THE OECD-WTO BALANCED TRADE IN SERVICES DATABASE (BaTIS)

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Complete, consistent and balanced bilateral trade in services statistics are vital for the empirical analysis of international trade as well as for policy-making and trade negotiations. Unfortunately, such data are not readily available. This paper presents the work of OECD and WTO to build an updated version of the Balanced Trade in Services (BaTIS) dataset, a complete and consistent trade in services matrix to serve as input for the compilation of the TiVA Inter-Country Input-Output Tables and as a tool for the analysis of trade patterns in general. This edition of BaTIS provides annual data for 2005-2021, covering 202 economies, broken down by the 12 main EBOPS 2010 service categories. This paper accompanies the dataset and describes its compilation methodology in detail, including the collection and cleaning of the reported data, the different methodologies used to estimate missing information, and the final balancing of the export and import flows.

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1. Introduction

Since the publication of the first OECD-WTO Balanced Trade in Services (BaTIS) dataset in 2017, several advancements have been made in the compilation of trade in services statistics. Firstly, more and more economies have been working to improve their data compilation methods and practices, bringing them closer to the international guidelines. At the same time, increased emphasis has been placed on another dimension of international trade in services, namely the mode of supply. The relevance of this dimension in trade negotiations motivated the WTO to create a global dataset on Trade in Services by Mode of Supply (TISMOS, see Wettstein et al., 2019). Finally, growing interest in measuring digitalization has spurred the development of the first framework for measuring digital trade, in which services play a dominant role (OECD, WTO and IMF, 2019).

Despite such methodological and practical advancements, the accurate measurement of service flows continues to be challenging and the availability of high quality, detailed information on international trade in services remains inadequate for the needs of economic analysis and policy-making.

To address the information gaps, the OECD and WTO developed a transparent methodology to build a global dataset of coherent bilateral trade in services statistics by main service categories. The OECD-WTO methodology leverages all official statistics available at national level and supplements them with estimations and adjustments to provide users with a complete matrix of exports and imports, covering virtually all economies in the world. Subsequently, the asymmetries between reported and mirror flows are reconciled by calculating a symmetry-index weighted average between the two, following a similar approach to the one developed for merchandise trade statistics.

The ultimate goal of the OECD-WTO work is to develop and maintain a dataset that can be considered the international benchmark for trade in services statistics and which will be constantly improved as new official data become available. While the BaTIS dataset can serve as a stand-alone tool for economic analysis and policy-making, it also provides an essential input to the OECD Trade in Value Added (TiVA) initiative, as a balanced view of international trade is an essential feature of any inter-country Input-Ouput analysis.

The first edition of BaTIS followed the fifth edition of the IMF Balance of Payments and International Investment Position Manual (BPM5) and included annual data for 1995 to 2012, covering 191 economies and the 11 main service categories, in line with the Extended Balance of Payments Services Classification (EBOPS) 2002[2]. The second edition of BaTIS, based on BPM6, provided annual data for 2005 to 2019, covering 202 economies and the 12 main EBOPS 2010 service categories. The third edition of BaTIS covers the period 2005-2021 and maintains the same geographical coverage of the previous edition, focusing on the 12 main EBOPS 2010 service categories. In line with the previous editions, methodology codes provide information on the source and/or the adjustments made to each record in the BaTIS dataset.

The remainder of this paper provides further details regarding the steps followed in the construction of the dataset, as follows:

- Step A: Collection and cleaning of reported information;
- Step B: Estimation of non-reported bilateral flows; and

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[2] The description and the coverage of the first edition of BaTIS can be found here https://www.oecd.org/sdd/its/balanced-trade-in-services.htm.

- Step C: Balancing of import and export flows.

The results are presented and discussed in Section 5. Finally, Section 6 concludes and outlines areas for future work and research.

2. Step A: Data collection and cleaning

2.1. Trade in services with partner world

As BaTIS is built following a top-down approach, the official statistics on international trade in services with partner world constitute the basic building blocks and provide the boundaries for all the subsequent estimations. The WTO-UNCTAD trade in services dataset[3], arguably the most comprehensive set of information publicly available, has been used as a starting point for BaTIS. It covers exports and imports of services to and from the world for 202 reporting economies from 2005 to 2021, broken down by service category according to the availability of the source data. For the purposes of BaTIS, the 12 main service categories from EBOPS 2010 have been selected, as presented in Table 1[4].

Table 1. EBOPS 2010 categories classification: code names and hierarchy

Code	EBOPS 2010 category description	Type	Derivation
S	Total services	standard	
SA	Manufacturing services on physical inputs owned by others	standard	
SB	Maintenance and repair services n.i.e.	standard	
SC	Transport	standard	
SD	Travel	standard	
SE	Construction	standard	
SF	Insurance and pension services	standard	
SG	Financial services	standard	
SH	Charges for the use of intellectual property n.i.e.	standard	
SI	Telecommunications, computer, and information services	standard	
SJ	Other business services	standard	
SK	Personal, cultural, and recreational services	standard	
SL	Government goods and services n.i.e.	standard	
Memorandum items:			
SOX	Commercial services	derived	S – SL
SOX1	Other commercial services	derived	SE + SF + SG + SH + SI + SJ + SK
SPX1	Other services	derived	SE + SF + SG + SH + SI + SJ + SK + SL
SPX4	Goods-related services	derived	SA + SB

The WTO-UNCTAD dataset combines reported data from Eurostat, the OECD, the IMF Balance of Payments Statistics, as well as national sources. In some cases, data are derived from multiple sources.

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[3] Available at https://stats.wto.org/.

[4] In addition to total services and the 12 main service categories specified in EBOPS 2010, Table 1 presents a few memorandum items derived from the standard components and available in BaTIS. Commercial services, in particular, is used in the WTO context and excludes *government goods and services n.i.e.* because "services supplied in the exercise of governmental authority", that is neither on a commercial basis nor in competition with other suppliers, are excluded from the General Agreement on Trade in Services (GATS).

In addition to the reported information, the dataset already includes a number of adjustments made to ensure cross-country comparability and, where possible, estimations to complement reported data.

**Table 2. Summary of reported, estimated and corrected information
in the WTO-UNCTAD dataset (partner world)**

	Exports		Imports	
	% Count	% Value	% Count	% Value
Reported	88.0%	96.1%	87.6%	94.1%
Estimated / adjusted / derived	12.0%	3.9%	12.4%	5.9%
Total	100%	100%	100%	100%

As shown in Table 2, the reported information in the WTO-UNCTAD dataset covers around 95% of world trade in services. This reflects the fact that for a number of reporters sourced from Eurostat, the time series start after 2005 (mostly in 2010). In these cases, the time series were completed with estimates based on information published at national level. Other adjustments include, for example, the conversion to a free on board (f.o.b.) valuation, the conversion to the BPM6 presentation, or corrections for obvious misclassifications, as well as derivations from existing items, which exploit the parent-child relationships in EBOPS. Finally, completely missing time series (at the level of service items) were estimated using average shares for clusters of economies showing similar characteristics[5].

All the estimations carried out by WTO and UNCTAD were assumed to align to relevant quality requirements, and as such have been absorbed in BaTIS. However, two additional steps were needed to finalise the world dataset:

- Correction of negative insurance flows. When events, such as natural catastrophes, require large payments of claims, and exceed the value of premiums in the accounting period, the reported trade in insurance services can be negative[6]. As the interpretation (and treatment) of those negative flows is not straightforward, the negative values were replaced with zeros and total services adjusted accordingly. A similar approach was used to treat negative values and solve internal consistency problems for the bilateral dataset (see Section 2.2).

- Treatment of unallocated trade (by service category). In a few cases, the internal consistency between the reported total services and the sum of the 12 EBOPS categories did not hold, and some adjustments were needed. In the case of positive residual trade, the difference was allocated proportionally across the underlying EBOPS categories. When negative residual trade existed, total services was adjusted in line with the sum of the reported service categories.

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[5] More details on the estimations produced by WTO and UNCTAD are available in the methodological paper provided with the TISMOS dataset (Wettstein et al., 2019).

[6] With the changeover to the BPM6 standards, a smoothing method was introduced to limit the occurrence of negative flows and to facilitate the economic interpretation of such flows, as well as better alignment with SNA aggregates, and, in particular with the Supply and Use tables. Indeed, negative flows are much less common in BPM6 than in BPM5, but they can still occur.

2.2. Bilateral trade in services

As a second step, all available bilateral trade in services information, i.e. all information on trade in services by partner country, was collected from the following sources: the OECD Trade in Services by Partner Country statistics; Eurostat International Trade in Services statistics; UN Comtrade; official national sources; and complementary national sources[7]. Overall, only around 65 economies report full or at least partial bilateral information.

Table 3 gives an overview of the proportion of total world trade in services that is bilaterally specified, by year, flow and EBOPS category. As the table shows, there is a significant improvement in coverage over time, and around 65% of total world services trade is bilaterally specified towards the end of the period. Exports show a better coverage than imports, as advanced economies with more developed statistical systems tend to be larger service exporters (also, exports of services are generally considered to be better reported than imports). The coverage is however significantly lower for some of the more detailed service categories such as *construction*, *insurance and pension services*, or *personal, cultural, and recreational services*. In cases where trade is concentrated among mostly advanced economies, the coverage of bilateral information is relatively high (like for *charges for the use of intellectual property n.i.e*).

Some economies report bilateral trade flows with partners outside the list of 202 economies covered by BaTIS. This happens most often for some EU members, which publish a large list of trading partners for total services. Those additional partner economies (which include small territories such as American Virgin Islands, Marshall Islands, Isle of Man, etc.) are summed up into the 'Rest of the World' (ROW) aggregate. Occasionally, this aggregate may represent between 3% and 5% of total trade for some reporters in specific years, but on average it accounts for less than 1% at world level.

