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The ECB's enhanced effective exchange rates and harmonised competitiveness indicators

An updated weighting scheme including trade in services

No 49

Contents

Abstract

The nominal effective exchange rate (EER) of a currency is an index of the trade-weighted average of its bilateral exchange rates vis-à-vis the currencies of selected trading partners, while the real EER is derived by adjusting the nominal index for relative prices or costs. The nominal EER provides a summary measure of a currency's external value, while the real EER is the most commonly used indicator of the international price and cost competitiveness of an economy. Additionally, for all individual euro area countries, harmonised competitiveness indicators (HCIs) are published by the European Central Bank (ECB) based on the same methodology as the euro EERs. This paper describes how the calculation of the ECB's EERs and HCIs has been enhanced to take into account in the underlying trade weights the evolution of international trade linkages and, in particular, the growing importance of trade in services. The paper includes an in-depth description of the methodology used to calculate these enhanced EERs and HCIs. In particular, it presents how to overcome the challenges arising from the inclusion of services trade, foremost in terms of data availability, with imputation and estimation techniques. Importantly, the ECB's well-established methodology – which in particular accounts for competition faced by euro area exporters in third markets – did not have to be changed with the inclusion of services trade. Finally, the paper provides some evidence on the usefulness of the enhanced indicators for policymakers, economic analysts and the public at large.

JEL classification: C82, F10, F17, F30, F31, F40.

Keywords: competitiveness, effective exchange rate (EER), harmonised competitiveness indicator (HCI), nominal effective exchange rate (NEER), real effective exchange rate (REER), services trade, trade weights, gravity model.

1 Introduction

Nominal effective exchange rates (NEERs) are indices based on the weighted average of bilateral nominal exchange rates vis-à-vis the currencies of selected trading partners, while real effective exchange rates (REERs) are derived by adjusting these nominal indices for relative price and cost developments between a given economy and its trading partners. Similarly to NEERs and REERs, harmonised competitiveness indicators (HCIs) are computed for individual euro area Member States.[1]

NEERs provide a summary measure of a currency's value, while REERs are the most commonly used indicator of a country's international price and cost competitiveness and represent a key component of an economy's external balance assessment. The importance of REERs is reflected, for instance, by their inclusion in the scoreboard of the European Commission's macroeconomic imbalance procedure (MIP) and in the International Monetary Fund's (IMF's) external balance assessment (EBA).

Since 2021 the EERs and HCIs published by the European Central Bank (ECB) have been compiled by the Deutsche Bundesbank in close cooperation with the ECB.[2] The EERs and HCIs were originally solely based on manufacturing trade weights (Schmitz et al., 2012), before the weighting scheme was expanded in 2020 to also include services trade (Fidora and Schmitz, 2020).[3] While manufacturing trade still accounts for the largest part of euro area trade, trade in services has gained importance in recent decades: extra-euro area services trade relative to GDP has more than doubled since 2001 and accounted for around 30% of total extra-euro area trade at the end of 2021 (Chart 1, panels a and b). Having said this, the role of the services sector in international trade is even larger in value added terms than suggested by gross trade data (Johnson and Noguera, 2012). The growth in services trade reflects the fact that a wide range of heterogeneous services are nowadays traded internationally, in particular those affected by new technologies such as ICT services or other business services such as consultancy, accounting and legal (Chart 2). Due to digitalisation and increased virtual proximity between countries, such services can increasingly be delivered at distance without physical interaction between producers and customers (Hellmanzik and Schmitz, 2015) which also gives rise to trade in intermediate services (Baldwin, 2022). Moreover, euro area services trade is affected by price competitiveness developments in a similar fashion to manufactured goods (Christodoulopoulou and Tkacevs, 2016). For all these reasons it is crucial to include services trade in the weighting schemes underlying the effective exchange rates (EERs).

1 While intra-euro area trade flows are not considered in the calculation of trade weights for euro EERs, they are used for HCIs, which are constructed from the perspective of individual euro area Member States. Hence, in the HCIs all other euro area countries are considered as trading partners.

2 Since 2021 the Deutsche Bundesbank has been responsible for the production of daily, monthly and quarterly EERs/HCIs, the production of the underlying trade weights and user support. The ECB remains involved in the future development of EERs and HCIs, including methodological changes, publishes the data on its website and provides the underlying dataset on cost and price deflators.

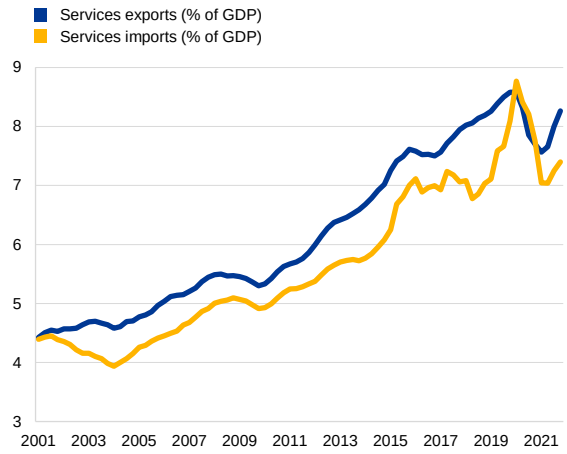
3 The ECB's weighting scheme does not include trade in agricultural products, raw materials and energy products (see Section 2.4).

Chart 1

Increasing importance of euro area services trade

a) In absolute terms…

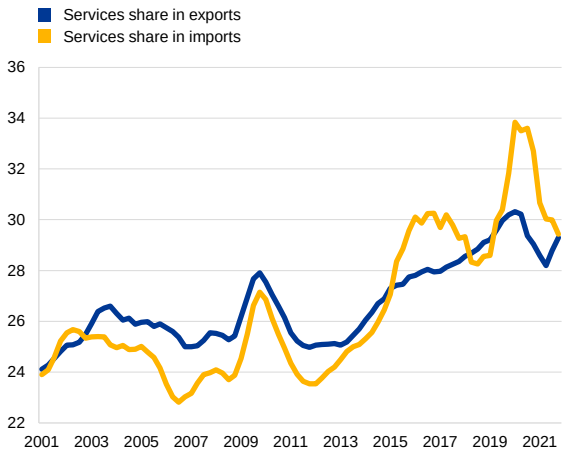
(services trade as a percentage of GDP, four-quarter moving sum)



Source: ECB.

b) … and relative terms

(services trade as a percentage of total trade, four-quarter moving sum)



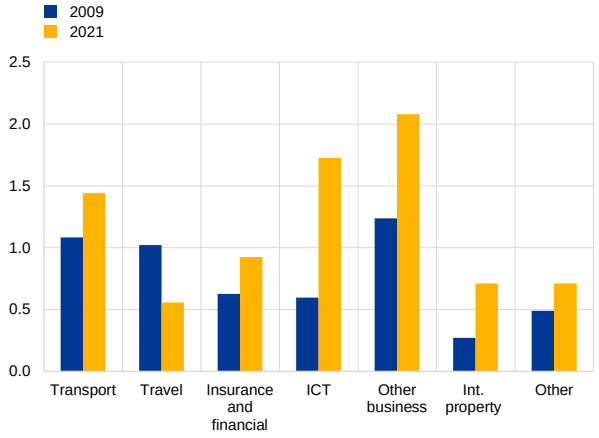
Source: ECB.

The inclusion of services is particularly important for countries where patterns in services trade differ significantly from those observed in manufactured goods. Chart 3 reveals substantial country heterogeneity across the euro area in terms of trade composition. Cyprus, Ireland, Luxembourg and Malta exhibit a services share exceeding 60% of total trade (when considering manufacturing plus services trade), while at the other end of the spectrum this share drops below 25% for countries like Belgium, Germany, Italy, Slovakia and Slovenia.

Chart 2

New technologies affect the composition of euro area services trade

(services exports as a percentage of GDP)

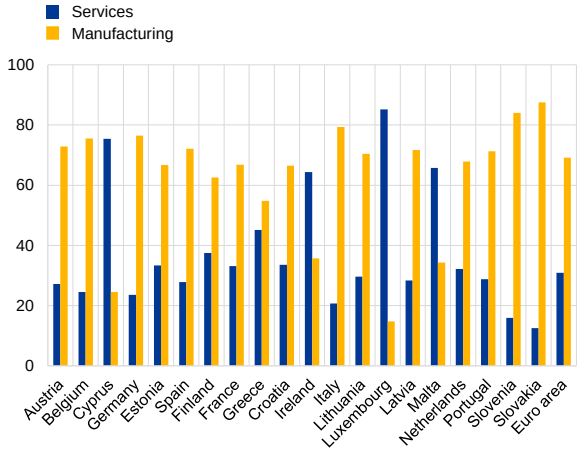


Source: ECB.

Chart 3

Country heterogeneity in trade composition

(shares as percentage of manufacturing plus services trade, exports and imports combined, 2019-21)



Source: ECB.

Previous efforts to include services trade in the weighting scheme underlying EERs were undertaken by different institutions. The Federal Reserve added services to its trade weights in 2019. However, this change was combined with a simplification of the methodological approach by switching to simple trade weights, i.e. moving away from the calculation of third-market effects (Beschwitz et al., 2019). Such a simplification implies a significant loss of information on the presence of global competition among the considered group of trading partners. Similarly, the Bank of England uses bilateral services trade data without accounting for third-market effects (Lynch and Whitaker, 2004), while the IMF includes trade in services by using tourism flows for countries where these are sizeable (Bayoumi et al., 2005). As regards the euro area, Schmitz (2012) constructed experimental EERs/HCIs for the euro and 17 euro area Member States based on bilateral services trade with up to 36 partner countries, for the periods 2004-06 and 2007-09.

Insufficient data availability previously precluded the inclusion of services trade in the weighting scheme underlying the computation of the ECB's official EERs. Significant progress in terms of data availability has been made in recent years, so that the data coverage now allows for the construction of enhanced EERs and HCIs based on both manufacturing and services trade, while remaining fully in line with the existing state-of-the-art methodology (i.e. including third-market effects).

This paper presents in Section 2 the methodology used for computing the enhanced EERs and HCIs including trade in services, while Section 3 focuses on the collection and processing of trade data, as this step brings particularly complex challenges when it comes to services. The paper details in Section 4 the main reasons why the new indicators provide an enhanced assessment of international competitiveness developments across countries and time for policymakers, economic analysts and the public at large, before concluding in Section 5.

2 Methodology for calculating the ECB's effective exchange rates

This section describes the methodology behind the EERs provided by the ECB, building on Buldorini et al. (2002) and Schmitz et al. (2012). HCIs for individual euro area Member States are constructed using the same method. This section first presents the formula to compute NEERs, followed by the formula for REERs and a description of the associated deflators. The different groups of trading partners are then introduced, with an emphasis on the most recent changes made to the largest group of partner countries. The following two subsections deal with the methodology of the underlying trade weights and in particular the inclusion of trade in services. Finally, an overview of the EERs and HCIs available at the ECB is provided.

2.1 The nominal effective exchange rate

NEERs are calculated as the geometric weighted average of a basket of bilateral nominal exchange rates. In the case of the euro, this can be formalised in the following way:

$$NEER^t = \prod_{i=1}^{N} \left(e_{i,euro}^t\right)^{w_i} \tag{1}$$

where N stands for the number of countries in the reference group of trading partners, $e_{i,euro}^t$ is an index of the average exchange rate of the currency of partner country i vis-à-vis the euro in period t (expressed in terms of foreign currency per euro) and w_i is the trade weight assigned to the trading partner i.

It is important to note that the underlying trade weights are computed for non-overlapping three-year periods. This implies that in equation (1) above, a given trading partner does not carry a single trade weight, but differing weights for each of the non-overlapping three-year periods (1995-97, 1998-2000, 2001-03, 2004-06, 2007-09, 2010-12, 2013-15, 2016-18 and 2019-21). Hence, the following process is implemented to obtain the final indicators.

- **Computation for the different sets of weights:** Equation (1) is first applied separately for each set of trade weights ($w_i^{1995-97}, \ldots, w_i^{2019-21}$).
- **Chain-linking:** The different pieces are subsequently chain-linked at the end of each of the three-year periods, starting from the one based on the trade weights for 1995-97.
- **Rebasing:** Finally, the series is rebased to the first quarter of 1999 (i.e. Q1 1999 = 100).

2.2 The real effective exchange rate and its deflators

The calculation framework for REERs is very similar to that of NEERs described in Section 2.1. The only difference lies in the fact that the bilateral nominal exchange rates are deflated using relative price or cost measures. It can therefore be formalised as follows, using the example of the euro:

$$REER^t = \prod_{i=1}^{N} \left(\frac{d_{euro}^t e_{i,euro}^t}{d_i^t} \right)^{w_i} \tag{2}$$

where N stands for the number of countries in the reference group of trading partners, $e_{i,euro}^t$ is an index of the average exchange rate of the currency of partner country i vis-à-vis the euro in period t, d_{euro}^t and d_i^t are, respectively, the deflators for the euro area and partner country i, and w_i is the trade weight assigned to the trading partner i.

The rest of the process (computation for the different sets of weights, chain-linking and rebasing) is the same as for NEERs.

One can easily infer from equation (2) that the choice of deflators is crucial. The aim is to select an indicator that has the most direct link with international price or cost competitiveness. However, this depends ultimately on how the concept of competitiveness is measured, so that different options are offered to economic analysts and policymakers. The deflators used to construct REERs are taken from the ECB's deflator database as described in Schmitz et al. (2012).

- **Consumer price index (CPI):** The most commonly used deflator is the CPI. It has the advantage of timely, monthly and broad data availability as well as comparability (being defined in a similar manner by many countries, in particular among industrial economies). On the downside, however, CPI baskets also include non-tradable goods and services, while excluding capital and intermediate goods. This can hinder the analysis of international competitiveness, particularly if there are significant differences in productivity between tradable and non-tradable sectors. Moreover, consumer prices can be distorted due to taxes and subsidies.

- **Producer price index (PPI):** The PPI, meanwhile, includes industrial products and intermediate goods that can be traded internationally, while excluding retail sales. Consequently, PPIs are viewed as a reasonable proxy for tradable goods prices. However, they exclude services prices and their composition and compilation vary considerably across countries.

- **GDP deflator (GDPD):** The GDPD also focuses on the production side of the economy. It has the advantage of being comparable across countries and takes into account inputs into a firm's production from other sectors, including services. GDPDs are considered to be the relative price measure that best reflects the "price of value added", as they are the most direct summary measure of capital and labour costs. On the negative side, they include non-tradable goods and suffer from possible distortions stemming from taxes and subsidies. Furthermore,

GDPDs are published at a lower frequency (quarterly) compared with CPIs and PPIs.

- **Unit labour costs in the total economy (ULCT)** and **unit labour costs in the manufacturing sector (ULCM):** Turning to cost measures, ULCM is often used as a proxy for unit labour costs in the tradable goods sector. This popular measure of competitiveness may, however, be too narrow a concept as it only focuses on a certain sector of the economy. ULCT circumvents this problem but has the disadvantage that it also reflects costs in non-tradable goods and services. In general, unit labour cost measures are rather volatile and sometimes subject to significant data revisions. As with GDPDs, unit labour costs are published less frequently (quarterly) than CPIs and PPIs. In addition, they do not cover all costs incurred by firms (e.g. the cost of capital, distribution costs and taxes). Moreover, factor substitution may affect these indicators without necessarily resulting in a change in productivity. Finally, available cost measures are typically more affected by data quality issues than price measures.

Among the deflators, a distinction can therefore be made between "broad" and "narrow" concepts. Broad deflators capture price and cost developments in the whole economy and include the CPI, GDPD and ULCT.[4] As regards narrow deflators, the ECB's database comprises the PPI and ULCM.[5] These two deflators measure price and cost developments in the manufacturing sector.

