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Using the Input-Output Approach to Measure Participation in GVCs: The Case of Costa Rica*

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Abstract: In order to illustrate how the input-output approach can be used to explore various aspects of a country's participation in GVCs, this paper applies indicators derived from the concept of trade in value-added (TiVA) to the case of Costa Rica. We intend to provide developing countries that seek to foster GVC-driven structural transformation with an example that demonstrates an effective way to measure progress. The analysis presented in this paper makes use of an International Input-Output Table (IIOT) that was constructed by including Costa Rica's first Input-Output Table (IOT) into an existing IIOT. The TiVA indicator has been used to compare and contrast import flows, export flows and bilateral trade balances in terms of gross trade and trade in value-added. The country's comparative advantage is discussed based on a TiVA-related indicator of revealed comparative advantage. The paper also decomposes the domestic content of value added in each sector and measures the degree of fragmentation in the value chains in which Costa Rica participates, highlighting the partner countries that add the most value.

Keywords: Trade in Value-added, TiVA, Global Value Chains, GVCs, Input-Output

JEL classification: F6; F13; F15, D57

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Using the Input-Output Approach to Measure Participation in GVCs: The Case of Costa Rica

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ABSTRACT

The fragmentation of global production across national borders has created valuable development opportunities for countries that are able to integrate into global value chains (GVCs) and climb towards higher value-added activities. In the midst of this transition, policy-makers require well conceptualized indicators that reveal the degree and nature of the interaction of their country with its main economic partners, reflecting better international production networks. We apply indicators derived from the concept of trade in value-added (TiVA) to the case of Costa Rica in order to illustrate how the input-output approach can be used to explore various aspects of a country's participation in GVCs. We intend to provide developing countries that seek to foster GVC-driven structural transformation with an example that demonstrates an effective way to measure progress.

The analysis presented in this paper makes use of an International Input-Output Table (IIOT) that was constructed by including Costa Rica's first Input-Output Table (IOT) into an existing (IIOT). The TiVA indicator has been used to compare and contrast import flows, export flows and bilateral trade balances in terms of gross trade and trade in value-added. The country's comparative advantage is discussed based on a TiVA-related indicator of revealed comparative advantage. The paper also decomposes the domestic content of value added in each sector and measures the degree of fragmentation in the value chains in which Costa Rica participates, highlighting the partner countries that add the most value.

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Introduction

GVCs have driven an important shift in global production from trade in goods to “trade in tasks” (see Grossman and Rossi-Hansberg, 2008). This phenomenon has also been explained as the so-called “the second great unbundling” (see Baldwin, 2011). The theoretical background is that the reduction of communication cost due to the IT revolution has enabled the international unbundling of factories and offices, which means that tasks can also be traded globally. As a result, countries no longer have to build or host the entire production chain, since they can integrate by developing or attracting productive capacity in one link of the chain where their comparative advantages fit the best.

Understanding how much domestic value is added through the export of goods and services, how value added creation process relates to the degree and position of participation in GVCs is crucial for designing effective development strategies and industrial policies. Credible metrics of domestic value-added in the context of GVCs need to be derived from the measurement of trade flows. A variety of techniques have been suggested to measure the degree and nature of trade interactions along international production networks (Hummels et al., 2001; Kuroiwa, 2006; Escaith, 2008; Koopman et al., 2008; 2010, 2014, Linden et al., 2009; Uchida and Inomata, 2009; Yang et al., 2009; Dedrick et al., 2010; Degain and Maurer, 2010; Xing and Detert, 2010; Fukasaku et al., 2011; Johnson and Noguera, 2012; Meng et al., 2011, 2012; Stehrer, 2012; Los et al., 2012, 2014; Timmer et al., 2013, 2014). However, the most widely accepted metrics are those that are based on the concept of “Trade in Value Added (TiVA)” (see OECD-WTO, 2013).

All TiVA-based metrics are calculated using international input output tables (IIOT). These tables are an extension of domestic input-output tables (IOTs), and contain information on the interactions between industries across countries. One of the pioneer works on the construction of IIOT was done by IDE-JETRO in the mid-1960s (see Meng et al, 2013). Since then there have been various efforts by international organizations to build time series of IIOTs that are constructed from data provided by each of the countries included. These efforts vary in the number of countries included, the level of disaggregation of sectors and the types of assumptions made during the construction process. The most commonly referenced tables are the OECD’s Inter-country Input Output Table (ICIO), the World Input Output Database (WIOD) and IDE-JETRO’s Asian IIOT (AIIOT).

Ideally all countries interested in tracking the progress of their participation in GVCs would seek their integration into efforts such as the OECD’s TiVA initiative, which is extending the ICIO to include more countries. Costa Rica is one of the countries that have chosen to follow this path. However, in order to guarantee methodological consistency, these efforts strive to apply the same assumptions to all countries involved. While this is arguably the right approach for an internationally oriented effort, from the perspective of specific countries, overarching assumptions may apply poorly in important cases, leading to significant distortions in results. This is particularly relevant given the large discrepancies that exist in bilateral trade data reported by trade partners.

In order to maintain consistency with national data sources, countries may choose to construct their own IIOT. From the perspective of a national statistics office or central bank, the process used to

construct the ICIO and WIOD is inhibitive, mainly because of the difficulties involved in obtaining data from each partner country. This analysis described in this paper is based on an IIOT that was built using a resourceful second-best approach, which strives to include a new country in a pre-existing IIOT^{§§}.

This paper is divided in two parts. Part I provides an overview of IIOTs and focuses on the methodology followed to integrate Costa Rica into the WIOD (a pre-existing IIOT), highlighting methodological insights. Section 1.1 describes the reasons why IIOTs are useful for the analysis of TiVA. Section 1.2 lays out the basic framework of an IIOT. Section 1.3 provides background regarding the construction of Costa Rica's domestic IOT. Section 1.4 describes the process followed to select the WIOD as the base table. Section 1.5 explains the way in which the domestic IOT was converted into the WIOD's format. Section 1.6 provides details on the decisions made to split import and export vectors by country and sector. Section 1.7 describes the method used to embed Costa Rica's IOT in the WIOD. Section 1.8 concludes the methodology with a summary of methodological insights.

Part II analyses a series of TiVA-based indicators derived from the use of the IIOT and uses the case of Costa Rica to explore their implications for policymakers. In Section 2.1, the TiVA indicator has been used to compare and contrast import flows, export flows and bilateral trade balances in terms of gross trade and trade in value-added. In section 2.2 the country's comparative advantage is discussed based on a TiVA-related indicator of revealed comparative advantage. Section 2.3 decomposes the domestic content of value added in each sector. Section 2.4 measures the degree of fragmentation in the value chains in which Costa Rica participates, highlighting the partner countries that add the most value.

1. Methodology

1.1. Why are 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 such as the World Trade Organization (WTO). In practice, however, the idea was only recently put in practice 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.

^{§§} A more detailed explanation can be found in a methodological paper by Bullón, Inomata, Meng, Mena, Sanchez and Saborío that is soon to be published. Similar works concerning how to integrate a country's IO into a pre-existing IIOT can be found in Meng et al. (2013), Cherubini and Los (2013), and Dietzenbacher et al. (2013).

However, this approach has three main disadvantages. Firstly, their applicability is limited when 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 value is 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.

Given the limitations of the conventional approach, increasing attention has been directed to a new strand of studies that use IIOTs. An IIOT provides a comprehensive map 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, input–output analysis covers an entire set of industries that comprise an economic system, and can thereby capture the cross-border value flows at the level of a country or a region. Theoretically, it has the capacity to track the value-added generation process of every commodity in every country at every production stage (see Koopman et al., 2014).

1.2. The basic framework of IIOTs

The construction of an IIOT is a major effort that brings together pieces taken from various national input-output tables, and hence the results can be read exactly in the same manner as for national tables. The major difference is that an IIOT explicitly presents international transactions between industries in the form of import matrices and export matrices by trading partners, which enables comprehensive mapping of global production networks.

