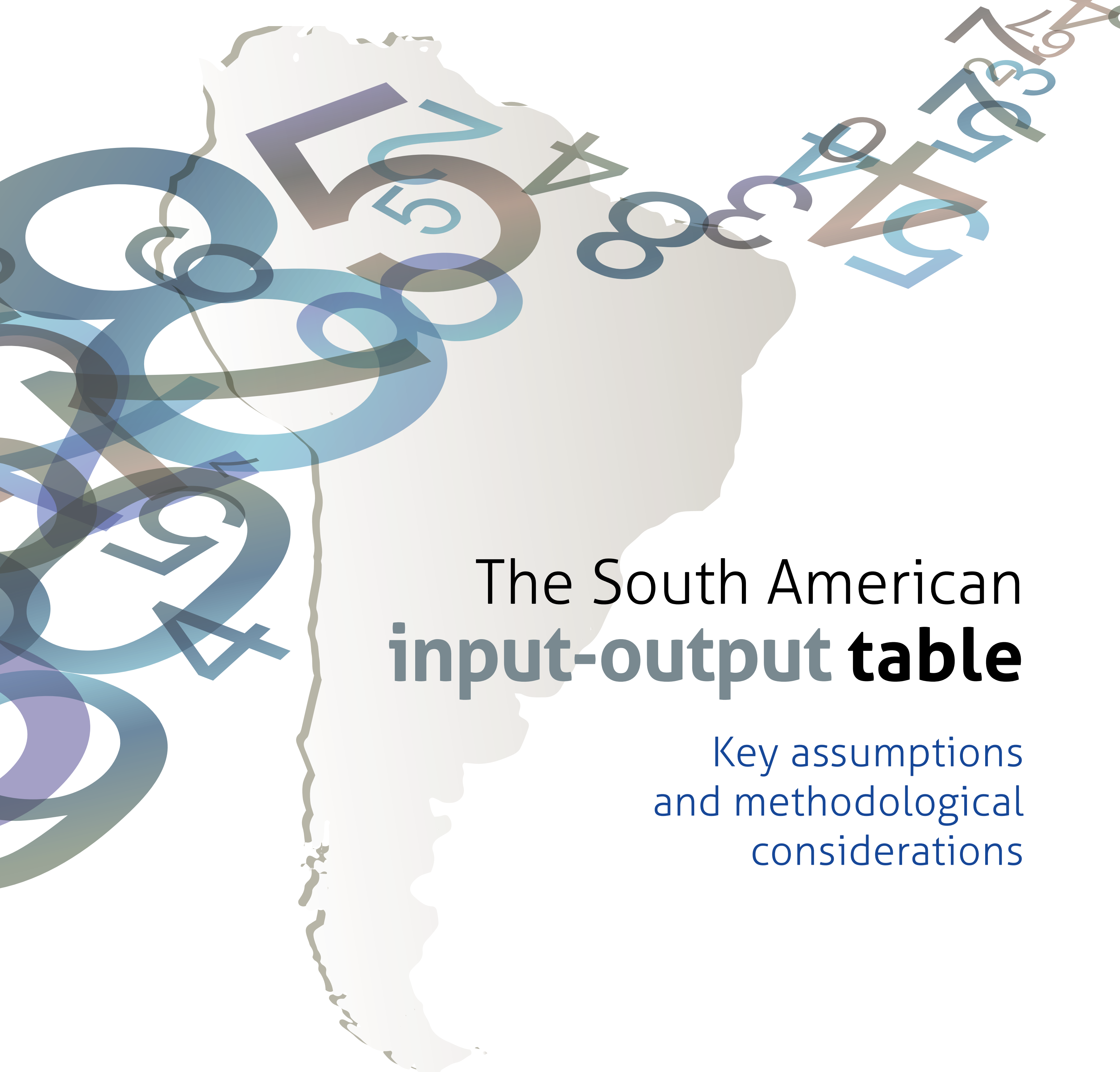

# The South American **input-output table**

## Key assumptions and methodological considerations

UNITED NATIONS
ECLAC

ipea Instituto de Pesquisa Econômica Aplicada

**Project Document**

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Economic Commission for Latin America and the Caribbean (ECLAC)

This document is the outcome of joint efforts by the technical teams of the Institute of Applied Economic Research (IPEA of Brazil) and the Economic Integration Unit of the International Trade and Integration Division of the United Nations Economic Commission for Latin America and the Caribbean (ECLAC) in the construction of the South American regional input-output table. The document was edited by José E. Durán Lima and Sebastián Castresana, Staff of the International Trade and Integration Division of ECLAC. The translation for the English version of the manual was supervised by Daniel Cracau, also of that Division.

In its preliminary stage, the project received financial support from the Brazilian Agency for Industrial Development (ABDI), the Inter-American Development Bank (IDB) and the Development Bank of Latin America (CAF). The work benefited from technical support from the International Exploration and Intelligence Unit of the Getúlio Vargas Foundation (FGV). The project also received financial support from the regular programme for technical cooperation of ECLAC, as well as from the United Nations Development Account project 1617AA on input-output tables for trade and industrial policy in Central and South America.

The national teams that participated are included in annex 5 at the end of the document.



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# Introduction

This note has been prepared as a result of the joint project of the Institute of Applied Economic Research (IPEA) of Brazil and ECLAC to prepare an interconnected input-output table for the countries of South America. This instrument will be useful for the analysis of value chains in the region.

In its preliminary stage, this project could count on financial support from the Brazilean Agency for Industrial Development Agency (ABDI), the Inter-American Development Bank (IDB) and the Development Bank of Latin America (CAF). The works have benefited from technical support from the Center for International Exploration and Intelligence Unit of the Presidency of the Getúlio Vargas Foundation (FGV). The project also received financial support from the Regular Program for Technical Cooperation of the United Nations Economic Commission for Latin America and the Caribbean, as well as the United Nations Development Account project 1617AA on "Input-Output Tables for Trade and Industrial Policy in Central America and South America."

The original project received valuable contributions from national experts in several countries in the region, the same who worked with the input-output tables (IOTs) of each country, as well as with the information necessary for its construction in case it was not available. There have been four working sessions, three in Brasilia and one in Santiago, with the participation of the technical teams of the two institutions and national consultants, to discuss the assumptions and methodological procedures. Afterwards, the ECLAC team proceeded with the assembly of all IOTs into a single interconnected IOT that captures industrial relations between all the countries of South America. Due to lack of statistical information, the cases of Guyana and Suriname are not included.

The effort made for the construction of the South American IOT presented here is unprecedented in Latin America. While there have been efforts to analyze the existent links at the regional level derived from the international trade statistics, a work of the presented magnitude has not been deployed before. This is especially valuable as the same work has been announced to be the most accurate method to address the study of regional and global production chains in Latin America and the Caribbean. A pioneering effort similar to the one presented here was done in the case of Asia-Pacific. The work was led by the Institute of Developing Economies of the Japan External Trade

Organization (IDE-JETRO) and concluded with the publication of a regional IOT that included nine countries in Asia Pacific together with the United States.[1]

Moreover, at a global scale two IOTs with worldwide scope have been published: the first by the World Input-Output Database (WIOD)[2] consortium and the second by the consortium of the Organization for Economic Cooperation and Development (OECD) and the World Trade Organization (WTO) whose database is known as TIVA (Trade in Value Added).[3] While both arrays have a global vocation, the first (published since 2012) included only two Latin American countries (Brazil and Mexico) and the second (public since June 2015) includes only six countries in the region (Argentina, Brazil, Chile, Costa Rica, Colombia, and Mexico). Therefore, these IOTs can not assess global production chains of South America neither within nor outside the region.

The two major decisions and/or challenges addressed by the team involved in the project were: the harmonization of all sectors between the various available IOTs; and determining a common year for the assembly of the IOT. In the first case, a special effort was undertaken to identify a set of core sectors from which a unique list of industries for the South American IOT was developed. This effort was deployed considering the need for cross-sectoral analyses. For this reason, to the greatest extent, sectors as open as possible were considered. Regarding the common year, 2005 was identified within the discussions in the working sessions as the year for which a number of countries had their complete information (Brazil, Colombia and Uruguay) or complementary information, correspondingly, so that national teams could work on making the change of the base year where this was necessary.

The greatest contribution of the project, next to the integration of several national IOTs and their interconnection, is made by the inclusion of countries for which no IOT were available or where those existing belonged to a year very distant from 2005. This holds for the cases of the Plurinational State of Bolivia, Paraguay and the Bolivarian Republic of Venezuela. In all three cases, additional work was needed to transform the supply-use tables available in official bodies (central banks and statistical offices) to such IOTs compatible with the information from other countries in the project.

Based on multiple sessions of work —where in some experts from the OECD and the United Nations Conference on Trade and Development (UNCTAD) were involved— it was decided that the Regional IOT[4] should have 40 sectors, identified based on the availability of information in most of the countries considered. This sectoral structure is fully compatible with the corresponding structure of the resulting table of the OECD-WTO project.

The final result of a South American IOT could only be achieved by the support of several national statistical agencies and central banks that lent substantive assistance to the many teams who helped with this project.

Getting to the expected result was neither a simple nor immediate exercise, and required a process that took several steps and specific milestones. The first milestone was undoubtedly the assembly of the national IOT correlated to the 40 sectors chosen for the South American IOT. A second milestone for each national team was to prepare the national information to be compatible to that of the other countries included. This exercise included: i) The solution of particular arising issues in obtaining information for 40 sectors such as opening aggregate sectors; ii) Opening of the intermediate use in domestic and imported inputs; iii) Valuation of all transactions at basic prices, i.e. excluding taxes and margins, but covering subsidies in cases where those existed; iv) Valuation of all transactions in 2005 dollars; v) Opening of imported intermediate use by origin, especially of South American origins; vi) opening of trade in services by origin.

1 The result of the described effort is available in full at: www.ide.go.jp/English/Data/Io/index.html.
2 The WIOD database is available at: www.wiod.org/new_site/database/wiots.htm.
3 The tables of this database are available at: www.oecd.org/sti/ind/input-outputtablesedition2015accesstodata.htm.
4 Throughout this document the terms regional IOT and South American IOT are equivalent.

Starting with all the exercises of harmonization and the preparation of bilateral trade flows of goods and services, the assembly of a first South American IOT that included 8 countries (Argentina, Plurinational State of Bolivia, Brazil, Chile, Colombia, Paraguay, Peru, Uruguay, and Bolivarian Republic of Venezuela) was performed at an intermediate stage of the project. This first version was presented in November 2015 in São Paulo, at a public meeting that was attended by IPEA, Federation of Industries of São Paulo (FIESP), CAF, IDB, and ABDI. Subsequently, between December 2015 and April 2016 similar exercises were conducted to include the cases of Paraguay and Ecuador. Thus, after the complementary work with new work teams could the assembly of an IOT which includes 10 South American countries was achieved and the data are made public along with this manual.

The South American IOT is a good starting point for the analysis of both domestic and foreign linkages at the South American level. Still, there is the need to move towards the broader objective of having a Latin American IOT. For this purpose, ECLAC is making efforts to complete similar IOT for the rest of the countries of Central America and the Caribbean that are not included in this exercise. Also, for the purpose of conducting analyses of structural change, tasks were developed to prepare a similar matrix for a more recent year.

This translation of the original Spanish manual "*La matriz de insumo-producto de América del Sur – Principales supuestos y consideraciones metodológicas*" aims on facilitating the international use of the South American IOT.

# I. Initial state of the process of constructing a South American input-output table

The national input-output tables are an important starting point of the analysis of productive linkages within an economy. They represent an integrated set of tables showing the balance between the supply and use of goods and services (products). By definition, input-output tables allow to value the components of supply, intermediate demand, final demand and the value added part.

Starting from the input-output approach it is possible to analyze in detail the production process regarding the requirement of inputs (products) of one sector from other ones at the national or international level (in the case of imported intermediate inputs). In turn, the products created by an economy can be exported to other countries, thereby configuring links of productive integration.

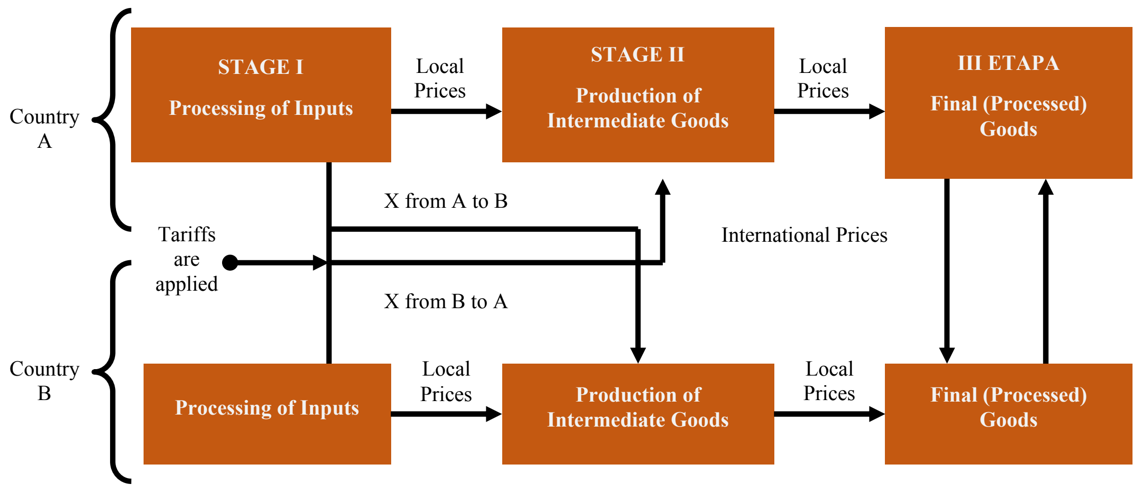
As is known, the use of input-output tables is based on certain assumptions, which can sometimes be considered somewhat excessively stringent. Two of the most important are that the production process takes place floowing constant and unchanging production techniques over time, so that the coefficients of an IOT reflect relationships between sectors that do not change significantly. It is further assumed that all companies in a given sector have the same production function, i.e. once the relations between sectors is identified, these reflect the relationships of all the companies involved. Besides these limitations, an IOT is a very useful tool for identifying directions for policy design.