Further information about the availability of bilateral trade in services statistics and the composition of the aggregate ROW is presented in Annex A. The average number of partner countries per reporter and sector is shown in Annex B.

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[7] Complementary national data sources include information published by institutions other than the main provider of balance of payments data. Those can cover a subset of services (most commonly travel) and sometimes are not entirely consistent with the official balance of payments statistics.

Table 3. Bilaterally specified trade in services, by year and category
(percentage of total value)

Service category	Code	Exports					Imports				
		2005	2010	2015	2020	2021	2005	2010	2015	2020	2021
Total services	S	31	55	72	71	65	28	51	66	66	61
Manufacturing services on physical inputs owned by others	SA	16	24	64	64	43	60	56	67	69	51
Maintenance and repair services n.i.e.	SB	21	53	66	62	51	20	50	71	69	63
Transport	SC	33	48	65	62	51	28	38	52	49	42
Travel	SD	26	43	62	58	55	32	44	61	43	44
Construction	SE	7	19	38	36	34	7	19	38	44	40
Insurance and pension services	SF	38	41	48	61	59	31	42	43	49	47
Financial services	SG	26	45	55	69	65	17	49	67	75	70
Charges for the use of intellectual property n.i.e.	SH	43	51	73	77	69	28	43	52	64	61
Telecommunications, computer, and information services	SI	15	41	52	54	50	20	48	60	65	59
Other business services	SJ	24	41	61	67	63	21	41	64	66	65
Personal, cultural, and recreational services	SK	10	46	53	59	62	21	33	41	47	46
Government goods and services n.i.e.	SL	18	24	32	34	24	22	26	25	23	35

Before proceeding to the subsequent estimations, the following cleaning steps were carried out on the collected bilateral data:

- Treatment of negative values. Negative trade flows are sometimes reported by the primary sources (most often for categories such as *manufacturing services on physical inputs owned by others*, *maintenance and repair services n.i.e*, *insurance and pension services*, and in some rare cases also for total services). As negative trade flows have no economic rationale, those values were corrected as follows:

  o For *manufacturing services on physical inputs owned by others* and *maintenance and repair services n.i.e*, the negative values were replaced by zeros.

  o For *insurance and pension services*, the negative values were replaced with zeros and the total services were adjusted accordingly for the reporter of such negative flows. If mirror flows existed, the corresponding amounts were added to the mirror flow and total services were recalculated in order to maintain the reported trade balance[8].

  o For all other service categories, negative values were removed and replaced with estimates as described in step B.

- Treatment of unallocated trade (by service category). When positive residual trade existed, the difference was allocated proportionally across the EBOPS subcomponents. When negative residual trade existed, total services was replaced with the sum of the reported items.

Finally, to ensure the hierarchical consistency between total services (S) and the 12 services items, the following rules were applied:

- If all 12 main EBOPS categories were reported and their sum was not equal to the reported total services (S), S was replaced by the sum of items.

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[8] The corrections made to *insurance and pension services*, *manufacturing services on physical inputs owned by others*, and *maintenance and repair services* were given the lowest weight in the final balancing procedure (see Section 4).

- If less than 12 EBOPS categories were reported and the sum of items was greater than the reported total services (S), S was replaced by the sum of individual items.

- If total services (S) was positive and all 12 main EBOPS categories were reported as zero, all service categories were removed and replaced by estimates as described in step B.

3. Step B: Estimating missing trade in services

Like in the previous edition of BaTIS, the construction of a complete matrix of trade in services exports and imports is a prerequisite for the subsequent balancing procedure and also constitutes an analytical product per se. Since bilateral trade in services data are not always available, a large number of bilateral observations need to be estimated to arrive at a complete matrix.

Once again, a 'top-down' approach was used: a full matrix of bilateral flows was first built at the level of total services, and then broken down by service categories. This approach reflects the assumption that the greatest amount and best quality data is available at the highest levels of aggregation, and ensures full consistency of the lower level estimates. More specifically, the estimation work was organised in three sub-steps:

- Step B.1: Estimating partner country breakdowns if some partner data are reported;
- Step B.2: Estimating partner country breakdowns if no official data are available;
- Step B.3: Ensuring the consistency of the dataset.

3.1. Step B.1: Estimating partner country breakdowns if some partner data are reported

Step B.1 involves the filling of all data gaps in existing time series. A time series exists if at least one data point (year) is reported for a given combination of reporter-partner-flow-category. When bilateral trade in services statistics are reported, in fact, they rarely cover the entire time span considered (2005-2021) and the complete list of service categories. This estimation step therefore uses derivations, backcasting, nowcasting and interpolation techniques to fill in the missing information. Gaps in total trade in services are always filled in first, and subsequent estimations for the sub-items are then rescaled to maintain internal consistency.

Simple derivations from reported items

A number of additional data points in the bilateral dataset were derived exploiting the parent-child relationships in the EBOPS hierarchy:

- If, for a country pair, the total bilateral trade (S) is zero, then all service categories were assumed to be zero for that particular pair/year;

- If, for a specific category and year, a country reports zero trade with the world as a whole, then all bilateral values were assumed to be zero.

Backcasting, nowcasting and interpolation

This step exploits the information contained within the time series. If a time series was reported for at least one year, and contained at least one missing value, either in the middle,

at the beginning or at the end of the time series, the missing data point was interpolated, backcasted or nowcasted, respectively.

Starting with total services, 3-year moving averages of the partner's share in total world trade were computed. Those shares were then applied to the world values to get an estimate of bilateral trade. The same approach was also applied to the bilateral breakdowns of individual EBOPS categories, which were subsequently benchmarked to the total services values.

Table 4 shows an example of application of these techniques to the bilateral trade between France and Spain.

Table 4. Exports of services from France to Spain,
by year and EBOPS category (in million USD)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
S	6468	7037	8444	9297	8046	8698	10466	10258	10764	11515	10164	11226	12310	15305	18040	11048	13410
SA	32	38	49	34	59	66	108	387	188	180	262	203	215	392	467	369	434
SB	51	57	71	67	87	107	174	149	120	174	105	158	166	253	234	247	270
SC	946	1031	1258	1322	1034	1572	1867	1818	2298	1865	1385	1399	1503	1798	1726	1712	2167
SD	2637	2827	3311	4043	3243	2526	3102	3036	2814	3151	3038	2930	3617	4865	5003	2673	3488
SE	87	93	98	120	99	60	5	6	14	26	22	4	5	9	0	3	6
SF	143	158	180	217	255	201	299	145	219	170	112	268	455	544	650	429	530
SG	79	92	122	83	108	187	240	397	497	378	346	264	235	220	233	367	427
SH	255	272	314	402	280	302	352	203	288	277	419	697	624	635	831	343	389
SI	393	434	549	510	546	668	777	707	878	679	764	1184	1200	1494	1893	1368	1725
SJ	1770	1933	2349	2461	2157	2781	3343	3357	3382	4526	3653	3990	4183	4725	6655	3491	3922
SK	42	41	79	38	29	167	201	53	68	89	59	130	105	336	348	46	52
SL	33	62	64	0	149	62	0	0	0	0	0	0	0	35	0	0	0

Note: Shaded cells represent backcasted and interpolated figures.

3.2. Step B.2: Estimating partner country breakdowns if no official data are available

At the end of step B.1, 75% of the complete matrix in terms of data points remains to be filled, covering all the cases where no reported data are available for a given reporter-partner-flow-category combination. Like in the previous edition of BaTIS, those gaps were filled using a set of gravity models. Intuitively, the gravity framework implies that the trade flows between two countries are proportional to their economic size (proxied by the reporter and partner's GDP) and inversely proportional to the trade costs between them (e.g. their geographical distance).

The gravity models were defined as parsimoniously as possible, and by explicit design, do not include any policy variables. This choice facilitates the subsequent use of the estimated values for analytical purposes, as it limits the problem of circular causality whereby the data that are used to test particular hypotheses (e.g. of the impact of certain policy measures on trade flows) are developed exactly based on that premise.

Gravity model specification

All regression models used in BaTIS share the following generic specification:

$$X_{ijt} = \exp\left(\beta_0 + \beta_1 size_{it} + \beta_2 size_{jt} + \beta_3 \ trade \ costs_{ij} + \beta_4 \ other \ predictors_{ijt}\right) * \varepsilon_{ijt}$$
$$M_{ijt} = \exp\left(\beta_0 + \beta_1 size_{it} + \beta_2 size_{jt} + \beta_3 \ trade \ costs_{ij} + \beta_4 \ other \ predictors_{ijt}\right) * \varepsilon_{ijt}$$

where X_{ijt} (M_{ijt}) represents the service exports (imports) of country *i* to (from) country *j* in year *t*, which are deemed to depend on:

- the size of the two trading partners, proxied by their nominal GDPs (sourced from IMF World Economic Outlook database, and complemented by World Bank WDI, UNData and WTO estimates);

- a set of trade cost variables, including the bilateral distance, contiguity, common language, and the presence, at any point in time, of a colonial relationship (all sourced from the CEPII GeoDist database and complemented with manual imputations for countries not covered by CEPII)[9];

- additional predictors, including bilateral (total) merchandise exports and imports (sourced from the UNCTAD Merchandise Trade Matrix[10]), the number of total tourist arrivals (exports) and departures (imports) in/from a country (sourced from UNWTO[11]), exports and imports of services to the world as a whole, a linear time trend, the reporter's GDP per capita and partner fixed effects.

