INCLUDING COSTA RICA INTO AN INTERNATIONAL INPUT-OUTPUT TABLE, AN EXERCISE BASED ON THE WIOD

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ABSTRACT

This paper describes the methodology used to include Costa Rica into a preexisting International Input-Output Table (IIOT), in this case the World Input Output Table (WIOD). We have embedded the first national IOT of Costa Rica into the WIOD by using a detailed bilateral approach that ensures consistency with the national accounts and the WIOD framework. The paper highlights some new methodological insights that could be of use to other countries that seek to insert their domestic IOT into an international IOT. This is the first IOT of Costa Rica, and the first attempt to include a county into an already existing IIOT. This exercise revealed key areas in which Costa Rica's data and partner's country data could be strengthened to improve the capture of information, especially in the area of trade in services.

1.

1. Why are International Input-Output Tables (IIOTs) useful for the analysis of trade in value-added?

The value-added approach to international trade is neither new nor surprising. It has been widely discussed at venues like the World Trade Organization (WTO). In practice, however, the idea was hardly realized due to the lack of an appropriate methodology and database.

The conventional approach to tracing cross-border value chains can be found in the studies that use firms' micro-level data. As seen in the famous example of the iPhone's production networks, the approach generally aims to identify the structure of the production process and/or the sales networks of a particular product, based on the information provided by manufacturers.

These "firm-level" approaches are useful in drawing the actual structure of supply chains since they utilize the data directly provided by individual firms rather than resorting to any forms of statistical inference. The weakness, however, is also apparent in its flipside.

Firstly, their applicability is limited in considering macroeconomic issues like trade policies, since the analytical focus is cast only to a particular product and/or activity of a few firms. It is far from being sufficient to capture the entire value flows at the national context.

Second, the majority of firm-level data does not explicitly present "compensation of employees", an important component of value-added items in the national account framework, but merges it with other types of production costs. The value-added analysis based on a firm's micro-data, therefore, is bound to be an approximation by the information on a firm's operating surplus (profit).

Finally, since values are generated at every point of the production process, the value-added analysis should be able to trace all the production stages along the entire supply chain. The firm-level approach, however, only considers the value-added structure of direct input suppliers (the first tier), but leaves all the rest of the value-added stream untracked. [1]

Given these limitations of the conventional approach, increasing attention is directed to a new strand of studies that use IIOTs. An IIOT provides a comprehensive mapping of international transactions of goods and services. Since the tables contain information on supply-use relations between industries across countries, which is totally absent in foreign trade statistics, it is possible to identify the vertical structure of international production sharing. Unlike the firm-level approach, the input–output analysis covers an entire set of industries that comprise an economic system, and thereby enables to capture the cross-border value flows at the level of a country or a region. Theoretically, it has capacity to track the value-added generation process of every commodity in every country at every production stage.

2. The basic framework of IIOTs

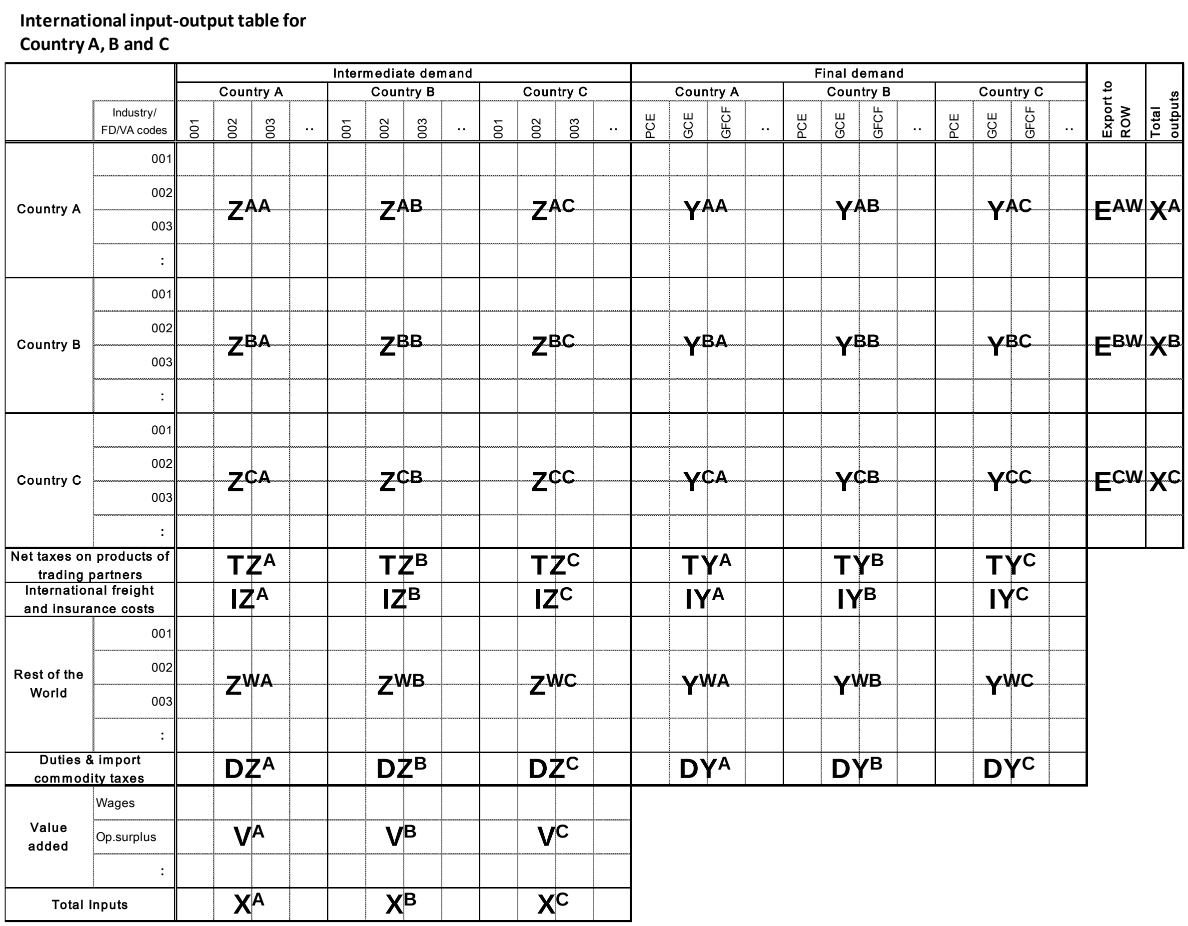
The IIOT is a major effort bringing together pieces taken from various national input-output

[1] Monge–Arino (2011) presents a rare research example that successfully overcame these analytical limitations. By conducting an extensive survey on the supply-use relations of leading companies in Costa Rica, the study identified the value-added structure of the country's core economic system. Though insightful, it is however difficult to envisage the approach to be applied to other countries, since its feasibility is fundamentally attributable to the idiosyncratic feature of Costa Rica that a few number of multinational corporations (such as Intel) are assumed to "sufficiently represent" the national economy.

tables, and hence the results can be read exactly in the same manner as for national tables. The major difference being that it explicitly presents international transactions between industries in the form of import matrices and export matrices by trading partners, which enables us to draw a comprehensive mapping of global production networks.