In the same vein, one could envisage the use of services-specific deflators such as the services component of the CPI and unit labour costs in the services sector. Currently, however, these deflators are not available for a sufficiently large group of countries.

2.3 Trading partners and baskets of currencies

The EERs of the ECB are currently computed against three different groups of trading partners from the perspective of the euro area:

- **a narrow group of 12 partner countries (EER-12)**, including Australia, Canada, Denmark, Hong Kong, Japan, South Korea, Norway, Singapore, Sweden, Switzerland, the United Kingdom and the United States;
- **an extended group of 18 partner countries (EER-18)**, comprising the EER-12 plus China and the five non-euro area EU Member States not included in the EER-12 (Bulgaria, the Czech Republic, Hungary, Poland and Romania);

4 In addition, the Deutsche Bundesbank uses deflators of total sales, which take into account the prices of imported goods, in addition to domestic value added, and therefore reflect price and cost developments to an even broader extent than GDP deflators (see Deutsche Bundesbank, 2016; Fischer et al., 2017; and Deutsche Bundesbank, 2023).

5 Alternatively, one could consider export prices as a direct measure of prices in foreign markets. However, export price indices suffer from disadvantages in terms of methodology and data availability, which complicate their use for competitiveness analysis (see Schmitz et al., 2012).

- **a broad group of 41 partner countries (EER-41)**, encompassing the EER-18 plus Algeria, Argentina, Brazil, Chile, Colombia, Iceland, India, Indonesia, Israel, Malaysia, Mexico, Morocco, New Zealand, Peru, the Philippines, Russia, Saudi Arabia, South Africa, Taiwan, Thailand, Türkiye, Ukraine and the United Arab Emirates.

In addition, the HCIs of individual euro area Member States also consider the 19 other euro area countries as trading partners.

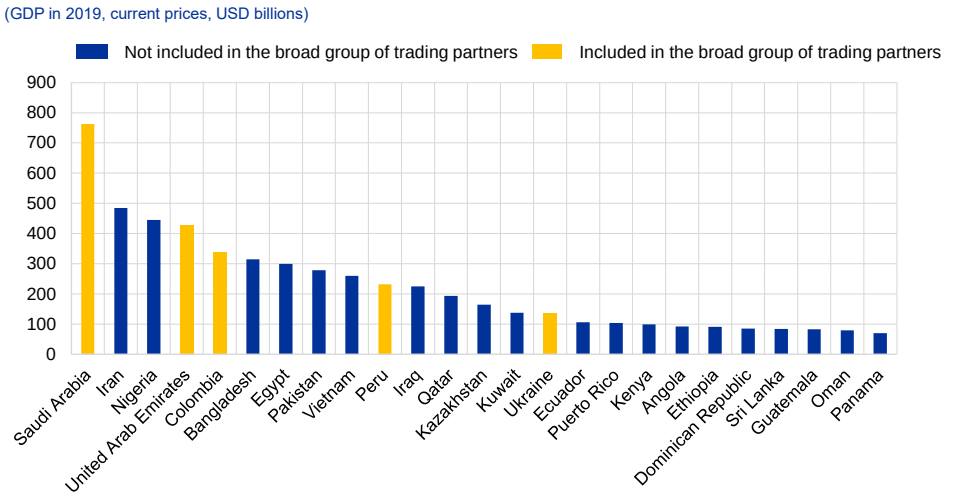
The composition of the broad group of trading partners was adjusted in July 2020, resulting in an expansion from 37 to 41 countries.

- Venezuela was excluded due to difficulties in measuring the exchange rate of the Venezuelan bolívar and Venezuelan consumer prices. Moreover, its trade with the euro area has decreased dramatically in recent years.[6]

- Colombia, Peru, Saudi Arabia, Ukraine and the United Arab Emirates were added since, at the time of the analysis, they met the requirements used by the ECB when assessing the addition of new countries to the list of partner countries (i.e. presence in the largest economies not yet included in terms of GDP; sizeable trade flows with the euro area; availability of reliable and timely data on exchange rates, bilateral trade flows, consumer prices and GDP, Chart 4).

Chart 4

Largest economies not included in the old broad group of trading partners



Sources: ECB and IMF.

As further detailed in Section 2.6, it is important to note that nominal, CPI-deflated and GDP-deflated indices are available for all three groups of trading partners, while PPI-deflated, ULCM-deflated and ULCT-deflated indicators cannot currently be computed against the broad group of partner countries (EER-41) due to data availability constraints.

6 The Bank for International Settlements (BIS) and the Federal Reserve followed the same approach in recent years and excluded Venezuela from the list of trading partners.

2.4 Trade basis

EERs require an appropriate weighting scheme to serve their purpose of comprehensively summarising the developments of a currency. Hence, it is common practice to use bilateral trade to determine the weight of each partner country's currency, with larger weights being assigned to countries accounting for a higher proportion of an economy's external trade.

Trade flows can be broadly classified into three main categories: manufactured goods, commodities and services. As outlined by Buldorini et al. (2002) and Schmitz et al. (2012), the EERs and HCIs of the ECB were for years solely based on trade weights in manufactured goods, as defined in Sections 5 to 8 of the Standard International Trade Classification (SITC).[7] This choice reflects the exclusion of commodities such as agricultural products, raw materials and energy products in the weighting scheme. Indeed, these items are considered homogeneous goods whose prices are determined in global markets without being influenced by the competitiveness of individual countries. Their inclusion would distort any competitiveness analysis, as such goods are often heavily regulated or subsidised.

The omission of services on the other hand was driven by data availability constraints. From a conceptual point of view, trade in services should be included, considering its increasing share and role in global market competition (Section 1). Improved data coverage made the full inclusion of services finally feasible in 2020, while also remaining fully in line with the existing state-of-the-art ECB methodology (i.e. including third-market effects). Using the methods shown in this paper, services were incorporated in the weighting scheme of the ECB's EERs in July 2020.

The ECB's enhanced EERs and HCIs reflect this important adjustment for their broadest indicators (i.e. nominal and deflated by CPI, GDPD and ULCT), while manufacturing-oriented indices (i.e. deflated by PPI and ULCM) continue to be based on manufacturing weights. If services-specific deflators are used in the future, they could be similarly based on services-only weights. To summarise:

Combined trade weights (covering manufacturing and services trade) are used for:

- nominal EERs/HCIs;
- EERs/HCIs deflated by CPI, GDPD and ULCT.

Manufacturing trade weights are used for:

- EERs/HCIs deflated by PPI and ULCM.

[7] These categories comprise chemicals and related products, manufactured goods, machinery and transport equipment, and miscellaneous manufactured articles.

2.5 Weighting method

The ECB updates the trade weights underlying the calculation of its EER indices every three years in order to capture medium-term changes in the pattern of euro area trade in a timely fashion. The general framework for the calculation follows the BIS methodology presented in Turner and Van't dack (1993), which was subsequently adapted to the euro area by Buldorini et al. (2002) and Schmitz et al. (2012).

For the sake of clarity, the euro area perspective is used throughout the description outlined below (i.e. the calculation is presented for the trade weights required for the EERs of the euro), but the same approach is used for all countries included in the EER-41 group of trading partners (i.e. for the trade weights required for their respective EERs) as well as for each euro area Member State (i.e. for the trade weights required for their respective HCIs). Moreover, the broad group of trading partners (EER-41) is used as a reference, since the weights of the two narrower groups of partner countries (EER-12 and EER-18) are simply obtained by rescaling the indicators generated for the broad group.

The weighting scheme combines information on both imports and exports, for which separate weights are initially created, following different methods. The logic pertaining to this framework is detailed below and further illustrated by an example of a simplified basket of euro area trading partners consisting of only two countries, country A and country B, and the rest of the world. The example focuses on services trade, but the same approach is applied to obtain manufacturing trade weights.

The **import weights** are calculated as simple shares of euro area imports from the broad group of trading partners (i.e. not including the rest of the world). In the case of services, the import weight of each partner country *i* can be expressed as follows:

$$w_i^{m\,Ser} = m_i^{Ser} / \sum_{k=1}^{N} m_k^{Ser}, \qquad i = 1, 2, \ldots, N \tag{3}$$

where m_i^{Serv} and m_k^{Ser} denote gross services import flows into the euro area from country *i* and *k* respectively during the reference period and N stands for the number of countries in the largest group of trading partners. The same approach is applied to obtain manufacturing import weights. In the example, this yields 1,120 / (1,120 + 480) = 70% for country A and 480 / (1,120 + 480) = 30% for country B.[8]

The calculation of **export weights** is more complex, as they are "double-weighted" to account for third-market effects. This implies that they are designed to capture the competition faced by euro area exporters, in each foreign market, from both domestic producers and third countries. Put simply, when it comes to euro area exports, a global exporter present in many countries is particularly relevant, much more so than the simple export flows from the euro area to this country would imply.

[8] All values in this example are expressed in euro (unless otherwise mentioned). For ease of exposition, denomination in euro is not explicitly included in the example.

Table 1

Trade weights in practice

Supply matrix (including rest of the world)				
Exports by country ↓ to market →	**Euro area**	**Country A**	**Country B**	**Other countries**
Euro area		1,000	600	400
Country A	1,120		400	100
Country B	480	800		300
Domestic production	2,500	1,200	1,600	EXCLUDED
Import weights				
Share of total euro area imports		1,120 / (1,120 + 480) = 70%	480 / (1,120 + 480) = 30%	EXCLUDED
Simple export weights (including rest of the world)				
Share of total euro area exports		1,000 / (1,000 + 600 + 400) = 50%	600 / (1,000 + 600 + 400) = 30%	400 / (1,000 + 600 + 400) = 20%
Intensity of competition – supply structure matrix				
Supply share of country A in market h		1,200 / (1,200 + 800) = 60%	400 / (400 + 1,600) = 20%	100 / (100 + 300) = 25%
Supply share of country B in market h		800 / (1,200 + 800) = 40%	1,600 / (400 + 1,600) = 80%	300 / (100 + 300) = 75%
Double export weights				
Euro area simple export weights adjusted to account for third-market effects		(0.5 x 0.6) +(0.3 x 0.2) +(0.2 x 0.25) = 41%	(0.5 x 0.4) +(0.3 x 0.8) +(0.2 x 0.75) = 59%	
Trade weights				
Euro area trade weights		((0.7 x 1,600) + (0.41 x 2,000)) / (1,600 + 2,000) = 53.89%	((0.3 x 1,600) + (0.59 x 2,000)) / (1,600 + 2,000) = 46.11%	

Hence, one cannot apply the method used for imports and compute the export weights as simple shares of euro area exports (i.e. not including the rest of the world). In the example, this would result in country A having a much larger weight than country B: country A would have a weight of 1,000 / (1,000 + 600) = 62.5%, while country B would

have a weight of 600 / (1,000 + 600) = 37.5%. This would not accurately represent the relevance of each country for euro area exports.

Although a very large percentage (50%) of euro area total exports to the world go to country A, it can be seen from the supply structure matrix that in country A, only 60% (1,200) of the total supply of products is due to domestic production and 40% (800) is accounted for by imports from country B. Moreover, while the share of total euro area exports (including the rest of the world) to country B is significantly lower (30%), country B has a much larger share of domestic production at 80% (1,600). Hence, country A generates relatively weaker competition in country B than vice versa. In addition, country B creates much stronger competition for the euro area than country A in the rest of the world. For these reasons, the weight of country B should be relatively larger than in the simple export weights, which is reflected in the double export weights.

As shown in the example, two types of data are required to compute the double export weights: the simple export weights (including the rest of the world) and the supply structure matrix. The export weights also take into account each trading partner's bilateral exports to different foreign markets. In this way, the trade weights reflect the competition faced by euro area exporters in each given foreign market from exporters of the countries included in the group of trading partners. For this purpose, a distinction is made between N, the trading partners, and R, the group of countries referred to as the rest of the world (whereby $H = N + R$, with H being the total number of export markets in the world). In order to capture the effect of competition faced by euro area exporters from domestic producers in the economies of the trading partners, the domestic supply in these countries is included in the calculation of export weights. It is assumed that the euro area and the N competitor countries are the only suppliers of services in the R countries. Consequently, the calculations neither include exports from the rest of the world to the N trading partners nor the rest of the world's domestic output.

The simple export weights (including the rest of the world) are first calculated as the share of each market j in total euro area exports to the world:

$$w(simple)_j^{x^{Ser}} = x_j^{Ser} / \sum_{k=1}^{H} x_k^{Ser}, \qquad j = 1, 2, \ldots, H \tag{4}$$

where x_j^{Ser} and x_k^{Ser} denote the gross services export flows of the euro area to markets j and k respectively in the reference period, while H represents the total number of export markets in the world.

The simple export weights are subsequently adjusted to capture third-market effects, which yields the double export weights of each partner country i:

$$w(double)_i^{x^{Ser}} = \sum_{j=1}^{H} \left(S(share)_{i,j}^{Ser} \; w(simple)_j^{x^{Ser}} \right), \qquad i = 1,2 \ldots, N \tag{5}$$

where $S(share)_{i,j}^{Ser}$ is the share of country i in the services supply of market j.

The shares are obtained in the following way:

$$S(share)_{i,j}^{Ser} = S_{i,j}^{Ser} / \sum_{k=1}^{N} S_{k,j}^{Ser} \tag{6}$$

where $S_{i,j}^{Ser}$ (for $i \neq j, i = 1,2, \ldots, N$, and $j = 1,2, .., H$) denotes the gross services export flows from country i to market j and $S_{i,i}^{Ser}$ (for $i = 1,2, \ldots, N$) represents the gross services output of country i that is sold in its domestic market. $S_{i,i}^{Ser}$ serves as a proxy for the gross value of the domestically produced supply of services. For each country, it is obtained by adding services imports to the value added of the services sector (using data from the United Nations, Eurostat and the Organisation for Economic Co-operation and Development (OECD), with the exception of Taiwan for which the national statistical institute was the only available source), and then subtracting services exports. Imports of services are used as a proxy for both domestic inputs stemming from other sectors and imported inputs.

According to Turner and Van't dack (1993), this method can be used to obtain an estimate of the gross value of services produced and sold domestically which is comparable with international trade data that are also expressed in similar (gross value) terms. The approach to estimate domestic production, although well established in the literature, can in rare cases lead to negative domestic supply values, incompatible with the computation process for double export weights. For this reason, corrections were implemented in such cases, bringing the values to zero. As previously explained and illustrated in Table 1, the total supply (of each market j) presented in equation (6) ($\sum_{k=1}^{N} S_{k,j}^{Ser}$) does not incorporate the rest of the world's domestic output and exports (countries outside the broad group of partner countries).

The overall weight of each partner country i in the broad group of trading partners is obtained as the weighted average of export and import weights, i.e.:

$$w_i{}^{Ser} = \left(\frac{m^{Ser}}{x^{Ser} + m^{Ser}} \right) w_i^{m^{Ser}} + \left(\frac{x^{Ser}}{x^{Ser} + m^{Ser}} \right) w(double)_i^{x^{Ser}}, \qquad i = 1,2, \ldots, N \tag{7}$$

where $w_i^{m^{Ser}}$ and $w(double)_i^{x^{Ser}}$ are partner country i's import and export weights respectively and m^{Ser} and x^{Ser} are total imports and exports by the euro area respectively.