IIOTs can take various forms depending on analytical purposes and data availability. *Figure 1* presents the 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 IIOT (three-country case)

	Industry/ FD/VA codes	Intermediate demand												Final demand												Export to ROW	Total outputs
		Country A				Country B				Country C				Country A				Country B				Country C					
		001	002	003	..	001	002	003	..	001	002	003	..	PCE	GCE	GFCF	..	PCE	GCE	GFCF	..	PCE	GCE	GFCF	..		
Country A	001																										
	002	Z ^{AA}				Z ^{AB}				Z ^{AC}				Y ^{AA}				Y ^{AB}				Y ^{AC}				E ^{AW}	X ^A
	003																										
	:																										
Country B	001																										
	002	Z ^{BA}				Z ^{BB}				Z ^{BC}				Y ^{BA}				Y ^{BB}				Y ^{BC}				E ^{BW}	X ^B
	003																										
	:																										
Country C	001																										
	002	Z ^{CA}				Z ^{CB}				Z ^{CC}				Y ^{CA}				Y ^{CB}				Y ^{CC}				E ^{CW}	X ^C
	003																										
	:																										
Net taxes on products of trading partners						TZ ^A				TZ ^B				TY ^A				TY ^B				TY ^C					
International freight and insurance costs						IZ ^A				IZ ^B				IY ^A				IY ^B				IY ^C					
Rest of the World	001																										
	002	Z ^{WA}				Z ^{WB}				Z ^{WC}				Y ^{WA}				Y ^{WB}				Y ^{WC}					
	003																										
	:																										
Duties & import commodity taxes						DZ ^A				DZ ^B				DY ^A				DY ^B				DY ^C					
Value added	Wages																										
	Op.surplus					V ^A				V ^B				V ^C													
	:																										
Total Inputs						X ^A				X ^B				X ^C													

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 Country C, respectively. Z^{WA} indicates the imports from other countries, as grouped under the name of 'Rest of the World' (ROW). 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.

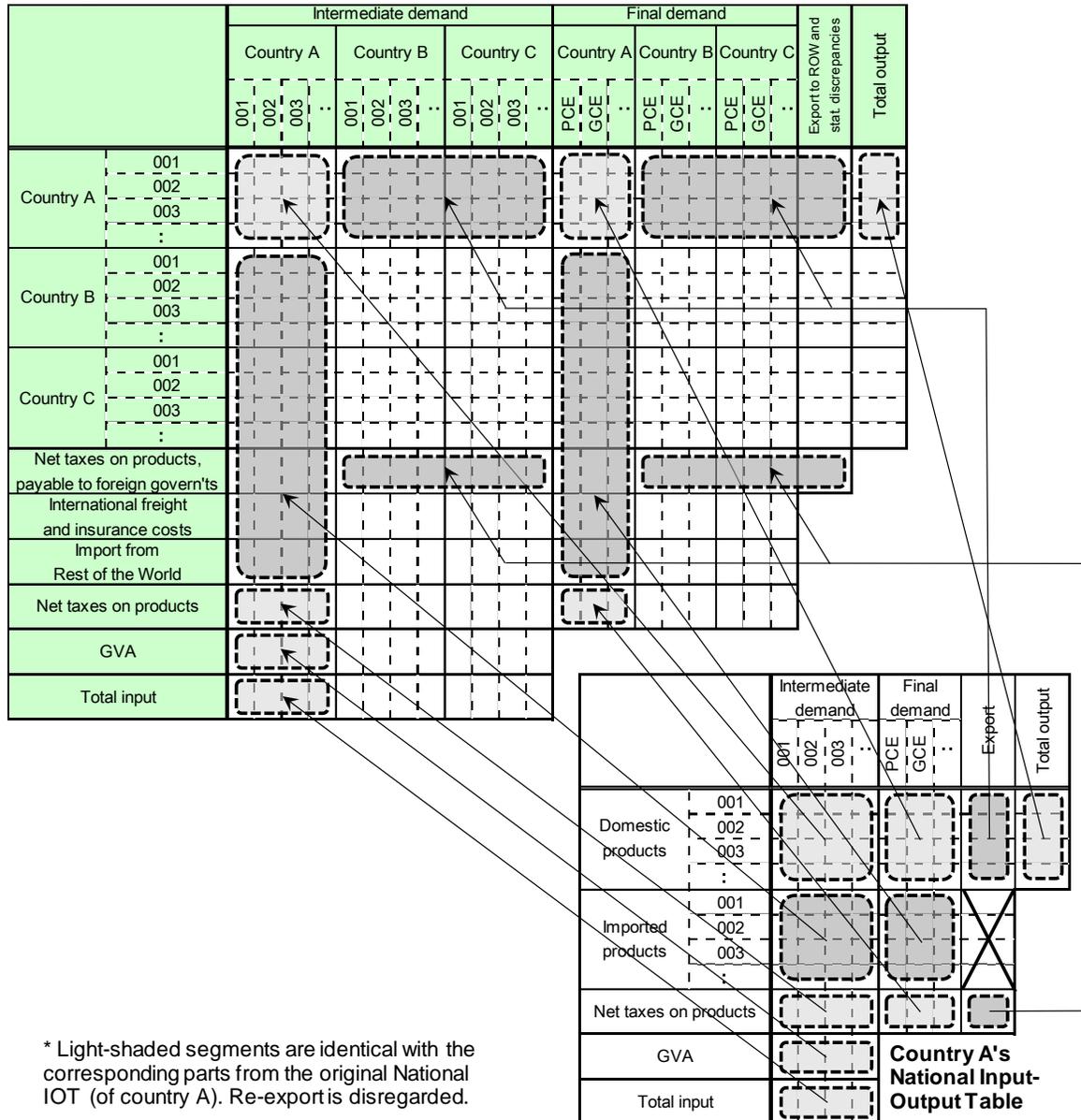
The fourth column of sub-matrices from the left shows the composition of goods and services that have gone to the final demand sectors of Country A. Y^{AA} and Y^{BA} , for example, present respectively the goods and services produced domestically and those imported from Country B that flow into Country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

E^{*W} are the export 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.

Figure 2: Compositional correspondence of the IIOT to a national input-output table (three-country case)



Source: Drawn by the author.

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 generally replaced by the import matrices of trading partners, and hence the problem of symmetries arises. Theoretically, Country A's exports

of a particular product to Country B should be equal to Country B's imports of the same product from country A, as long as they are compared at the appropriate valuation scheme (c.i.f. or f.o.b.). In practice, this is often not the case for many reasons, including the following:

- Inappropriate estimation of transaction margins (international freight and insurance costs, trade and transport margins, various taxes) in converting the valuation scheme of import matrices.
- Mismatches between the record of international transactions in Supply and Use Tables (SUTs) /National Accounts and the custom statistics/balance of payments statistics.
- Improper declaration of product classifications at the customs border, either at entry or exit;
- Confusion about the 'real' country of origin or destination for re-exported products;
- Confusion regarding the assignment of intellectual property.
- Shipping time-lags across different accounting periods (quarters or years);
- The presence of "merchandising" trade;
- Smuggling; and
- Other unrecorded transactions.

Some existing IIOTs, notably the Inter-country Input-Output Tables (ICIO) of the OECD and the World Input-Output Database (WIOD) 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 WIOD.

1.3. Construction of the Costa Rica's domestic IOT

Costa Rica's 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 (United Nations, 2010). The SNA 2008 addresses important issues brought about by changes in the economic environment, advances in methodological research and the evolution of user needs.

The process followed to construct the domestic IOT draws upon data from the fully balanced version of the Supply Use Table (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. Since small firms dominate the Costa Rican economy, secondary activities were reported in few cases. For this reason, it was assumed that the domestic IOT can be used interchangeably as an industry based table and as a product based table. The IOT was originally built with 76 products, and was later aggregated to match the WIOD's 35 industries.

The SUT includes 183 products and 134 economic activities or industries. 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). Appendix 1 and Appendix 2 describe the data sources used to construct the SUT, and highlight the new recommendations that were adopted in line with the SNA 2008.

1.4. Selection of the IIOT in which to embed Costa Rica

There are two general approaches that can be adopted to construct an IIOT that includes a country which is not currently in an existing IIOT. The first is to construct the entire table using national sources of all the relevant countries. This is the strategy that the organizations named in *Table 1* have followed to construct their IIOTs. This paper use a second approach intended to leverage existing resources to achieve the same objective by embedding the new country into an existing IIOT. From the perspective of the country that is embedded into the IIOT, the value of the resulting IIOT will depend to a large extent on how good of a fit the existing IIOT is as the base table. Table 1 shows the most commonly used IIOTs, with a summary of some of their most important characteristics:

Table 1: Main characteristics of existing IIOTs

Database	Producing organisation	Reference years	Number of countries	Industry/product classification
AIOT	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

Source: Constructed by the author, based on E. Dietenbacher and Tukker, A. (2013).

The following criteria were used to select the WIOD as the preexisting IIOT that would serve as the best base table given the characteristics of Costa Rica's domestic IOT and the nature of its trade patterns:

1-Assumptions made to construct the table: The tables with the greatest number of countries have to make technology assumptions in the case of many countries in order to account for the fact that many countries do not have a detailed SUT that could serve to build an IOT based on true data. These assumptions lead to a significant margin of error in estimates of interactions between industries across countries. For this reason, EORA and GTAP-MRIO were discarded from the selection process.

2-Reference year: Ideally the reference year of the base table would match the year for which the domestic IOT is available. Costa Rica's first IOT was constructed for 2011, and at the time, the most recent IOTs were for 2009¹, which meant that the Costa Rican IOT would have to be backdated. Having already discarded EORA, by this criterion the WIOD, and the ICIO were the most attractive options. EXIOPOL and AIIOT were considered outdated.