So far, many countries build their input-output tables based on an integrated data set of available information from economic, agricultural, population and housing censuses, surveys on expenditure and household income, customs information, administrative records, and mainly national accounts records. The main objective of the methodology is to estimate the value of the country's gross domestic product (GDP), either by the method of production by type of expenditure, or by type of income. Because the focus is of this type, and not necessarily on regional or international productive links, the intermediate input vector does not separate domestic supplies from imported inputs in several cases, and does not specify the country of origin of imports. A similar situation is prevalent in the case of the (domestic or foreign) final offer regarding the opening of exports by type of good (intermediate consumption, capital, or final good), and their destinations.

Diagram 1 illustrates the logic of the relationships between the various stages of production in a context of regional integration. Here, reciprocal trade in intermediate goods, basic inputs, on the one hand, and semi-finished goods, on the other hand, defines value chains that involve more than one country, because the final products contain domestic and imported inputs.

In the case of South America, the analysis of productive interrelations in the various stages of the production process should be made viable with a special emphasize on regional value chains[5], this is the aggregation of South American supplies (of more than one country) in the domestic production process of another South American country. So far, integrated analyses using this approach with a single regional IOT have not been possible in the case of South America. For this reason, ECLAC and IPEA conducted an exercise analyzing the state of the art of national input-output tables in South America.

**Diagram 1**
**Stages of the production process including international trade**




Source: Durán, Álvarez and Cracau (2016).

Table 1 shows the state of art of national IOTs and/or Supply-Use Tables (SUT) until January 2016, and includes the detail of information available for the twelve countries of South America. Although in all cases statistical agencies have SUTs available for 2011, 2012 or a more recent year, the common year with the most IOT is 2005, the year for which the IOT of Brazil, Colombia and Uruguay are available. In addition, 4 other countries have information on IOTs close to 2005 (Argentina, Chile, Ecuador and Peru), leaving only the cases of: Plurinational State of Bolivia, Paraguay, and Bolivarian Republic of Venezuela, with the farthest information in time (1990, 1994 and 1997, respectively). Meanwhile, in the case of Guyana and Suriname, the situation is more critical because there is no official information available to perform a task of deriving an IOT with the integration of various inputs. Unfortunately, for these countries there is no information on SUT available.

[5] This type of analysis in academic terms is known under various names: production sharing (Yeats, 1998; Ng and Yeats, 1999); international production networks (Mitsuyo and Kimura, 2005; Dedrick, Kraemer and Linden, 2010); coproduction (Grunwald and Flamm, 1985); vertical specialization (Hummels, Ishii and Yi, 2001; Yi, 2003; Knetter and Slaughter, 1999; Fontagné, Freudenberg and Péridy, 1997); disintegration of production (Feenstra, 1998; Feenstra and Hanson, 1996); Krugman, preferred to call it "breakdown of the value chain" (Krugman, 1995). Lately, this approach that is referred to as "international supply-chain trade" has become popular following the document "*WTO 2.0: Global governance of supply-chain trade*" authored by Baldwin (2012). From then on, the literature and the studies on the subject have multiplied.

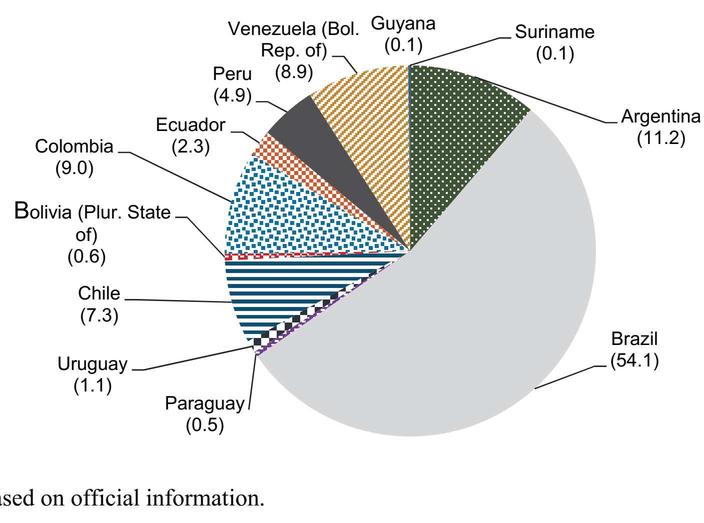
**Table 1**
**State of the art of input-output tables and/or supply-use tables, by January 2016**

| Countries | Base year | SUT | Industries | Products | WTO/OECD | WIOD |
|---|---|---|---|---|---|---|
| Argentina | 1994/2004 | 2004 | 163 | 271 | X | |
| Bolivia (Plurinational State of) | 1990 | 1988-2002 | 35 | 35 | | |
| Brazil | 2000/2005 | 2005 | 55 | 110 | X | X |
| Chile | 2003/2008 | 2003-2014 | 111 | 177 | X | |
| Colombia | 1994/2000/2005 | 2000-2013 | 56 | 373 | X | |
| Ecuador | 2007 | 2007-2014 | 47 | 60 | | |
| Guyana | - | - | - | - | | |
| Paraguay | 1994/1997 | - | 46 | 46 | | |
| Peru | 1994/2007 | 2005 | 45 | 45 | | |
| Suriname | - | - | - | - | | |
| Uruguay | 2005/2008 | 2005 | 56 | 56 | | |
| Venezuela (Bolivarian Republic of) | 1997 | 2005 | 121 | 121 | | |

Source: ECLAC, based on official information of Central Banks and Statistical Institutes. Information compiled between January 27 and February 4, 2016. Argentina: www.indec.gov.ar/nivel4_default.asp?id_tema_1=3&id_tema_2=9&id_tema_3=114; Plurinational State of Bolivia: www.ine.gob.bo/indice/indice.aspx?d1=0107&d2=6; Brazil: www.ibge.gov.br/home/estatistica/economia/matrizinsumo_produto/default.shtm; Colombia: www.dane.gov.co/index.php/estadisticas-por-tema/cuentas-nacionales/cuentas-nacionales-anuales; Chile: si3.bcentral.cl/estadisticas/Principal1/informes/ccnn/anuales/anuarios.html; Ecuador: www.bce.fin.ec/index.php/component/k2/item/763; Paraguay: www.economia.gov.py/v2/sistema/files/files/constru-20120511-110959.pdf; Uruguay: bcu.gub.uy/estadisticas-e-indicadores/cuentas%20nacionales/cou_05_08/presentacion05_couanualesprod.htm; Bolivarian Republic of Venezuela: www.bcv.org.ve/cuadros/series/mip97/mip97.asp?id=425.

The South Amerrican IOT assembled according to the GDP of 2005 is broadly representative of South America, as it captures 99.8% of all the subregional GDP (see figure 1). However, it was stated that it does not allow linking to the relatively smaller partners, namely Guyana and Suriname. The following section describes the set of actions followed by each national team to achieve a uniform IOT in the first place, and then from that on to move towards the assembly of a South American IOT.

**Figure 1**
**South America: distribution of gross domestic product in 2005**
*(In percentages of total)*




Source: ECLAC, based on official information.

# II. Steps taken within the construction of the South American IOT

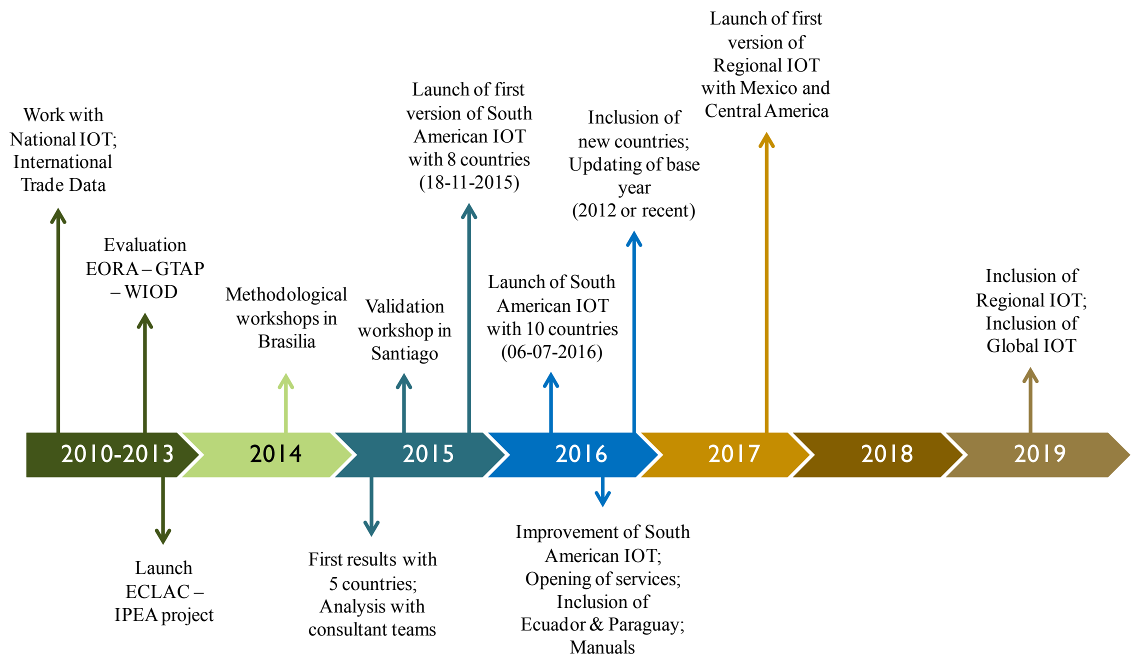
This section describes the main steps taken by the various national teams for building IOT with the basic information needed for the construction of a South American IOT. The methodology used is similar to the one that has been used by researchers of IDE-JETRO, OECD-WTO and WIOD, who function as global references in the field.[6] The national teams were in charge of preparing individual inputs for the vectors and matrices required for assembly (supply table, also called table of intersectoral transactions; opening of the intermediate use in domestic and imported one; opening of the final demand; and determination of the value added). Lastly, the ECLAC team handled the construction of the regional IOT by using the various inputs of each national team for the assembly.

Diagram 2 shows the path initially taken by the International Trade and Integration Division of ECLAC, and later shared between ECLAC and IPEA to reach a first South American input-output table. In this diagram, one can already anticipate the interest of ECLAC in getting to the contruction of a regional MIP that, in a first instance, would represent the productive structure of whole Latin America by including Mexico and Central America, and eventually a country in the Caribbean region.

During 2016 and 2017 concrete works will take place in countries that were not part of this first exercise with the objective to incorporate them into a new, more comprehensive process. Also, concrete work will be developed to bring national IOTs of South American countries to a more recent year, so that it outgh to be possible to have an instrument that enables the analysis of both the productive structure of the region as a whole as well as the links between several countries in the region. Moreover, for the near future it is expected that the region can be incorporated into any of the global projects of value chain analysis.

[6] The presentation of the methodology focuses primarily on the documents de Backer and Yamano (2012), Dietzenbacher et al. (2013), IDE-JETRO (2006), Meng, Zhang and Inomata (2013) as well as Timmer (2012).

**Diagram 2**
**ECLAC: process of constructing the South American input-output table and future steps**




Source: ECLAC, based on milestones of the work carried out by ECLAC in the process of the construction of the South American Input-Output Table, and the follow-up process to move towards a regional Input-Output Table.

In the following, the path taken for the construction of each data set required as input for the South American IOT will be described in detail and chronologically.

## A. Data collection

The construction of the regional IOT is based on different sources of official information from the countries. The starting point provided the Supply-Use Tables (SUTs) or IOTs of each country, depending on the respective availability. Additional information from national accounts and/or data of trade in goods and services were used to make the required sectoral openings and adjustments, as is detailed below.

Trade data were considered at the most detailed level possible, i.e. at the classification according to the level of 6-digit of the Harmonized Commodity Descriptiona and Coding System (HS). Values of re-exports have not been isolated, in view of the limited availability of information regarding the countries considered. Finally, there are sectors for which such information that would allow identifying the national value added are simply not disclosed. An example is the defense sector. These cases were not considered.

The collection phase involved the collaboration and involvement of national teams. They interacted with experts from national accounts of central banks and/or statistical institutes, as well as local experts.

It was necessary for some particular cases to resort to secondary information, i.e. statistical information at the sectoral level, as well as studies and/or work performed by experts that served as basis for the construction of particular IOT. This path was followed in the cases of Plurinational State of Bolivia and Paraguay.

## B. Harmonization of the national SUTs/IOTs

The SUTs/IOTs of eachcountry were harmonized in several areas:

- Reference year: the adjustment of the reference year of SUTs/IOTs in cases where the basic information was not 2005. It was necessary to bring them to that year using either the RAS method or the method of cross entropy starting from information of national accounts obtained at central banks or statistical institutes, as appropriate.
- Valuation (basic prices[7]): the analysis of sectoral linkages, both domestic and regional, required the use of data at basic prices. In cases where the available data are at purchasers' prices (for example, in the cases of Ecuador and Plurinational State of Bolivia) it was necessary to make the respective adjustments, discounting taxes and trade margins.
- Sectoral structure: the sectoral breakdown of the SUTs/IOTs in different countries shows differences, so that the structure of sectors of the regional IOT had to be defined taking into account the availability of information in each country. It was aimed to adjust the structure of the IOT as much as possible to the global OECD-WTO and WIOD data bases, also considering the need for wider openings that allow the effective analysis of sectoral production chains. This procedure was performed to select a set of 40 sectors that were finally defined for the South American IOT.
- Opening of the total Intermediate Use in domestic and imported one: In some cases it was necessary to perform an opening exercise when the data were not provided separately as needed, using information available from official sources.
- Opening of the import and export vectors by countries/regions: in the cases of intermediate use and final demand, respectively. Thus, the IOT can serve as a policy instrument to define linkages between countries and/or sectors.

Although they are part of the harmonization, the points three and five mentioned deserve to be treated extensively in the following subsections.

## C. Definition of the sectoral structure of the South American IOT

As seen in Table 1, most of the IOT and SUTs show great diversity in the number of sectors in which intermediate demand can be presented. That number varies with the degree of disaggregation that relates to the productive structure of each country. Usually, this opening corresponds to the existing production pattern in each case. If a country shows a higher intensity in the agricultural sector, it is understandable that this sector is the most widely disaggregated one. The same holds with mining or other areas. The most extreme case is that of Plurinational State of Bolivia, which only has 35 economic sectors. By contrast, Argentina reported the largest number of industries: 163. Table 2 shows the cases of heterogeneity at the sectoral level expressed by the countries with the lowest and highest numbers of industries within the major economic sectors identified. For example, the IOT of Brazil presents itself highly aggregated in agriculture, forestry, hunting and fishing, with only 2 sectors. Likewise, the oil and mining sector in Plurinational State of Bolivia (only 1 sector). Note that in the manufacturing sectors, Argentina has a greater breakdown, having an opening of 78 industries (see table 2).

