY						98.2	99.2	99.2	99.2	99.3	99.3	99.8	99.67	99.31	99.36	99.57	99.38	99.35	99.56	99.46	99.15		99.39			98.62	98.55	98.78
RWA																99.07	99.47	98.96	99.59	95.1	97.25	91.13						
SEN																								94.61				
SRB																							99.62	98.57	99.61	99.38	99.58	99.61
STP																							84.23	84.61				89.42
SVK																99.89	99.91	99.94	99.9	99.88	99.98	99.97	100	100	100	100	96.76	99.99
TUR																			99.94	99.9	99.86	99.92	99.94	99.91	99.96	99.94	99.89	99.79
TZA																												99.99
URY	64	32.5	33	29.6	32.86	36.2	32.77	38.6	47.9	48.8	50.4	51.1	51.32										97.9	98.01	98.25	97.75	96.85	98.47
USA	54	51	50.8	49.9	49.22	43.6	45.55	84	83.8	82.9	82.9	82.4	87.09	89.82	86.71	86.32	88.07	52.58	96.42	99.51	95.78	89.77	90.2	92.14	97.78	100	100	100

Note: Yellow cells correspond to data sourced from UN COMTRADE, blue cells were sourced from internal legacy data files from previous versions of ITIC and green cells correspond to data from the US Census Bureau. Figures represent the percentage of total imports for each reporting country with both CIF and FOB valuations.
Source: Authors' elaboration.

Annex B.

Figure B.1. Identification and removal of year-specific inconsistencies





Note: Data for years in which observed margins are highlighted in red were removed. CIF-weighted margin is an aggregate calculated as sum (CIF value * observed margin) / sum (CIF value).
Source: Authors' calculation.

Annex C.

Aggregating margins from six-digits to four-digits HS codes

Avoiding duplicates

Selection of quantity units

The matrix expansion, developed prior to predicting margins, is based on the quantity units. As there are instances in the trade data where one quantity unit is used for certain years and another quantity unit for different years within the same reporter, partner, and product group, the expansion process creates individual series that are entirely independent but correspond to the same reporter, partner, and product (each with a set of margin predictions). When aggregating these separate series without applying any preselection of quantity units, duplicates of predictions at six-digits codes are included when computing the aggregated margins. To address this issue, when there are duplicates due to different quantity units, a selection of only one quantity unit is made based on the amount of trade associated with each quantity unit. The quantity unit with the highest associated trade value overall is chosen for selecting the predicted margins.

Selection of artificial six digits product codes

A situation like that of the quantity units arises related to the artificial HS codes used to manage having different HS versions in the data. Since the expansion of the test data happens at the level of six-digits HS codes, the artificial codes are considered for the expansion. This creates separate series for different artificial codes that in reality correspond to one product over time. To prevent the inclusion of duplicates coming from this source when aggregating the predicted margins, a selection of predicted margins related to artificial codes is carried out to ensure that for every reporter-partner-six-digit product code group there is only one unique predicted margin per year.

From six-digits to four-digits HS codes

If within the group of six-digit codes to be aggregated into one four-digit code, one (or more) six-digit codes is associated with observed trade, then a CIF-weighted average is applied. This implies that in such cases, the predicted margins associated with unobserved trade will not be considered for the aggregation (the weight is zero for the unobserved cases). Conversely, if none of the six-digit codes in the group are associated with observed trade, then a simple average of the predicted margins is computed across all those codes. The aggregation procedure is conducted in groups by reporter-partner-year.

Table C.1. Aggregating predicted margins: six-digits into four-digits product codes

Predicted margins associated with six-digits code that belong to the same four-digits code
four-digits code 8702: Imports from the United Kingdom to France

Year	870210	870220	870230	870240	870290
1995	0.041	0.053	0.039	0.036	0.041
1996	0.042	0.054	0.040	0.037	0.042
1997	0.041	0.053	0.039	0.036	0.042
1998	0.037	0.049	0.035	0.032	0.038
1999	0.039	0.051	0.037	0.034	0.040
2000	0.041	~~0.055~~	~~0.041~~	~~0.039~~	0.042
2001	0.039	~~0.053~~	~~0.039~~	~~0.037~~	~~0.040~~
2002	0.038	~~0.052~~	~~0.038~~	~~0.036~~	~~0.039~~
2003	0.037	~~0.052~~	~~0.038~~	~~0.035~~	0.038
2004	0.037	~~0.052~~	~~0.038~~	~~0.035~~	~~0.039~~
2005	0.039	0.054	0.040	0.037	0.041
2006	0.039	~~0.054~~	~~0.040~~	~~0.038~~	0.041
2007	0.040	0.053	0.039	0.037	0.040
2008	0.040	~~0.056~~	~~0.042~~	~~0.039~~	0.041
2009	0.038	~~0.053~~	~~0.039~~	~~0.036~~	0.039
2010	0.040	0.055	0.041	0.038	0.040
2011	0.041	0.055	0.041	0.039	0.041
2012	0.040	~~0.055~~	~~0.041~~	~~0.038~~	~~0.041~~
2013	0.040	0.055	0.041	0.038	0.040
2014	~~0.039~~	~~0.053~~	~~0.039~~	~~0.037~~	0.039
2015	0.034	0.048	0.034	0.032	0.035
2016	~~0.033~~	~~0.048~~	~~0.033~~	~~0.031~~	0.033
2017	0.048	0.048	~~0.035~~	~~0.034~~	0.034
2018	0.049	~~0.049~~	~~0.035~~	~~0.034~~	~~0.036~~
2019	0.048	~~0.048~~	~~0.033~~	~~0.031~~	~~0.035~~
2020	0.047	0.047	0.032	0.029	0.032
2021	~~0.050~~	~~0.050~~	0.035	0.032	0.035
2022	~~0.053~~	~~0.053~~	0.038	0.035	0.038