3- 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 important trade partners in Central America are not in the publically available IOTs that are based on SUTs. This meant that a large proportion of Costa Rica's interactions with the Rest of the World in the resulting IOT are in fact interactions with its close neighbors. Having discarded EORA, GTAP-MRIO and EXIOPOL, the most attractive options were again the WIOD and the ICIO. The AIIOT was less relevant because of its focus on Asia.

4- Sector coverage: Since the Costa Rican domestic IOT has a detailed sector disaggregation, the ideal base table would have a similar level of product/industry detail. Among the two most attractive options by other criteria, (WIOD and ICIO), the WIOD has a greater level of detail.

1.5. The domestic IOT and the WIOD

Even though the Costa Rican domestic IOT was constructed following international standards, several adjustments had to be made to give a format compatible with the WIOD. The format was standardized regarding prices, sector categorization and reference year.

1-Prices: There are three types of price conversions that were considered in adapting the IOT to the format of the WIOD:

a) *Currency*: The domestic IOT is in Costa Rican colones, whereas the WIOD is in US dollars. The Costa Rica Central Bank provided the annual average exchange rate used in the national accounts in order to convert the domestic IOT into US dollars.²

b) *Current vs. constant prices*: In this case, no conversion was required because both the domestic IOT and the WIOD are in current prices³.

c) *Basic vs. producer prices*: In this case, no conversion was required because both the domestic IOT and the WIOD are in basic prices.

¹ The WIOD for 2011 was not publically available towards the beginning of the research project.

² The WIOD uses the exchange rates provided by the IMF to convert national currencies to dollars; however, the IMF does not provide the exchange rate from colones to dollars.

³ While the WIOD also has a time series data in previous year's prices.

2-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. The fundamental difference between the two approaches is that the product-by-product approach deals with primary and secondary products manufactured by a firm separately, whereas the industry-by industry approach gives secondary products the same treatment as primary products. This difference is most relevant in cases in which a firm's secondary products correspond to an industry other than the one that corresponds to the primary products. The survey data used to construct the IOT revealed that in the case of Costa Rica, only 3.5% of all production in the economy is in secondary products outside of their primary industry, which means that it can be safely assumed that the product-by-product IOT can be used interchangeably as an industry-by-industry IOT⁴. The only adjustment necessary was to convert from the product categories used in the IOT to the WIOD's 35 industry categories using a standard conversion table. From this point on the sector categorizations in the domestic IOT will be referred to as industries.

3-Reference year: When the effort to embed Costa Rica in the WIOD began, the last year available in the WIOD time series was 2009. In order to ensure consistency in the reference year used, a domestic IOT was constructed for 2009, using available data for 2009 to backdate the domestic IOT for 2011. Each part of the table was constructed separately through the following steps:

a) *Intermediate demand:* To build the intermediate demand matrix for 2009, three standard inputs were required: the intermediate demand matrix for 2011, the column of total intermediate supply in each of the WIOD industries and the row of total intermediate use in each of the WIOD industries. The overall strategy that best practices would recommend would be to use the totals of supply and usage for 2009 while imposing the structure of the 2011 matrix in order to fill the 2009 matrix. Typically the totals of supply and usage could be taken directly from the SUT for 2009 with no further adjustments. However, in the case of Costa Rica, the intermediate demand structure of the 2009 SUT is the result of adjustments that have been throughout time to a structure based on survey data from 1991⁵. Since 1991, the structure of the Costa Rican economy has experienced a significant transformation, and despite efforts to adjust the structure using estimates, the structure inherent in the 2011 SUT way well be closer to the real 2009 structure than the structure inherent in the 2009 SUT. In order to maintain consistency with the GDP published by the Central Bank in 2009, the structure and total values for economy-wide usage and supply were taken from the 2009 SUT, however, the industry shares were adjusted in cases in which there were significant deviations from the structure in the 2011 IOT.

Once the column of total supply in each of the WIOD industries and the row of total use in each of the WIOD industries had been constructed; a RAS algorithm⁶ was applied to adjust the contents of the matrix to fit the totals for 2009. The algorithm iterates between row adjustments and column adjustments until the adjustments converge at a stable equilibrium. During each iteration, the values in each row (or column) are adjusted such that they sum to the row (or column) total, maintaining their share in the total. In order to guarantee that the RAS algorithm would run smoothly, all zero-

⁴ Future versions of the domestic IOT may use an industry-by-industry approach.

⁵ For many years Costa Rican SUTs used 1991 as the base year. The base year has now been updated to 2011.

⁶ The RAS algorithm is also known as the iterative proportional fitting procedure (see Miller and Blair, 1985).

values found in the vectors of total intermediate consumption and total production, were adjusted to become positive values close to zero.

b) *Exports and Imports*: The column of exports and row of imports were constructed from trade data from the General Customs Directorate, and Balance of Payments data from the Central Bank. These vectors were appended to the intermediate demand matrix. These were latter split by country and industry of origin and destination, as described in Appendix 3.

c) *Value added*: The value added matrix was constructed using a similar procedure to that used to construct the vector of total intermediate supply in each of the WIOD industries. The structure and row totals were taken from the 2009 SUT and industry shares were adjusted making reference to the shares for the equivalent rows from the 2011 IOT.

d) *Final demand*: The final demand matrix was extracted from the 2009 SUT.

1.6. Insertion of domestic IOT into the WIOD

In order to insert Costa Rica into the WIOD, the country was extracted from the rest of the world (ROW) both in terms of countries’ imports and countries’ exports, and interactions within ROW. In order to illustrate the strategy adopted to insert Costa Rica by extracting it from ROW, the following stylized example will be used. The example includes a simplified IOT which contains only the intermediate demand between country N and ROW, where Costa Rica is a part of ROW. The steps followed use Costa Rican data to extract Costa Rica from ROW in order to create ROW* the rest of the world without Costa Rica. The example draws upon the nomenclature defined in section 1.2.

Figure 3: Illustration of the extraction of Costa Rica from ROW in a simplified IOT

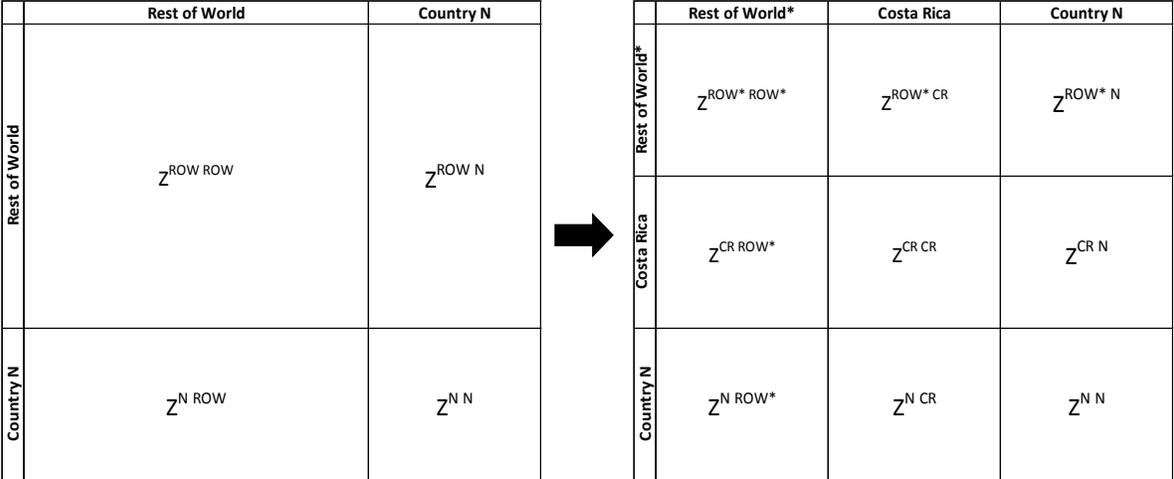


Figure 3 demonstrates that in essence the objective of inserting a new country into an existing IIOT, consists of extracting the new country from ROW in order to create ROW* and then inserting the new country's data. In practice, this was carried out in four steps, where the steps described for intermediate demand were also carried out for final demand:

- Create the row of Costa Rica's exports: 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 ($Z^{CR N} + Z^{CR ROW*}$). It then required extracting Costa Rica's exports to each country from exports of ROW to each country in the WIOD ($Z^{ROW* N} = Z^{ROW N} - Z^{CR N}$) and extracting Costa Rica's exports to ROW* from ROW's domestic matrix ($Z^{ROW ROW} - Z^{CR ROW*} = Z^{ROW* ROW*} + Z^{CR CR} + Z^{ROW* CR}$).
- Create the column of Costa Rica's imports: 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 ($Z^{N CR} + Z^{ROW* CR}$). It then required extracting Costa Rica's imports from each country from imports from ROW ($Z^{N ROW*} = Z^{N ROW} - Z^{N CR}$) and extracting Costa Rica's imports from ROW* from what was left of ROW's domestic matrix from the first step ($Z^{ROW ROW} - Z^{CR ROW*} - Z^{ROW* CR} = Z^{ROW* ROW*} + Z^{CR CR}$).
- Extract Costa Rica's domestic matrix from ROW's domestic matrix: This first involved inserting the intermediate 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 what was left of ROW's domestic matrix from the second step ($Z^{ROW ROW} - Z^{CR ROW*} - Z^{ROW* CR} - Z^{CR CR} = Z^{ROW* ROW*}$).
- Accommodating all other matrices: The above processes are also applied to the final demand sections in the same manner. Other parts (e.g. value-added) of the WIOD were taken directly from the domestic IOT and inserted in the corresponding locations in the WIOD for Costa Rica.

