*SI Appendix for*

“Mapping the structure of the world economy”

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# Extended Multi-region input-output tables and analysis

Thanks to Leontief’s innovation and to governance by the United Nations[[1](#_ENREF_1)], every input-output table conforms to a standardised structure (Fig. S1). Producing entities (so-called *sectors*) are listed along rows and columns in a symmetrical fashion, and every element in the table holds a number that describes the monetary value of a transaction between the row sector supplying a product to the column sector that uses it. Sectors are usually aggregates over many industrial establishments, for example wheat growing, iron ore mining, steel manufacturing, electricity generation, road transport, or banking services. An input-output table holds in its columns the inputs, or the *production recipe*, and in its rows the *sales structure* of all sectors. In its entirety, it contains complete information on the internal interdependence, or structure, of an economy.



Figure S1a: Schematic of an input-output table. ID = Intermediate demand, matrix T; FD = Final demand, matrix y; PI = Primary inputs, matrix v.

In accordance with the standards set in the United Nations’ System of National Accounts [[1](#_ENREF_1)], input-output tables make a distinction between primary and intermediate inputs, and intermediate and final outputs. *Intermediate inputs and outputs* (matrix **T** in Fig. S1a) are supplied and used by producers of goods and services, that is companies and the public sector. However, in order to operate, each producer also needs inputs from non-producing entities, for example labour or capital, and such inputs are included in the *primary inputs* block (matrix **v**). Finally, each producer not only supplies other producers, but also final consumers such as households, and such outputs are contained in the *final demand* block (matrix **y**).

In addition, the United Nations guidelines [[2](#_ENREF_2)] provide for an integration of the monetary input-output tables with so-called *satellite accounts* that hold additional information for example on the use of natural resources such as water or energy, on pollution such as emissions, or on other physical inputs into production such as human labour. Satellite accounts are constructed in the same sector classification as the monetary account, and then simply appended to input-output tables.

The System of National Accounts also provides for an input-output table variant called a supply-use table, where the concept of producing sectors is refined into two concepts: an *industry*, and the *products* that it produces. The difference between the sector perspective and the industry-product perspective is that the latter allows one industry to produce more than one product, and one product to be produced by more than one industry. This enhanced detail in a supply-use table is captured in two separate matrices called the *use* matrix (**T**) and the supply matrix (**V**, see Fig. S1b).



**Figure S1b:** Schematic of a supply-use table. ID = Intermediate demand, matrices **T** and **V**; FD = Final demand, matrix **y**; PI = Primary inputs, matrix **v**; IN = Industries, PR = Products.

The System of National Accounts also defines three different valuations at which input-output transactions can be expressed: basic prices, producers’ prices, and purchasers’ prices. Basic prices refer to the factory- or farm-gate value of a product, whereas producers’ and purchasers’ prices include various mark-ups such as transport and trade margins, taxes, and subsidies. A full set of input-output tables may include many tables that assume the shapes shown in Figs. S1a and S1b, but contain different types of mark-ups. In unison, the three basic blocks expressed at basic prices as well as various valuations, provide an exhaustive picture of all money flows in an economy.

Input-output tables are used for input-output analysis, a versatile macroeconomic technique that is used in an enormously diverse range of applications, ranging from economic policy modelling, logistics and scheduling, key sector identification, environmental footprinting, structural decomposition, and life-cycle assessment [[3](#_ENREF_3), [4](#_ENREF_4)]. The unique feature of input-output analysis is that it uses the information on the interdependence of economic sectors in order to quantify complex, indirect repercussions, originating as a result of an initial economic activity, and then travelling along a vast supply-chain network. This capability is embodied in the famous inverse matrix conceived by Leontief [[5](#_ENREF_5)]. Well-known examples are carbon footprints that include the emissions consequences of all indirect supply-chain transactions resulting out of a single purchasing decision.

In a single-region input-output table, primary inputs include imports, and final demand includes exports. This is because in the context of a single region, foreign agents are not in intermediate, but at the extreme positions of supply chains. One input-output table variant that was already devised by Leontief [[6](#_ENREF_6)], but has only experienced intensive research and major breakthroughs throughout the past decade, are multi-region input-output (MRIO) tables. In essence, an MRIO table links many single-region input-output tables into one consistent account of intra-regional and inter-regional trade (Fig. S1c). Today, MRIO tables exist at the sub-national as well as the international level.



**Figure S1c:** Schematic of a 2-country section within an environmentally-extended multi-region input-output table, for the example of *r* = USA (supply-use table), and *s* = Uzbekistan (input-output table). ID = Intermediate demand, matrices **T** and **V**; FD = Final demand, matrix **y**; PI = Primary inputs, matrix **v**; IN = Industries, PR = Products.

When applied to MRIO tables, input-output analysis is more powerful than in single-region applications, simply because the MRIO database underlying the analytical techniques offers information on national production recipes as well as international trade relationships. This constitutes the main motivation behind developing ever-more detailed, ever-larger MRIO tables, and in particular the reason for developing the Eora MRIO database.

# Balancing and time series iteration

In the following we will denote MRIO table components for the year in valuation by , where *MRIO* = **T** (domestic input-output, use, or trade), **y** (final demand excluding exports), **v** (value added), **V** (supply tables), aggregate exports **e**, aggregate imports **m**, or imports matrices **M** (for intermediate use) and **N** (for final demand), indexed by exporting country *r*, importing country *s*, supplying sector *i*, and demanding sector *j*. We derive gross output **x** = **T1** + **y** + **e**, where **1** is a summation vector. The symbols **e** and **m** are used instead of **T***rs,r≠s* when we refer explicitly to exports or imports statistics. Sectors can be industries as well as commodities, depending on whether countries are represented by IIOT, CIOT or SUT. Sectors can also be value-added and final demand categories. A dot ∙ is used to denote summation over the replaced index instead of using the summation sign ****. A circle ° next to another index is used to denote summation over the replaced index, but excluding the adjacent index. We will denote valuation alternatively by script (pu – purchasers’ price, pr – producers’ price, ba – basic price, m*n* – margin *n*, tx – tax, sb – subsidy) or numeric indices. We will leave out the year index wherever it is not needed.

The time series is constructed iteratively, by starting with the 2000 initial estimate (chosen because this year provides the best overall availability of national input-output tables, per *SI Appendix*, Table S3), reconciling this with all 2000 constraints, and taking the solution as the initial estimate for 2001, and so on. Back-casting to 1990 proceeds similarly. A balanced table for one year will be an inappropriate initial estimate for the next year under strong economic growth. Therefore, we have constructed initial estimates by scaling all prior solutions with inter-year ratios specific to transactions (use, trade) **T**, final demand **y**, value added **v**, and supply tables **V**. These ratios were derived from country time series data on GDP, exports, imports, and value added[[7](#_ENREF_7)].

Balanced MRIO tables were obtained by specifying an initial estimate (vectorised as **a**0), and applying the quadratic programming approach by Van der Ploeg[[8](#_ENREF_8)]. Here, external constraint information **c** (often called “superior data”) are linear functions **c = C a + ** of the vectorised MRIO entries **a**, as well as disturbances **** that describe the constraint violation. We chose this approach because the disturbances allow effective handling of disparate, unaligned, conflicting and unreliable information[[9](#_ENREF_9), [10](#_ENREF_10)], and because signs and zeros are not necessarily preserved. The sign- and zero-preservation inherent in the variants of the RAS balancing method is undesirable because it does not allow account items such as net taxes and changes in inventories to switch signs, and it forces all variables connected to zero-valued constraints to zero without compromise.

Van der Ploeg extends **a** with the disturbances ****, to a compound unknown **p**, distributed as

 (S1)

with mean **p**0 = [**a**0 | 0], and variance **** = [****a | ****c]. Exactly known constraints are a special case with the corresponding element in ****c being zero. Extending **G** = [**C** | –**I**], where **I** is the unity matrix, and assuming that all covariance terms in ****vanish, the generalised optimisation problem becomes

Minimise *f* (**p**, **p**0, ****) subject to **G p** = **c** . (S2)

**S2.1 Quadratic Programming approaches**

One approach that has been used to reconcile large input-output tables and Social Accounting Matrices is Quadrat Programming [[8](#_ENREF_8)]. Here the objective function is *f* (**p**, **p**0) = (**p** – **p**0)’ -1 (**p** – **p**0). Setting up the Langrangean as *L* = (**p** – **p**0)’ -1 (**p** – **p**0) + ****(**Gp** – **c**), solving the first-order condition leads to analytical solutions **** = (**G****G**’)-1(**Gp;**0 – **c**) and **p** = **p**0 - **G**, however these do not guarantee any non-negativity that might need to be imposed on some elements. We therefore add inequality constraints *li* ≤ *pi* ≤ *ui* forcing the solution to lie within lower and upper bounds *li*, *ui* ∈ [–∞,+∞]. These lower and upper bounds result from definitions of accounting variables. For example, the bounds for changes in inventories are [–∞,+∞], those for subsidies are [–∞,0], and those for remaining MRIO elements are are [0,+∞].

The mixing of equality and inequality conditions precludes analytical solution, and requires sophisticated numerical solvers. Several commercial solvers were tested during Eora’s development phase. Most commercially available solvers such as CPLEX are designed to operate on a single processor leading to unacceptably long runtimes for the reconciliation of the Eora tables. We then focused on parallel optimisation and found that most parallel solvers such as PGAPack or PARAGenesis (which both apply the genetic algorithm) are not applicable to the reconciliation problem of the Eora tables. The GAMS modelling system (available at <http://www.gams.com/>), which is also popular for MRIO reconciliation, offers an optimiser that is not parallelisable. XPRESS (available at <http://www.fico.com/>) offers a parallel optimisation suite for a number of optimisation approaches such as linear programming, mixed-integer programming or quadratic programming. However, the large number of variables within the Eora tables exceeds the design boundaries of XPRESS by a factor of 1000. A parallel version of CPLEX is available for linear and quadratic programming. However, for linear programs, the problem is solved using different solvers in parallel (see <http://www-01.ibm.com/support/docview.wss?uid=swg21400049>). Each individual solver is executed serially on a single processor. The parallelization therefore doesn’t gain any speed-ups for the individual solvers offered by CPLEX. Detailed explanation on the parallelization of the CPLEX solver for quadratic programming is currently not provided on the CPLEX website (see <http://www.aimms.com/features/solvers/cplex>). However, at the time of writing CPLEX only supported linear constraints for quadratic programming, but not boundary constraints. Hence, CPLEX’s quadratic programming solver could not be applied to Eora’s particular optimization problem. During the earlier development of Aisha, a distributed-memory-type parallelisation of CPLEX using MPI was investigated. This approach proved to be unsuccessful because the communication overhead caused by the exchange of data between the different computing nodes eliminated any computational speedups obtained through multi-core parallelisation. A good overview of available optimisation packages is available at <http://www.mat.univie.ac.at/~neum/glopt/software_g.html>.