Bilateral merchandise trade proved to be a very important predictor of bilateral service flows as trade in goods and services are generally highly correlated (especially for some service categories such as transport). Tourist arrivals in a country also performed relatively well as predictor, given the importance of travel in total trade in services (around a fifth of total services at world level but significantly higher for some economies).

Services trade with the world as a whole was used in the previous edition of BaTIS only to predict missing flows at the level of individual service categories, not total services. In this edition, instead, a cross validation exercise (described in Annex F) demonstrated that the inclusion of this predictor, despite the endogeneity with the response variable, improves significantly the predictive power of the models and was therefore used to predict all missing bilateral flows.

The inclusion of reporter, partner and trading pair fixed effects is recommended in the empirical literature to capture omitted variables and to account for unobservable 'multilateral resistance' terms[12]. However, a theory-consistent set of fixed effects cannot be used in BaTIS due to the need for out-of-sample predictions. Consequently, the reporter's GDP per capita was used as a proxy for (some) of the unobservable characteristics of the reporter, a linear time trend was added to capture global developments in trade, and

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[9] The CEPII GeoDist database is available at http://www.cepii.fr/cepii/en/bdd_modele/bdd.asp. The manual imputations can be provided upon request.

[10] https://unctadstat.unctad.org.

[11] UNWTO Compendium of Tourism Statistics dataset, Tourism Statistics Database (unwto.org)

[12] The multilateral resistance terms capture the fact that a country's trade depends on the trade frictions across all possible destinations, not just on bilateral trade costs for a specific country pair. See Anderson and Van Wincoop (2003).

partner fixed effects were used, where possible, to absorb any omitted variable correlated with a specific trading partner[13].

The models were fitted on the dataset resulting from all the previous estimation steps, using the Poisson Pseudo-Maximum Likelihood estimator (PPML). This method is considered superior to a log-linearised Ordinary Least Squares model (OLS), as it avoids biases in the parameter estimates in the presence of heteroscedasticity and allows for the presence of zero trade flows (Santos Silva and Tenreyro, 2006).

Estimation strategy

The baseline gravity specification described above would result in the best possible predictions for the missing bilateral flows. However, as the matrix of regressors is not completely full, reduced models had to be used sequentially to derive the predictions, starting from the full, preferred model described above[14]. As the regressions were separately fitted on exports and imports, a total of ten models was used to fill in the gaps in the total services matrix. Only one model was used for each country pair, on the condition that it predicted at least five data points in the time series. Any gaps resulting from missing predictors were filled in with the backcasting/nowcasting techniques described in step B1.

Table 5 summarises the specifications of the models used to predict the missing observations for total services, together with the percentage of observations and trade value predicted by each model.

Table 5. Summary of the model specifications for the prediction of missing total services

		Full model (M1.1)	Reduced model (M1.2)	Reduced model (M1.3)	Reduced model (M1.4)	Reduced model (M1.5)
Distance		X	X	X	X	X
Contiguity		X	X	X	X	X
Common language		X	X	X	X	X
Colony		X	X	X	X	X
GDP reporter		X	X	X	X	X
GDP partner		X	X	X	X	X
GDP per capita (reporter)		X	X	X	X	X
Trade in services with world		X	X	X	X	X
Merchandise trade (bilateral)		X	X			
Tourist arrivals/departures		X		X		
Time trend (linear)		X	X	X	X	X
Partner FE		X	X	X	X	
Exports	% of total estimated observations	47.4	4.2	38.3	7.6	2.6
	% of total estimated value	68.4	0.6	29.4	0.6	0.9
Imports	% of total estimated observations	27.7	24.9	14.7	30.2	2.5
	% of total estimated value	61.4	8.5	19.4	10.0	0.7

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[13] The model selection builds on the work carried out for the first edition of BaTIS. For a detailed description of the model selection procedure, see Fortanier et al. (2017).

[14] The cross-validation presented in Annex F shows that the predictions are most accurate for the preferred model M1.1. In terms of prediction error: M1.1 < M2.1 < M3.1 < M4.1 < M5.1.

All missing bilateral flows at the level of individual service categories were estimated using the same gravity approach as total trade in services, with the preferred, full model being complemented by a set of reduced models to deal with gaps in the availability of the explanatory variables.

Again, in order to maintain the coherence of the time series, only one model was used to estimate a given reporter-partner series, and any gaps were filled using the backcasting, nowcasting or interpolation techniques described in step B.1.

Table 6 summarizes the specifications of the models used to predict missing flows for the individual service items, as well as the percentage of data points and trade values predicted by each model.

Table 6. Summary of the model specifications for the prediction of missing individual service categories

	Full model (M2.0)	Reduced model (M2.1)	Reduced model (M2.2)	Reduced model (M2.3)
GDP reporter	X	X	X	X
GDP partner	X	X	X	X
Distance	X	X	X	X
Contiguity	X	X	X	X
Common language	X	X	X	X
Colony	X	X	X	X
GDP per capita (reporter)	X	X	X	X
Trade in services with world (relevant category)	X	X	X	X
Time trend (linear)	X	X	X	X
Merchandise trade (bilateral)	X	X		
Partner FE	X	X	X	
Tourist arrivals/departures (travel only)	X			
Exports % of total estimated observations	4.4	50.8	39.0	5.7
Exports % of total estimated value	17.5	50.8	25.8	5.9
Imports % of total estimated observations	1.9	51.3	39.6	7.1
Imports % of total estimated value	12.8	52.5	28.6	6.2

It is worth emphasizing that the a priori order of preference of the models generally provides the most accurate predictions, and that the choice of the model was solely driven by data availability in the regressor matrix for the vast majority of cases. However, in some specific instances, expert judgement was used to inform the choice of the most suitable model, both for total trade in services and for the individual categories.

For instance, when merchandise flows are too concentrated in primary commodities (e.g. oil) and thus very erratic, the merchandise trade variable was deliberately excluded from the explanatory variables. Similarly, partner fixed effects were intentionally excluded when based on very few, quite specific bilateral relationships.

3.3. Towards a complete matrix: summary of the estimation steps

The process described in Sections 2 and 3 resulted in a fully consistent dataset of exports and imports by service category for 202 reporters and partners, from 2005 to 2021. Table 7 provides a summary overview of all the different types of estimates that were produced, showing that 96% of the data points and nearly half of the trade value in the final bilateral database had to be estimated.

Table 7. Building BaTIS: reported and estimated flows in the dataset

	Total Services		Other EBOPS categories	
	% Value	% Count	% Value	% Count
Total reported flows	**59**	**11**	**52**	**4**
Total estimated flows	**41**	**89**	**48**	**96**
Derivations, corrections	1	1	1	24
Interpolations, back-casting, nowcasting	17	18	17	8
Gravity estimations	23	70	31	65
Grand Total	**100**	**100**	**100**	**100**

3.4. Step B.3: Ensuring the internal consistency of the dataset

Having completed all the bilateral trade relationships in the BaTIS matrix, the following step is aimed at ensuring that the dataset is internally consistent in all directions, i.e. that the sum of trade across all partner countries equals the reported values with world as a whole for every service category, and that the sum across the service categories equals to total trade in services for each trading pair. In order to achieve this, first the bilateral exports and imports (by service item) were rescaled to match each country's reported trade with the world as a whole. Secondly, a bi-proportional adjustment procedure (RAS) was carried out to eliminate any residual discrepancies between total services and the sum of the 12 service categories.

Rescaling of estimates to officially reported world totals

For those countries that did not report any geographical detail, the rescaling involved a relatively straightforward proportional scaling of the model-based estimates to the reported world totals (by service category). On the other hand, reported values and higher quality estimates (derivations, back- and nowcasting) were in principle kept as such (not rescaled) if relatively well aligned with the world totals. However, reported values were also rescaled if, despite reporting a nearly complete set of partners, large unallocated trade still existed or if the difference between the sum of (reported) bilateral trade was larger than the world totals (i.e. unallocated trade was negative).

Three groups of reporters were therefore identified for which different rescaling strategies were applied. The attribution of countries to groups 2 and 3 was determined based on the ratio between unspecified trade and the sum of the unscaled model estimates. If that ratio was smaller than three, then reporters were allocated to group 3 and only the estimates were rescaled, not the reported data. If the ratio was equal or larger than three, implying a substantial misalignment between the reported bilateral flows and the world totals, the reporter was allocated to group 2 and the reported data was rescaled together with the estimated figures. In summary, the following rescaling rules were applied:

- *Group 1. Countries that do not report any geographical detail and for which all bilateral flows are derived from gravity-model estimates*

  The gravity-based bilateral estimates were rescaled to match the world totals (by service category). The relative importance of each partner remained the same before and after the rescaling.

- *Group 2. Countries that report many geographical partners but their non-geographically specified trade is substantial or negative*

  Both reported data and estimated flows are rescaled to match the world totals (by service category).

- *Group 3. Countries where data consist of a mix of reported data and model-based estimates, and the amount of unspecified trade is similar to the total amount of trade estimated by the model for the missing partners*

  Reported data (including high quality estimates) were kept as such; model-based estimates were rescaled to benchmark the world totals.

In all cases specified above, if no trade with economies outside the BaTIS coverage was reported, 0.5% of total trade was allocated to the partner 'rest of the world' (ROW) to cover any territories beyond the BaTIS scope (see also Section 2.2).

Final bi-proportional scaling (RAS)

Any remaining discrepancies between the total services values and the sum of services items was reconciled via a bi-proportional scaling routine (RAS), which used the reported world totals as constraints to ensure a fully consistent BaTIS matrix.