[7] The basic prices reflect the apparent costs of the sectors, because transportation and marketing should be separated from the use of property. This is key in the input-output analysis, where production technology plays a central role.

**Table 2**
**Sectoral analysis of the degree of desaggregation of the industries in broad categories in the South American IOTs**
*(Maximum and minimum number of sectors)*

| Broad Sectors | Minimum numbers of industries | Country | Maximum numbers of industries | Country |
|---|---|---|---|---|
| Agriculture, Forestry, Hunting and Fishing | 2 | Brazil | 14 | Paraguay |
| Oil and Mining | 1 | Bolivia (Plurinational State of) | 8 | Venezuela (Bolivarian Republic of) |
| Manufacturing | 17 | Bolivia (Plurinational State of) | 78 | Argentina |
| Services | 12 | Bolivia (Plurinational State of) | 73 | Argentina |
| All sectors | 35 | Bolivia (Plurinational State of) | 163 | Argentina |

Source: ECLAC, based on the information of the IOT of the countries.

To determine the optimal level of sectors to be opened in the South American IOT, and to pass from heterogeneity to homogeneity, a second sectoral analysis was considered that identified 20 major sectors. Some include several segments of a value chain, such as food, beverages and tobacco, or textile, apparel and footwear. This second aggregation aimed to determine the congruence at the sectors level using an intermediate aggregation and to evaluate possibilities of larger opnenings, when this was possible. This exercise also allowed the identification of sectors for which the production structure of a country did not qualify for the opening due to the low density of industry. Table 3 presents the details regarding the number of industries for a classification with 20 sectors. A first review of the industries by country showed that some cases existed for which it was necessary to make efforts to achieve greater sectoral breakdown using new sources of information beyond the information provided by the respective national IOT. Among the outstanding examples, we find the food, beverages and tobacco industry in Brazil where the IOT has only two sectors, and machinery and equipment with only one or two sectors in several countries (one in Plurinational State of Bolivia, Ecuador and Uruguay, and two in Colombia and Chile). Moreover, this second analysis shows clearly the absence of some industries in some countries. This is the case of the rubber and plastics industry in Plurinational State of Bolivia, the metals and derived products in Uruguay, and vehicles and their parts also in Plurinational State of Bolivia, (see table 3).

With the general information of this detailed analysis at the level of intermediate aggregation, the technical team discussed the possibilities of greater sectoral opening for what would be the South American IOT, considering the feasibility of reaching the greatest disaggregation possible in some key industries such as the food sector, where it proceeded to assess the opening in meat, meat products and dairy products, flour milling, bakery and pasta, sugar and its derivatives, and other food products. For these openings, it was necessary to consult with national experts, and evaluate the possibility of using additional information provided by the statistical offices or central banks. Among the sources of information that were used intensively are the supply-use tables in their versions of products by industries or products by products. In some cases, these are presented with greater openness, enabling the aggregation of the forty sectors that were finally defined.

**Table 3**
**South America: sectoral evaluation of industries by IOT and/or SUT available, circa 2005**

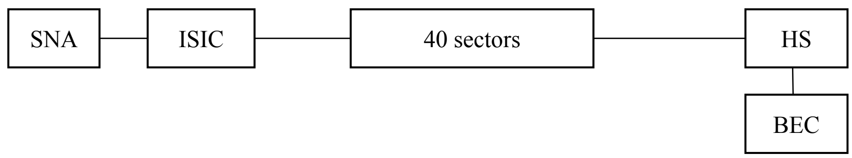
| Sector | General classification | Argentina | Bolivia (Plurinational State of) | Brazil | Chile | Colombia | Ecuador | Peru | Paraguay | Uruguay | Venezuela (Bolviarian Republic of) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| I | Agriculture, forestry, hunting and fishing | 7 | 5 | 2 | 12 | 5 | 11 | 5 | 6 | 8 | 9 |
| II | Oil and mining | 5 | 1 | 3 | 6 | 4 | 4 | 5 | 1 | 1 | 8 |
| III | Food, beverages and tobacco | 21 | 7 | 2 | 16 | 10 | 17 | 16 | 8 | 13 | 15 |
| IV | Textiles, apparel and footwear | 8 | 1 | 3 | 4 | 4 | 3 | 6 | 3 | 5 | 6 |
| V | Wood, pulp and paper | 6 | 2 | 3 | 6 | 3 | 2 | 5 | 2 | 3 | 3 |
| VI | Chemicals and pharmaceuticals | 7 | 2 | 9 | 6 | 2 | 3 | 6 | 2 | 4 | 4 |
| VII | Rubber and plastics | 4 | 0 | 1 | 1 | 1 | 2 | 1 | 0 | 1 | 2 |
| VIII | Non-metallic minerals | 4 | 1 | 3 | 4 | 1 | 2 | 3 | 1 | 1 | 7 |
| IX | Metals and derived products | 6 | 2 | 4 | 3 | 1 | 2 | 4 | 2 | 0 | 5 |
| X | Machinery and equipment | 12 | 1 | 4 | 2 | 2 | 1 | 3 | 1 | 1 | 6 |
| XI | Vehicles and their parts | 6 | 0 | 4 | 1 | 1 | 1 | 1 | 0 | 1 | 2 |
| XII | Other manufacturing | 4 | 1 | 1 | 3 | 3 | 2 | 2 | 1 | 1 | 1 |
| XIII | Electricity, gas and water | 4 | 1 | 1 | 5 | 3 | 2 | 2 | 1 | 1 | 2 |
| XIV | Construction services | 1 | 1 | 1 | 4 | 2 | 1 | 1 | 1 | 1 | 2 |
| XV | Wholesale and retail | 3 | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 2 |
| XVI | Transport services | 13 | 1 | 1 | 8 | 4 | 1 | 5 | 1 | 2 | 4 |
| XVII | Hotels and restaurants | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 |
| XVIII | Post and telecommunication services | 4 | 1 | 1 | 4 | 1 | 2 | 2 | 1 | 1 | 2 |
| XIX | Financial services and business services | 23 | 1 | 2 | 10 | 3 | 3 | 2 | 1 | 3 | 11 |
| XX | Other Services | 23 | 5 | 8 | 11 | 9 | 9 | 29 | 1 | 5 | 28 |
| | All sectors | 163 | 35 | 55 | 111 | 61 | 71 | 101 | 35 | 56 | 121 |

Source: ECLAC, based on the national IOTs and/or SUTs.

The particular decision to seek a further opening than that in table 3 was taken following the preconceived suitability of the South American IOT to work as a tool for the analysis of regional value chains in which more than one country participates. Therefore, the main criterion was the opening of both the primary industries as well as the entire manufacturing, and as far as possible the opening of the services. The only manufacturing industries from the list of the 20 sectors referred to above that remained without opening were the rubber and plastics, non-metallic minerals, and the group of other manufacturing. In the case of services, the following cases remained: electricity, gas and water, construction, transport, and postal services and communications. Meanwhile, finance and insurance were separated from business services. In addition, the sectors wholesale and retail trade, together with hotels and restaurants were added in the category of other services.

The Sectoral harmonization was facilitated by building two sets of individual converters. A first set correlates the particular classifications of the SUTs from the System of National Accounts (SNA) to the International Standard Industrial Classification (ISIC). Both classifications were normalized to the 40 sectors defined for the South American IOT. On the other hand, in order to facilitate the later work of opening trade data, a second group of converters was defined that correlated the Harmonized System (HS) with the classification of Broad Economic Categories (GCE), and with the 40 sectors identified for the South American IOT. Thus, it was possible to define two alternative ways to obtain the 40 sectors of the South American IOT (see diagram 3). The first was used to bring the national IOT towards the finally defined sectors, ensuring that all groups of goods are comparable across countries. The ISIC definitions favored this process. Moreover, with the second set of converters, it was possible to separate trade according to its broad category, namely: intermediate, capital, or consumption goods.

**Diagram 3**
**Converters applied for determining the sectors of the South American IOT**




Source: ECLAC, based on the analysis of the national IOTs and various classifications.

Table 4 shows all openings with their respective correspondences to the ISIC, revision 3.

**Table 4**
**Forty selected sectors for the assembly of a South American IOT**

| Sector | Description | Code ISIC Rev. 3 |
|---|---|---|
| s1 | Agriculture and forestry | 0111, 0112, 0113, 0121, 0122, 0130, 0140, 0200 |
| s2 | Hunting and fishing | 0150, 0500 |
| s3 | Mining and quarrying (energy) | 1010, 1020, 1030, 1110, 1120, 1200 |
| s4 | Mining and quarrying (non-energy) | 1310, 1410, 1421, 1422, 1429 |
| s5 | Meat and meat products | 1511, 1512, 1514, 1520 |
| s6 | Wheat products and pasta | 1531, 1532, 1541, 1544 |
| s7 | Sugar and confectionery | 1542, 1543 |
| s8 | Other processed food | 1513, 1549 |
| s9 | Beverages | 1551, 1552, 1553, 1554 |
| s10 | Tobacco | 1600 |
| s11 | Textiles | 1711, 1712, 1729, 1730 |
| s12 | Apparel | 1721, 1722, 1723, 1810, 1820, 1911, 1912 |
| s13 | Footwear | 1920 |
| s14 | Wood and products of wood and cork | 2010, 2021, 2022, 2023, 2029 |
| s15 | Pulp, paper, printing and publishing | 2101, 2102, 2109, 2211, 2212, 2213, 2219, 2221, 2222, 2230 |
| s16 | Coke, refined petroleum and nuclear fuel | 2310, 2320, 2330 |
| s17 | Basic chemical products | 2411, 2412, 2413 |
| s18 | Other chemical products (excluding pharmaceuticals) | 2421, 2422, 2424, 2429, 2430 |
| s19 | Pharmaceuticals | 2423 |
| s20 | Rubber and plastics products | 2511, 2519, 2520 |
| s21 | Other non-metallic mineral products | 2610, 2691, 2692, 2693, 2694, 2695, 2696, 2699 |
| s22 | Iron and steel | 2710, 2731 |
| s23 | Non-ferrous metals | 2720, 2732 |
| s24 | Fabricated metal products, except machinery and equipment | 2811, 2812, 2813, 2891, 2892, 2893, 2899 |

Table 4 (concluded)

| Sector | Description | Code ISIC Rev. 3 |
|---|---|---|
| s25 | Machinery and equipment n.e.c. (excluding electrical machinery) | 2911, 2912, 2913, 2914, 2915, 2919, 2921, 2922, 2923, 2924, 2925, 2926, 2927, 2929, 2930 |
| s26 | Office, accounting and computing machinery | 3000 |
| s27 | Electrical machinery and apparatus, nec | 3110, 3120, 3130, 3140, 3150, 3190, 3210 |
| s28 | Radio, television and communication equipment n.e.c. | 3220, 3230 |
| s29 | Medical, precision and optical instruments | 3311, 3312, 3313, 3320, 3330 |
| s30 | Motor vehicles, trailers and semi-trailers | 3410, 3420, 3430 |
| s31 | Aircraft and spacecraft | 3530 |
| s32 | Other transport equipment | 3511, 3512, 3520, 3591, 3592, 3599 |
| s33 | Manufacturing n.e.c.: recycling (including furniture) | 3610, 3691, 3692, 3693, 3694, 3699, 3710, 3720 |
| s34 | Electricity and gas | 4010, 4020, 4030 |
| s35 | Construction | 4510, 4520, 4530, 4540, 4550 |
| s36 | Transportation | 6010, 6021, 6022, 6023, 6030, 6110, 6120, 6210, 6220, 6301, 6302, 6303, 6304, 6309 |
| s37 | Post and telecommunication | 6411, 6412, 6420 |
| s38 | Finance and insurance | 6511, 6519, 6591, 6592, 6599, 6601, 6602, 6603, 6711, 6712, 6719, 6720 |
| s39 | Business services of all kinds | 7010, 7020, 7111, 7112, 7113, 7121, 7122, 7123, 7129, 7130, 7210, 7220, 7230, 7240, 7250, 7290, 7310, 7320, 7412, 7413, 7414, 7421, 7422, 7430, 7491, 7492, 7493, 7495, 7499 |
| s40 | Other services | 4100, 5010, 5020, 5030, 5040, 5050, 5110, 5121, 5122, 5131, 5139, 5141, 5142, 5143, 5149, 5150, 5190, 5211, 5219, 5220, 5231, 5232, 5233, 5234, 5239, 5240, 5251, 5252, 5259, 5260, 5510, 5520, 7411, 7494, 7511, 7512, 7513, 7514, 7521, 7522, 7523, 7530, 8010, 8021, 8022, 8030, 8090, 8511, 8512, 8519, 8520, 8531, 8532, 9000, 9111, 9112, 9120, 9191, 9192, 9199, 9211, 9212, 9213, 9214, 9219, 9220, 9231, 9232, 9233, 9241, 9249, 9301, 9302, 9303, 9309, 9500, 9900 |

Source: ECLAC, based on the national IOTs and/or SUTs. The final aggregation and/or disaggregation was performed taking into account the work of the respective national teams as a starting point.

The first opening was made in the Macrosector of agriculture, forestry, hunting and fishing. It was split and entered disaggregated into the first two sectors of the regional IOT:

Sector 1: agriculture and forestry includes several crops (cereals, vegetables and legumes and fruits, plants) as well as livestock breeding, forestry and related services. This opening was the minimum that could be done. Coming up with higher openings was not possible due to the cases of Brazil, Colombia, and Plurinational State of Bolivia, which present fewer sectors than all other countries. The dissimilar agricultural structures do not allow finer sectoring, as for example the sector coca is only included in the IOT of Plurinational State of Bolivia, while Colombia, has opened the sector of coffee products, and Argentina has an opening for the case of soybeans. These three cases do not coincide with any other national IOTs.

Sector 2: hunting and fishing. It includes the trapping and related activities as well as marine fisheries and aquaculture. In Ecuador, Chile and Peru, the fisheries sector is of greater relative importance than in other countries. Not so in the case of the rest of South America, where sectoral structures have less subsectors.