IIOTs can take various forms depending on analytical purposes and data availability. Figure 1 presents a general format of the table based on the recommendation in the United Nations Handbook on the compilation of input-output tables.

Figure 1 Schematic image of an international input-output table (three-country case)



Source: Drawn by the author.

Each cell in the columns of the table shows the input composition of industries of the respective country. The sub-matrix Z^{AA}, for example, shows the input composition of Country A's industries in relation to domestically produced goods and services, that is, the domestic transactions of Country A. Z^{BA} and Z^{CA} in contrast show the input composition of Country A's industries for the imported goods and services from Country B and those from Country C, respectively. Z^{WA} indicate the imports from other countries, as grouped under the name of ‘Rest of the World’. TZ^A, IZ^A and DZ^A give domestic taxes (net), international freight and insurance, and duties and commodity taxes levied on import transactions of Country A’s industries.

The fourth column of sub-matrices from the left shows the composition of goods and services that have gone to the final demand sectors of Country A. Y^{AA} and Y^{BA}, for example, present respectively the goods and services produced domestically and those imported from Country B that flow into Country A’s final demand sectors. The rest of the column is read in the same manner as for the 1st set of sub-matrices of the table.

E^{*W} are exports (vectors) of each country to the Rest of the World, and V^* and X^* are value-added and total input / total output, as seen in the conventional national input–output table. Figure 2 shows compositional correspondence of the IIOT to a national input-output table.

It should be noted that the export vectors to the Rest of the World contain various statistical discrepancies arising out of data conflicts among different sources since the vectors are constructed as “residuals” of the entire IIOT matrix.

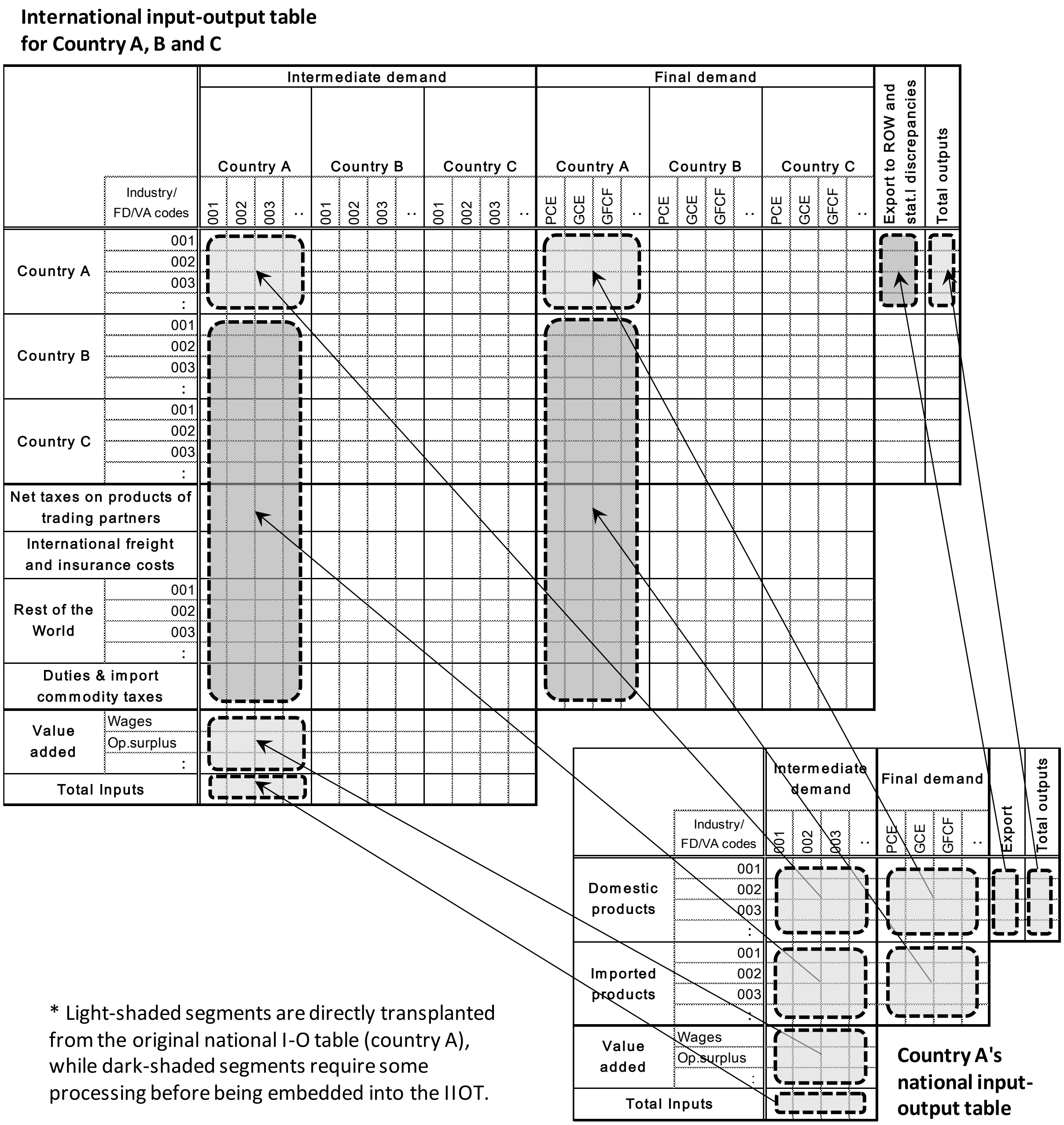
One of the sources of discrepancies stems from the fact that during the linking process of national input-output tables, the export data in each national table is replaced by the import matrices of trading partners, and hence the problem of symmetries arises. Theoretically, Country A exports of a particular product to Country B should be equal to Country B imports of the same product from country A, given that they are compared at the appropriate valuation scheme (c.i.f. or f.o.b.). In practice, this is often not the case due to many reasons, for example:

- Improper declaration of product classification at the customs border, either entry or exit;
- Confusion about the ‘real’ country of origin/destination for re-exported products;
- Shipping time-lag across different accounting periods (quarters or years);
- Presence of “merchandising” trade;
- Smuggling; and
- Other unrecorded transactions.