4. Step C. Balancing of export and import flows

Having a complete and consistent BaTIS dataset, the final step involved the reconciliation of the trade asymmetries to produce the final balanced matrix.

The balancing process took place in two stages: (i) the asymmetries for exports and imports of total services (S) were reconciled, to arrive at a balanced matrix of total trade in services; (ii) the balancing at the level of service categories was carried out at the level of shares to ensure complete internal consistency in the matrix:

- first, the share of each individual service category in the (unbalanced) total services flows was calculated;

- then, those shares were balanced at the bilateral level; and

- finally, the balanced shares were applied to the balanced value for total services.

Again, this top-down approach was taken to ensure consistency, but also to recognise that the bilateral data at the higher level of aggregation (totals) are assumed to be of higher quality than those at the level of individual items.

The reconciliation procedure entailed the calculation of a weighted average of the reported trade and its mirror flow (i.e. as reported by the partner country), and therefore the balanced value is always between the two flows, at least for total services[15].

The computation of the balancing weights follows the approach developed in cooperation with the Eurostat Full International and Global Accounts for Research in Input-Output (FIGARO) team.

First, a bilateral *asymmetry indicator* was calculated as:

$$A_{ijkt} = \frac{|X_{ijkt} - M_{jikt}|}{X_{ijkt} + M_{jikt}}$$

where X and M represent exports and mirror imports, respectively, and *I* refers to the exporter, *j* to the importer, *k* to the service category and *t* to the year.

Secondly, an *asymmetry index* was calculated for each exporter (θ_{ikt}), importer (φ_{jkt}), service category *k* and year *t* as the trade-weighted average of the bilateral asymmetry indicator:

$$\theta_{ikt} = \sum_j A_{ijkt} \frac{X_{ijkt} + M_{jikt}}{\sum_j (X_{ijkt} + M_{jikt})}$$

$$\varphi_{jkt} = \sum_i A_{ijkt} \frac{X_{ijkt} + M_{jikt}}{\sum_i (X_{ijkt} + M_{jikt})}$$

Finally, the complement to 1 of the asymmetry index (*symmetry index*) was calculated, the 3-year moving average of which was used as weight to derive the balanced trade value.

$$SI_{ikt} = \overline{(1 - \theta_{ikt})}$$

$$SI_{jkt} = \overline{(1 - \varphi_{jkt})}$$

This method for the calculation of the symmetry indices does not need a discretionary threshold to determine the percentage of 'good' bilateral trade flows[16]. Moreover, the use of 3-year moving averages further limits any unwanted fluctuations in the symmetry indices. Such stability is important in the process of balancing trade statistics as it avoids introducing potential disruptions in time series solely due to strong variance in the balancing weights.

In addition to weighing the bilateral flows by the symmetry index of each partner, the balancing procedure also takes into account the varying levels of confidence surrounding the different estimation methodologies. For this purpose, four additional weights (w) were applied:

- weight of 1 for reported data or very high-quality estimates (such as derivations from reported items);

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[15] The reconciled values for the individual service items, instead, may be outside the range of the reported and mirror value as the balancing was performed on the shares, not on the values themselves.

[16] In the first (BPM5) edition of BaTIS, the symmetry index was calculated as the percentage of bilateral trade considered of sufficient quality (i.e. for which the asymmetry indicator was less than 30%). See Fortanier et al. (2017) for more information.

- weight of 0.75 for estimates based on information from existing time series (backcasting, nowcasting and interpolations);

- weight of 0.5 for gravity model estimates; and

- weight of 0.25 for reported data that are considered implausible or incorrect[17].

The final balancing formula between reporter i and partner j, for service item k in year t is therefore as follows:

$$T_{ijkt} = \frac{(SI_{ikt} * w) * X_{ijkt} + (SI_{jkt} * w) * M_{jikt}}{(SI_{ikt} * w) + (SI_{jkt} * w)}$$

Table 8 displays the average symmetry index for total services exports and imports (2005-2021), for a selection of large service traders, as well as the variation of this symmetry index over time (measured by its standard deviation). Overall, the symmetry indices of large service exporting economies are relatively high and show low standard deviations, while non-OECD countries typically display lower symmetry indices.

Table 8. Symmetry indices for total services trade, 2005-2021, selected economies (that report bilateral data)

	Exports		Imports			Exports		Imports	
	mean	sd	mean	sd		mean	sd	mean	sd
Australia	0.82	0.04	0.68	0.07	**Korea**	0.73	0.04	0.76	0.02
Belgium	0.74	0.02	0.84	0.02	**Luxembourg**	0.62	0.03	0.77	0.02
Brazil	0.64	0.03	0.68	0.03	**Malaysia**	0.63	0.03	0.72	0.04
Canada	0.79	0.02	0.87	0.02	**Netherlands**	0.75	0.03	0.76	0.03
China	0.73	0.04	0.74	0.03	**New Zealand**	0.76	0.05	0.76	0.02
Denmark	0.70	0.04	0.80	0.03	**Russia**	0.59	0.02	0.69	0.03
France	0.81	0.01	0.85	0.01	**Singapore**	0.65	0.03	0.66	0.05
Germany	0.81	0.01	0.85	0.01	**Spain**	0.82	0.03	0.80	0.02
Hong Kong, China	0.65	0.06	0.67	0.11	**Sweden**	0.74	0.01	0.82	0.01
Ireland	0.75	0.03	0.74	0.05	**Switzerland**	0.77	0.02	0.63	0.03
Italy	0.80	0.01	0.84	0.02	**United Kingdom**	0.81	0.02	0.71	0.04
Japan	0.80	0.02	0.80	0.03	**United States**	0.81	0.02	0.75	0.03

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[17] These cases include zero trade reported for items that are in fact not compiled (may happen for *manufacturing services on inputs owned by others*, for instance), or corrections of reported negative insurance flows (see Section 2.2).

5. Results

5.1 Reported vs balanced trade for total trade in services

The BaTIS balanced trade values, resulting from the reconciliation method described above, differ by construction from both the reported flows and the relevant mirror flows. The size of the difference between the reported and the balanced value is a function of the asymmetry level between two countries as well as the symmetry index of each partner country. In general, the balanced value for a specific service category will be closer to that reported by the country whose statistics are, on average, more in line with what has been reported by its partner country (i.e. the country with a higher symmetry index).

Figure 1 shows the comparison between the reported exports and imports and the final balanced trade at world level for total services. Because of the top-down approach followed, BaTIS does not change the overall picture of world trade. However, exports are systematically higher than imports and the difference does not seem to decrease over time: on the contrary, it increases from about 2% in 2005 to above 5% in 2018-2019, in parallel with the growth in overall services trade.

Figure 1: World services trade
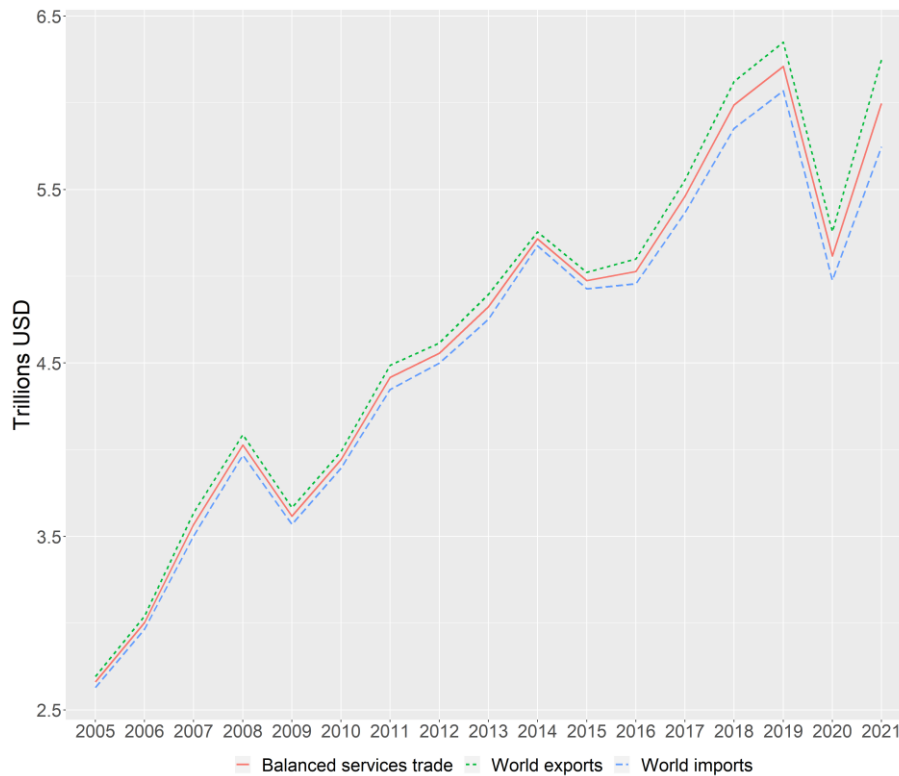
While the difference between reported and balanced values is minimal at world level, it can be quite substantial for individual traders. In particular, it appears that some countries systematically under- or over-report their trade in services compared with what their

partners declare, resulting in significant differences between the sum of the balanced trade figures and the original reported totals.

Table 9 provides insights into the size of such differences by showing the ratio between the sum of balanced trade and the sum of reported trade across all partners and years for a selection of leading economies that reported bilateral data.