As a result of the unavailability of commercial solvers, we resorted to writing tailored QP solvers. At the time of writing, the AISHA tool offers two optimisation algorithms to solve van der Ploeg’s generalised optimisation problem for a quadratic objective function. The first one is a QP method described by Huang *et al* [[11](#_ENREF_11)], the second one is based on Cimmino’s Algorithm (see [[12](#_ENREF_12)]).

**S2.2 RAS variants**

AISHA also offers a RAS-type optimisation algorithm called KRAS (see [[10](#_ENREF_10)]), which is an extension of RAS that can be applied to RAS-type problems such as the one given in Equation S2, where the objective function is

Let *j* be the counter over the elements of **p** and the columns of **G**, let *i* be the counter over the rows of **G**, and let *n* be the current iteration step. Let *N* be the total number of elements in **p** and let *M* be the total number of constraints (which is equal to the number of rows in **G**). Let denote the Lagrange-multipliers. Setting up a Langrangean as

and solving the first-order condition leads either to either an iterative Gauss-Seidel-type adjustment scheme (GRAS variant) given by

and

with *i*=*n* mod *M,* or (via Bregman’s method; KRAS variant) to an updating condition

that requires solving a generalised polynomial

|  |  |  |
| --- | --- | --- |
|  |  | (S3) |

The main difference between KRAS and other RAS variants is that KRAS can handle conflicting constraints, by considering the provided reliability information during the optimisation process. Additionally KRAS is parallelisable, and can also handle sign flips and inequality constraints *li* ≤ *pi* ≤ *ui*. In comparison to QP algorithms, the coding of RAS variants is less complex, and their execution requires less RAM.

**S2.3 Comparison of optimisation objectives**

As shown in the two preceding sections, the reconciliation of an MRIO can be approached using different methods. The most common approaches are RAS-type methods, linear programming techniques and quadratic approaches such as van der Ploeg’s least-square method. Each approach can be motivated, and all of them have precedents within IO research and applications (see [[11](#_ENREF_11)]). However, obviously, each approach yields a different result. The magnitude of the differences between various methods depends highly on the nature of the constraints and the feasibility of the optimization problem. The more the initial estimate has the be adjusted by the optimisation routine in order to adhere to the externally given constraints, the more the results of various methods will differ from one another. Consider the 2-dimensional problem

Hence, in this case we have

The feasible set defined by are the points that lie on the blue line within the graph. The different objective functions for this example are:

The constraints equation can be used to express as a function of for the feasible set. We have

With this formulation we can express the objective functions as functions of the single variable on the feasible set (Fig S2a).

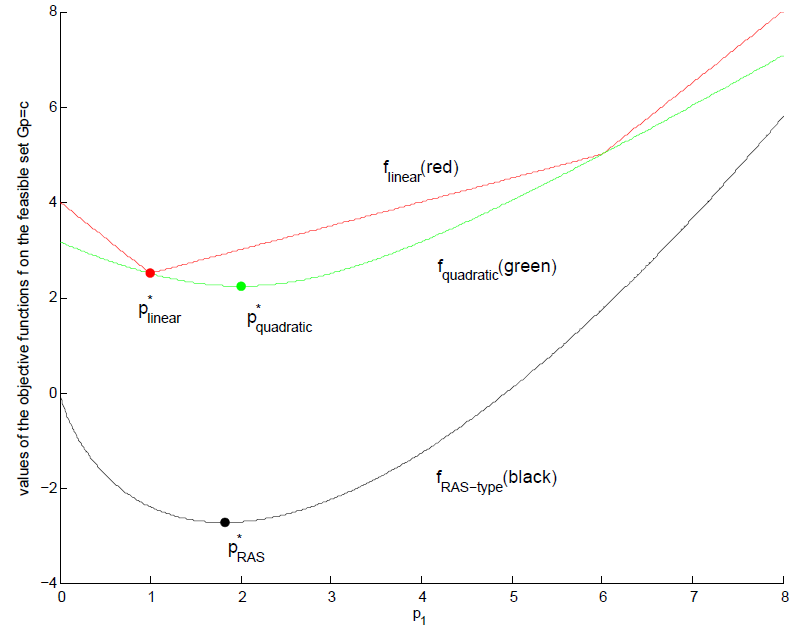


Fig S2a: Visualization of the values of the three different objective functions on the feasible set defined by as functions of . All three objective functions have their unique minima, however these are different from one another. The values of the objective functions do not give any indication whether a particular objective function is more suitable for the 2-dimensional problem than others.

We observe that the values for optimal solutions of the different objective functions are different. The optimal values can be used to calculate corresponding values to find the solutions on the feasible set given by . Fig S2a shows the three different solutions together with the feasible set and the initial estimate in the plane.

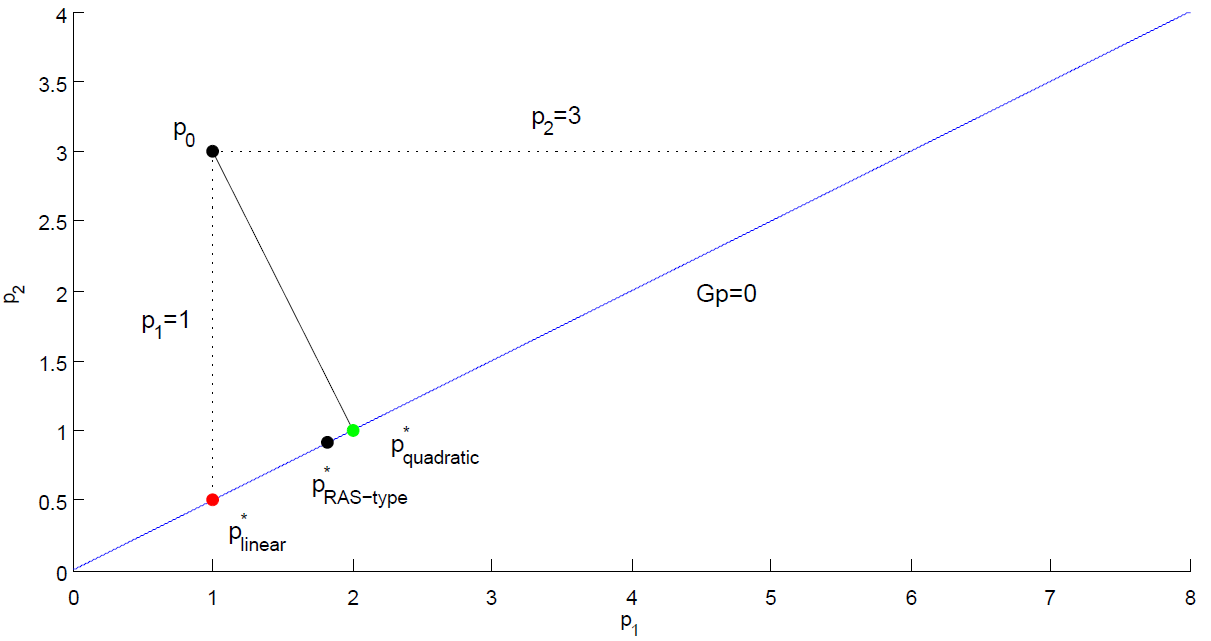


Fig S2b: Visualization of the different solutions of the 2-dimensional problem posed above, for different optimization methods. The blue line represents the set of feasible points defined by the equation , **p**0 is the initial estimate. The colors for the solutions of the different approaches are the same as in plot Fig S2a: The red dot represents the solution for the linear approach, the black dot on the blue line for the RAS-type approach, and the green dot for the quadratic programming method. The line connecting the initial estimate and the result of the quadratic approach is perpendicular to the set of feasible points, and hence intuitively the “shortest” distance.

The solution to the quadratic approach is usually the one that we will interpret as the “best” solution, because it is the point “closest” to the blue line in a Euclidean sense. Also, only the quadratic approach yields the solution that represents the minimal absolute distance between the initial estimate and **p**0 the blue line.

The solution for the linear programming approach has a similar yet slightly less intuitive explanation. A linear programming approach uses a so-called 1-type norm to measure the distance between two points. For this 2-dimensional example, the 1-norm only allows the movement along the grid lines of the 2-dimensional plane when measuring the distance between two points. The distance between the initial estimate and any point on the blue line is measured by adding the distance in p1–direction and the distance in p2–direction. In this problem, the minimal distance in a 1-norm sense is achieved if the point on the blue line and the initial estimate have the same p1–coordinate. That way, no additional distance into the p2–direction has to be added to the 1-norm of the distance between the points. Another popular example to motivate the 1-norm is that of a taxi driver in Manhattan (see <http://en.wikipedia.org/wiki/Taxicab_geometry>): If we consider that Manhattan’s streets are made up by a perfect grid of streets in North-South direction and by streets in East-West direction, then a taxi driver who wants to driver between two arbitrary intersections within the grid has to measure the distance between those intersection by adding up the distances that he has to travel in North-South direction and in East-West direction. This is exactly the 1-norm between the two intersections. The taxi driver cannot travel the direct way between the two intersections (which would measure the distance between the two intersections in the 2-norm), as this might require travelling diagonally through the grid, which is obviously impossible.

RAS-type functions do not measure an intuitive distance between different points within a space, but an information loss that occurs when moving from one point to the other. Bacharach [[13](#_ENREF_13)] goes into great detail motivating this information loss interpretation of the RAS objective function.

# Initial estimate

Considering that the estimation of our MRIO (and in fact most IO tables) from external constraints is an underdetermined problem, it is worth constructing an initial estimate that is as realistic as possible. For the 187 countries in our MRIO, data availability is vastly different, so that if not carefully planned, setting up an initial estimate can be hampered by case-dependent manual operations. In order to avoid time-consuming labour, we aim at setting up an initial estimate in a way that uses a) the same data source for all countries, b) as much specific data and as little proxy data as possible. We use: First, the National Accounts Main Aggregates Database (MA[[7](#_ENREF_7)]), containing final demand (; 4 categories *l*) in purchasers’ prices, and value added (; 7 sectors *j*) in basic prices, imports () and exports () valued f.o.b.; second, the UN National Accounts Official Data (OC[[14](#_ENREF_14)]) containing data on gross output and intermediate demand , and additional detail for final demand (; 6 categories *l*) in purchasers’ prices, and value added (; 18 sectors *j*) in basic prices; and third the UN ComTrade international trade data (CT[[15](#_ENREF_15)]) containing exports valued f.o.b. and imports . (Table S1).

Table S1: Summary of data for each data sources

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Data sources** | **Abbreviation of data sources** | **Data** | **Formula of data** | **Number of categories** | **Price** |
| National Accounts Main Aggregates Database | MA | final demand |  | 4 | purchasers’ prices |
| value added |  | 7 | basic prices |
| imports |  | 1 | f.o.b. |
| Exports |  | 1 | f.o.b. |
| UN National Accounts Official Data | OC | gross output |  | 1 | basic prices |
| intermediate demand |  | 1 | purchasers’ prices |
| final demand |  | 6 | purchasers’ prices |
| value added |  | 18 | basic prices |
| UN ComTrade | CT | exports |  | About 5000 (HS 6-digits) | f.o.b. |
| Imports |  | About 5000 (HS 6-digits) | . |

## SUTs and IOTs

We construct the diagonal intra-national transaction blocks of the initial estimate according to

(S3a)

(S3b)

(S3c)

, (S3d)

where MA and OC denote the source of the data.[[1]](#footnote-1) Equation S3 shows that the magnitudes of each country’s initial estimate **T**, and () are determined by each country’s value of () in the MA database and the ratios in the OC database. The sectoral structure of the initial estimate is determined by proxies , , , and in all valuations.