The trade weights synthesising manufactured goods and services trade information are derived by combining the two types of weights previously computed:

$$w_i{}^{Combined} = \left(\frac{x^{Ser} + m^{Ser}}{x^{Ser} + m^{Ser} + x^{Man} + m^{Man}}\right) w_i{}^{Ser} + \left(\frac{x^{Man} + m^{Man}}{x^{Ser} + m^{Ser} + x^{Man} + m^{Man}}\right) w_i{}^{Man}$$

$$, \qquad i = 1,2, \dots, N \tag{8}$$

The coefficients used to determine the weight of each trade basis in the final combined scheme are therefore determined in line with the structure of each analysed economy, i.e. reflecting if it is more manufacturing-oriented or services-oriented. In the case of euro area countries (Table 2), strong heterogeneity is visible, with certain countries such as Cyprus and Luxembourg showing services shares well above average and consequently primarily affected by the enhanced weighting scheme.

Table 2

Share of services and manufacturing in combined trade flows (2019-21)

(percentage of trade flows, imports and exports combined)

Country	Services	Manufacturing
Austria	27.2	72.8
Belgium	24.5	75.5
Cyprus	75.5	24.6
Germany	23.6	76.4
Estonia	33.3	66.7
Spain	27.9	72.1
Finland	37.4	62.6
France	33.2	66.8
Greece	45.2	54.8
Croatia	33.5	66.5
Ireland	64.3	35.7
Italy	20.7	79.3
Lithuania	29.6	70.4
Luxembourg	85.2	14.8
Latvia	28.3	71.7
Malta	65.7	34.3
Netherlands	32.1	67.9
Portugal	28.8	71.2
Slovenia	16.0	84.0
Slovakia	12.5	87.5
Euro area	30.9	69.1

Source: ECB.

Once the weighting scheme of the broad group of trading partners is produced, the trade weights of the two smaller groups of partner countries are obtained by proportionally rescaling the weights of the broad group under equations (7) and (8).

For the narrow group of countries (EER-12):

$$w_{i(narrow)} = \frac{w_{i(broad)}}{\sum_{k=1}^{12} w_{i(broad)}}, \qquad i = 1,2,\ldots,12 \tag{9}$$

For the extended group of countries (EER-18):

$$w_{i(extended)} = \frac{w_{i(broad)}}{\sum_{k=1}^{18} w_{i(broad)}}, \qquad i = 1,2,\ldots,18 \tag{10}$$

2.6 Overview of the availability of the ECB's EERs/HCIs

The ECB publishes, in cooperation with the Deutsche Bundesbank, EERs for the euro and for the currencies of each of the countries present in the different groups of trading partners (e.g. the NEER of the US dollar against the EER-12, EER-18 and EER-41). The availability of EERs provided by the ECB is summarised in Table 3.

Table 3

Availability of effective exchange rates (EERs)

	Nominal (NEER)	Real (REER) deflated by …				
		CPI [1]	PPI [2]	GDPD [3]	ULCT [4]	ULCM [5]
Weighting scheme	TMS [6]	TMS	MAN [7]	TMS	TMS	MAN
Highest frequency	Daily	Monthly	Monthly	Quarterly	Quarterly	Quarterly
Dissemination	Every working day at 16:30	First working day of month M_{t+1}		First working day of quarter Q_{t+2}		
Date of first observation						
EER-12 [8]	21 Sep 1981	Jan 1993	Jan 1993	Q1 1995	Q1 1995	Q1 1995
EER-18 [9]	4 Jan 1993	Jan 1993	Jan 1995	Q1 1995	Q1 1995	Q1 1995
EER-41 [10]	4 Jan 1993	Jan 1993		Q1 1998		

Notes: Time series available for the euro and all non-euro area currencies in the group of trading partners. **1** Consumer price index. **2** Producer price index. **3** Gross domestic product deflator. **4** Unit labour costs in the total economy. **5** Unit labour costs in the manufacturing sector. **6** Combined manufactured products (SITC 5 to 8) and services (Total EBOPS Services). **7** Manufactured products (SITC 5 to 8). **8** Narrow group of trading partners Australia, Canada, Denmark, Hong Kong, Japan, Norway, Singapore, South Korea, Sweden, Switzerland, the United Kingdom and the United States. **9** Extended group of trading partners EER-12 plus Bulgaria, China, the Czech Republic, Hungary, Poland and Romania. **10** Broad group of trading partners EER-18 plus Algeria, Argentina, Brazil, Chile, Colombia, Iceland, India, Indonesia, Israel, Malaysia, Mexico, Morocco, New Zealand, Peru, the Philippines, Russia, Saudi Arabia, South Africa, Taiwan, Thailand, Türkiye, Ukraine and the United Arab Emirates.

In addition, the ECB provides EERs for the individual euro area Member States, called harmonised HCIs in this context. An overview of the data availability is displayed in Table 4.

Table 4

Availability of harmonised competitiveness indicators (HCIs)

	Nominal	Real deflated by …				
		CPI [1]	PPI [2]	GDPD [3]	ULCT [4]	ULCM [5]
Weighting scheme	TMS [6]	TMS	MAN [7]	TMS	TMS	MAN
Highest frequency	Daily	Monthly	Monthly	Quarterly	Quarterly	Quarterly
Dissemination	Every working day at 16:30	Fourth working day of month M_{t+1}		Fourth working day of quarter Q_{t+2}		
Date of first observation						
EA20 [8]	Jan 1993	Jan 1993	Jan 1993	Q1 1995	Q1 1995	Q1 1996
EER-12 [9]	Jan 1993	Jan 1993	Jan 1994	Q1 1995	Q1 1995	Q1 1996
EER-18 [10]	Jan 1993	Jan 1993	Jan 1995	Q1 1995	Q1 1995	Q1 1996
EER-41 [11]	Jan 1993	Jan 1993		Q1 1998		
EA20 + EER-12	Jan 1993	Jan 1993	Jan 1994	Q1 1995	Q1 1995	Q1 1996
EA20 + EER-18	Jan 1993	Jan 1993	Jan 1995	Q1 1995	Q1 1995	Q1 1996
EA20 + EER-41	Jan 1993	Jan 1993		Q1 1998		

Notes: Time series available for all 20 euro area legacy currencies. **1** Consumer price index. **2** Producer price index. **3** Gross domestic product deflator. **4** Unit labour costs in the total economy. **5** Unit labour costs in the manufacturing sector (currently not published). **6** Combined manufactured products (SITC 5 to 8) and services (Total EBOPS Services). **7** Manufactured products (SITC 5 to 8). **8** Former legacy currencies of the 20 euro area Member states. **9** Narrow group of trading partners Australia, Canada, Denmark, Hong Kong, Japan, Norway, Singapore, South Korea, Sweden, Switzerland, the United Kingdom and the United States. **10** Extended group of trading partners EER-12 plus Bulgaria, China, the Czech Republic, Hungary, Poland and Romania. **11** Broad group of trading partners EER-18 plus Algeria, Argentina, Brazil, Chile, Colombia, Iceland, India, Indonesia, Israel, Malaysia, Mexico, Morocco, New Zealand, Peru, the Philippines, Russia, Saudi Arabia, South Africa, Taiwan, Thailand, Türkiye, Ukraine and the United Arab Emirates.

3 Bilateral trade in manufactured goods and services

The methodology behind the weighting scheme used for the ECB's EERs and HCIs (as detailed in Sections 2.4 and 2.5) relies on obtaining the required trade data. The scope of the initial data collection covers bilateral trade flows between all countries included in the broad group of trading partners (EER-41) plus the individual euro area Member States, thus representing 61 countries. The trade flows consist of imports and exports in both manufacturing goods and services. In addition to bilateral trade flows, time series on total imports and exports are needed.

The methods used to overcome data availability problems and to obtain the full matrix of bilateral flows are presented in detail in this section. Starting from the reported figures, mirror data and balancing techniques are used to increase data coverage and reduce trade asymmetries. Subsequently, an econometric approach is employed via a gravity model to fill any remaining data gaps. Finally, additional corrections are applied to ensure consistency between the total trade flows of each country and the (partly estimated) bilateral trade flows.

This enhanced methodology, implemented for the first time in 2020, not only allows for the inclusion of trade in services in the weighting, but also offers improvements to the data collection for manufacturing trade.

3.1 Initial availability of reported data

In order to cover the data needs as much as possible with actual (i.e. non-estimated) data and thus limit the use of estimation techniques, different trade data sources are combined. As shown in the summary table available in Annex A, data on trade in manufactured goods were collected from the United Nations Comtrade Database and Eurostat. In line with the previous ECB methodology, manufacturing is classified according to Sections 5 to 8 of the SITC. The data from the two sources were combined in a single dataset, giving priority to Eurostat if data were available from both sources. In practice, such cases correspond to the Member States of the European Union for which there are no major deviations across the two datasets.[9]

International trade flows in manufactured goods are characterised by very high data availability. For the more recent three-year periods (since 2004-06), the reported data cover more than 95% of the required data, while earlier periods show only moderately lower data availability (Table 5).

[9] Differences may arise from vintage issues or if different trade concepts are applied (in some cases the community concept is reported for Eurostat and the national concept for UN Comtrade).

Table 5

Data availability after download – manufacturing data

(percentage of available observations)

	MANUFACTURING								
	1995-97	1998-2000	2001-03	2004-06	2007-09	2010-12	2013-15	2016-18	2019-21
	Full sample								
Stage 1: Reported values	81.0	88.6	92.7	95.0	95.7	96.3	96.6	96.5	95.9
	Euro area								
	82.4	89.7	94.6	95.9	96.4	97.2	97.9	98.2	99.0

Note: 100% coverage is defined as full coverage of bilateral flows plus total flows vis-à-vis the rest of the world.

Euro area Member States report nearly all required data on manufacturing trade flows for the most recent three-year periods. As shown in Annex B.1, only two euro area countries exhibit data availability lower than 98% for the period 2019-21 (Cyprus and Malta with 90% and 96% respectively). Excluding the strong downward bias introduced by Luxembourg in the period 1995-98, the picture remains fairly stable across periods. As illustrated in Annex B.2, the situation for countries included in the broad group of trading partners (EER-41) is very similar, also for recently added countries (with the noticeable exceptions of the United Arab Emirates in the period 1995-97 and Algeria in the period 2019-21).

The statistics on international trade in services were collected from three institutions (as detailed in the summary table available in Annex A): the United Nations, Eurostat and the OECD. Depending on availability, data corresponding to both the Extended Balance of Payments Services classification 2002 (EBOPS 2002) and the Extended Balance of Payments Services classification 2010 (EBOPS 2010) or only one of the two classifications were extracted (always for the item total EBOPS services).[10]

Services span a wide range of economic activities, are very heterogeneous and also exhibit intangible characteristics. They are therefore inherently more difficult to define and measure than goods. In this context, the coverage of trade in services statistics is predictably less complete. The data availability of bilateral services trade flows has nevertheless substantially improved in recent years, so that the reported values now cover about 55% of the required observations across the full sample of countries, encompassing all trading partners of the EER-41 group plus the individual euro area Member States (Table 6).

[10] Ideally, complete time series information based on a unique classification should be used throughout, but this proved impossible for data availability reasons.

Table 6

Data availability after download – services data

(percentage of available observations)

	SERVICES								
	1995-97	1998-2000	2001-03	2004-06	2007-09	2010-12	2013-15	2016-18	2019-21
	Full sample								
Stage 1: Reported values	12.8	21.8	37.3	50.7	55.7	59.9	55.2	54.9	54.9
	Euro area								
	24.8	40.7	70.4	88.3	90.8	97.0	96.0	95.4	96.5

Note: 100% coverage is defined as full coverage of bilateral flows plus total flows vis-à-vis the rest of the world.

For euro area Member States, the availability of trade in services data is much higher, reaching more than 95% since 2010 and closely matching the data availability of manufactured goods. As shown in Annex C.1, only three countries presented data availability lower than 90% during the period 2019-21 (Germany, Malta and Spain, with 78%, 81% and 89% respectively). For the countries included in the broad group of trading partners, the picture is less satisfactory (Annex C.2), with many countries not reporting any bilateral flows. Hence, additional methods were used to fill any remaining data gaps (as described in the following subsections).

3.2 Extending the coverage with mirror data

As shown in Section 3.1, the required trade data cannot be solely obtained via the collection of reported figures. Considering the nature of trade statistics, the incomplete original building block of reported data can be extended considerably by means of mirror data techniques. Conceptually, a trade flow is always characterised by its symmetrical nature. An export of country A to country B is an import of country B from country A. The same flow or economic phenomenon is in principle reported twice, from the perspective of country A and from the perspective of country B. This is commonly referred as mirror statistics.

Mirror data were employed as an initial step to complete the matrix of bilateral flows: in case a country does not report bilateral data vis-à-vis a certain partner country, the gap is filled by mirror data reported by the partner country, if available. As the coverage of reported values is already remarkably high for manufacturing trade flows, the impact of mirror data is mostly visible for earlier periods. For example, the data availability for the period 1995-97 was expanded from 81.0% to 87.5% using mirror data (Table 7).

Table 7

Data availability after download and use of mirror data techniques – manufacturing data

(percentage of available observations)

	MANUFACTURING								
	1995-97	1998-2000	2001-03	2004-06	2007-09	2010-12	2013-15	2016-18	2019-21
Stage 1: Reported values	81.0	88.6	92.7	95.0	95.7	96.3	96.6	96.5	95.9
Stage 2: Mirror / balanced values	87.5	93.1	96.4	97.4	97.9	98.3	98.5	98.7	98.8

Note: 100% coverage is defined as full coverage of bilateral flows plus total flows vis-à-vis the rest of the world.

The impact of mirror data techniques is greater when it comes to trade in services. Data availability for the most recent periods increases to around 80%, while coverage for earlier periods substantially improves as well (Table 8). The two periods with data availability below 50% (1995-97 and 1998-2000) are therefore the ones primarily affected by the use of estimation techniques (see Section 3.4).

Table 8

Data availability after download and use of mirror data techniques – services data

(percentage of available observations)

	SERVICES								
	1995-97	1998-2000	2001-03	2004-06	2007-09	2010-12	2013-15	2016-18	2019-21
Stage 1: Reported values	12.8	21.8	37.3	50.7	55.7	59.9	55.2	54.9	54.9
Stage 2: Mirror / balanced values	22.1	37.5	58.2	73.8	78.6	83.4	79.5	79.1	79.3

Note: 100% coverage is defined as full coverage of bilateral flows and total flows vis-à-vis the rest of the world.

3.3 Addressing asymmetries with balanced values

The mirror data framework described in Section 3.2 needs to be further adjusted to tackle a well-known problem in trade data: bilateral trade asymmetries. Such a phenomenon occurs when for a given flow the value reported by a country does not match the mirror data reported by the partner country. Considering the prominence of this issue, a balancing process based on a symmetry index was developed, derived partly from the approach used in the Balanced Trade in Services (BaTIS) dataset of the OECD and World Trade Organization (WTO), as outlined by Fortanier et al. (2017).

In cases where a country reports bilateral trade data vis-à-vis a certain partner country and the corresponding mirror data are also available (as reported by the partner country), a weighted average between the two values is computed. The weight

attributed to each value is defined by the reporting “reliability” of each country. In general terms, a reporter is assumed to be more reliable if a larger share of its reported observations corresponds closely (i.e. is “symmetrical”) to the data reported by the trading partners.

More specifically, a trade flow is considered symmetrical if the absolute difference between the two values (from the reporter and from the partner country) is smaller than 30% of their sum (Table 9). As an example, if the sum of the two values reported for a given bilateral flow equals €200 million, the reporting of the flow will be considered symmetrical only if the absolute difference between the two values is lower than €60 million (e.g. €90 million from the reporter and €110 million from the partner results in an absolute difference of €20 million).

The “30% criteria” to assess the symmetry may be perceived as relatively accommodating, but it takes into account that a certain degree of asymmetry is inherently present in all trade flows. It is moreover strict enough to meet the fundamental objective of detecting and highlighting cases where countries consistently report figures that are drastically misaligned with the mirror data across many trading partners. To account for reporting changes and potential evolutions in compilation and estimation methods, a time-varying approach was selected, with symmetry indices being computed for each year and used accordingly in the balancing process.