Table 9. Ratio between the sum of balanced bilateral trade and reported total trade (S),
selected countries reporting bilateral trade statistics (%)

	Exports		Imports			Exports		Imports	
Australia	7.5	(+)	32.4	(+)	Korea	10.4	(-)	12.2	(-)
Belgium	16.9	(-)	6.8	(-)	Luxembourg	20.7	(-)	4.6	(-)
Brazil	2.6	(-)	8.7	(-)	Malaysia	16.8	(-)	8.6	(-)
Canada	10.1	(-)	1.8	(+)	Netherlands	3.1	(-)	1.9	(-)
China	8.0	(-)	18.5	(-)	New Zealand	0.1	(-)	10.6	(+)
Denmark	18.7	(-)	9.8	(-)	Russia	14.4	(-)	12.6	(-)
France	10.4	(-)	5.3	(-)	Singapore	0.4	(-)	3.2	(-)
Germany	2.3	(+)	4.5	(+)	Spain	2.3	(-)	16.9	(+)
Hong Kong, China	25.0	(+)	32.0	(+)	Sweden	7.3	(-)	3.5	(+)
Ireland	9.3	(-)	9.4	(-)	Switzerland	20.8	(+)	53.9	(+)
Italy	3.4	(+)	0.8	(+)	United Kingdom	0.6	(-)	36.8	(+)
Japan	6.0	(-)	6.5	(-)	United States	6.8	(+)	19.6	(+)

Note: (+) and (-) denote the respectively overall positive or negative difference during the 2005-2021 period, with (+) and (-) indicating that balanced trade values were on average higher (lower) than reported statistics.

For some of the leading traders, especially in Europe, the average asymmetries at total services level are relatively low and appear to have decreased compared to the previous edition of BaTIS. In some cases, however, important differences persist. For Ireland and Luxembourg, for example, both exports and imports appear over-reported, with the difference reaching 20% in the case of Luxembourg's exports. Similarly, China and Singapore seem to over-estimate the level of their exports and imports compared to what their trading partners assess, while the opposite is true for Hong Kong (China). On the other hand, the reported exports of the United Kingdom and the United States are well aligned with the balanced figures, while they both seem to underestimate the level of their imports (by 20% for the United States and 37% for the United Kingdom). For Switzerland, which only recently started publishing bilateral trade in services statistics, the balanced figures are significantly higher than reported, particularly on the imports side and for services such as transport, travel and other business services.

With a few exceptions, the balancing has a limited impact on the relative importance of the leading traders in world trade and on the shares of the top trading partners for these traders. Figure 2 shows, for a selection of reporting countries with significant trade in services, the share of their top 10 partners according to their reported and balanced figures for total services.

Figure 2. Top 10 partner countries for selected service exporters: reported versus balanced trade data in 2021 (partner share in total exports)
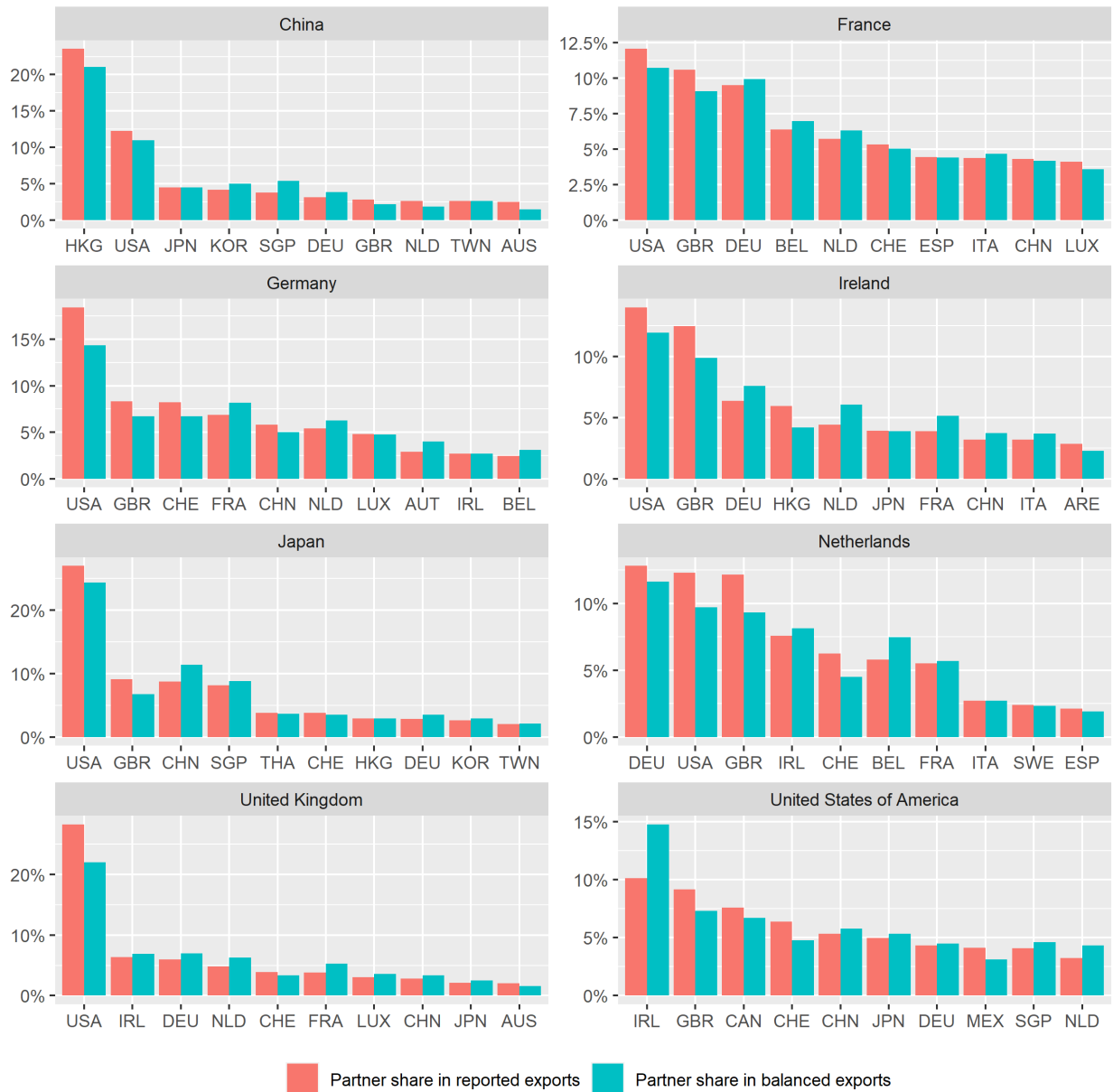
While for (most of) the OECD economies the asymmetries are relatively moderate, this is not always the case for other countries covered in BaTIS, including those that do not publish bilateral trade in services data. In some cases, asymmetries can be so large that the total balanced trade figures end up being very different from the reported values.

An overview of such extreme cases is provided in Table 10. Similarly to what already observed in the previous edition of BaTIS, Bermuda is at the top of the list: its balanced exports and imports are respectively 43 and 15 times higher than reported over the time period considered. While these figures might seem exaggerated, they reflect the fact that, amongst others, the United States, the Netherlands, Ireland and the United Kingdom report

sizeable transactions with Bermuda, most notably in insurance and financial services, which appear to go completely undetected in Bermuda's own data. These issues are most probably linked to the presence of foreign-controlled MNEs and also occur, although at a smaller scale, in countries such as the Cayman Islands and Barbados.

Furthermore, Mexico, Cyprus and the United Arab Emirates all see their balanced exports considerably exceed the reported ones, while the opposite occurs for, amongst others, Macao (China), India and Israel. On the import side, some large non-OECD member economies such as India, Saudi Arabia and Thailand, appear to over-report their trade in services.

Table 10. Extreme cases of under- or over-reporting, total services, selected economies (% and million USD)

	Exports			Imports	
	Ratio between balanced and reported ('05-'21)	Average balanced trade value ('05-'21)		Ratio between balanced and reported ('05-'21)	Average balanced trade value ('05-'21)
Liberia	6070%	11,416	Bermuda	1524%	15,418
Bermuda	4346%	62,130	Cayman Islands	361%	4,807
Barbados	805%	12,135	Barbados	789%	5,249
Cayman Islands	39%	3,436	Macao, China	160%	8,902
Mexico	24%	33,279	Bahamas	127%	3,485
Tunisia	60%	6,768	Afghanistan	20%	1,367
Cyprus	43%	16,966	Congo	37%	3,730
Mauritius	40%	3,511	Uzbekistan	10%	3,596
United Arab Emirates	14%	46,949	Switzerland	53%	168,041
Panama	45%	13,280	Brunei Darussalam	62%	2,608
…			…		
Qatar	-22%	8,430	Qatar	-25%	16,425
Israel	-24%	27,484	Thailand	-23%	34,023
Jordan	-24%	4,056	Nigeria	-27%	15,232
India	-33%	98,213	Sri Lanka	-28%	3,451
Kuwait	-42%	4,617	Saudi Arabia	-25%	54,425
Cambodia	-35%	1,869	Kuwait	-42%	11,911
Lebanon	-51%	6,802	India	-35%	82,235
Macao, China	-40%	16,348	Iraq	-13%	11,398
Iran	-48%	4,355	Lebanon	-39%	7,002
Turkmenistan	-56%	1,337	Iran	-42%	8,979

5.2 Reported vs balanced trade for individual service categories

As shown in Figure 1, the aggregate absolute differences between the reported data and the final balanced estimates are around 2 to 3% at world level. Those differences are generally much larger, however, for the individual service categories.

Table 11 summarizes the (trade weighed) average differences between reported and balanced figures, again calculated as the ratio between the sum of the balanced trade and the sum of reported trade across all reporters, partners and years. The ratios are displayed for all the bilateral flows (including the BaTIS estimations) and for the reported flows only.