The discrepancies can be also attributed to inappropriate estimation of transaction margins (international freight and insurance costs, trade and transport margins, various taxes) in converting the valuation scheme of import matrices. Furthermore, there may be mismatches between the record of international transactions in SUTs/National Accounts and the custom statistics/balance of payments statistics.

Some existing IIOTs, notably the Inter-country Input-Output Tables of the OECD and the World Input-Output Tables of the European Commission (in which the Costa Rican I-O table has been embedded, as described later) have featured Rest of the World as a single endogenous region in the transaction matrices. This allows the inter-country Leontief inverse to be derived with respect to the corresponding segments, see Dietzenbacher, et.al (2013) for the derivation method of endogenous Rest of the World matrices in the case of the World Input-Output Tables, see the next section.

Figure 2 Compositional correspondence of the IIOT to a national input-output table



* Light-shaded segments are directly transplanted from the original national I-O table (country A), while dark-shaded segments require some processing before being embedded into the IIOT.

Source: Drawn by the author.

3. Construction of the national IOT

The IOT for 2011 was constructed in accordance with the best practices recommended by the System of National Accounts 2008 (SNA 2008), adopted by the United Nations Statistical Commission (UNSC). The SNA 2008 addresses important issues brought about by changes in the economic environment, advances in methodological research and the needs of users.

The process used for the domestic construction of the IOT draws upon data from the fully balanced version of the SUT for 2011 in basic prices. The IOT was built at a product level rather than industry level. All secondary production was assigned to the same categories as primary production and intermediate consumption of secondary consumption was also allocated to the primary product category. In all other aspects, the SNA 2008 methodology was followed.

3.1. Basic layout of the SUT

The SUT includes 183 products and 136 economic activities or industries (see appendix for detailed list). These were classified using the Central Product Classification (Rev 2), the Central American Tariff System (2013), the Broad Economic Categories (Rev 4) and the International Standard Industrial Classification (Rev 4).

3.1.1. Data sources

Domestic Production:

Domestic production was estimated using sales data from the Central Bank's Registry of Economic Variables for Businesses and Establishments (REVBE), which contains over 26,500 observations.

International production:

Import data from the Costa Rican General Customs Directorate and the Balance of Payments data from the Central Banks were used to build an import matrix in CIF values that contains intermediate demand, final demand and fixed capital formation of imported products. The REVBE was used to assign imports to specific economic activities. The Ministry of Finance´s Annual Declaration of Clients, Suppliers and Specific Expenses (ADCSSE) was used in conjunction with administrative data from the REVBE to determine the destination of sales in order to distribute imports to the industries that use that use them. The ADCSSE is used by all firms and organizations that pay income taxes to declare sales and purchases over 2.5 million colones (approximately USD 5,000) and rentals, professional services and commission and interest over 50 million colones (approximately USD 100,000). These values were adjusted from CIF to FOB by removing the insurance and transport margin.

Taxes and subsidies:

a) *Value added tax* was calculated for final consumption by households, intermediate consumption and fixed capital formation.

- Final consumption by households: The applicable tax rate for each product category was estimated using data from the Central Bank's National Survey of Income and Expenditures, applying a 13% tax to all taxable goods and services consumed by each of the 2,500 households in the sample and then extrapolating for all households.
- Intermediate consumption: The General Sales Tax Law was used to determine the activities for which different firms are allowed to deduce the sales tax from their purchase of goods and services. This information was used to calculate the share of economic activities that are legally exempt from taxes and the share for the rest of the activities. The government and all companies in the Free Trade Zone Regime are exempt from paying taxes.
- Fixed capital formation: Since the majority of products in the category are imported, the 13% tax rate was applied after adjusting for all customs taxes. Goods with tax-exempt status were not included in the calculation, such as machinery and farm equipment. The 13% tax rate was applier directly to gross domestic capital formation.

b) *Import and export taxes:* The applicable tax rate was estimated based on data from the Costa Rican General Customs Directorate.

c) *Selective consumption tax and other taxes on products:* The applicable tax rate was estimated based on information provided by the Ministry of Finance.

<u>Distribution margins:</u>

Administrative data from the Ministry of Finance for a sample of 620 companies was used to calculate trade and transport margins for each product by usage (intermediate consumption, final consumption, gross capital formation and exports).

<u>Domestic usage:</u>

The structure of domestic usage was estimated using the following data sources:

a) *Agriculture:* A sample of 100 case studies which were constructed based on several site visits and interviews with the main producers of 38 products.

b) *Services and manufacturing:* A sample of 450 companies was constructed pooling data from three data sources. The first was the Central Bank's Economic Study of Firms, which includes firms with more than five employees and above the 15th percentile in revenues. The second was The Trade Promotion Agency´s financial and administrative data from firms in special economic regimes. The third was interviews with specific firms for clarification purposes.

b) *Wholesale and retail trade:* Trade production was assumed equivalent to trade margins.

c) Construction: Both public and private construction projects were included. Data on state owned construction projects was obtained from the Ministry of Transportation and from local governments. Data on private construction projects was obtained trough the Federated Association of Engineers and Architects, an institution required by law to collect this information in the process of granting construction permits.

d) *Government and state owned enterprises:* Administrative data reported by all of these institutions, including financial and expenditure data for each economic activity.

e) *Financial intermediation and insurance services:* Census of financial firms, except cooperatives and pawnshops, for which there was a sample of 177 enterprises. Data from audited financial statements was obtained from the financial regulatory bodies.

International usage:

Export data from the General Customs Directorate and the Balance of Payments data from the Central Bank.

Final consumption of households:

This data was estimated based on the National Institute for Statistics and Census' National Household Survey (ENIG) for 2004, and extrapolated to the year 2011 using price and volume indicators. This survey contains information for 2,415 products and was complemented with sales records from the Ministry of Finance.

Final consumption of NGOs:

This data was estimated based on information reported by non-profit associations collected through the Central Bank's Economic Enterprises Survey.

Final consumption of the government:

A dataset was constructed from basic data provided by government institutions.