1.7. 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 was larger than the value which ROW imported or exported. In each of these cases the data used and assumptions made were revised and improved to reduce the incidence of negative numbers as much as possible. Remaining negative values were removed and placed in a separate category to ensure that these cases did not affect analysis of the matrix adversely. The negative numbers that emerge from ROW*'s exports were grouped in a separate row and the negative numbers that emerge from ROW*'s imports were grouped in a separate column.

There are four types of underlying data discrepancies that lead to negative values:

- Cases in which Costa Rica's data are less accurate than the data used to construct the WIOD, even before splitting by countries and usages.
- Cases in which the underlying assumptions used by Costa Rica about how to split various vectors by country and usage are inaccurate, even though the aggregate data on exports and imports for each sector is accurate.
- Cases in which data provided by key countries is less accurate than the data used by Costa

Rica, even before splitting by countries and usages.

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

1.8. 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 to enhance their participation in GVCs may be interested in constructing their own IIOT. This methodological section has described the process through which Costa Rica was included in an IIOT 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. This paper addresses three that may be of particular interest:

1-Lack of access to partner country data:

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. Part I of this paper has described 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 IIOT 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.

2-Discrepancies in country's trade data relative to partner countries' mirror data:

It is well known that there are significant discrepancies between the values that trade partners report for their bilateral trade. The rise of GVCs 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 assumptions for all countries, which oftentimes overestimate or underestimate trade flows for specific countries (see Zhu et al., 2011). The typical assumption made is that import data is more reliable than export data since the revenues collected from tariffs from incoming products create a strong incentive to keep tight controls.

Under certain conditions, this standard assumption can lead to significant deviations from national accounts data for countries whose GDP is highly reliant on trade. 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 Rican 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 without 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 for 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 follow that of products for the conglomerate of countries in the WIOD. Since this is a very crude assumption, were possible, sector-by-sector strategies were adopted to estimate values using secondary data and reasonable assumptions. The following three clear examples are worth highlighting:

- a) Hotels and restaurants: This industry is essentially tourism. In the case of exports, migration data on the origin and domestic expenditure 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 refer 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 the 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.

2-Application of the trade in value added based indicators to the case of Costa Rica

This part of the paper makes use of the IIOT constructed according to the methodology described in part I, to calculate a few key indicators that are based on the concept of trade in value added (TiVA). Costa Rica is a relevant case to illustrate the value of these analytical tools because it is a small, open economy, with significant participation in GVCs that involve several countries. In these cases the multiple counting of intermediate values and the implicit distortion of measurement of bilateral trade based on conventional statistics are most likely to provide a misleading perspective of a country's trade structure and the trade dynamics that are driving economic growth.

2.1 Gross trade vs. trade in value added (TiVA)

A good starting point for any country that wishes to glean new insight from TiVA indicators is to compare traditional statistics on gross trade with those that emerge from an analysis based on TiVA. This section discusses the insights that emerge from this analysis for Costa Rica when comparing gross and value-added metrics for exports, imports and trade balances.

Figure 4a and 4b compare export and import statistics measured by gross value and value added for the case of Costa Rica. A quick review of these figures reveals that the measure of trade of goods and services overstates the importance of exports for the national economy. Furthermore, since in traditional accounting terms imports contribute negatively to GDP, their importance to economic growth and competitiveness is understated.

Figure 4a: Costa Rica exports, partner shares, in gross and value added terms, 2009

Structure of exports by partner
as a % of total

Destination	Gross value	Value added
Rest of the World	41,6%	38,5%
United States	26,8%	28,2%
Western Europe	15,8%	17,1%
China	6,1%	5,4%
Mexico	4,1%	3,1%
Canada	2,3%	2,7%
Rest of Europe	1,7%	2,5%
Japan	0,9%	1,5%
Brazil	0,9%	1,0%
Total	100%	100%

Exports gross value & value added
US\$ million

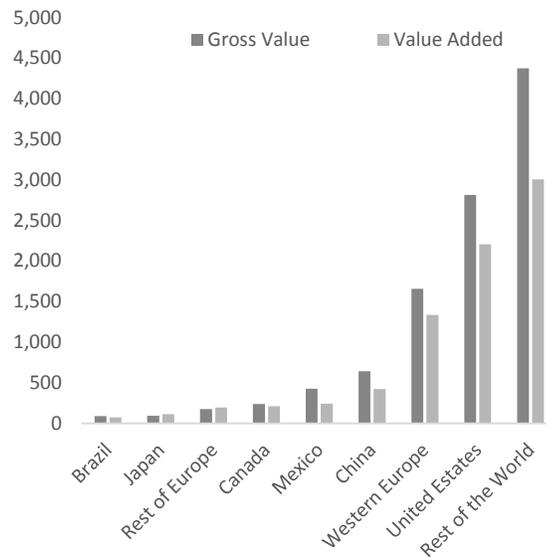
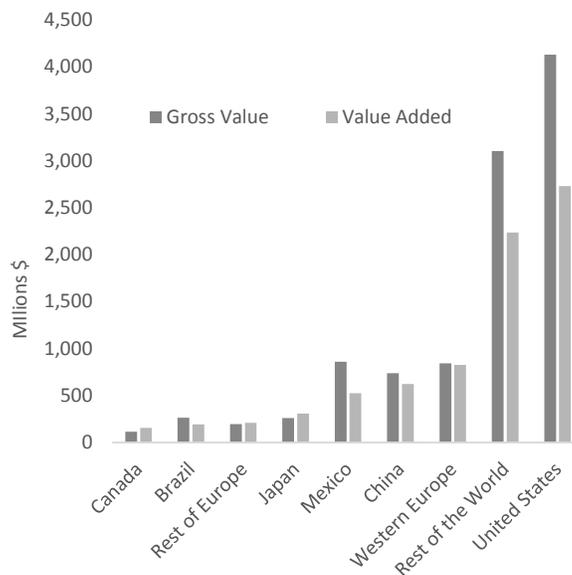


Figure 4b: Costa Rica imports, partner shares, in gross and value added terms, 2009

Structure of imports by partner
(% of total imports)

Partner	Gross Value	Value Added
United States	39.3%	34.9%
Rest of the World	29.6%	28.6%
Western Europe	8.0%	10.6%
China	7.0%	8.0%
Mexico	8.2%	6.7%
Japan	2.5%	4.0%
Rest of Europe	1.9%	2.7%
Brazil	2.5%	2.5%
Canada	1.1%	2.0%
Total	100%	100%

Imports by gross value & valued added
(US\$ million)