We use the most detailed and diverse tables – from the USA, Japan and Australia – to construct generic 25-sector “international” SUT proxies, which we use for all “common-classed” countries. We used Japan, Australia and USA for two reasons. The first reason is sector detail; all three countries have input-output tables with more than 344 sectors. We have not used China’s input-output table, because this table only has 122 sectors, and the intersection of four national IO tables would have included very few sectors. The second reason is the coverage of commodities. Peters and Hertwich [[17](#_ENREF_17)] chose other countries’ input-output structure based on similar per capita energy use, CO2 emissions, and GDP. However, even if country A’s per capita GDP is similar to country B’s per capita GDP the economic structure of country A and B could be completely different. If country A did not produce the main products of country B, embodied emission could change considerably. Therefore, an important criterion is for the basic table structure to cover a wide variety of industries and commodities. The three countries we chose are suitable in this sense because these cover a wide range of industries and commodities such as agriculture, mining, manufacturing and service. This is supported in a study by Andrew et al [[18](#_ENREF_18)] who found that in constructing an MRIO, modelling a Rest-of-World (RoW) region on the basis of many countries’ input-output tables is preferable to choosing a “representative” country. Our approach in choosing a generic proxy for (RoW) countries without input-output tables follows the same principle. In the future we aim at adding more countries to the SUT proxies. Finally, other studies used approaches similar to ours. For example, Weber and Matthews [[19](#_ENREF_19)] and Ahmad and Wyckoff [[20](#_ENREF_20)] assumed that the rest of the world has the same structure and emission intensity as the US economy.

Each valuation ( in the equations) is determined by the ratios of these “common-based” countries. The initial estimates for the “separately-classed” countries, where national input-output tables exist in a classification that is more detailed than our common 25-sector classification, are constructed from the most suitable IIOT, CIOT, or SUT proxies, that is from any available table for that country that is closest in terms of year and valuation. In cases where national information on separately-classed is incomplete (for example for certain valuations) we also use the 3-country proxies.

## International trade in goods

The accepted approach to estimating international trade matrices in an MRIO table is via trade coefficients that are a function of the exporting country *r*, the importing country *s*, the exporting sector *i*, and the importing sector *j*. The absolute value of trade flows can then be written as , where is some absolute measure of trade from *r* or into *s*. The data available to enumerate this equation are imports matrices included in the input-output tables of some importing countries *s*, and trade statistics (exports or imports; ) such as from Eurostat[[21](#_ENREF_21)], IDE/JETRO[[22](#_ENREF_22)], OECD[[23](#_ENREF_23)], and UN ComTrade [[15](#_ENREF_15)].

There are however a few hurdles to overcome. First, neither database gives a complete picture of trade, because in the national imports matrices there is no information on the exporting country, and in the trade databases there is no information on the using sector. Second, imported commodities {*i*} in the trade database are usually classified differently to the imported commodities {} in the national input-output tables of the importing country *s*. A “trade-to-importing country” concordance matrix is necessary to bridge the two classification systems. Further, the international trade blocks have to adhere to the row classification {} of exporting country *r*’s input-output tables, which again usually does not coincide with the commodity classification {} of the trade database, requiring a second “exporting-country-to-trade” concordance matrix . Third, import and export data from various sources are inconsistent (Figs. S3a-b). Discrepancies can be due to valuation (usually exports are valued f.o.b., and imports c.i.f.), incompleteness with regard to trade in services, transactions coverage (for example Japan excludes transactions smaller than ¥200,000), exchange rates fluctuations, temporal delay between export and import leading to different recorded years, differences in accounting periods (for example India’s accounts April to March), and differences in recorded regions (for example if Japan exports to Hong Kong, the import may be recorded as ‘China’ not ‘Hong Kong’; or, an export to the British Virgin Islands may be recorded as ‘Great Britain’ or ‘Virgin Islands’) [[24-26](#_ENREF_24)]. As a consequence, national imports matrices are generally preferred for representing absolute trade flow, and trade statistics are only used for allocating across trade partners [[27](#_ENREF_27)].



**Figure S3a:** Distribution of export/import ratios across magnitudes of trade flows . As expected, the distribution peaks around (Following Ahmad and Wyckoff’s [[20](#_ENREF_20)] assumption that 10% of f.o.b. import value reflects insurance and freight costs, or f.o.b. × 0.9 = c.i.f) however inconsistent ratios and an accumulation of what appears to be severe reporting errors exist for many small transactions.



**Figure S3b:** Distribution of export/import ratios and across magnitudes of trade flows and . As expected, the distributions peak around however inconsistent ratios and an accumulation of what appears to be severe reporting errors exist for small transactions even after summing over importing or exporting countries. Plotting by traded commodity against gives even worse results.

These three circumstances necessitate a general formulation for estimating international transaction from incomplete data, with the term used for modeling the sectoral use structure, and the term used for modelling the country origin structure of traded commodities. The concordance matrices have to adhere to certain normality conditions; most importantly, the rowsum or column sum should be 1, so that the total value of the aggregated matrix still equals the total value of the original matrix. We construct the off-diagonal international transaction blocks of the initial estimate according to[[2]](#footnote-2)

(S4a)

(S4b)

(S4c)

(S4d)

(S4e)

(S4f)

(S4g)

(S4h)

where

are the two structure terms used in the set of Equations S4. In the equation for margins *n*=1:2, we use the trade (trd) and transport (tra) sectors in the UN SNA Main Aggregates database to distribute across margin types. We use , because we assume that international margins are equally likely to be supplied by the supplying or receiving country. We use a total aggregate of the cif-to-fob scaler throughout because disaggregated ratios proved to fluctuate excessively (see Figs. S4a-b). Where national imports matrices and are not available, we approximate

and . (S5)

The equations in this section show that national imports matrices are key data items for estimating country-pair-specific trade matrices by pro-rating across countries of origin and using sectors.

Eq. S4a basically means that we estimate the international trade block in basic (factory or farm gate) prices by disaggregating the import matrix (M) using bilateral trade data for describing the imports origin structure (os) for each importing country. Two obstacles in this estimation are that a) the raw import matrix is expressed in c.i.f. (cost-insurance-freight) prices, and that b) the exporting country’s classification is not same as the importing country’s classification. Therefore, we first convert c.i.f. prices to f.o.b. (free-on-board) prices using COMTRADE data for deriving c.i.f.-to-f.o.b. scalers, and then convert f.o.b. prices to basic prices using national IO table for deriving f.o.b.-to-basic-price scalers. We change the import matrix’s origin structure to match the exporting country’s classification using concordance matrix and COMTRADE’s bilateral trade data. Some countries do not report their exports and imports to COMTRADE. In this case, we have used other country’s reports to approximate the origin structure. For example, if Iran doesn’t provide data for imports from Japan then we used exports from Japan to Iran that Japan reports to COMTRADE.

## International trade in services

The ComTrade database[[15](#_ENREF_15)] does not include trade in services. We added service sectors at the end of all concordance, and use

(S6)

(S7)

as the origin structure term. As an initial estimate of the service trade we used commodity import and export ratios. The ensuing relationships are analogous to Equations S4a–f.

## Re-exports

According to the United Nations[[28](#_ENREF_28)], “*exports of a country can be distinguished as exports of domestic goods and exports of foreign goods. The second class is generally referred to as re-exports*”. Similarly, “*imports can be distinguished as imports of foreign goods and imports of domestic goods. Import of domestic goods is referred as re-imports*”. Re-exports and re-imports can cause some of the inconsistencies of trade data, so that their explicit inclusion into the MRIO leads to less data conflict. Therefore we added only one column (row) of re-exports (re-imports) into our MRIO. We construct re-export initial estimates (rows) according to

*,* (S8)

whereis the total number of sectors in country *r*’s classification, andare total re-exports of country *r.* Re-import initial estimates (columns, into intermediate demand only) can be expressed as

,(S9)

whereis the total number of sectors in country *s*’s classification. Finally, the row and column sum balance reads

***.***(S10)

## FISIM

Some financial intermediaries defray cost and generate profits through imposing borrowing and lending rate differentials on the capital they service, thus avoiding direct transactions with customers. In such cases financial intermediation services are indirectly measured (FISIM). Whilst the SNA 1968 stipulates to record such estimated output as the intermediate consumption of a nominal industry, the SNA 1993 allows allocating FISIM across using sectors[[1](#_ENREF_1)]. Reporting practices differ amongst countries: the UK’s accounts always include a nominal FISIM sector, Japan’s accounts have FISIM always allocated across users, and Spain switched from nominal FISIM sector to user allocation between 1999 and 2000. On one hand there is no information to transform one practice into the other. On the other hand FISIM are not negligible, hence they must be included to avoid severe account imbalances. We have hence decided to always include a nominal FISIM sector into our MRIO classification, and to leave this sector empty where FISIM is allocated across users. Note that in cases such as Spain, this can lead to sharp discontinuities over time when practices are changed. In order to eliminate such discontinuities we follow a procedure suggested by EUROSTAT, which is to spread total FISIM to using industries proportionally to their share of gross output, and reduce the operational surplus of each industry by the pro-rated amount.

# Concordances and maps

In order to carry out calculations on trade blocks most effectively, we link national product classifications (NPC; *N*C classes for country C) to the 6-digit subheadings of the OECD Harmonised System (HS6; *N*HS6 classes), and store those as *N*C x *N*HS6 sparse binary matrices. The link is established directly for countries where a NPC-HS6 concordance is provided. Alternatively, we have produced NPC-HS623 concordances in a two-step process via either NPC↔ISIC (International Standard Industrial Classification of All Economic Activities) and ISIC↔HS6 or NPC↔CPC (Central Product Classification) and CPC↔HS6. In case of trade in services, we use the CPC service classification instead of the Harmonised System.

Binary concordance matrices **C** cannot be used to convert vectors **v** from one to another classification (via matrix multiplication **v**’ = **Cv**), because multiple correspondences of an aggregate product in the disaggregated classification mean that **C** is not normalised, so that **v**’ would have a row sum different to that of **v**. In order to enumerate the trade blocks of our MRIO (Equations S4a-f), we require both row- and column-normalised mapping matrices, or maps. We calculate these maps from concordances by pro-rating with a suitable proxy trade variable (see Text S4.2). In most cases, HS6 is always more detailed than national input-output classification, so that the correspondence is unique, and the binary concordance matrix is already normalised to distribute HS6-classed data across national classes, and only needs to be normalised to distribute national-classed data across HS6. This is achieved by using HS6 import data as a proxy. In a few cases (notably Japan and the USA), parts of the national input-output classifications are more detailed than HS6, thus requiring a second normalisation to distribute HS6-classed data across national classes.