Fixed capital formation:

Since most goods in this category are imported, data was constructed based on foreign trade records from the General Customs Directorate and information required by law for the Ministry of Finance. This data was used to determine which products are capital assets and the final economic activities in which they are used. Additional data from the Federated Association of Engineers and Architects was also used.

Changes in inventories:

Tax declarations to the Ministry of Finance were used.

3.1.2. Recommendations adopted from SNA 2008

The following new standards were adopted from the SNA 2008 recommendations:

Exports of manufacturing services: Only imports and exports that include a change in ownership are registered. In the case of Costa Rica, this affected 14 large firms.

Central Bank production: A distinction is drawn between non-market services, estimated using costs, and market services, estimated using to revenues. Financial intermediation services are treated as market services. Services that relate to monitoring, currency stability and the production of statistics are considered as non-market activities.

Production of non-life insurance: Compensations and premiums were smoothed over time in order to remove the appearance of volatility from the sector.

Indirectly measured financial intermediation services: All loans and deposits offered by or deposited in financial institutions are included and calculated using a common risk-free interest rate.

4. Selection of the international IOT

At a very high level, there are two possible approaches to constructing an international IOT. The first is to construct the entire table using national sources of all the relevant countries. This is the strategy that organizations such as IDE-JETRO, the OECD and WIOD have followed to construct their IIOTs. The second approach is to add new countries to an existing International IOT that was built using the first approach. This research project followed the second approach in order to facilitate the integration of Costa Rica´s data into an IIOT. When selecting the motherboard table in which to integrate Costa Rica, the following pre-existing IIOT's were considered:

Table 1: Main characteristics of existing IIOT's

Database	Producing organisation	Reference years	Number of countries	Industry/product classification
AIIOT	IDE-JETRO	1975、1985、1990、1995、2000、2005	10	56 (1975) 78 (1985-95) 76 (2000-05)
EORA	University of Sydney	1990-2009:yearly	Approx. 150	20～500
EXIOPOL Database (CREEA)	European Commission	2000	43 + ROW	129 industries 129 products
GTAP-MRIO	Purdue University	1990、1992、1995、1997、2001、2004、2007	129	57 industries
ICIO	OECD	1995、2000、2005、2008、2009	56 + ROW	18 industries
WIOD	European Commission	1995-2011 : yearly	40 + ROW	35 industries 59 products

Source: IDE-JETRO

The following criteria were considered in the selection of the motherboard table:

(a) Country coverage: An economic interdependency analysis was performed to determine Costa Rica's main trade and investment partners. It is important to note that several of the main trade partners are not in any of the publically available IIOTs and do not even have a domestic IOT.
(b) Sector coverage: Since the domestic IOT is quite detailed, we wanted to select a table that would take advantage of these sectors.
(c) Assumptions made: Typically, the tables with the greatest number of sectors and countries are based on broad underlying assumptions, which leads to a significant margin of error in any of the conclusions that can be drawn from the table.

WIOD provided a country coverage that include most of the main partners of Costa Rica, while its product classification allowed to focus on certain sectors of particular interest for Costa Rica. Finally, the fact that its methodology is derived from a SUT framework, should provide a good fit for the data provided by Costa Rica.

5. Converting the domestic IOT into the format used by the WIOD

(a) Prices:
  - Currency: The domestic IOT is in Costa Rican colones, whereas the WIOD is in dollars.[2] For the case of the IOT, the Costa Rica Central Bank provided the annual average exchange rate used in the national accounts.
  - Current vs constant prices: Both the domestic IOT and the WIOD are in current prices. While the WIOD has a time series including several years in constant prices, the table for individual years is in current prices.
  - Basic vs producer prices: Both the domestic IOT and the WIOD are in basic prices.

(b) Sector categorization: The WIOD uses an industry-by-industry approach to define the sectors in the table, whereas Costa Rica's domestic IOT for 2011 was constructed using a product by product approach, even though the Supply and Use Table (SUTs) contain the necessary information. The survey data used to construct the IOT revealed that in the case of Costa Rica firms rarely engage in secondary activities, which means that the sector categorization according to products and industries is very similar. Future versions of the domestic IOT will use an industry-by-industry approach. In order to ensure consistency, the Central Bank provided the domestic IOT in the ISIC rev 2 classification used by the WIOD.

(c) Year: When the research project begun, the last year available in the WIOD time series was 2009. In order to insert the domestic IOT for 2011 in the 2009 WIOD, we first backdated the Costa Rican table through the following steps:

  - Aggregated level data (total intermediate use by industry, household consumption, government consumption and gross capital formation and exports) included in the table was obtained from the information available in national

[2] The WIOD uses the exchange rates provided by the IMF to convert national currencies to dollars

accounts, specifically from the 2009 SUT. A new matrix for 2009 was created inputting SUT data in the row and columns totals, with blanks in the rest of the information.

- The data on intermediate demand for 2009 was obtained using a RAS procedure. This algorithm made use of the internal shares of the intermediate demand matrix for 2011, and the total intermediate demand and intermediate supply from the SUT for 2009, applying an iterative procedure adjusting column and row values. This method is the most widely known and commonly used, automatic balancing procedure. In addition, this bivariate method corrects rows and columns on one input-output table at the same time.
- In order to guarantee that the RAS algorithm would run smoothly, all zero values found in the vectors of total intermediate consumption and total production, were adjusted to become positive values close to zero. At the end of the backdating process, the intermediate consumption matrix obtained through the RAS method had to match these totals. These adjustments were minor relative to the total value contained in the symmetric input-output table, and fall within the normal statistical error.

5.1. Splitting vectors from the domestic IOT to prepare for insertion in the WIOD

5.2. Exports matrix

The domestic IOT contains and exports vector by product category, however it does not specify the country or sector destinations. In order to integrate the domestic IOT into the WIOD, the export vector must first be split according to the country and sector destinations. Merchandise exports and service exports were treated separately:

5.2.1. Merchandise exports

5.2.1.1. Splitting by country

In order to split the export vector by country destinations there are two fundamental methodological decisions, presented in the table below:

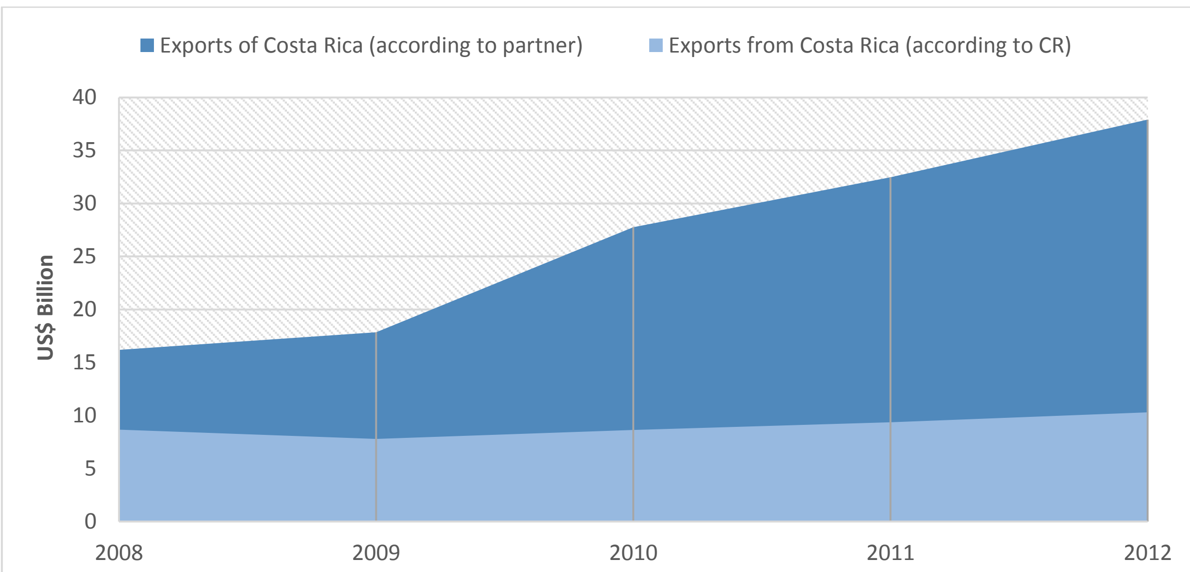
	Shares using origin's data	**Shares using destination's data**
Origin's export data	Consistent with SNA. Does not capture final destination and can miss the actual value of exported goods.	Consistent with SNA. Can better reflect final destination, use and goods values, but CIF values and trade discrepancies can distort trade structure.
Destination's import data	Not consistent with SNA, trade structure does not reflect final destination or goods values.	Not consistent with SNA, can better reflect final destination, use and goods values. But, CIF values and trade discrepancies can distort trade structure.

The first is whether to use the country of origin's export data or the country of destination's import data. In general the destination's import data is considered more reliable because it makes better adjustments for re-exports and because the recorded values of traded products tends to be more accurate. However, the disadvantage of using the destination's import data is that if there are large discrepancies between the origin's export data and the destination's import data, then the numbers used will differ significantly from those used in the national account data utilized to calculate the country's GDP.

The second is whether to calculate the shares using the origins data or the shares using the destination´s data.

According to selected partners data[3], by 2012 Costa Rica exported more than US$ 37.9 billion; nearly 3.7 times the amount reported by Costa Rica. Discrepancies are also growing in time: for the period 2008-2012, mirror data shows a Compound Average Growth Rate (CAGR) of 24%, while national data shows a CAGR of 4.4%. By 2012 the difference between national data and mirror data attained US$ 27.7 billion (see next figure).

Figure 3: Exports of Costa Rica according to source, 2008-2012



Source: COMEX with data from WITS, Eurostat, USITC, PROCOMER and Trade Map.
Note: trade data includes only countries with reported positive imports from Costa Rica by 2012.

Even though discrepancies are growing, they are concentrated in a few partners and products. By 2012, three partners accumulated 72% of the accounted differences: United States, European Union and China. Certain tariff lines – mostly related to microprocessors and computer parts – show large discrepancies due to the way in which intellectual property is assigned

[3] Selected countries represented an average of 91% of Costa Rica's exports between 2008-2012.

Table 2: Products exported by Costa Rica with the most important discrepancies

US$ million

HS-6D	Description	Partner	2011		2012		Difference		Particip. % in Dif.*	
			Partner	CR	Partner	CR	2011	2012	Dif. 2011	Dif. 2012
854231	Electronic integrated circuits as processors and controllers	USA	6,167	559	7,686	659	5,608	7,027	81%	85%
		China	3,694	139	5,105	259	3,555	4,846	98%	98%
847330	Parts & accessories of computers	EU	6,178	0	6,945	0	6,178	6,945	89%	91%

Source: COMEX with data from WITS, Eurostat, USITC, PROCOMER and Trade Map.
Preliminary data.
*Difference participation estimated using the total of positive differences.

For this reason we chose to use the origin`s export data in order to maintain the consistency with national accounts. However in order to reflect the fact that in most tariff lines, the mirror data is likely to be more accurate, we chose to assign shares of exports by destination according to mirror data shares. [4]

Formally, let $e_{i,k}^{l}$ indicate the share in exports of product *i* from country *k* to a particular country defined as:

$$e_{i,k} = \frac{\tilde{E}_{i,k}}{\tilde{E}_i} \quad (1)$$

where $\tilde{E}_{i,k}$ is the total value from products that are classified by WIOD product group *i* exported by country *k*, and $\tilde{E}_i$ the total export value of WIOD product group *i*. such that

$$E = \sum_i E_i\, e_{i,k} (2)$$

5.2.1.2. Splitting by sector

The challenge here is how to combine the information available from the bilateral trade statistics of Costa Rica with each of its partners; and the information already available in the WIOD. ITS information, combined with BEC, helps to obtain shares at three use categories: "Intermediate consumption", "final consumption" and "capital goods". However, WIOD already provides detailed information about the use made by each country of its imports from the rest of the countries into 40 categories: 35 categories for intermediate consumption; three for final consumption; one for capital and another one for change in

[4] The best choice would be to use the structure obtained from mirror data and apply it to the exports vector with national data. Certainly, it implies that as national values are used, Costa Rica's exports could be underestimated for certain countries, but this effect can be balanced with those countries with a bigger share in mirror data

inventories. There are three steps that were followed to make use of both sources of information:

First, for each country, imports in the WIOD were aggregated into one vector per sector. This generates a matrix that reflects the general structure of imports for each of the countries in the WIOD. This matrix contains the three large broad economic categories from BEC- which are subdivided in turn into the 40 stated above. Change in inventories is included into the matrix and included as part of capital, as it modifies the total output and needs to be taken into account. A share is obtained within each of the three broad groups.

Formally, let $m_{i,j}^{l}$ indicate the share of product *i* used in product *j* within group *l* (intermediate consumption, final demand or capital goods), by a particular country:

$$m_i^l = \frac{\bar{M}_{i,j}^l}{\bar{M}_{i.}^l} \quad (3)$$

where $\bar{M}_i^l$ is the total value of imports that are classified by use category *l* and WIOD product group *i*, and $\bar{M}_i$ the total value of WIOD product group *i* imported.