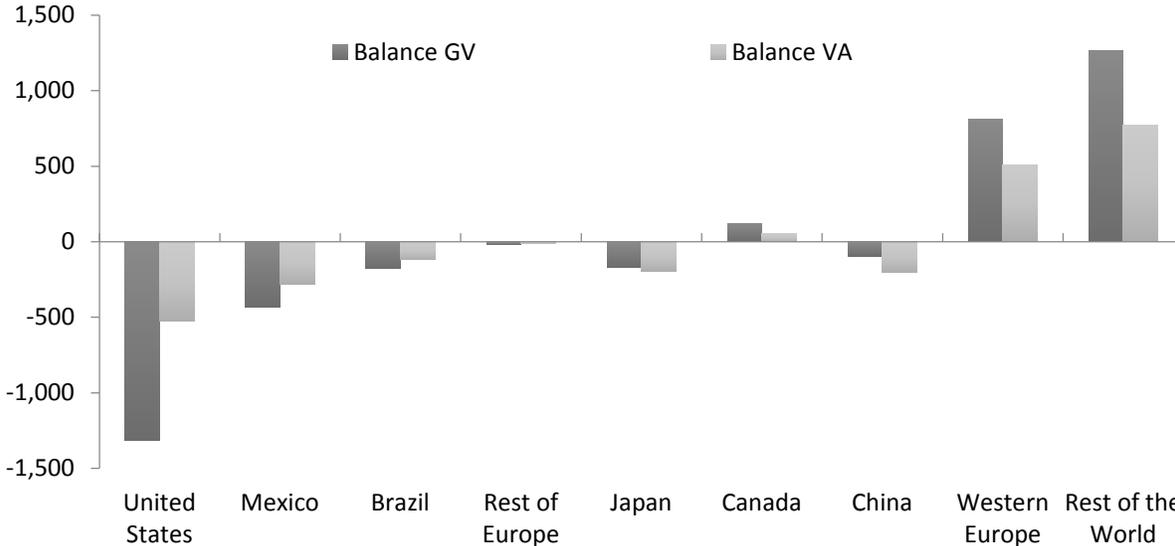


It would seem that in the case of Costa Rica the proportion of domestic value added in trade with its different trade partners is high enough that there is no significant shift in the importance of trade partners when shifting from gross trade to value-added trade. In gross terms, exports to the “Rest of the world” are by far the main destination for Costa Rican exports (41.6%) and the United States is

in second position (26.8%). In value added terms, these partners remain the most important. Regarding imports, the United States and “Rest of the World” remain Costa Rica’s main sources of imports in terms of value added, but with slightly lower shares compared to gross terms. Western Europe and China become a more important source of imports when looking at value added imports.

While a comparison of gross and value-added exports and imports does not reveal any major differences, when they are combined a notable shift in the Costa Rica’s bilateral trade balances emerge with some of its major trade partners (Figure 5). The Costa Rican trade deficit with United States for the year 2009, for example, drops by 60% when measured in value added terms because a large proportion of Costa Rica’s exports to the United States are embodied in goods whose final destination is a third country. Deficits were also smaller with Mexico and Brazil. In contrast the trade surpluses with Western Europe and Rest of the world were reduced by 37.3% and 39.2% respectively in value added terms in 2009.

Figure 5: Bilateral trade balances, 2009
(US\$ million)



Analysis in terms of trade in value added is now a vital tool that informs the debate on trade policy. There are at least two areas in which measuring trade in value-added brings a new perspective and is likely to impact the policy decisions taken by countries like Costa Rica:

- Good statistics today will contribute to better policies tomorrow: Accurate statistics provide the essential foundation for policy analysis, forecasting and benchmarking work. For example, trade data are often used to guide industrial policies. In terms of employment, for example, decomposing the value of imports into the contribution of each economy can reveal who benefits from trade by demonstrated the locations and industries in which jobs are created.
- Market access in terms of GVCs: Measuring trade in value added sheds new light on today’s trade reality, where competition is not between nations, but between firms. Competitiveness in a world of global value chains means access to competitive inputs and technology along GVCs. Countries that strive to deepen their participation in GVCs can use data on value-added trade to

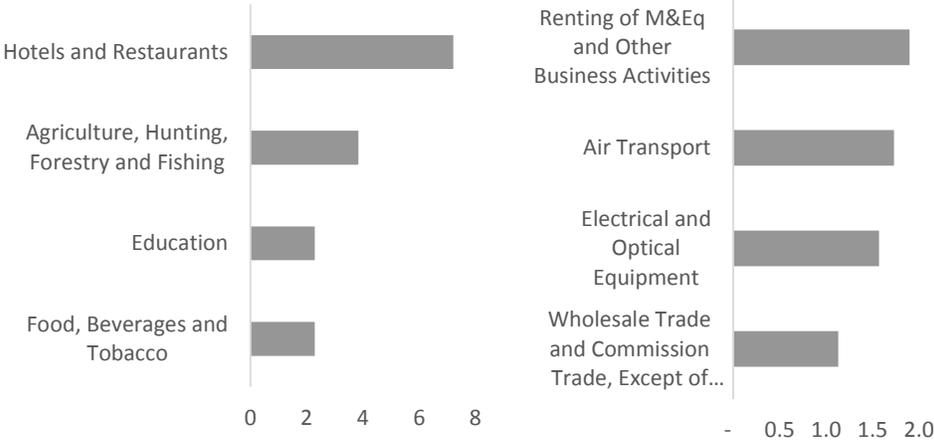
engage in plurilateral and multilateral negotiations that foster the integration of firms with direct and indirect trade partners in GVCs.⁷

2.2 Analysis of TiVA-based Revealed Comparative Advantages.

The revealed comparative advantage (RCA) is an index measuring a country’s specialization in a given industry by comparing the share it represents in the country’s exports to the world share of the industry in world exports (see Balassa, 1965). A comparison of RCA in gross and value-added terms reveals the importance of trade in intermediate inputs for comparative advantage (Figure 6).

The indicator of (RCA) in value added terms can provide additional evidence on a country’s export performance, as compared to measures based on gross exports. In the case of Costa Rica the index of RCA is greater than one for eight sectors, indicating that Costa Rica holds a comparative advantage in these sectors in the world market. Costa Rica’s comparative advantage is focused in sectors like hotels and restaurants, agriculture, education, renting of machinery and equipment and other business activities, air transport⁸ and electrical and optical equipment. This RCA analysis also suggests that the country has production advantages in the sectors which are integrated in global value chains.

Figure 6: Costa Rica, industries with highest RCA, 2009



Three of those industries are closely linked to the natural capital of the country, including the tourism industry (hotels and restaurants)⁹, the agriculture industry, and the food industry. However,

• ⁷ For example in 1997 Costa Rica joined the ITA agreement, which proved critical to the countries insertion into the electronics GVC. The country is also participating in the multilateral Agreement on Trade Facilitation (TFA), with will cut red tape in international trade, dramatically reducing trading costs allowing domestic and international firms greater participation in the global value chains. Finally, Costa Rica has also joined its trading partners in negotiating the TISA to further liberalize trade in services. This agreement will enhance competition and investment in the service trade while eliminating trade barriers and ensuring greater regulatory transparency. This agreement will allow countries services-based exports to integrate easily in the global trend of GVCs.

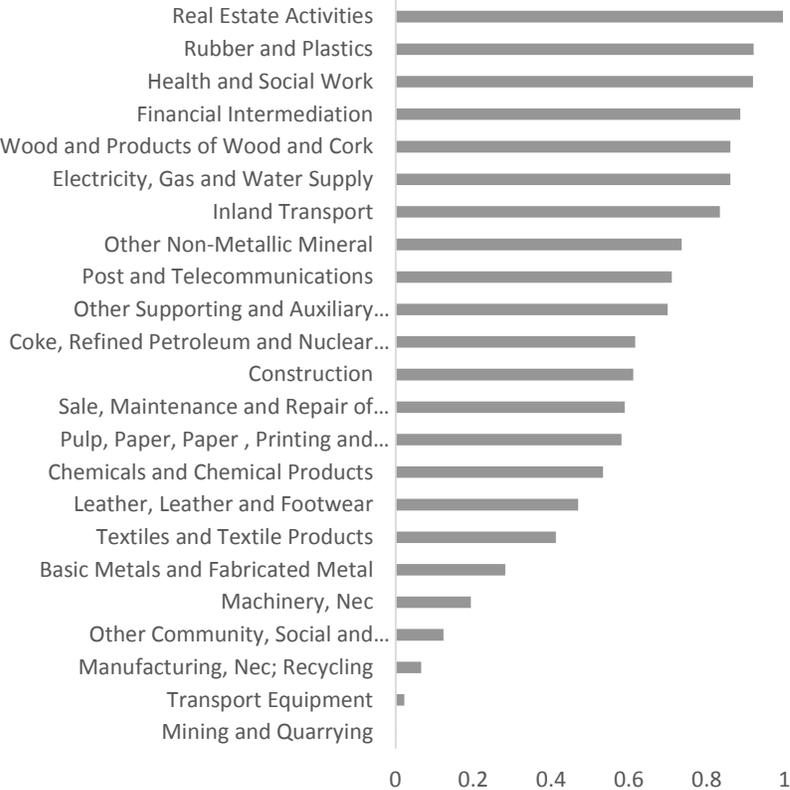
⁸ The higher RCA for Air Transportation sector is mainly contributed by airport services covered in this sector since Costa Rica does not have any international airlines.

⁹ It should be noted that even though Costa Rica is well known for his tourism industry, a RCA so high could also indicate that WIOD data may be reflecting an underestimation of the actual values of this industry in partner countries.

other business activities (mainly offshore services), and the industry of electrical and optical equipment are the result of policies adopted in order to attract Foreign Direct Investment (FDI) in specific areas of interest for the country¹⁰. The key for this success has been the relatively good performance of the education system, and the successful upgrading of some key infrastructures - mainly the international airport - and a more efficient wholesale trade industry.