Problems with concordances appear especially when sector classifications aggregate sectors that are substantially different in nature. For example, some databases do not separate electricity generation from electricity distribution, presumably because these services are offered by the same utility company. In these cases, one cannot even clearly delineate pure goods from pure services, let alone uniquely concord such a classification to ISIC or HS, since electricity is generally included in the category "goods" whilst its distribution is classed a "service". The only remaining solution is to aggregate electricity distribution into electricity generation. For example, the UN National Accounts Official Country database provides the totals for both goods and services exported and imported, and the Eora tables use these data as four constraints per country. If one country features an aggregate electricity generation/distribution sector, we would strictly speaking need to aggregate these four constraints into two total export and import constraints. To avoid such a loss of detail, we regard electricity distribution as a good, like electricity, enabling us to keep goods and services export and import data as separate constraints.

## Normalisation of concordance matrices used for trade flow estimation

The form in Equations S4 and S5 must adhere to the normalisation

, (S11)

or

. (S12)

The equality in Equation S11 can be fulfilled if

. (S13)

This is because

. (S14)

Here, the are the row sums of re-classified from row classification {} into trade database classification {}. The three conditions in Equation S14 have the form of weighted sums over and . Summing the first conditions over *i* yields

, (S15)

from which we can deduce the normalisation condition on as

(S16)

Expressed in words, this condition says that each commodity in the national input-output tables of importing country *s* must be fully and uniquely allocated to one or more trade classes . Summing the second condition over yields

, (S17)

from which we can deduce the normalisation condition on as

(S18)

Expressed in words, this condition says that each trade class in the trade database must be fully and uniquely allocated to one or more commodities in the national input-output tables of exporting country *r*.

Both concordance matrices hence have to be normalised so that their column sums equal 1. This is a direct consequence of the choice of the national imports matrix as a scaler, since this imports matrix is located at the right hand side of the product in Equation S12, and its summed value has to be preserved.

## Creation of maps from concordances

Let **C** be a *n* × *m* binary concordance matrix. Let *m* > *n*, so that the columns of **C** contain the disaggregated classification. Then, there will be rows *i* of **C** with . During the normalisation of **C** to a map, these rows have to be scaled so that . Let **x***m* be a row vector containing the *m*-classed proxy variable to be used for pro-rating, and be the diagonal matrix corresponding to **x***m*. Using an *m*-classed summation vector **1***m*, the *n*-classed representation of **x***m* can be written as. The row-normalised map (row map) corresponding to **C** is then . Column-normalisation proceeds similarly.

# A small example

Here we provide a simplified small example showing how we treat conflicting data, time series data, different sector detail, and so on. Further detail is provided in this paper and also in reference [[29](#_ENREF_29)].

Assume we have data for a 3-sector IO table in 2000 (Table S5.1), a 2-sector intermediate demand matrix in 2001 (Table S5.2), and a 1-sector final demand and value added scalar in 2000 and 2001 (Table S5.3).

Table S5.1 2000 input-output table

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Primary industry | Secondary industry | Services | Final demand |
| Primary industry | 10 | 1 | 3 | 10 |
| Secondary industry | 3 | 20 | 4 | 15 |
| Services | 1 | 5 | 10 | 20 |
| Value added | 10 | 16 | 19 |  |

Table S5.2 2001 input-output table

|  |  |  |
| --- | --- | --- |
|  | Goods | Services |
| Goods | 40 | 9 |
| Services | 7 | 11 |

Table S5.3 Final demand and value added in 2000 and 2001

|  |  |
| --- | --- |
| Total final demand in 2000 | 50 |
| Total value added in 2000 | 50 |
| Total final demand in 2001 | 60 |
| Total value added in 2001 | 60 |

We use the 3-sector IO table in 2000 for the year 2000 initial estimate. Then we write the data in Tables S5.2 and S5.3 as additional constraints. The optimizer handles the MRIO table as a vector (*SI Appendix*, Text S2, above) so we vectorize the initial estimate **a** as

(1)

In 2000, we have constraints for total final demand and value added,

(2)

Total final demand corresponds to “1” values (in grey) in Table S5.4,

Table S5.4 Final demand correspondence

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Primary industry | Secondary industry | Services | Final demand |
| Primary industry | 0 | 0 | 0 | 1 |
| Secondary industry | 0 | 0 | 0 | 1 |
| Services | 0 | 0 | 0 | 1 |
| Value added | 0 | 0 | 0 |  |

and the total value added corresponds to the “1” values (grey) in Table S5.5,

Table S5.5 Value added correspondence

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Primary industry | Secondary industry | Services | Final demand |
| Primary industry | 0 | 0 | 0 | 0 |
| Secondary industry | 0 | 0 | 0 | 0 |
| Services | 0 | 0 | 0 | 0 |
| Value added | 1 | 1 | 1 |  |

So we can vectorize and transpose these two binary correspondence matrices to create the constraint equation rows in **G** for the two constraints established at step (2):

(3)

Following the optimization problem formulated in Text S2 and Eqs 1-3 we establish the following problem to find a solution (where is the MRIO table **a** extended with slack variables **** to allow deviation from prescribed constraint values **c**, as described in Text S2) that fulfils all constraints,

(4)

Of course, our study considers other problems such as upper and lower bounds and data uncertainty, but for simplicity we will not cover these situations in this example. In 2001, we use the 2000 MRIO solution as an initial estimate for the 2001 MRIO.

The aggregated 2-sector intermediate demand matrix for 2001 is handled in the same way. The constraints for the 2001 MRIO would include

(5)

(6)

For example, the first element of the intermediate demand matrix in 2001 (40 in Table S5.2) corresponds to four data points in the initial estimate MRIO as seen in Table S5.6:

Table S5.6 Intermediate demand correspondence example

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Primary industry | Secondary industry | Services | Final demand |
| Primary industry | 1 | 1 | 0 | 0 |
| Secondary industry | 1 | 1 | 0 | 0 |
| Services | 0 | 0 | 0 | 0 |
| Value added | 0 | 0 | 0 |  |

Using the 2000 solution as an initial estimate and the 2001 constraints we can solve the optimization problem and arrive at a 2001 MRIO solution. Using this approach we can treat any data as constraints in an input-output table with any level of sector detail.

This example shows only one sheet (basic prices) for simplicity, but our study has 5 price sheets (basic price, taxes on products, subsidies on products, trade margin, and transport margin) as illustrated in Figure S5a.

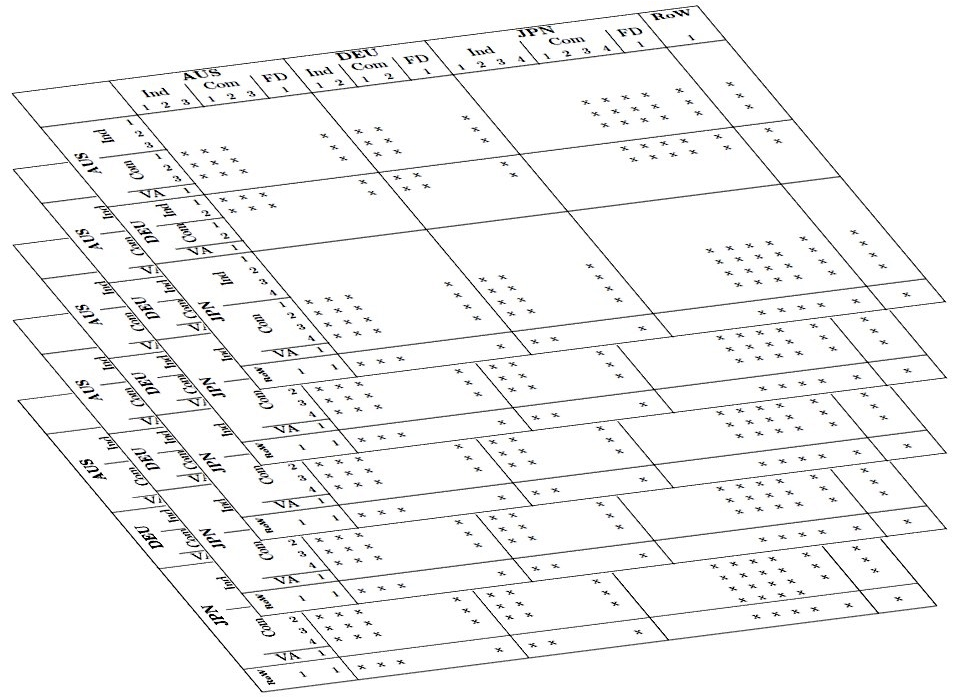


Figure S5a: Stack of input-output tables representing basic prices, margins and taxes.

# National IO Table Data Sources

We have used following national input-output tables. We showed only primary data sources for each country to avoid duplication. In addition to these tables, we have used Eurostat [[21](#_ENREF_21)], IDE/JETRO[[22](#_ENREF_22)], OECD[[23](#_ENREF_23)] database.

**Aruba**

Central Bureau of Statistics Aruba. (2002). Supply and use table 1995-2000. *National Accounts of Aruba, 1995-2000*. Retrieved November 16, 2010, from <http://www.cbs.aw/cbs/manageDocument.do?dispatch=view&id=488>

Central Bureau of Statistics Aruba. (2002). Supply and use table 1995-1998. *National Accounts of Aruba, 1995-1998*. Retrieved November 16, 2010, from <http://www.cbs.aw/cbs/manageDocument.do?dispatch=view&id=487>

Central Bureau of Statistics Aruba. (2003). Supply and use table 1999-2002. *National Accounts of Aruba, 1999-2002*. Retrieved November 16, 2010, from <http://www.cbs.aw/cbs/manageDocument.do?dispatch=view&id=489>

Central Bureau of Statistics Aruba. (2007). Supply and use table 2000. *National Accounts of Aruba, 2000 - 2006*. Retrieved November 16, 2010, from <http://www.cbs.aw/cbs/manageDocument.do?dispatch=view&id=1220>

**Netherlands Antilles**

Central Bureau Of Statistics Netherlands Antilles. (2009). The Supply and Use Table 2004 Netherlands Antilles. Retrieved November 16, 2010, from [http://www.cbs.an/files/SUS NA 2004.pdf](http://www.cbs.an/files/SUS%20NA%202004.pdf)

**Argentina**

Instituto Nacional de Estadística y Censos. (2001). Matriz de Insumo - Producto Argentina 1997 (MIPAr97).

**Armenia**

Armenian Statistical Service of Republic of Armenia. (n.d.). Supply & Use tables Armenia 2006.

**Australia**

Australian supply and use tables 1990-2007; Wood, R., Construction, stability and predictability of an input-output time-series for Australia. *Economic Systems Research* **2011,** *23*, (2), 175-211.