A second opening corresponded to the macrosector oil and mining that was subdivided into two new sectors:

Sector 3: mining and quarrying (energy). This sector, in addition to the extraction of crude oil and natural gas and the extraction of various minerals linked to power generation, includes: coal, lignite, peat, uranium and thorium, and service activities related to such extraction, especially of oil and gas.

Sector 4: mining and quarrying (non-energy). It includes the extraction of various minerals: iron ore, non-ferrous metal ores, extraction of stone, sand and clay, mining for making fertilizers, salt, and mining and quarrying.

The macrosector III, corresponding to foodstuff, beverages and tobacco was opened in six subsectors: sector 5: meat and meat products, sector 6: wheat products and pasta, sector 7: sugar and confectionary, sector 8: other processed food, sector 9: beverages, and sector 10: tobacco.

The six sub-sectors identified are largely complementary and sufficient for deepening the analysis of productive linkages and value chains in South America, especially in some particular areas of interest in a large number of countries for which agribusiness is highly relevant. Argentina, Chile, Ecuador, Peru, Uruguay and Bolivarian Republic of Venezuela, have, in particular, more than 15 sectors in their national matrices. As an example, it is indicated that the sector of sugar and confectionery provides intermediate inputs to other sectors of this macrosector, especially to wheat products and pasta, as well as drinks.

Meanwhile, the macrosector IV: textiles, apparel and footwear resulted in three sectors: sector 11: textiles, sector 12: apparel and the sector 13: footwear. Note that the three sectors considered also directly connect to the category of intermediate inputs. Thus, they enable analyses of intra-industry linkages in the provision both of domestic and imported inputs to the same macrosector, as well as to others out of the 40 sectors of the regional IOT.

The macrosector V: wood, pulp and paper, was separated into two sectors: sector 14: wood and products of wood and cork and the sector 15: pulp, paper, printing and publishing. The logic of this opening followed the intention to capture the interaction between the two sectors of the highest importance and complementarity of the macrosector. Both subsectors, in addition to their own intersectoral linkages, are themselves suppliers of semi-finished and industrial intermediate inputs for other economic sectors. This holds especially in the case of the wood pulp industry, including paper and cardboard, that provides transverse inputs for a wide number of additional manufacturing sectors. A favorable element of this opening was that exactly the two chosen sectors were the lowest common denominator for the ten countries considered. Plurinational State of Bolivia, Ecuador and Paraguay for their part only showed these two sectors in their respective IOT. To deepen the analysis using a greater opening, one would have to consider the national IOTs. However, this had been only possible for the cases of Argentina, Chile, and Peru, where a greater sectoral disaggregation exists.

In the case of chemicals and pharmaceutics (extended chemistry), macrosector VI, an opening in 4 sectors was performed. Such disaggregation followed the logic of separating different levels of added value. First, the sectors related to energy from fuels were included, sector 16: coke, refined petroleum and nuclear fuel. All countries have this sector individualized in their IOTs and/or national SUT. The oil-exporters (Argentina, Brazil, Colombia, Ecuador, and Bolivarian Republic of Venezuela) as well as Chile even have it more desaggregated.

A second subsector considered, the sector 17: Basic chemical products, included the segment of the basic raw materials (polymers, vinyls, polyurethane, among others) originated in the petrochemical industry and which, in turn, are inputs for other industries such as those of rubber and plastics, or even of food. The basic chemical industry is important in the cases of Argentina, Brazil, Colombia and Chile.

Another subsector considered for the opening of the extended chemistry was the sector 18: other chemical products that specifically considers other manufacturing derived from chemicals such as cleaning supplies, pesticides, paints, varnishes, and the production of artificial fibers. It shall be clarified that in this sector, some national cases required openings due to the fact that in many countries these products were aggregated together with pharmaceuticals. In this case, it was necessary for the national teams (Plurinational State of Bolivia, Colombia, Chile and Paraguay) to undertake openings of the sectors.

Sector 19: pharmaceuticals. It includes the manufacture of medicinal chemicals, and pharmaceutical manufacturing.

In the cases of rubber and plastics products (sector 20) and other non-metallic mineral products (sector 21) no opening was performed. These two sectors are identical to the groups in table 3 and correspond to sectors VII and VIII of the list of macrosectors evaluated for the selection exercise. The reason for not applying an additional opening for these sectors is due to the practical impossibility of materializing new openings. For example in the case of rubber and plastics, only Argentina, Ecuador and Bolivarian Republic of Venezuela, show higher openings, while in Plurinational State of Bolivia, as well as Paraguay this sector does not exist. In the rest of the countries, the industry exists as an aggregate. A similar situation occurred when evaluating the openings of non-metallic minerals.

Metals and derived products, macrosector IX, was opened in 3 sectors, starting from the segment of the industry that adds less value to the one of further elaboration. Of all the countries considered, the biggest challenge in opening the sector was found in the case of Colombia, where the complete macrosector was concentrated in one large sector. The opening and sectoral separation by degree of elaboration was clearly deliberate with the objective to obtain the map of the South American productive structure as open as possible. This is expected to make visible the highest possible number of productive links among the countries of South America. Clearly, some countries in South America have industries in more than one of the three sectors considered, and these are important:

Sector 22: iron and steel includes the segment of basic iron and steel industries and iron smelting. The countries for which this sector is most important in South America are Argentina, Brazil, Peru and Bolivarian Republic of Venezuela.

Sector 23: non-ferrous metals includes non-ferrous metal smelting and the manufacturing of primary products of precious and non-ferrous metals. Regarding these productos there was the need for opening in the cases of Plurinational State of Bolivia, Colombia and Uruguay.

Sector 24: fabricated metal products. This sector includes a wide range of fabricated metal products like tanks, metal structures, metal sheeting, cutlery, pipes, among other products.

The opening of the macrosector machinery and equipment resulted in five sectors: sector 25: machinery and equipment (excluding electrical machinery), sector 26: office, accounting and computing machinery, sector 27: electrical machinery and apparatus, sector 28: radio, television and communication equipment, and sector 29: medical, precision and optical instruments. All these sectors are of particular interest to the productive structure of the countries of greater relative size in South America, as they have much more developed heavy manufacturing industries than the subregion's countries of smaller scale. Still, small countries could somehow be included in the production functions of some segment of the production chain of the industries established by these five particular sectors.

The macrosector vehicles and their parts were transformed into 3 sectors: sector 30: motor vehicles, trailers and semi-trailers, sector 31: aircraft and spacecraft, sector 32: other transport equipment. This opening is of particular interest to identify high-technology intersectoral relationships in South America, and also to identify areas of cooperation in the demand/supply of intra-regional inputs.

Other manufacturing (sector 33), electricity and gas (sector 34) and construction services (sector 35), transportation (sector 36), and post and telecommunication (sector 37) were not modified.

Finally, sectors 38, 39 and 40 were added following the ISIC, Rev. 3, nomenclature as indicated in table 4. It is noted that the sector 40 incorporates all those service sectors that were not considered in the other sectors of the above mentioned services.

As anticipated, the particular breakdown of all sectors into its final classification of 40 sectors follows the logic to facilitate analyses of sectoral linkages of both goods and services related to trade between the countries of South America at the highest degree of disaggregation possible.

From the specific information of each country, and based on the 40 sectors selected for the South American IOT, each team performed an exercise to construct all sectors for their corresponding tables of total supply, intermediate use, final demand, and value added. As it had been the case in the preliminary exercise, it was necessary to perform various types of special arrangements to achieve full homogenisation of all sectors in all countries. Basically four types of exercises were applied:

i) Fusion (F). Two or more sectors were aggregated to coincide with one of the 40 sectors identified above. This process is straightforward and consists of adding sectors of the relevant national IOTs. Among the 40 defined sectors, those that were mostly aggregated from other sectors include: agriculture and forestry; mining (energy), mining (non-energy); other food products; rubber and plastics products; business services, and other services (see table 5).

ii) Opening (O). For cases where a particular sector of a national IOT incorporated more than one of the 40 identified sectors it was necessary to perform a separation process of the sectors. In that case, it was necessary that national teams will make the openings and/or corresponding ramifications on the basis of the information by products of the supply-use tables. In some cases, it was necessary to perform a special analysis of production volumes to determine the structure of the new subsectors. The cases of drinks and tobacco in Peru, vehicles and their parts in Brazil and the Substances and chemicals in the IOT of Colombia are cited as examples. In all cases, the aggregate sectors of the national IOT had to be broken down into more than one sector (Beverages and Tobacco in the case of Peru; Aircraft and spacecraft and Motor vehicles in the case of Brazil; and Basic chemical products, Other chemical products, and Pharmaceuticals in the 40x40 IOT of Colombia). As in these three cases, similar openings in other sectors and countries were performed (see table 5).

iii) Direct allocation (D). In cases where sectors of the IOT and/or supply-use tables had the same sector opening as the one indicated in the 40 sectors defined for the South American IOT, the allocation was done directly without the requirement to add and/or disaggregate the sectors as in the previous cases. Some of the cases for which this criterion could be mostly applied were: non-ferrous metals, construction, transportation, and communication, among others.

iv) Sector with no production (NP). For some countries, and in exceptional cases, sectors were identified for which there was no significant production. This appeared in specific and limited sectors such as mining (non-energy) in the case of Uruguay, and sectors of medium and high technology manufacturing. The latter ones included in particular: radio, television and telecommunication equipment in the IOT of Plurinational State of Bolivia, Colombia and Bolivarian Republic of Venezuela, and the aircraft industry in Ecuador and Bolivarian Republic of Venezuela. (see table 5). In all these cases, the assigned values were zero, indicating no production.

**Table 5**
**South America: final scheme of the mapping of national IOTs to a South American IOT, 2005**

| Sector IOT | Description sector | Argentina | Brazil | Bolivia (Plurinational State of) | Chile | Colombia | Ecuador | Paraguay | Peru | Uruguay | Venezuela (Bolivarian Republic of) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s1 | Agriculture and forestry | F | D | F | F | F | F | F | F | F | F |
| s2 | Hunting and fishing | F | D | D | D | D | F | D | F | F | F |
| s3 | Mining and quarrying (energy) | D | D | F | F | F | F | NP | F | NP | F |
| s4 | Mining and quarrying (non-energy) | F | F | D | F | F | F | D | F | O | F |
| s5 | Meat and meat products | D | O | F | D | D | D | D | D | D | D |
| s6 | Wheat products and pasta | F | O | D | F | D | F | D | F | F | F |
| s7 | Sugar and confectionery | F | O | D | D | D | F | D | F | D | F |
| s8 | Other processed food | F | O | D | F | F | F | F | F | F | F |
| s9 | Beverage | F | O | D | F | D | F | O | F | F | F |
| s10 | Tobacco | D | D | D | D | D | D | O | D | D | D |
| s11 | Textiles | F | D | O | F | F | F | O | F | F | F |
| s12 | Apparel | D | D | O | D | D | D | O | D | D | D |
| s13 | Footwear | F | D | O | D | D | D | D | F | F | D |
| s14 | Wood and products of wood and cork | F | D | D | D | D | D | D | F | D | D |
| s15 | Pulp, paper, printing and publishing | F | F | D | F | F | D | D | F | F | F |
| s16 | Coke, refined petroleum and nuclear fuel | D | D | D | D | D | D | D | D | D | D |
| s17 | Basic chemical products | F | D | O | D | O | D | O | F | F | D |
| s18 | Other chemical products (excluding pharmaceuticals) | F | F | O | O | O | D | O | F | F | F |
| s19 | Pharmaceuticals | D | D | O | O | O | D | O | D | D | D |
| s20 | Rubber and plastics products | F | D | O | F | D | F | O | F | F | F |
| s21 | Other non-metallic mineral products | F | F | D | F | D | F | D | F | D | F |
| s22 | Iron and steel | D | D | O | D | O | D | O | D | O | F |
| s23 | Non-ferrous metals | D | D | O | D | O | D | O | D | O | D |
| s24 | Fabricated metal products, except machinery and equipment | F | D | O | D | O | D | O | F | O | D |
| s25 | Machinery and equipment nec (excluding electrical machinery) | F | D | O | D | D | D | O | F | O | F |
| s26 | Office, accounting and computing machinery | D | D | O | O | O | D | O | O | O | D |
| s27 | Electrical machinery and apparatus, nec | F | F | O | O | O | D | O | D | O | D |
| s28 | Radio, television and communication equipment nec | F | D | NP | O | NP | D | O | O | O | NP |
| s29 | Medical, precision and optical instruments | D | D | O | O | O | F | NP | O | O | D |
| s30 | Motor vehicles, trailers and semi-trailers | F | F | O | O | O | D | NP | O | O | D |
| s31 | Aircraft and spacecraft | D | D | O | O | O | NP | NP | O | O | NP |
| s32 | Other transport equipment | D | D | O | O | O | D | O | O | O | D |

Table 5 (concluded)

| Sector IOT | Description sector | Argentina | Brazil | Bolivia (Plurinational State of) | Chile | Colombia | Ecuador | Paraguay | Peru | Uruguay | Venezuela (Bolivarian Republic of) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s33 | Manufacturing nec; recycling (including furniture) | F | D | D | F | F | F | D | F | D | F |
| s34 | Electricity and gas | F | D | D | F | F | D | O | D | D | D |
| s35 | Construction | D | D | D | D | F | D | D | D | D | F |
| s36 | Transportation | F | O | D | F | F | F | D | F | F | F |
| s37 | Post and telecommunication | F | O | D | D | D | F | D | F | D | F |
| s38 | Finance and insurance | F | D | D | F | D | F | D | F | D | F |
| s39 | Business services of all kinds | D | F | F | D | D | D | F | F | D | F |
| s40 | Other services | F | F | F | F | F | F | F | F | F | F |

Source: ECLAC, based on the national IOTs and/or SUTs. The final aggregation and/or disaggregation was performed taking into account the work of the respective national teams as a starting point.

## D. Opening of the imports and exports by country/region of origin and destination

The opening of the data on international trade in goods and services by origin and destination stemming from national SUTs/IOTs is a key step in the construction of the South American IOT, as these flows allow connecting the various national IOTs. This provides intersectoral linkages not only in the intermediate use of domestic inputs, but also in the vector of intermediate inputs imported from diverse origins. The same principle applies for inter-sectoral linkages on the export-side. The disaggregated data for all countries in South America were obtained from the database of trade of the Latin American Integration Association (ALADI).