A low RCA also hints at several industries that could be affecting the competitiveness of other industries and their inclusion into the GVCs. This is the case of the financial intermediation industry, electricity supply, inland transport, and post and telecommunications. All these industries are essential in providing a positive productive framework, and in the case of Costa Rica, have been identified as important bottlenecks. Currently, the country has already opened its telecommunications market to foreign investment, and has begun a political discussion on the public framework of electricity production and distribution.¹¹ However, the poor quality of its land transportation framework and the limited depth of its financial system remain issues yet to be solved.

Figure 7 : Costa Rica, industries with lowest RCA, 2009



¹⁰ For detailed information concerning the impact of FDI on Costa Rica economy, one can refer to “Attracting knowledge-intensive FDI to Costa Rica: challenges and policy options, *Making Development Happen Series*, 1. (OECD, 2012).

¹¹ The government holds the monopoly of production and distribution of electricity, while it has opened a limited space for private production.

The results of comparative advantages by sector in Costa Rica accurately describe the country's integration in GVCs. Over one half of the GVC-integrated exports correspond to electronics products, while more than one third correspond to medical devices. Similarly, the offshore services value chain has grown significantly in recent years. In comparison with other countries, figures 8a and 8b show how Costa Rica's RCA index in the electronic sector and in the offshore services sector were among the highest in 2009, reflecting country's relatively competitiveness. Costa Rica is the nation with the 4th largest participation of high tech products in its manufacturing exports and the 1st in Latin America.

Figure 8a: Domestic Value-added-adjusted RCA in the sector of electronics and optical equipment, 2009

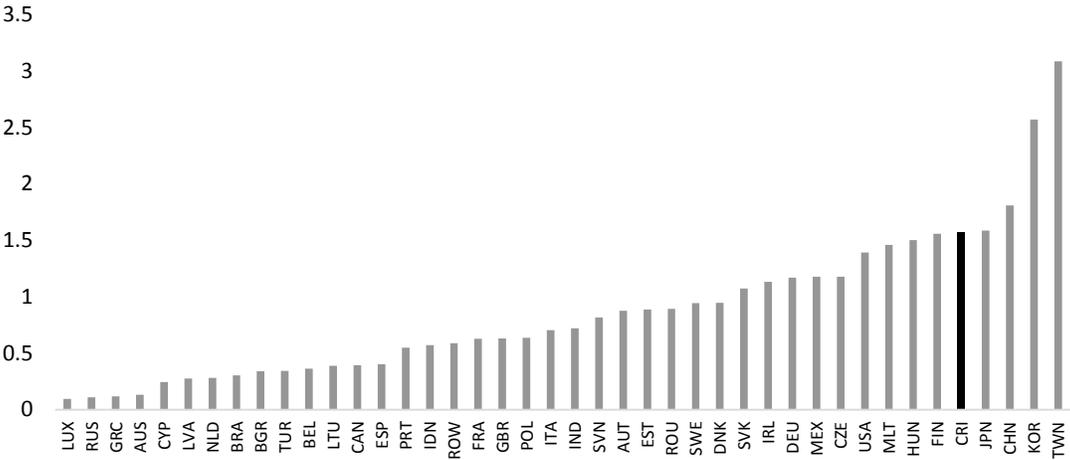
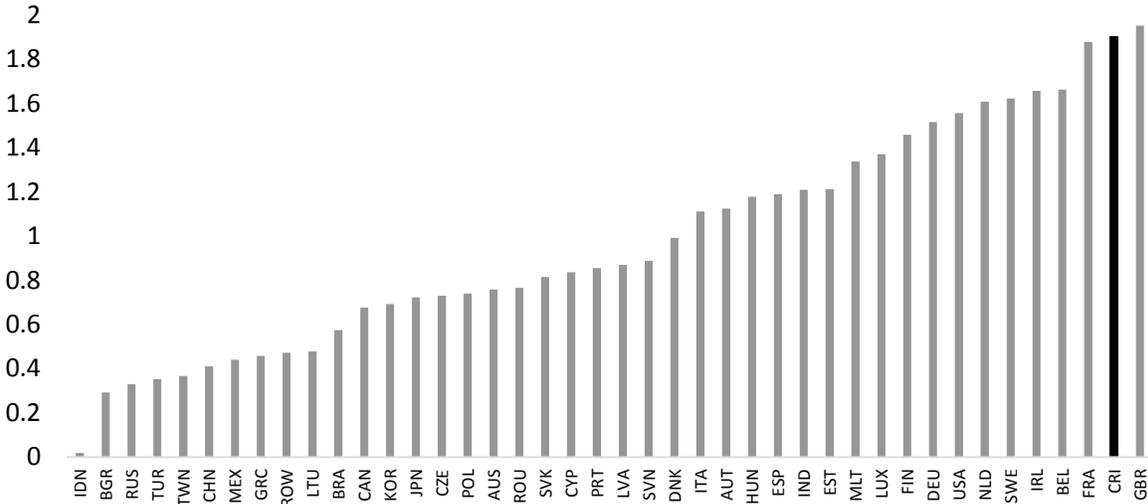
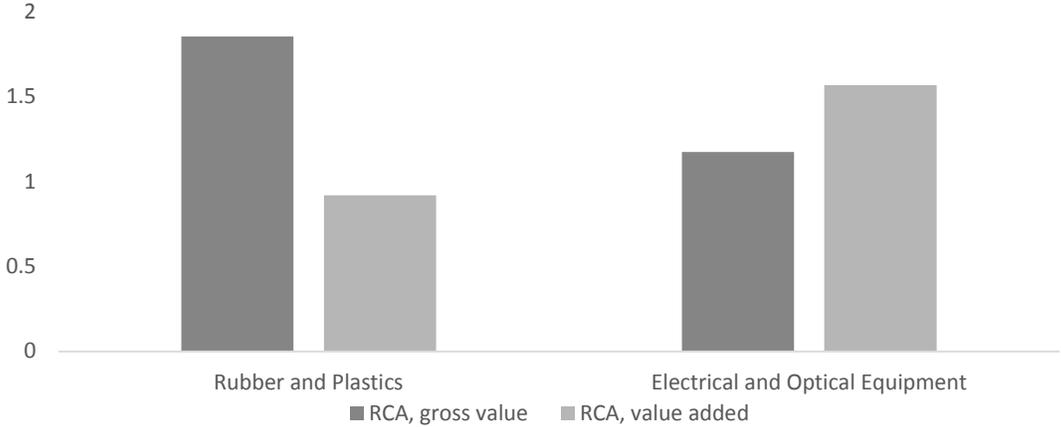


Figure 8b: Domestic Value-added-adjusted RCA in the sector of renting of machinery & equipment and other business activities, 2009



As previously mentioned, the problem of multiple counting of certain value-added components in the official trade statistics suggest that the traditional computation of RCA could be misleading. This analysis of value added decomposition of exports provides a way to remove the distortion of multiple accounting by focusing on domestic value-added in exports. In Costa Rica’s case, there an important difference in the RCA index in the rubber and plastics industries, which reveal a comparative advantage in gross terms but a comparative disadvantage in value-added terms (Figure 9).

Figure 9 : Gross and Domestic Value-added-adjusted Revealed Comparative Advantage Indicators, 2009



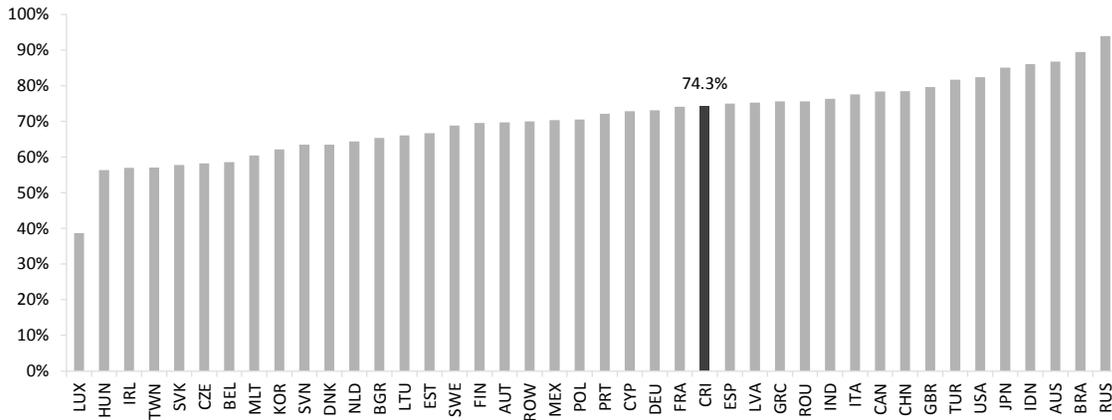
These examples are sufficient to demonstrate the fact that policymakers’ understanding of their economy’s strengths and weaknesses can suffer significant distortions if metrics of revealed comparative advantage are conceived in terms of gross trade instead of value added trade. Accurate metrics of where value is actually added are far more revealing than total export values.