With an absolute ratio of 2% for exports and 3.4% for imports, *travel* is the most aligned category at world level. *Transport*, instead, appears to be systematically over-reported on the import side. Somewhat surprisingly, reported and balanced values for *charges for the use of intellectual property n.i.e* seem to be relatively well aligned, possibly reflecting the fact that those services are mostly traded by economies with advanced statistical systems.

The two new BPM6 items, *manufacturing services on physical inputs owned by others* and *maintenance and repair services n.i.e.*, seem to be systematically under-reported on the import side (indeed, these items are not yet compiled by many reporters, including a few OECD members). As a consequence, balanced trade values in these categories are very close to the reported exports, as the most important exporters in these categories are more likely to report the related transactions.

Imports of *insurance services* are systematically higher than exports, while the opposite is true for *financial services*, possibly hinting at a misclassification of transactions in this area.

High asymmetries are also observable for *telecommunication, computer and information services* and *government goods and services n.i.e*, while the discrepancies for *construction*, *personal, cultural and recreational services* and, most notably, *other business services* are relatively moderate at the aggregate level.

Table 11. Ratio between the sum of balanced bilateral trade and reported trade,
by EBOPS category (%)

	Exports		Imports	
	All observations	Reported flows	All observations	Reported flows
Total services	-1.8	-1.1	1.2	7.1
Manufacturing services on physical inputs owned by others	2.7	-15.5	36.1	0.0
Maintenance and repair services n.i.e.	-2.6	-6.8	51.7	20.4
Transport	6.6	2.8	-11.0	1.0
Travel	-2.0	0.6	3.4	5.7
Construction	-2.0	-6.8	9.7	4.1
Insurance and pension services	25.6	1.8	-22.2	-0.2
Financial services	-20.1	-23.0	48.4	44.8
Charges for the use of intellectual property n.i.e.	7.4	5.3	-4.4	-2.4
Telecommunications, computer, and information services	-21.2	-14.4	26.5	24.1
Other business services	-0.7	4.5	-3.3	0.8
Personal, cultural, and recreational services	0.8	7.5	2.9	3.3
Government goods and services n.i.e.	27.4	32.4	-6.7	2.5

Note: A positive (negative) ratio indicates that the balanced values are higher (lower) than the reported figures.

6. Conclusions and next steps

This paper presented the OECD-WTO BaTIS dataset, describing the methodology developed by the OECD and WTO to build a complete, consistent and balanced matrix of trade in services statistics.

Further work is necessary to improve future editions of the dataset. Over the past years, a number of countries have been actively involved in bilateral and multilateral efforts to examine the causes of the observed asymmetries, including by sharing compilation methodologies and detailed information[18]. Such efforts at the level of national compilers are crucial to improve the reliability of trade in services statistics at source and to enhance public trust in these data. National efforts to reconcile the observed asymmetries are preferable to any mechanical balancing procedure, and therefore new results made available will be absorbed in the future editions of BaTIS.

While the development of BaTIS was driven by the need for complete and coherent trade in services statistics for the purposes of constructing global Supply and Use and Input-Output tables, the dataset also constitutes a standalone analytical product. In particular for countries with less developed statistical systems, BaTIS can serve as a starting point to identify the most important trends and to support trade in services policies, hopefully fostering continuous improvements in existing data compilation practices.

BaTIS is intended to be regularly updated and improved. The most prominent areas for future work include:

- Expanding the breakdown of service categories. Increasing the level of detail of the items covered in BaTIS would greatly enhance the use of the dataset for policy-making. Importantly, this would also facilitate the conversion of the information from the EBOPS classification to the Central Product Classification (CPC) categories[19], which in turn would provide a more accurate link between trade in services information and national Supply and Use Tables and Input-Output tables.

- Adding the Mode of Supply dimension. The methodology underpinning the construction of BaTIS is fully compatible with the WTO dataset on Trade in Services by Mode of Supply (TISMOS). Indeed, the two products were developed with a view to be eventually merged. A detailed, multidimensional dataset providing information on the type of service traded, the partner and the mode of supply, whereas challenging to construct, would constitute an invaluable tool for policy-makers and trade negotiators. Furthermore, given the inherent relationship between the supply of services via mode 1 (cross border supply) and the digital delivery of services (OECD, WTO and IMF, 2019), the addition of the mode of supply dimension to BaTIS would allow a deeper understanding of how services are traded in the 21st century.

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[18] A number of bilateral and trilateral meetings have been held in the context of the OECD Working Party on Trade in Goods and Services (WPTGS).

[19] The CPC nomenclature provides a comprehensive classification structure for products (goods and services) and serves as an international standard for tabulating all kinds of economic data requiring product detail. Most notably, it is widely used in the compilation of Supply and Use tables and other National Accounts aggregates.

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Annex A. List of economies covered in the BaTIS dataset

List of reporters and partners:

Afghanistan, Albania, Algeria, Angola, Anguilla, Antigua and Barbuda, Argentina, Armenia, Aruba, Australia, Austria, Azerbaijan, Bahamas, Bahrain, Bangladesh, Barbados, Belarus, Belgium, Belize, Benin, Bermuda, Bhutan, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Brunei Darussalam, Bulgaria, Burkina Faso, Burundi, Cabo Verde, Cambodia, Cameroon, Canada, Cayman Islands, Central African Republic, Chad, Chile, China, Chinese Taipei, Colombia, Comoros, Congo, Costa Rica, Côte d'Ivoire, Croatia, Cuba, Curaçao, Cyprus, Czech Republic, Democratic Republic of the Congo, Denmark, Djibouti, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, Eritrea, Estonia, Eswatini, Ethiopia, Faeroe Islands, Fiji, Finland, France, French Polynesia, Gabon, Georgia, Germany, Ghana, Greece, Grenada, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Hong Kong (China), Hungary, Iceland, India, Indonesia, Iran, Iraq, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Kiribati, Democratic People's Republic of Korea, Korea, Kuwait, Kyrgyz Republic, Lao People's Democratic Republic, Latvia, Lebanon, Lesotho, Liberia, Libya, Lithuania, Luxembourg, Macao (China), Madagascar, Malawi, Malaysia, Maldives, Mali, Malta, Mauritania, Mauritius, Mexico, Moldova, Mongolia, Montenegro, Montserrat, Morocco, Mozambique, Myanmar, Namibia, Nepal, Netherlands, Netherlands Antilles, New Caledonia, New Zealand, Nicaragua, Niger, Nigeria, North Macedonia, Norway, Oman, Pakistan, Palestine, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Qatar, Romania, Russia, Rwanda, Saint Kitts and Nevis, Saint Lucia, Saint Martin, Saint Vincent and the Grenadines, Samoa, Sao Tomé and Principe, Saudi Arabia, Senegal, Serbia, Serbia and Montenegro, Seychelles, Sierra Leone, Singapore, Slovak Republic, Slovenia, Solomon Islands, Somalia, South Africa, Spain, Sri Lanka, Sudan, Suriname, Sweden, Switzerland, Syrian Arab Republic, Tajikistan, Tanzania, Thailand, The Gambia, Timor-Leste, Togo, Tonga, Trinidad and Tobago, Tunisia, Türkiye, Turkmenistan, Turks and Caicos Islands, Tuvalu, Uganda, Ukraine, United Arab Emirates, United Kingdom, United States, Kosovo, Uruguay, Uzbekistan, Vanuatu, Venezuela, Viet Nam, Yemen, Zambia, and Zimbabwe.

List of partners covered in entity "Rest of the World" (ROW):

Andorra, Antarctica, American Samoa, Bonaire, Sint Eustatius and Saba, Bouvet Island, Cocos (Keeling) Islands, Cook Islands, Christmas Island, Western Sahara, Falkland Islands (Islas Malvinas), Micronesia, Federated States of, French Southern Territories, French Guiana, Guernsey, Gibraltar, Greenland, Guadeloupe, South Georgia and the South Sandwich Islands, Guam, Heard Island and Mcdonald Islands, Isle of Man, British Indian Ocean Territory, Jersey, Liechtenstein, Monaco, Marshall Islands, Northern Mariana Islands, Martinique, Norfolk Island, Nauru, Niue, Saint Pierre and Miquelon, Pitcairn, Puerto Rico, Palau, Reunion, British Overseas Territory of Saint Helena, Ascension and Tristan da Cunha, San Marino, South Sudan, Tokelau, United States Minor Outlying Islands, Holy See, Virgin Islands, British, Virgin Islands, US, and Wallis and Futuna Islands.