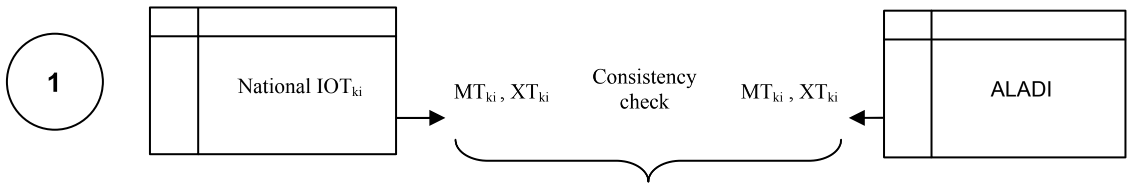
Diagram 4 shows the procedure for opening trade vectors in detail. The first step was comparing the structures of trade (exports and imports) in the official database of the IOT of each country against the structure of trade in the ALADI database. In this consistency check, the vectors corresponding to the structuress of the two data sources were compared for each sector *k* of the 40 IOT sectors. Note that at this point it was necessary to use trade converter that maps from HS to ISIC, and that in turn considers the type of good by economic category, i.e. whether it deals with intermediate goods, capital goods or goods for final consumption.[8]

After verifying the consistency of the structures, the following process involved the application of the totals of the vector of imported intermediate use, together with the structure of imports by origin separated into intermediate goods, goods for final consumption and capital goods as taken from the ALADI data base. With this procedure, a matrix of is constructed corresponding to the imported intermediate goods used as part of the sectoral production function.

[8] Section IV presents the results obtained from this check in detail.

**Diagram 4**
**Methodology applied for the opening of the imported intermediate use and the final demand**

**VALIDATION**



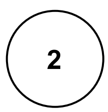

$$sM_{ki-IOT} \approx sM_{ki-ALADI} ,$$

$$sX_{ki-IOT} \approx sX_{ki-ALADI} ,$$

where $$sM_{ki-IOT} = \frac{M_{ki-IOT}}{MT_{i-IOT}} ; sM_{ki-ALADI} = \frac{M_{ki-ALADI}}{MT_{i-ALADI}} ;$$

$$sX_{ki-IOT} = \frac{X_{ki-IOT}}{XT_{i-IOT}} ; \quad sX_{ki-ALADI} = \frac{X_{ki-ALADI}}{XT_{i-ALADI}} .$$

**OPENING**




$$M_{kij-IOT} = MT_{ki-IOT} * sM_{kij-ALADI} ,$$

$$XM_{kij-IOT} = XT_{ki-IOT} * sX_{kij-ALADI} ,$$

where $$sM_{kij-IOT} = \frac{M_{kij-IOT}}{MT_{ij-IOT}} ; sM_{ki-ALADI} = \frac{M_{kij-ALADI}}{MT_{ij-ALADI}}.$$

*sM* = share in total imports;

*sX* = share in total exports;

*M* imports; *X* exports;

*MT* total imports;

*XT* total exports;

*k* a subindex that identifies the sectors of the IOT;

*i* a subindex that identifies the countries of the IOT; and

*j* a subindex that identifies the origin/destination of the imports/exports.

Source: ECLAC, own elaboration.

As is recorded, detailed information on imports and exports of the ALADI database was used to open the tables and vectors of intermediate use (at CIF prices), of final demand exported to the countries included in the IOT and of imports and exports by country of origin or destination, respectively. Thus, for each country included in the South American, IOT sub-tables and sub-vectors of imports and exports were constructed: one for each country/region of origin or destination, respectively, considering the other Latin American countries included in the South American IOT and the rest of the world. This was done to bring forward the work for the eventual expansion of the IOT to a complete Latin American one and its linkage to some of the ongoing global IOT projects. Later on, this could give ease to explore intersectoral links with third countries outside the region. Trade with the rest of the world was then unbundled into a set of regions. Namely: Mexico, Central American Common Market, Caribbean Community (CARICOM), rest of Latin America and the Caribbean, the United States, Canada, European Union, China, rest of Asia and rest of World. The values of the flows of the reporting countries were harmonized with the mirror statistics from the trading partners. This was done to ensure consistency between the different national IOTs.

For those countries where disaggregated information about intermediate and final use separated in domestic and imported parts were not available, it was necessary for the teams to obtain such information from the agencies responsible for the national accounts statistics of each country. Where this was not possible, imports were divided into three categories of use (intermediate consumption, final consumption and capital goods) according to the classification by Broad Economic Categories (revision 3 of the BEC classification provided by the UN). From that, a unique structure of international supply was applied to each category.[9]

Once the sub-tables at CIF prices were obtained, data were converted to FOB prices. In this process the import data provided by ALADI were used, where FOB imports can be found. The ratio $CIF_{ALADI} / FOB_{ALADI}$ was applied to the CIF import data of the national IOTs. Then, the tables of imported use (FOB) were calculated and the vector of freight and insurances was obtained as the difference.

One of the challenges of the assembly exercise occurred in the opening of trade in services, because information about bilateral trade in services does not exist in all cases. In the region, only three countries report information for their services statistics: Brazil, Chile and Colombia.

For the unbundling of services imports by origin, a methodology was followed that combined the data available from the balance of payments with some ad-hoc criteria applied on the basis of sectoral assumptions. Table 6 shows the correspondence of the sectors considered in the 40x40 IOT with ISIC, Rev. 3, at the 3-digit level and the sources of the balance of payments. This was the main source used for the opening of the services, which are reported by each country to the United Nations Service Trade Database.[10] Since the reporting of the countries refers to the flows opened by sectors only to the world, and does not include breakdown of exports/imports by destination/origin, it was necessary to perform particular estimates for this dimension in each of the sectors. Here, the total exports of a sector to the world were used as reference.[11]

**Table 6**
**Services sectors IOT 40: correspondence to balance of payments**

| IOT 40 | Services sectors | ISIC Rev.3 | Balance of payment |
|---|---|---|---|
| 34 | Electricity and gas | 401,402,403,410 | |
| 35 | Construction | 451,452,453,454,455 | 249 |
| 36 | Transportation | 601,602,603,611,612,621,622,630 | 205 |
| 37 | Post and telecommunication | 641,642 | 245 |
| 38 | Finance and insurance | 651,659,660,671,672 | 260,253 |
| 39 | Business services of all kinds | 701,702,711,712,713,721,722,723,724,725,729,731,732, 741,742,743,749 | 275,276,277, 278,280,284 |
| 40 | Other services | 501,502,503,504,505,511,512,513,514,515,519, 521,522, 523,524,525,526,551,552,801,802,803,809,851,852,853, 900,911,912,919,921,922,923, 924,930,950,990 | 236,263,289 |

Source: ECLAC, based on the national IOTs and/or SUTs. The final aggregation and/or disaggregation was performed taking into account the work of the respective national teams as a starting point.

9 The importance of each trading partner as source of imports is different for each of the three categories. The distribution of imports within each category of use is done by assuming proportionality of imports, which implies the hipothesis that an industry uses an import of a particular product in proportion to its total use of that product, see Timmer (2012).

10 This database is now available online at: comtrade.un.org/data/ (Type of product: services).

11 See Bullón et al. (2015).

In the cases of electricity and gas, as well as in the sector of construction, it was chosen only to report the total value traded with the world, because the values reported in the balance of payments for such services are very small, almost nonexistent, or are recorded in the account of other business services, for example. Exceptionally, these more detailed data are only available when in the original table prepared by the national team, bilateral flows are reported. Note that this is the case for the complete flows for all sectors of the IOT of Colombia.

For the transport sector, the only countries that have trade data by trading partner are Chile and Colombia. Total flows of trade sector services reported by the Central Bank of Chile are consistent, as expected, with the totals reported in its balance of payments, but unfortunately this information is only available starting in 2008. Therefore, for estimating the data corresponding to 2005, the structure of trade flows of this year was applied. The data obtained from the Quarterly Sample of Services prepared by DANE (Statistical Institute of Colombia) have the disadvantage that the sectoral totals are not equal to those reported by the Bank of the Republic of Colombia in its balance of payments, as this latter uses administrative records. Given this limitation, the trade structure by trading partner as reported by DANE was used. For the remaining countries, data were estimated using the records of freight value as obtained from the ALADI database (imports). As there is neither a record of the company hired to perform the export of the service nor of its nationality, it was assumed that who exports the good also exports the transportation service. Formally, the estimate was performed by applying a weighting that reflects the structure of business partners according to the reported freight value. The final distribution was made based on the total of each national IOT as already indicated in diagram:

$$\text{Equation 1}: \; sms_{ij} = \frac{Freight{-}M_{ij-ALADI}}{Freight{-}MT_{-ALADI}};$$

where

*sms* = share of transportation services imports;

$Freight\text{-}M_{ij}$ = Freight paid for the import of goods of a country *j* (ALADI database); and

$Freight\text{-}MT_i$ = Total freight paid for the imports by country *i*.

The sector post and telecommunication was completed with official data from the Central Bank of Brazil and the Quarterly Sample of Services of DANE. In the remaining countries, bilateral trade in communication was estimated using the trade in goods complementary to this activity. In this case, the group 764 of SITC, Rev. 3, was considered: telecommunications equipment and parts and pieces. Thus, the structure of these bilateral trade flows of goods of group 764 was applied to calculate the flow of communications using the totals reported by the balance of payments. To get to the final values for the South American IOT by partner, the same logic as in the case of transportation was applied, i.e., multiplying the total registered in each national IOT by the weighting obtained from the relative share of each country in the trade of group 764.

For the finance and insurance sector, the only country that reported official data is Brazil. It was necessary to make specific estimates for the remaining countries. In this case, the estimator used was obtained from bilateral flows of Foreign Direct Investment. These data are available for virtually all countries except Bolivarian Republic of Venezuela. Investment inflows therefore are a proxy of exports and outward investment similarly for imports. As Bolivarian Republic of Venezuela, does not provide this information, the mirror information reported by other countries was used.

In the case of the business services of all kind, official information of the Central Bank of Brazil, the Quarterly Sample of Services from DANE and the Central Bank of Chile (data from 2008-2013) was used. As noted above, in the latter country the structure of trade in 2008 was applied to reconstruct the flows of trade for 2005; in addition, the available data only report information on exports.

For the sector of other services that accounts for government services, computer and information services, royalties and licenses, personal and cultural services and travel, tourism was used as a proxy. This is, on the one hand, due to the heterogeneity and lack of official data and, on the other hand, due to the importance of tourism within this group of services, as the travel account represents on average more than 80% in the set of South American countries. Thus, a table of trade in travel services was built using inbound and outbound tourism statistics by nationality of Argentina, Uruguay, and Bolivarian Republic of Venezuela, together with the information on the same statistics provided by the World Tourism Organization. In the case of Argentina, Chile and Uruguay, statistics on spending and average length of stay by partner country were employed. The formal procedure for making the estimates followed the method previously mentioned to obtain weights on the basis of bilateral trade flows estimated using the travel account. Then, the weights were used to build the flows of each partner by multiplying it with the value of the total of the group of other services recorded in the IOT of each country.

## E. Construction of a South American IOT

At this stage, the national SUTs/IOTs (harmonized in terms of the reference year, the valuation in current dollars at basic prices and the sectoral structure) were combined with the bilateral trade data (organized into sub-tables and sub-vectors of imports and exports) to build a "standardized" and open IOT for each country. This harmonized IOT, in turn, can then be integrated with the IOTs of the remaining countries in South America.

The South American IOT is constructed from these homogeneous versions of national IOTs that consider the aggregation of the 40 sectors detailed above.

The first step to proceed with the purpose of the assembly of the IOTs, is, as already said, verifying that for each country to join, the reference year is actually 2005, so that the structure of sectoral output for the 40 sectors is effectively representative of that year. Each team made the adjustment to that year using particular official information of the country and the structure of the matrix of technical coefficients for both domestic and imported intermediate use.

Specifically, the transformation process began with obtaining the "margins" of the IOT 2005. These comprehend data referring to gross value of production (GVP), the added value of production, the imports, the taxes and subsidies on goods, and the intermediate consumption of each of the 40 sectors at the column-level. Information from the national accounts (provided by the country either by the Central Bank or the Institute of Statistics) on production levels (GVP) and gross value added per sector was used for this. Hereby, an adjustment of sectors to correspond to the 40 sectors identified for each IOT was undertaken when the change of the base was necessary.

At the row-level, the data making up the margins are the components of final demand, i.e. final consumption, investment and exports. Once the margins of 2005 broken down into 40 sectors were obtained together with the structural matrix (or matrix of technical coefficients) of the year for which it was available, each team was able to estimate the relations of purchases-sales between sectors from a method suitable for this purpose. In general, three altenative methods could be used. However, the RAS method was used predominantly. Table 6 schematically shows the characteristics used by each national team, both for the use of the structural matrix of technology and the year for which it is available, as well as for the source of the data to complete the margins. In each case, the method used by each team to complete the new matrix suitable for 2005 is explicitly stated. Overall, the most commonly used method is the RAS (see table 7).

**Table 7**
**Methods applied for the transformation of national IOTs to a common base year (2005)**

| Country | Reference year of the technology | Official source of "margins" 2005 | Method of transformation |
|---|---|---|---|
| Argentina | 2004 | Instituto Nacional de Estadísticas y Censos de Argentina (INDEC) | RAS |
| Bolivia (Plurinational State of ) | 1990 | Instituto Nacional de Estadística de Bolivia (INE) | RAS and benchmark technology |
| Brazil | 2005 | Instituto Brazileiro de Geografia e Estatística (IBGE) | Direct allocation |
| Colombia | 2005 | Departamento Administrativo Nacional de Estadística de Colombia (DANE) | Direct allocation |
| Chile | 2003, 2008 | Banco Central de Chile | RAS and interpolation |
| Ecuador | 2007 | Banco Central del Ecuador | RAS |
| Paraguay | 1997 | Banco Central del Paraguay | RAS |
| Peru | 2007 | Instituto Nacional de Estadística e Informática del Peru (INEI) | RAS |
| Uruguay | 2005 | Banco Central del Uruguay | Direct allocation |
| Venezuela (Bolivarian Republic of) | 1997 | Banco Central de Venezuela | RAS |

Source: ECLAC, based on the national IOTs and official information.