**Austria**

Eurostat. (2009). ESA 95 Supply, Use and Input-Output tables. Retrieved April 30, 2009, from <http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95_supply_use_input_tables/data/workbooks>

**Belgium**

Eurostat. (2009). ESA 95 Supply, Use and Input-Output tables. Retrieved April 30, 2009, from <http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95_supply_use_input_tables/data/workbooks>

**Bolivia**

INSTITUTO NACIONAL DE ESTADÍSTICA. (n.d.). Bolivia: MATRIZ DE INSUMO-PRODUCTO 1999-2002.

**Brazil**

Lenzen, M.; Pinto de Moura, M. C.; Geschke, A.; Kanemoto, K.; Moran, D. D., A cycling method for constructing input-output table time series from incomplete data. *Economic Systems Research* **2012,** *24*, accepted.

**Canada**

OECD. (2006). The OECD Input-Output Database: 2006 edition. Retrieved from http://www.oecd.org/sti/inputoutput/

OECD. (2009). The OECD Input-Output Database: 2009 edition. Retrieved from http://www.oecd.org/sti/inputoutput/

**Switzerland**

Swiss Statistics. (2009). Tableau Input-Output 2001. Retrieved June 3, 2009, from <http://www.bfs.admin.ch/bfs/portal/fr/index/themen/04/02/01/dos/02.html>

Swiss Statistics. (2009). Tableau Input-Output 2005. Retrieved June 3, 2009, from <http://www.bfs.admin.ch/bfs/portal/fr/index/themen/04/02/01/dos/02.html>

**Chile**

Banco Central de Chile. (n.d.). DE LA MATRIZ INSUMO-PRODUCTO 1996.

Banco Central de Chile. (n.d.). Matriz de insumo-producto 2003.

**China**

National Bureau of Statistics of China. (2006). *Input-output table of China 2002*. Beijing: China Statistical Publishing House.

National Bureau of Statistics of China. (n.d.). Input-output table of China 1990, 1992, 1995, 1997, 2000, 2002, 2005, 2007.

**Columbia**

Departamento Administrativo Nacional de Estadistica. (n.d.). Matriz de utilización de productos 2000-2007.

Departamento Administrativo Nacional de Estadistica. (n.d.). Matriz oferta de productos 2000-2007.

**Czech Republic**

Eurostat. (2009). ESA 95 Supply, Use and Input-Output tables. Retrieved April 30, 2009, from <http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95_supply_use_input_tables/data/workbooks>

**Germany**

Statistisches Bundesamt. (n.d.). Input-Output-Tabelle 1991-2006.

**Denmark**

Statistics Denmark. (2009). Danish annual Input-Output tables 1990 - 2006. Retrieved May 21, 2009, from <http://www.dst.dk/HomeUK/Statistics/ofs/NatAcc/IOTABLES.aspx>

**Ecuador**

BANCO CENTRAL DEL ECUADOR. (n.d.). Supply and use table 2000-2007.

**Spain**

National Statistics Institute. (2010). Spanish National Accounts: Input-output Framework 1995-2006. Retrieved February 15, 2010, from <http://www.ine.es/jaxi/menu.do?type=pcaxis&path=/t35/p008&file=inebase&L=1>

**Estonia**

Eurostat. (2009). ESA 95 Supply, Use and Input-Output tables. Retrieved April 30, 2009, from <http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95_supply_use_input_tables/data/workbooks>

**Finland**

Eurostat. (2009). ESA 95 Supply, Use and Input-Output tables. Retrieved April 30, 2009, from <http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95_supply_use_input_tables/data/workbooks>

**France**

Eurostat. (2009). ESA 95 Supply, Use and Input-Output tables. Retrieved April 30, 2009, from <http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95_supply_use_input_tables/data/workbooks>

**UK**

Wiedmann, T., Wood, R., Lenzen, M., Minx, J. C., Guan, D., & Barrett, J. (2008). Development of an Embedded Carbon Emissions Indicator. London. Retrieved from <http://www.defra.gov.uk/environment/business/scp/research/themes/theme1/scale0708.htm>

Office for National Statistics. (2011). United Kingdom Input-Output Analytical Tables 2005. Office for National Statistics.

**Georgia**

GEOSTAT. (n.d.). Supply and use tables 2006-2008.

**Greenland**

Statistics Greenland. (1998). Input-output tabeller og multiplikatorer for Grønland 1992.

Statistics Greenland. (n.d.). Input-output tabel for 2004.

**Greece**

Eurostat. (2009). ESA 95 Supply, Use and Input-Output tables. Retrieved April 30, 2009, from <http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95_supply_use_input_tables/data/workbooks>

**Hong Kong**

Tormey, J. (1993). Creating Synthetic Single Region Input-Output Data for SALTER: Hong Kong and the Rest of the World. Canberra.

**Hungary**

Eurostat. (2009). ESA 95 Supply, Use and Input-Output tables. Retrieved April 30, 2009, from <http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95_supply_use_input_tables/data/workbooks>

**Indonesia**

IDE-JETRO. (2005). *Asian International I/O Table 2000*.

**India**

Ministry of Statistics and Programme Implementation. (2009). Input-Output Transactions Table for India 1993-1994. Retrieved June 3, 2009, from <http://mospi.nic.in/mospi_cso_rept_pubn.htm>

Ministry of Statistics and Programme Implementation. (2009). Input-Output Transactions Table for India 1998-1999. Retrieved June 3, 2009, from <http://mospi.nic.in/mospi_cso_rept_pubn.htm>

Ministry of Statistics and Programme Implementation. (2009). Input-Output Transactions Table for India 2003-2004. Retrieved June 3, 2009, from <http://mospi.nic.in/mospi_cso_rept_pubn.htm>

Ministry of Statistics and Programme Implementation. (2009). Input-Output Transactions Table for India 2006-2007. Retrieved June 3, 2009, from <http://mospi.nic.in/mospi_cso_rept_pubn.htm>

**Ireland**

Eurostat. (2009). ESA 95 Supply, Use and Input-Output tables. Retrieved April 30, 2009, from <http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95_supply_use_input_tables/data/workbooks>

**Iran**

Statistical center of Iran. (n.d.). INPUT-OUTPUT TABLES FOR IRAN 2001.

Statistical center of Iran. (n.d.). INPUT-OUTPUT TABLES FOR IRAN 1991.

**Israel**

Central Bureau of Statistics Israel. (2002). Input-Output Tables - 1995. Retrieved from

Central Bureau of Statistics Israel. (2010). Supply and Use Table 2005 and Supply Table 2006-2007. Retrieved October 29, 2010, from <http://www.cbs.gov.il/webpub/pub/text_page_eng.html?publ=62&CYear=2007&CMonth=1>

Central Bureau of Statistics Israel. (2010). Supply and Use Table 2004 and Supply Table 2005-2006. Retrieved October 29, 2010, from <http://www.cbs.gov.il/webpub/pub/text_page_eng.html?publ=62&CYear=2006&CMonth=1>

Central Bureau of Statistics Israel. (2010). SUPPLY AND USE TABLE 2000 AND SUPPLY TABLE 1995-2003. Retrieved October 29, 2010, from <http://cbs.gov.il/www/publications/supply_tables03/supply_tables_e.htm>

**Italy**

Eurostat. (2009). ESA 95 Supply, Use and Input-Output tables. Retrieved April 30, 2009, from <http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95_supply_use_input_tables/data/workbooks>

**Japan**

Ministry of Internal Affairs and Communications. (1994). 1990 Input-Output Tables for Japan. Research Institute of Economy, Trade and Industry.

Ministry of Internal Affairs and Communications. (1999). 1995 Input-Output Tables for Japan. Research Institute of Economy, Trade and Industry.

Ministry of Internal Affairs and Communications. (2004). 2000 Input-Output Table for Japan. Research Institute of Economy, Trade and Industry.

Ministry of Internal Affairs and Communications. (2009). 2005 Input-Output Tables for Japan. Retrieved May 9, 2009, from <http://www.e-stat.go.jp/SG1/estat/List.do?bid=000001019588&cycode=0>

**Kazakhstan**

Müller, M. *Central Asian Input-Output Tables*; Personal communication July 2011; Zentrum für Entwicklungsforschung, Rheinische Friedrich-Wilhelms-Universität: Bonn, Germany, 2011.

**Kenya**

IFPRI. (2010). Social Accounting Matrices. Retrieved December 17, 2010, from <http://www.ifpri.org/>

**Kyrgyzstan**

Müller, M. *Central Asian Input-Output Tables*; Personal communication July 2011; Zentrum für Entwicklungsforschung, Rheinische Friedrich-Wilhelms-Universität: Bonn, Germany, 2011.

**Korea**

The Bank of Korea. (2009). 1990 Benchmark Tables. Retrieved November 19, 2009, from <http://ecos.bok.or.kr/>

The Bank of Korea. (2009). 1995 Benchmark Tables. Retrieved November 19, 2009, from <http://ecos.bok.or.kr/>

The Bank of Korea. (2009). 2000 Benchmark Tables. Retrieved November 19, 2009, from <http://ecos.bok.or.kr/>

The Bank of Korea. (2009). 2003 Benchmark Tables. Retrieved November 19, 2009, from <http://ecos.bok.or.kr/>

The Bank of Korea. (2009). 2005 Benchmark Tables. Retrieved November 19, 2009, from <http://ecos.bok.or.kr/>

The Bank of Korea. (2009). 1993 Updated Tables. Retrieved November 19, 2009, from <http://ecos.bok.or.kr/>

The Bank of Korea. (2009). 1998 Updated Tables. Retrieved November 19, 2009, from <http://ecos.bok.or.kr/>

The Bank of Korea. (2009). 2006 Updated Tables. Retrieved November 19, 2009, from <http://ecos.bok.or.kr/>

The Bank of Korea. (2009). 2007 Updated Tables. Retrieved November 19, 2009, from <http://ecos.bok.or.kr/>

**Kuwait**

Central Statistical Office. (n.d.). National Accounts Statistics Input & Output Tables 2000.

**Lithuania**

Eurostat. (2009). ESA 95 Supply, Use and Input-Output tables. Retrieved April 30, 2009, from <http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95_supply_use_input_tables/data/workbooks>

**Luxemburg**

Eurostat. (2009). ESA 95 Supply, Use and Input-Output tables. Retrieved April 30, 2009, from <http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95_supply_use_input_tables/data/workbooks>

**Latvia**

Eurostat. (2009). ESA 95 Supply, Use and Input-Output tables. Retrieved April 30, 2009, from <http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95_supply_use_input_tables/data/workbooks>

**Mauritania**

Central Statistical Office. (2009). Supply and Use Table: The Mauritian Economy - 2002. Retrieved May 13, 2009, from <http://www.gov.mu/portal/goc/cso/indicate_1.htm>

Central Statistical Office. (2010). Supply and Use Table: The Mauritian Economy - 1997. Retrieved October 28, 2010, from <http://www.gov.mu/portal/goc/cso/indicate_1.htm>

**Maldives**

Department of National Planning. (2010). Supply and Use Tables for Maldives 1997. Retrieved October 28, 2010, from <http://www.planning.gov.mv/>

**Mexico**

Instituto Nacional de Estadística y Geografía. (n.d.). Matriz de Insumo-Producto 2003.