An alternative approach, used by Fortanier et al. (2017), consists of basing the symmetry indices on the share of symmetrical bilateral trade (analysed in levels), instead of the pure percentage of the reported flows meeting the symmetry criterion (regardless of the level of the flows). This strategy has the advantage of giving more importance to bilateral trade flows representing a larger share of the total trade of a country. However, it has the disadvantage of introducing a negative bias towards reporters that trade extensively with countries that report lower-quality data.

Table 9

Criterion of symmetrical reporting and symmetry index

	Formula
Criterion of symmetrical reporting	$\left\|x_{i,j}^{rep} - x_{i,j}^{mir}\right\| < \left(x_{i,j}^{rep} + x_{i,j}^{mir}\right) * 30\%$ Where $x_{i,j}^{rep}$ is the gross export flows of country i to country j, as reported by country i, and $x_{i,j}^{mir}$ represents the same flow but from the mirror data reported by country j $\left\|m_{i,j}^{rep} - x_{i,j}^{mir}\right\| < \left(m_{i,j}^{rep} + x_{i,j}^{mir}\right) * 30\%$ Where $m_{i,j}^{rep}$ is the gross import flows of country i from country j, as reported by country i, and $x_{i,j}^{mir}$ represents the same flow but from the mirror data reported by country j
Symmetry index	$SI_{i,t} = \frac{Flows_{i,t}^{symmetrical}}{Flows_{i,t}^{total}}$ Where: $SI_{i,t}$ stands for the symmetry index of country i in year t $Flows_{i,t}^{symmetrical}$ is the number of flows (imports and exports) reported by country i in year t for which the mirror data are available and the reporting is considered symmetrical $Flows_{i,t}^{total}$ represents the total number of flows (imports and exports) reported by country i in year t for which the corresponding mirror data are available

Notes: The trade flows between all 61 trading countries are considered (EER-41 countries + euro area Member States). For each country, the symmetry index is computed separately for manufacturing and services. If a country does not report bilateral trade data, no symmetry index can be computed. Hence, mirror data, if available, are used as a default in these cases.

In concrete terms, the method outlined in Table 9 implies that if country A reports in year *t* for a given trade flow a value of €100 million, while the mirror data of partner country B show a value of €200 million, a weighted average between the two figures will be computed. Assuming that the reported data of country A are generally considered rather symmetrical, with a symmetry index of 0.9 in year *t*, and that country B shows a symmetry index of only 0.4 in year *t*, the final value of the flow will be (€100 million * 0.9 + €200 million * 0.4) / (0.9 + 0.4) = €130.8 million. This value is hence closer to the one reported by country A, in line with the assessed reporting reliability of the two countries.

As detailed in Annex D.1, the manufacturing symmetry indices are relatively high and stable over time. Taking the average over time, they vary between 54% (Hong Kong) and 96% (Germany and Italy), with the median reaching 85%. Overall, the symmetry indices of the euro area Member States are comparatively high, in particular when it comes to the largest economies (96%, 92%, 96% and 95% for Germany, France, Italy and Spain respectively). Two notable exceptions are Cyprus (62%) and Malta (66%), which have some of the lowest scores in the sample.

The analysis of services symmetry indices (Annex D.2) is somewhat hindered by relatively lower data availability. The averages across years range between 23% (Chile) and 91% (Germany), with a median level of 67%. This pronounced difference with manufacturing symmetry indices is nevertheless expected considering the inherent difficulties of measuring trade in services statistics and ultimately explains

why a balancing process is needed. Importantly, large services exporters such as the United States, Japan, South Korea and the United Kingdom (i.e. the countries most affected by the inclusion of services in the weighting scheme) seem on average to report more consistent data, as shown in higher symmetry indices.

3.4 Completing the dataset with a gravity model

As previously indicated, the use of mirror data techniques allows almost full coverage to be achieved for trade in manufactured goods. Resorting to advanced estimation techniques was therefore not essential as long as the focus was solely put on manufacturing data. Indeed, the very few remaining gaps in the time series could easily be filled by using leads and lags (i.e. the observations available directly after or before the missing periods). However, the inclusion of trade in services in the weighting scheme created the need to update this methodology, as a significant number of required trade flows were still missing after using mirror data techniques. This became even more necessary with the incorporation of additional countries into the broad group of trading partners in July 2020.

To complete the coverage of bilateral flows, the missing data points were estimated by means of an econometric gravity model. Such models represent a well-established methodology in economics, used in particular to explain trade patterns. The gravity model was first introduced by Tinbergen (1962) to explain bilateral trade flows by the size of the economies and the distance between the countries. It has since become the workhorse model for bilateral trade (Head and Mayer, 2014). In essence, it states that bilateral trade between two countries is proportional to the size of their economies, as measured by their respective GDP, and inversely proportional to the trade costs between them (captured in particular by geographical distance). Certain additional factors, such as a common language or common legal systems, enter the equation as factors easing bilateral trade costs. The specifications defined in this paper are largely consistent with those used for the OECD-WTO BaTIS dataset by Fortanier et al. (2017).

As an initial step, a regression model was defined to estimate the determinants of bilateral exports and imports of manufactured goods. The selected gravity specification involved two time-varying independent variables: GDP of the reporter and GDP of the partner country (obtained from the IMF World Economic Outlook database), in log terms based on current US dollar values. In addition, the following time-invariant regressors were included in the equation (from the GeoDist database of the Centre d'Études Prospectives et d'Informations Internationales (CEPII)):[11]

- log of population-weighted distance in kilometres (pop-wt);
- contiguity (contig);
- time zone difference (tdiff);
- common language (comlang_ethno);
- common legal system (comleg_posttrans);
- common colony (comcol).

[11] See Mayer and Zignago (2011).

Moreover, a dummy variable was included for joint EU membership.

The regression results, as shown in Table 10, confirm the very high predictive power of the model, in line with the solid conceptual framework behind the use of the gravity equation in international trade. All the variables included in the specification generally show a very high degree of statistical significance and plausible coefficients.

Table 10

Results of the regressions (exports and imports of manufactured goods)

	Dependent variable: log(manufacturing trade flows)	
	Exports	Imports
GDP reporter	0.631*** (0.015)	0.874*** (0.015)
GDP partner	0.874*** (0.015)	0.631*** (0.015)
Weighted distance	-1.250*** (0.009)	-1.250*** (0.009)
Contiguity	0.406*** (0.019)	0.406*** (0.019)
Time zone difference	0.019*** (0.002)	0.019*** (0.002)
Common language	0.449*** (0.013)	0.449*** (0.013)
Common legal system	0.174*** (0.007)	0.174*** (0.007)
Common colony	0.598*** (0.025)	0.598*** (0.025)
EU partners	0.443*** (0.015)	0.443*** (0.015)
Constant	20.615*** (0.129)	20.615*** (0.129)
Reporter FE	Yes	Yes
Partner FE	Yes	Yes
Year FE	Yes	Yes
Observations	95,107	95,107
R2	0.871	0.871
Adjusted R2	0.871	0.871
Residual std. error (df = 94951)	0.953	0.953
F statistic (df = 155; 94951)	4,142.511***	4,142.511***

Note: *p<0.1; **p<0.05; ***p<0.01.

As a second step, the predicted values were used to generate the full matrix of bilateral manufacturing trade flows.

- **Purely estimated values:** For cases in which bilateral trade flows were fully missing from the dataset (after the implementation of mirror data techniques), the predicted values were copied as such, after checking their plausibility.
- **Chain-linked estimates:** For cases in which flows were incomplete (with certain bilateral observations being available but showing some gaps across time), the growth rate of the predicted values was used to link the estimates and the actual (non-estimated) values, without creating breaks in the final time series.

This process represents a strong refinement compared with the method used previously to fill the gaps in the time series for manufacturing trade, which was based on a pure backward and/or forward extension of the available values.

Subsequently, the same approach was applied to services trade, with the exception that manufacturing trade was also included as an additional independent variable in the regression models. As presented in Table 11, the regression results closely match those of manufacturing flows, in line with the literature on gravity models for international services (Head and Mayer, 2014). The high statistical significance of the additional regressor confirms the intuition of the value added from including manufacturing data in the prediction of services trade flows (corroborated by extensive robustness tests performed using multiple specifications).

Table 11

Results of the regressions (exports and imports of services)

	Dependent variable: log(services trade flows)	
	Exports	Imports
GDP reporter	0.325*** (0.020)	0.553*** (0.020)
GDP partner	0.553*** (0.020)	0.325*** (0.020)
Manufacturing trade	0.460*** (0.004)	0.460*** (0.004)
Weighted distance	-0.666*** (0.013)	-0.666*** (0.013)
Contiguity	0.212*** (0.022)	0.212*** (0.022)
Time zone difference	-0.010*** (0.003)	-0.010*** (0.003)
Common language	0.127*** (0.017)	0.127*** (0.017)
Common legal system	0.164*** (0.009)	0.164*** (0.009)
Common colony	-0.354*** (0.034)	-0.354*** (0.034)
EU partners	0.0002 (0.021)	0.0002 (0.021)
Constant	10.762*** (0.209)	10.762*** (0.209)
Reporter FE	Yes	Yes
Partner FE	Yes	Yes
Year FE	Yes	Yes
Observations	64,415	64,415
R2	0.868	0.868
Adjusted R2	0.868	0.868
Residual std. error (df = 64258)	0.951	0.951
F statistic (df = 156; 64258)	2,709.970***	2,709.970***

Note: *p<0.1; **p<0.05; ***p<0.01.

3.5 Final dataset

A final correction is needed to preserve the internal consistency of the dataset. In exceptional cases, it may indeed occur that the reported total imports or exports (vis-à-vis all countries in the world) are lower than the sum of final bilateral flows, which should conceptually not be the case. In such instances, the totals were recomputed from the aggregation of bilateral trade. This method was also applied in case of missing total series.

At this stage, the two datasets containing the required manufacturing and services trade data are fully complete (Table 12). In terms of data hierarchy, balanced values represent the best-case scenario and are always used when available. When they are missing but either reported values or mirror values are present, the latter are selected. In the rest of the cases, chain-linked estimates are prioritised over purely estimated values since the former are deemed more reliable thanks to their link to existing values. The purely estimated values, solely based on the gravity model, only account for 0.2% of the final manufacturing dataset and 12.6% of the final services dataset.

Table 12

Structure of final trade datasets

(percentage of the final datasets, covering 100% of the trade data requirements)

	1995-97	1998-2000	2001-03	2004-06	2007-09	2010-12	2013-15	2016-18	2019-21
MANUFACTURING									
Reported values only	7.3	5.2	4.5	3.4	3.2	3.0	2.7	3.1	3.8
Mirror values only	6.6	4.5	3.7	2.4	2.2	2.0	1.8	2.2	2.9
Balanced values	72.8	82.5	87.4	90.9	91.8	92.6	93.2	92.7	91.4
Chain-linked estimates	12.3	6.8	3.4	2.4	1.9	1.5	1.4	1.2	1.0
Purely estimated values	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Correction of totals	0.9	0.9	0.8	0.7	0.7	0.7	0.7	0.8	0.8
SERVICES									
Reported values only	10.3	16.9	22.3	24.4	24.2	24.8	25.5	25.3	25.4
Mirror values only	9.3	15.6	20.9	23.1	22.9	23.5	24.3	24.2	24.4
Balanced values	2.0	4.6	14.8	25.9	31.1	34.7	29.2	29.1	29.0
Chain-linked estimates	65.3	49.9	29.2	13.6	8.8	4.0	7.9	8.3	8.1
Purely estimated values	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6
Correction of totals	0.6	0.4	0.3	0.4	0.4	0.4	0.4	0.5	0.5

Note: 100% coverage is defined as full coverage of bilateral flows plus total flows vis-à-vis the rest of the world.

3.6 Specific issues of trade in services data

Trade in services data are affected by a number of data issues that need to be taken into account when constructing a dataset of bilateral flows.

One of these issues relates to the presence of non-plausible zeros in the reported observations. Considering that “only” 61 countries in total are considered as part of the computation of the enhanced EERs/HCIs, the world’s smallest economies are de facto excluded. Hence, one should not expect any (or too many) true “zero” total services trade flows between two countries in the sample. In practice, however, some zeros are reported, which can be deemed implausible taking the size of the economies into account (e.g. flows between Portugal and Belgium or between Finland and New Zealand). Consequently, zero flows have been removed from the initial dataset and treated in the same way as missing observations.

Additionally, bilateral total EBOPS services trade data can be affected by negative values. This is noticeable in the data from certain reporters, for example France and Germany. Conceptually, these negative values can stem from two sub-items of the EBOPS classification:

- **EBOPS 2002:** insurance services (“S253“) and other business services (“S268”, due to the lower item “merchanting”);
- **EBOPS 2010:** insurance and pension services (“SF“).

As the inclusion of negative values is not compatible with the computation of trade weights or trade shares, these values are removed from the dataset and treated as missing, similarly to the “zero” values. From a conceptual point of view, a preferable option would be to re-aggregate total EBOPS services trade data from the lower items, excluding the “problematic” sub-items in case of negative values. However, such an approach proved impossible due to insufficient data availability for the various EBOPS sub-items across the country sample. In addition, certain inconsistencies between total EBOPS services and the different categories further prevent re-aggregation from the sub-items.

4 Enhanced indicators for competitiveness analysis

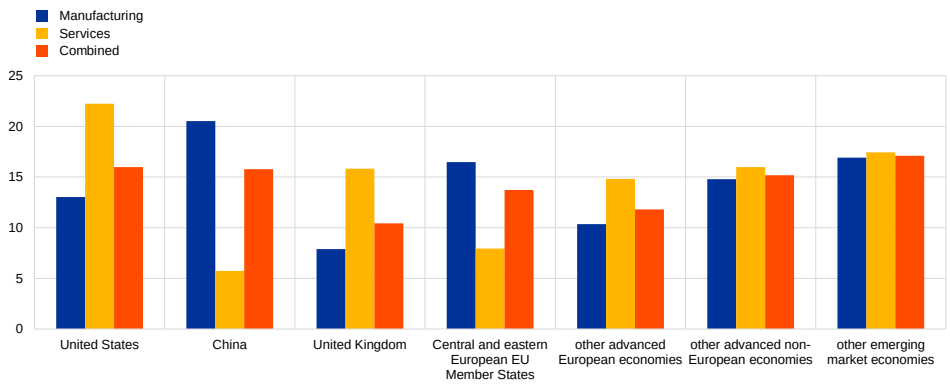
4.1 Trade weights

The inclusion of services in the weighting scheme underlying the computation of the ECB's EERs not only corresponds to a conceptual refinement but has a practical and sizeable impact on the indicators. This can be directly perceived by comparing the manufacturing, services and combined trade weights of the euro area's largest trading partners (Chart 5).

Chart 5

Trade weights in the euro EER-41: manufacturing, services and combined

(percentages)



Source: ECB.
Notes: Trade weights are averages over the period 2019-21. "Central and eastern European EU Member States" comprises Bulgaria, the Czech Republic, Hungary, Poland and Romania; "other advanced European economies" comprises Denmark, Iceland, Norway, Sweden and Switzerland; "other advanced non-European economies" comprises Australia, Canada, Hong Kong SAR, Israel, Japan, New Zealand, Singapore, South Korea and Taiwan; and "other emerging market economies" comprises Algeria, Argentina, Brazil, Chile, Colombia, India, Indonesia, Malaysia, Mexico, Morocco, Philippines, Peru, Russia, Saudi Arabia, South Africa, Thailand, Türkiye, Ukraine and the United Arab Emirates.