# III. Assembly of the South American Regional IOT

The analysis of production chains within and outside of Latin America and the Caribbean requires a regional IOT. For now, it is possible to construct such an IOT for a maximum of seventeen countries (see annex 1). The regional IOT could be connected to WIOD or TIVA for international analysis. However, progress in this direction will require the cooperation of the national statistical authorities.

The assembly of the regional IOT involves consolidating parts of the national IOTs into a single one. It is, thus, necessary to separate national IOTs in sub-tables and/or vectors. Those are made from a homogeneous master file in Excel for incorporating information from national teams. This file is used for the assembly of the regional IOT. Diagram 5 shows a reduced model of the procedure.[12]

The regional IOT can be separated into four major quadrants: the quadrant of intermediate use, that of end-use, that of value added and other taxes and finally that of production vectors.

The first step in the assembly of the regional IOT was placing the vectors of total production of each country in the corresponding cells. These vectors are used as an anchor in the assembly. Their values do not change under any circumstances and are the same as those of national IOTs. For that reason, the sum of supply (the columns) of one sector of a country must be equal to the value of total production of the same sector and the same country. The same should apply in the case of demand.

The second step invcluded copying the vectors of value added together with their components (compensation, gross operating surplus and taxes less subsidies), the vector of other taxes less subsidies and the vector of insurance and freight.

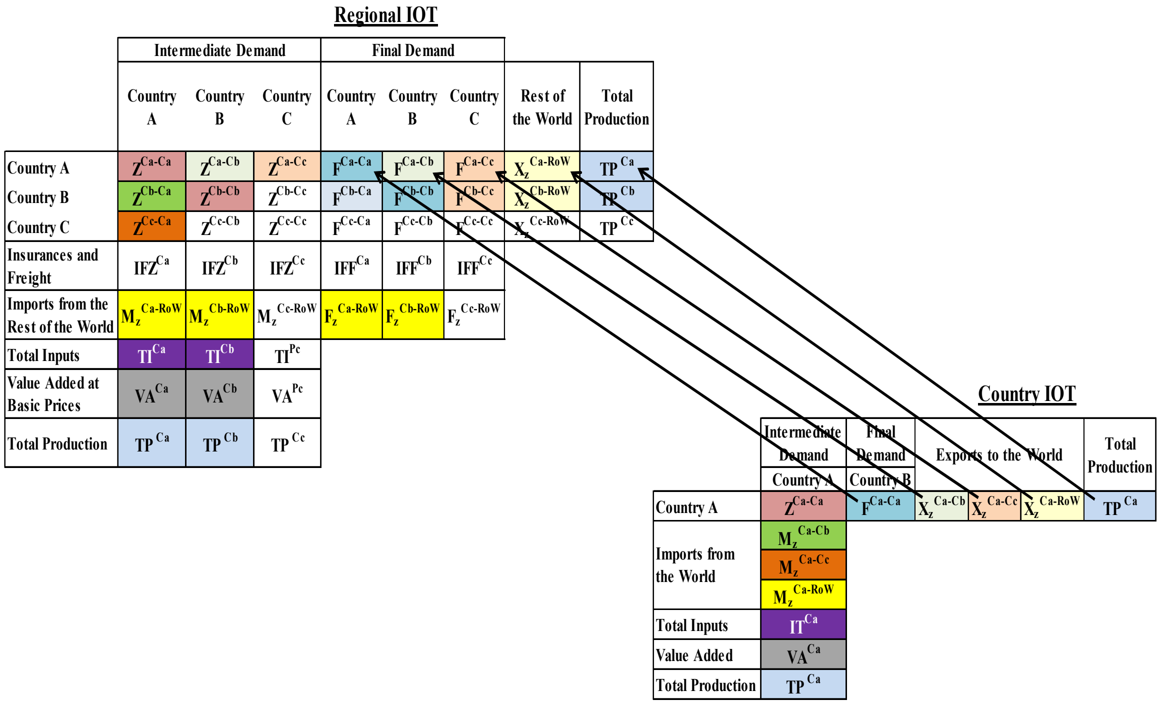
The next step is to move the tables of both domestic and imported intermediate use.[13] Thus a large quadrant of South American intermediate use remains, where the main diagonal is the national intermediate use of each of the countries and the rest of the tables are the productive interrelations of the countries of South America. All these tables are in basic prices and in current dollars.

[12] This is a reduced diagram of an IOT of 3 countries. Subfigure A shows the assembly of the supply side while subfigure B shows the assembly of demand.

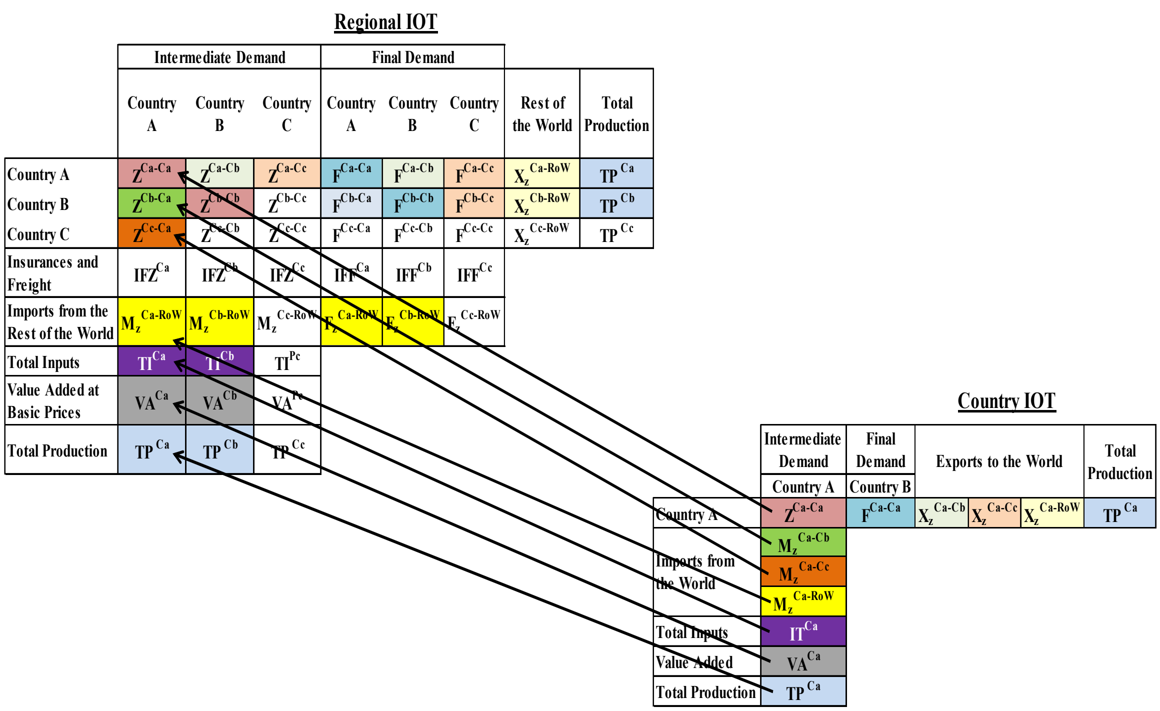
[13] The tables of imported intermediate use are the result of what has been explained earlier. The intermediate use for the remaining 9 partners in South America were obtained, plus Mexico, the Central American Common Market (Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama), CARICOM, rest of Latin America and the Caribbean, the United States, Canada, European Union (28), China, rest of Asia and rest of the World.

**Diagram 5**
**Assembly of the national IOTs to the regional IOT**

A. Assembly of supply




B. Assembly of demand




Source: ECLAC, own elaboration.

The last step regarding the supply side is assembling the vectors of insurance and freight and of other taxes on products. Once this process is complete, a check of the total is performed.[14]

In the case of the demand side, the first step in the assembly is completing the South American IOT with the vectors of domestic final demand. Then, the final demand exported to the partner countries of the IOT was completed. The national teams provided the exports distinguished between intermediate and final goods.

Using the WIOD converter discussed above and the ALADI export databases, the next step included the opening of exports of final goods of the national IOTs, into exports of consumption goods and capital goods. After this opening, the same strategy to distribute the geographical participation was applied as in the case of the imports of intermediate goods. Then, South American IOT was completed with this information.

Finally, the vector of exports to the rest of the world was calculated. Using the official data and the data structure of ALADI, the exports by use were calculated for each of the other countries participating in bilateral trade. After calculating that value, all vectors of exports by use were grouped into a single vector of exports by country.

After the construction of the necessary data for the South American IOT and the assembly itself, balancing the IOT is required. As previously said, the only data of the national teams that were modified in the process of construction and assembly are the exports of intermediate goods to members of the IOT, which are replaced by imports of intermediate goods from partners. As will be mentioned below, the mirror statistics of international trade are far from perfect and, therefore, discrepancies appear, which can usually be attributed to several factors such as differences in the months of departure and arrival of the goods. For example: in country A, the export is recorded in a month in the last quarter of a given year (e.g. 2005), while in country B, it is recorded as an import when the merchandise arrives and passes the customs process, which could well be in the first quarter of the next year compared to the one in country A. Other reasons include differences in classifications of goods, the use of another country as an intermediate destination of the goods, freight passing the customs process after several months staying in customs warehouses, among others.[15] It was checked that such differences do not exceed +/- 5% of the sector's Gross Value of Production (GVP).[16] At this first stage, these discrepancies were captured in a vector denominanted preliminary statistical adjustment.

The assembly process was performed by a programming routine using the software Stata. Such routine is performed in a master file that is feeded from other files. In total, there are 41 routines files, or do-files, and 10 Excel files that serve as input for the construction and assembly process.[17]

The diagram of the routine of constructing the files needed for later assembly has the following order: first, the import of data files provided by the national teams in individual Stata files is performed (see diagram 6). Then, in cases where necessary, transformations were performed, thus obtaining new Stata files (see diagram 7). Last, the final assembly of the IOT is performed (see diagram 8). Note that the files in diagrams 6-8 are labeled according to their Spanish original names.

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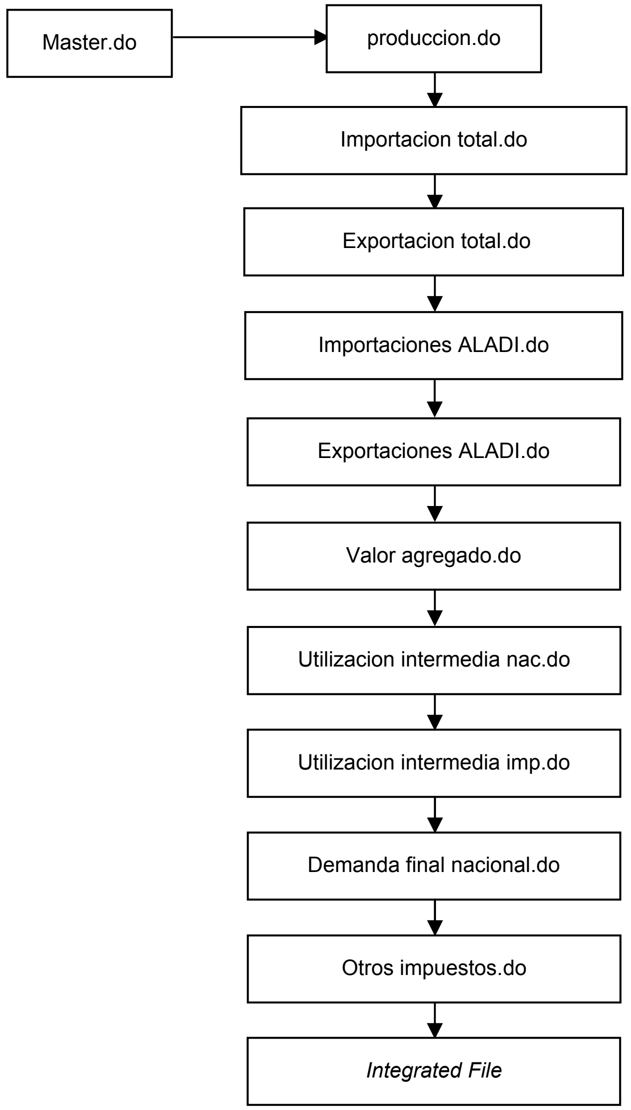
14 In the next section, the checks performed are discussed more detailedly.

15 For a review of greater detail regarding the origin of this type of differences, we refer the interested reader to: unstats.un.org/unsd/tradekb/Knowledgebase/50657/Bilateral-asymmetries.

16 This was verified for at least 90% of the sectors in the IOT.

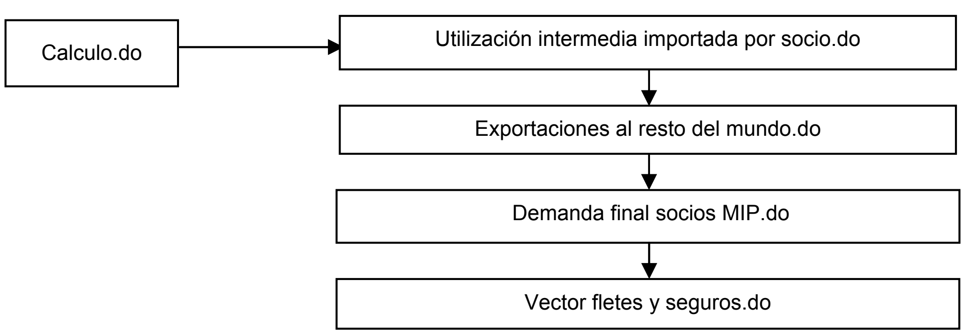
17 The construction and assembly process takes approximately 40 minutes.