**Macedonia**

Eurostat. (2009). ESA 95 Supply, Use and Input-Output tables. Retrieved April 30, 2009, from <http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95_supply_use_input_tables/data/workbooks>

**Malta**

Eurostat. (2009). ESA 95 Supply, Use and Input-Output tables. Retrieved April 30, 2009, from <http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95_supply_use_input_tables/data/workbooks>

**Mongolia**

National Statistical Office. (n.d.). Statistical Yearbook of Mongolia 2007.

**Mauritania**

Central Statistical Office. (2009). Supply and Use Table: The Mauritanian Economy - 2002. Retrieved May 13, 2009, from <http://www.gov.mu/portal/goc/cso/indicate_1.htm>

Central Statistical Office. (2010). Supply and Use Table: The Mauritanian Economy - 1997. Retrieved October 28, 2010, from <http://www.gov.mu/portal/goc/cso/indicate_1.htm>

**Malaysia**

Department of Statistics. (n.d.). Malaysia Input-Output tables 1991 and 2000.

**Netherland**

Eurostat. (2009). ESA 95 Supply, Use and Input-Output tables. Retrieved April 30, 2009, from <http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95_supply_use_input_tables/data/workbooks>

**New Zealand**

New Zealand’s Official Statistics Agency. (2010). Supply and use tables – year ended March 2003. Retrieved October 29, 2010, from <http://www.stats.govt.nz/browse_for_stats/economic_indicators/nationalaccounts/supply-use-tables-yr-end-mar-03.aspx>

New Zealand’s Official Statistics Agency. (2010). Inter-industry study 1996. Retrieved October 29, 2010, from <http://www.stats.govt.nz/browse_for_stats/businesses/business_growth_and_innovation/inter-industry-study.aspx>

New Zealand’s Official Statistics Agency. (2010). Supply and Use tables – Year ended March 2007. Retrieved October 29, 2010, from <http://www.stats.govt.nz/browse_for_stats/economic_indicators/nationalaccounts/supply-use-tables-yr-end-mar-07.aspx>

**Norway**

Statistics Norway. (2010). Input-Output 1992-2007. Retrieved October 29, 2010, from <http://www.ssb.no/nr_en/input-output.html>

**Peru**

Instituto Nacional de Estadística e Informática. (2000). Matrices Especiales de la Tabla Insumo Producto 1994.

**Philippine**

IDE-JETRO. (2005). *Asian International I/O Table 2000*.

**Poland**

Eurostat. (2009). ESA 95 Supply, Use and Input-Output tables. Retrieved April 30, 2009, from <http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95_supply_use_input_tables/data/workbooks>

**Portugal**

Eurostat. (2009). ESA 95 Supply, Use and Input-Output tables. Retrieved April 30, 2009, from <http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95_supply_use_input_tables/data/workbooks>

**Paraguay**

Banco Central del Paraguay. (n.d.). Supply and use tables 1994.

**Romania**

Eurostat. (2009). ESA 95 Supply, Use and Input-Output tables. Retrieved April 30, 2009, from <http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95_supply_use_input_tables/data/workbooks>

**Russia**

OECD. (2006). The OECD Input-Output Database: 2006 edition. Retrieved from http://www.oecd.org/sti/inputoutput/

OECD. (2009). The OECD Input-Output Database: 2009 edition. Retrieved from http://www.oecd.org/sti/inputoutput/

**Singapore**

Singapore Department of Statistics. (2009). Singapore Input-Output Tables 2000. Supplied by email.

Singapore Department of Statistics. (2009). Singapore Input-Output Tables 1995. Supplied by email.

Singapore Department of Statistics. (2009). Singapore Input-Output Tables 1990. Supplied by email.

**Slovakia**

Eurostat. (2009). ESA 95 Supply, Use and Input-Output tables. Retrieved April 30, 2009, from <http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95_supply_use_input_tables/data/workbooks>

**Slovenia**

Eurostat. (2009). ESA 95 Supply, Use and Input-Output tables. Retrieved April 30, 2009, from <http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95_supply_use_input_tables/data/workbooks>

**Sweden**

Eurostat. (2009). ESA 95 Supply, Use and Input-Output tables. Retrieved April 30, 2009, from <http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95_supply_use_input_tables/data/workbooks>

**South Africa**

Statistics South Africa. (1999). Final Supply and Use Tables: An input-output framework (SUT), 1993. Retrieved May 21, 2009, from <http://www.statssa.gov.za/publications/statspastfuture.asp?PPN=Report-04-04-01&SCH=2176>

Statistics South Africa. (2001). Final Supply and Use Tables: An input-output framework (SUT), 1998. Retrieved May 21, 2009, from <http://www.statssa.gov.za/publications/statspastfuture.asp?PPN=Report-04-04-01&SCH=2176>

Statistics South Africa. (2002). Final Supply and Use Tables: An input-output framework (SUT), 1999. Retrieved from <http://www.statssa.gov.za/publications/statspastfuture.asp?PPN=Report-04-04-01&SCH=2176>

Statistics South Africa. (2003). Final Supply and Use Tables: An input-output framework (SUT), 2000. Retrieved May 21, 2009, from <http://www.statssa.gov.za/publications/statspastfuture.asp?PPN=Report-04-04-01&SCH=2176>

Statistics South Africa. (2006). Final Supply and Use Tables: An input-output framework (SUT), 2002. Retrieved May 21, 2009, from <http://www.statssa.gov.za/publications/statspastfuture.asp?PPN=Report-04-04-01&SCH=2176>

Statistics South Africa. (2010). Final Supply and Use Tables: An input-output framework (SUT), 2005. Retrieved October 30, 2010, from <http://www.statssa.gov.za/publications/statspastfuture.asp?PPN=Report-04-04-01&SCH=2176>

**Taiwan**

National Statistics Republic of China. (2009). Input-Output Tables of Taiwan 1991. Retrieved April 29, 2009, from <http://eng.stat.gov.tw/ct.asp?xItem=8488&ctNode=1650>

National Statistics Republic of China. (2009). Input-Output Tables of Taiwan 1994. Retrieved April 29, 2009, from <http://eng.stat.gov.tw/ct.asp?xItem=8488&ctNode=1650>

National Statistics Republic of China. (2009). Input-Output Tables of Taiwan 1996. Retrieved April 29, 2009, from <http://eng.stat.gov.tw/ct.asp?xItem=8488&ctNode=1650>

National Statistics Republic of China. (2009). Input-Output Tables of Taiwan 1999. Retrieved April 29, 2009, from <http://eng.stat.gov.tw/ct.asp?xItem=8488&ctNode=1650>

National Statistics Republic of China. (2009). Input-Output Tables of Taiwan 2001. Retrieved April 29, 2009, from <http://eng.stat.gov.tw/ct.asp?xItem=8488&ctNode=1650>

National Statistics Republic of China. (2009). Input-Output Tables of Taiwan 2004. Retrieved April 29, 2009, from <http://eng.stat.gov.tw/ct.asp?xItem=8488&ctNode=1650>

National Statistics Republic of China. (2010). Input-Output Tables of Taiwan 2006. Retrieved October 30, 2010, from <http://eng.stat.gov.tw/ct.asp?xItem=8488&ctNode=1650>

**Thailand**

Office of The National Economic and Social Development Board. (2009). Input-Output Tables for Thailand 1990. Retrieved April 1, 2009, from <http://www.nesdb.go.th/Default.aspx?tabid=97>

Office of The National Economic and Social Development Board. (2009). Input-Output Tables for Thailand 1995. Retrieved April 1, 2009, from <http://www.nesdb.go.th/Default.aspx?tabid=97>

Office of The National Economic and Social Development Board. (2009). Input-Output Tables for Thailand 1998. Retrieved April 1, 2009, from <http://www.nesdb.go.th/Default.aspx?tabid=97>

Office of The National Economic and Social Development Board. (2009). Input-Output Tables for Thailand 2000. Retrieved April 1, 2009, from <http://www.nesdb.go.th/Default.aspx?tabid=97>

Office of The National Economic and Social Development Board. (2010). Input-Output Tables for Thailand 2005. Retrieved October 30, 2010, from <http://www.nesdb.go.th/Default.aspx?tabid=97>

**Turkey**

Turkish Statistical Institute. (2010). Turkish supply and use tables, 1996. Retrieved November 16, 2010, from <http://www.turkstat.gov.tr/PreTablo.do?tb_id=58&ust_id=16>

Turkish Statistical Institute. (2010). Turkish supply and use tables, 1998. Retrieved November 16, 2010, from <http://www.turkstat.gov.tr/PreTablo.do?tb_id=58&ust_id=16>

**Ukraine**

State Statistics Service of Ukraine. (2010). Input-Output table (at consumer prices). Retrieved November 18, 2010, from <http://www.ukrstat.gov.ua/operativ/operativ2006/vvp/vitr_vip/vitr_e/arh_vitr_e.html>

**Uruguay**

Banco Central del Uruguay. (n.d.). Cuadros Estadísticos.

**Uzbekistan**

Müller, M. *A General Equilibrium Approach to Modeling Water and Land Use Reforms in Uzbekistan*; <http://hss.ulb.uni-bonn.de/2006/0801/0801.pdf;> Zentrum für Entwicklungsforschung, Rheinische Friedrich-Wilhelms-Universität: Bonn, Germany, 2006.

Müller, M.; Djanibekov, N. *Calibration of an Agricultural Sector Model for the Region Khorezm (Uzbekistan) based on Survey Data*; <http://ageconsearch.umn.edu/bitstream/50354/2/533.pdf;> International Association of Agricultural Economists (IAAE): Beijing, China, 2009

**Venezuela**

Banco Central de Venezuela. (n.d.). Matriz Insumo Producto Año 1997.

**Vietnam**

General Statistics Office of Vietnam. (2010). Viet nam Input-output table in 1989, 1996, 2000, 2007.

**USA**

U.S. Bureau Of Economic Analysis. (2009). Benchmark Input-Output Data 1992. Retrieved April 19, 2009, from <http://www.bea.gov/industry/io_benchmark.htm>

U.S. Bureau Of Economic Analysis. (2009). Benchmark Input-Output Data 1997. Retrieved April 19, 2009, from <http://www.bea.gov/industry/io_benchmark.htm>

U.S. Bureau Of Economic Analysis. (2009). Benchmark Input-Output Data 2002. Retrieved April 19, 2009, from <http://www.bea.gov/industry/io_benchmark.htm>

U.S. Bureau Of Economic Analysis. (2011). Input-Output Accounts Data 1998-2009. Retrieved May 28, 2011, from <http://www.bea.gov/industry/io_annual.htm>

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# References

1. UNSD *1993 System of National Accounts*; unstats.un.org/unsd/sna1993/toctop.asp; United Nations Statistics Division: New York, USA, 2009.