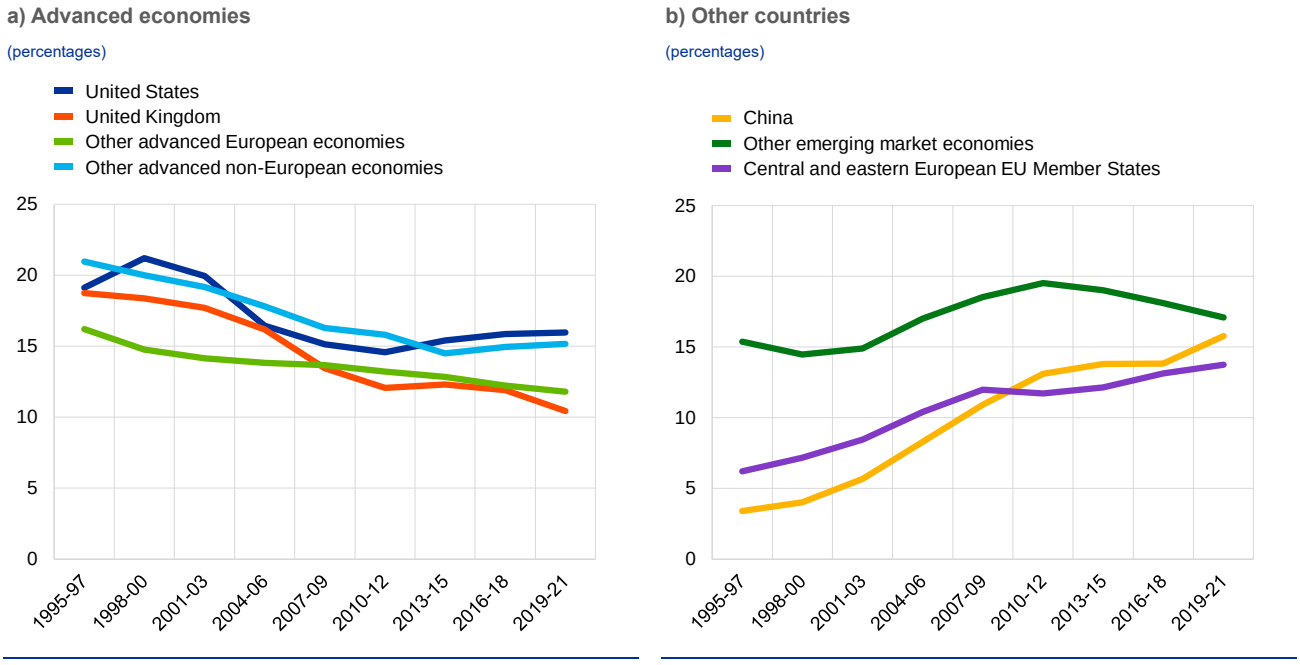
The most striking difference is visible for China, which is the largest trading partner of the euro area in terms of manufactured goods (21%), whereas it is only the fourth largest partner for services (6%). By contrast, the United States and United Kingdom are by far the largest euro area trading partners for services, with much higher shares than for manufacturing (22% vs 13% for the United States, 16% vs 8% for the United Kingdom). For the United States, this phenomenon is partly explained by its high relevance as a trading partner of the euro area when it comes to telecommunications, computer and information services as well as other business services (according to euro area balance of payments data). The services weight of the "other advanced European economies" group is also much higher than for manufacturing (driven partly by Switzerland), while it is considerably lower for central and eastern European EU Member States (such as the Czech Republic and Poland), whose trade linkages with the euro area are to a large extent shaped by their integration in European manufacturing value chains.

These patterns have consequences for the combined weights: compared with the manufacturing weights (the unique trade basis of the previous ECB methodology), the United States surpasses China as the euro area's largest trading partner, while Switzerland overtakes Poland as the fourth largest trading partner.

Chart 6 presents longer time trends for the combined weights of the largest countries and country groups since 1995. It shows that the shares of the United States, the United Kingdom and other advanced economies (European and non-European) have decreased over time. Over the past decade, however, the decrease in importance of the United States, in particular, and non-European advanced economies has tailed off and even partly reversed. The trade weight of China has increased strongly over time, with yet another rise in the latest three-year period, while that of other emerging economies, which became increasingly important for euro area trade during the 2000s, has declined over the past decade. Central and eastern European EU Member States have consistently gained in importance owing to their further integration into European value chains.

Chart 6

The evolution of combined trade weights in the euro EER-41 over time



Source: ECB.

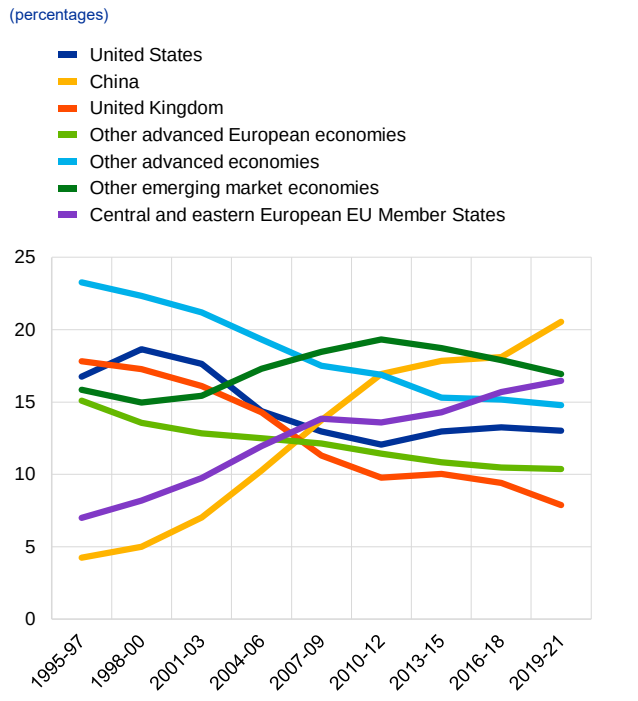
Source: ECB.

These broad shifts in trading partner importance reflect – sometimes diverging – developments in manufacturing (Chart 7) and services trade (Chart 8). Whereas the services weights of the United States and other advanced economies declined from the late 1990s, their importance increased over the past decade; by contrast, those of the United Kingdom decreased further. In manufacturing trade, developments have been similar for the United States – albeit from a lower initial trade weight – while the United Kingdom and other advanced economies have steadily lost importance as trading partners. At the same time, the rise in the trade shares of China and central

and eastern European EU Member States was more contained in services than in manufacturing, while the share of other emerging economies evolved in a comparable fashion in manufacturing and services trade.

Chart 7

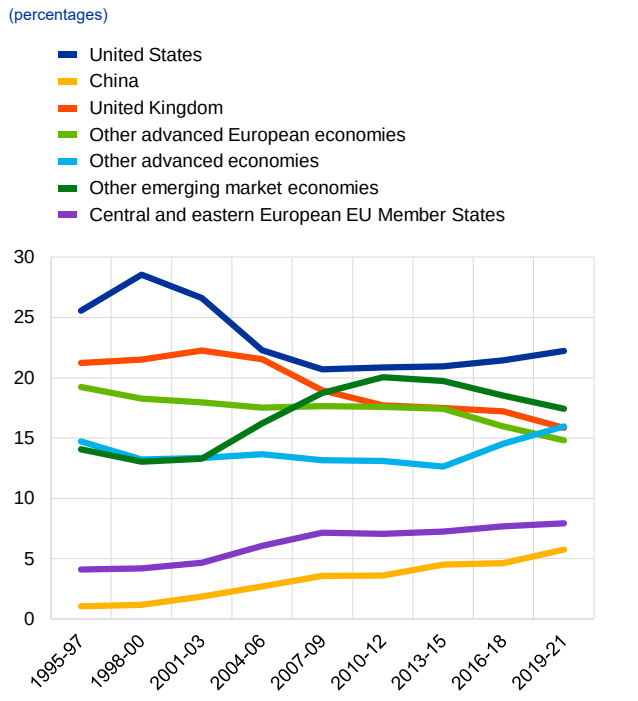
Evolution of trade weights of the EER-41 group of trading partners – manufacturing



Source: ECB.

Chart 8

Evolution of trade weights of the EER-41 group of trading partners – services



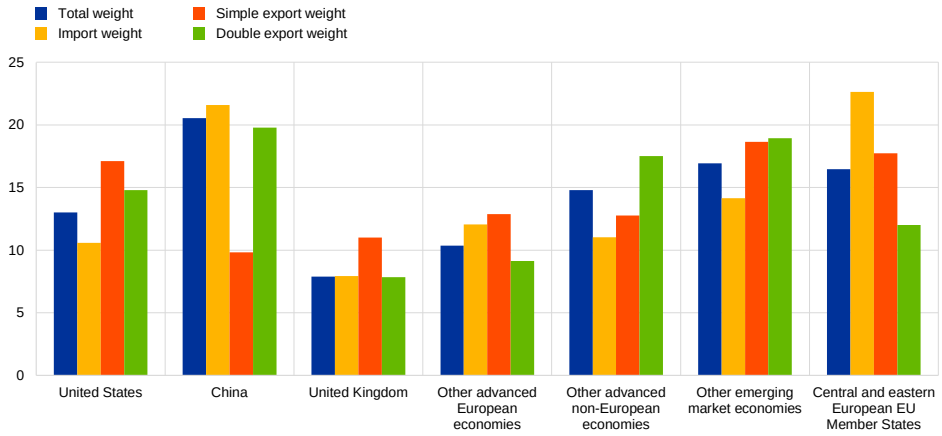
Source: ECB.

As illustrated in Section 2.5, third-market effects can have a significant impact on export weights and thus on the final overall weights. Considering the importance of this type of competition, a simplification of the methodology by excluding third-market effects would imply a much lower information content of the overall trade weights. The most noticeable pattern in this regard relates to China when it comes to manufacturing trade (Chart 9), as the double export weight of China (20%) is double the simple export weight (10%). This reflects China's role as the leading global exporter of goods, which also implies that it is an important competitor in third markets. The manufacturing weights of other advanced non-European economies also gain from third-market effects, in particular Japan, Hong Kong and South Korea, as they are important competitors for the euro area in third markets. By contrast, the manufacturing weights of central and eastern European EU Member States are negatively affected by the inclusion of third-market effects. The role this region plays in Europe's highly integrated value chains implies that it is more important for the euro area in terms of imports than exports, both on the basis of direct exports and even more so when third-market competition is considered (Fidora and Schmitz, 2020).

Chart 9

The importance of third-market effects in the manufacturing trade weights of the euro EER-41

(percentages)



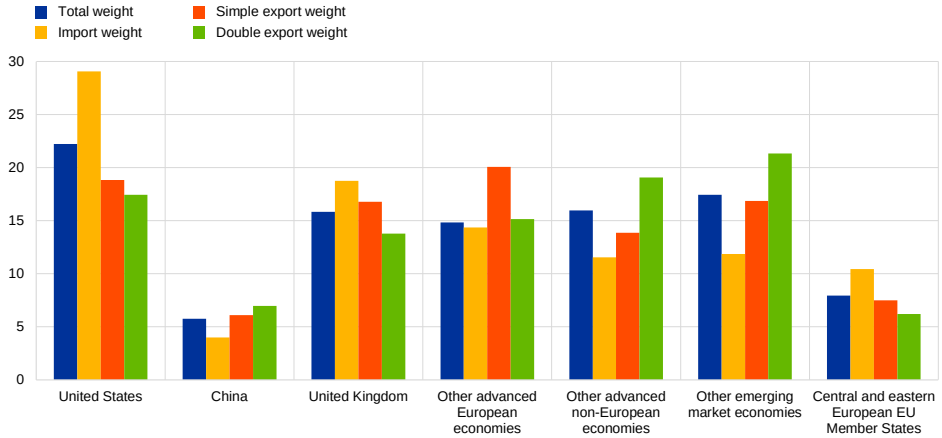
Source: ECB.
Note: Trade weights refer to the period 2019-21.

Interestingly, third-market effects are also important for services trade weights (Chart 10), although the patterns differ partly from those observed for manufacturing. Other advanced non-European economies and other emerging market economies gain in importance when including third-market effects by displaying the largest positive discrepancy between simple and double export weights.

Chart 10

The importance of third-market effects in the services trade weights of the euro EER-41

(percentages)



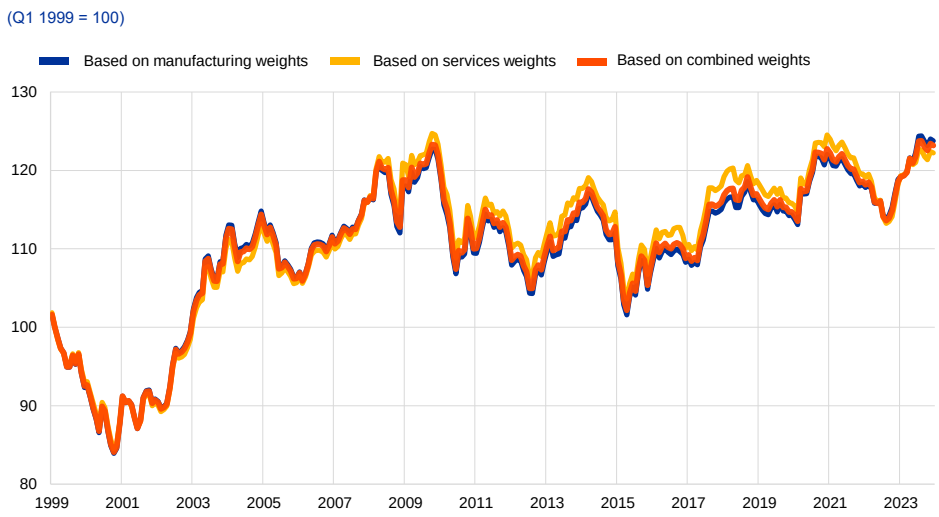
Source: ECB.
Note: Trade weights refer to the period 2019-21.

4.2 EERs and HCIs

Since the inception of the euro in 1999, there has been close co-movement for the broad euro NEER-41, no matter if based on manufacturing, services or (enhanced) combined weights (Chart 11). However, swings in the services-based indicators appear to be slightly more pronounced, especially in the euro appreciation episodes of 2008 and 2019, implying that the enhanced indicators exhibit somewhat larger fluctuations compared with the purely manufacturing-based indicators of the old methodology.

Chart 11

Nominal EERs of the euro



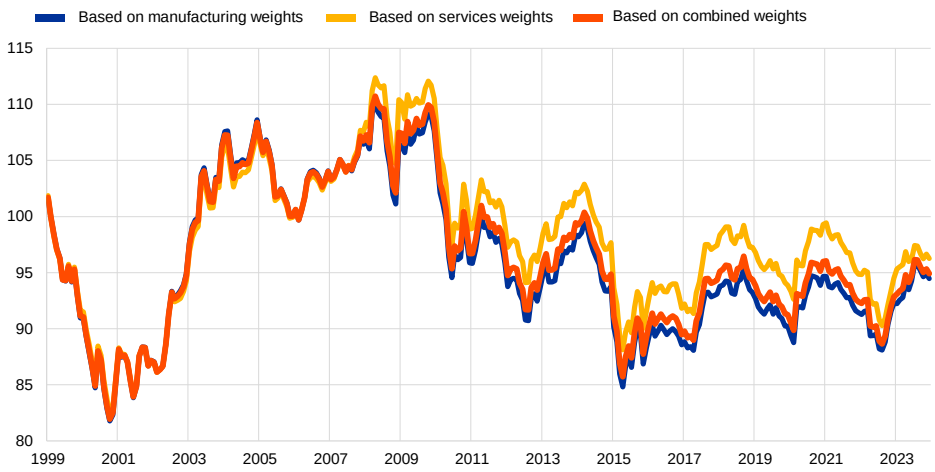
Sources: ECB and own calculations.
Notes: Based on the broad group of trading partners (EER-41). A downward movement reflects a depreciation of the euro, while an upward movement indicates an appreciation.