Internal shares $\hat{I}_i^l$ were calculated within each of these 3 broad groups, such that the sum of the values in every category would add to 1. Formally, let $n_{i,j}^{l}$ indicate the share of the use *j* within each group *l* of product *i.*

where $\hat{N}_i^l$ is the total value within each sector that is classified by use category *l* (intermediate consumption, final demand and capital goods) and WIOD product group *i,* and $\hat{N}_i$ the total value of internal share of WIOD product group *i.*

A WITS database was downloaded to capture all the countries in the world's imports from Costa Rica for 2009 in HS2007 at the 6 digit level. In order to make this database usable, the HS values were converted into the WIOD's 35 industry categories and the three BEC categories discussed above. In the case of the BEC categories motor spirits, cars, and others, the following basic assumptions were made to distribute them in the other categories: oil was distributed 50 % in intermediate consumption and 50% in final consumption, cars and others were distributed 50% in final consumption and 50% in gross fixed capital formation.

The aggregated WIOD and the WITS database were then used to create the export matrix by destination country and sector. The BEC shares from the WITS database were multiplied by the sector shares from the aggregated WIOD, to create the distribution by destination usage (BEC and sector) where,

Export matrix equals

$$\bar{M}E$$

Where,

$$\bar{M} = \sum_j M_i \, m_{i,\bar{k}}^l$$

Formally, let $m^{l}_{i,\bar{k}}$ indicate the share of use categories l (intermediate consumption, final demand and capital) in imports from product i by a particular country from country k defined as

$$m^{l}_{i,\bar{k}}=\frac{\bar{M}^{l}_{i,\bar{k}}}{\bar{M}_i}$$

where $\bar{M}^{l}_{i,k}$ is the total value from import products that are classified by use category l and WIOD product group i imported from country $\bar{k}$ = Costa Rica, and $\bar{M}_i$ the total value of WIOD product group i imported from Costa Rica.

5.2.2. Services exports

a) **Splitting by country:** In the case of Costa Rica, systematic survey data on the origin of services imports and exports destinations is not available. However, where possible other data sources were utilized to estimate the data for each service sector, and for this reason each sector will be treated separately:

Renting of Machinery and equipment; and other services: (this sector represents 15.6% of the total exports of Costa Rica). Unfortunately, there is no additional data regarding the destination of the exports related to this category. However based on the SUT, this sector consists mostly of offshore services. Furthermore four alternates were considered:

i. To use the exports structure of a country in the region (time zone) with a significant amount of FDI in services. Mexico and Canada.
ii. To use the shares of origin of FDI inflows in services, which would assume that the services are always exported to the country of ownership.
iii. To use certain goods that are complementary to services.
iv. To use the general structure of goods

Ideally, there would be enough data to evaluate the degree to which each of the underlying assumptions above is most valid in order to decide which to use. A second best approach would be to compare the three options using sensitivity analysis.

Hotels and Restaurants: This sector represents 11.7% of the total exports of Costa Rica. For this sector the distribution of incoming tourists during 2009 based on migration data collected at all entry points was considered[5]. This data was weighted according to the expenditures per capita by tourists from each country obtained from surveys to exiting tourists by the Costa Rica Tourism Board.

Education, health and social-work: This sector represents 0.6% of the total exports of Costa Rica. Data from Central Bank of Costa Rica based on sectorial consultations.

Wholesale trade and commission trade, except motor vehicles and motorcycles. This sector

[5] This data was cleaned following the Chamber of Tourism approach, by removing tourists from Nicaragua who entered by land[5], as they are mostly seasonal migrants

represents 2.4% of the total exports of Costa Rica. In this case, the structure for merchandise exports of the goods was used, given the lack of data on export destinations in this particular sector.

Air transport. This sector represents 2% of the total exports of Costa Rica. In this case there are no significant domestic airlines which provide international services, which means that all services in this sector are airport services. The General Directorate of Civil Aviation provided the frequency of flights from different airlines, and these airlines were identified by the country of ownership in order to distribute the airport services according to destinations. However, data available was not able to distinguish between cargo planes and passenger planes.

Inland transport: This sector represents 1.9% of the total exports of Costa Rica. Inland transport services could correspond to imports or exports of goods to or from Costa Rica. The following assumptions were made:

-The transportation service is always paid for by firms in the destination country

-All goods exported through land borders are transported by companies with a legal presence in Costa Rica.

Given these assumptions we used customs data regarding land exports to identify the distribution of final destinations.

Other supporting and auxiliary transporting activities; activities of travel agencies: This sector represents 1.1% of the total exports of Costa Rica. Given the lack of data, exports were distributed according to the structure of exports of merchandise.

Other sectors with non-zero values: The remaining categories have less than 0.5% each, and it was therefore considered that the basic assumption under which those sectors have the same structure as the exports of goods was appropriated. The following sectors had non-zero values: post and telecommunications; financial intermediation; real estate activities; and other community, social and personal services.

Sectors with no registered export values: construction, sale, maintenance and repair of motor vehicles and motorcycles; retail trade, water transport; public administration and defense; and private households with employed persons.

b) **Splitting by sectors**: In the case of services two steps were followed:

-The same aggregated WIOD matrix described in the case of merchandise was created for services sectors.

-In the case of services, data was not available to determine the BEC categories of exports. Therefore, it was assumed that service imports (exports) $\ddot{M}$ from Costa Rica were used in the same proportion as the imports (exports) from the total of the other countries, where:

$$\ddot{E} = \sum_{j} \tilde{S}_i \, e_{i,k}^{l}$$

Formally, let $\tilde{S}_i$ Costa Rica total export of services $e_{i,k}^{l}$ indicate the share of use categories l (intermediate consumption, final demand and capital) in exports to product i by a particular country from country k.

5.3. Import matrix

Besides the domestic IOT, Costa Rica Central Back prepared an import matrix that contains imports with the sector of origin and the sector of destination in CIF values for the merchandise related sectors, but adjusted in the totals to turn it FOB. In order to integrate the domestic IOT into the WIOD, the import matrix must be split according to the country origins in FOB values. Merchandise exports and service exports were treated separately.