**Diagram 6**
**Order of the routine for importing the files to Stata**



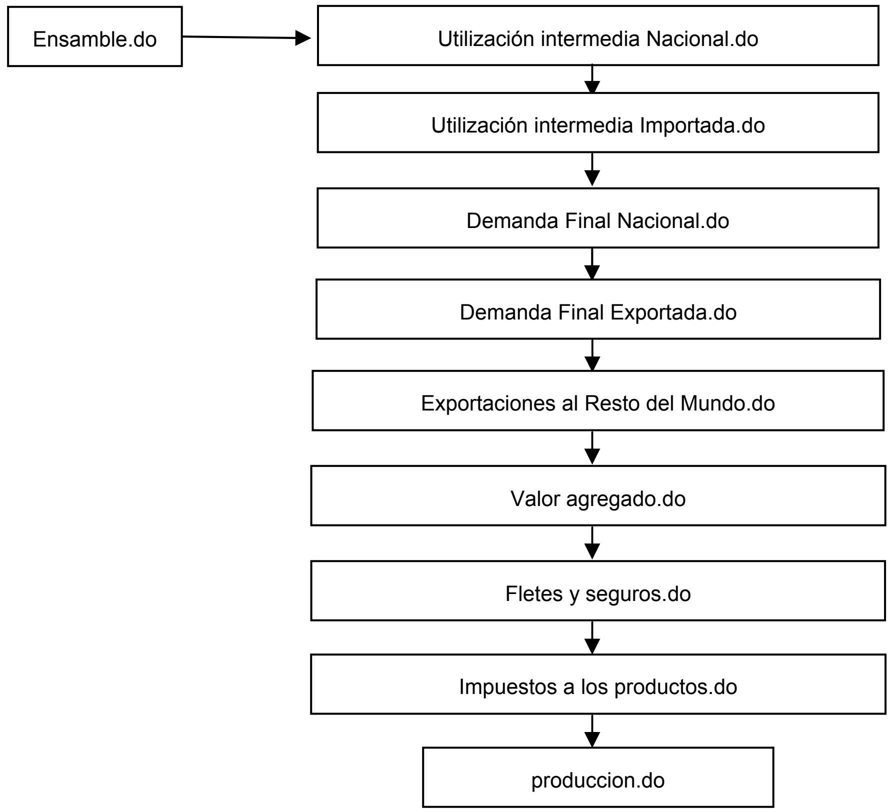

Source: ECLAC, own elaboration.

**Diagram 7**
**Order of the routine for transforming the intermediate use**




Source: ECLAC, own elaboration.

**Diagram 8**
**Order of the routine for the final assembly of the files**




Source: ECLAC, own elaboration.

# IV. Quality checks

During the construction and assembly process of the South American IOT, different checks were conducted to validate the information and consistency of the work. These controls can be distinguished into two stages: check regarding national IOTs and check regarding construction and assembly.

As discussed in the previous section, national teams had to upload the information into a master file. For this reason, it was decided to perform some basic checks. The first step focused on a basic macroeconomic consistency check of the IOT. This means verifying that the total offer equaled the total demand. Or to put it another way:

Equation 2: $$\sum_{i=1}^{40} UiNat_{ji} + \sum_{i=1}^{40} Ui\ Imported_{ji} + Value\ Added_j + Insurances\ and\ Freight_j + Other\ taxes_j = \sum_{j=1}^{40} UiNat_{ij} + Final\ Demand_i$$

Once this consistency was confirmed for all countries, the import data were checked. Basically, it was checked that the vector of imports of intermediate goods and the sum of the row of intermediate goods imported by sector, are exactly alike.

After having completed the checking of the master files of the national teams, the checks strictly linked with the construction and assembly were carried out.

The first check was that the structure of imports by sector between IOT and ALADI data is similar. Here, the similarity index was used, calculated from the share of each individual sector within the 40 sectors considered.[18] Because the ALADI data are used for the opening of the table of imported use, it had to be verified that these import structures are as similar as possible (see table 8).

The same exercise was carried out to check the case of exports, since they are used for the opening of exports of final demand and the exports to the rest of the world (see table 9).

[18] The closer the index comes to 100, the more similar are the import baskets.

**Table 8**
**Similarity index between imports of ALADI and national IOTs**

| | Total | Intermediate goods | Final goods |
|---|---|---|---|
| Argentina | 88.2 | 82.6 | 94.5 |
| Brazil | 89.0 | 86.3 | 80.7 |
| Bolivia (Plurinational State of) | 86.8 | 79.9 | 69.2 |
| Chile | 81.4 | 89.8 | 74.7 |
| Colombia | 87.2 | 84.7 | 79.7 |
| Ecuador | 71.0 | 79.7 | 67.0 |
| Peru | 80.2 | 83.6 | 66.0 |
| Paraguay | 87.9 | 84.1 | 80.5 |
| Uruguay | 89.7 | 83.9 | 85.6 |
| Venezuela (Bolivarian Republic of) | 79.1 | 70.0 | 65.8 |

Source: ECLAC, own elaboration.

**Table 9**
**Similarity index between exports of ALADI and national IOTs**

| | Total | Intermediate goods | Final goods |
|---|---|---|---|
| Argentina | 85.2 | 89.6 | 83.8 |
| Brazil | 81.4 | 86.7 | 83.9 |
| Bolivia (Plurinational State of) | 80.3 | 82.1 | 82.4 |
| Chile | 84.8 | 86.1 | 72.8 |
| Colombia | 72.6 | 75.8 | 90.9 |
| Ecuador | 66.6 | 91.3 | 88.8 |
| Peru | 65.5 | 68.1 | 86.1 |
| Paraguay | 84.4 | 80.8 | 23.3 |
| Uruguay | 87.2 | 80.6 | 92.5 |
| Venezuela (Bolivarian Republic of) | 86.9 | 90.4 | 80.1 |

Source: ECLAC, own elaboration.

The last check that was performed aimed on ensuring the consistency of bilateral trade flows, i.e. that the structure of exports of intermediate goods from country A to country B is the same as the structure of imports of intermediate goods in the country B from country A (in FOB). As previously signaled, an opening of the intermediate use imported was performed by country of origin for the trading partners of the IOT. That is why exports of intermediate goods from, for example, Argentina to Brazil were replaced by the imports of intermediate goods of Brazil stemming from Argentina. As already discussed, the mirror statistics on foreign trade are not always identical.[19] Within the ultimate purpose of the construction and assembly of the IOT and in order to generate the least possible distortions, it is necessary that the structure is maintained alike (see table 10).[20]

[19] Please recall that the origin of these differences is diverse. They Rank from bad estimation of gross margins, different statistical sources, adjustments in statistical centers, valuation of exchange rates, time of arrival from port to port to adjustments in the construction of the IOTs in the national offices.

[20] In some cases it can be seen that the index results in a low value, with evidence that the baskets are dissimilar. However, in these cases the partner's share in total trade is very low so that the differences are minimal in absolute values.

**Table 10**
**Similarity index between import and export baskets**

| | Argentina | Brazil | Bolivia (Plurinational State of) | Chile | Colombia | Ecuador | Peru | Paraguay | Uruguay | Venezuela (Bolivarian Republic of) |
|---|---|---|---|---|---|---|---|---|---|---|
| Argentina | | 98.3 | 90.5 | 96.8 | 94.7 | 77.3 | 97.4 | 85.4 | 95.3 | 86.0 |
| Brazil | 97.1 | | 89.6 | 91.7 | 90.7 | 92.0 | 94.8 | 94.1 | 94.5 | 78.8 |
| Bolivia (Plurinational State of) | 91.9 | 99.3 | | 80.4 | 91.8 | 61.3 | 89.1 | 91.0 | 58.2 | 99.6 |
| Chile | 90.1 | 96.5 | 61.8 | | 96.1 | 96.1 | 88.9 | 84.6 | 94.0 | 96.9 |
| Colombia | 93.4 | 91.5 | 90.7 | 94.5 | | 77.0 | 96.1 | 65.9 | 39.5 | 88.5 |
| Ecuador | 89.8 | 97.5 | 85.2 | 97.0 | 91.7 | | 99.3 | 75.5 | 80.2 | 89.6 |
| Peru | 77.5 | 95.8 | 97.2 | 97.2 | 97.4 | 75.3 | | 20.4 | 76.8 | 83.6 |
| Paraguay | 38.1 | 97.6 | 91.5 | 32.5 | 90.1 | 98.4 | 94.5 | | 25.4 | 27.8 |
| Uruguay | 97.4 | 93.1 | 92.0 | 95.4 | 53.8 | 12.8 | 72.7 | 93.4 | | 55.2 |
| Venezuela (Bolivarian Republic of ) | 32.9 | 26.9 | 37.0 | 16.1 | 87.6 | 69.0 | 30.8 | 41.1 | 0.5 | |

Source: ECLAC, own elaboration.

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# Annexes

# Annex 1
# Method to calculate input-output tables: RAS

The preparation of Input-Output Tables (IOT) traditionally follows a methodology called direct method. It involves the collection and organization of data from fields work in different sectors of the economy. This method presents significant restrictions because of the difficulties involved in obtaining, organizing, systematizing and harmonizing the information required for its processing.

To overcome these limits, alternative methods were developed that allow obtaining IOT by using smaller amounts of information. Such methods mostly start with adapting tables initially constructed under the direct method, and then combine them with information about the selected areas and periods.

Among these approaches, the RAS method[21] is one of the most widespread instruments for obtaining tables due to the consistency that maintains the relation between the original IOT and its temporal projection. This methodology was also adapted to perform spatial adjustment, i.e. reduced matrices in relation to the national IOT obtaining the so-called regional tables.[22] In the development of this work, the focus will be on the methodology of seasonal adjustment.

It is therefore common to refer to the RAS technique as an indirect method of obtaining information. Direct search of data, often through surveying companies, is replaced by a deductive adjustment process based on partially available information.

The method is originally based on a calculation process that can be considered, in general terms, as solving a statistical problem of adjunsting a matrix to match with the new data from the National Accounting: temporary adjustment.

The convergence of the matrix and the updated data is achieved by estimating successive sets of multipliers to adjust both the rows, and columns of the original matrix, until the sum of the elements of the different rows and columns match the entered statistical data.

The procedure for its application in its simplest form requires information regarding the "margins" of the input-output table: gross value of production (GVP), gross value added (VA) and final demand (FD). The intermediate demand for inputs and outputs is obtained by difference from this information. This result is considered to establish limit vectors in order to generate the adjusted intersectoral sales and purchases from the original IOT and by using an iterative procedure.

The approach of assuming that the margins of an unknown matrix $Z^1$ are known may sound as lacking stringency for those who are not involved in the work of economics and statistics. Within the National Accounting, however, the situation is very common in both problems of pure prediction and those of the adaptation of an old table to new data from National Accounting. It is even found in the process of obtaining regional tables from national tables and own data of Regional Accounting.

The main advantages of the RAS method lie primarily in its simplicity, since it allows estimating a large number of coefficients with a reduced amount of direct information (that is, the aforementioned margins). Another advantage lies in its versatility, as it can be supplemented with partial information on intermediate transactions (modified RAS) minimizing errors inherent in the mathematical method.

Finally, it maintains the signs of the original coefficients, which guarantees —because no coefficient may be negative— that the conditions of viability of the model are preserved.

21 The original methodology was developped by Stone et al. (1963).
22 The method was later adapted by Czamanski and Malizia (1969).

In the following, a simple example of the application of the RAS method to adjust the coefficients and, later, obtaining a seasonally adjusted IOT is presented.[23]

## Adjustment of coefficients using the RAS method

Let us assume that we start with an interindustrial transaction matrix $Z^0$ and a vector of actual output $q^0$, which together allow the definition of a matrix $A^0$ of technical coefficients. The adjustment process then includes calculating a new matrix $A^{0*}$ that is as similar as possible to $A^0$ and complies with the newly available information. This information usually considers a new output vector $q^1$ as well as new margins Z, $z^1_{i.}$, $z^1_{.j}$, which are traditionally denoted as vectors *u* and *v* (column and row, in each case).

$$u = \begin{pmatrix} u_1 \\ \vdots \\ u_n \end{pmatrix} \text{ with } u_i = \sum_{j=1}^{n} z_{ij} \; ; \quad v = (v_1 \quad \cdots \quad v_n) \text{ with } v_i = \sum_{j=1}^{n} z_{ij}$$

It is noted that by providing the output vector $q^1$ and the total of intermediate inputs (*u* and *v*), the value added will also be provided.

As explained above, the sectoral figures of intermediate consumption by rows and columns are usually not provided as initial data. However, the information on final demand, value added and imports allows calculating them, as we already know, by:

$$u_i = q_i - f_i \; ; \quad v_i = w_i - g_i = q_i + m_i - g_i$$

where

$u_i$: intermediate sales;
$q_i$: national supply;
$f_i$: final demand;
$v_i$: intermediate purchases;
$w_i$: total supply (national plus imported);
$g_i$: value added;
$m_i$: imports.

In the following, we present a simple example of the application of the RAS technique (of temporal adjustment) of the type applied by the national teams.

## Example of adjustment of coefficients[24]

Let us assume the matrix of technical coefficients $A^0$ and the total output vectors and the margins of the interindustrial consumption matrix (sales and intermediate consumption) $u^1$, $q^1$ and $v^1$, correspondingly, that are calculated based on the new data obtained.

$$A^0 = \begin{pmatrix} 0.120 & 0.100 & 0.049 \\ 0.210 & 0.247 & 0.265 \\ 0.026 & 0.249 & 0.145 \end{pmatrix} ; \; u^1 = \begin{pmatrix} 245 \\ 136 \\ 159 \end{pmatrix} ; \; q^1 = \begin{pmatrix} 421 \\ 284 \\ 283 \end{pmatrix}$$

23 As is evident, the temporary adjustment can be projected "forward" in time, as well as "backwards".
24 This example was taken from Pulido and Fontela (1993).

$$v^1 = (251 \quad 107 \quad 182)$$

The first step is to estimate intermediate consumption by rows, as:

$$\hat{u}^1 = [A^0 * q^1] = \begin{pmatrix} 92.787 \\ 233.553 \\ 122.697 \end{pmatrix}$$

and from here calculate the initial weightings using the element wise division and transformation to a diagonal matrix

$$r^1 = [diag(u^1 \, ./ \, \hat{u}^1)] = \begin{pmatrix} \frac{245}{92.787} & 0 & 0 \\ 0 & \frac{136}{233.553} & 0 \\ 0 & 0 & \frac{159}{122.697} \end{pmatrix}$$

$$= \begin{pmatrix} 2.640 & 0 & 0 \\ 0 & 0.582 & 0 \\ 0 & 0 & 1.296 \end{pmatrix}$$

This means that the exogenous data on intermediate consumption by rows indicate that the sector 1 has sold 264 for 100 of what would correspond to it, in accordance with the new sectoral productions but using the technology of the base year. Similarly, sector 2 has only reached 58 for 100 and 3 has reached 130 for 100.