2. UNSD *Handbook of National Accounting: Integrated Environmental and Economic Accounting (SEEA 2003)*; United Nations Statistics Division: New York, USA, <http://unstats.un.org/unsd/envAccounting/seea2003.pdf>, 2003.

3. Rose, A.; Miernyk, W., Input-output analysis: the first fifty years. *Economic Systems Research* **1989,** *1*, 229-271.

4. Miller, R. E.; Blair, P. D., *Input-Output Analysis: Foundations and Extensions*. Prentice-Hall: Englewood Cliffs, NJ, USA, 2010.

5. Leontief, W. In *The dynamic inverse*, Contributions to Input-Output Analysis: Fourth International Conference on Input-Output Techniques, Geneva, Switzerland, 1970; Carter, A. C.; Bródy, A., Eds. North-Holland Publishing Company: Geneva, Switzerland, 1970; pp 17-46.

6. Leontief, W. W.; Strout, A. A., Multiregional input-output analysis. In *Structural Interdependence and Economic Development*, Barna, T., Ed. Macmillan: London, UK, 1963; pp 119-149.

7. UNSD *GDP and its breakdown at current prices in US Dollars*; unstats.un.org/unsd/snaama/dnllist.asp; United Nations Statistics Division: New York, USA, 2008.

8. van der Ploeg, F., Balancing large systems of National Accounts. *Computer Science in Economics and Management* **1988,** *1*, 31-39.

9. Lenzen, M.; Gallego, B.; Wood, R., A flexible approach to matrix balancing under partial information. *Journal of Applied Input-Output Analysis* **2006,** *11&12*, 1-24.

10. Lenzen, M.; Gallego, B.; Wood, R., Matrix balancing under conflicting information. *Economic Systems Research* **2009,** *21*, (1), 23-44.

11. Huang, W.; Kobayashi, S.; Tanji, H., Updating an input-output matrix with sign-preservation: Some improved objective functions and their solutions. *Economic Systems Research* **2008,** *20*, 111-123.

12. Censor, Y.; Zenios, S. A., *Parallel Optimization: Theory, Algorithms, and Applications*. Oxford University Press: New York, USA, 1997.

13. Bacharach, M., *Biproportional matrices & input-output change*. Cambridge University Press: Cambridge, UK, 1970.

14. UNSD *National Accounts Official Data*; data.un.org/Browse.aspx?d=SNA; United Nations Statistics Division: New York, USA, 2008.

15. UN *UN comtrade - United Nations Commodity Trade Statistics Database*; comtrade.un.org/; United Nations Statistics Division, UNSD: New York, USA, 2009.

16. National Statistics *Input-Output Tables of Taiwan Area, R.O.C.*; <http://eng.stat.gov.tw/ct.asp?xItem=8488&ctNode=1650;> Republic of China: Taipei, Taiwan, 2009.

17. Peters, G. P.; Hertwich, E. G., Pollution embodied in trade: The Norwegian case. *Global Environmental Change* **2006,** *16*, (4), 379-387.

18. Andrew, R.; Peters, G.; Lennox, J., Approximation and regional aggregation in multi-regional input-output analysis. *Economic Systems Research* **2009,** *21*, (3), 311–335.

19. Weber, C. L.; Matthews, H. S., Embodied environmental emissions in U.S. international trade, 1997-2004. *Environmental Science and Technology* **2007,** *41*, (14), 4875-4881.

20. Ahmad, N.; Wyckoff, A. *Carbon dioxide emissions embodied in international trade of goods*; 2003(15); Organisation for Economic Co-operation and Development: Paris, France, 03-Nov-2003, 2003.

21. Eurostat *ESA 95 Supply Use and Input-Output tables*; <http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95_supply_use_input_tables/data/workbooks;> European Commission: Luxembourg, Luxembourg, 2009.

22. IDE-JETRO *Asian International Input-Output Table*; <http://www.ide-jetro.jp/English/Publish/Books/Sds/material.html;> Institute of Developing Economies, Japan External Trade Organization: Wakaba, Mihama-ku, Chiba, Japan, 2006.

23. SourceOECD *ITCS International Trade by Commodities Statistics*; <http://www.sourceoecd.org/;> OECD: Paris, France, 2009.

24. Oosterhaven, J.; Stelder, D.; Inomata, S., Estimating international interindustry linkages: non-survey simulations of the Asian-Pacific economy. *Economic Systems Research* **2008,** *20*, (4), 395-414.

25. JETRO *Points to remember when checking trade statistics (in Japanese)*; [www.jetro.go.jp/library/reference/trade2.html#5;](http://www.jetro.go.jp/library/reference/trade2.html#5;) Japan External Trade Organization: 2009.

26. Parniczky, G., On the inconsistency of world trade statistics. *International Statistical Review* **1980,** *48*, 43-48.

27. Bouwmeester, M.; Oosterhaven, J., Methodology for the construction of an international supply-use table. In *International Input-Output Meeting on Managing the Environment*, Sevilla, Spain, 2008.

28. UN *Distinction between Exports and Re-exports / Imports and Re-imports*; comtrade.un.org/kb/article.aspx?id=10152; United Nations Statistics Division, UNSD: New York, USA, 2009.

29. Geschke, A.; Lenzen, M.; Kanemoto, K.; Moran, D. D., AISHA: A tool to construct a series of contingency tables. In *19th IIOA Conference*, Alexandria, VA, 2011.

Table S2: List of countries in the Eora MRIO database

|  |  |  |
| --- | --- | --- |
| UN code | Name | Sectors (PR/IN) |
| 4 | Afghanistan | 26/0 |
| 8 | Albania | 26/0 |
| 12 | Algeria | 26/0 |
| 20 | Andorra | 26/0 |
| 24 | Angola | 26/0 |
| 28 | Antigua and Barbuda | 26/0 |
| 32 | Argentina | 125/196 |
| 51 | Armenia | 26/0 |
| 533 | Aruba | 26/0 |
| 36 | Australia | 345/345 |
| 40 | Austria | 61/61 |
| 31 | Azerbaijan | 26/0 |
| 44 | Bahamas | 26/0 |
| 48 | Bahrain | 26/0 |
| 50 | Bangladesh | 26/0 |
| 52 | Barbados | 26/0 |
| 112 | Belarus | 26/0 |
| 56 | Belgium | 61/61 |
| 84 | Belize | 26/0 |
| 204 | Benin | 26/0 |
| 60 | Bermuda | 26/0 |
| 64 | Bhutan | 26/0 |
| 68 | Bolivia | 37/37 |
| 70 | Bosnia and Herzegovina | 26/0 |
| 72 | Botswana | 26/0 |
| 76 | Brazil | 56/111 |
| 92 | British Virgin Islands | 26/0 |
| 96 | Brunei Darussalam | 26/0 |
| 100 | Bulgaria | 26/0 |
| 854 | Burkina Faso | 26/0 |
| 108 | Burundi | 26/0 |
| 116 | Cambodia | 26/0 |
| 120 | Cameroon | 26/0 |
| 124 | Canada | 49/0 |
| 132 | Cape Verde | 26/0 |
| 136 | Cayman Islands | 26/0 |
| 140 | Central African Republic | 26/0 |
| 148 | Chad | 26/0 |
| 152 | Chile | 75/75 |
| 156 | China | 0/123 |
| 170 | Colombia | 60/60 |
| 178 | Congo | 26/0 |
| 188 | Costa Rica | 26/0 |
| 191 | Croatia | 26/0 |
| 192 | Cuba | 26/0 |
| 196 | Cyprus | 26/0 |
| 203 | Czech Republic | 61/61 |
| 384 | Côte d'Ivoire | 26/0 |
| 408 | Democratic People's Republic of Korea | 26/0 |
| 180 | Democratic Republic of the Congo, previously Zaïre | 26/0 |
| 208 | Denmark | 131/0 |
| 262 | Djibouti | 26/0 |
| 214 | Dominican Republic | 26/0 |
| 218 | Ecuador | 49/61 |
| 818 | Egypt | 26/0 |
| 222 | El Salvador | 26/0 |
| 232 | Eritrea | 26/0 |
| 233 | Estonia | 61/61 |
| 231 | Ethiopia | 26/0 |
| 242 | Fiji | 26/0 |
| 246 | Finland | 61/61 |
| 250 | France | 61/61 |
| 258 | French Polynesia | 26/0 |
| 266 | Gabon | 26/0 |
| 270 | Gambia | 26/0 |
| 268 | Georgia | 47/68 |
| 276 | Germany | 0/72 |
| 288 | Ghana | 26/0 |
| 300 | Greece | 61/61 |
| 304 | Greenland | 31/0 |
| 320 | Guatemala | 26/0 |
| 324 | Guinea | 26/0 |
| 328 | Guyana | 26/0 |
| 332 | Haiti | 26/0 |
| 340 | Honduras | 26/0 |
| 344 | Hong Kong | 38/38 |
| 348 | Hungary | 61/61 |
| 352 | Iceland | 26/0 |
| 356 | India | 116/116 |
| 360 | Indonesia | 0/77 |
| 364 | Iran | 100/148 |
| 368 | Iraq | 26/0 |
| 372 | Ireland | 61/61 |
| 376 | Israel | 163/163 |
| 380 | Italy | 61/61 |
| 388 | Jamaica | 26/0 |
| 392 | Japan | 0/402 |
| 400 | Jordan | 26/0 |
| 398 | Kazakhstan | 0/121 |
| 404 | Kenya | 51/51 |
| 414 | Kuwait | 55/0 |
| 417 | Kyrgyzstan | 89/87 |
| 418 | Lao People's Democratic Republic | 26/0 |
| 428 | Latvia | 61/61 |
| 422 | Lebanon | 26/0 |
| 426 | Lesotho | 26/0 |
| 430 | Liberia | 26/0 |
| 434 | Libyan Arab Jamahiriya | 26/0 |
| 438 | Liechtenstein | 26/0 |
| 440 | Lithuania | 61/61 |
| 442 | Luxembourg | 26/0 |
| 446 | Macao Special Administrative Region of China | 26/0 |
| 450 | Madagascar | 26/0 |
| 454 | Malawi | 26/0 |
| 458 | Malaysia | 0/98 |
| 462 | Maldives | 26/0 |
| 466 | Mali | 26/0 |
| 470 | Malta | 61/61 |
| 478 | Mauritania | 26/0 |
| 480 | Mauritius | 57/67 |
| 484 | Mexico | 80/80 |
| 492 | Monaco | 26/0 |
| 496 | Mongolia | 26/0 |
| 499 | Montenegro | 26/0 |
| 504 | Morocco | 26/0 |
| 508 | Mozambique | 26/0 |
| 104 | Myanmar | 26/0 |
| 516 | Namibia | 26/0 |
| 524 | Nepal | 26/0 |
| 528 | Netherlands | 61/61 |
| 530 | Netherlands Antilles | 16/41 |
| 540 | New Caledonia | 26/0 |
| 554 | New Zealand | 127/210 |
| 558 | Nicaragua | 26/0 |
| 562 | Niger | 26/0 |
| 566 | Nigeria | 26/0 |
| 578 | Norway | 61/61 |
| 275 | Occupied Palestinian Territory | 26/0 |
| 512 | Oman | 26/0 |
| 586 | Pakistan | 26/0 |
| 591 | Panama | 26/0 |
| 598 | Papua New Guinea | 26/0 |
| 600 | Paraguay | 34/47 |
| 604 | Peru | 46/46 |
| 608 | Philippines | 0/77 |
| 616 | Poland | 61/61 |
| 620 | Portugal | 61/61 |
| 634 | Qatar | 26/0 |
| 410 | Republic of Korea | 0/78 |
| 498 | Republic of Moldova | 26/0 |
| 642 | Romania | 61/61 |
| 643 | Russian Federation | 49/0 |
| 646 | Rwanda | 26/0 |
| 882 | Samoa | 26/0 |
| 674 | San Marino | 26/0 |
| 678 | Sao Tome and Principe | 26/0 |
| 682 | Saudi Arabia | 26/0 |
| 686 | Senegal | 26/0 |
| 688 | Serbia | 26/0 |
| 690 | Seychelles | 26/0 |
| 694 | Sierra Leone | 26/0 |
| 702 | Singapore | 154/154 |
| 703 | Slovakia | 61/61 |
| 705 | Slovenia | 61/61 |
| 706 | Somalia | 26/0 |
| 710 | South Africa | 95/96 |
| 724 | Spain | 76/119 |
| 144 | Sri Lanka | 26/0 |
| 736 | Sudan | 26/0 |
| 740 | Suriname | 26/0 |
| 748 | Swaziland | 26/0 |
| 752 | Sweden | 61/61 |
| 756 | Switzerland | 43/43 |
| 760 | Syrian Arab Republic | 26/0 |
| 761 | Taiwan | 0/163 |
| 762 | Tajikistan | 26/0 |
| 764 | Thailand | 0/180 |
| 807 | Macedonia | 61/61 |
| 768 | Togo | 26/0 |
| 780 | Trinidad and Tobago | 26/0 |
| 788 | Tunisia | 26/0 |
| 792 | Turkey | 61/61 |
| 795 | Turkmenistan | 26/0 |
| 800 | Uganda | 26/0 |
| 804 | Ukraine | 0/121 |
| 784 | United Arab Emirates | 26/0 |
| 826 | United Kingdom | 511/511 |
| 834 | United Republic of Tanzania | 26/0 |
| 840 | USA | 429/429 |
| 858 | Uruguay | 84/103 |
| 860 | Uzbekistan | 0/123 |
| 548 | Vanuatu | 26/0 |
| 862 | Venezuela | 122/122 |
| 704 | Viet Nam | 0/113 |
| 887 | Yemen | 26/0 |
| 894 | Zambia | 26/0 |
| 716 | Zimbabwe | 26/0 |