5.3.1. Merchandise imports

a) Preparing the data to calculate ratios: We obtained a database from the General Customs Directorate which contains imports by HS category by country of origin and mode of transportation in CIF and FOB values. We added to the data base the WIOD categories and BEC categories.

$$M = \sum_{j} E_i \, e_{i,k}^{l} \tag{1}$$

Formally, let $e_{i,k}^{l}$ indicate the share of use categories l (intermediate consumption, final demand and capital) in imports of product i by a particular country from country k defined as

$m_{i,k}^{l} = \frac{\widetilde{M}_{i,k}^{l}}{\widetilde{M}_i}$

where $\widetilde{M}_{i,k}^{l}$ is the total value from products that are classified by use category l and WIOD product group i imported to country k, and $\widetilde{M}_i$ the total value of WIOD product group i imported from a country.

b) Splitting by country: We first calculated the share that corresponds to each country of origin within each WIOD sector using the FOB values. These shares were used to subdivide each of the origin sectors in the import matrix by countries of origin, including change in inventories.

$$m_{i,k}^{l} = \frac{\widetilde{M}_{i,k}^{l}}{\widetilde{M}_i}$$

c) Splitting by BEC: Secondly, we calculated the share of each BEC category within each WIOD sector by country using the FOB values. These ratios were used to subdivide each of the origin sectors (by country) by BEC category. This guarantees that the characteristics of each country and each BEC category within countries are maintained.

d) Converting from CIF to FOB values: We used the CIF-FOB database to calculate the ratio of FOB values to CIF values for each of the origin sectors by origin country and BEC categories. Each of the values in the split import matrix were multiplied by the FOB /CIF ratios that corresponded to their BEC category. The only assumption made is that the insurance and freight margins for the products with the same country sector of origin and BEC usage to not depend on the specific sector of usage. The trade insurance and freight margins themselves are included in imports of inland, water and air transport services and financial intermediation services sectors.

5.3.2. Services imports

Since there is no data on imports that specifies origins, each sector was treated separately.

(a) Inland transport, air transport and financial intermediation: Before addressing each of these sectors separately, some previous work was completed to include the insurance and freight margins extracted from the CIF values above into their respective sectors. We used the mode of transport at the port of entry in the same expanded database from General Customs Directorate to subdivide the freight costs to land, sea and air freight.

Since the domestic IOT merges sea and air transport, these two categories were combined as air freight. This information was used to calculate the air freight to CIF ratio, the land freight to CIF ratio and the insurance to CIF ratio for each country of origin and destination sectors. Each of these ratios was multiplied by the import matrix by countries, sectors and BEC to construct an import matrix for inland transport, air transport and financial intermediation. Each of these matrices were collapsed into a vector specifying each destination sector. These vectors were added to the vectors for each corresponding sector in the domestic IOT. The assumption is that all services in the insurance and freight margin are imported.

After making these adjustments each sector was treated separately:

- Inland transport: We used customs data to determine the share of countries of origin. The underlying assumption is that the transportation service provider is from the country of origin of the import. All observations where the country of origin has no direct land contact with Costa Rica were eliminated in this calculation. These shares were used to disaggregate the vector by countries

- Air transport: We used data on incoming flights from the general Directorate of Civil Aviation, assigning the country of origin of each airline. These shares were used to disaggregate the vector by countries and BEC categories. Using this proxy implies that all flights were given the same weight into the total share by country. We followed the Central Bank decision to use the structure of air transport, since many logistics firms do not separate the costs of air and sea transport.

- Financial Intermediation: The data on international financial transaction in Costa Rica is not available to researchers. As a second best, we decided to use the structure of countries of origin of financial intermediation imports for two similar countries, Mexico and Canada. The country shares for the financial intermediation imports were calculated for both countries, they were then averaged and re-indexed to obtain an estimate of the shares for Costa Rica. These shares were used to disaggregate the vector by countries.

(b) Other supporting and auxiliary transporting activities, activities of travel agencies; post and telecommunications and renting of Machinery and equipment and other services: In the case of these sectors, there is no available data or the sources are confidential. As in the case of financial intermediation, we decided to use the structure of countries of origin of each sector's imports for two similar countries, Mexico and Canada. The country shares for the sector's imports were calculated for Mexico and Canada, they were then averaged and re-indexed to obtain an estimate of the shares for Costa Rica. These shares were used to disaggregate the vector by countries.

(c) Sale, maintenance and repair of motor vehicles and motor cycles: Inquiries made by the Central Bank throughout the surveying process suggest that 100 percent of trade in this sector was with Central America. Since no other Central American countries are in the WIOD, these exports were assigned to the Rest of the World. These shares were used to disaggregate the vector by countries.

(d) Hotels and Restaurants: Data on Costa Rican tourists reported by destination countries does not often exist because exports to Costa Rican tourists are a very small proportion of GDP. As an alternative, national migration data on destinations of Costa Rican tourists was used. It was assumed that all tourists spend the same amount during their stay due to lack of data. These shares were used to disaggregate the vector by countries.

(e) No registered values: Construction; Wholesale trade and commission trade except motor vehicles and motorcycles; retail trade; water transport; real estate activities; public administration and defense; Education; health and social-work; Other community, social and personal services; private households with employed persons

6. Insertion of domestic IOT in WIOD

6.1. Insertion

In order to insert Costa Rica into the WIOD Costa Rica was extracted from the rest of the world both in terms of countries imports and countries exports, and interactions within row.

- Extract Costa Rica´s exports to each country from exports of ROW to each country in the WIOD, including ROW. This first involved inserting Costa Rica's split export matrix in a new row in the WIOD to capture Costa Rica's exports to each country. Then these values were subtracted from the exports of ROW to each country, in order to create the exports of ROW* to each country, where ROW* is ROW excluding Costa Rica.

- Extract Costa Rica's bilateral imports from each country from imports of ROW to each country in the WIOD, including ROW. This first involved inserting Costa Rica's split import matrix in a new column in the WIOD to capture Costa Rica's imports to each country. Then these values were subtracted from the imports of ROW from each country, in order to create the imports of ROW* from each country, where ROW* is ROW excluding Costa Rica.
- Extract Costa Rica's domestic matrix from ROW's domestic matrix: This first involved inserting the intermediate and final demand sections of Costa Rica's domestic IOT in the space in the WIOD representing interactions between Costa Rica and Costa Rica. Then these values were subtracted from the matrix of interactions between ROW and ROW. The value added matrix from the domestic IOT was inserted in the value added section of the WIOD for Costa Rica.