Chart 12 shows a similar picture for real euro EERs deflated by consumer prices, however with a higher divergence between manufacturing-based and enhanced indicators, especially in 2021. Between January 1999 and December 2023, the enhanced euro REER-41 indicated a somewhat smaller real depreciation (6.7%) compared with the manufacturing-based indicator (7.1%).

Chart 12

Real EERs of the euro deflated by consumer prices

(Q1 1999 = 100)



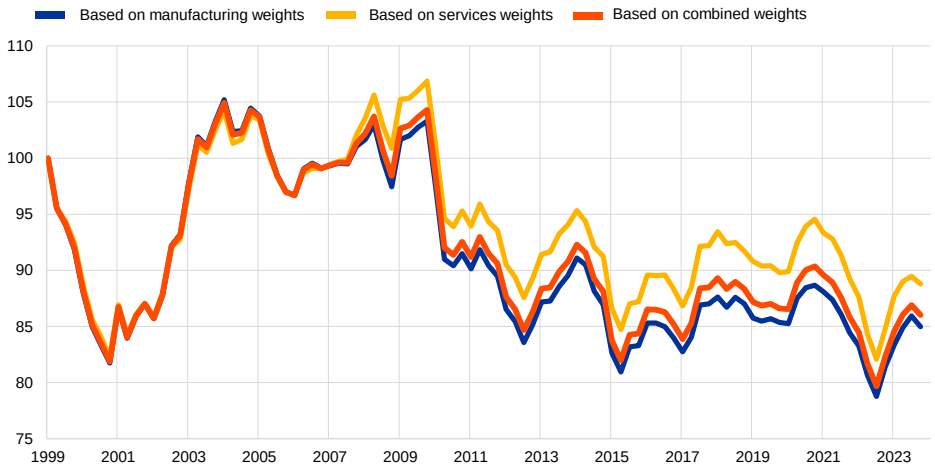
Sources: ECB and own calculations.
Notes: Based on the broad group of trading partners (EER-41). A downward movement reflects a depreciation of the euro, while an upward movement indicates an appreciation.

Chart 13 reveals a comparable pattern for the GDP-deflated REER-41. For the nominal, CPI-deflated and GDP-deflated indicators, the close co-movement between the different indicators until 2007 is very striking, before larger divergences appear. This suggests that since then differences in the trade weights among the various indicators have been more strongly correlated with differences in bilateral exchange rate developments.

Chart 13

Real EERs of the euro (GDP-deflated)

(Q1 1999 = 100)

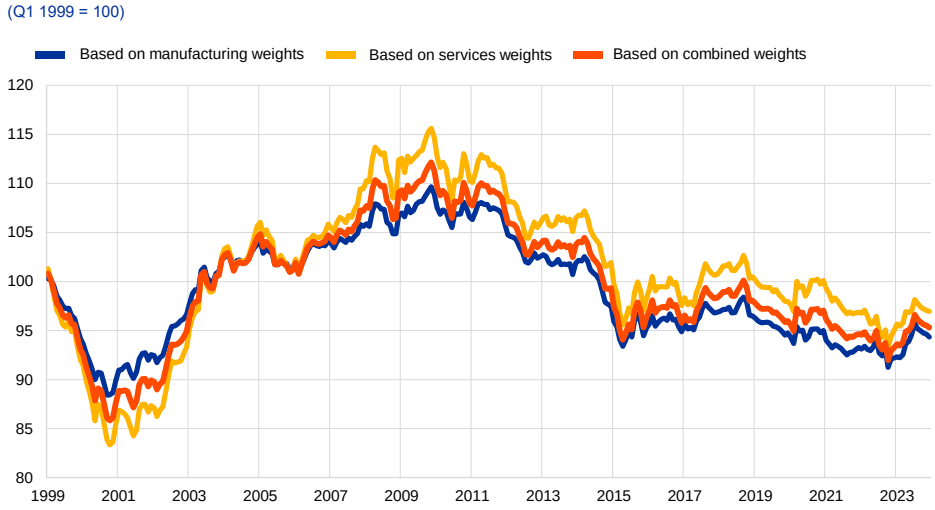


Sources: ECB and own calculations.
Notes: Based on the broad group of trading partners (EER-41). A downward movement reflects a depreciation of the euro, while an upward movement indicates an appreciation.

For euro area countries, especially those with a high share of services trade, the analysis of competitiveness differs quite substantially between the manufacturing-based and the enhanced indicators. Chart 14 presents such evidence for Greece's CPI-deflated broad HCI comprising the EER-41 trading partners and the other 19 euro area countries. Importantly, the real appreciation in Greece (i.e. the loss of price competitiveness) between 2000 and 2010 was more pronounced in the enhanced indicator (28%) than in the manufacturing indicator based on the previous methodology (22%). Such differences demonstrate that the methodology underlying the enhanced indicators matters quantitatively and offers a more complete assessment of international competitiveness and external balances with important implications for policymakers.

Chart 14

HCIs of Greece deflated by consumer prices



Sources: ECB and own calculations.
Notes: Based on the broad group of trading partners (EER-41 + 20 euro area countries). A downward movement reflects a depreciation of the exchange rate, while an upward movement indicates an appreciation.

5 Conclusions

This paper provides a detailed description of enhancements to the trade weighting scheme underlying the EER and HCI indices provided by the ECB. Since services account for an increasing share of international trade and thus play a growing role in assessing competitiveness, it is critical to take them into account when constructing trade weights for the EERs and HCIs.

This paper illustrates the impact of services on trade weights as well as on EER and HCI indices. Moreover, it shows the challenges associated with the inclusion of services trade, foremost in dealing with constraints in terms of data availability. While incomplete data coverage impeded the inclusion of services in the past, improved data coverage for the most recent periods associated with imputation and estimation techniques has enabled the inclusion of services trade. Importantly, the ECB's well-established methodology – which in particular accounts for competition faced by euro area exporters in third markets – did not have to be changed with the inclusion of services trade.

In addition, this paper provides an up-to-date general overview of the ECB's methodology for calculating EER and HCI indices, as previously introduced by Buldorini et al. (2002) and Schmitz et al. (2012). Consequently, the paper may serve as a reference guide for analysts and researchers working with the EER and HCI indices provided by the ECB.

Looking ahead, it is important that the ECB's methodology remains state-of-the art to provide an encompassing and up-to-date measurement of EERs and HCIs. This may imply changes to trading partner groups (as regularly considered with the triennial update of the trade weights) as well as improvements to the data used for trade weights and deflators. Moreover, potential methodological improvements need to be evaluated against their costs and merits. In recent years, discussions on potential extensions of the ECB's indicators mainly related to the impact of global value chains in the measurement of competitiveness (Gunnella, Fidora and Schmitz, 2017).

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Annex

A: Summary trade flows data sources

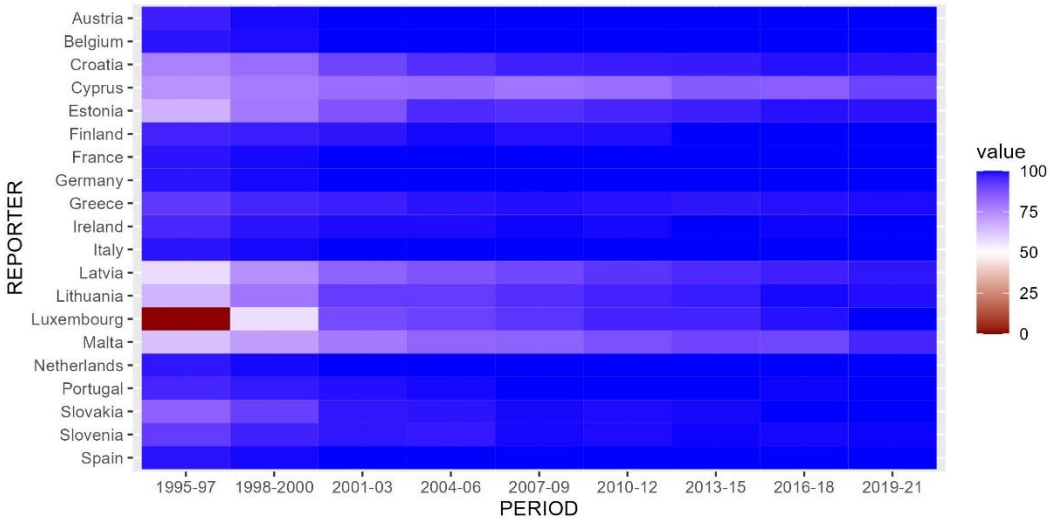
Table A

SOURCE	DATABASE	ITEM
MANUFACTURING		
United Nations	Comtrade Database	Sections 5 to 8 of the Standard International Trade Classification (SITC)
Eurostat	EU trade since 1988 by SITC	Sections 5 to 8 of the Standard International Trade Classification (SITC)
SERVICES		
United Nations	Comtrade Database	Total EBOPS Services (“200”) / EBOPS 2002
Eurostat	International trade in services (from 1985 to 2003) (bop_its_deth)	Total EBOPS Services (“200”) / EBOPS 2002
Eurostat	International trade in services (since 2004) (bop_its_det)	Total EBOPS Services (“200”) / EBOPS 2002
Eurostat	International trade in services (since 2010) (bop_its6_det)	Total EBOPS Services (“S”) / EBOPS 2010
OECD	EBOPS 2002 - Balanced International Trade in Services (1995-2012)	Total EBOPS Services (“200”) / EBOPS 2002 / reported values
OECD	EBOPS 2010 - Trade in services by partner economy	Total EBOPS Services (“S”) / EBOPS 2010

B: Overview of data availability – manufactured goods

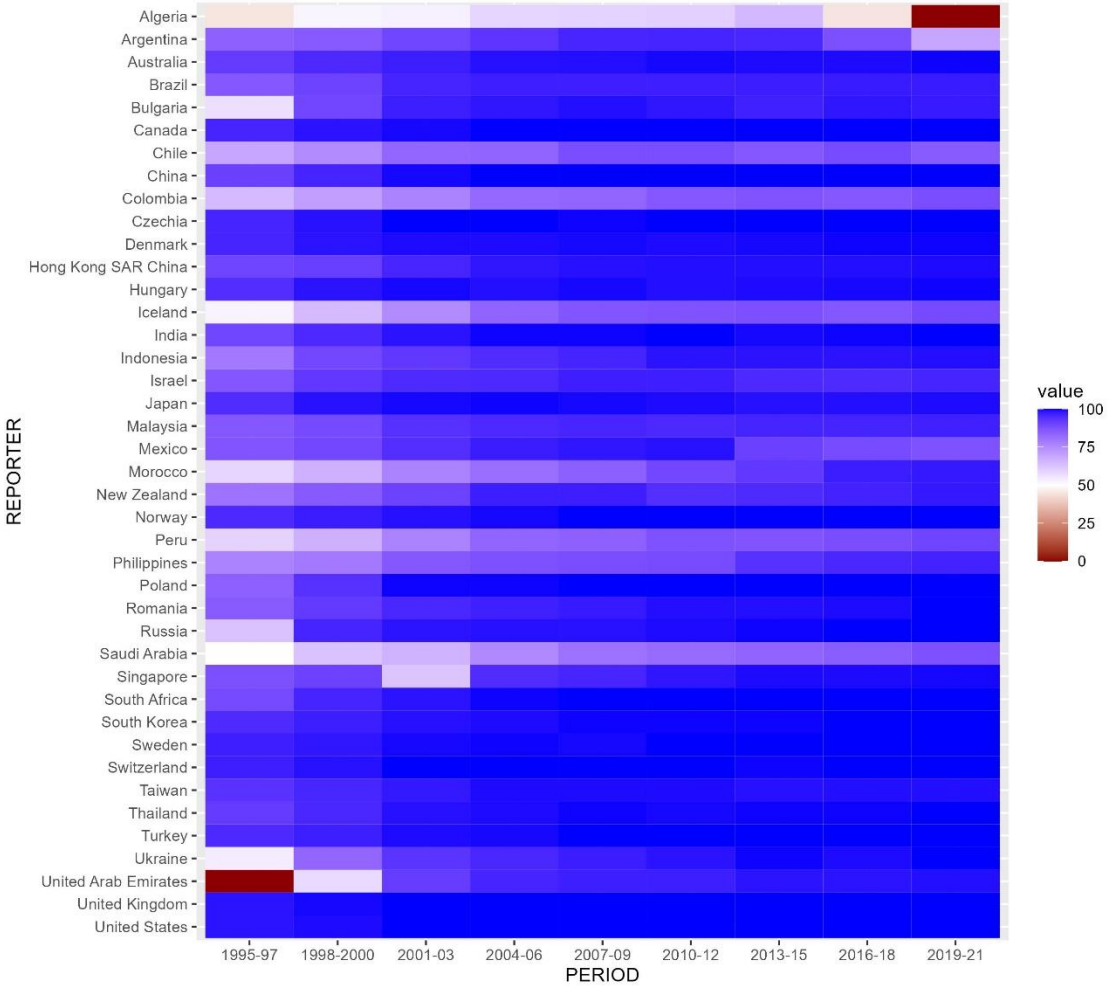
B.1 Euro area countries

Percentage of the required data that is available (directly reported)



B.2 Non-euro area countries

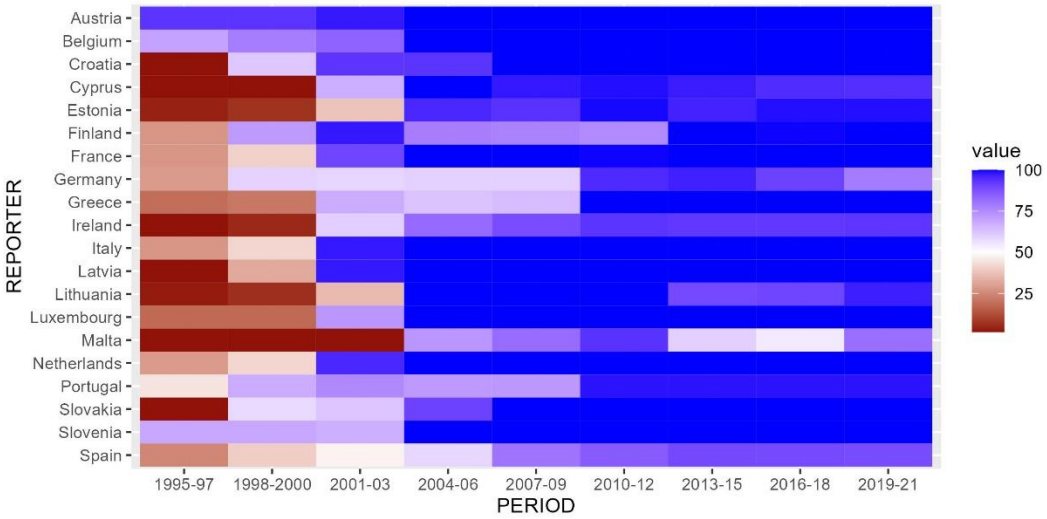
Percentage of the required data that is available (directly reported)