Annex B. Reported data availability: average number of partners by reporter and EBOPS 2010 category

ISO3	Country name	S	SA	SB	SC	SD	SE	SF	SG	SH	SI	SJ	SK	SL
RKS	Kosovo	191	64	64	64	64	64	64	64	64	64	64	64	64
ALB	Albania	200	59	59	59	59	59	59	59	59	59	59	59	59
ARG	Argentina	197	6	83	186	187	13	190	70	72	121	175	133	-
AUT	Austria	200	58	58	58	58	58	58	58	58	58	58	58	58
AUS	Australia	34	6	34	34	34	34	34	34	34	34	34	34	34
BIH	Bosnia and Herzegovina	195	-	-	59	59	-	-	-	-	59	-	59	-
BGD	Bangladesh	24	75	140	192	194	56	63	136	64	166	186	132	146
BEL	Belgium	200	59	59	59	59	58	59	59	58	59	59	58	59
BGR	Bulgaria	200	58	58	58	58	58	58	58	58	58	58	58	58
BOL	Bolivia	-	-	-	-	34	-	-	-	-	-	-	-	-
BRA	Brazil	38	-	-	-	-	-	-	-	-	-	-	-	-
BTN	Bhutan	1	-	1	1	1	1	1	1	1	1	1	-	1
BLR	Belarus	-	-	-	148	117	40	121	118	80	132	53	131	-
CAN	Canada	57	-	81	46	58	81	81	81	81	81	81	81	42
CHE	Switzerland	40	-	-	40	40	-	40	40	40	40	40	-	-
CHL	Chile	-	-	-	34	11	-	-	-	-	5	13	-	-
CHN	China	13	13	13	13	13	13	13	13	13	13	13	13	13
COL	Colombia	-	2	16	60	-	1	-	-	39	65	70	60	-
CRI	Costa Rica	198	198	198	198	198	198	198	198	198	198	198	198	198
CYP	Cyprus	200	59	59	59	59	59	59	59	59	59	59	58	59
CZE	Czech Republic	200	59	59	59	59	59	59	59	59	59	59	59	59
DEU	Germany	187	58	58	58	58	58	58	58	58	58	58	58	58
DNK	Denmark	199	58	58	58	58	58	58	58	58	58	58	58	58
EST	Estonia	200	59	59	59	59	59	59	59	59	59	59	58	59
ESP	Spain	59	-	-	-	11	-	-	-	-	-	-	-	6
FIN	Finland	200	59	59	59	59	59	59	59	59	59	59	59	59
FRA	France	200	59	59	59	59	59	59	59	59	59	59	59	59
GBR	United Kingdom	67	66	66	67	67	66	66	66	66	66	66	66	67
GRC	Greece	199	59	59	59	59	59	59	59	59	59	59	59	59
HKG	Hong Kong, China	52	1	7	52	22	-	51	51	52	52	51	52	-
HRV	Croatia	200	58	58	58	58	58	58	58	58	58	58	58	58
HUN	Hungary	200	59	59	59	59	59	59	59	58	59	59	58	58
IRL	Ireland	199	59	59	59	59	59	59	59	58	59	59	59	59
ISR	Israel	-	-	43	-	37	44	-	15	42	33	-	17	-
ISL	Iceland	166	-	31	55	57	-	-	-	41	41	41	34	18
ITA	Italy	200	59	59	59	59	59	59	59	59	59	59	59	59
JPN	Japan	34	31	33	34	34	34	34	34	33	34	34	33	34
KOR	Korea, Republic of	3	3	-	3	3	-	3	-	3	3	3	-	3
KAZ	Kazakhstan	-	16	61	121	112	26	-	27	34	68	76	36	62
LTU	Lithuania	200	59	59	59	59	59	59	59	59	59	59	59	59
LUX	Luxembourg	200	1	1	58	58	1	1	58	1	1	58	1	1
LVA	Latvia	199	59	59	59	59	59	59	59	59	59	59	59	59
MNE	Montenegro	200	59	59	59	59	59	59	59	59	59	59	59	59
MLT	Malta	193	59	58	59	59	59	59	59	59	59	59	56	58
MEX	Mexico	80	21	21	36	2	-	-	-	17	31	48	6	-
MYS	Malaysia	47	20	-	20	20	20	-	-	-	20	20	20	20
NLD	Netherlands	199	59	59	59	59	58	59	59	58	59	59	59	57
NOR	Norway	1	-	-	-	-	-	-	-	-	-	-	-	-
NZL	New Zealand	196	-	51	57	194	56	70	56	55	59	63	56	185
PER	Peru	-	-	-	-	70	-	-	-	-	-	-	-	-
PAK	Pakistan	46	-	81	188	181	68	186	185	121	186	188	92	148
POL	Poland	200	59	59	59	59	59	59	59	59	59	59	59	36
PRT	Portugal	196	12	12	13	48	12	12	12	12	12	12	12	57
ROM	Romania	200	59	59	59	59	59	59	58	59	59	59	59	56
SRB	Serbia	199	59	59	59	59	59	59	59	59	59	59	59	59

RUS	Russian Federation	199	96	172	196	85	155	177	197	167	197	198	179	1
SWE	Sweden	200	58	58	58	58	58	58	58	58	58	58	58	58
SGP	Singapore	31	9	9	9	-	9	9	9	9	9	9	9	-
SVN	Slovenia	200	59	59	59	59	59	59	59	59	59	59	59	59
SVK	Slovak Republic	199	59	59	59	59	59	59	59	59	59	59	59	59
TUN	Tunisia	67	-	-	145	104	-	-	-	-	-	-	-	72
TUR	Türkiye	193	50	51	57	-	27	57	51	52	55	57	50	53
TTO	Trinidad and Tobago	-	-	-	-	-	2	3	3	3	3	3	1	-
UKR	Ukraine	6	6	6	6	6	6	6	6	6	6	6	6	6
USA	United States of America	71	-	71	71	71	71	71	71	71	71	71	71	71

Annex C. Results of PPML regressions for total services (exports)

	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	-8.66***	- -9.54***	9.97***	5.84***	20.16***
	-1.39	-1.29	-1.21	-1.12	-1.28
Distance	-0.20***	-0.20***	-0.44***	-0.45***	-0.53***
	0	0	0	0	0
Contiguity	0.11***	0.13***	0.34***	0.34***	0.20***
	-0.01	-0.01	-0.01	-0.01	-0.01
Common language	0.36***	0.35***	0.48***	0.48***	0.64***
	-0.01	-0.01	-0.01	-0.01	-0.01
Colony	0.18***	0.19***	0.09***	0.11***	0.23***
	-0.01	-0.01	-0.01	-0.01	-0.01
GDP of reporter	-0.03***	-0.03***	0.21***	0.20***	0.21***
	0	0	0	0	0
GDP of partner	0.23***	0.22***	0.45***	0.44***	0.74***
	-0.01	-0.01	-0.01	-0.01	0
GDP/capita of reporter	0.08***	0.07***	-0.09***	-0.07***	-0.11***
	-0.01	0	-0.01	0	-0.01
Total trade with world	0.63***	0.63***	0.81***	0.79***	0.77***
	-0.01	-0.01	-0.01	-0.01	-0.01
Merchandise trade (bilateral)	0.38***	0.38***			
	0	0			
Arrivals	0.01***		-0.03***		
	0		0		
Time trend	0.00**	0.00***	-0.01***	-0.00***	-0.01***
	0	0	0	0	0
Partner FE	Y	Y	Y	Y	Y
Deviance	15,158,168.68	16,312,837.78	21,921,130.33	24,012,043.42	40,572,349.18
Num. obs.	90,061.00	104,177.00	113,949.00	134,580.00	134,580.00
Mc Fadden pseudo R2	0.94	0.94	0.93	0.93	0.88

Note: Significance levels indicated with *** for 0.1%, ** for 1% and * for 5%. The McFadden pseudo-R2 is defined as one minus the ratio between the (maximized) likelihood value from the fitted model, and the corresponding value for the null model.

Annex D. Results of PPML regressions for total services (imports)

	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	1.13	-13.44***	13.71***	0.44	25.54***
	-1.86	-1.62	-1.53	-1.33	-2.77
Distance	-0.20***	-0.19***	-0.40***	-0.40***	-0.52***
	0	0	0	0	-0.01
Contiguity	0.22***	0.22***	0.31***	0.31***	0.10***
	-0.01	-0.01	-0.01	-0.01	-0.02
Common language	0.35***	0.31***	0.54***	0.50***	0.68***
	-0.01	-0.01	-0.01	-0.01	-0.02
Colony	-0.05***	-0.03**	-0.08***	-0.06***	0.12***
	-0.01	-0.01	-0.01	-0.01	-0.02
GDP of reporter	0.03***	-0.03***	0.25***	0.19***	0.19***
	0	0	0	0	-0.01
GDP of partner	0.11***	0.15***	0.23***	0.27***	0.72***
	-0.02	-0.02	-0.02	-0.02	0
GDP/capita of reporter	-0.09***	-0.05***	-0.14***	-0.12***	-0.19***
	0	0	-0.01	0	-0.01
Total trade with world	0.73***	0.68***	0.87***	0.84***	0.85***
	-0.01	-0.01	-0.01	-0.01	-0.01
Merchandise trade	0.39***	0.38***			
	0	0			
Departures	-0.14***		-0.12***		
	0		0		
Time trend	-0.00**	0.00***	-0.01***	-0.00***	-0.01***
	0	0	0	0	0
Partner FE	Y	Y	Y	Y	Y
Deviance	15,396,056.73	17,486,958.22	22,016,429.53	25,017,777.00	48,079,492.58
Num. obs.	76,961.00	98,128.00	98,210.00	128,889.00	128,889.00
Mc Fadden pseudo R2	0.93	0.93	0.92	0.92	0.84

Note: Significance levels indicated with *** for 0.1%, ** for 1% and * for 5%. The McFadden pseudo-R2 is defined as one minus the ratio between the (maximized) likelihood value from the fitted model, and the corresponding value for the null model.