Table S3: Availability of input-output tables

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
| Aruba |  |  |  |  |  | x | x | x | x | x | x | x | x |  |  |  |  |  |  |  |  |
| Netherlands Antilles |  |  |  |  |  |  |  |  |  |  |  |  |  |  | x |  |  |  |  |  |  |
| Argentina |  |  |  |  |  |  |  | x |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Armenia |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | x |  |  |  |  |
| Australia | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |  |  |  |
| Austria |  |  |  |  |  | x |  | x |  | x | x | x | x | x | x | x |  |  |  |  |  |
| Belgium |  |  |  |  |  | x |  | x |  | x | x | x | x | x | x |  |  |  |  |  |  |
| Bolivia |  |  |  |  |  |  |  |  |  | x | x | x | x |  |  |  |  |  |  |  |  |
| Brazil | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |  |  |
| Canada |  |  |  |  |  | x |  |  |  |  | x |  |  |  |  |  |  |  |  |  |  |
| Switzerland |  |  |  |  |  |  |  |  |  |  |  | x |  |  |  | x |  |  |  |  |  |
| Chile |  |  |  |  |  |  | x |  |  |  |  |  |  | x |  |  |  |  |  |  |  |
| China | x |  | x |  |  | x |  | x |  |  | x |  | x |  |  | x |  | x |  |  |  |
| Colombia |  |  |  |  |  |  |  |  |  |  | x | x | x | x | x | x | x | x |  |  |  |
| Czech Republic |  |  |  |  |  | x | x | x | x | x | x | x | x | x | x | x |  |  |  |  |  |
| Germany |  | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |  |  |  |  |
| Denmark | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |  |  |  |  |
| Ecuador |  |  |  |  |  |  |  |  |  |  | x | x | x | x | x | x | x | x |  |  |  |
| Spain | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |  |  |  |  |
| Estonia |  |  |  |  |  |  |  | x |  |  | x | x | x | x | x | x |  |  |  |  |  |
| Finland |  |  |  |  |  | x | x | x | x | x | x | x | x | x | x | x |  |  |  |  |  |
| France |  |  |  |  |  | x | x | x | x | x | x | x | x | x | x | x |  |  |  |  |  |
| United Kingdom |  |  | x | x | x | x | x | x | x | x | x | x | x | x | x | x |  |  |  |  |  |
| Georgia |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | x | x | x |  |  |
| Greece |  |  |  |  |  |  |  |  |  |  | x | x | x | x | x | x | x | x |  |  |  |
| Greenland |  |  | x |  |  |  |  |  |  |  |  |  |  |  | x |  |  |  |  |  |  |
| Hong Kong |  |  | x |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Hungary |  |  |  |  |  |  |  |  | x | x | x | x | x | x | x | x |  |  |  |  |  |
| Indonesia |  |  |  |  |  |  |  |  |  |  | x |  |  |  |  |  |  |  |  |  |  |
| India |  |  |  | x |  |  |  |  | x |  |  |  |  | x |  |  | x |  |  |  |  |
| Ireland |  |  |  |  |  |  |  |  | x |  | x | x | x |  |  | x |  |  |  |  |  |
| Iran |  | x |  |  |  |  |  |  |  |  |  | x |  |  |  |  |  |  |  |  |  |
| Israel |  |  |  |  |  | x | x | x | x | x | x | x | x | x | x | x | x | x |  |  |  |
| Italy |  |  |  |  |  | x | x | x | x | x | x | x | x | x | x |  |  |  |  |  |  |
| Japan | x |  |  |  |  | x |  |  |  |  | x |  |  |  |  | x |  |  |  |  |  |
| Kazakhstan | x |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Kenya |  |  |  |  |  |  |  |  |  |  |  |  |  | x |  |  |  |  |  |  |  |
| Kyrgyzstan |  |  |  |  |  |  |  |  |  |  |  | x |  |  |  |  |  |  |  |  |  |
| South Korea | x |  |  | x |  | x |  |  | x |  | x |  |  |  |  | x | x | x |  |  |  |
| Kuwait |  |  |  |  |  |  |  |  |  |  | x |  |  |  |  |  |  |  |  |  |  |
| Lithuania |  |  |  |  |  |  |  |  |  |  | x | x | x | x | x |  |  |  |  |  |  |
| Luxembourg |  |  |  |  |  | x | x | x | x | x | x | x | x | x | x | x | x | x |  |  |  |
| Latvia |  |  |  |  |  |  | x |  | x |  |  |  |  |  |  |  |  |  |  |  |  |
| Maldives |  |  |  |  |  |  |  | x |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Mexico |  |  |  |  |  |  |  |  |  |  |  |  |  | x |  |  |  |  |  |  |  |
| Macedonia |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | x |  |  |  |  |  |
| Malta |  |  |  |  |  |  |  |  |  |  | x | x |  |  |  |  |  |  |  |  |  |
| Mongolia |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | x |  |  |  |  |  |
| Mauritius |  |  |  |  |  |  |  | x |  |  |  |  | x |  |  |  |  |  |  |  |  |
| Malaysia |  | x |  |  |  |  |  |  |  |  | x |  |  |  |  |  |  |  |  |  |  |
| Netherlands |  |  |  |  |  | x | x | x | x | x | x | x | x | x | x | x |  |  |  |  |  |
| Norway |  |  |  |  |  |  |  |  |  |  |  | x | x | x | x | x | x |  |  |  |  |
| New Zealand |  |  |  |  |  | x |  |  |  |  |  |  | x |  |  |  |  | x |  |  |  |
| Peru |  |  |  |  | x |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Philippines |  |  |  |  |  |  |  |  |  |  | x |  |  |  |  |  |  |  |  |  |  |
| Poland |  |  |  |  |  |  |  |  |  |  | x | x | x | x | x |  |  |  |  |  |  |
| Portugal |  |  |  |  |  | x | x | x | x | x | x | x | x | x | x | x | x |  |  |  |  |
| Paraguay |  |  |  |  | x |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Romania |  |  |  |  |  |  |  |  |  |  | x |  |  | x | x | x |  |  |  |  |  |
| Russian Federation | x |  |  |  |  | x |  |  |  |  | x |  |  |  |  |  |  |  |  |  |  |
| Singapore | x |  |  |  |  | x |  |  |  |  | x |  |  |  |  |  |  |  |  |  |  |
| Slovakia |  |  |  |  |  | x | x | x | x | x | x | x | x | x | x |  |  |  |  |  |  |
| Slovenia |  |  |  |  |  |  |  |  |  |  | x | x | x | x | x | x |  |  |  |  |  |
| Sweden |  |  |  |  |  | x | x | x | x | x | x | x | x | x | x | x | x |  |  |  |  |
| Thailand | x |  |  |  |  | x |  |  | x |  | x |  |  |  |  | x |  |  |  |  |  |
| Turkey |  |  |  |  |  |  |  |  |  |  |  |  | x |  |  |  |  |  |  |  |  |
| Taiwan |  | x |  |  | x |  | x |  |  | x |  | x |  |  | x |  |  |  |  |  |  |
| Ukraine | x |  |  |  |  |  |  |  |  |  |  |  |  | x | x | x | x | x | x |  |  |
| Uruguay |  |  |  |  |  |  |  | x |  |  |  |  |  |  |  |  |  |  |  |  |  |
| USA |  |  | x |  |  |  | x | x | x | x | x | x | x | x | x | x | x | x | x | x |  |
| Uzbekistan | x |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Venezuela |  |  |  |  |  |  |  | x |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Viet Nam |  |  |  |  |  |  | x |  |  |  | x |  |  |  |  |  |  | x |  |  |  |
| South Africa |  |  |  | x |  |  |  |  | x | x | x |  | x |  |  |  |  |  |  |  |  |

1. Neither the MA nor OC database contain information on Taiwan. **T**, **y**, **v** and **V** for Taiwan were constructed based on national data from [[16](#_ENREF_16)]. [↑](#footnote-ref-1)
2. The CT database does not contain information on Taiwan. **T**, **y** and **v** for Taiwan were constructed using trade data from [[23](#_ENREF_23)]. [↑](#footnote-ref-2)