C: Overview of data availability – services

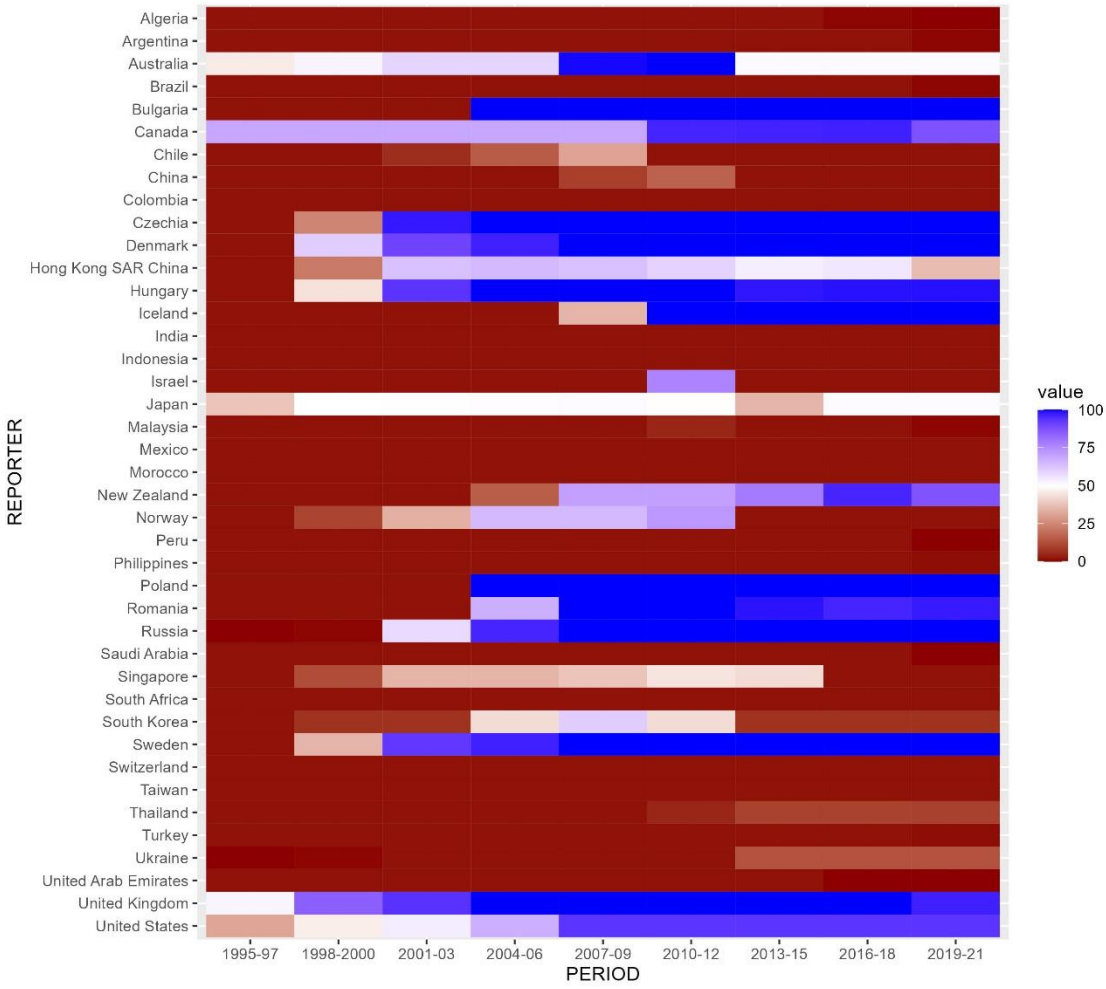
C.1 Euro area countries

Percentage of the required data that is available (directly reported)



C.2 Non-euro area countries

Percentage of the required data that is available (directly reported)



D: Symmetry indices

D.1 Manufactured goods

REPORTER	AVG	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
AE	0.71	NA	NA	NA	NA	0.72	0.73	0.75	0.79	0.73	0.66	0.62	0.63	0.67	0.75	0.75	0.74	0.75	0.70	0.76	0.72	0.75	0.77	0.65	0.65	0.59	0.69	0.73
AR	0.83	0.92	0.90	0.86	0.81	0.83	0.80	0.82	0.87	0.90	0.89	0.89	0.92	0.91	0.88	0.89	0.86	0.87	0.85	0.85	0.80	0.82	0.84	0.82	0.66	0.58	0.65	0.64
AT	0.90	0.93	0.93	0.95	0.94	0.93	0.93	0.94	0.94	0.90	0.89	0.86	0.92	0.88	0.88	0.86	0.86	0.88	0.88	0.88	0.87	0.86	0.90	0.90	0.88	0.90	0.91	0.88
AU	0.87	0.93	0.90	0.90	0.90	0.90	0.85	0.84	0.86	0.86	0.84	0.84	0.89	0.82	0.83	0.85	0.87	0.84	0.86	0.85	0.89	0.87	0.92	0.86	0.89	0.84	0.88	0.85
BE	0.93	0.96	0.93	0.94	0.94	0.92	0.94	0.93	0.91	0.91	0.91	0.90	0.93	0.92	0.92	0.93	0.92	0.94	0.94	0.91	0.94	0.96	0.92	0.92	0.93	0.92	0.91	0.91
BG	0.87	NA	0.89	0.91	0.90	0.84	0.87	0.83	0.82	0.85	0.82	0.78	0.83	0.91	0.89	0.89	0.90	0.89	0.85	0.85	0.85	0.86	0.87	0.92	0.92	0.91	0.88	0.94	0.89
BR	0.89	0.93	0.91	0.95	0.93	0.96	0.95	0.88	0.88	0.87	0.89	0.90	0.88	0.90	0.87	0.89	0.87	0.91	0.92	0.87	0.86	0.86	0.86	0.83	0.84	0.87	0.88	0.89
CA	0.80	0.89	0.84	0.81	0.78	0.75	0.72	0.73	0.79	0.81	0.83	0.82	0.84	0.82	0.80	0.83	0.79	0.76	0.83	0.80	0.86	0.83	0.81	0.81	0.86	0.74	0.74	0.78
CH	0.86	0.89	0.91	0.90	0.88	0.94	0.90	0.91	0.85	0.94	0.90	0.92	0.92	0.85	0.89	0.88	0.82	0.83	0.80	0.79	0.81	0.80	0.83	0.82	0.82	0.81	0.80	0.79
CL	0.88	0.89	0.84	0.86	0.85	0.86	0.84	0.86	0.92	0.86	0.90	0.90	0.87	0.88	0.87	0.87	0.91	0.91	0.87	0.87	0.88	0.86	0.87	0.92	0.92	0.92	0.91	0.91
CN	0.77	0.62	0.68	0.69	0.71	0.67	0.68	0.71	0.71	0.76	0.78	0.82	0.81	0.84	0.82	0.85	0.82	0.81	0.82	0.80	0.82	0.82	0.80	0.82	0.79	0.79	0.80	0.77
CO	0.84	0.92	0.89	0.86	0.85	0.84	0.86	0.90	0.88	0.90	0.80	0.80	0.80	0.92	0.86	0.88	0.85	0.81	0.88	0.84	0.81	0.76	0.87	0.77	0.81	0.78	0.84	0.80
CY	0.62	0.83	0.71	0.73	0.76	0.68	0.67	0.64	0.63	0.71	0.77	0.63	0.53	0.65	0.55	0.52	0.55	0.57	0.41	0.41	0.53	0.58	0.49	0.68	0.63	0.53	0.68	0.59
CZ	0.88	0.88	0.90	0.91	0.88	0.80	0.79	0.76	0.78	0.80	0.89	0.91	0.94	0.90	0.95	0.93	0.91	0.93	0.92	0.95	0.89	0.91	0.93	0.91	0.89	0.86	0.85	0.84
DE	0.96	0.95	0.97	0.98	0.98	0.97	0.97	0.97	0.97	0.97	0.95	0.95	0.95	0.96	0.92	0.97	0.97	0.97	0.96	0.95	0.97	0.95	0.95	0.98	0.97	0.96	0.95	0.94
DK	0.93	0.98	0.95	0.92	0.95	0.94	0.94	0.93	0.97	0.94	0.95	0.93	0.95	0.94	0.96	0.88	0.93	0.95	0.95	0.95	0.96	0.96	0.94	0.84	0.89	0.88	0.86	0.85
DZ	0.80	0.75	0.77	0.68	0.76	0.88	0.81	0.89	0.73	0.88	0.84	0.80	0.80	0.84	0.80	0.78	0.77	0.78	0.79	0.87	0.84	0.78	0.83	0.79	NA	NA	NA	NA
EE	0.83	0.93	0.83	0.88	0.85	0.80	0.82	0.81	0.83	0.81	0.89	0.85	0.83	0.87	0.84	0.86	0.76	0.76	0.75	0.73	0.78	0.81	0.82	0.90	0.85	0.80	0.86	0.85
ES	0.95	0.96	0.95	0.93	0.96	0.97	0.95	0.97	0.95	0.97	0.95	0.93	0.93	0.93	0.94	0.97	0.95	0.96	0.97	0.96	0.93	0.94	0.94	0.97	0.95	0.93	0.95	0.92
FI	0.88	0.91	0.94	0.92	0.94	0.91	0.92	0.84	0.84	0.84	0.85	0.87	0.87	0.88	0.83	0.83	0.85	0.86	0.89	0.87	0.86	0.91	0.90	0.91	0.93	0.90	0.90	0.92
FR	0.92	0.91	0.90	0.90	0.90	0.92	0.89	0.91	0.90	0.91	0.93	0.90	0.96	0.94	0.94	0.93	0.95	0.93	0.92	0.91	0.92	0.88	0.92	0.92	0.91	0.92	0.94	0.89
GB	0.94	0.94	0.92	0.94	0.95	0.93	0.93	0.93	0.93	0.95	0.94	0.92	0.90	0.97	0.94	0.96	0.95	0.95	0.96	0.93	0.92	0.93	0.91	0.93	0.92	0.94	0.93	0.95
GR	0.89	0.88	0.86	0.90	0.92	0.95	0.91	0.91	0.86	0.84	0.86	0.88	0.87	0.89	0.89	0.89	0.89	0.87	0.91	0.89	0.90	0.90	0.92	0.89	0.92	0.86	0.87	0.88
HK	0.54	0.62	0.57	0.58	0.58	0.58	0.57	0.53	0.54	0.54	0.56	0.56	0.54	0.54	0.55	0.55	0.54	0.51	0.52	0.51	0.50	0.51	0.51	0.54	0.52	0.52	0.53	0.53
HR	0.85	0.90	0.94	0.88	0.87	0.86	0.89	0.88	0.81	0.79	0.79	0.74	0.80	0.75	0.79	0.81	0.81	0.78	0.78	0.81	0.95	0.93	0.90	0.90	0.85	0.89	0.91	0.89
HU	0.84	0.89	0.84	0.84	0.88	0.86	0.76	0.77	0.79	0.78	0.83	0.83	0.84	0.87	0.90	0.84	0.89	0.88	0.86	0.88	0.83	0.82	0.86	0.82	0.85	0.86	0.84	0.83
ID	0.81	0.86	0.85	0.78	0.60	0.77	0.83	0.81	0.81	0.80	0.78	0.79	0.83	0.80	0.80	0.85	0.86	0.81	0.79	0.82	0.83	0.83	0.82	0.86	0.79	0.79	0.81	0.81
IE	0.82	0.93	0.92	0.92	0.90	0.86	0.87	0.87	0.92	0.93	0.82	0.83	0.82	0.80	0.79	0.84	0.76	0.81	0.77	0.80	0.79	0.79	0.77	0.66	0.71	0.75	0.75	0.69
IL	0.86	0.91	0.90	0.90	0.90	0.92	0.89	0.89	0.91	0.93	0.89	0.89	0.88	0.79	0.87	0.86	0.84	0.87	0.88	0.82	0.78	0.81	0.83	0.80	0.85	0.87	0.77	0.81
IN	0.90	0.91	0.89	0.91	0.92	0.85	0.87	0.89	0.87	0.92	0.94	0.95	0.98	0.92	0.90	0.88	0.87	0.87	0.89	0.88	0.89	0.87	0.90	0.92	0.90	0.91	0.91	0.91
IS	0.79	0.93	0.88	0.81	0.93	0.88	0.89	0.75	0.79	0.86	0.87	0.77	0.81	0.76	0.79	0.82	0.79	0.82	0.76	0.72	0.67	0.72	0.66	0.67	0.72	0.73	0.75	0.69
IT	0.96	0.96	0.97	0.96	0.96	0.97	0.96	0.95	0.98	0.97	0.95	0.96	0.97	0.97	0.97	0.98	0.98	0.98	0.97	0.97	0.98	0.98	0.95	0.97	0.96	0.95	0.93	0.93
JP	0.85	0.91	0.89	0.88	0.87	0.84	0.82	0.80	0.78	0.82	0.88	0.87	0.86	0.86	0.86	0.84	0.84	0.84	0.84	0.83	0.85	0.83	0.85	0.81	0.84	0.85	0.85	0.85
KR	0.87	0.93	0.90	0.88	0.91	0.87	0.86	0.85	0.85	0.87	0.88	0.89	0.85	0.89	0.90	0.89	0.88	0.82	0.85	0.88	0.86	0.86	0.90	0.89	0.87	0.83	0.87	0.86
LT	0.85	0.88	0.90	0.88	0.84	0.79	0.80	0.82	0.74	0.78	0.92	0.93	0.85	0.90	0.89	0.92	0.87	0.83	0.84	0.75	0.81	0.81	0.84	0.86	0.86	0.83	0.87	0.83
LU	0.81	NA	NA	NA	NA	0.90	0.80	0.81	0.85	0.84	0.82	0.86	0.78	0.79	0.89	0.82	0.78	0.83	0.77	0.80	0.77	0.79	0.77	0.77	0.80	0.83	0.82	0.78
LV	0.86	0.78	0.86	0.92	0.94	0.91	0.92	0.94	0.91	0.97	0.92	0.90	0.78	0.90	0.79	0.83	0.79	0.77	0.78	0.78	0.79	0.82	0.81	0.88	0.82	0.84	0.87	0.92
MA	0.77	0.80	0.79	0.75	0.87	0.89	0.85	0.84	0.83	0.78	0.82	0.80	0.81	0.72	0.79	0.75	0.78	0.74	0.73	0.75	0.74	0.68	0.70	0.63	0.71	0.71	0.74	0.74
MT	0.66	0.77	0.88	0.78	0.81	0.69	0.74	0.79	0.72	0.80	0.77	0.74	0.73	0.74	0.69	0.64	0.62	0.58	0.59	0.51	0.65	0.46	0.50	0.51	0.57	0.55	0.50	0.48
MX	0.65	0.71	0.76	0.78	0.73	0.66	0.68	0.66	0.67	0.61	0.58	0.60	0.70	0.63	0.60	0.61	0.62	0.63	0.65	0.68	0.65	0.66	0.68	0.65	0.68	0.64	0.57	0.55
MY	0.80	0.89	0.81	0.81	0.79	0.81	0.78	0.75	0.77	0.76	0.77	0.79	0.78	0.83	0.78	0.76	0.78	0.81	0.79	0.81	0.82	0.81	0.77	0.82	0.82	0.83	0.83	0.77
NL	0.88	0.88	0.90	0.92	0.95	0.92	0.92	0.92	0.91	0.93	0.90	0.90	0.88	0.87	0.88	0.88	0.88	0.87	0.87	0.84	0.83	0.90	0.88	0.85	0.84	0.79	0.78	0.83
NO	0.71	0.75	0.79	0.81	0.71	0.75	0.67	0.68	0.72	0.69	0.72	0.77	0.80	0.72	0.72	0.73	0.71	0.69	0.71	0.68	0.74	0.73	0.68	0.65	0.62	0.60	0.67	0.62
NZ	0.89	0.92	0.92	0.86	0.88	0.91	0.87	0.91	0.91	0.90	0.92	0.88	0.89	0.86	0.88	0.86	0.92	0.83	0.93	0.93	0.88	0.92	0.87	0.86	0.91	0.84	0.85	0.79
PE	0.89	0.88	0.88	0.85	0.82	0.89	0.90	0.89	0.88	0.89	0.93	0.92	0.89	0.94	0.91	0.89	0.90	0.89	0.93	0.89	0.86	0.90	0.90	0.85	0.88	0.88	0.84	0.85
PH	0.76	0.71	0.89	0.86	0.82	0.86	0.81	0.77	0.79	0.81	0.70	0.75	0.74	0.76	0.71	0.70	0.66	0.60	0.77	0.71	0.73	0.77	0.81	0.77	0.78	0.81	0.79	0.75
PL	0.87	0.87	0.88	0.88	0.82	0.84	0.81	0.79	0.81	0.79	0.87	0.90	0.93	0.90	0.94	0.95	0.91	0.88	0.86	0.88	0.85	0.86	0.88	0.92	0.87	0.91	0.88	0.87
PT	0.86	0.95	0.93	0.96	0.94	0.92	0.95	0.93	0.92	0.88	0.86	0.82	0.81	0.83	0.86	0.85	0.85	0.84	0.84	0.77	0.85	0.83	0.80	0.82	0.81	0.79	0.80	0.85
RO	0.85	0.90	0.94	0.90	0.92	0.89	0.88	0.88	0.88	0.83	0.81	0.82	0.72	0.87	0.85	0.85	0.85	0.84	0.85	0.88	0.85	0.81	0.83	0.81	0.84	0.84	0.85	0.80
RU	0.65	NA	0.54	0.61	0.70	0.67	0.56	0.60	0.60	0.68	0.64	0.62	0.67	0.65	0.65	0.60	0.60	0.73	0.65	0.70	0.71	0.69	0.71	0.68	0.73	0.64	0.64	0.67
SA	0.78	0.79	0.85	NA	0.83	0.80	0.81	0.81	0.71	0.86	0.80	0.84	0.78	0.77	0.81	0.80	0.80	0.78	0.80	0.73	0.76	0.76	0.78	0.76	0.73	0.76	0.77	0.69
SE	0.94	0.91	0.93	0.92	0.93	0.96	0.94	0.96	0.94	0.95	0.97	0.94	0.95	0.95	0.97	0.94	0.93	0.94	0.96	0.94	0.96	0.93	0.94	0.96	0.96	0.95	0.90	0.90
SG	0.75	0.83	0.79	0.81	0.84	0.80	0.76	0.77	0.82	NA	0.77	0.79	0.77	0.77	0.83	0.75	0.78	0.75	0.77	0.80	0.76	0.73	0.68	0.69	0.65	0.67	0.65	0.53
SI	0.90	0.90	0.85	0.91	0.89	0.92	0.89	0.89	0.88	0.84	0.89	0.88	0.92	0.87	0.94	0.93	0.91	0.92	0.93	0.93	0.97	0.92	0.92	0.90	0.88	0.89	0.87	0.85
SK	0.85	0.91	0.87	0.90	0.88	0.91	0.84	0.78	0.79	0.79	0.85	0.92	0.85	0.89	0.88	0.87	0.88	0.85	0.88	0.87	0.84	0.83	0.84	0.79	0.81	0.79	0.80	0.80
TH	0.86	0.87	0.88	0.94	0.89	0.89	0.88	0.84	0.85	0.81	0.82	0.87	0.83	0.87	0.89	0.87	0.83	0.85	0.85	0.85	0.83	0.87	0.85	0.88	0.84	0.85	0.83	0.85
TR	0.88	0.91	0.94	0.92	0.93	0.91	0.87	0.90	0.90	0.91	0.92	0.86	0.89	0.88	0.84	0.87	0.84	0.85	0.86	0.88	0.89	0.84	0.86	0.87	0.87	0.85	0.86	0.87
TW	0.83	0.90	0.89	0.88	0.85	0.79	0.80	0.78	0.81	0.82	0.82	0.83	0.84	0.83	0.80	0.85	0.84	0.83	0.81	0.84	0.80	0.84	0.85	0.83	0.82	0.82	0.83	0.81
UA	0.80	NA	0.75	0.81	0.84	0.82	0.83	0.72	0.78	0.82	0.81	0.90	0.88	0.91	0.87	0.80	0.85	0.86	0.75	0.74	0.69	0.73	0.78	0.78	0.70	0.83	0.76	0.81
US	0.89	0.86	0.89	0.88	0.87	0.85	0.88	0.88	0.86	0.87	0.87	0.92	0.91	0.91	0.92	0.92	0.89	0.87	0.92	0.92	0.92	0.88	0.88	0.88	0.91	0.86	0.91	0.86
ZA	0.85	0.88	0.90	0.86	0.82	0.90	0.81	0.83	0.83	0.85	0.88	0.86	0.89	0.86	0.85	0.88	0.88	0.84	0.86	0.82	0.89	0.85	0.84	0.84	0.81	0.81	0.76	0.76