2.3 Decomposition of the domestic content of gross exports

Since it is domestic value added that correlates to domestic productive capacity, policymakers are often interested in understanding the domestic content in gross exports. Decomposing gross exports into a series of components adds richness to this analysis.

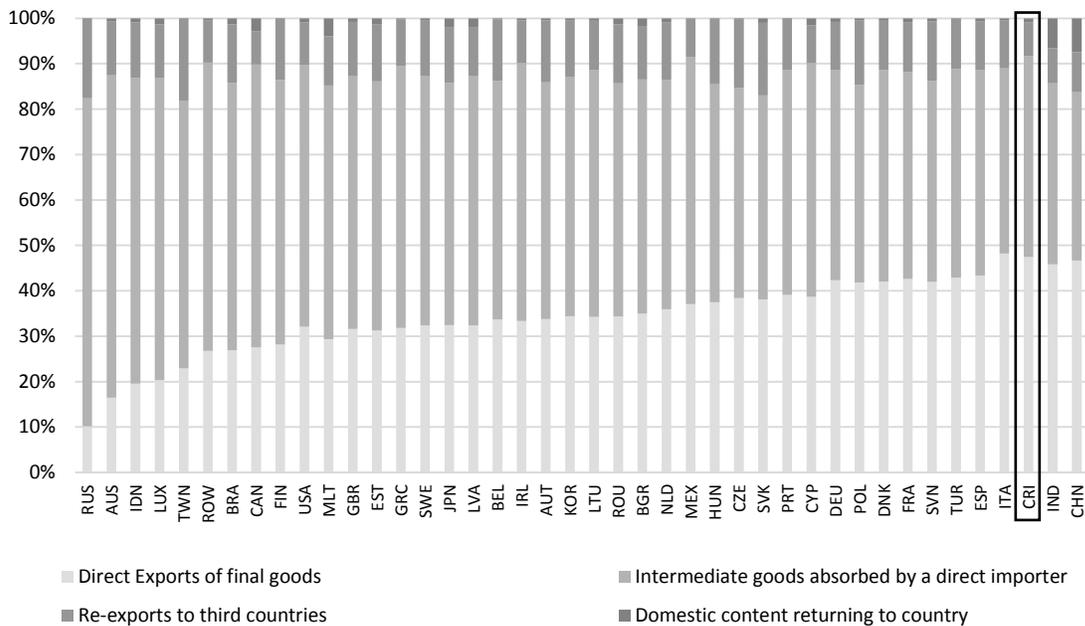
As a starting point a cross-country comparison can be used to provide a sense of how much domestic value is added in the country of interest compared to other countries. Figure 10 shows that in the case of Costa Rica, more than 74% of exports in 2009 revealed domestic content. Typically, large countries and natural resource rich countries have higher domestic content. Costa Rica is a midrange country, and it appears that despite being a small, open economy, there is a significant capacity to source intermediate inputs from domestic providers in key sectors.

**Figure 10: Percentage of domestic value added content of gross exports, 2009
(% of total gross exports)**



To enrich this analysis the gross value of exports can be disaggregated by their destination into direct exports, re-exports, intermediate goods and domestic component returning to country (see Koopman et al., 2014). Results for Costa Rica show that the destination of more than 47% of the domestic content is incorporated in direct exports of final goods, which reveals that in many industries the country plays a role downstream in the value chain. The proportion of intermediate goods absorbed by direct importers is quite low in relation to other countries, which confirms this interpretation. As a country with a small domestic market, the domestic content returning to the country is negligible and as a country that is not known as a logistic hub, re-exports to third countries are also small.

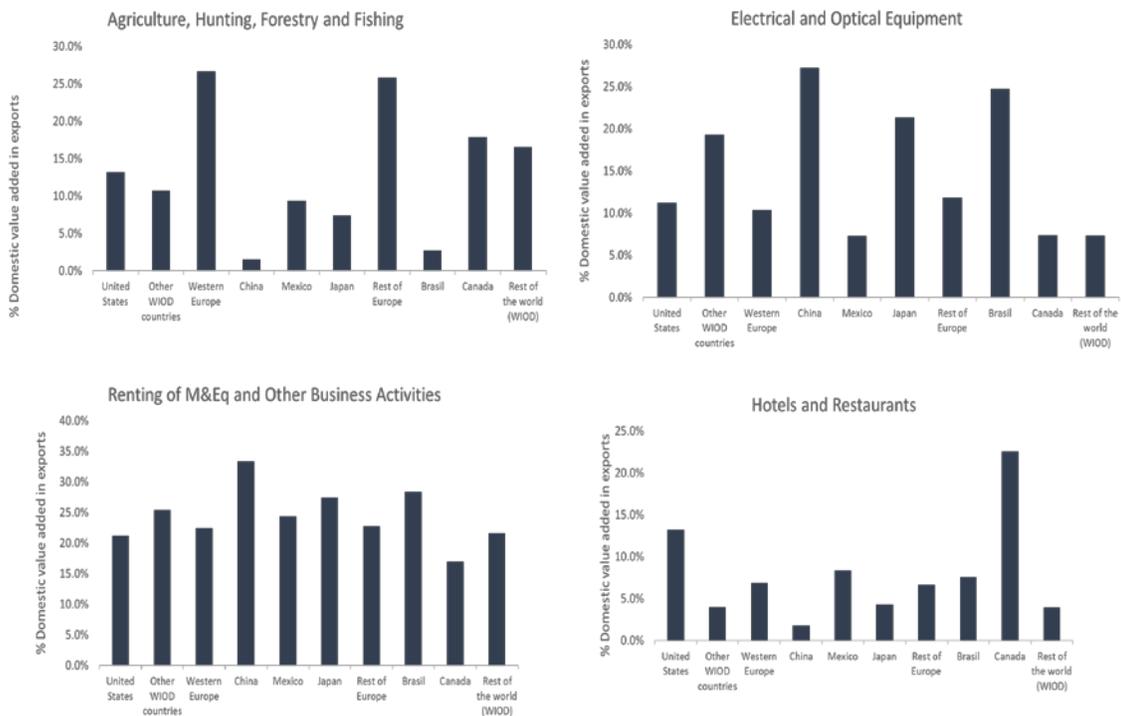
Figure 11: Decomposition of gross exports, 2009



2.4 Value-added exports in key industries as a share of total value-added exports to each partner.

In order gain an intuitive understanding of the extent to which export partners engage with Costa Rica in dominant value chains, it can be helpful to determine value/added exports in key industries as a share of total value/added exports to each partner. Figure 12 shows this breakdown for four key industries: agriculture, hunting, forestry and fishing; electrical and optical equipment; hotels and restaurants; and renting of machinery and equipment (which contains offshore services). The cross country analysis reveals that the largest part of the value added was inserted in the offshore services industry (renting of machinery and equipment and other business activities) in which the United States, China and Brazil rely heavily on their supply chain from Costa Rica. It is also worth noting that Europe seems to engage mainly in agricultural value chains, and that Asian countries and Brasil engage significantly in the Electrical and Optical Equipment GVC.

Figure 12. Share of value added in national exports by country and sector, 2009



Conclusion and next steps

This paper has described a cost effective strategy that developing countries could use to develop the tools needed to better understand and monitor their participation in global value chains. The case of Costa Rica has been used to describe a methodology that can be used to build a domestic input output table, which can then be embedded into an existing international input output table to build a tool that can be used to calculate a series of indicators that shed light on a country's participation in GVCs based on trade in value added. In order to illustrate the value of building an IIOT, four simple indicators have been used to compare and contrast results using gross statistics vs value-added statistics. For country's interested in this line of analysis there are a series of more sophisticated indicators that can be used enrich the analysis.

There are three main conclusions that can be drawn from this paper. The first relates to the value of input-output analysis as a tool to understand global trade dynamics. This paper demonstrates the ways in which I-O analysis can be useful to policymakers in determining which industries are the strongest, which supporting industries may need to be strengthened, the nature of relationships with key partner countries and the extent to which a country is participating upstream or downstream in GVCs. Furthermore, it lays out a detailed procedure through which any developing country can construct its own IIOT by embedding its data in an existing IIOT in order to better reflect the contextual idiosyncrasies that are often lost in time consuming efforts to build IIOT from raw data.

The second conclusion relates to the need for countries to work together to strengthen the underlying data used to construct trade statistics. As described above, the appearance of negative values after embedding Costa Rica in the WIOD reveal weaknesses in domestic and partner aggregate trade data and also in the data used to allocate trade flows by origin or destination and by usage. There is significant work to be done in reconciling bilateral trade statistics and there is ample room for improvement of trade statistics in services. These are efforts that are most likely best addressed as multilateral efforts.