Note: Cells in grey indicate observed trade associated with them. Crossed margins are not considered when aggregating because no trade was observed between the two partners in this product (unobserved trade - i.e. they have zero weight).
Source: Authors 'calculation.

Table C.1 illustrates an example demonstrating the aggregation process within each individual reporter-partner-product group and how the computation of aggregates can vary across the timespan based on the observed trade availability. In this specific instance, the aggregated four-digit code margin is primarily influenced by codes 870210 and 870290, given that they are associated with import data for several years. The remaining three codes typically do not contribute to the composition of the trade-weighted average. Moreover, years in which there is no observed data, 2020 for example, the CIF/FOB margin aggregated by four digits codes is computed as a simple average across all six digits codes.

Annex D.

Since ITIC includes a considerable number of countries for an extended period, the regressors for some countries were not available at the time of the analysis, especially the data on GDP per capita. The following selection of reporter and partner countries is not estimated directly from the model. Gaps were filled by imputing CIF-weighted averages across different groups on an iterative basis, as explained in section 4 of the paper.

Table D.1 Countries lacking one or more regressors.

Country code	Description	Country code	Description
ASM	American Samoa	**MYT**	Mayotte
AND	Andorra	**FSM**	Micronesia
ATA	Antarctica	**NRU**	Nauru
BES	Bonaire, Saba, Saint Eustatius	**NIU**	Niue
BVT	Bouvet Island	**NFK**	Norfolk Island
BAT	Br. Antarctic Terr.	**MNP**	Northern Mariana Islands
IOT	British Indian Ocean Territory	**PLW**	Palau
VGB	British Virgin Islands	**PCN**	Pitcairn
CXR	Christmas Island	**REU**	Réunion
CCK	Cocos (Keeling) Islands	**BLM**	Saint Barthélemy
COM	Comoros	**SHN**	Saint Helena
COK	Cook Islands	**KNA**	Saint Kitts and Nevis
FLK	Falkland Islands (Malvinas)	**LCA**	Saint Lucia
FRO	Faroe Islands	**SPM**	Saint Pierre and Miquelon
GUF	French Guiana	**VCT**	Saint Vincent and the Grenadines
ATF	French Southern and Antarctic Lands	**SMR**	San Marino
GIB	Gibraltar	**SGS**	South Georgia and the South Sandwich Islands
GRL	Greenland	**SSD**	South Sudan
GLP	Guadeloupe	**TKL**	Tokelau
GUM	Guam	**UMI**	United States Minor Outlying Islands
HMD	Heard Island and McDonald Islands	**PCI**	US Misc. Pacific Isds
VAT	Holy See	**WLF**	Wallis and Futuna
MHL	Marshall Islands	**ESH**	Western Sahara
MTQ	Martinique		

Annex E.

Methodology codes

In the final dataset, distinct methodological codes are employed to differentiate between reported and estimated data, as well as to indicate other adjustments and aggregations. While the dataset published in the OECD Data Explorer features a simplified version of these codes (consistent with other OECD analytical datasets in international trade), A version of the data containing extended and more detailed methodology codes is available in the bulk download file within the download options of the OECD Data Explorer: International transport and insurance costs of merchandise trade (ITIC). Table E.1 presents the sets of methodology codes used in ITIC.

Table E.1. Methodology codes used in ITIC

Code - simplified	Description - simplified	Code - extended	Description - extended
ME	Model-based Estimation	**ME_U**	Estimations from the regression model (aggregated to four-digit HS levels): simple average of predictions at HS six-digit level (unobserved trade)
		ME_O	Estimations from the regression model (aggregated to four-digit HS levels): weighted average of predictions at HS six-digit level (observed trade)
		ME_OCA	Estimations from the regression model (aggregated to four-digit HS levels): weighted average of predictions calibrated to explicit data as reported by country (observed trade)
		ME_UCA	Estimations from the regression model (aggregated to four-digit HS levels): weighted average of predictions calibrated to explicit data as reported by country (unobserved trade)
-	Explicit data	**A**	Explicit data as reported by country (aggregated to four-digit HS levels)
AD	Adjustment	**AD_NEG**	Imputation: implausible regression-based estimates replaced by the minimum margin in the same reporter-partner-year group
		AD_NEI	Imputation: margin imputed as 0 for trade intra EU + Switzerland + Norway between neighbouring countries.
AG	Aggregation	**AG_WLD**	Aggregation: estimated by using a global trade-weighted average across all partners for each product-year combination or for each product

Note: The extended code list is only available in the bulk download file.
Source: Authors' own elaboration.