D.2 Services

REPORTER	AVG	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
AE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
AR	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
AT	0.77	0.75	0.50	0.50	0.75	0.69	0.64	0.63	0.75	0.76	0.74	0.75	0.80	0.81	0.83	0.83	0.85	0.84	0.84	0.82	0.82	0.90	0.87	0.88	0.80	0.81	0.78	0.75
AU	0.78	0.85	0.85	0.89	0.89	0.83	0.70	0.78	0.90	0.93	0.79	0.81	0.89	0.71	0.73	0.73	0.71	0.68	0.63	0.70	0.75	0.69	0.77	0.80	0.82	0.88	0.70	0.54
BE	0.72	0.80	0.75	0.75	0.75	0.75	0.73	0.71	0.65	0.58	0.62	0.66	0.61	0.71	0.66	0.68	0.70	0.73	0.74	0.71	0.72	0.79	0.71	0.77	0.80	0.80	0.75	0.74
BG	0.66	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.54	0.68	0.66	0.83	0.74	0.74	0.72	0.65	0.67	0.72	0.67	0.67	0.64	0.66	0.60	0.67	0.55	0.55
BR	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CA	0.65	0.68	0.57	0.62	0.65	0.60	0.72	0.67	0.66	0.69	0.72	0.70	0.71	0.74	0.64	0.76	0.61	0.68	0.62	0.61	0.58	0.57	0.57	0.63	0.56	0.62	0.60	0.71
CH	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CL	0.23	NA	NA	NA	NA	NA	NA	NA	NA	0.33	0.00	0.12	0.25	0.12	0.28	0.53	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CN	0.81	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.92	0.83	0.88	0.75	0.69	NA	NA	NA	NA	NA	NA	NA	NA	NA
CO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CY	0.35	NA	NA	NA	NA	NA	NA	NA	0.36	0.36	0.39	0.34	0.41	0.37	0.30	0.30	0.37	0.27	0.29	0.31	0.31	0.35	0.34	0.37	0.40	0.45	0.38	0.41
CZ	0.72	NA	NA	NA	NA	NA	0.44	0.76	0.71	0.77	0.81	0.79	0.75	0.75	0.67	0.73	0.71	0.75	0.76	0.75	0.70	0.74	0.69	0.68	0.71	0.74	0.74	0.71
DE	0.91	1.00	1.00	1.00	1.00	0.86	0.78	0.82	0.84	0.90	0.87	0.86	0.84	0.90	0.90	0.88	0.91	0.90	0.93	0.90	0.94	0.94	0.94	0.92	0.98	0.96	0.87	0.83
DK	0.71	NA	NA	NA	NA	0.71	0.62	0.61	0.72	0.74	0.78	0.76	0.66	0.69	0.64	0.64	0.61	0.69	0.68	0.73	0.74	0.70	0.73	0.74	0.76	0.80	0.75	0.75
DZ	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EE	0.70	NA	NA	NA	NA	NA	NA	NA	NA	0.58	0.65	0.76	0.74	0.61	0.72	0.82	0.77	0.72	0.62	0.68	0.69	0.68	0.63	0.80	0.64	0.74	0.77	0.70
ES	0.65	0.00	0.25	0.25	0.50	0.58	0.57	0.62	0.69	0.74	0.73	0.73	0.75	0.79	0.69	0.70	0.66	0.66	0.66	0.73	0.75	0.72	0.77	0.76	0.82	0.79	0.76	0.78
FI	0.74	0.50	0.50	0.50	0.50	0.83	0.79	0.68	0.69	0.76	0.76	0.72	0.78	0.65	0.73	0.74	0.76	0.72	0.77	0.83	0.82	0.83	0.88	0.81	0.85	0.79	0.79	0.88
FR	0.84	0.83	0.88	0.75	0.75	0.88	0.75	0.80	0.83	0.81	0.83	0.81	0.80	0.76	0.69	0.82	0.79	0.88	0.92	0.91	0.89	0.91	0.91	0.83	0.89	0.94	0.87	0.85
GB	0.70	1.00	0.75	0.75	0.88	0.73	0.62	0.65	0.62	0.62	0.66	0.65	0.75	0.73	0.65	0.67	0.67	0.69	0.65	0.66	0.67	0.68	0.73	0.74	0.70	0.70	0.66	0.62
GR	0.67	0.25	0.25	NA	NA	0.75	0.50	0.50	0.50	0.72	0.79	0.76	0.83	0.74	0.74	0.84	0.60	0.64	0.61	0.73	0.70	0.69	0.79	0.75	0.77	0.79	0.76	0.71
HK	0.59	NA	NA	NA	NA	NA	0.57	0.64	0.54	0.54	0.53	0.52	0.58	0.56	0.55	0.60	0.58	0.66	0.67	0.62	0.64	0.65	0.65	0.58	0.58	0.60	0.46	NA
HR	0.67	NA	NA	NA	NA	0.36	0.47	0.55	0.44	0.57	0.62	0.65	0.44	0.67	0.67	0.74	0.76	0.68	0.71	0.82	0.72	0.79	0.81	0.80	0.78	0.76	0.79	0.85
HU	0.64	NA	NA	NA	NA	0.25	0.14	0.34	0.35	0.38	0.63	0.77	0.81	0.81	0.74	0.72	0.64	0.66	0.69	0.76	0.72	0.71	0.80	0.81	0.75	0.76	0.76	0.78
ID	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
IE	0.60	NA	NA	NA	NA	1.00	0.50	0.00	0.65	0.65	0.63	0.57	0.52	0.57	0.55	0.55	0.66	0.61	0.69	0.62	0.66	0.61	0.66	0.67	0.56	0.61	0.57	0.61
IL	0.25	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.31	0.22	0.23	NA	NA	NA	NA	NA	NA	NA	NA	NA
IN	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
IS	0.65	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.58	0.43	0.52	0.58	0.72	0.61	0.68	0.76	0.69	0.65	0.72	0.69	0.79
IT	0.75	0.17	0.38	0.38	0.50	0.75	0.92	0.78	0.81	0.72	0.82	0.83	0.79	0.75	0.74	0.83	0.78	0.73	0.81	0.87	0.83	0.90	0.89	0.80	0.87	0.89	0.87	0.90
JP	0.74	0.83	0.59	0.64	0.71	0.73	0.70	0.67	0.75	0.75	0.81	0.81	0.76	0.79	0.63	0.57	0.65	0.69	0.68	NA	0.78	0.78	0.79	0.82	0.85	0.88	0.76	0.74
KR	0.81	NA	NA	NA	0.50	0.75	0.75	1.00	1.00	1.00	1.00	0.62	0.60	0.49	0.48	0.57	0.56	0.54	0.83	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.75
LT	0.68	NA	NA	NA	NA	NA	NA	NA	NA	0.56	0.57	0.60	0.72	0.67	0.62	0.68	0.58	0.60	0.69	0.72	0.65	0.67	0.75	0.75	0.75	0.78	0.73	0.75
LU	0.55	1.00	0.50	0.50	0.50	0.40	0.40	0.56	0.54	0.50	0.56	0.51	0.55	0.50	0.56	0.52	0.53	0.51	0.50	0.48	0.55	0.56	0.55	0.61	0.62	0.64	0.65	0.64
LV	0.63	NA	NA	NA	NA	NA	0.56	0.50	0.70	0.71	0.45	0.65	0.76	0.68	0.71	0.68	0.62	0.65	0.49	0.62	0.62	0.76	0.64	0.58	0.64	0.60	0.65	0.69
MA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MT	0.46	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.55	0.68	0.69	0.61	0.49	0.45	0.39	0.53	0.48	0.41	0.32	NA	NA	0.40	0.36	0.35	0.29	0.37
MX	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MY	0.33	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.33	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NL	0.78	1.00	0.50	0.62	0.75	0.75	0.79	0.85	0.77	0.77	0.74	0.80	0.78	0.79	0.76	0.76	0.76	0.74	0.74	0.80	0.83	0.87	0.85	0.91	0.83	0.84	0.74	0.81
NO	0.55	NA	NA	NA	NA	0.33	0.50	0.50	0.69	0.60	0.50	0.54	0.46	0.47	0.41	0.44	1.00	0.62	0.66	NA	NA	NA	NA	NA	NA	NA	NA	NA
NZ	0.66	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.66	0.67	0.62	0.59	0.78	0.71	0.69	0.55	0.66	0.74	0.67	0.60	0.67	0.67	0.64	0.61
PE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PH	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PL	0.77	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.65	0.73	0.75	0.71	0.69	0.66	0.71	0.71	0.75	0.82	0.81	0.90	0.85	0.83	0.83	0.81	0.83	0.79
PT	0.70	0.50	0.00	0.00	0.00	0.75	0.75	0.71	0.86	0.84	0.86	0.83	0.86	0.87	0.76	0.82	0.75	0.74	0.74	0.79	0.81	0.81	0.82	0.84	0.79	0.77	0.71	0.79
RO	0.71	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.62	0.69	0.66	0.65	0.70	0.51	0.62	0.65	0.75	0.80	0.75	0.76	0.74	0.79	0.81	0.75	0.79
RU	0.65	NA	NA	NA	NA	NA	NA	NA	0.62	0.70	0.62	0.63	0.65	0.67	0.64	0.65	0.71	0.66	0.64	0.67	0.61	0.61	0.66	0.61	0.60	0.67	0.69	0.65
SA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SE	0.76	NA	NA	NA	NA	0.88	0.87	0.84	0.79	0.71	0.61	0.73	0.75	0.66	0.71	0.70	0.69	0.76	0.72	0.72	0.81	0.84	0.82	0.84	0.76	0.78	0.74	0.76
SG	0.62	NA	NA	NA	NA	NA	0.43	0.43	0.43	0.50	0.64	0.56	0.61	0.67	0.60	0.70	0.69	0.81	0.69	0.65	0.71	0.75	NA	NA	NA	NA	NA	NA
SI	0.68	NA	NA	NA	NA	0.00	0.20	NA	0.52	0.57	0.65	0.74	0.75	0.77	0.75	0.67	0.78	0.76	0.74	0.87	0.83	0.78	0.81	0.84	0.76	0.72	0.79	0.76
SK	0.61	NA	NA	NA	NA	0.00	0.63	0.60	0.56	0.59	0.53	0.54	0.51	0.67	0.67	0.65	0.44	0.41	0.59	0.65	0.69	0.71	0.74	0.75	0.77	0.78	0.77	0.76
TH	0.52	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.25	0.33	0.75	0.62	0.50	0.67	0.50	0.50	0.67	0.40
TR	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TW	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
UA	0.30	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.17	0.17	0.17	0.33	0.33	0.33	0.50	0.17	0.50
US	0.73	0.83	0.78	0.72	0.70	0.79	0.81	0.81	0.81	0.78	0.75	0.78	0.73	0.70	0.70	0.72	0.79	0.76	0.66	0.74	0.62	0.77	0.79	0.72	0.74	0.67	0.51	0.46
ZA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

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