The final conclusion relates to Costa Rica's current development trajectory and the role that its participating in GVCs is planning to boost competitiveness and growth. The comparison of trade flows and comparative advantages in gross and value-added terms reveals that industries that are a part of GVCs, namely electronics, medical devices and offshore services, have thrived in recent years allowing Costa Rica to become an important link in these international chains.

The analysis provides Costa Rican policymakers with evidence that trade policy should focus less on direct trade partners and more the sorts of indirect trade partners to whom value is ultimately being exported. The fact that Costa Rica appears to still be downstream on average, suggests that there are a series of complementary policies that must continue to be driven in order to ensure that firms and households can capture more value moving forward. In this sense, policies that relate to education, labor markets, macroeconomic policies, and innovation are critically important for Costa Rica to continue to build the prerequisite productive capacity needed for to upgrade towards more sophisticated links in GVCs.

The estimates presented in this paper constitute work in progress. In order to capture structural changes in terms of global value chains, future work will build a time series to capture periods before and after 2009. This extension will contribute to identify more medium terms changes in Costa Rica's integration in the global production, as well as the implemented policies in targeted sectors. The IIOT will also be used to use more advanced indicators that can uncover a series of additional insights.

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Appendices

Appendix 1: Data sources used to construct the 2011 SUT

1-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.

2-International production:

Import data from the Costa Rican General Customs Directorate and Balance of Payments data from the Central Bank 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 them. The ADCSSE is used by all firms and organizations that pay income taxes to declare sales and purchases over 2.5 million Costa Rican colones (approximately USD 5,000) and rentals, professional services and commission and interest over 50 million Costa Rican colones (approximately USD 100,000). These values were adjusted from CIF to FOB by removing the insurance and transport margin.

3-Taxes and subsidies:

a) *Value added tax* was estimated 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 Regime¹² 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 applied directly to gross domestic capital formation.

¹² The Free Trade Zone Regime offers fiscal benefits to companies that make significant investments in strategic sectors, outside of the greater metropolitan area, in R&D and in environmentally friendly ways

b) *Import and export taxes*: The applicable tax rate was estimated based on data provided by the 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.

4-Distribution margins:

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).

5-Domestic usage:

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

- a) *Agriculture*: A sample of 100 case studies was constructed based on several site visits and interviews with the main producers of 38 agricultural 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 Foreign Trade Promotion Agency's financial and administrative data from firms in special economic regimes. The third was interviews with specific firms for clarification purposes.
- c) *Wholesale and retail trade*: Trade production was assumed to be equivalent to trade margins.
- d) *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 through the Federated Association of Engineers and Architects, an organization required by law to collect this information in the process of granting construction permits.
- e) *Government and state owned enterprises*: Administrative data reported by all of these institutions, including financial and expenditure data for each economic activity.
- f) *Financial intermediation and insurance services*: A 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 financial regulatory bodies.

6-International usage:

Export data from the General Customs Directorate and the Balance of Payments data from the Central Bank was used to construct the export vectors for each sector.

7-Final consumption

Final consumption was estimated for households, NGOs, and the government using the following sources:

- a) *Households*: This data was estimated based on the National Institute for Statistics and Census' National Household Survey 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.
- b) *NGOs*: This data was estimated based on information reported by non-profit associations collected through the Central Bank's Economic Enterprises Survey.
- c) *Government*: A dataset was constructed from basic data provided by government institutions.

8-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 from 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.

9-Changes in inventories:

Tax declarations to the Ministry of Finance were used.

Appendix 2: Recommendations adopted from the SNA 2008

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

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

2-Central Bank production: A distinction is drawn between non-market services, estimated using costs, and market services, estimated using 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.

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

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

Appendix 3: Splitting vectors from the domestic IOT to prepare for insertion in the WIOD

The domestic IOT contains an export vector that is subdivided by industry of origin. Besides the domestic IOT, Costa Rica Central Bank 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. Goods and services were treated separately.

Exports matrix

The domestic IOT contains an export vector that is subdivided by industry of origin. However, this vector does not specify the destination country or industry. In order to integrate the domestic IOT into the WIOD, the export vector was first split according to the country and industry destinations. Merchandise exports and service exports were treated separately as follows:

- **Merchandise exports**

Merchandise exports were first split by country of destination and then by industry of destination.

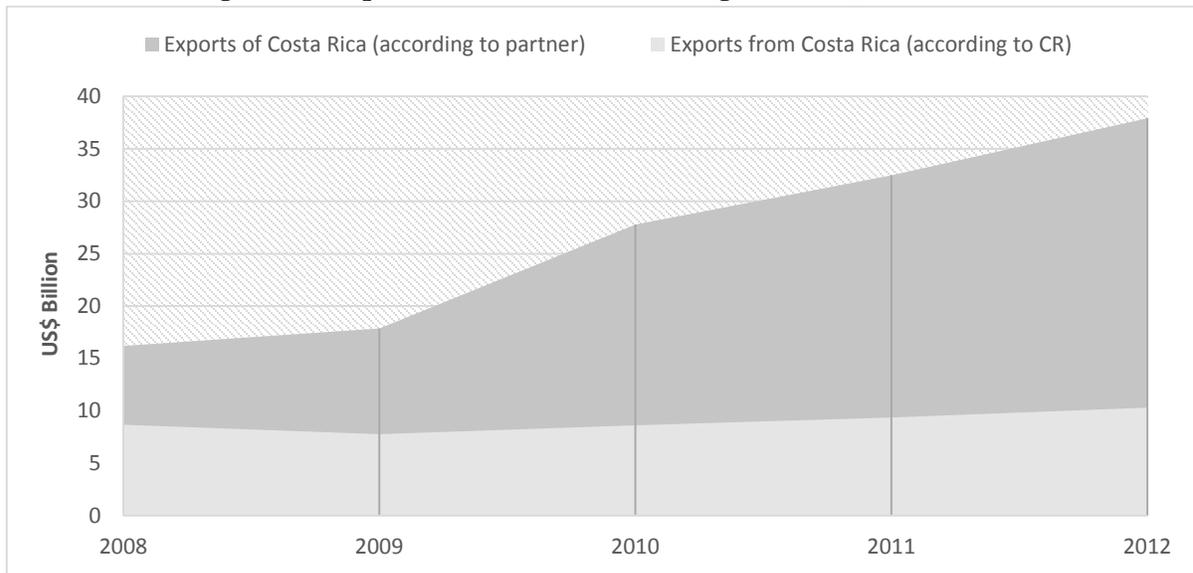
i. Splitting by country of destination

In order to split the export vector by destiny there are two fundamental methodological decisions. The first decision is whether to use the country of origin's export data, or the country of destination's import data to estimate the aggregate export flows. 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. Once the aggregate flows have been determined, the second decision is whether to calculate the country shares using the country of origin's export data or the country of destination's import data.

According to selected partners data¹³, 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%. *Figure 13* shows that by 2012 the difference between national data and mirror data attained US\$ 27.7 billion.

¹³ Selected countries represented an average of 91% of Costa Rica's exports between 2008-2012.

Figure 13: 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.

A more detailed view of the discrepancies suggests that these are not due to problems in measurement at Costa Rican customs, but rather in the mirror data. *Table 2* shows that 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 inappropriately assigned to Costa Rica.

Table 2: Products exported by Costa Rica with the most important discrepancies (US\$ millions)

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.¹⁴

¹⁴ The best choice would be to use the structure obtained from mirror data and apply it to the exports vector with

ii. 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 trade partners and the information already available in the WIOD. International Trade Statistics 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 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.

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).

- **Services exports**

i. Splitting by country of destination

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

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 larger share in mirror data.

exports related to this category. However based on the SUT, this sector consists mostly of offshore services. Furthermore four alternates were considered:

- 1) To use the exports structure of a country in the region (time zone) with a significant amount of FDI in services. Mexico and Canada.
- 2) 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.
- 3) To use certain goods that are complementary to services.
- 4) 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. As a primary hypothesis, the fourth approach was used, however further research is needed in order to lift this assumption.

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 considered¹⁵. 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. Shares were derived from data obtained by the Central Bank of Costa Rica based on sectorial consultations.

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

¹⁵ This data was cleaned following the Chamber of Tourism approach, by removing tourists from Nicaragua who entered by land¹⁵, as they are mostly seasonal migrants

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.

ii. 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) from Costa Rica were used by each partner in the same general structure as the imports (exports) from the total of the other countries.

Import matrix

Besides the domestic IOT, Costa Rica Central Bank 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.

- **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.

- 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.
- 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 do 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.

- **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.
- (d) Hotels and Restaurants: Data on Costa Rican tourists reported by destination countries does not often exist because they represent a very small proportion of the tourism industry and/or the whole sector is not that important as a percentage of the 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.