Annex E. Estimated bilateral trade by model, service category and flow

Item	Description	Model	Exports		Imports	
			% of total est. obs.	% of total est. val.	% of total est. obs.	% of total est. val.
SA	Manufacturing services on physical inputs owned by others	M2.1	63	73	60	91
		M2.2	33	21	34	3
		M2.3	4	6	6	6
SB	Maintenance and repair services n.i.e.	M2.1	60	68	59	69
		M2.2	37	27	39	29
		M2.3	4	5	3	2
SC	Transport	M2.1	50	68	52	70
		M2.2	39	23	43	28
		M2.3	11	9	5	2
SD	Travel	M2.0	43	64	19	54
		M2.1	4	1	16	5
		M2.2	41	29	27	25
		M2.3	13	7	38	16
SE	Construction	M2.1	59	78	55	48
		M2.2	37	19	44	52
		M2.3	4	3	1	0
SF	Insurance and pension services	M2.1	57	56	55	49
		M2.2	39	40	41	44
		M2.3	4	4	4	7
SG	Financial services	M2.1	57	72	56	59
		M2.2	41	25	42	40
		M2.3	3	3	2	1
SH	Charges for the use of intellectual property n.i.e.	M2.1	60	54	58	64
		M2.2	36	39	40	35
		M2.3	3	7	2	1
SI	Telecommunications, computer, and information services	M2.1	54	73	53	75
		M2.2	43	25	43	22
		M2.3	3	2	4	3
SJ	Other business services	M2.1	54	75	53	76
		M2.2	41	20	42	18
		M2.3	5	5	6	6
SK	Personal, cultural, and recreational services	M2.1	60	76	58	66
		M2.2	36	21	40	32
		M2.3	3	3	2	1
SL	Government goods and services n.i.e.	M2.1	55	47	54	36
		M2.2	39	51	40	62
		M2.3	6	2	6	2

Note: The percentages refer to the gravity-based estimates only, i.e. they exclude the reported data as well as the other types of estimates.

## Annex F. Assessing the predictive power of the gravity models

This Annex describes the cross-validation exercise carried out to measure the out-of-sample accuracy of the models used to predict total services trade. In particular, the predictive power of the five models used in the previous edition of BaTIS was compared with that of the same models but with the addition of the trade in services with partner world variable for all five specifications.

		Full model (M1.1)	Reduced model (M1.2)	Reduced model (M1.3)	Reduced model (M1.4)	Reduced model (M1.5)
Old BaTIS specification	Distance	X	X	X	X	X
Old BaTIS specification	Contiguity	X	X	X	X	X
Old BaTIS specification	Common language	X	X	X	X	X
Old BaTIS specification	Colony	X	X	X	X	X
Old BaTIS specification	GDP reporter	X	X	X	X	X
Old BaTIS specification	GDP partner	X	X	X	X	X
Old BaTIS specification	GDP per capita (reporter)	X	X	X	X	X
Old BaTIS specification	Merchandise trade	X	X			
Old BaTIS specification	Tourist arrivals/departures	X		X		
Old BaTIS specification	Time trend (linear)	X	X	X	X	X
Old BaTIS specification	Partner FE	X	X	X	X	
Additional variable	Trade in services with world	X	X	X	X	X

The sample used for the cross-validation contained information available for all specifications, i.e. the sample of model M1.1. The algorithm took the following steps:

    i.   The sample was randomly split into two datasets: the training set (70%) and the test set (30%). Each reporter-partner pair was represented in both sets.

    ii.   Each model was fit on the training set and then the coefficients were used to predict the test set.

    iii.   For each specification M1.1, M1.2, M1.3, M1.4, and M1.5, the prediction accuracy was computed using the mean absolute error (MAE) criterion.

    iv.   Steps i. to iii. were repeated 200 times.

The resulting distributions of the MAE are plotted in Figure 3, with the top panel including the old specifications and the bottom panel covering the trade with world as additional predictor. As expected, the preferred specification M1.1 better predicts trade on average. The second-best model is M1.2, the third M1.3, then M1.4 and finally M1.5. This means that, starting from the most parsimonious model (M1.5), adding each explanatory variable provides useful information and enables to better predict bilateral trade. The bottom panel shows that the accuracy of the out of sample predictions improves significantly (for all five specifications) when total trade in services with partner world is added as explanatory variable, despite the obvious endogeneity with the response variable. Although small values appeared more difficult to predict, these results hold when the sample is split between large trade flows (above 50 million USD) and smaller flows (below 50 million of USD). Also, changing the proportions of the training and test sets or the number of repetitions gave a similar picture.

Figure 3: Accuracy of predictions for total services trade: mean absolute error (million USD)
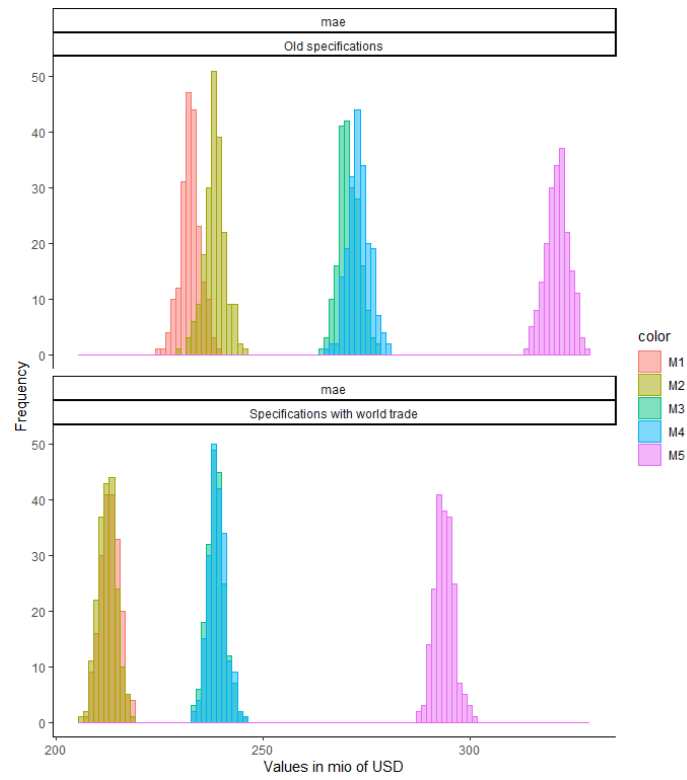
Annex G. McFadden pseudo R-squared for the gravity estimations of individual service categories, by model and flow

Service category	Code	Exports				Imports			
		M2.0	M2.1	M2.2	M2.3	M2.0	M2.1	M2.2	M2.3
Manufacturing services on physical inputs owned by others	SA	-	87	87	77	-	91	91	85
Maintenance and repair services n.i.e.	SB	-	61	64	50	-	86	85	80
Transport	SC	-	90	89	84	-	90	89	84
Travel	SD	91	90	90	86	92	91	91	84
Construction	SE	-	78	76	68	-	77	76	70
Insurance and pension services	SF	-	89	89	81	-	88	91	65
Financial services	SG	-	94	94	84	-	90	91	75
Charges for the use of intellectual property n.i.e.	SH	-	92	92	80	-	90	90	75
Telecommunications, computer, and information services	SI	-	91	91	86	-	91	90	79
Other business services	SJ	-	94	93	85	-	94	93	87
Personal, cultural, and recreational services	SK	-	91	90	86	-	86	86	78
Government goods and services n.i.e.	SL	-	83	84	73	-	91	91	80

Note: The full regression tables at the level of individual service categories are available upon request.

Annex H. Methodology codes used in BaTIS

Methodology	Description
R_OECD	Reported: OECD International Trade in Services Statistics (ITSS).
R_EURO	Reported: EUROSTAT International Trade in Services statistics.
R_EUEQ	Reported: EUROSTAT Quarterly Balance of Payments statistics.
R_NAT	Reported: National source.
R_NAT.1	Reported: National source, but different from main balance of payments provider. Data rescaled to fit world totals.
R_UNSD	Reported: United Nations Statistics Division (Comtrade).
R_IBP	Reported: IMF Balance of Payments statistics (partner world only).
E0	Estimated as negligible/zero.
E1	Simple derivation from reported figures.
E1.2	Simple derivation - after backcasting/nowcasting/interpolation.
E2	Estimation of most recent year(s) missing in primary source by using the national BOP growth rate (partner world only).
E2.1	Estimation of most recent year(s) missing in primary source by using the national BOP growth rate. Past shares used to estimate subitems (partner world only).
E3	Estimated using past or future shares (partner world only).
E4	Correction of mistakes in source data, such as implausible negative values, definition not in line with international recommendations, etc. (partner world only).
E5	Estimates based on regional growth rates (partner world only).
E6	Correction for negative insurance.
E7	Completely missing time series information. Estimated using reported shares within a cluster of similar economies for a given year (partner world only).
E8	Gaps in reported time series: estimated by back/nowcasting or interpolation (partner world only).
E8.0	Gaps in reported time series: estimated as zero using interpolation or back-nowcasting (bilateral data).
E8.1	Gaps in reported time series: estimated as non-zero value using interpolation or back-nowcasting (bilateral data). As only one data point is reported, the same share is applied to all years.
E8.2	Gaps in reported time series: estimated as non-zero value using interpolation or back-nowcasting (bilateral data).
M1.1	Estimation of total services from gravity model: specification (M1.1).
M1.2	Estimation of total services from gravity model: specification (M1.2).
M1.3	Estimation of total services from gravity model: specification (M1.3).
M1.4	Estimation of total services from gravity model: specification (M1.4).
M1.5	Estimation of total services from gravity model: specification (M1.5).
M2.0	Estimation of service item from gravity model: specification (M2.0).
M2.1	Estimation of service item from gravity model: specification (M2.1).
M2.2	Estimation of service item from gravity model: specification (M2.2).
M2.3	Estimation of service item from gravity model: specification (M2.3).
M8.0	Remaining gaps in total services after prediction from gravity models: estimated as zero using interpolation or back-nowcasting on predicted data.
M8.2	Remaining gaps in total services after prediction from gravity models: estimated as non-zero value using interpolation or back-nowcasting on predicted data.
M8.3	Imputation of Rest of the World aggregate.
W0	Derived as zero, as partner world is zero.
A	Aggregation of figures with different methodology codes (used for country groups).
Z	Reporter or partner country not available at the time of analysis.