From these results, we will "correct" the orginal matrix of the coefficients, by rows, increasing the supply coefficients of sector 1 to 264 for 100:

$$A^1 = [r^1 * A^0] = \begin{pmatrix} 0.317 & 0.264 & 0.129 \\ 0.122 & 0.144 & 0.154 \\ 0.034 & 0.323 & 0.188 \end{pmatrix}$$

Evidently, this will now fit with the new requirements for the margins of intermediate consumption:

$$[A^1 * q^1] = \begin{pmatrix} 245 \\ 136 \\ 159 \end{pmatrix} = u^1$$

but, in turn, will not fit by columns:

$$\hat{v}^2 = \left[ \left( diag\left( A^{1^T} * \left[ diag(I_3) * q^{1^T} \right] \right) \right)^T \right] = (199.062 \quad 207.476 \quad 133.462) \neq v^1$$

This brings us now to establish corrective coefficients for columns of the type:

$$s^1 = [diag([v^1 \,./\, \hat{v}^2]^T)] = \begin{pmatrix} \frac{251}{199.062} & 0 & 0 \\ 0 & \frac{107}{207.476} & 0 \\ 0 & 0 & \frac{182}{133.462} \end{pmatrix}$$

$$= \begin{pmatrix} 1.261 & 0 & 0 \\ 0 & 0.516 & 0 \\ 0 & 0 & 1.364 \end{pmatrix}$$

This means that the sector 1 has used 126 for 100 of what would correspond according to its new production and technology as collected in the original matrix yet corrected by rows. Similarly, sector 2 has remained with 52 for 100 and sector 3 has reached at 136 for 100.

To compensate for these gaps, we will now adjust the coefficients of the previous matrix by columns using the calculated coefficients:

$$A^2 = [A^1 * s^1] = \begin{pmatrix} 0.400 & 0.136 & 0.176 \\ 0.154 & 0.074 & 0.210 \\ 0.043 & 0.167 & 0.256 \end{pmatrix}$$

Of course, now the cumulated margins fit by columns,

$$(diag[(q^1 * [diag(I_3)]^T) * A^2])^T = (251 \quad 107 \quad 182) = v^1$$

but we will lack the fit regarding the sum by rows,

$$\hat{u}^2 = [A^2 * q^1] = \begin{pmatrix} 256.805 \\ 145.533 \\ 137.662 \end{pmatrix} \neq u^1$$

which brings us to using new coefficients for the adjustment by rows:

$$r^2 = [diag(u^1 \,./\, \hat{u}^2)] = \begin{pmatrix} \frac{245}{256.805} & 0 & 0 \\ 0 & \frac{136}{145.533} & 0 \\ 0 & 0 & \frac{159}{137.662} \end{pmatrix}$$

$$= \begin{pmatrix} 0.954 & 0 & 0 \\ 0 & 0.934 & 0 \\ 0 & 0 & 1.155 \end{pmatrix}$$

Now, the corrections are significantly smaller than those in the previous stage. For example, sector 1 that showed supplies directed towards other sectors out of phase by 264 for 100 in the first calculation, now shows 95 for 100 regarding the target value.

This iteration process will be carried out $h$ times, until the difference between the adjusted coefficients of the two sets is neglible, that is, when the $k$ elements of the main diagonal of the adjustment matrices $r_k^h$ and $s_k^h$ are similar to 1, i.e. (as shown in the table A.1).

**Table A.1**
**Values of the correctors $r_k^h$ and $s_k^h$**

| Iteration $h$ | $r_1^h$ | $r_2^h$ | $r_3^h$ | $s_1^h$ | $s_2^h$ | $s_3^h$ |
|---|---|---|---|---|---|---|
| 1 | 2.640456 | 0.582308 | 1.298750 | 1.260910 | 0.515722 | 1.363687 |
| 2 | 0.954029 | 0.934496 | 1.155005 | 1.038099 | 0.962508 | 0.973032 |
| 3 | 0.986130 | 0.996468 | 1.022627 | 1.007460 | 0.993627 | 0.993599 |
| 4 | 0.997111 | 0.999982 | 1.004499 | 1.001515 | 0.998699 | 0.998680 |
| 5 | 0.999407 | 0.999995 | 1.000918 | 1.000310 | 0.999733 | 0.999729 |
| 6 | 0.999878 | 0.999998 | 1.000188 | 1.000063 | 0.999945 | 0.999944 |
| 7 | 0.999975 | 0.999999 | 1.000038 | … | … | … |

Source: ECLAC, own elaboration.

In the example shown above, the iteration ends at step 13 with the final adjusted matrix:

$$A^{0*} = \begin{pmatrix} 0.120 & 0.100 & 0.049 \\ 0.210 & 0.247 & 0.265 \\ 0.026 & 0.249 & 0.145 \end{pmatrix}$$

Beyond obtaining a matrix from the described process, the implementation using statistical iteration techniques does not detract from the processing of an economic significance in its development. The corrections by row respond to input substitution effects of some sectors by others; the corrections by columns represent manufacturing effects, i.e. characteristic of the change in the production technology of each sector.

# Annex 2

**Table A.2**
**Latin America: availability of input-output tables and supply-use tables by country**

| | Country | Year IOT | SUT | Years SUT | Valuation | Intermediate use domestic/imported | Converters (sectors SUT/IOT-HS) | Number of industries | Number of products |
|---|---|---|---|---|---|---|---|---|---|
| Group 1 | Brazil | 2005 | Yes | 1990-2009 | Basic prices (2005)<br>Purchaser's prices (rest) | Yes (2005) | Yes | 55 | 110 |
| | Chile | 2003/2008 | Yes | 1996/2003/2008 | Basic prices (2005 and 2008) | Yes (2003 and 2008) | - | 111 | 177 |
| | Colombia | 2005 | Yes | 2000-2009 | Basic prices (2005)<br>Purchaser's prices (rest) | Yes (2005) | Yes | 56 | 373<br>(not available online) |
| | Uruguay | 2005/2008 | Yes | 1997-2008 | Basic prices (2005 and 2008) | Yes (2005 and 2008) | Yes | 54 | - |
| Group 2 | Argentina | 2004 | Yes | 2004 | Basic prices (1997) | Yes (2004) | - | 124 | 195 |
| | Bolivia (Plurinational State of ) | 1990 | Yes | 1990-2006 | Basic prices (1990)<br>Purchaser's prices (rest) | Yes (1990) | - | 35 | 35 |
| | Costa Rica | 2011 | - | - | Basic prices (2011) | Yes | | 76 | 76 |
| | Guatemala | 2001 | Yes | 2001-2012 | Purchaser's prices | No | - | 23 | 66 |
| | Honduras | 2000 | Yes | 2000-2012 | Purchaser's prices | No | | 16 | 55 |
| | Ecuador | 2007 | Yes | 2000-2007 | Basic prices (2000)<br>Purchaser's prices (rest) | Yes (2005) | - | 47 | 60 |
| | Mexico | 2003 | - | - | Basic prices | Yes | Yes | 79 | 79 |
| | Nicaragua | 2006 | Yes | 2006-2007 | Purchaser's prices | Only national | Yes | 39 | 39 |
| | Panama | 2007 | Yes | 2007 | Purchaser's prices | No | - | 60 | 176 |
| | Peru | 2007 | Yes | 2007 | Basic prices (1994) | Yes (2007) | - | 45 | 45 |
| Group 3 | Paraguay | - | | | | | | | |
| | El Salvador | - | - | - | - | - | - | - | - |
| | Venezuela (Bolivarian Republic of) | 1997 | Yes | 1997 | Basic prices (1997) | Yes (1997) | - | 121 | 121 |

Source: ECLAC, own elaboration.

# Annex 3

**Diagram A.1**
**Example of a Latin American Input-Output Table**

| | Intermediate demand | | | | | | | | | | | | Final demand | | | | | | | | | | | | Exports | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Argentina | Bolivia (Plurinational State of) | Brazil | Chile | Colombia | Costa Rica | Ecuador | Mexico | Paraguay | Peru | Uruguay | Venezuela (Bolivarian Republic of) | Argentina | Bolivia (Plurinational State of) | Brazil | Chile | Colombia | Costa Rica | Ecuador | Mexico | Paraguay | Peru | Uruguay | Venezuela (Bolivarian Republic of) | Rest of Latin America | Rest of the world | Total production |
| Argentina | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bolivia (Plurinational State of) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Brazil | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chile | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Colombia | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Costa Rica | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ecuador | $Z^{\text{Country I-Country j}}$ | | | | | | | | | | | | $F^{\text{Country I-Country j}}$ | | | | | | | | | | | | $X_z^{\text{Country I-Country J}}$ | $X_z^{\text{Country i-Country J}}$ | $TP^{\text{Country i}}$ |
| Mexico | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Paraguay | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Peru | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Uruguay | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Venezuela (Bolivarian Republic of) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Insurance and freight | $IFZ^{\text{Country j}}$ | | | | | | | | | | | | $IFF^{\text{Country j}}$ | | | | | | | | | | | | | | |
| America | $M^{\text{Country j-RoIA}}$ | | | | | | | | | | | | $F^{\text{Country j-RoIA}}$ | | | | | | | | | | | | | | |
| Imports from rest of the world | $M^{\text{Countryj-RoW}}$ | | | | | | | | | | | | $F^{\text{Country j-RoW}}$ | | | | | | | | | | | | | | |
| Total imputs | $TI^{\text{Country j}}$ | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Value added at basic prices | $VA^{\text{Country j}}$ | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total production | $TP^{\text{Country j}}$ | | | | | | | | | | | | | | | | | | | | | | | | | | |

Source: ECLAC, own elaboration.

# Annex 4
# Country files

| | |
|---|---|
| Country | Argentina |
| Reference year | 2004 |
| Main inputs | Input-output table 1997<br>This IOT was used as primary information to complete the IOT 2004, and update it to 2005.<br>Input-output table 2004<br>Supply-use table 2004<br>Source: Ministerio de Economía (MECON) |
| Country | Plurinational State of Bolivia |
| Reference year | 1990 |
| Main inputs | Input-output table 2005 at basic prices<br>Source: Instituto Nacional de Estadística (INE) |
| Country | Brazil |
| Reference year | 2005 |
| Main inputs | Input-output table 2005 at basic prices<br>Source: Instituto Brazilero de Geografía y Estadisticas (IBGE) |
| Country | Chile |
| Reference year | 2003-2008 |
| Main inputs | Input-output table 2005 at basic prices<br>Input-output table 2008 at basic prices<br>Source: Banco Central de Chile |
| Country | Colombia |
| Reference year | 2005 |
| Main inputs | Input-output table 2005 at basic prices<br>Source: Departamento Administrativo Nacional de Estadística (DANE) |
| Country | Ecuador |
| Reference year | 2007 |
| Main inputs | Input-output table 2005 at basic prices<br>Source: Banco Central del Ecuador |
| Country | Paraguay |
| Reference year | 1994-2009 |
| Main inputs | Input-output table 2009 at basic prices<br>Source: Banco Central del Paraguay (Gustavo Biedermann) |
| Country | Peru |
| Reference year | 2007 |
| Main inputs | Input-output table 2007 at basic prices<br>Source: Instituto Nacional de Estadística e Informática |
| Country | Uruguay |
| Reference year | 2005 |
| Main inputs | Input-output table 2005 at basic prices<br>Annual Survey of Economic Activity<br>Source: Banco Central del Uruguay e Instituto Nacional de Estadísticas |
| Country | Bolivarian Republic of Venezuela |
| Reference year | 1997 |
| Main inputs | Input-output table 1997<br>Source: Banco Central de Venezuela |

# Annex 5
# Teams that participated in the Project

| | |
|---|---|
| Team CEPAL | Coordinator: José E. Durán Lima, Chief of the Regional Integration Unit.<br>Technical team: Sebastián Castresana, Statistical Assistant, José E. Durán Lima, Economic Affairs Officer, Javier Meneses, Statistical Assistant, and Mario Saeteros, Consultant. |
| Team IPEA | Coordinator: Renato Baumann, Economist.<br>Technical team: Renato Baumann and Renato Flôres, Consultant. |
| Argentina | Main researcher: Pedro Elosegui (Laboratorio de Ideas en Desarrollo, LiD, Universidad Maimónides).<br>Associated researchers: Adrián Gutierrez Cabello (Universidad Nacional de San Martín), Edgardo Lifchitz (Universidad Nacional de San Martín), Emilio Blanco (BCRA), Ignacio Sarmiento (University of Illinois at Urbana-Champaign), and Máximo Sangiácomo (BCRA). |
| Brazil | Main researcher: Weslem Faria |
| Plurinational State of Bolivia | Main researcher: Beatriz Muriel H., Senior Researcher (Fundación INESAD).<br>Associated researchers: Horacio Vera and Gabriela Olivares, Junior Researcher (Fundación INESAD). |
| Chile | Main researcher: Patricio Aroca, Doctor en Economía (Universidad Adolfo Ibáñez).<br>Associated researcher: Nicolás Garrido, Doctor en Economía (Universidad Diego Portales). |
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| Ecuador | Main researcher: Adrián Gutierrez Cabello (Universidad Nacional de San Martín).<br>Associated researcher: Pedro Elosegui (Laboratorio de Ideas en Desarrollo, LiD, Universidad Maimónides).<br>Edgardo Lifchitz (Universidad Nacional de San Martín), Emilio Blanco (BCRA), Ignacio Sarmiento (University of Illinois at Urbana-Champaign), and Máximo Sangiácomo (BCRA). |
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| Peru | Main researcher: Ana Rivas, Associated Researcher (IOB-Universidad de Amberes, Amberes-Belgica).<br>Associated researcher: Jorge Aznaran. |
| Uruguay | Main researcher: Marcel Vaillant, Profesor Titular Comercio Internacional (dECON, UDeLaR).<br>Associated researcher: Alvaro Lalanne, Consultant (ECLAC office in Montevideo). |
| Bolivarian Republic of Venezuela | Main researcher: Agustín A. Velázquez Afonso, Research Fellow (Institute for Prospective Technological Studies, Joint Research Centre, Seville, Spain).<br>Associated researcher: Elvis A. Hernandez-Perdomo, PhD, Researcher (University of Hull), Visiting Professor (Universidad Central de Venezuela). |

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