6.2. Dealing with negative values in ROW

In some cases the values left for exports to ROW* or imports from ROW* were negative. This occurred when the value imported or exported by Costa Rica is larger than the value which ROW imported or exported. In each of these cases the data used and assumptions made were revised and improved (where possible) to reduce the incidence of negative numbers as much as possible. In order to ensure that these cases do not affect analysis of the matrix adversely, they were removed and placed in a separate category. The negative numbers that emerge from ROW's exports are grouped in a separate row and the negative numbers that emerge from ROW`s imports are grouped in a separate column.

We engaged in further analysis to quantify the extent to which there are discrepancies in the data and the sources of error. Negative numbers can emerge due to four reasons:

Costa Rica's data was less accurate that the data used to construct the WIOD, even before splitting by countries and usages.

Even though the aggregate data on exports or imports for each sector in Costa Rica is accurate, the underlying assumptions about how to spilt various vectors by country and usage, were inaccurate.

Data provided by key countries were less accurate that the data used by Costa Rica, even before splitting by countries and usages.

Even though the aggregate data on exports or imports for each sector in partner countries is accurate, the underlying assumptions about how to split various vectors by country and usage were inaccurate.

7. Summary of methodological insights

International Input-Output Tables are a valuable tool for countries to understand their interactions with the global economy. For this reason, many developing countries that strive enhance their participation in global value chains may be interested in construction their own IIOT. This methodological paper has described the process through which Costa Rica was included in an International IOT for 2009 based on the WIOD, with the objective of describing the process that other countries would have to follow in order to build their own table. The process that was followed draws upon the guidelines used to build the WIOD. However, each country faces its own set of data constraints and case-specific assumptions must be made that leverage existing data and local contextual knowledge. There are, however, common challenges that many countries are likely to face and this paper addresses three which may be of particular interest:

<u>1-Lack of access to partner country data:</u>

Ideally, the process to build an IIOT, would use each of the country's original data sources to construct and then balance the table. This is the approach that has been used to build the WIOD, the OECD's ICIO and other efforts. However, from the perspective of a national statistics office or central bank this process is inhibitive, mainly because of the difficulties involved in obtaining data from each partner country. While it might be conceivable to obtain SUTs from each country, the data and context-based knowhow required to make reasonable assumption in order to include each country in the IIOT is generally not accessible. This paper describes a new second-best approach, which strives to include new countries in a pre-existing IIOT. This process involves new steps that leverage existing international data, such as the following:

- *Choosing a base IIOT:* There are a range of publically available IIOT's which can be used as a base table. The availability of several options allows researchers to optimize their objectives by weighing the advantages and disadvantages according to three criteria: the number of partner countries in the table, the level of disaggregation and the robustness of the assumptions made in combining data sources.
- *Making use of data in the base IIOT:* The base IOT contains a wealth of data regarding the origins of each country´s imports and the destination of its exports, both in terms of country and industry. This data can be leveraged in cases in which domestic data is lacking to estimate the shares to split the import and export vectors for different products by country.
- *Inserting the domestic IOT in the base IIOT:* In order to build the IIOT, a creative approach must be used to extract the new country from the category called rest of the world (ROW). This involves extracting the new country's exports from ROW's exports, extracting the new countries imports from ROW's imports and extracting the new countries domestic IOT from ROW's domestic IOT.

<u>2-Discrepancies in country's trade data relative to partner countries' mirror data:</u>

It is well known that there are significant discrepancies between the values that trade partners report for their bilateral trade. The rise of global value chains has exacerbated these discrepancies due to the ambiguity in the way intellectual property should be assigned by country, inaccuracies in the measurement of insurance and freight margins and other issues. Organizations such as the OECD are working with various countries to reduce these discrepancies, however, in the meantime efforts to build IIOT's from each country's individual data must make consistent assumption for all countries, which oftentimes overestimate or underestimate trade flows for specific countries. The typical assumption made is that import data is more reliable than export data since there the revenues collected from tariffs from incoming products create a strong incentive to keep tight controls. In cases of countries whose GDP is highly reliant on trade in which discrepancies between data sources are large, this can lead to significant deviations from national accounts data.

In the case of Costa Rica, in industries in which the country has a significant participation in technology-based GVCs, discrepancies between national export data and mirror data are large due to the way in which partner countries incorrectly assign intellectual property, rather than lax measurements of exports. Using import data would grossly exaggerate Costa Rica's contribution to the global economy. For this reason, domestic export data was used in order to ensure a more conservative estimate that would maintain consistency with national accounts data.

In order to estimate imports, the norms followed by the WIOD were adopted because Costa Rica is not a large importer of intellectual property and because the quality of data makes it possible to accurately isolate the insurance and freight margin. The Costa Rica General Customs Directorate keeps accurate records of insurance and freight margins for imports based on true data. This data was used to convert imports from CIF to FOB values with making any assumptions.

3-Lack of data on origins and destinations for services imports and exports

One of the greatest data challenges that Costa Rica and many other countries face, is the lack of accurate data on the origins and destination of services imports and exports. While the Central Bank has surveys to the services sector, it has proven difficult to collect reliable data on destinations and origins. In an age in which many services are sold over the internet and a range of offshore services companies provided services to countries all over the world, obtaining this data has proven challenging.

The default approach used in many efforts to construct IIOTs is to assume that the distribution of origins and destinations followed that of products for the conglomerate of countries in the WIOD. Since this is a very crude assumption, were possible, sector-by sector second best strategies were adopted to estimate values using secondary data and reasonable assumptions. The following three clear examples are worth highlighting:

a) Hotels y restaurants: This sector consists of tourism. In the case of exports, data migration data on origin and expenditures of incoming tourists was used to approximate the destination of exports. In the case of imports, data on the destination was used, since expenditure data was not available.
b) Air transport: Since Costa Rica does not have any international airlines, the exports in this category refers to airport services. On the other hand, Costa Rica´s imports of air transport consist mainly of airline services. For these reasons the flags of all flights arriving in Costa Rica were used to estimate both the destinations of exports and the origin of imports
c) Inland transport: Data on the destination and origin of vehicles entering at the borders was used to calculate the shares.

While there are strategic approaches that can be used to make the most of available data, clearly it is also important to work on strengthening available data. There are areas in which improvements to Costa Rican data sources would be particularly valuable. The most notable improvement would be if the Central Bank could lengthen the current surveys to the service sector in order to include the disaggregation of services data by uses and countries. There are also areas in which the integration of Costa Rica into the WIOD has revealed weaknesses in the partner country data used to construct the WIOD. This seems to be most evident in the case of tourism.

8. Bibliography

Bibliography here

9. Appendix

Appendix 1 here